U.S. Department of Energy

NNSA Service Center, Oakland, California

ANNUAL SITE ENVIRONMENTAL REPORT
CALENDAR YEAR 2003

for the

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH
UNIVERSITY OF CALIFORNIA, DAVIS

Submitted to:

United States Department of Energy
National Nuclear Security Administration
Service Center
1301 Clay Street
Oakland, California 94612-5208

Prepared by:

Weiss Associates
5801 Christie Avenue, Suite 600
Emeryville, California 94608-1827

August 20, 2004
Rev. 0

DOE/NNSA Oakland Operations Delivery Order No. DE-AD03-04NA99610

Weiss Associates
Environmental Science, Engineering and Management

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Approvals Page

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Joyce Adams, R.G.
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Robert O. Devany, R.G., C.E.G., C.H.G.
Project Manager
Weiss Associates

Department of Energy
National Nuclear Security Administration
Service Center

National Nuclear Security Administration

SEP 03 2004

SUBJECT: 2003 Site Environmental Report (SER) for the Laboratory for Energy-Related Health Research (LEHR)

Dear Sir or Madam:

The enclosed 2003 LEHR SER prepared by Weiss Associates (WA) summarizes the environmental protection activities at LEHR for Calendar Year 2003. SERs are prepared annually for all DOE sites conducting significant environmental activities and are distributed to relevant regula-tory agencies and other interested parties.

To the best of my knowledge, the 2003 LEHR SER accurately summarizes results for the 2003 Monitoring Program and Restoration Program at LEHR. This assurance is based upon a thorough review by the NNSA Service Center and WA, and by documented quality assurance protocols applied to the monitoring and data analysis at LEHR.

Please provide your comments or suggestions for future versions of the report using the enclosed reader survey form. Additionally, your questions or comments on this report may be made directly to the NNSA Service Center by contacting Jay Tomlin of the Oakland Environmental Programs Division at 510-637-1637.

Sincerely,

Henry M. De Graca, Manager
Oakland Environmental Programs Division

Enclosure

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CERTIFICATION OF ACCURACY FOR:

ANNUAL SITE ENVIRONMENTAL REPORT, CALENDