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Annual Site Environmental Report of the Lawrence Berkeley Laboratory

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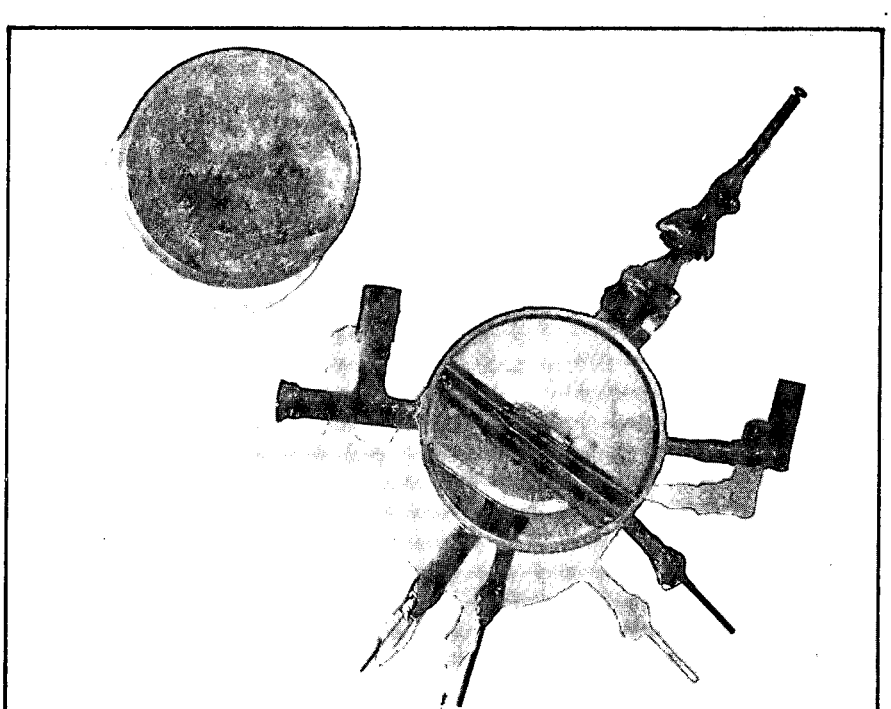
ENVIRONMENT, HEALTH AND SAFETY DIVISION

Annual Site Environmental Report of the Lawrence Berkeley Laboratory

1990

G.E. Schleimer and R.O. Pauer (editors)

May 1991



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DISCLAIMER

LBL-27170 1991

ANNUAL SITE ENVIRONMENTAL REPORT OF THE LAWRENCE BERKELEY LABORATORY

Data for Calendar Year

1990

Prepared by the Staff of the
Environmental Protection, Health and Safety Division
Lawrence Berkeley Laboratory
University of California
Berkeley, California 94720

Gary E. Schleimer
and
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Editors

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CONTENTS

ANNUAL SITE ENVIRONMENTAL REPORT OF THE LAWRENCE BERKELEY LABORATORY, 1990

Executive Summary

The Environmental Monitoring Program of the Lawrence Berkeley Laboratory is described. Data for 1990 are presented, and general trends are discussed.

In 1976 R.H. Thomas published the LBL Annual Environmental Monitoring Report in two parts. Part I (LBL-4678)[1] discussed in detail the modeling used to determine the population dose equivalent due to Laboratory radiological operations. That volume also described natural radiation background, geological features, climate and meteorology, and the environmental surveillance program of the Lawrence Berkeley Laboratory (LBL). Part II (LBL-4827)[2] included only the results of the sampling and measuring programs and other data necessary to determine the environmental impact of the Laboratory's radiological operations for 1975.

Although the 1980 Annual Report, LBL-12604, was kept brief, abstracted sections from LBL-4678 were included so that the document might stand alone. The same format has been used in this report, along with updates to LBL-4678, where appropriate, and a greatly expanded description of LBL's nonradiological environmental activities.

Readers wishing a more comprehensive discussion of LBL site characteristics and population dose modeling may obtain a copy of LBL-4678 from

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The bulk of the sample preparation and lab work was done by V.J. Montoya. Sample assays and computer data entry were done by M.A. Davi and L.R. Gunn. Special assays of air samples were performed by A.R. Smith.

The editors wish to gratefully acknowledge the assistance of the Information Resources Department.

In order to establish whether LBL research activities produced any impact on the population surrounding the Laboratory, a program of environmental air and water sampling and continuous radiation monitoring was carried on throughout the year.[3] For 1990, as in the previous several years, dose equivalents attributable to LBL radiological operations were a small fraction of both the relevant radiation protection guidelines

(RPG) of 100 mrem/yr and of the natural radiation background. DOE Order 5400.5[4] 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. (Typically, DOE facility impacts are a small fraction of that value.) The Order also provides tables that contain derived concentration guides (DCG) 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. Table 1 summarizes the exposures to a hypothetical maximally exposed member of the public, as well as the calculated sum of all exposures to the population within 80 km (50 mi) of LBL. 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 impact of LBL airborne radionuclide releases was 1% of the NESHAPs limit.

The maximum effective dose equivalent delivered to a hypothetical member of the community is defined as the maximum perimeter dose equivalent at an area where non-LBL personnel work or reside.

This value (the 1990 dose equivalent at the Olympus Gate Environmental Monitoring Station B-13D) was ≤ 1.9 mrem for the year [1.8 mrem from direct radiation (see Table 2) and 0.1 mrem from radionuclide releases], about 2% of the RPG of 100 mrem. The hypothetical maximum exposure to an individual from airborne radionuclides would be just outside the northern LBL perimeter, north of LBL Building 75. The 1990 effective dose equivalent would have been 0.1 mrem—0.1% of the RPG.

The total population dose equivalent attributable to LBL operations during 1990 was ≤ 8 person-rem, an average of about 0.0005% of the RPG of 100 mrem maximum effective dose equivalent to individual members of the surrounding population. [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.

Small amounts of ^{14}C, ^{35}S, ^{125}I, ^{175}Hf, ^{203}Hg, and unidentified alpha emitters were released from LBL laboratory stacks (Table 3). The CEDE attributable to the foregoing releases is <0.1 person-rem. The majority of the impact of LBL radionuclide operations is from the airborne release of 160 Ci of tritium (as HTO), which is responsible for a CEDE of approximately ≤ 6 person-rem and a hypothetical maximum offsite individual exposure (from airborne radionuclides) of ≤ 0.1 mrem.

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,

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	1.8 mrem	0.1 mrem	1.9 mrem	≤ 8 person-rem
Location	Residence NE of B13D	LHS[a]	Residence NE of B13D	≤ 80 km from Laboratory
DOE Radiation Protection Standard[b]	100 mrem	100 mrem	100 mrem	—
% of STD	1.8	0.1	1.9	—
Background	100 mrem	300 mrem	300 mrem	1.5×10^6 person-rem
LBL impact as a % of background	1.8	0.3	0.63	0.0005

[a]LHS = Lawrence Hall of Science
[b]Source: Ref. 3.

Table 2. Fence-post annual effective dose equivalent at the LBL boundary due to accelerator operation, 1990.

Monitoring station	1990 total above background		
	gamma[a] (mrem)	neutrons (mrem)	Total[b] (mrem)
Station 13 A (Bldg. 88)	0.7 ± 0.2	0.7 ± 0.1	1.4 ± 0.2
Station 13 B (Bldg. 90)	< 0.2	c	< 0.2
Station 13 C (Panoramic)	0	0	0
Station 13 D (Olympus Gate)	0	1.8 ± 0.3	1.8 ± 0.3
Standard for comparison	—	—	100[d]

(Dose to individuals at maximum point of exposure)

[a]Average gamma background measured inside the 4 perimeter monitoring stations was 78 ± 12 mrem during 1990.

[b]The errors shown are those associated with the actual counts and calibration-source uncertainties. Neutron flux-to-dose equivalent conversion factors are not known to this accuracy.

[c]Uncertainties Associated with the B 13 B neutron detector invalidated its data for 1990

[d]Source: Ref. 3.

Table 3. Total monitored quantities of radionuclides discharged into the atmosphere, 1990.

Nuclide	Half Life	Quantity Discharged	
		(Ci/yr)	(Bq/yr)
^{3}H as HTO	12.3 yr	160	5.9×10^{12}
^{14}C as $^{14}CO_2$	5730 yr	4.3×10^{-3}	1.6×10^{8}
^{125}I	60.1 d	8×10^{-4}	3×10^{7}
^{35}S	87.2 d	2×10^{-5}	7×10^{5}
^{175}Hf	70.0 d	1.2×10^{-6}	4.4×10^{4}
^{203}Hg	46.9 d	1×10^{-7}	4×10^{3}
Unidentified alpha emitters[a]	—	$<1 \times 10^{-6}$	$<4 \times 10^{4}$

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

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.[5] 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.

Tritium levels averaging 26,000 pCi/l, which exceed the EPA 40 CFR 141 Community Drinking Water Standard of 20,000 pCi/l, were found in the outflow of one of LBLs hydraugers (designated 7712H in this report), and an average of 28,000 pCi/l was found in rainwater samples taken on site 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 has instituted a program to markedly reduce airborne tritium releases (the origin of the environmental tritium). The releases from the facility during 1990 were 33% of the 1989 releases. Aside from LBL sewage, no offsite water has been found to contain more than 6% of the EPA Drinking Water Standard for tritium.

A group of hydraugers that drains the slope east of Building 51, whose discharge was found to contain levels of several chlorinated hydrocarbons exceeding Safe Drinking Water Act limits, were "manifolded" together and their outflow treated by charcoal filtering. The effluent from the charcoal bed is used as makeup water for the Building 51 cooling towers. A major LBL subsurface characterization study has been funded for FY 1991 and 1992. (See the Environmental Activities and Groundwater sections of this report.)

Gross data for radioactivity in environmental air and water for the period 1981–1990 are presented for comparison with the 1990 data. These gross data show that, except for periods following atmospheric nuclear weapons tests (China, 1980) and the Chernobyl fire (1986), gross radioactivity concentrations in air and water in the vicinity of LBL show only small fluctuations about historical background levels.

Introduction

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 science 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.

The Laboratory also supports nationwide university-based research by providing national facilities, including the National Center for Electron Microscopy, three large accelerators, several small accelerators, a number of radiochemical laboratories, several

large gamma irradiators, and a tritium (^3H) labeling laboratory. The Bevatron (Building 51 in Fig. 1) 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. 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. Aside from shutdown periods, the first two of these accelerators provide beams around the clock. 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 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.

The Site

LBL is situated on 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 350 meters above sea level. Most of the site is within the City of Berkeley, but about one-quarter of the eastern part is within the City of 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 predominately 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).[6]

The Laboratory's activities are located on site and off site. There are 81 buildings 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 onsite space consists of 1,350,000 gross square feet (gsf) in about 60 buildings: 1,307,000 in DOE buildings and trailers, and 43,000 in University-owned buildings. Offsite space utilized by LBL consists of 260,000 gsf in various University buildings on the UC at Berkeley (UCB) campus and 130,000 gsf in leased facilities in Emeryville and Berkeley.

The Laboratory's population is approximately 4,000, including about 600 visiting scientists and engineers. About 3,200 are located on site, 700 are located in campus buildings, and about 100 are in offsite leased space.

Key to LBL Buildings Shown in Figure 1

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

*Under construction.

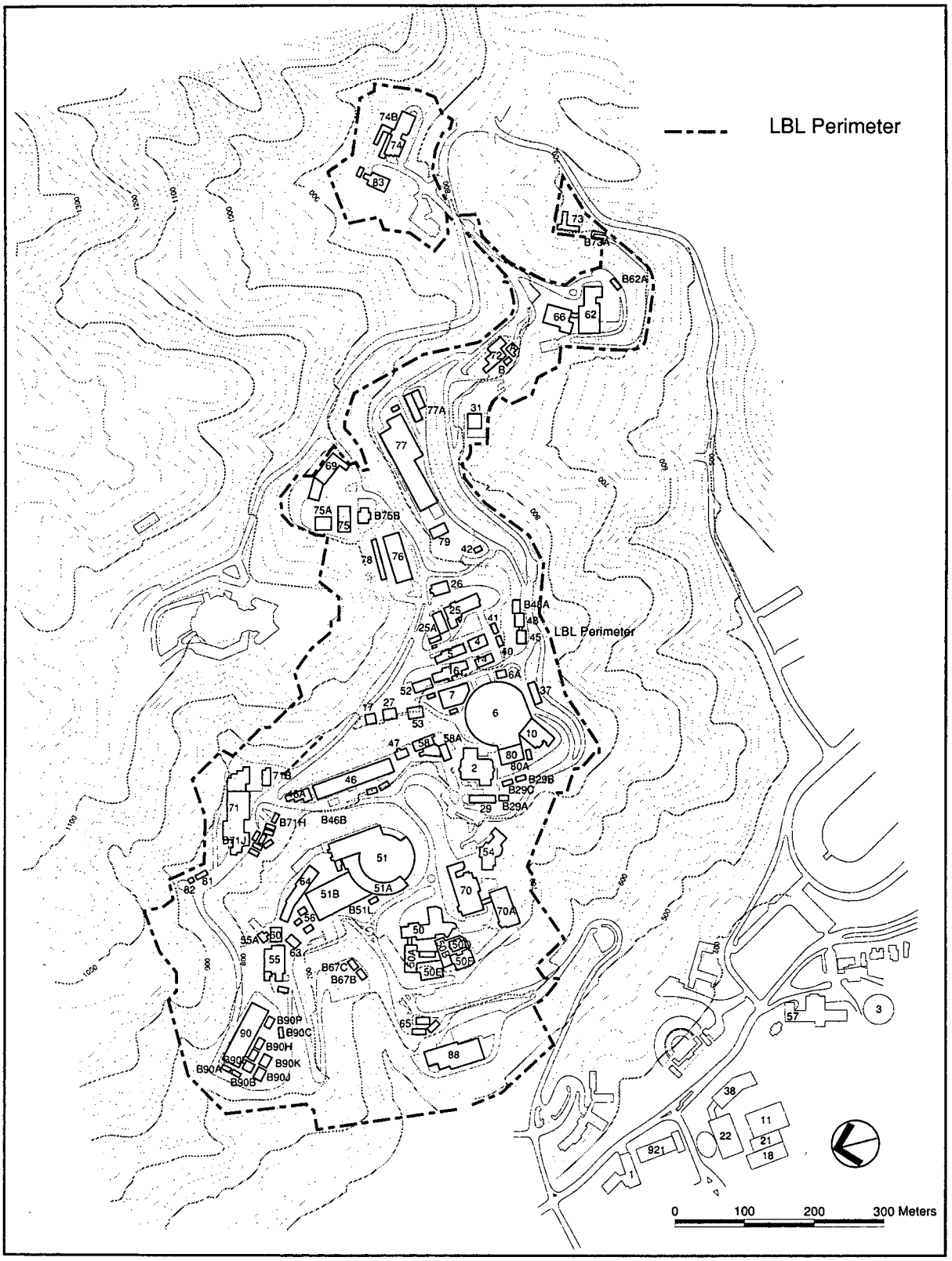


Figure 1. Lawrence Berkeley Laboratory buildings.

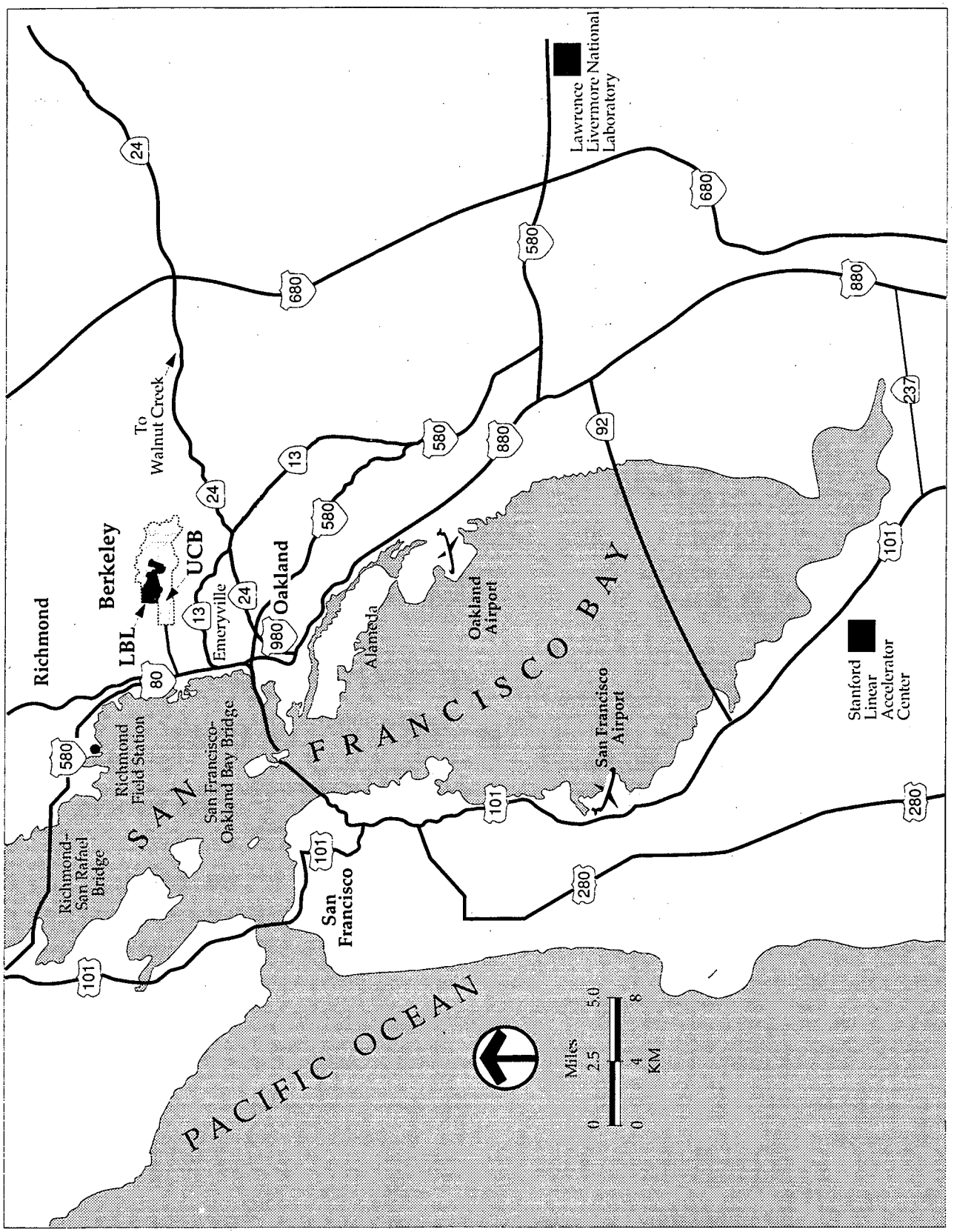


Figure 2. Lawrence Berkeley Laboratory environs.

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 than 1.3 cm/hr. Thunderstorms and hail and snow are extremely rare. Winds are usually light, but summer sea breezes range up to 9–13 m/s (20–30 mph). Winter storm winds from the south or southwest have somewhat lesser velocities.

Geology

Most of the LBL site is underlain by complex sedimentary and volcanic rock. In general, the bedrock is relatively weak and weathers deeply. Consequently, a colluvial cover has been produced that is a few feet thick. The major geologic unit consists of poorly consolidated sandstones, siltstones, claystones, and conglomerates of relatively low strength and hardness. These rocks are blanketed by clay soils having high shrink-swell characteristics. The western and southern portions of the site are underlain by moderately well consolidated shales, siltstones, sandstones, and conglomerates. Throughout most of the upper elevations a volcanic unit overlays and is interbedded with the upper layers of the major geologic unit.

The Hydrogeology

Highly complex groundwater conditions are present at LBL. Year-round springs, annual surface seeps, and variable water levels in observation wells indicate discontinuous and localized aquifers. These conditions are due to a combination of factors: open-fracture volcanic flow rock, impervious claystone interbeds, permeable sandstone lenses, and irregular fracture patterns associated with past folding and faulting. During the rainy season, groundwater levels increase and cause a decrease in slope stability. Consequently, the Laboratory has installed an elaborate groundwater detection and drainage system. The drainage system uses both pumped vertical and free-flowing horizontal wells (hydraugers). Groundwater drainage feeds into Blackberry Creek on the north portion and into Strawberry Creek on the south portion of the Laboratory. Both creeks eventually flow through the UCB campus and then into the City of Berkeley storm drainage system, which empties into San Francisco Bay (Fig. 3).

Water Supply

The Laboratory's primary water supply is the East Bay Municipal Utility District (EBMUD) Shasta Reservoir, which holds approximately two million gallons. The Laboratory's high-pressure fire and domestic systems are supplied from this reservoir. A secondary source is EBMUD's Berkeley View Tank, which holds approximately one million gallons. Water mains have automatic shutoff valves for protection in case of a main breakage. The LBL water distribution system operates entirely by gravity flow,

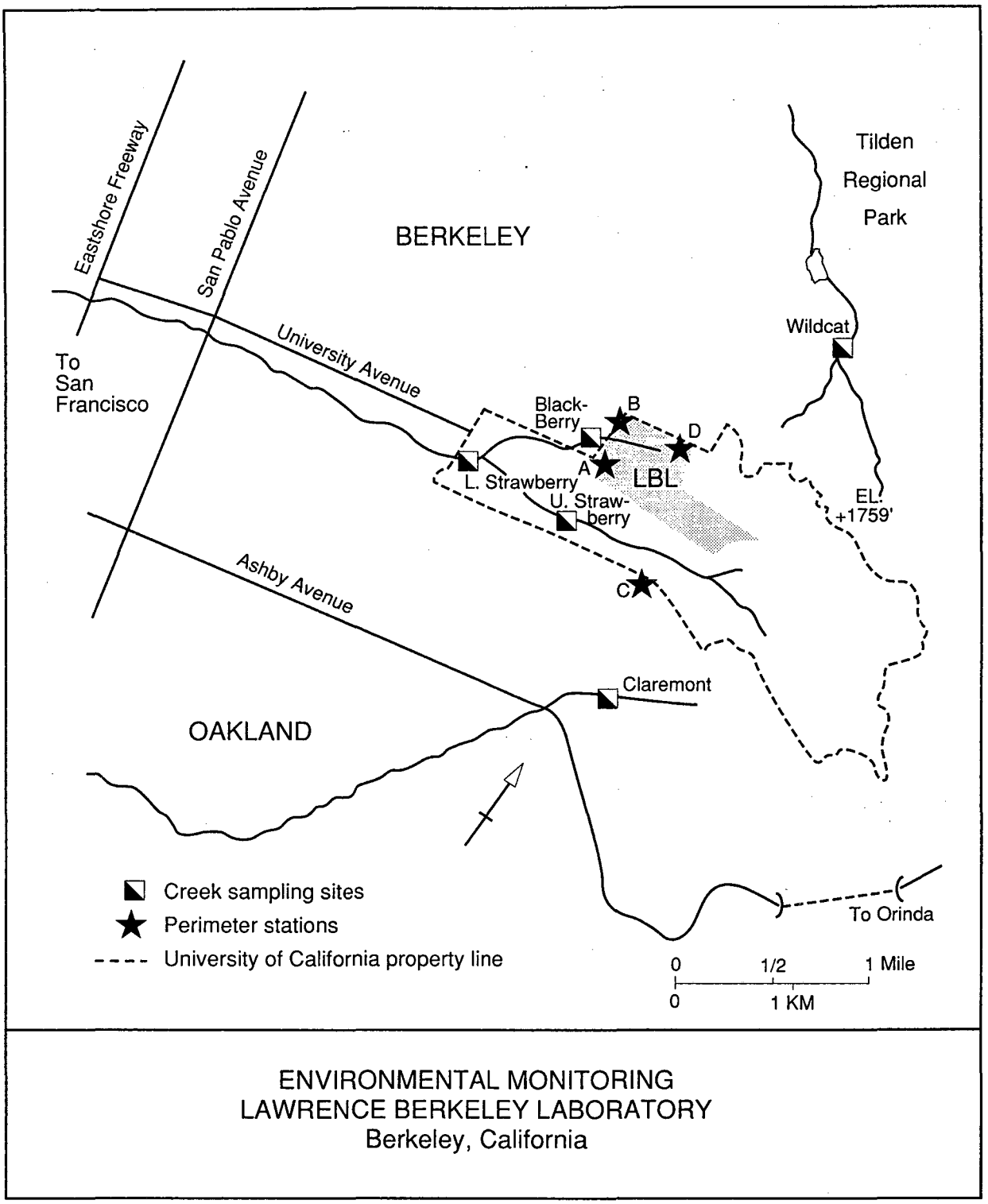


Figure 3. Map of LBL perimeter monitoring stations and creek sampling sites.

requiring no pumps or energy consumption. The Laboratory has recently installed two 750,000-l (200,000-gal) water storage tanks at separate locations for fire protection. Diesel-powered pumps provide the necessary flow and pressure for maintaining a reliable fire protection system during emergencies.

Sanitary Sewer Systems

The west-side LBL sanitary system connects to the City of Berkeley sewer main at Hearst Avenue. On the south side of the Laboratory, a second connection is also made to the City of Berkeley system. The Berkeley system flows to the EBMUD Sewage Treatment Facility, where the wastewater undergoes primary and secondary treatment before its discharge to San Francisco Bay.

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. This system provides for runoff intensities expected in a 25-year maximum-intensity storm.

Compliance Summary
1990 Calendar Year

Compliance Status

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)

The site investigation program continued in order to determine the extent of soil and groundwater contamination due to past activities. Low levels of chlorinated hydrocarbon and tritium contamination have been identified on site. The levels of contamination exceed EPA maximum contaminant levels for drinking water; however, there are no known drinking water wells in the area. These contaminants have not been found off site.

Resource Conservation and Recovery Act (RCRA)

The California Department of Health Services (DHS) conducted a RCRA compliance inspection on January 24–29, 1990. As a result of that inspection, violations of hazardous waste statutes and regulations were found for labeling, access, storage over one year, improper storage of lead/acid batteries, documentation, and separation of incompatibles. In addition, information on the chemical analysis of the rinse waters and the wastewater evaporator unit were requested. As required, LBL submitted a response to the violations and a schedule of compliance to DHS on May 15, 1990.

A second RCRA inspection was conducted by DHS on November 29, and December 3 and 4, 1990. Numerous violations of hazardous waste control statues and regulations were found.

National Environmental Policy Act (NEPA)

During 1990 the Laboratory submitted a NEPA Environmental Assessment to DOE headquarters for the proposed Hazardous Waste Handling Facility. The Laboratory also had several small General Purpose Plant projects that were classified as Categorical Exclusions.

Clean Air Act (CAA)

The Laboratory is not in compliance with all of 40 CFR 61 Subpart H, "National Emissions Standard for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities." The final rule, passed on December 15, 1989, required compliance with all provisions of the standard by March 15, 1990. The Laboratory is in compliance with the radiation dose limit of 10 mrem per year to an offsite individual. However, it is not in compliance with monitoring (Section 61.93) and quality assurance (Appendix B, Method 114) provisions of the Act.

Two proposed facilities, the Research Medicine Cyclotron and Advanced Light Source injector, were evaluated by LBL for potential radiological emissions. The evaluations determined that the impacts would be less than 1% of the exposure limits to an offsite individual and that permits were not required.

The Bay Area Air Quality Management District inspected LBL on January 8, 1990, and issued a notice of violation for operating equipment that may cause air pollution without a Permit to Operate. The violation was the result of a delay in the payment of the permit fee. The fee was submitted immediately and an operating permit was obtained.

Clean Water Act (CWA)

On May 16, a wastewater discharge violation occurred at the Building 77 Plating Shop degreaser for 1,1,1-trichloroethane. An investigation determined that a leak in the degreaser contaminated the wastewater, and this was immediately repaired.

On July 19, a wastewater discharge violation occurred at the site boundary for oil and grease. An investigation determined that the most probable source was the LBL cafeteria, although this could not be confirmed. Subsequent samples for oil and grease were well within discharge limits.

An investigation of several wastewater discharge violations at the site boundary for chlorinated hydrocarbons identified two potential sources. Both are research activities that discharge methylene chloride and chloroform into the sanitary sewer system. Both activities have been discontinued until an adequate collection system is installed.

The California Regional Water Quality Control Board was notified in writing that levels of tritium exceeding the EPA drinking water limits were found in the groundwater on site. Tritium has not been found in offsite samples. It was also noted that the there are no known drinking-water wells in the area.

Safe Drinking Water Act (SDWA)

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

Toxic Substances Control Act (TSCA)

The Environmental Protection Agency (EPA) conducted a TSCA PCB inspection on February 22, 1990. A Federal Facility Notice of Non-compliance was issued on June, 29, 1990. Six violations were noted regarding proper record keeping and documentation. LBL's response, submitted on July 25, 1990, was determined by EPA, Region 9, to be satisfactory.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

LBL used registered pesticides in 1990. "Restricted use" pesticides were applied by licensed contractors. LBL personnel apply "general use" pesticides only.

Endangered Species Act (ESA)

The proposed Hazardous Waste Handling Facility Project was reviewed for impacts on the three listed endangered species on the LBL site. A more comprehensive review of the HWHF's impact on one species is in process and is expected to be completed in 1991.

Executive Order 11988, "Floodplain Management"

The Laboratory's main site is not in a floodplain. All offsite projects are reviewed for floodplain management impacts.

Executive Order 11990, "Protection of Wetlands"

There are no wetlands at the Laboratory's main site. All offsite projects are reviewed for protection of wetlands.

Current Issues and Actions

An Agreement in Principle (AIP) was entered into between the DOE and the State of California (State). The State's designated lead agency for the purposes of the AIP is DHS. 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. On November 2, 1990, representatives from the State toured LBL as a part of the program.

The operations in the tritium facility were thoroughly reviewed for the potential to release tritium. Modifications to the facility equipment were made, resulting in a 68% reduction in airborne releases. Additional modifications are being considered that may result in further reductions.

Summary of Permits

Hazardous Waste Permits

The Hazardous Waste Handling Facility is operating under a permit issued by DHS for EPA, Region 9. A new permit application was prepared and submitted to DHS. DHS responded to LBL's submittal of the Part B Permit with a Notice of Deficiency (NOD), which listed 49 items requiring inclusion, clarification, or expansion. A revised Part B application incorporating the items requested was submitted to the Department on August 30, 1990. A second Part B application revision in response to verbal comments from DHS was submitted on March 29, 1991. After the State approves the application, it will be submitted to EPA, Region 9, for approval.

The Plating Shop wastewater pretreatment unit is operating under a temporary variance issued by the California Department of Health Services. An application for an operating permit for a new unit is being prepared and will be submitted to DHS. This unit does not require a permit from the EPA.

Wastewater Discharge Permits

The East Bay Municipal Utility District has issued a sitewide permit and two specific permits for metal finishing operations.

Underground Storage Tank Permits

Fourteen operating permits, issued by the City of Berkeley, have been obtained for tanks containing diesel, gasoline, transformer oil, and waste oil.

Air Permits

Thirty-six operating permits, issued by the Bay Area Air Quality Management District, have been obtained for equipment associated with solvent cleaning, machining, painting, wood dust collection, sandblasting, gasoline dispensing, and sulfur hexafluoride discharges.

Compliance Summary
January 1, 1991–April 1, 1991

Compliance Status

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)

Programs described in the 1990 Calendar Year Compliance Summary are continuing.

Resource Conservation and Recovery Act (RCRA)

On March 21, 1991, DHS issued a Report of Violation as a result of an inspection in November and December of the previous year. Seventeen violations of hazardous waste

control statues and regulations were found. Violations were found with regards to unpermitted treatment and storage, manifests, labels, facility access, containment, training, planning documents, inspection, and storage. The violations are being reviewed and will be corrected within 30 days in accordance with DHS statues and regulations.

On March 29, a revised hazardous waste permit application was submitted to DHS for the Hazardous Waste Handling Facility. This application updated an application previously submitted on August 31, 1990.

National Environmental Policy Act (NEPA)

The Environmental Assessment for the Hazardous Waste Handling Facility is undergoing comment and revision to finalize the NEPA process prior to construction.

Clean Air Act (CAA)

A program has been initiated to bring the Laboratory into compliance with the National Emission Standards for Radioactive Emissions, 40 CFR 61 Subpart H. The program includes a review of all potential emission sources, evaluation of their release potentials, quantification of associated offsite exposures, review of acceptable monitoring methods, and installations of appropriate monitoring equipment. Monitoring strategies for specific sources are being reviewed by LBL and EPA, Region 9. A memorandum of understanding regarding an extension of compliance deadlines is currently under negotiation between the DOE and EPA.

On January 31, two notices of violation were issued by the Bay Area Air Quality Management District (BAAQMD) for the improper operation of two degreasing units. The necessary repairs were made and a corrective action report was submitted. These issues are considered closed.

On February 22, a notice of violation was issued by BAAQMD for the installation of an abatement device without a permit. On March 8, a permit application was submitted and is currently being reviewed by BAAQMD.

Clean Water Act

No new activities or violations affected by this act have occurred during the reporting period.

Safe Drinking Water Act (SDWA)

At LBL, drinking water is supplied by the East Bay Municipal Utility District. There are no onsite wells.

Toxic Substances Control Act (TSCA)

No new activities or violations affected by this act have occurred during the reporting period.

Federal Insecticide, Fungacide and Rodenticide Act (FIFRA)

Programs described in the 1990 Calendar Year Compliance Summary are continuing.

Endangered Species Act (ESA)

The proposed Hazardous Waste Handling Facility Project was reviewed for impacts on endangered species and is considered to be in full compliance with this Act.

Executive Order 11988, "Floodplain Management"

The Laboratory's main site is not in a floodplain. All offsite projects are reviewed for floodplain management impacts.

Executive Order 11990, "Protection of Wetlands"

There are no wetlands at the Laboratory's main site. All offsite projects are reviewed for protection of wetlands.

Current Issues and Actions

A DOE Tiger Team Audit was conducted in January and February 1991. According to the Tiger Team Report, numerous widespread deficiencies were identified; however, no imminent hazards were found. The Team did not recommend the cessation of any operation or the closure of any facility. Nevertheless, the Tigers identified 70 compliance and 16 best-management-practice environmental findings. Key areas of noncompliance were waste management practices, lack of quality assurance/quality control plans, lack of environmental monitoring plans, and lack of effective oversight. The Laboratory is developing a comprehensive action plan to respond to all of the Tiger Team findings. This plan will be submitted to DOE in May.

Two single-wall underground storage tanks, used to store vehicle fuel, were replaced by double-wall tanks. Five single-wall tanks are still in service.

In 1991, there will be a substantial increase in the level of effort directed towards determining the extent of soil and groundwater contamination at the site.

Summary of Permits

Air Permits

Six Applications for an Authority to Construct/Permit to Operate have been submitted to the Bay Area Air Quality Management District. One has been determined to be exempt from the permitting requirements; five are still pending.

Underground Storage Tanks

Application forms were submitted to the City of Berkeley for 14 underground storage tanks as a part of its annual permitting program.

Environmental Program Information

Environmental Program Overview

This section of the report provides a brief overview of LBL's environmental surveillance practices and the rationale for those activities. Subsequent sections will detail the areas outlined here.

DOE Orders require that DOE Facilities and DOE Contractor-managed facilities like LBL comply with applicable DOE, Federal, State, and local environmental regulations. Furthermore, it is the policy of LBL to conduct its operations in a manner that is in complete compliance with all applicable environmental laws and regulations, Executive Orders, and DOE policies.

DOE Orders

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

To ensure that LBL research activities are carried out in compliance with the foregoing, the Laboratory supports a program of monitoring of the workplace, effluents, and environment. Elements of the program include

- Sampling of workplace and effluent air in all areas where significant quantities of radionuclides are handled. (Samplers are changed weekly.)
- Continuous 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. The LBL waste storage yard is also so monitored, since packaged radioactive materials are stored there before shipment to a radioactive-waste disposal site.
- Sampling of the two LBL sewer outfalls. Outfall flow and pH are continuously measured at each site. Composite samples are removed weekly and analyzed for tritium, radioiodines, and gross alpha and beta emitters.
- Daily composites, which are analyzed for a series of regulated metals, and "grab" samples, which are analyzed for chlorinated hydrocarbons, oil and grease, cyanides, phenols, total suspended solids, and filterable chemical oxygen demand. (The nonradiological assays are mandated by LBL's sitewide wastewater discharge permit.)
- Continuous sampling of environmental air at 10 points about the site and at 8 offsite and perimeter locations. Fourteen of the sites are sampled for particulates, eight for HTO, four for radioiodine, and one for $^{14}CO_2$. Samplers are changed weekly.

- Rainfall and dry-deposition sampling at 9 onsite and 4 perimeter locations. Samples are taken monthly. Two additional sites are sampled whenever there is a significant rainfall. The rainwater is analyzed for tritium and gross alpha and beta activity.
- Sampling of groundwater by collecting "grab" samples at six of LBL's many hydraugers monthly and at each of the creeks that drain the LBL watershed weekly. The samples are analyzed for tritium and gross alpha and beta emitters.

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 is done for those species, and ambient air is sampled for HTO, radioiodines, and $^{14}CO_2$.

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 and the Chernobyl fire).

Clean Air Act

The Clean Air Act is a broad Federal statute that specifies ambient air quality standards, sets emission limits for specific air pollutants from certain sources, and determines limits and operating criteria for a number of hazardous air pollutants. In California, the Act is implemented through local Air Quality Management Districts. LBL is under the jurisdiction of the Bay Area Air Quality Management District.

The Bay Area Air Quality Management District implements the Clean Air Act by establishing a set of Rules and Regulations for operations or equipment that may cause air pollution. These regulations are enforced through an air quality permit system and periodic inspections. If a violation of the District's regulations is found, a notice of violation is issued.

The permit system requires review of equipment design and inspection of the equipment to ensure compliance with the District's requirements. Equipment requires two types of permits: an Authority to Construct, followed by a Permit to Operate. After an Authority to Construct has been issued and construction is complete, District personnel inspect the facility in operation to verify that the equipment performs as required. If it does, the District issues a Permit to Operate, which may contain specific operating conditions for equipment. All permitted sources are renewed and reinspected by the District annually.

There are 33 permitted sources at LBL. Three new sources were added in 1990. A list of the permits follows in a later section of this report.

The Bay Area Air Quality Management District inspected LBL on January 8, 1990, and issued a notice of violation for operating, without a Permit to Operate, equipment that

may cause air pollution. The violation was the result of a delay in the payment of the permit fee. The fee was submitted immediately, and an operating permit was obtained.

The National Emission Standard for Hazardous Airborne Pollutants (NESHAPs), detailed in the United States Code of Federal Regulations 40 CFR 61 Subpart H, requires that facilities that release radionuclides into the air report those releases to the appropriate regional office of the Environmental Protection Agency (EPA) in a specific format. See Appendix B for a copy of LBL's report for 1990.

California Air Toxics "Hot Spots" Information and Assessment Act (AB 2588)

The purpose of AB 2588 is to gather information on substances that may pose a chronic or acute threat to public health when present in the ambient air. It is based on the assumption that certain facilities emit enough toxic air contaminants to create localized "hot spots" where contamination exceeds typical ambient levels and may exceed health and safety thresholds. The information will be used to make emission information available to the public and will also be used by various public agencies in assessing and reducing the risk to the public. The requirements of AB 2588 are implemented through the local Air Quality Management Districts.

The Bay Area Air Quality Management District required the submission of two reports in 1989:

- By August 1, an emission inventory plan that identifies the substances that must be reported and provides a plan to estimate the emissions from their sources.
- By November 1, emission calculations that were specified in the emission inventory plan.

These reports must be updated biennially, and the next submission will be in 1991.

Clean Water Act

The Clean Water Act was established in 1977 as a major amendment to the Federal Water Pollution Control Act of 1972 and was substantially modified by the Water Quality Act of 1987. The Act provides a set of statutes intended to support the restoration and maintenance of water quality in all waters throughout the country. To implement the Act, EPA issued pretreatment standards for industrial dischargers as well as general standards controlling toxic pollutants. In California, the authority to implement the pretreatment program had been delegated to the State. The State, in turn, has required the local Public Owned Treatment Works (POTW) to enforce its provisions.

At LBL, the pretreatment standards are enforced by EBMUD. These standards have been incorporated into EBMUD Ordinance No. 311, 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 recordkeeping requirements.

At LBL, there are two operations that are regulated by the EBMUD pretreatment program and 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.

On May 16, a wastewater discharge violation occurred at the Building 77 Plating Shop degreaser for 1,1,1-trichloroethane. An investigation determined that a leak in the degreaser had contaminated the wastewater, and this was immediately repaired.

On July 19, a wastewater discharge violation occurred at the site boundary for oil and grease. An investigation determined that the most probable source was the LBL cafeteria, although this could not be confirmed. Subsequent samples for oil and grease were well within discharge limits.

An investigation of several wastewater discharge violations at the site boundary for chlorinated hydrocarbons identified two potential sources. Both are research activities that discharge methylene chloride and chloroform into the sanitary sewer system. Both activities have been discontinued until an adequate collection system is installed.

Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) 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, or dispose of hazardous waste in a way that protects human health and the environment. 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.

California has not received authorization to administer the EPA RCRA program. However, the EPA has contracted the State Department of Health Services (DHS) to perform RCRA permit reviews and inspections. In addition, California has established its own set of regulations, which are also enforced by DHS, governing the management of hazardous wastes.

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 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 again revised in order to update the application in general, and to add a proposed new Hazardous Waste Handling Facility. This application was subsequently reviewed by DHS, and a Notice of Deficiency was sent in December 1989. A new permit application was prepared and submitted to the DHS on August 31, 1990. After the State approves the application, it will be submitted to EPA, Region 9, for approval.

In addition, small quantities of certain hazardous chemicals are treated on site in several treatment units. These units are exempt from EPA RCRA regulations but are included in the State's regulations.

In 1984 a wastewater treatment unit was installed at the Building 77 Plating Shop and operated under a variance granted by DHS. In 1989 a new, larger treatment unit was installed; however, its operation has been delayed pending approval of a permit application.

The remaining treatment units treat low-risk hazardous waste streams by simple processes and will be regulated by DHS under a permit-by-rule system. In this system, DHS will use a post-audit approach of inspecting facilities they are operating, rather than extensive review of their proposed operation before permitting. Included in this category are the following four treatment units:

- Printed-circuit-board wastewater, Building 25 — neutralization and metal precipitation.
- Laboratory acid wastewater, Building 2 — neutralization.
- Laboratory acid wastewater, Building 70A — neutralization.
- Oil/water separator, Building 76.

Comprehensive Environmental Response, Compensation and Liability Act

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) provides the regulatory framework and funding needed to properly clean up 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 EPA, and the sites are ranked according to their potentials for impairing human health or damaging the environment. The sites with the highest potentials are placed on the National Priorities List (NPL) and are forced into an environmental cleanup action.

EPA has allowed DOE to establish its own independent CERCLA program, subject to EPA oversight, in DOE Order 5480.14. Under this Order, a preliminary assessment was performed for potential waste sites and submitted to EPA in 1988. No significant hazardous waste sites were identified at LBL, due to their relatively small impact to the surrounding environment, and no sites have been placed on the NPL. Further assessment and, if necessary, cleanup of sites will likely take place under RCRA authority as a condition of the hazardous waste permit, or possibly under some combined RCRA/CERCLA action, rather than under a CERCLA program alone.

Superfund Amendments and Reauthorization Act, Title III

Title III of the 1986 Superfund Amendments and Reauthorization Act (SARA) to CERCLA created a system for planning for hazardous material emergencies and for making information regarding use and storage of hazardous materials available to the public. In California, many of the SARA Title III requirements overlap with independent requirements in State-mandated programs. After two years of negotiations with EPA, the California legislature amended the State requirements to reduce inconsistencies between State and Federal requirements.

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. In California, the reporting requirements of SARA Sections 311 and 312 were incorporated into the requirements of the Hazardous Materials Release Response Plan and Inventory Law (AB 2189). 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. At LBL, AB 2189 is enforced by the City of Berkeley.

In 1990, LBL conducted a comprehensive inventory of hazardous chemicals. The three reporting thresholds of AB 2189, which are generally smaller than those found in SARA Title III, were used. The following thresholds apply to the entire facility:

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

In addition, an emergency response plan was developed to meet the requirements of AB 2189. The inventory data and emergency response plan were packaged together in a report, called a Business Plan, and submitted to the City of Berkeley on December 22, 1989. An updated Business Plan was submitted in 1990, as required.

Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) establishes the legal framework for the manufacture, distribution, use, and disposal of regulated substances. 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. Those with PCB concentrations exceeding 50 parts per million have been replaced or put into a PCB reduction program. Replacement of the high-risk indoor PCB transformers has been completed. Currently, there are no PCB transformers at LBL.

Safe Drinking Water Act

The Safe Drinking Water Act 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 onsite wells. EBMUD obtains its water from western-slope Sierra Nevada surface waters more than 150 km 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 the 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. Backflow prevention devices are installed where a potential for cross-contamination of the domestic water and wastewater exists, and a regular maintenance program is also in effect. The domestic water is routinely sampled for coliform bacteria. Starting in 1988, periodic checks were also made for lead, copper, and zinc.

The National Primary Drinking Water Regulations limit radiological exposure to the public from community drinking-water systems to 4 mrem/yr. 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. (Consumption of water contaminated with the listed limit of a single contaminant for a year would produce an exposure of 4 mrem to the consumer.) The standard for tritium is 20,000 pCi/l. The unidentified alpha emitter limit is 5 pCi/l. The unidentified beta emitter limit is 8 pCi/l.

Federal Insecticide, Fungicide and Rodenticide Act

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 unregulated herbicides only.

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.

1) Source Operating Permits, Bay Area Air Quality Management District—expires July 1, 1991

Cold Solvent Cleaning Equipment

- Building 46 – Source #121
- Building 76 – Source #67
- Building 76 – Source #72
- Building 77 – Source #119
- Building 77 – Source #130
- Building 934 – Source #118

Gasoline Dispensing Equipment

- Building 76 – Source #76

Machine Shop Exhaust System

- Building 53 – Source #39
- Building 58 – Source #46
- Building 70A – Source #55
- Building 77 – Source #84
- Building 77 – Source #85
- Building 77 – Source #89
- Building 79 – Source #105
- Building 79 – Source #116
- Building 88 – Source #114
- Building 88 – Source #115

Paint Drying Oven

- Building 77 – Source #104

Paint Spray Booth

- Building 76 – Source #74
- Building 77 – Source #96

Sandblast Exhaust Equipment

- Building 77 – Source #97

Sulfur Hexafluoride Chamber

- Building 58 – Source #124

Ultrasonic Degreaser

- Building 16 – Source #129
- Building 53 – Source #38

Vapor Degreaser

- Building 16 – Source #129
- Building 25A – Source #22
- Building 46 – Source #91
- Building 53 – Source #120
- Building 77 – Source #92

Wood Dust Exhaust System

- Building 74 – Source #64
- Building 76 – Source #73

Resin Molding and Curing

- Building 10 - Source #132
- Building 10 - Source #133

2) Wastewater Discharge Permits, East Bay Municipal Utility District

- Plating Shop, Building 25 – Permit #776-00025 — expires June 5, 1991
- Plating Shop, Building 77 – # 776-00077 — expires June 5, 1991
- LBL Site – #066-00791 — expires June 5, 1991

3) Application for construction of a Hazardous Waste Treatment, Storage and Disposal Facility Permit, EPA CA 4890008986, California Department of Health Services for the Environmental Protection Agency. The current permit is extended until resolution of the new Part B application.

4) Underground Storage Tank Permits, City of Berkeley — expires July 1, 1991

Diesel Oil

- Building 2 – (2) 1,000 and 4,000 gal
- Building 51 – 550 gal
- Building 55 – 1,000 gal
- Building 66 – (2) 2,000 and 6,000 gal
- Building 70 – 600 gal
- Building 70A – 1,000 gal
- Building 74 – 12,000 gal
- Building 76 – 10,000 gal

Gasoline

- Building 76 – 10,000 gal

Transformer Oil

- Building 58 – 2,000 gal

Waste Oil

- Building 69 – 2,000 gal

Spill Control

- Building 58 – 2,000 gal

Environmental Assessments

Environmental Impact Report — Construction of Replacement Hazardous Waste Handling Facility. A NEPA Environmental Assessment (EA) for the Replacement Hazardous Waste Handling Facility was submitted to the DOE for administrative review in November 1989. The report found no significant environmental impacts that could not

be mitigated through design and proper execution. The Laboratory has reviewed and responded to comments from the DOE offices of Energy Management (EM), Energy Research (OER), and Environmental Health (EH). A revised EA was prepared and submitted to DOE/SAN in March 1991.

Environmental Activities

Construction of a new wastewater treatment unit has been completed. The new unit is needed to maintain Plating Shop wastewater discharges within the limits mandated by the EPA Metal Finishing Pretreatment Standard (40 CFR 433). It will replace a smaller unit that has been increasingly subject to mechanical breakdowns. Unfortunately, startup of the new unit has been delayed until an operating California hazardous waste permit is obtained.

The Air Emission Estimates Report calculates annual average emissions and hourly maximum emissions using mass-balance techniques where possible. Source emissions that could not be calculated will be estimated by source testing or pooled source test data. These values were determined initially in 1990 and will be updated in 1992.

A Business Plan was prepared in response to the California Hazardous Materials Release Response Plan and Inventory Law, AB 2187 and AB 2189, and submitted to the City of Berkeley. The law requires businesses to establish Plans that outline procedures for emergency response to releases or threatened releases of hazardous materials. The three major elements of the Business Plan are emergency response, training, and a hazardous material inventory.

An Environmental Monitoring and Remediation Project was initiated in 1989 as a consequence of finding elevated levels of hazardous substances in groundwater and the recognition that the extensive use, handling, and storage of hazardous substances at LBL could potentially contribute to contamination at other locations. Using the limited sampling data and the known chemical usage and handling activities at LBL, a Conceptual Design Report was developed assuming a probable contamination scenario. The preliminary investigations continued through FY 1990 and will provide further results to enhance the understanding of existing conditions. This will be followed by a detailed site characterization planned for 1991, remediation of any impaired areas, and a long-term monitoring program, if necessary.

Environmental Radiological Program Information

Penetrating Radiation

To determine the radiological impact of LBL accelerator operations, we maintain permanent environmental monitoring stations (EMSs) at four points about LBL's perimeter (Fig. 3).

Each station contains sensitive neutron and gamma pulse counters. The neutron detectors are ~500-cm^3 cylindrical BF_3 gas-proportional counters housed in 2.5-inch-thick cylindrical paraffin moderators. The gamma detectors are energy-compensated

Geiger-Muller chambers. The output pulses from each of the eight detectors (one of each type is installed at each monitoring station) are prescaled and telemetered to registers in Building 75.[7] Each LBL accelerator building contains at least one somewhat-smaller moderated BF_3 neutron detector, whose output pulses are also prescaled and telemetered to Building 75. By comparing the accelerator neutron monitor output with the output of the perimeter-station neutron monitors, one may assign the perimeter dose equivalent to the accelerator responsible for it. Operational checks of the system are performed daily, and detectors are calibrated annually. A typical dose equivalent value for a perimeter-monitoring-station neutron detector corresponds to 0.13 μrem/pulse. A gamma-register pulse corresponds to about 1.3 μrem.

The neutron background attributable to cosmic rays measured at LBL exhibits small fluctuations about a mean value of 3.3 mrem/year.[1] Table 2 lists the accelerator-produced fence-post dose equivalents measured at each environmental monitoring station during 1990. The fence-post neutron dose equivalent and gamma-ray dose equivalent attributable to LBL accelerator operations in 1990 (see Table 2) are characterized as follows.

1. The maximum offsite exposure to an individual would have been received by a person living in the vicinity of the Olympus Gate Monitoring Station (OGMS). The Bevalac contributed 80% and the SuperHILAC alone 20% of the 1.8 mrem fence-post dose equivalent measured at the OGMS. As this station is 30 m from offsite homes, its measured dose reflects a realistic assessment of the maximum offsite person dose (to a person continuously occupying the nearest home).

2. The 88-Inch Cyclotron fence-post dose equivalent of 1.4 ± 0.2 mrem is primarily attributable to scattered photons and stray neutrons produced during light-ion (^3H, p^+, D^+, ^4H) runs during 1990.

3. The B13B neutron detector data were not sufficiently robust to use.

The DOE Orders, which provide detailed requirements for radiation protection, under which DOE contractors (LBL, for example) operate, include a table (see Ref. 4) that assigns dose equivalent rate vs. neutron flux values for neutrons of various energies.

In order to better characterize the impact of the neutrons from the 88-Inch Cyclotron, a seven-detector neutron spectrometer was installed at the B13A monitoring station in January 1988. During that year seven light-ion-beam runs (^3He, p^+, ^2H) produced measurable neutron fluences. The spectrometer data were analyzed by Rai Ko Sun of the LBL Environment and Safety Hazards Control Department (ESHC) using the computer code LOUHI.[8,9] The historically assumed neutron fluence-to-dose value used by the authors in the absence of spectral data was 2.45×10^4 n/cm^2/mrem. The mean neutron fluence-to-dose value established by the LOUHI runs was 2.2×10^5 n/cm^2/mrem, 11% of the historically conservative value and 60% of the value used in the 1986 and 1987 annual editions of this report (based on average neutron energy measurements). The value of 0.7 ± 0.1 mrem attributable to neutron fluence reported for 1990 reflects less-conservative but more-realistic neutron energy vs. dose equivalent conversion factors.

3. With the exception of seven periods at the 88-Inch Cyclotron EMS, during which an accelerator-correlated fence-post gamma dose of 0.7 ± 0.2 mrem was produced

(see Table 2), the continuous gamma measurements telemetered from the four monitoring stations showed no significant correlation with LBL accelerator operation during 1990 and were thus interpreted as constituting the natural gamma background for 1990. The mean value of gamma background inside the monitoring stations was 78 ± 12 mrem for 1990.

ESHC operates a radiological and chemical waste storage yard and an instrument calibration facility at Building 75. (The small trailer "complex" on Fig. 1 south of Building 75 is Building 75B, which houses ESHC administration and operations personnel.)

A recording Geiger-Muller instrument located in the western end of Building 75A continuously monitors impact from waste storage in Building 75A and the adjacent corporation yard. The instrument measured a total exposure of 290 ± 30 mrem for a net exposure of 212 ± 20 mrem during 1990.

The sources of radiation monitored by the Building 75A instrument are both inside Building 75A and roughly midway between the Building 75A monitor and the LBL perimeter fence; thus a conservative "fence-post" dose estimate for these sources of radiation would be 212 mrem/year. However, the perimeter fence at this location is on UC land, and the nearest offsite 40-hour 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 waste handling facility sources would be ~0.06 mrem/yr at the Lawrence Hall of Science (40-hr/week occupancy) or ~0.09 mrem/yr at the nearest home. A radiation worker who continuously occupied the zone of exposure from this sample would have received an exposure of ~50 mrem, 1% of the worker limit. (All radiation workers at LBL wear personal dosimeters while at the Laboratory.) The nearest onsite office occupied by a nonradiation worker is 50 m from the source. The dose to such a person would be ~7 mrem per year.

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 house (40-hr/wk occupancy); and <0.02 mrem/yr at the nearest house (168-hr/wk occupancy).

Airborne Radionuclides

LBL employs a wide variety of radionuclides in its research program, including ^{3}H, ^{14}C, ^{32}P, ^{35}S, ^{22}Na, ^{45}Ca, ^{51}Cr, $^{57,60}Co$, $^{68}Ge/Ga$, ^{54}Mn, $^{82,85,90}Sr$, ^{86}Rb, $^{95}Nb/Zr$, ^{99}Mo, ^{99M}Tc, ^{111}In, $^{123,125}I$, ^{123}Te, $^{172,175}Hf$, ^{203}Hg, ^{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 ^{125}I. As noted in the environmental program overview section of this report, 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 1990 are ^{3}H as HTO (water vapor), ^{14}C as $^{14}CO_2$, ^{35}S as $^{35}SO_2$, ^{125}I in various gaseous forms, and ^{203}Hg as mercury vapor. Both ^{226}Ra and ^{227}Ac produce gaseous radioactive daughters, specifically two isotopes of radon—^{222}Rn and ^{219}Rn, respectively—but the quantities of ^{226}Ra and ^{227}Ac used in LBL research activities are 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.

The unidentified alpha-emitter-releases figure in Table 3 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 700×10^{-12} μCi/ml.

Silica-gel HTO samples are changed weekly. Each of the four perimeter environmental monitoring stations contains a tritium sampler, as does the Building 3 site. In addition, the Lawrence Hall of Science (LHS), a facility on UC land north of LBL's perimeter, the UC Mathematical Science Research Institute (MSRI), and an enclosure located at the northeast corner of Building 69A are similarly monitored. These four locations are identified in Fig. 4. The stack from the tritium-labeling facility is also monitored for tritium as described above.

Triethylene diamine (TEDA)-doped activated carbon cartridges are used to sample air for radioiodine at the four perimeter stations shown in Fig. 3. Radioiodines in air, specifically ^{125}I, is assayed by analyzing the activated-carbon cartridges with a sodium iodide detector connected to a multichannel analyzer. The detection limit for ^{125}I is 4×10^{-15} 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. If acid fumes in the sampled air drop the pH of the sample to about 6, a color change results, and the sample is assumed to be invalid (an infrequent occurrence). An aliquot (5 ml) of the NaOH is added to a liquid scintillation "cocktail" and counted in a liquid scintillation counter. The detection limit for $^{14}CO_2$ is 200×10^{-12} μCi/ml.

Gross atmospheric particulate beta and alpha activities are measured by air sampling at the 14 points shown in Fig. 5.

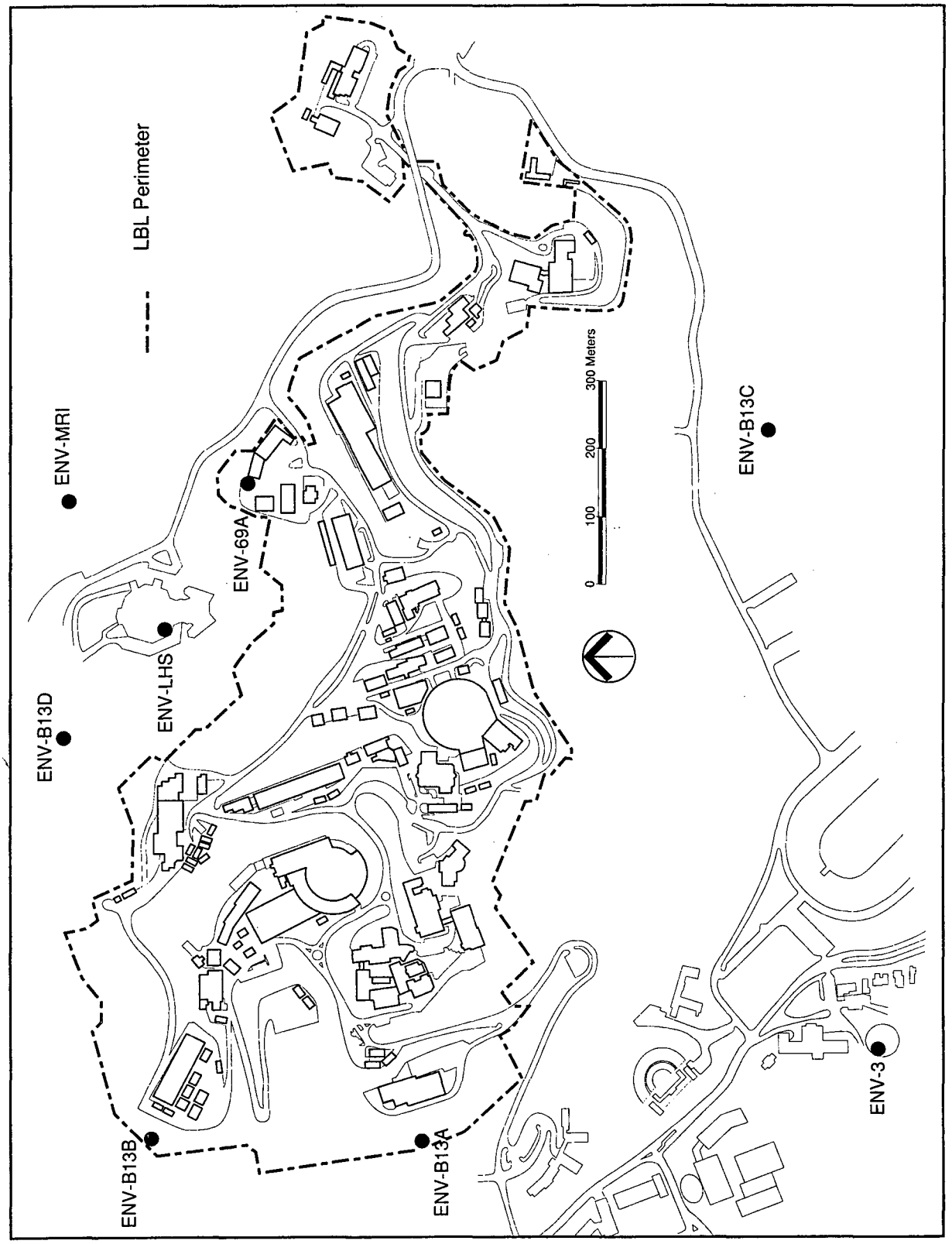


Figure 4. Map of airborne environmental tritium sampling sites.

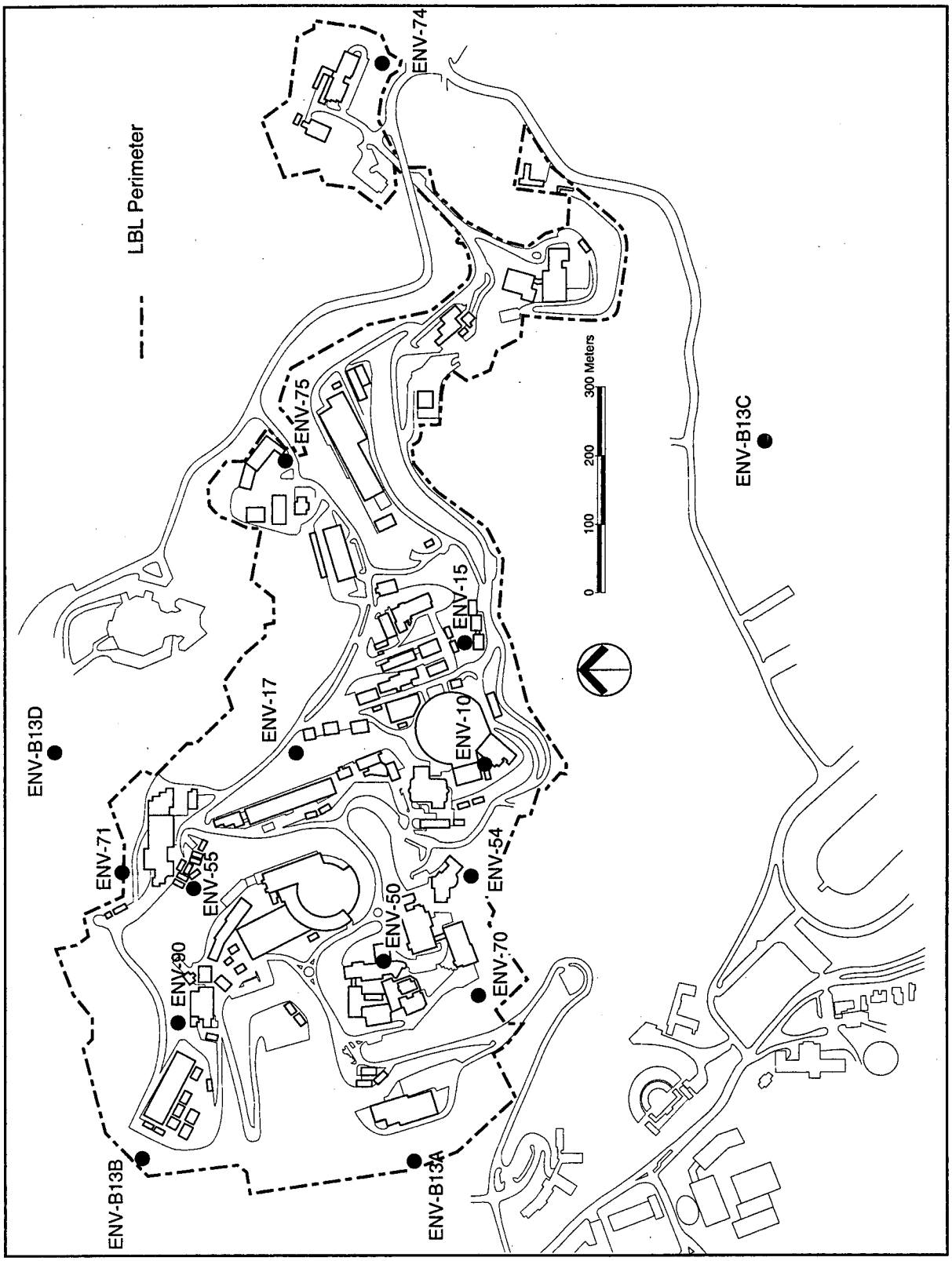


Figure 5. Map of airborne radioactive particulate sampling sites.

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 thorium daughters (naturally occurring airborne radionuclides) to decay. The filters are loaded into an automatic counter that determines gross alpha activity by means of a large-area 0.25-mil Mylar-window gas proportional counter. Gross beta activity is counted with Geiger-Muller detectors with 30 mg/cm^2 windows. The detection limit for alpha emitters is 3×10^{-15} μCi/ml. The detection limit for beta emitters is 120×10^{-15} μCi/ml. To ensure accuracy of all counting results, each group of samples counted includes at least one radiation standard sample and a number of background samples.

Alan R. Smith of 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 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 minutes. Aside from very low concentrations of ^{137}Cs attributable to atmospheric nuclear weapons testing, the 1986 Chernobyl fire, and resuspension of surface soil [^{137}Cs was found in concentrations of less than 4×10^{-17} μCi/ml, about 0.00001% of the applicable derived concentration guide (DCG)], the only other 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). It was found in concentrations ranging from 3.7×10^{-14} to 2.3×10^{-13} μCi/ml and averaged 1.0×10^{-13} μCi/ml, which is < 0.003% of the DCG. The detection limit for ^{7}Be is 2×10^{-16} μCi/ml for a 1,000 minute count. The concentrations of ^{210}Pb, a natural air contaminant, were not computed.

Inasmuch as the DOE Orders[4] 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 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 Ref. 4. 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 3. Aside from the tritium release that is 33% of the 1989 value, the figures are similar to those of last year, and the releases resulted in a small collective effective dose equivalent (see Table 1 and the section on Public Doses Resulting from LBL Operations).

One may note that a number of the average values listed in several of the tables in this report (notably Tables 4, 6, 7, 9, 11, and 13) 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).

Although small quantities of radionuclides (Table 3) were discharged into the atmosphere during 1990, the data from the general environmental air sampling were within the range of historical background values.

The environmental air sampling program for ^{14}C and ^{3}H found detectable concentrations of these nuclides (Tables 4 and 5). The radioiodine sampling program (Table 6) detected no significant ^{125}I in perimeter air during 1990. Essentially, 100% of the tritium released from LBL was discharged from the Building 75 stacks. Table 7 summarizes the gross particulate radioactivity measured in LBL air samples during 1990. The Table 7 data for 1990 may be compared with data from Table 8, which lists LBL perimeter air-sample-data maxima and averages for the period 1981–1990.

Waterborne Radionuclides

Rainwater (see Fig. 6); creek water (see Fig. 3); groundwater, which flows from the horizontal wells (hydraugers), whose bores are represented by the heavy dashed lines in Fig. 7; and sewage from LBL's two sewer outfalls are analyzed for tritium, gross beta, and alpha emitters (see Fig. 7; 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 the Groundwater Protection section of this report.)

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 Fig. 6 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 atmospheric deposition at outlying perimeter stations lie within the range of historical normal background measurements; however, tritium exceeding the EPA Drinking Water Standards was detected in rainfall collected within the Laboratory boundary near the stack from the Building 75 Tritium Facility (Tables 9 and 10). The deposition values, adjusted for rainfall, are compared with the Safe

Table 4. Summary of airborne environmental HTO and $^{14}CO_2$ sampling, 1990.

	No. of samples	Concentration (10^{-9} µCi/ml) Avg.	Min.	Max.	Average as % of standard[a]
Samples for Tritium as HTO					
On-Site					
ENV 69A	51	0.7 ± 0.2	≤ 0.7	3 ± 1	0.7
ENV 3	48	0.2 ± 0.1	≤ 0.7		0.2
Perimeter					
MRI	52	0.11 ± 0.06	≤ 0.7	3 ± 1	0.1
LHS	51	≤ 0.1	≤ 0.7	0.7 ± 0.3	≤ 0.1
B-13A	47	≤ 0.1	≤ 0.7	≤ 0.7	≤ 0.1
B-13B	47	≤ 0.1	≤ 0.7	≤ 0.7	≤ 0.1
B-13C	47	< 0.1	≤ 0.7	≤ 0.7	≤ 0.1
B-13D (Olympus)	50	≤ 0.1	≤ 0.7	≤ 0.7	≤ 0.1
Standard for Comparison[a]	—	100	—		—
Samples for Carbon-14 (as $^{14}CO_2$)					
On-Site					
ENV 3	49	≤ 0.03	≤ 0.2	0.4 ± 0.1	≤ 0.006
Standard for Comparison[a]	—	500	—	—	—

[a]Source: Ref. 3.

Table 5. Summary of perimeter airborne environmental HTO and $^{14}CO_2$ sampling, 1981–1990.

Year	No. of Samples	Concentration (10^{-9} μCi/ml) HTO Avg.	HTO Max.	No. of Samples	$^{14}CO_2$ Avg.	$^{14}CO_2$ Max.
1981	100	< 0.2	1.1	50	< 0.06	0.2
1982	102	0.3 ± 0.1	3 ± 1	51	< 0.04	0.3 ± 0.2
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
Standard for comparison[a]		100		500		

[a]Source: Ref. 3.

Table 6. Summary of radioiodine in perimeter air samples, 1990.

Perimeter Station	No. of samples	Concentration (10^{-15} μCi/ml) ^{125}I Avg.	^{125}I Min.	^{125}I Max.	Average as % of standard ^{125}I
Bldg. 88	51	≤ 1.4	≤ 10	16 ± 9	≤ 0.0003
Bldg. 90	51	≤ 1.4	≤ 10	< 11	≤ 0.0003
Panoramic Way	51	≤ 1.4	≤ 10	< 11	≤ 0.0003
Olympus Gate	51	≤ 1.4	≤ 10	21 ± 10	≤ 0.0003
Standard for comparison[a]		5×10^5			

[a]Source: Ref. 3.

Table 7. Summary of gross particulate radioactivity in air samples, 1990.

		Concentration (10^{-15} µCi/ml)						Average as % of standard	
		Alpha			Beta				
	No. of samples	Avg.	Min	Max[a]	Avg.	Min.	Max[a]	Alpha	Beta
On-site average of 10 locations	496	.51	< 2	5 ± 1	12 ± 3	< 80	120 ± 20	8	0.1
Perimeter Stations									
Bldg. 88	51	1.3 ± .5	≤ 3	6	≤ 16	≤ 120	≤ 120	≤ 18	< 0.2
Bldg. 90	51	≤ 0.5	≤ 3	5	≤ 16	≤ 120	≤ 120	≤ 7	< 0.2
Panoramic Way	51	0.7 ± 0.5	≤ 3	6	≤ 18	≤ 120	140 ± 120	≤ 10	< 0.2
Olympus Gate	51	≤ 0.47	≤ 3	5 ± 4	≤ 16	≤ 120	≤ 120	≤ 6	< 0.2
Standard for Comparison[b]		7			9,000				

[a]Highest single weekly sample.

[b]Source: Ref. 3—alpha conservatively assumed to be ^{232}Th; beta assumed to be ^{90}Sr.

Table 8. Annual gross particulate radioactivity found in LBL perimeter air samples, 1981–1990.

		Concentration (10^{-15} μCi/ml)			
		Alpha		Beta	
Year	No. of Samples	Avg.	Max.	Avg.	Max.
1981	195	1.1 ± 0.2	5	120 ± 40	500[a]
1982	197	0.9 ± 0.2	4 ± 2	14 ± 10	140 ± 100
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[b]
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
Standard for comparison[c]		7		9000	

[a]The People's Republic of China conducted an atmcspheric nuclear test on October 15, 1980. Radionuclides from the test were not detected in LBL air samples until early 1981.

[b]Chernobyl fire, April 26, 1986.

[c]Source: Ref. 3—alpha conservatively assumed to be ^{232}Th; beta conservatively assumed to be ^{90}Sr.

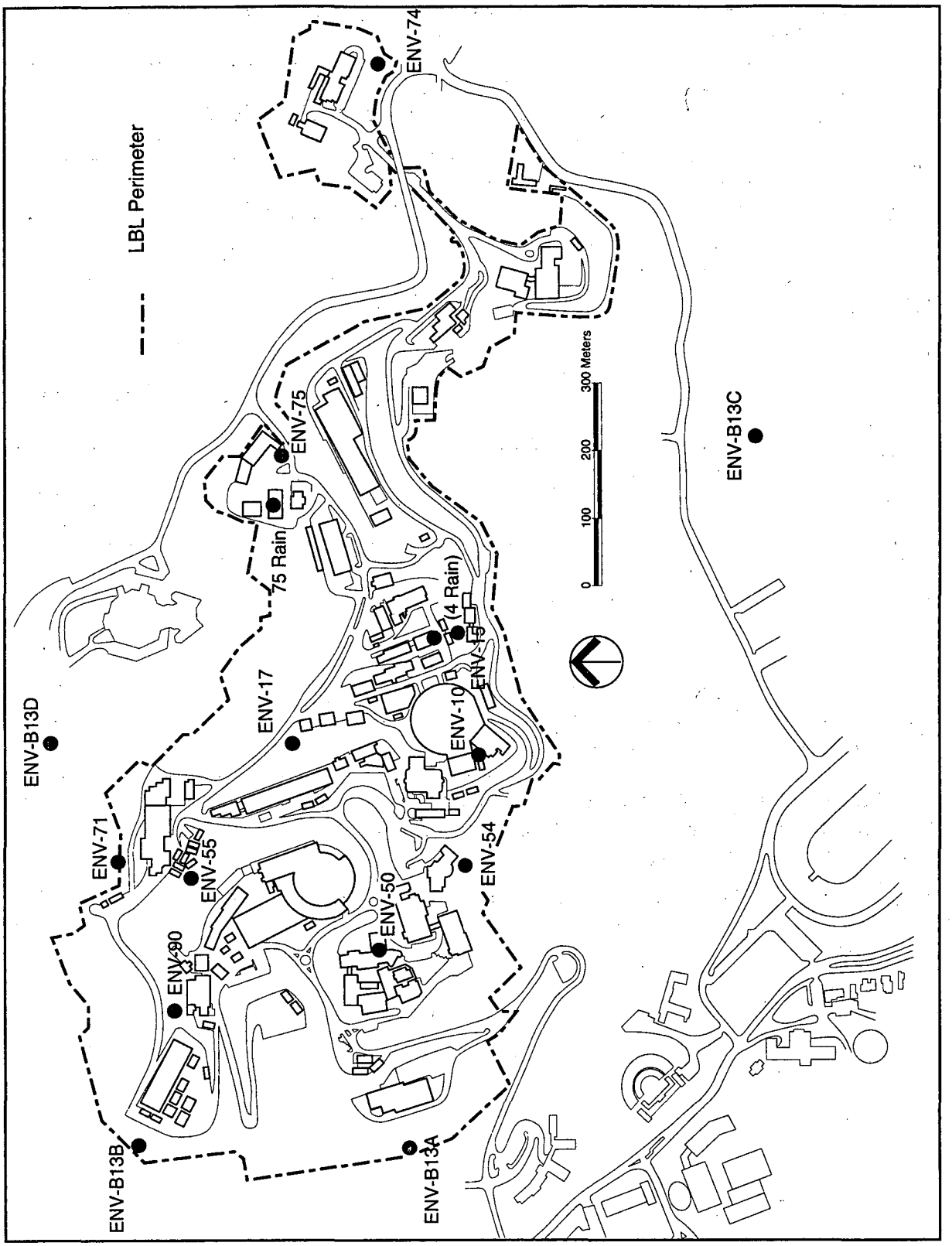


Figure 6. Map of rain and dry deposition collectors.

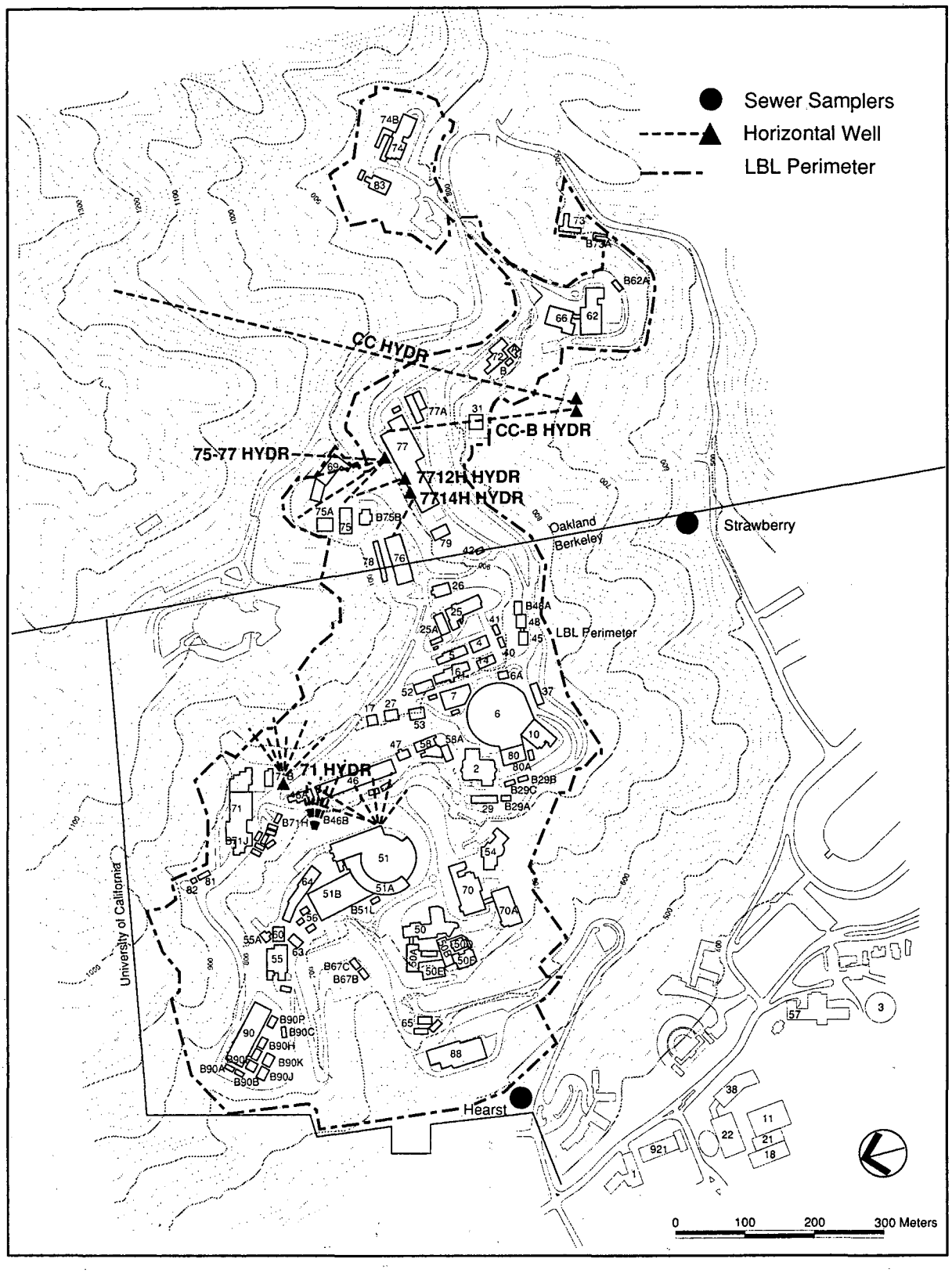


Figure 7. Map of LBL hydrauger and sewer sampling sites.

Table 9. Summary of atmospheric deposition, 1990.

	Total deposition (10^{-3} µCi/m^2)						Tritium in rainfall as HTO[a] (µCi/m^2)		
		Alpha		Beta					
	No. of samples	Avg.	Max.[b]	Avg.	Min.	Max.[b]	No. of samples	Avg.	Max.[b,d]
On-Site (12 locations)	165	0.017	0.086	0.61	0.13	2.4	120	1 ± 0.2	10 ± 2
Perimeter (4 locations)	48	0.023	0.039	0.61	0.24	1.3	36	< 0.01	< 0.05
Perimeter Averages as a % of Standards		1		16				< 0.11	
Drinking-water standard × 469[c]		2.34		3.75				9.38	

[a]The on-site tritium-in-rainfall data are computed from samples taken at 11 locations.

[b]Highest total for any one site.

[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 469 liters of water (the average quantity of rainfall/m^2 during 1990). Thus, the values used are 469 times the 40 CFR 141 values. [No standards for comparison have been established, so drinking-water standards (radionuclide concentration/l) are used.]

[d]The location of this deposition collector is on the north side of Bldg. 75 (see Fig. 6). The average HTO concentration in samples taken from the Bldg. 75 collector was 2.8×10^4 pCi/l, or about 1.4 times the HTO drinking-water standard.

Table 10. LBL perimeter station deposition trends, 1981–1990.

			Concentration (10^{-3} μCi/m^2)				(μCi/m^2)		
			Alpha		Beta			HTO	
Year	No. of Samples	Rainfall (cm)	Avg.	Max.	Avg.	Max.	No. of Samples	Avg.	Max.
1981	48	83.1	< 0.01	0.09	6.9	9.7	36	< 0.1	< 0.2
1982	48	109.0	< 0.01	0.017	1.9	5.2	36	< 0.2	0.3
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

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 uses no well water or local surface water as drinking water.

Sewer outfalls are sampled continuously, sample-to-flow ratios are designed to be between 10 and 20 parts per million, and composite samples are taken weekly. The five creek sample points indicated in Fig. 3 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.

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 cm^2), assuming an alpha energy of 5.2 MeV and a beta energy of 1 MeV.

Table 11 summarizes the 1990 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 12 summarizes the surface- and drinking-water samples for 1981–1990.

Table 13 summarizes the sewage sampling data for 1990. The average and maximum values listed for sewer beta concentrations reflect the weekly activity found in the hotter of the acid or radioiodine planchettes. Table 14 summarizes the sewage data for the years 1981–1990.

Public Doses Resulting from LBL Operations

Accelerator-Produced Radiation

The development of LBL's model used to assess the population dose equivalent attributable to penetrating radiation is detailed in Ref. 1. The model used population figures from the 1970 U.S. census.

Although the population within 80 km (50 mi) of LBL increased by 13% during the 1970s[6,10,11] from 4.6 to 5.1 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 LBL model developed by Thomas[1] computes population dose equivalent from the maximum measured value of perimeter (fence-post) neutron dose. During 1990 the maximum fence-post dose, measured at the Olympus Gate Monitoring Station, was

Table 11. Summary of surface- and drinking-water samples, 1990.

		Concentration (10^{-9} µCi/ml)						Concentration (10^3 pCi/l)					
		Alpha			Beta			Tritium as HTO			Average as % of standard		
	No. of samples	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max	Alpha	Beta	Tritium
On-site streams													
Blackberry	51	≤0.2	≤0.7	2.2±2	2.2±0.1	0.6±0.5	7±0.7	≤0.1	≤0.7	1.1±0.4	4	28	0.5
Lower Strawberry	51	≤0.12	≤0.4	≤1.4	2.1±0.1	≤0.4	8±0.8	≤0.1	≤0.7	2.6±1	2	26	0.5
Upper Strawberry	51	≤0.3		≤1.3	2.1±0.1	≤0.9	4±1	≤0.1	≤0.7	2.2±1	6	26	0.5
Average		≤0.2			2.1±0.1			≤0.1			4	26	0.5
Off-site streams													
Claremont	50	≤0.3	≤0.7	≤4	1.8±0.1	≤0.6	7.2±1.1	≤0.1	≤0.7	1.8±0.6	6	23	0.5
Wildcat	50	≤0.2	≤0.7	≤3	1.5±0.1	≤0.5	5.2±1	≤0.1	≤0.7	1.9±1	4	29	0.5
Tap Water	—	≤0.04	≤0.2	≤0.5	0.8±0.1	≤0.5	1.4±0.6	≤0.1	≤0.7	1.1±0.7	0.8	10	0.5
Standard of Comparison[a]		5			8			20					

[a]Source: 40 CFR 141.

Table 12. Summary of surface- and drinking-water samples, 1981–1990.

	Concentration (10^{-9} µCi/ml)								Concentration (10^{3} pCi/l)			
	Three On-site Streams				Two Off-site Streams				Drinking Water			
	Alpha		Beta		Alpha		Beta		Alpha		Beta	
Year	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.
1981	< 0.2	3	3.1 ± 0.1	45	< 0.2	3	1.6 ± 0.1	22	< 0.1	0.4	1.0 ± 0.1	---
1982	< 0.3	3 ± 2	1.7 ± 0.1	5 ± 1	< 0.3	5 ± 3	1.4 ± 0.1	6 ± 1	< 0.1	1.1 ± 0.5	0.9 ± 0.1	2.2 ± 1
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

Table 13a. Summary of sewage sampling data, 1990.

	Total quantities discharged			
	Total volume (10^6 liters)	Alpha (μCi)	Beta Emitters	Quantity mCi
Hearst Sewer	160	< 25	^{131}I[a]	11 ± 3
			^{33}S	7 ± 2
Strawberry Sewer	96	< 15	^{3}H	290 ± 50

a)The ^{131}I releases were from voidings by LBL employees who had undergone thyroid diagnostic or theraputic procedures off-site. LBL has not used I-131 in its research for 2 years – the releases are included for completeness.

Table 13b. Summary of sewage sampling data, 1990 (continued).

		Concentration (10^{-9} μCi/ml)							Concentration (10^3 pCi/l)			Average as % of standard		
		Alpha[a,b]			Beta[c]				Tritium			Alpha[b]	Beta[c]	Tritium
	No. of samples	Avg.	Min.	Max.	Avg.	Min.	Max.	No. of samples	Avg.	Min.	Max.	%	%	%
Hearst	96	≤ 0.2	≤ 0.7	≤ 1.5	32 ± 6	6 ± 3	500±100[d]	51	≤ 0.2	≤ 0.7	1 ± 0.9	0.4	3.2	0.01
Strawberry	98	≤ 0.2	≤ 0.8	≤ 1.5	20 ± 4	≤2	120 ± 50	51	3.0 ± 0.7	≤ 0.7	35 ± 7	0.4	2	0.15
Overall	194	≤ 0.2			25 ± 6			102	1.2 ± 0.7			0.4	2.5	0.6
Standard for comparison[e]		50			1000				2000					

[a]The alpha values are based on 48 Hearst and 49 Strawberry samples, respectively.

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

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

[d]The nuclide responsible for the maximum Beta discharge was ^{35}S

[e]Source: Ref. 3.

Note: The standards cited here are for ingestion of specific radionuclides and are provided for comparison purposes only.

Table 14. Sanitary-sewer discharge trends, 1981–1990.

			Concentration (10^{-9} µCi/ml)						Concentration (10^{-9} µCi/ml)			
			Hearst						Strawberry			
		Total	Gross alpha		Gross beta			Total	Gross alpha		Gross beta	
Year	No. of Samples	Flow (10^6l)	Avg.	Max.	Avg.	Max.	No. of Samples	Flow (10^6l)	Avg.	Max.	Avg.	Max.
1981	49	280	<0.2	1	21	150	43	89	0.5	14	240	2500
1982	42	300	0.05	1.1	20	460 ± 20	29	180	0.5	17 ± 12	60	640 ± 40
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

1.8 mrem for the year (Table 2). An examination of the time sequence of the telemetered neutron fluence from the Olympus detector indicated that the neutron fluence peaks correlated with the fluence peaks from the neutron detector located in the Bevalac roughly 80% of the time and with the peaks from only the SuperHILAC detector 20% of the time. The Bevalac and the SuperHILAC operated continuously seven days per week during 1990 except for maintenance "summer" and year-end shutdowns. The Bevalac shutdowns were from June 3 to September 15 and December 22 through January 2, 1991. 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

$$M < 10^3 \times H_o \, (1.0 - 0.56f) \, , \qquad (1)$$

where f = the fraction of the fence-post dose contributed by the 88-Inch Cyclotron and/or the SuperHILAC. Since 80% of the fence-post dose has been assigned to the Bevatron, f = 0.2 [in Eq. (1)].

Thus the expression becomes

$$M < 10^3 \, (1 - 0.11) \, H_o \, . \qquad (2)$$

Since H_o was 1.8 mrem (or 0.0018 rem), the Collective Effective Dose Equivalent (CEDE) to the 5.1 million people within 50 miles of LBL attributable to LBL accelerator operation during 1990 was < 1.6 person-rem.

Airborne Radionuclides

The dose to the maximally exposed individual and the CEDE resulting from airborne releases of radionuclides are listed in Table 1. They were 0.1 mrem and 5.6 person-rem, respectively. The 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 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, and
- distance to the nearest offsite individual.

The data used were as follows:

- The released quantities of tritium, ^{14}C, ^{125}I, ^{175}Hf, ^{203}Hg, and "^{232}Th" are listed in Table 3 of this report.
- The stack is 10 m high and 1 m in diameter and has an exhaust velocity of 7 m/s.
- The nearest offsite "neighbor," the Lawrence Hall of Science (LHS), is 130 m north of the stack.

The LHS staff members received the highest hypothetical dose equivalent of 0.1 mrem in 1990.

Since COMPLY cannot compute population dose equivalent, a microcomputer version of AIRDOSE-EPA "MICROAIRDOSE"[12] was used.

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

- radionuclide release data,
- committed dose-equivalent factors for released radionuclides,
- site-specific meteorological data,
- agricultural parameters,
- site-specific food and water source parameters,
- radionuclide-independent parameters, and
- 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, ^{14}C, ^{125}I, and ^{35}S listed in Table 3 of this report are used. The small releases of ^{175}Hf and ^{203}Hg were ignored, as their collective impacts would be << 1% of the total.
- Values are from three sources: values for ^{3}H and ^{14}C are from the original AIRDOSE Report;[13] dose conversion factors for ^{125}I were taken from the EPA DARTAB-RADRISK data base for 70-yr dose commitment; the data for ^{35}S and ^{232}Th are from Ref. 14.
- 1960–1964 Oakland Airport five-year average data were used. Although it is most desirable to use onsite meteorology data for the "release year" (1990), the EPA Region 9 regional meteorologist indicated that the use of the Oakland Airport five-year average data is, for this application, an acceptable second choice.[15] (LBL expects to collect its own onsite data by the end of 1991.)
- Default parameters provided with the MICROAIRDOSE code were used from Ref. 16.
- Food and water source parameters were compiled by Victor J. Montoya of the ESHC's Environmental Monitoring Section 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.)
- Values are from Ref. 17.
- The population distribution about LBL was compiled into 16 compass directions of 10 radial sectors each by Winifred B. Corniea, formerly of ESHC's Environmental Monitoring Section, using data in Ref. 11.

Table 15 summarizes the total CEDE due to LBL operations.

Table 15. Population effective dose equivalent resulting from LBL operations, 1990.[a]

Contributing factor		Population effective dose equivalent (person-rem)
Penetrating radiation from accelerator operations		≤ 1.6
Radionuclide release		
H-3	≤ 6	
C-14	≤ 0.004	
I-125	≤ 0.02	
S-35	< 0.0001	
Unidentified alpha emitters[b]	< 0.02	
Subtotal		≤ 6
Total LBL-produced effective population dose equivalent		≤ 8

[a] For 1990, the population dose attributable to natural background sources for the population within 80 km (50 mi) of LBL was approximately 5.1×10^6 persons × 0.3 rem/person/yr = 1.5×10^6 man-rem.

[b] ^{232}Th was used as a conservative substitute.

Trends—LBL Environmental Impact

Accelerator-Produced Penetrating Radiation

Figures 8–11 show the annual accelerator-produced dose equivalent reported by the four perimeter environmental monitoring stations from the year they were established to date. 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. That upward trend was reversed in 1983. The 1990 maximum perimeter dose equivalent of 1.8 mrem (Fig. 8) remains a small fraction of the radiation protection guideline[4] of 100 mrem/yr, reflecting improvements in accelerator beam optics, local shielding, and cave selection.

Airborne and Waterborne Radionuclides

Figure 12 shows the annual releases of tritium (as HTO) from the Building 75 Tritium Facility from 1974 through 1990.

The 160 Ci released during routine operations in 1990 is approximately 33% of the 1989 releases and is responsible for approximately 70% of the LBL-produced population-dose equivalent from all sources for 1990. 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. 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 had been approved by Laboratory management, and the overall reduction in tritium releases from 1989 to 1990 was 67%. However, the first phase was not in place until May 1990. Thus, the improvement exceeded design expectations.

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 13–15 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 16 shows surface and drinking water trends. Figures 17 and 18 illustrate annual average radionuclide concentrations in the LBL sewer outfalls. Under the terms of its license, the UCB campus had historically discharged radionuclides into the Strawberry sewer, complicating the analysis of LBL sewer-sampling data. In recent years the University discharges were reduced, and in May 1990 they were eliminated entirely.

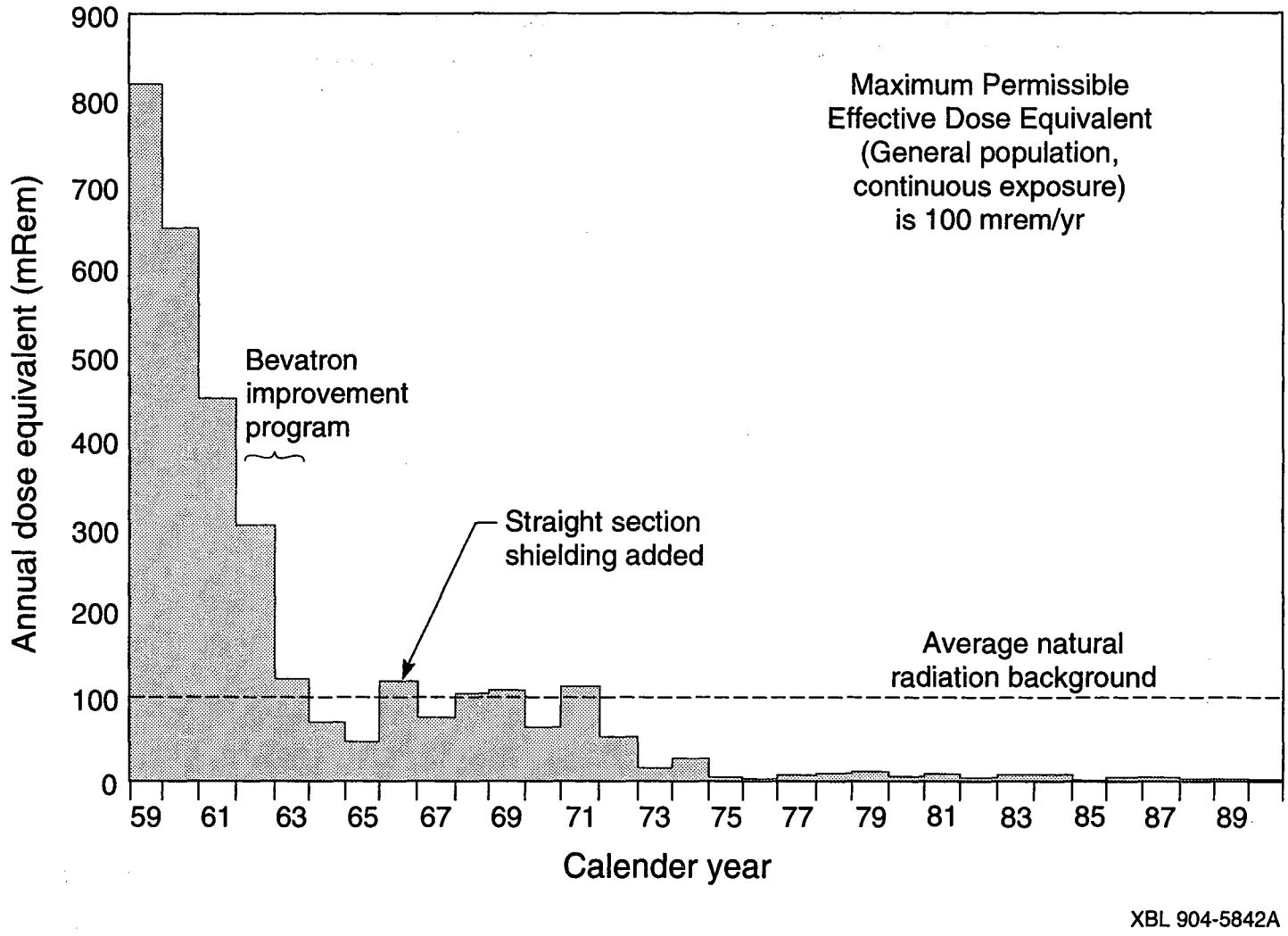


Figure 8. Annual accelerator-produced dose equivalent at the Olympus Gate Environmental Monitoring Station, 1959–1990.

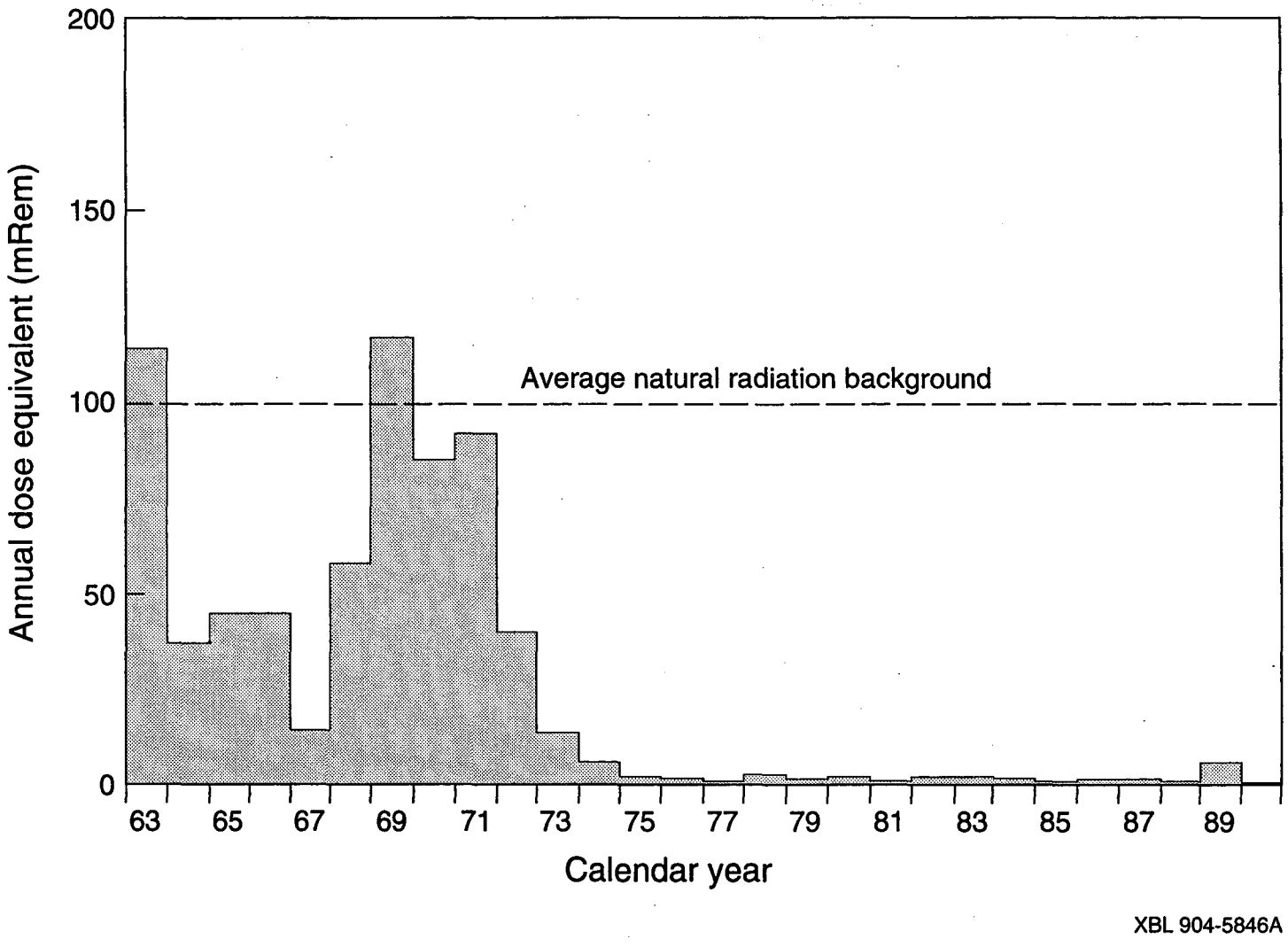


Figure 9. Annual accelerator-produced dose equivalent at Building 90 Environmental Monitoring Station, 1962–1990.

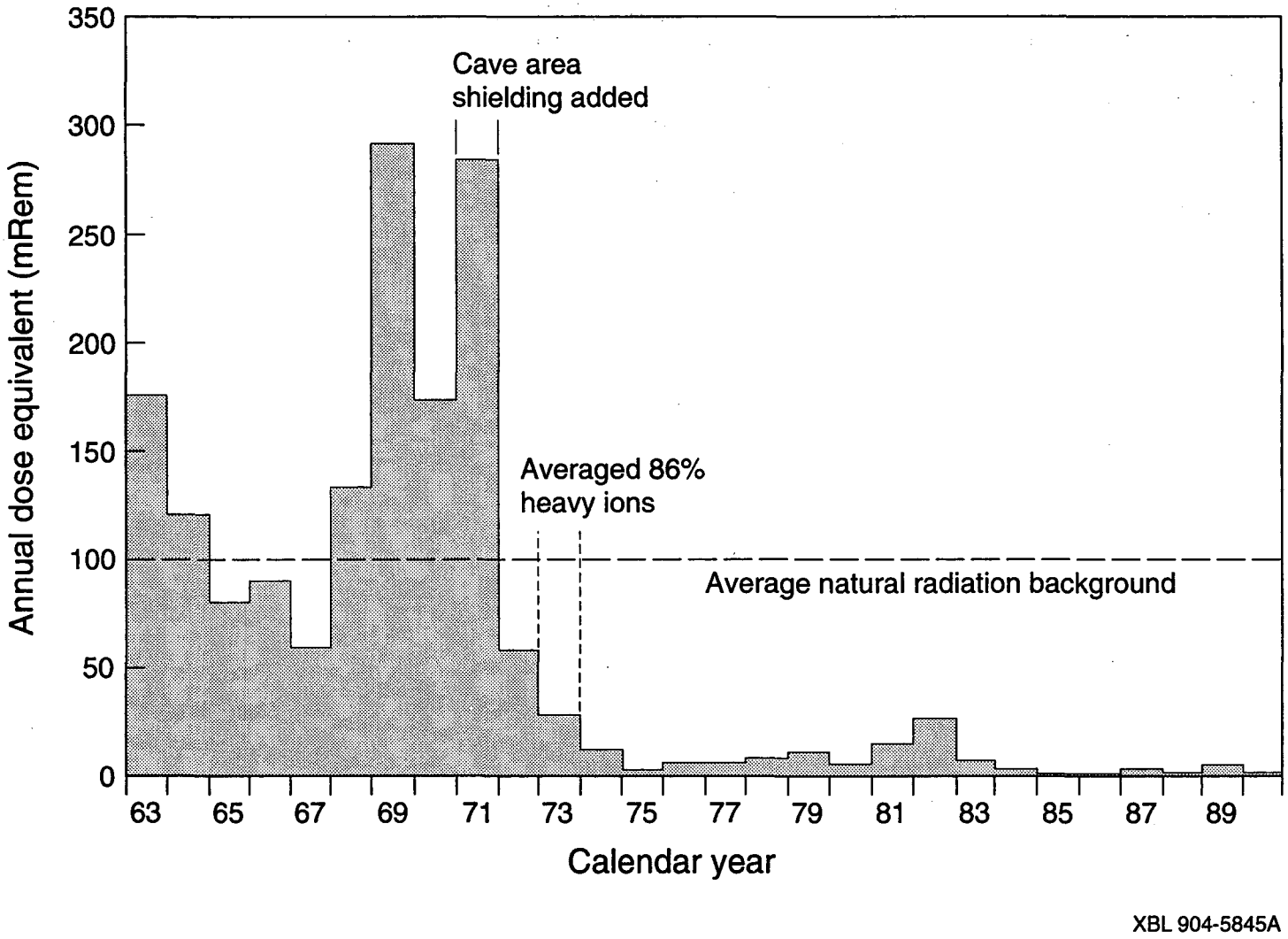


Figure 10. Annual accelerator-produced dose equivalent at the 88-Inch Cyclotron Environmental Monitoring, 1963–1990.

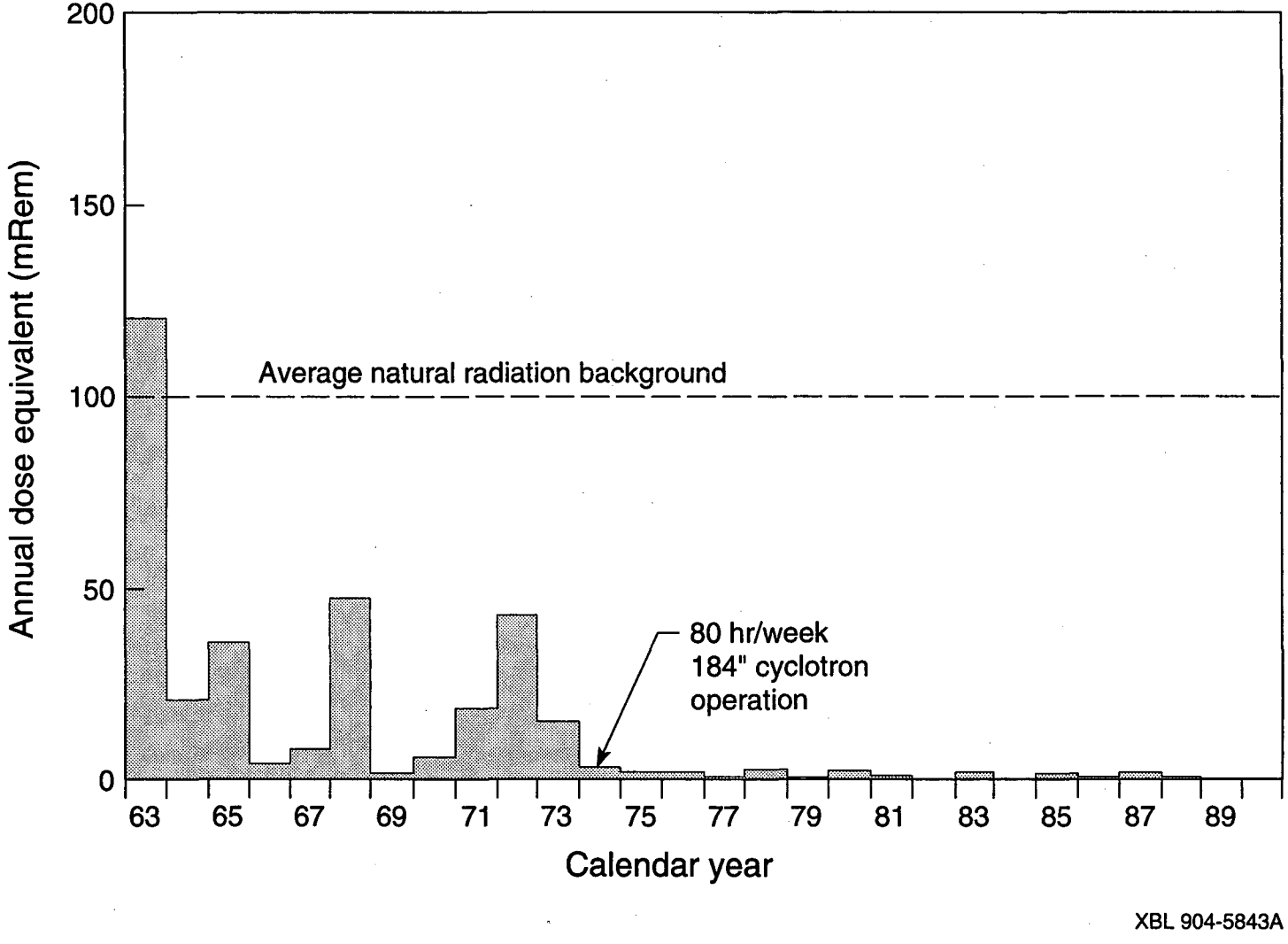


Figure 11. Annual accelerator-produced dose equivalent at the Panoramic Way Environmental Monitoring Station, 1963–1990.

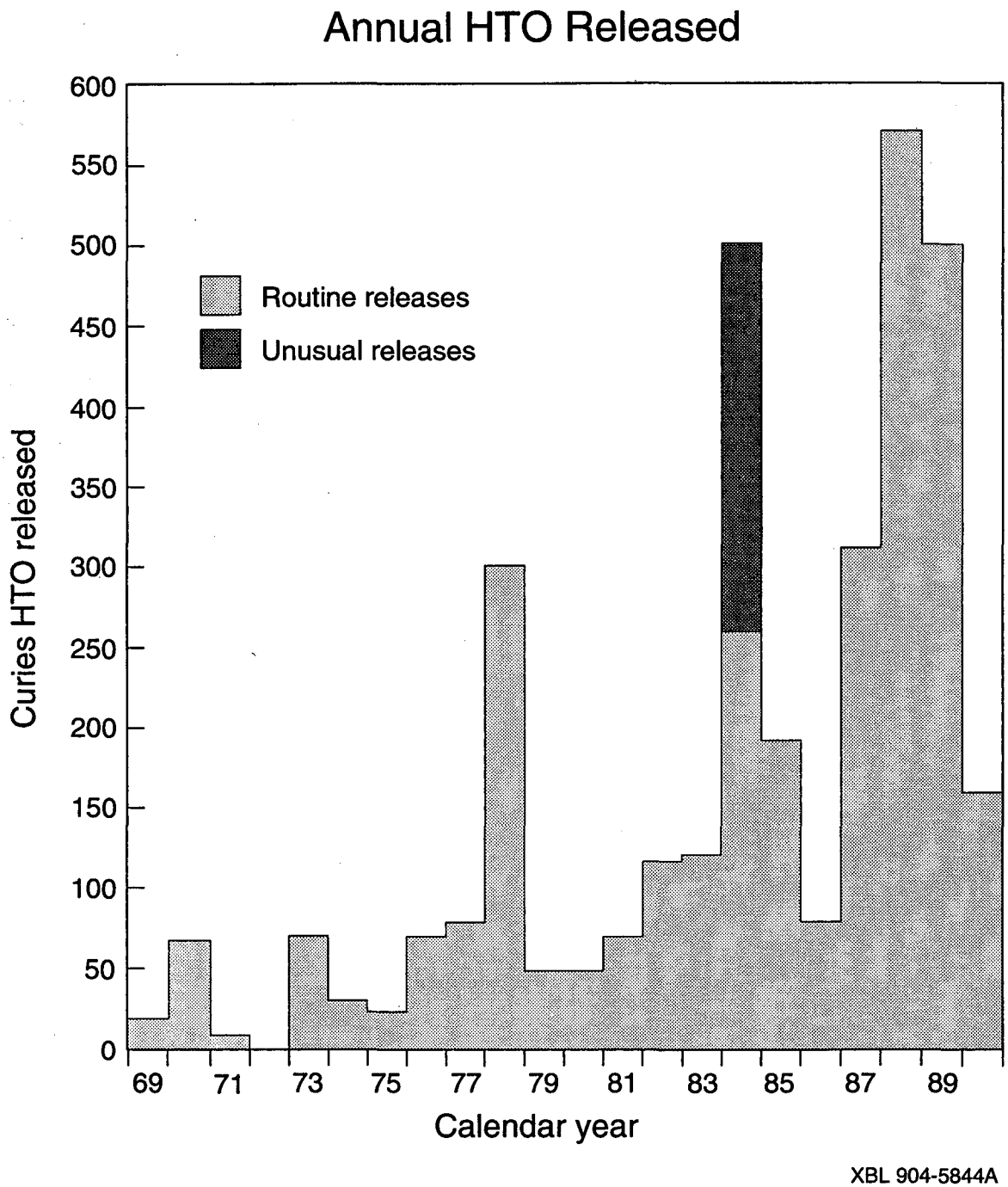


Figure 12. Annual releases of tritium (HTO) from the Building 75 Tritium Facility, 1969–1990.

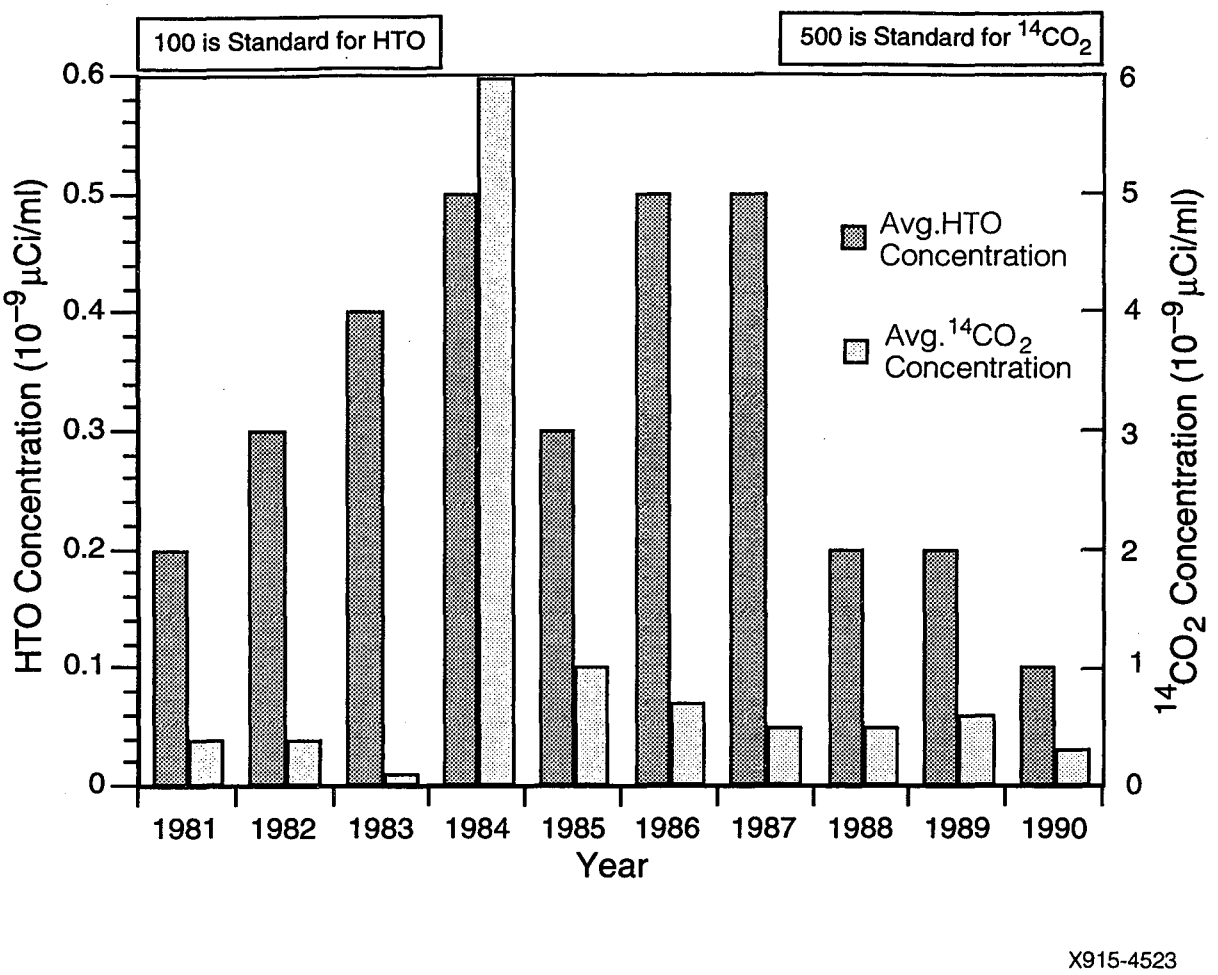


Figure 13. Perimeter airborne environmental HTO and $^{14}CO_2$ trends (Table 5 data plotted). Note that the scale for $^{14}CO_2$ concentration is ten times the scale for HTO concentration.

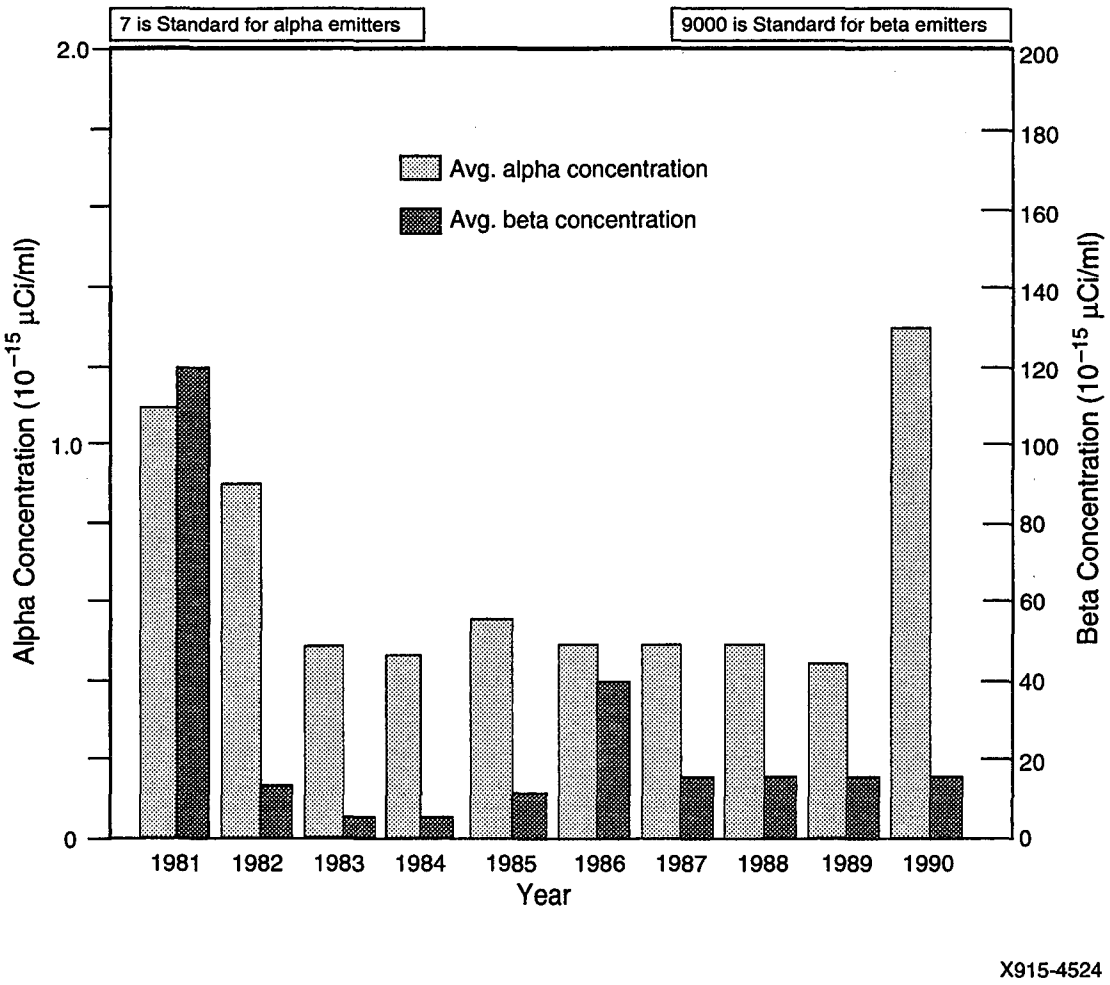


Figure 14. Annual average gross alpha and beta particulate radioactivity found in LBL perimeter air samples, 1981–1990 (Table 8 data plotted). Note that the scale for beta emitters is ten times the scale for alpha emitters.

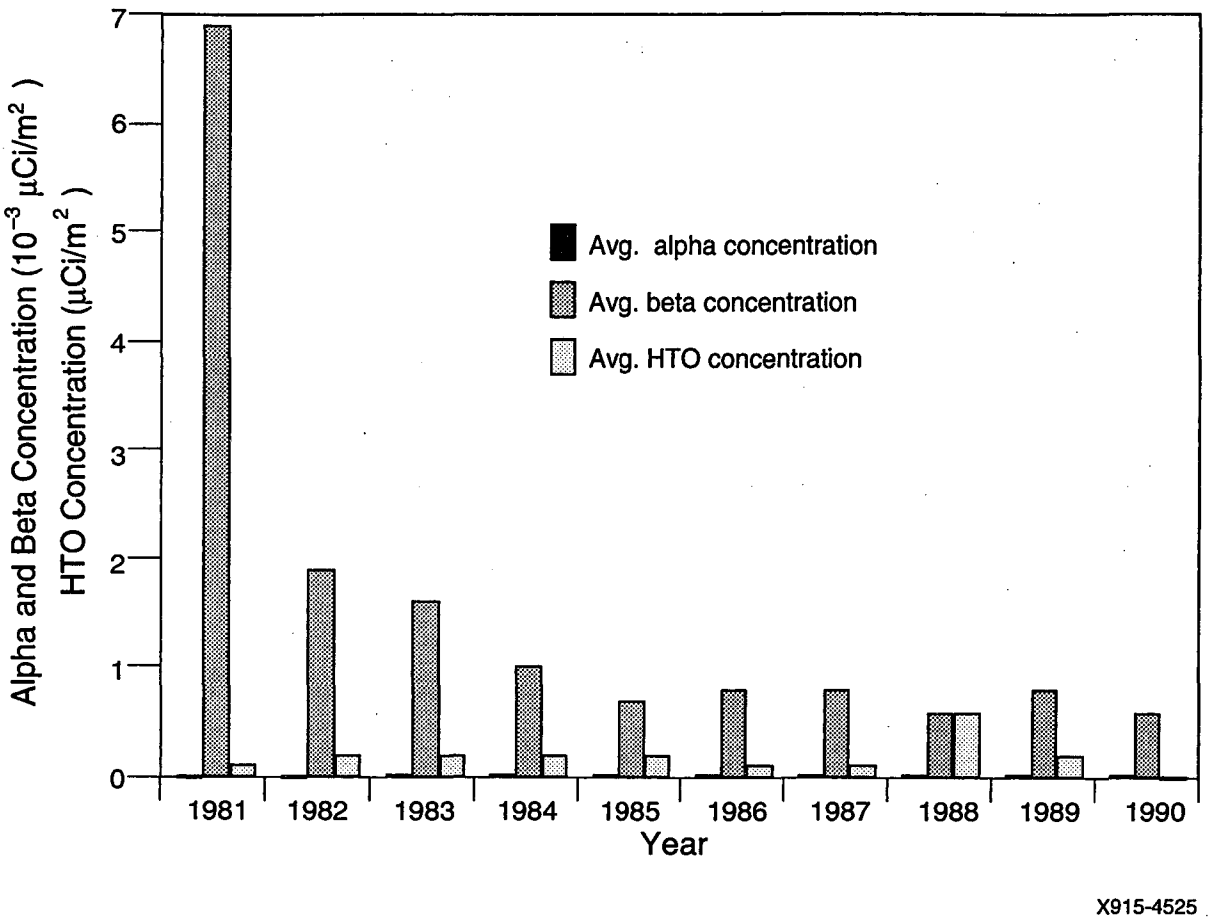


Figure 15. Annual alpha and beta emitters and HTO in LBL perimeter deposition samples, 1981–1990 (Table 10 data plotted).

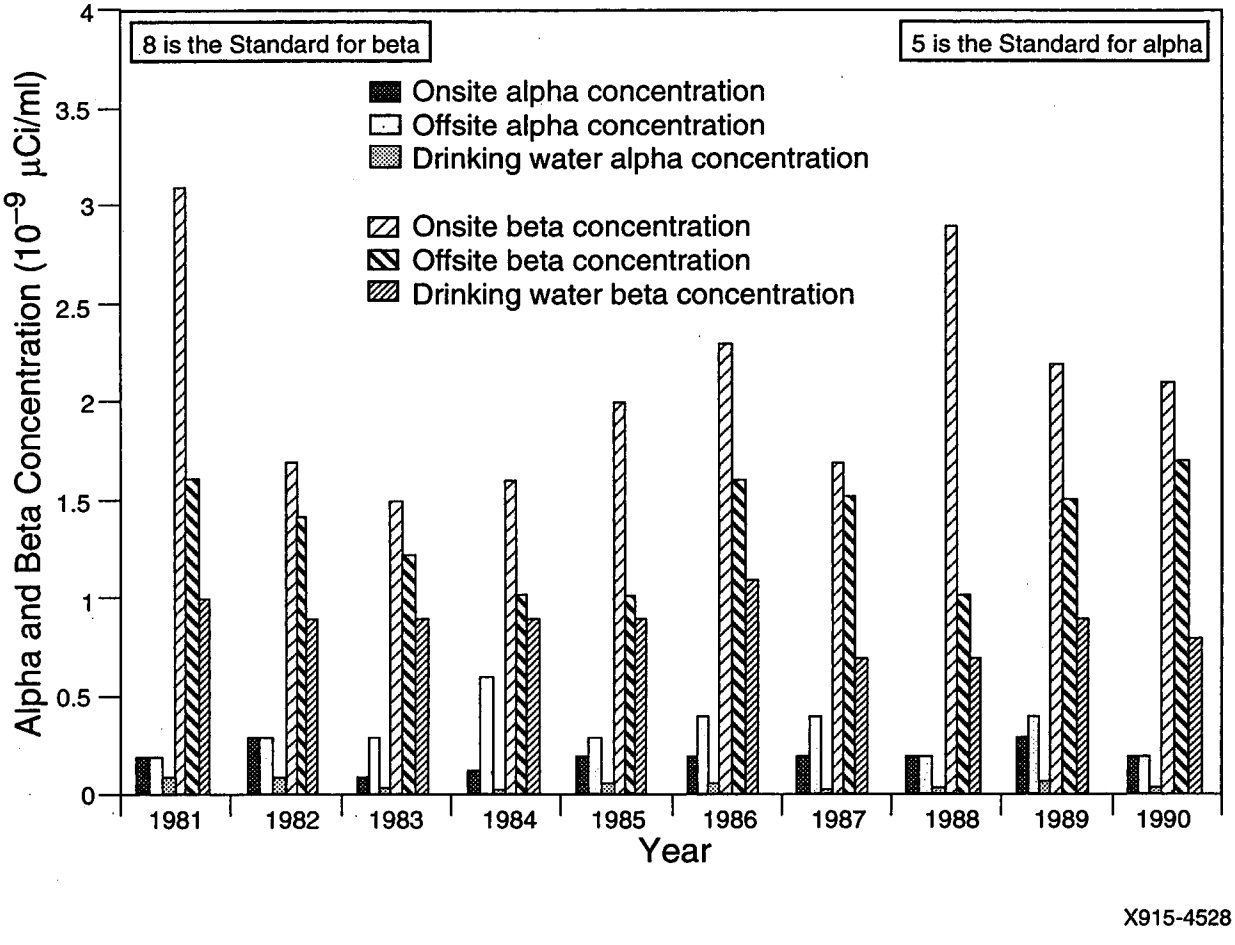


Figure 16. Annual average concentrations of alpha and beta emitters in surface and drinking water samples, 1981–1990 (Table 12 data plotted).

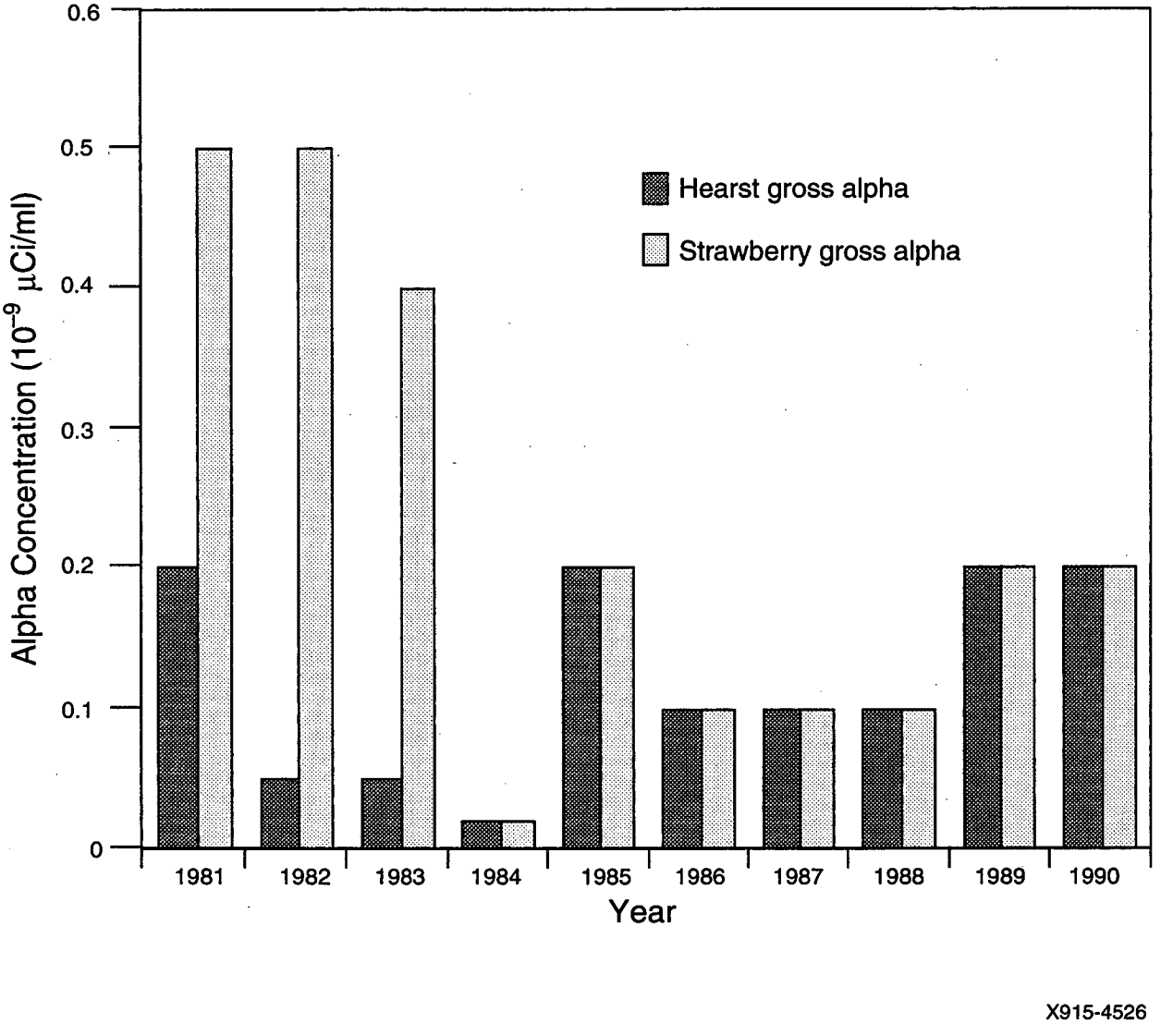


Figure 17. Annual average alpha emitter concentrations in LBL sewer effluents, 1981–1990 (Table 14 alpha data plotted).

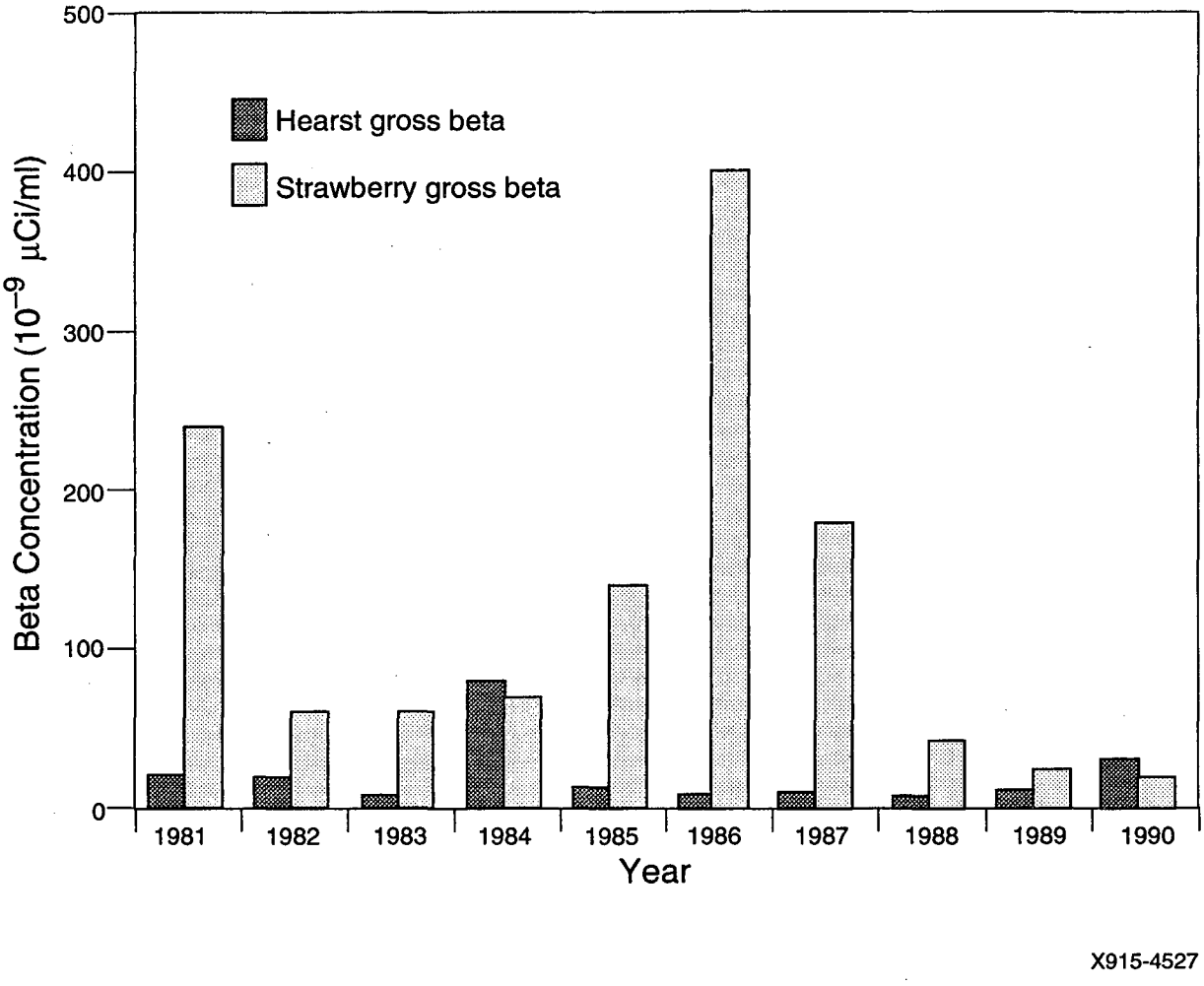


Figure 18. Annual average beta emitter concentrations in LBL sewer effluents, 1981–1990 (Table 14 beta data plotted).

Environmental Nonradiological Program Information

Waterborne Pollutants

Building 25 Plating Shop

As required by the EBMUD Wastewater Discharge Permit #775-00025, wastewater samples were taken from the discharge to the Building 25 treatment unit. In addition, EBMUD collected samples during the year and reported their results to LBL. The samples were analyzed for ten metals as specified by the permit.

There was one wastewater discharge violation in 1990. The violation was for the concentration of copper in the wastewater. Following the notice of violation, the operation of the unit was suspended. Its equipment was checked thoroughly and found to be operating within prescribed tolerances.

It is suspected that the high level of copper may have been the result of a nonuniform mixture of wastewater in the holding tank for the treatment unit. When this material was processed through the unit, an upset condition occurred that was not detected by the unit operator. Two corrective measures were implemented in order to prevent a reoccurrence of the problem. (1) A stirring mechanism was installed in the holding tank to ensure a uniform wastewater mixture. (2) The frequency of monitoring for copper during discharge was increased from once per day to every two hours.

Table 16 summarizes the results from the samples taken by LBL and EBMUD.

Building 77 Plating Shop

As required by EBMUD Permit #776-00077, wastewater samples were taken from the discharge for the Building 77 treatment unit. In addition, EBMUD collected samples throughout the year and reported their results to LBL. Samples were analyzed for eight metals, organics, and cyanide, as specified by the permit.

There were no violations detected in 1990. Table 17 summarizes the results for the samples taken by LBL and EBMUD.

Site Wastewater Discharges

There are two sanitary sewer systems serving LBL: the Strawberry Sanitary Sewer and the Hearst Sanitary Sewer. Effluent from each sewer system is monitored at the LBL boundary. Periodic daily sampling is performed to ensure compliance with the site discharge limits mandated by EBMUD Ordinance No. 311.

At both monitoring stations, representative composite and grab samples were collected according to a schedule prescribed by the permit. Composite samples were analyzed for metals; grab samples were analyzed for volatile organic compounds, oil/grease, and cyanide. Tables 18 and 19 summarize the site wastewater discharge sampling data.

Table 16. Building 25 treatment effluent—1990 sampling data.

Metal	No. of Samples	Concentration (mg/l) Min.	Max.	Avg.	Avg. % of Limit	2 × Std. Dev. (mg/l).	No. over Limit	Limit (mg/l)
Arsenic	1	0.00	0.00	0.00	0.15	NA	0	2
Cadmium	4	0.00	0.01	0.00	0.40	0.00	0	0.69
Chromium	7	0.01	0.05	0.02	1.01	0.03	0	2
Copper	7	0.55	3.60	1.55	45.82	0.86	1	3.38
Iron	2	0.53	1.20	0.87	0.87	NA	0	100
Lead	7	0.03	0.47	0.14	20.70	0.14	0	0.69
Mercury	1	0.00	0.00	0.00	6.00	NA	0	0.05
Nickel	4	0.02	0.06	0.04	1.01	0.04	0	3.98
Silver	3	0.00	0.01	0.01	0.53	0.01	0	1
Zinc	4	0.02	0.12	0.06	2.11	0.05	0	2.61

Table 17. Building 77 treatment effluent—1990 sampling data.

Metal	No. of Samples	Concentration (mg/l) Min.	Max.	Avg.	Avg. % of Limit	2 × Std. Dev. (mg/l)	No. over Limit	Limit (mg/l)
Cadmium	11	0.00	0.39	0.09	13.60	0.23	0	0.69
Chromium	11	0.01	0.59	0.27	13.67	0.47	0	2.0
Copper	11	0.02	2.10	0.67	19.90	1.28	0	3.38
Iron	1	0.06	0.06	0.06	0.06	NA	0	100
Lead	11	0.02	0.17	0.06	8.04	0.10	0	0.69
Nickel	11	0.01	2.40	0.44	10.96	1.35	0	3.98
Silver	1	0.00	0.00	0.00	0.30	NA	0	1
Zinc	11	0.01	1.10	0.25	9.44	0.77	0	2.61
Chlor	1	0.49	0.49	0.49	98.00	NA	0	0.5
Total Cyanide	11	0.01	0.70	0.14	2.86	0.41	0	5

Table 18. Summary of Hearst Monitoring Station—1990 sampling data.

Analyte	No. of Samples	Concentration (mg/l) Min.	Max.	Avg.	Avg. % of Limit	2 × Std. Dev. (mg/l)	No. over Limit	Limit (mg/l)
Arsenic	1	0.01	0.01	0.01	0.70	NA	0	1
Cadmium	11	0.00	0.01	0.00	0.33	0.00	0	1
Chromium	13	0.01	0.37	0.06	2.98	0.20	0	2
Copper	13	0.04	2.40	0.28	5.56	1.28	0	5
Iron	3	1.60	4.69	2.63	2.63	3.41	0	100
Lead	13	0.01	0.11	0.04	1.81	0.07	0	2
Mercury	8	0.00	0.00	0.00	1.35	0.00	0	0.05
Nickel	13	0.01	0.02	0.01	0.22	0.01	0	5
Silver	12	0.01	0.38	0.09	8.93	0.20	0	1
Zinc	13	0.08	3.20	0.40	8.01	1.69	0	5
Chlor HCS	7	0.01	2.11	0.61	121.57	1.63	3	0.5
Oil & Grease	7	1.00	43.00	19.43	19.43	30.70	0	100
Cyanide	2	0.02	0.02	0.02	0.40	0.00	0	5

Table 19. Summary of Strawberry Monitoring Station—1990 sampling data.

Analyte	No. of Samples	Concentration (mg/l) Min.	Max.	Avg.	Avg. % of Limit	2 × Std. Dev. (mg/l)	No. over Limit	Limit (mg/l)
Arsenic	1	0.01	0.01	0.01	0.50	NA	0	2
Cadmium	12	0.00	0.10	0.02	0.51	0.05	0	1
Chromium	14	0.01	0.17	0.06	3.01	0.09	0	2
Copper	14	0.06	0.98	0.23	4.57	0.48	0	5
Iron	2	1.50	2.70	2.10	2.10	1.70	0	100
Lead	14	0.01	0.04	0.03	1.25	0.02	0	2
Mercury	8	0.00	0.00	0.00	2.05	0.00	0	0.05
Nickel	14	0.01	0.37	0.09	1.77	0.20	0	5
Silver	13	0.01	0.26	0.03	3.42	0.14	0	1
Zinc	14	0.08	1.40	0.26	5.20	0.67	0	5
Chlor HCS	10	0.01	3.46	0.80	161.00	2.20	4	0.5
Oil & Grease	5	7.00	32.00	17.00	17.00	18.81	0	100
Cyanide	2	0.02	0.02	0.02	0.40	0.00	0	5

There were three wastewater discharge violations at the Hearst Monitoring Station for total chlorinated hydrocarbons. The major contaminants detected were methylene chloride and chloroform. Purchase records were reviewed for these two materials. As a result, the discharge was eventually determined to be the result of a research activity. This activity was suspended until an alternative method of handling the wastewater was installed.

At the Strawberry Monitoring Station, four wastewater discharge violations were found for levels of total chlorinated hydrocarbons. The primary contaminants were 1,1,1-trichloroethane and methylene chloride. A survey was performed of the major branches to the Strawberry Sanitary Sewer System, and the source was determined to be a building operated by UCB. UCB officials have discontinued the discharges.

Airborne Pollutants

LBL has prepared the following air toxic emission estimates to comply with requirements of the Air Toxics Information and Assessment Act, AB 2588. Air toxic emission estimates were calculated according to procedures outlined in the AB 2588 Emission Inventory Plan, which LBL submitted to the Bay Area Air Quality Management District in October 1989. Estimates were prepared for substances designated by the California Air Resources Board and submitted in the Emissions Estimates Report in December 1989.

The estimates represent emissions from the following sources: boilers, cooling towers, epoxy mixing and epoxy curing, tritium labeling, lead pot hood, metal part cleaners, nondestructive testing hood, oil tank hood, paint spray booths, printing press, sandblasting, soldering, steam evaporator, storage tanks, vacuum coating hood, vapor degreasers, and welding. Annual average emissions and hourly maximum emissions were estimated for the sources analyzed.

Table 20 summarizes the emission estimates determined in 1989. This report must be updated every two years, and these levels will be updated in 1991.

Groundwater Protection

LBL's groundwater protection program is in its infancy. While a number of geotechnical studies had been performed for specific capital projects, no comprehensive strategy for characterizing the site's subsurface had been undertaken. In the summer of 1986, as a part of the environmental baseline study for the development of the East Canyon area within the site, LBL staff collected several samples of soil, groundwater, surface water, and vegetation from within the property's boundary, as well as from adjacent areas. Groundwater samples were collected from a few flowing horizontal drains (hydraugers). Chemical analysis of water samples from two adjacent hydraugers (1.3 and 1.4) east of Building 51 (see Fig. 19) showed low levels of solvents (chlorinated hydrocarbons). Flow rates from these hydraugers are of the order of one or two liters per minute. Because of the persistence of these levels of chemical contamination in the

Table 20. Air toxics emission estimates.

Substance	Annual Average Emissions (lb/yr)	Hourly Max. Emissions (lb/hr)
Benzene	0.7	<0.1
Chromium	<0.1	<0.1
1,4-dioxane	185.4	0.2
Epichlorohydrinpolyglycol	50.0	0.1
Ethylene Glycol Butyl Ether	6.7	0.3
Formaldehyde	10.8	<0.1
Freon	195.0	4.9
Gasoline	1334.0	58.6
Isophorone Diisocyanate	0.5	0.1
Lead	2.5	0.1
Lead Chromate	1.6	<0.1
Methyl Alcohol	25.3	1.2
Methylene Chloride	398.0	0.2
Naphthalene	5.4	0.6
Nickel	<0.1	<0.1
Petroleum Hydrocarbons	<0.1	<0.1
Perchloroethylene	102.0	<0.1
Phosphoric Acid	9.5	1.0
Potassium Zinc Chromate	0.2	<0.1
Propylene Glycol Methyl Ether	33.4	1.2
Sodium Hydroxide	<100	—
Toluene	115.7	.5
Tritium	8.9×10^{-7}	1×10^{-10}
1,1,1-Trichloroethane	1278.0	5.6
Xylene	74.4	0.7
Zinc Chloride	1.2	<0.1
Zinc Chromate	0.4	<0.1

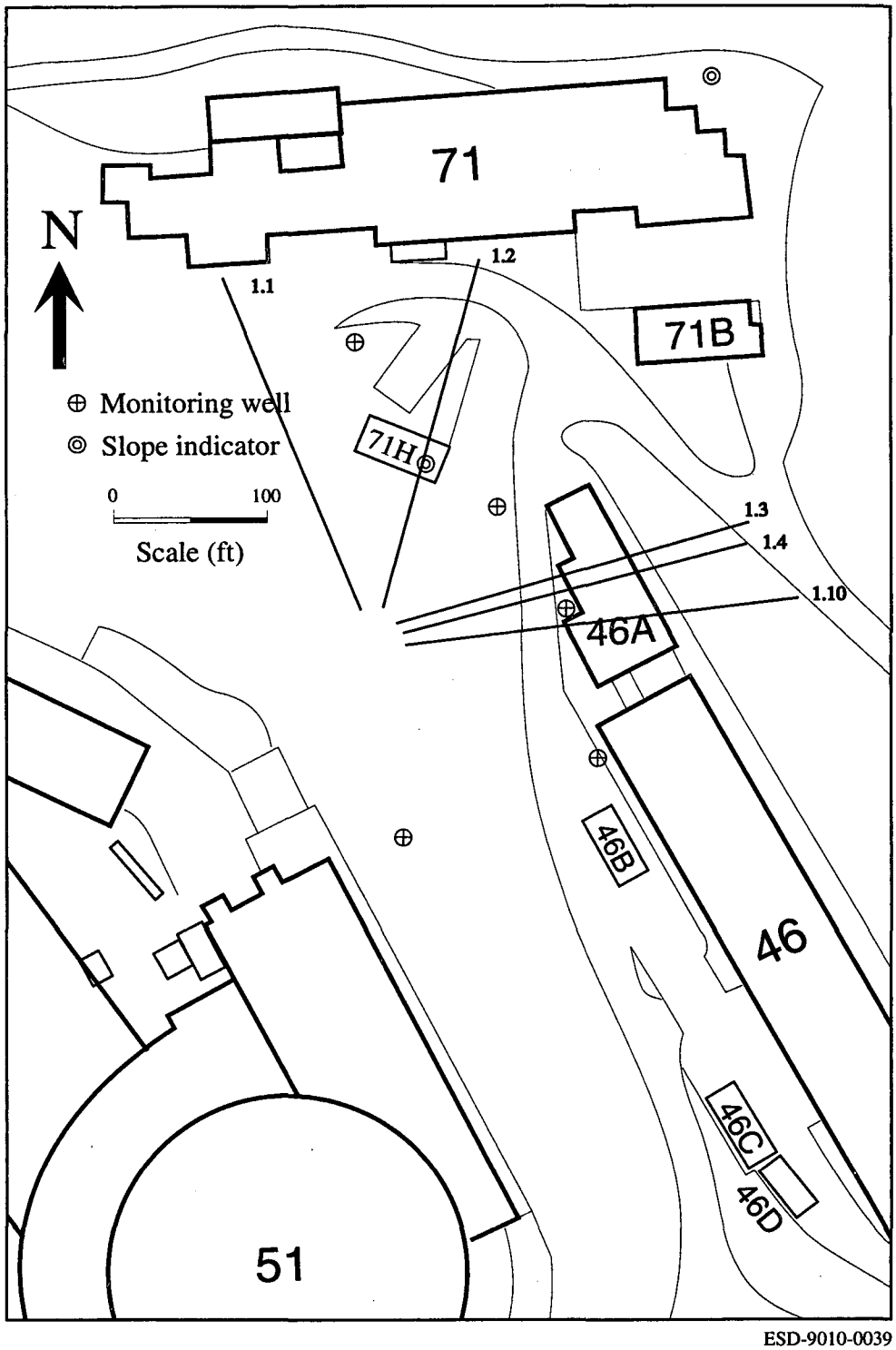


Figure 19. Approximate position of Hydraugers 1.1, 1.2, 1.3, 1.4 and 1.10 of 51 series.

effluent water from these two hydraugers and the observation of contamination elsewhere on the site, in 1989 LBL submitted a proposal to DOE for a sitewide environmental characterization and monitoring program. Meanwhile, during Fiscal Year 1990, LBL carried out a preliminary investigation. This investigation essentially concentrated on three areas as shown circled in Fig. 20. Groundwaters in these areas are believed to be confined to three different hydrologic sub-basins. The results of this investigation are as follows:

1. The source of contamination observed in the hydraugers' effluent east of Building 51 is believed to be leakage from a sanitary sewer coming from Building 71 (see Fig. 21). This sewer line was decommissioned during 1988. A few chlorinated hydrocarbons were also detected in a relatively narrow aquifer formed along the bed of the main branch of the original Blackberry Canyon Creek. A piezometric map of this narrow aquifer is shown in Fig. 22. Observed concentrations of chlorinated hydrocarbons in the groundwater never exceeded 0.1 mg/L during the course of this investigation. To investigate the extent of contamination, three new monitoring wells (90-4, 90-5, and 90-6) were constructed downstream from the observed position of the contaminant plume. Locations of these wells are shown in Fig. 23. Chemical analyses of water samples from these wells indicate that the plume of contamination is contained in an area up-gradient from these three wells.

2. Chemical analysis of "grabbed" samples from a few wells and slope indicators in the "old town" area (Buildings 7, 52, and 53) showed chlorinated hydrocarbon concentrations ranging up to 2 mg/L (see Fig. 24 for measured values of PCE). However, study of subsurface geologic information from past and recent drilling, as well as a single pumping test, indicates that the contaminated water is limited to a very thin saturated seam (about 4 inches thick), having a very low hydraulic transmissivity. Further studies will be carried out to check the validity of this conclusion.

3. Chemical analysis of water samples collected from three closely spaced wells in the Corporation Yard (Building 69–75 area) showed low concentrations of chlorinated solvents (less than 0.1 mg/L). Figure 25 shows measured concentrations of PCE in these wells, and Fig. 26 presents a piezometric map of this area. Based on present information, the plume of contamination in this area appears to be relatively small.

A more detailed discussion of this preliminary study can be found in Javandel (1990).[18]

A sitewide program of investigation is being implemented during Fiscal Year 1991 to complete the characterization of possible areas of subsurface environmental contamination at LBL. Specific attention will be paid to determining if contamination exists in groundwaters at the property boundaries.

As part of the ongoing environmental monitoring program, six of LBL's many hydraugers were sampled monthly. Samples taken were counted for tritium and gross alpha and beta activity. One sampling point, designated 75–77 hydr, collects water from a group of four bores, which were drilled horizontally ~60 m into the earth fill where Buildings 75, 75A, 75B, and 69 were built. The bores are manifolded together and drain

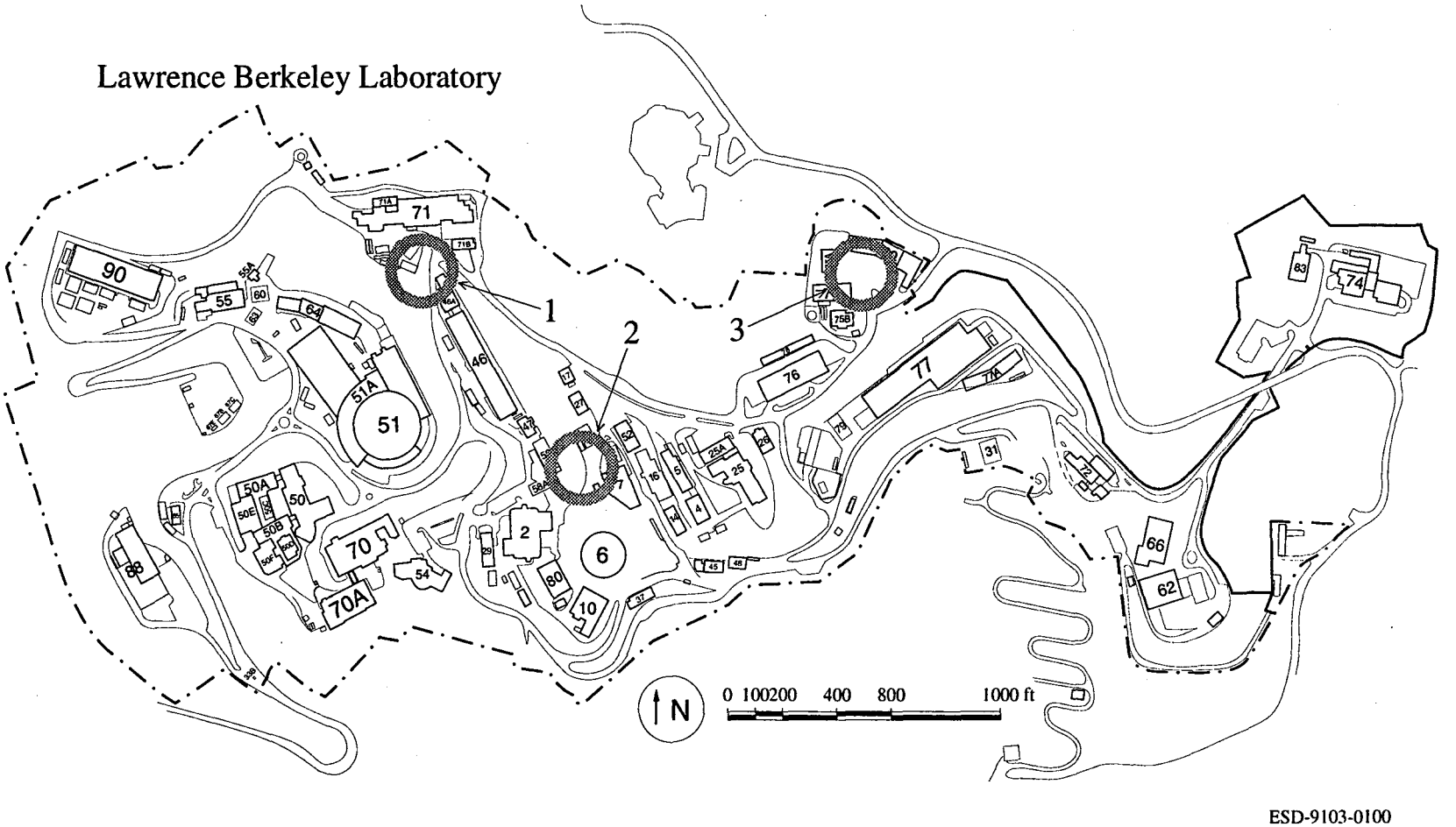


Figure 20. Location of three sites where environmental investigations were carried out.

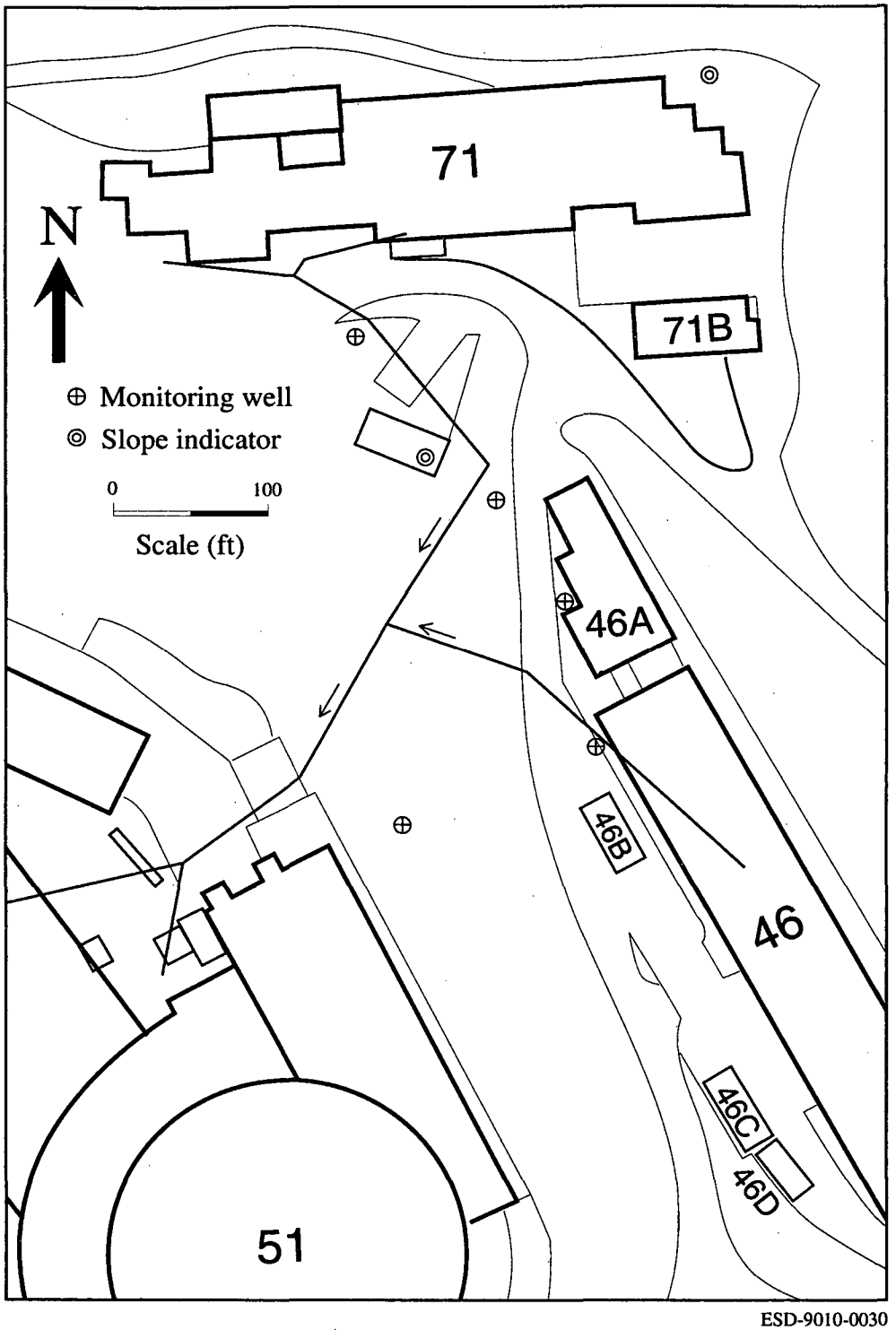
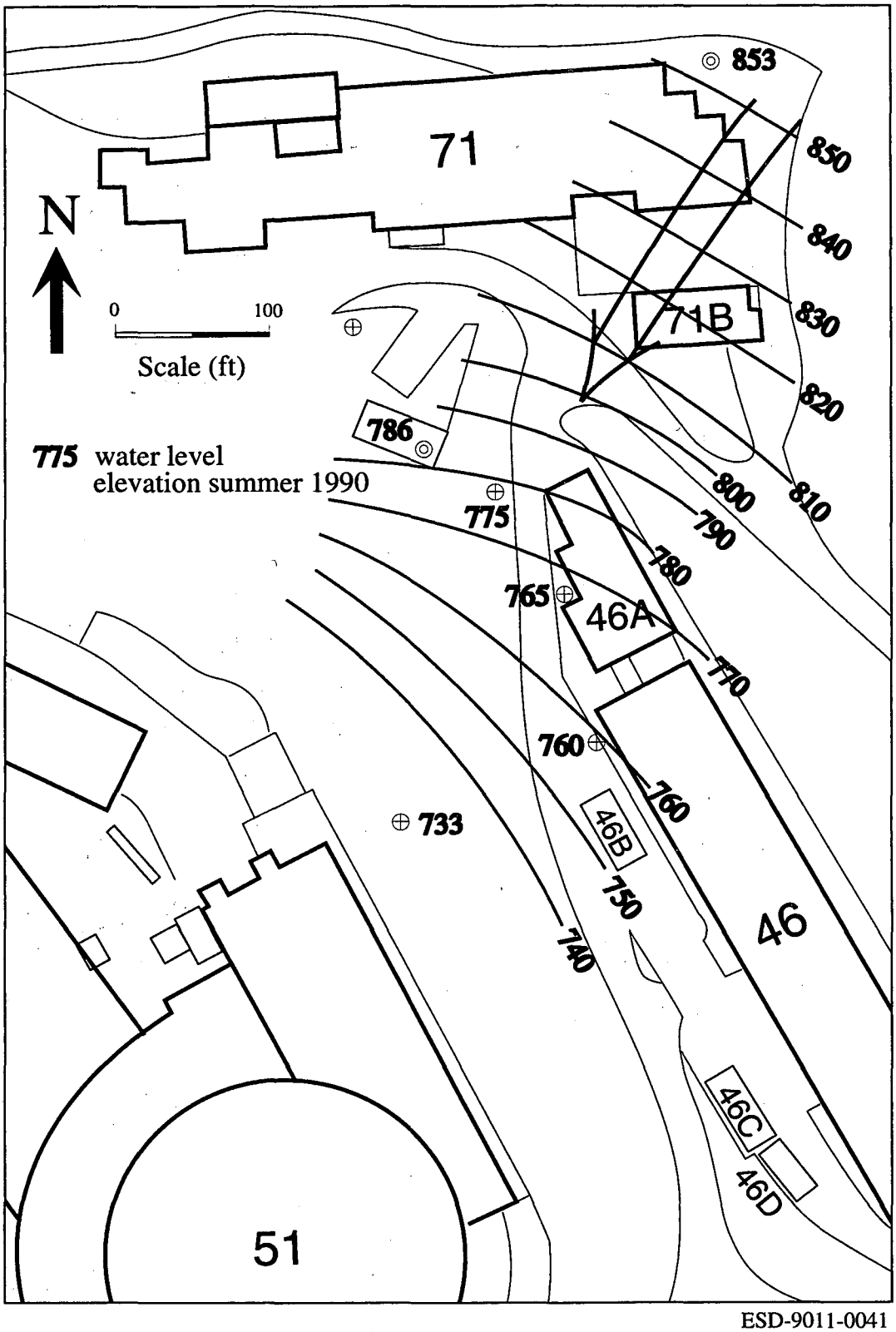


Figure 21. Sanitary sewer lines in the vicinity of Bldgs. 46, 51 and 71.



ESD-9011-0041

Figure 22. Piezometric map of groundwater in the vicinity of Bldgs. 46, 51 and 71, during the summer of 1990.

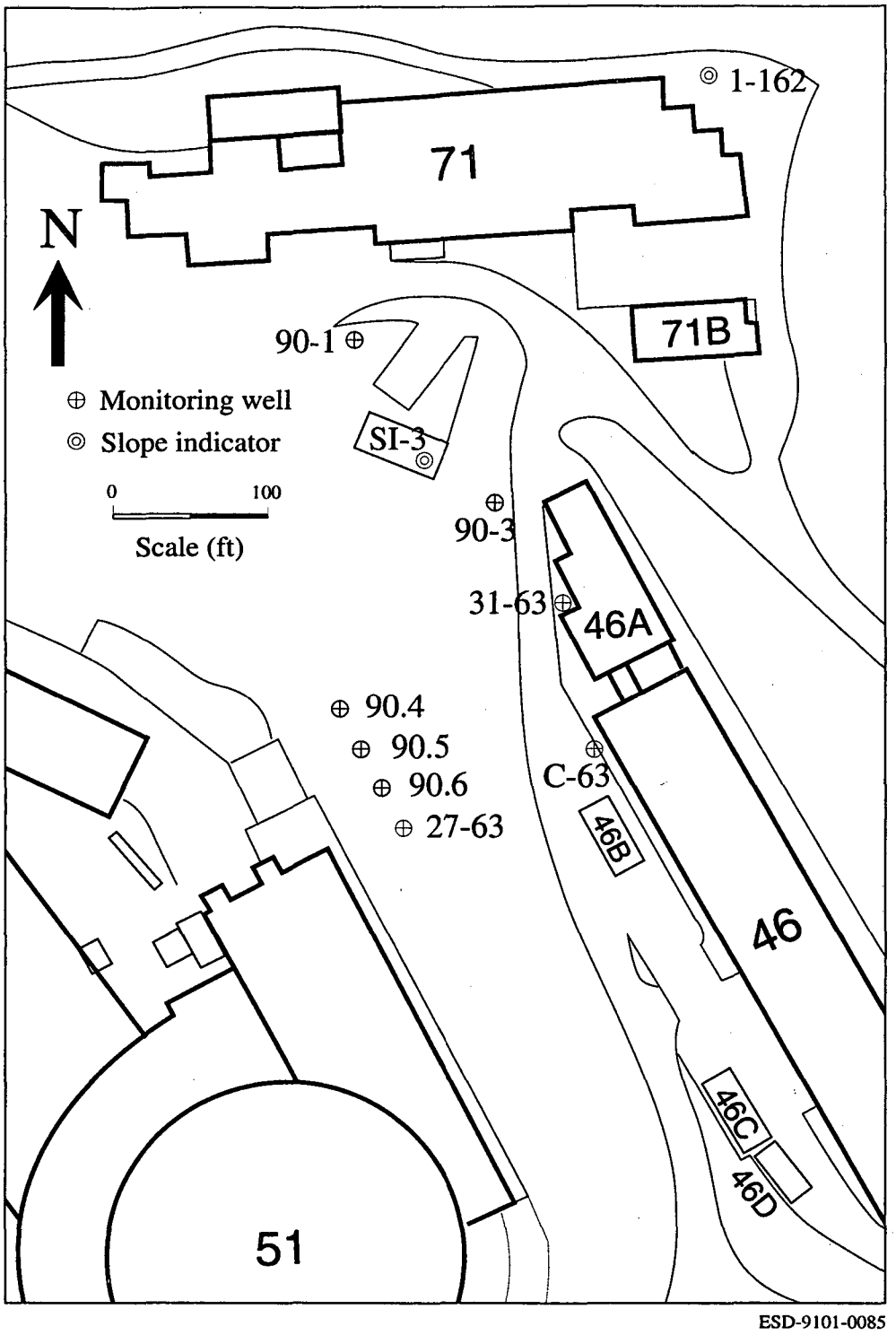
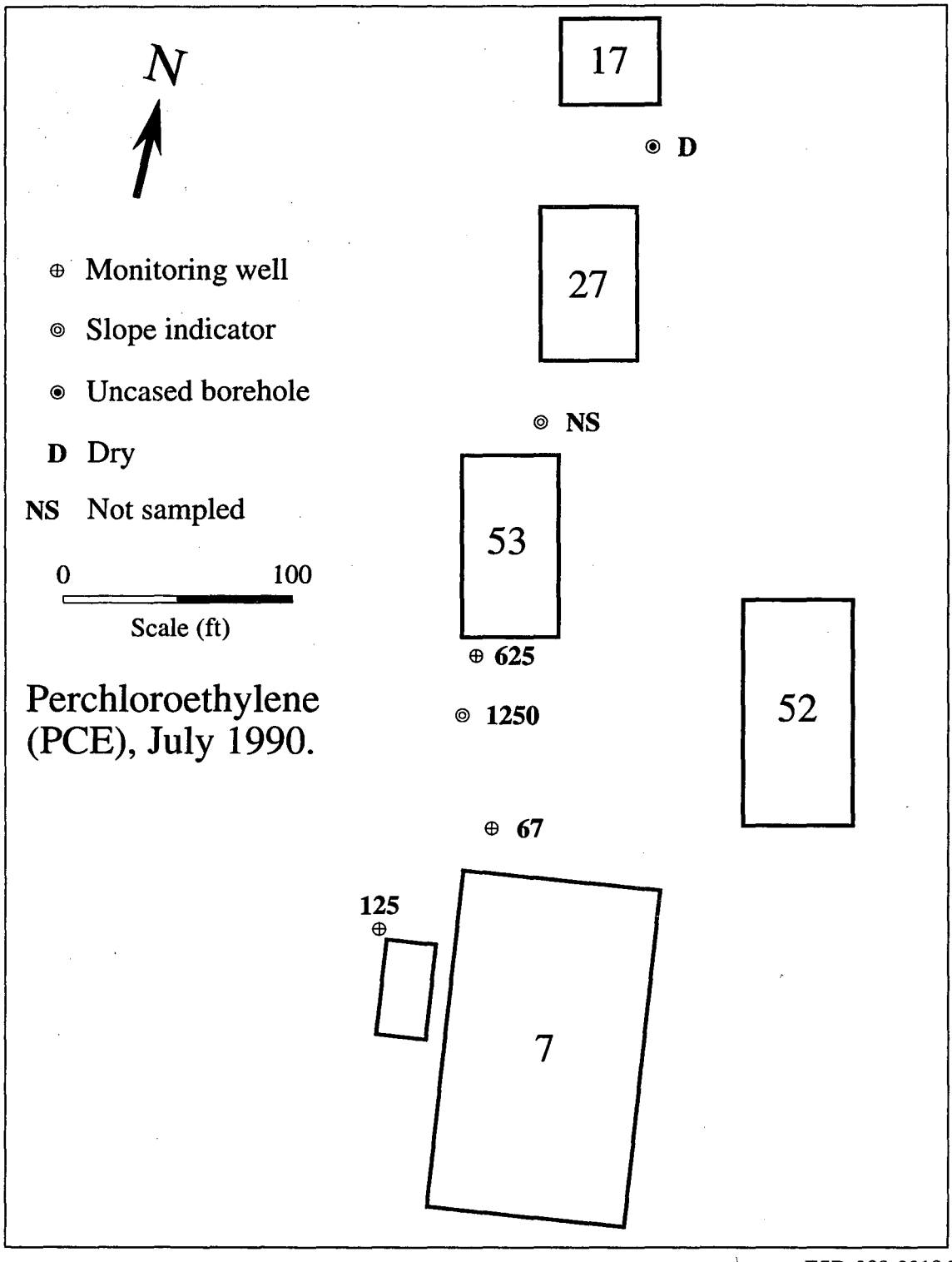


Figure 23. Location of monitoring wells and slope indicators in the vicinity of Buildings 46–51–71.



ESD-908-0018d

Figure 24. Perchloroethylene (PCE) concentration in ppb, measured in water samples from wells and slope indicators in July 1990.

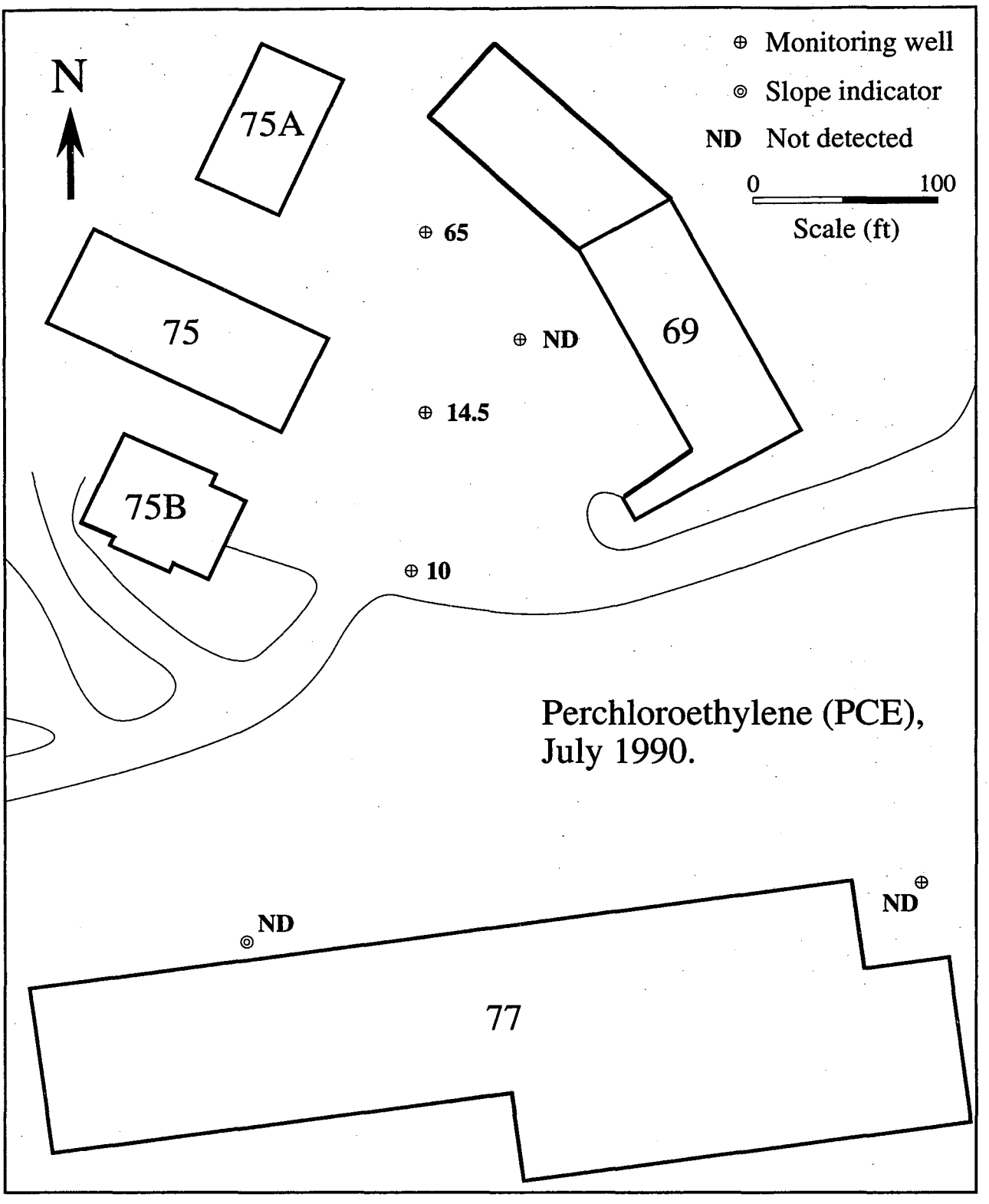
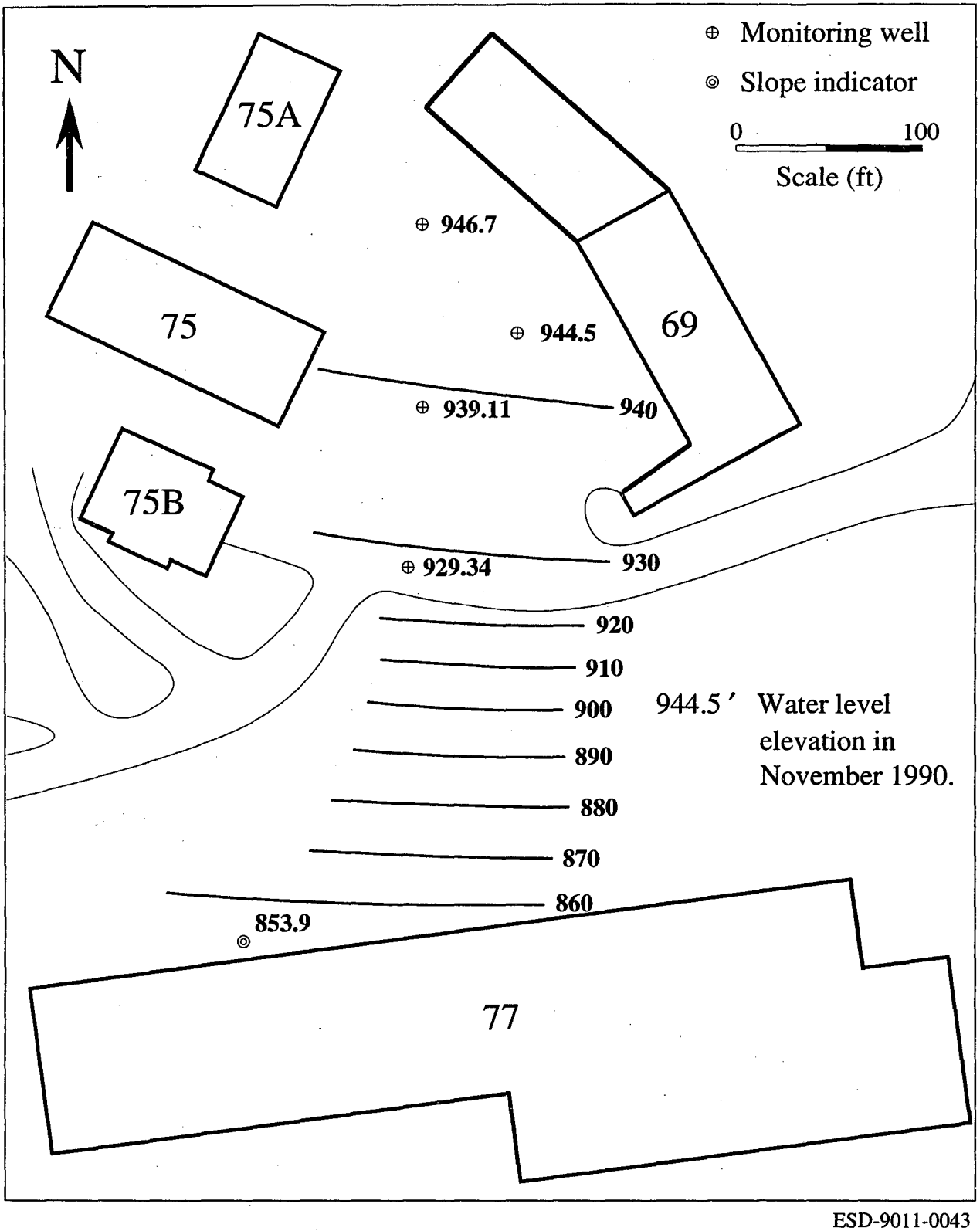


Figure 25. Perchloroethylene (PCE) concentration in ppb, measured in water samples from wells and slope indicators in July 1990.



ESD-9011-0043

Figure 26. Piezometric map of groundwater in November 1990.

north of Bldg. 77 (see Fig. 7 for the approximate "fan out" of the hydrauger bores). The second hydrauger, designated CC hydr, is an approximately 750-m-long horizontal bore from the Chicken Creek access road into Little Grizzly Peak (see Fig. 1). The hydrauger designated CC-B hydr is a 150-m bore. The hydrauger designated 7712H hydr is approximately 64 m long, begins under the east end of LBL Building 76, and drains through the retaining wall north of Building 77. The hydrauger designated 7714H hydr is approximately 68 m long and runs approximately north-south from its origin in the earth lens on which Building 75 was constructed 10 m southeast of Building 75 to the retaining wall north of Building 77. The hydrauger designated 71 hydr is a manifolded group of six bores that fan easterly into the hillside south and east of Building 71. All sampled hydraugers except 7714H continued to flow throughout 1990. The flow from 7714H stopped in August. The 75–77 hydrauger was chosen to be sampled, since it drains water from the earth fill that is rained upon by the highest measured tritium-in-rainfall concentration (see Table 9). The CC hydrauger is the deepest hydrauger (below grade) at LBL and is sampled so that the deepest available groundwater can be assayed. The 71 hydrauger group is sampled because it drains groundwater from the western side of the hill on which the tritium stack is located. The 7712H and 7714H hydraugers are sampled because their bores begin closest to the tritium facility.

Table 21 summarizes the hydrauger data for 1990. Significant concentrations of tritium were found in three of the hydraugers sampled. Indeed, the average tritium concentration of 26,000 pCi/l found in the 7712H hydrauger exceeded the EPA 40 CFR 141 limit of 20,000 pCi/l of tritium in community drinking water. It should be noted that the flow from 7712H is low (on the order of 0.2 l/min) and that the local surface and groundwater does not serve as a source of drinking water. The waters that flow from the 7712H and 14H hydraugers and the 75–77 hydrauger system are heavily mineralized. The gross radioactivity found in those three hydraugers is typical of such waters. There is no reason to attribute any of the radioactivity found in the hydraugers (aside from tritium) to LBL activities.

Quality Assurance

During 1990, in addition to the quality-assurance procedures described in the body of this report, samples that were blind-spiked with tritium were analyzed along with each group of environmental samples assayed for HTO.

The calibration of all penetrating radiation detectors was performed with National Institute of Standards and Technology (NIST) or NIST-traceable radioactive standards.

Particulate air sampling was performed with media certified to collect >99.9% of all particles ≥0.3 μm in diameter.

The cartridges used for sampling air for radioiodine were batch certified (certificates of performance provided) by the registered independent testing laboratory that performed the evaluations.

Table 21. Summary of ground-water samples, 1990.

Hydrauger Designation	No. of Samples	Concentration (10^{-9} µCi/ml)						Concentration (10^{3} pCi/l)			Average as % of drinking-water standard		
		Alpha			Beta			Tritium as HTO			Alpha	Beta	Tritium
		Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	%	%	%
CC Hydr.	12	≤0.7	≤2.2	≤2.2	0.7±0.2	≤0.5	1.1±0.7	≤0.1	≤0.7	1.1	≤14	9	0.5
CC-B Hydr.	12	≤1.2	≤1.2	≤4.2	1.1±0.2	≤0.8	2.4±0.9	≤0.1	≤0.7	1.1	≤24	14	0.5
71 Hydr.	12	0.6±0.5	≤1.0	≤2.0	0.8±0.2	≤0.72	1.8±0.6	0.2±0.1	≤0.7	≤0.7	12	10	1
75–77 Hydr.	11	≤1.6	≤3.2	≤10.5	3.5±0.3	≤0.9±1.4	13.4±2.0	4.5±0.7	2.7±0.5	6.1±1.5	≤32	44	23
77 12H Hydr.	12	≤1.6	≤2.0	≤9.0	4.0±0.5	1.6±1.0	6.0±1.6	26.0±3.0	19.0±2.0	32.0±4.0	≤32	50	130[b]
77 14H Hydr.	7	≤6.0	≤2.0	≤32.0	6.5±1.0	1.0±0.8	33.0±10	7.0±1.0	4.0±0.7	8.0±1.0	≤120	81	70
Drinking-water standard[a]		5			8			20					

[a]40 CFR 141, beta assumed to be ^{90}Sr.

[b]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 20×10^{-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.

The LBL Environmental Monitoring Section analyzed DOE's Environmental Measurements Laboratory (EML) QAPXXXII and QAPXXXIII water samples for tritium, as well as air and water samples for several gamma emitting nuclides. The results, as reported in Refs. 19 and 20, are tabulated in Table 22.

During 1990 the Section began analyzing Environmental Protection Agency (EPA) Intercomparison Studies Program Samples in preparation for California State Certification of the radioanalytical laboratory. The results are tabulated in Table 23. After an inauspicious start, the laboratory was brought into control.

All nonradiological assays for contaminants in water were performed by California State-certified water-testing laboratories. Sample containers used were provided by those vendors. Sample collection, preservation, and chain-of-custody procedures were carried out by LBL personnel according to vendor specifications.

Table 22. LBL QAP sample results, 1990.

QAP Sample #	Date	Medium	Nuclide	Reported LBL Results[a] (± percent)	EML Value	Ratio LBL/EML
XXXII	3/90	Air	^{7}Be	$4.40 \times 10^{3} \pm 22$	5.14×10^{3}	0.86
		Air	^{54}Mn	$9.40 \times 10^{2} \pm 21$	1.26×10^{2}	0.98
		Air	^{57}Co	$6.50 \times 10^{2} \pm 23$	6.50×10^{2}	1.00
		Air	^{60}Co	$1.06 \times 10^{3} \pm 18$	9.40×10^{2}	1.13
		Air	^{134}Cs	$1.90 \times 10^{3} \pm 21$	1.82×10^{3}	1.04
		Air	^{137}Cs	$2.20 \times 10^{3} \pm 18$	2.04×10^{3}	1.08
		Air	^{144}Ce	$3.20 \times 10^{3} \pm 31$	3.12×10^{3}	1.03
		Water	^{3}H	$1.70 \times 10^{5} \pm 10$	1.96×10^{5}	0.87
		Water	^{54}Mn	$9.6 \times 10^{3} \pm 26$	1.03×10^{4}	0.93
		Water	^{57}Co	$1.96 \times 10^{4} \pm 20$	1.98×10^{4}	0.99
		Water	^{60}Co	$2.07 \times 10^{4} \pm 19$	2.06×10^{4}	1.00
		Water	^{134}Cs	$5.17 \times 10^{4} \pm 19$	4.62×10^{4}	1.12
		Water	^{137}Cs	$2.05 \times 10^{4} \pm 19$	1.98×10^{4}	1.04
		Water	^{144}Ce	$4.44 \times 10^{4} \pm 27$	4.03×10^{4}	1.10
XXXIII	9/90	Air	^{54}Mn	$2.92 \times 10^{3} \pm 11$	3.33×10^{3}	0.88
		Air	^{57}Co	$1.22 \times 10^{3} \pm 12$	1.14×10^{3}	1.07
		Air	^{60}Co	$2.48 \times 10^{3} \pm 11$	2.54×10^{3}	0.98
		Air	^{134}Cs	$1.88 \times 10^{3} \pm 11$	1.63×10^{3}	1.15
		Air	^{137}Cs	$1.71 \times 10^{3} \pm 11$	1.57×10^{3}	1.09
		Air	^{144}Ce	$1.84 \times 10^{3} \pm 11$	1.65×10^{3}	1.12
		Water	^{3}H	$4.50 \times 10^{5} \pm 12$	3.90×10^{5}	1.15
		Water	^{54}Mn	$2.62 \times 10^{4} \pm 11$	3.01×10^{4}	0.87
		Water	^{57}Co	$1.38 \times 10^{5} \pm 11$	1.30×10^{5}	1.06
		Water	^{60}Co	$5.48 \times 10^{4} \pm 11$	4.91×10^{4}	1.12
		Water	^{134}Cs	$4.04 \times 10^{4} \pm 10$	3.55×10^{4}	1.14
		Water	^{137}Cs	$4.33 \times 10^{4} \pm 10$	3.90×10^{4}	1.11
		Water	^{144}Ce	$9.12 \times 10^{4} \pm 10$	9.23×10^{4}	0.99

[a]Results for water are in Bq/ml; results for air are in Bq/sample.

Table 23. Summary of Performance in EPA intercomparison study samples, 1990.

Date Received	Analysis	Due Date	Media	LBL Results (pCi/L)*			EPA Value (pCi/L)*	Passed
5/14/90	Gross α	6/8/90	Water	5	6	5	22 ± 6	No
	Gross β		Water	22	21	19	15 ± 5	Yes
6/27/90	^{3}H	7/20/90	Water	3181	3208	2675	2933± 358	Yes
9/17/90	Gross α	11/9/90	Filter	21	23	21	10 ± 5	No
	Gross β		Filter	88	87	83	62 ± 5	No
	^{90}Sr		Filter	30	30	29	20 ± 5	No
	^{137}Cs		Filter	31	27	29	20 ± 5	No
9/20/90	^{89}Si	11/23/90	Water	6	6	6	10 ± 5	Yes
	^{90}Sr		Water	11	11	12	9 ± 5	Yes
9/90	Gross α	10/19/90	Water	8	7	7	10 ± 5	Yes
	Gross β		Water	10	11	8	10 ± 5	Yes
10/11/90	^{60}Co	11/16/90	Water	23	25	22	20 ± 5	Yes
	^{65}Zn		Water	85	87	86	115 ± 12	No
	^{106}Ru		Water	148	142	165	151 ± 15	Yes
	^{134}Cs		Water	11	11	12	12 ± 5	Yes
	^{137}Cs		Water	12	13	14	12 ± 5	Yes
	^{133}Ba		Water	94	100	94	110 ± 11	Yes

*The filter results were pCi/Filter.

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Appendix A
List of Tables and Figures

Tables

Figures

Appendix B

U. S. Department of Energy
Air Emissions Annual Report
(under Subpart H, 40 CFR 61.94)
Calendar Year 1990

Site Name: Lawrence Berkeley Laboratory

Operations Office Information

Office:	San Francisco Operations Office		
Address:	1333 Broadway Oakland, CA 94612		
Contact:	Edward Ballard	Phone:	(415) 273-7967

Site Information

Operator:	University of California		
Address:	1 Cyclotron Road Berkeley, CA 94720		
Contact:	Gary Schleimer	Phone:	(415) 486-7623

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 science 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.

The Laboratory also supports nationwide university-based research by providing national facilities, including the National Center for Electron Microscopy, three large accelerators, several small accelerators, a number of radiochemical laboratories, several large gamma irradiators, and a tritium (^{3}H) labeling laboratory. The Bevatron (Building 51 in Fig. 1) 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. 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. Aside from shutdown periods, the first two of these accelerators provide beams around the clock. The 88-Inch Cyclotron provides beams ~120 hr/wk.

The tritium facility located in Building 75 was designed to handle kilocurie quantities of tritium, ^{3}H (a radioactive isotope of hydrogen), used as a labeling agent for a variety of molecules subsequently employed in chemical 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.

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 350 meters above sea level. Most of the site is within the City of Berkeley, but about one-quarter of the eastern part is within the City of 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).[1]

The Laboratory's activities are located on site and off site. There are 81 buildings 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 1,350,000 gross square feet (gsf) in about 60 buildings: 1,307,000 in DOE buildings and trailers, and 43,000 in University-owned buildings. Off-site space utilized by LBL consists of 260,000 gsf in various University buildings on the UC at Berkeley (UCB) campus and 130,000 gsf in leased facilities in Emeryville and Berkeley.

The Laboratory's population is approximately 4,000, including about 600 visiting scientists and engineers. About 3,200 are located on site, 700 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 than 1.3 cm/hr. Thunderstorms and hail and snow are extremely rare. Winds are usually light, but summer sea

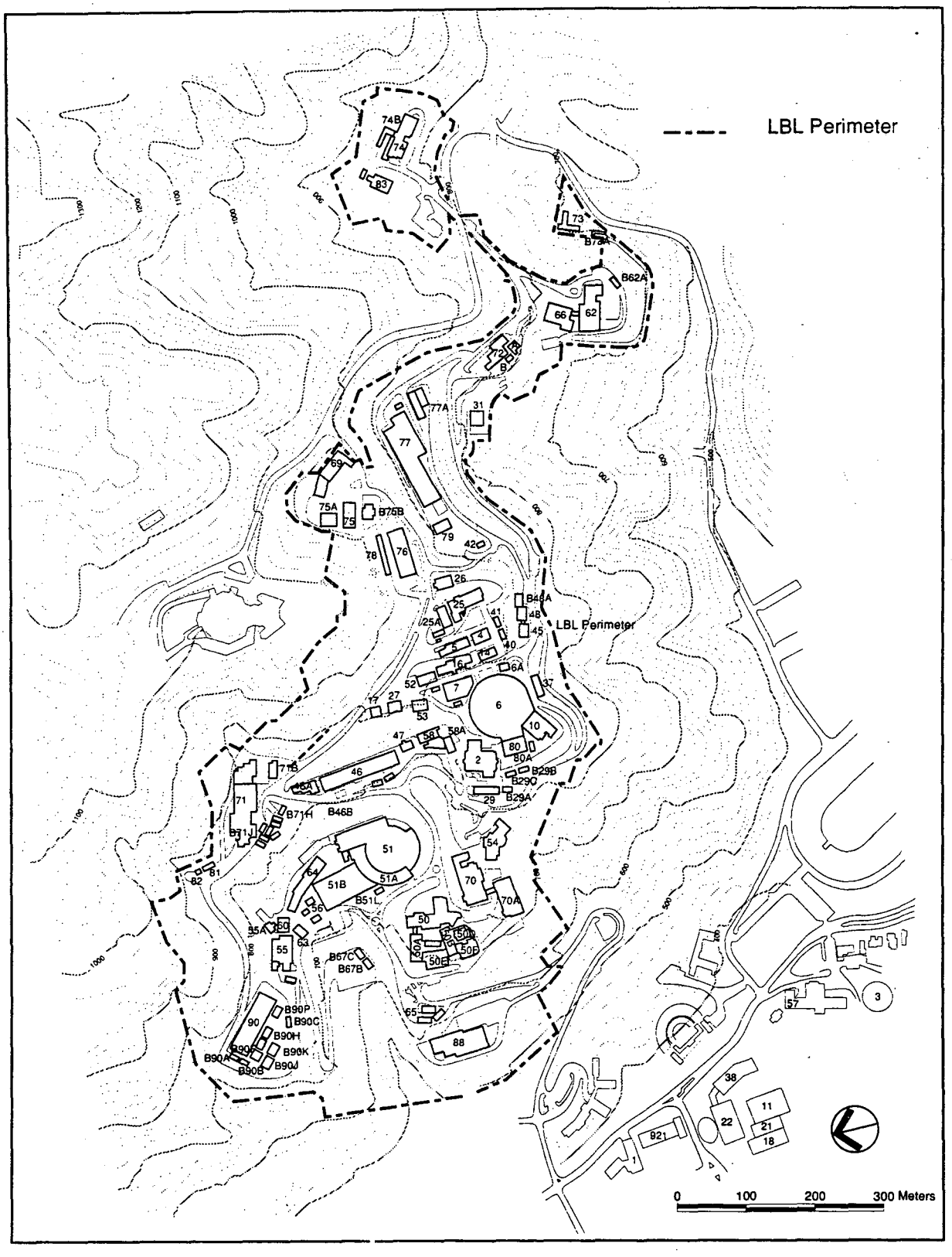

Figure 1. Lawrence Berkeley Laboratory buildings.

Key to LBL Buildings Shown in Figure 1

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

*Under construction.

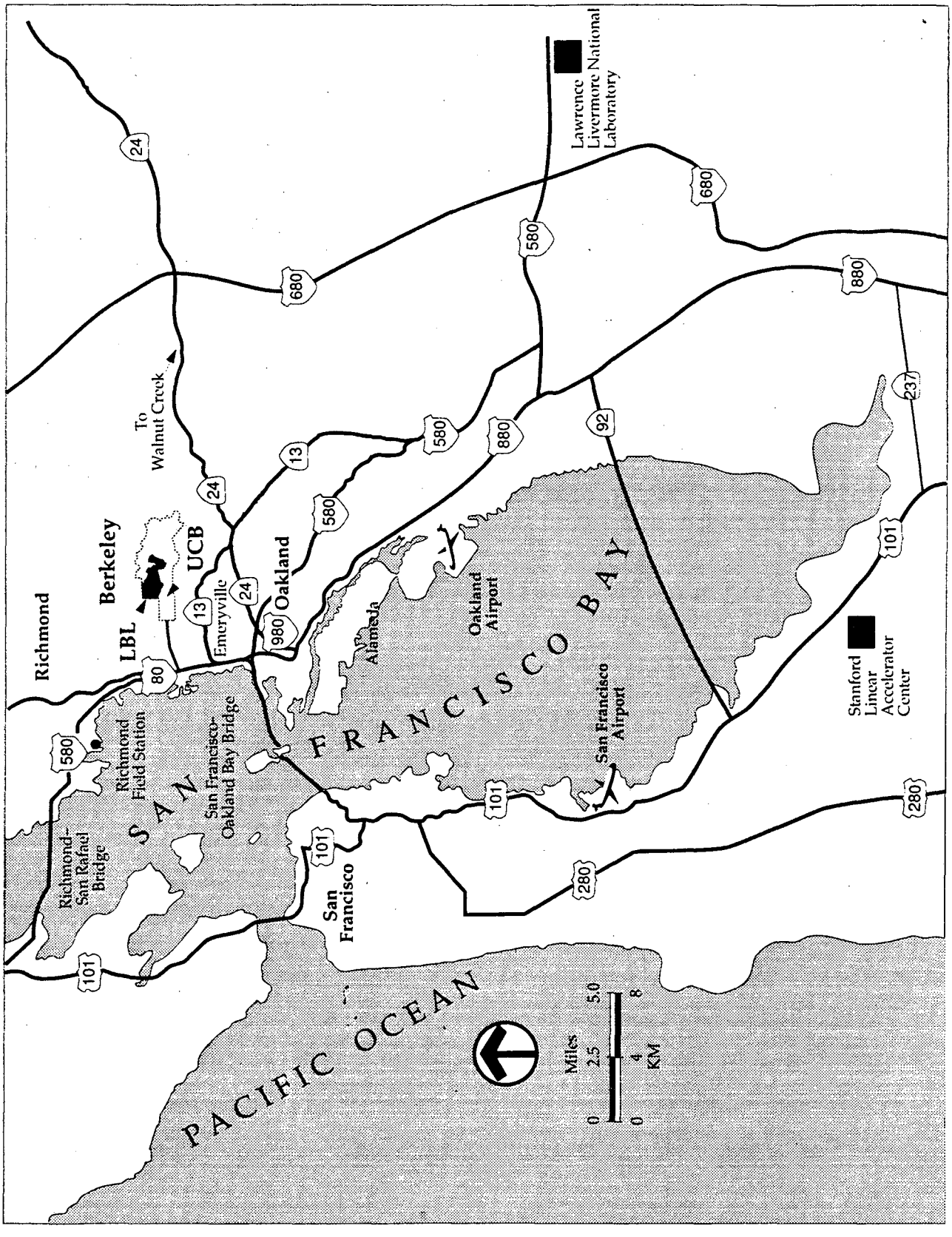

Figure 2. Lawrence Berkeley Laboratory environs.

breezes range up to 9–13 m/s (20–30 mph). Winter storm winds from the south or southwest have somewhat lesser velocities.

Source Description

LBL employs a wide variety of radionuclides in its research program, including ^{3}H, ^{14}C, ^{32}P, ^{35}S, ^{22}Na, ^{45}Ca, ^{51}Cr, $^{57,60}Co$, $^{68}Ge/Ga$, ^{54}Mn, $^{82,85,90}Sr$, ^{86}Rb, $^{95}Nb/Zr$, ^{99}Mo, ^{99M}Tc, ^{111}In, $^{123,125}I$, ^{123}Te, $^{172,175}Hf$, ^{203}Hg, ^{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 ^{125}I.

On April 23, 1991, the Laboratory received a Finding of Violation (FOV) dated April 18, 1991, numbered document 9-91-18B, from Region IX of the United States Environmental Protection Agency. The finding orders the laboratory to "evaluate *all* radionuclide release points and determine the monitoring requirements at LBL in accordance with §61.93 and demonstrate compliance with §61.92 within 30 days of the order." The finding acknowledged that "the operations which appear to be the major contributors to the emissions from LBL have been modeled and have installed monitoring equipment." LBL is responding to the FOV with its compliance plan.

LBL's 1990 NESHAPS report from this point forth is based on the 72 release point which were monitored by continuous air sampling during 1990.

The 13 LBL buildings in which radiological activities were monitored are number 1,3, 55, 70, 70A, 71, 74, 74B, 75, 75A, 83, 88, 934.

Buildings 1, 3, 74, 74B, 83, and 934 carry on various radiobiological research activities and use ^{3}H, ^{14}C, ^{32}P, ^{35}S, ^{45}Ca, and $^{123,125}I$ in a wide variety of compounds and reactions. Experience has shown that only escaped vapors of gases from research activities contribute measurably to normal releases. The major impacts have been from ^{125}I, ^{14}C, and to a lesser extent, ^{35}S. ^{125}I is also used in labs in Building 55, the Research Medicine Facility. The Facility also uses a number of the positron-emitting nuclides, including ^{18}F, ^{99M}Tc, $^{68}Ge/Ga$ and $^{82,85}Sr/Rb$, as well as multimillicurie quantities of ^{125}I. Specific metabolites are prepared and both human and other species are "imaged" through positron cameras.

A variety of μCi and mCi quantities of actinides are handled in LBL Buildings 70 and 70A. In general, the materials are worked up in aqueous solutions in HEPA-filtered enclosures, thus radiochemical releases are rare.

LBL Buildings 71 and 88 are accelerator facilities which also contain laboratories whose stacks are sampled.

The grouped stacks listed represent those sampled release points whose stacks emitted radionuclides above the detection limit for the nuclides used in the facilities. (The actinide group stacks were included, even though releases were below detection limits, due to the hazardous potential of the nuclides handled.)

The reader will note that with the exception of the National Tritium Labeling Facility (NTLF) stacks, where modeled offsite dose is 0.1 mrem, the modeled doses from LBL stacks with measurable releases were a small fraction of 1% of the standard.

Section II. Air Emissions Data

Point Source	Type Control	Efficiency (%)	Distance to Receptor
Building 75 National Tritium Labeling Facility	Silica Gel	>99[1]	130m (School)

Grouped Source	# Stacks	Type Control	Efficiency (%)	Distance to Receptor
Building 75A Storage Box and Compactor Stacks	(2)	T-DAC[2] HEPA	>75 >99	200m (Workplace)
Buildings 74 & 74B Stacks	(5)	T-DAC[2] NONE	>75 0	200m (Residence)
Building 55 Stacks	(3)	HEPA[2] T-DAC	>99 >75	270m (Residence)
Building 3 Stacks	(5)	NONE	0	50m (Workplace)
Buildings 70 & 70A Stacks	(20)	HEPA (Manifolds) NONE (Hoods)	>99 0	330m (Residence)
Building 88 Radiochem. Stacks	(2)	NONE	0	100m (Residence)

Radionuclide	Annual Quantity (Ci)
^{3}H (as HTO)	160
^{14}C	4.3×10^{-3}
^{125}F	8×10^{-4}
^{35}S	2×10^{-5}
^{175}Hf	1.2×10^{-6}
^{203}Hg	1 x 10-7
Unidentified Alpha Emitters[3]	$<1 \times 10^{-6}$

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1 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.

2 TEDA-doped activated carbon traps.

3 The stacks included in this group source vent a number of laboratories whose research employs µCi and mCi 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 20 stacks. ^{232}Th was used as a conservative dose-equivalent representative of the actinides used.

Section III. Dose Assessments

Description of Dose Model

"Comply" was used to compute maximum offsite effective dose equivalent for all stacks and stack groups.

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 default meteorology contained in COMPLY was used, as was the default windspeed of 2 m/s.

Compliance Assessment

Effective Dose Equivalent: 0.1 mrem

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).

Name:_____

Signature:_____ Date:_____

LBL NESHAPS Report for CY 1990 (Attachment I)

DOE-Requested Supplemental Information

- **For comparison with data of previous years, report the whole body dose equivalent and organ dose equivalent consistent with calculations and estimates of previous years and give the critical organ.**

  The principal source of exposure to offsite individuals is from tritium, thus the organ and whole body doses are equivalent. The 1990 dose to the maximally exposed offsite individual attributable to tritium (as HTO) was 0.1 mrem.

- **Provide an estimate of collective effective dose equivalent (person-rem/yr) for 1990 releases.**

  The 1990 CEDE attributable to LBL releases is estimated to be 6 person-rem.

- **Indicate the status of compliance with the new NESHAPS effluent monitoring requirements of Subpart H. If an alternate method is proposed, describe the method, and indicate status of implementation and EPA approval. If the facility is currently operating with an unapproved monitoring approach, describe modification necessary to comply with an EPA approved monitoring system.**

  The Laboratory is out of compliance with the monitoring requirements of NESHAPS. A compliance plan has been developed — LBL is scheduled to be fully in compliance by the end of FY 1992.

  The LBL Hazardous Waste Facility will be brought into compliance first and other facilities will follow. The proposed methodology and its rationale has been provisionally accepted by the Air and Toxics Division of Region IX of the EPA. Current sampling devices are not isokinetic — replacements shall take isokinetic, representative samples as required by NESHAPS.

- **Report any unplanned releases of radionuclides to the atmosphere, the date of release and the resulting EDE to the public. Describe the incident and the corrective action taken.**

  No unplanned releases significant enough to trigger the LBL Occurrence Reporting System occurred in 1990.

- **Describe sources of diffuse or fugitive emissions (e.g., releases due to resuspension of residual radioactive material or from waste storage) and estimate the release rate in Ci/yr and EDE to the public, and describe the method used to determine the values reported.**

Fugitive emissions from stored tritium waste are estimated at < 2 Ci. The maximum effective dose equivalent (EDE) to a member of the public from such releases would be < 0.002 mrem.

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 stack releases and the concomitant offsite EDE.

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

- **Although exempt from Subpart H, provide information on Rn-220 emission from sources containing ^{232}U and ^{232}Th where emissions potentially can exceed 0.1 mrem/yr 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 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 quantities of uranium mill tailings, ^{226}Ra, ^{232}U, or ^{232}Th, to produce an impact of 0.1 mrem/yr to a member of the public.

LBL NESHAPS REPORT "COMPLY" INPUT PARAMETER AND MODELED DOSE INFORMATION - 1990

Source (LBL Facility or Bldg)	Number of Stacks grouped	Control(s)	Efficency (%)	Nuclides	Release (Ci)	Receptor	Distances - (M) To Receptor	To Produce	To Meat and Milk	Stack Height (M)	Bldg. Height (M)	Bldg Width (M)	Effective Dose Eqvivalent (mrem)
75 NTLF	2	Silica Gel	>99(1)	H-3 (HTO)	160	School	130	500	2000	10	0	0	0.1
75A STORAGE BOX AND COMPACTOR STACKS	2	T-DAC (2) HEPA	>75% >99%	I-125	8X10-5	Workplace	200	500	2000	8	6	24	5X10-4
BLDG 74 &74B STACKS	5	T-DAC(2) NONE	>75% 0	I-125 S-35	2X10-4 2X10-5	Residence	200	200	2000	7	5	60	2X10-3
BLDG 55 STACKS	3	HEPA T-DAC(2)	>99% >75%	I-125	6X10-4	Residence	270	270	2000	9	7	40	5X10-3
BLDG 3 STACKS	5	NONE	0	C-14 AS CO2	4X10-3	Workplace	50	270	2000	15	14	33	1X10-2
BLDG 70 & 70A STACKS	20	HEPA (MANIFOLDS) NONE (HOODS)	>99% 0	"TH-232" (3) HF-175 (4)	<1X10-6 1.2X10-6	Residence	330	330	2500	13	11	60	2X10-2
88 RADCHEM. STACKS	2	NONE	0	HG-203	1X10-7	Residence	100	100	3000	12	10	60	6X10-6

(1) Silica Gel traps are >99% efficent 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.
Th-232 was conservatively chosen to represent the alpha-emitting nuclides used at the facilities.

(4) The EDE from Hf-175 was not computed as it is not contained in "COMPLY's" nuclide table - the Hf-175 released would add little to the small EDE computed for the grouped stacks.

Appendix C
Acronyms and Other Initialisms

CEDE	collective effective dose equivalent
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
DCG	derived concentration guide
DHS	California Department of Health Services
DOE	Department of Energy
EBMUD	East Bay Municipal Utility District
ESHC	LBL Environment and Safety Hazards Control Department
EMS	Environmental Monitoring Station
EPA	U.S. Environmental Protection Agency
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
gsf	gross square feet
HEPA	high-efficiency particulate
LBCF	Low-Background-Counting Facility
LBL	Lawrence Berkeley Laboratory
LHS	Lawrence Hall of Science
MS	monitoring station
MSRI	UC Mathematical Sciences Research Institute
NCRP	National Commission on Radiation Protection and Measurements
NEPA	National Environmental Protection Act
NESHAPs	National Emission Standard for Hazardous Airborne Pollutants
NIST	National Institute of Standards and Technology
NPL	National Priorities List
PCB	polychlorinated biphenyls
POTW	Public Owned Treatment Works
RCRA	Resource Conservation and Recovery Act
RPG	radiation protection guidelines
SARA	Superfund Amendments and Reauthorization Act
SIC	Standard Industrial Classification
TSCA	Toxic Substances Control Act
UC	University of California
UCB	University of California at Berkeley

Appendix D
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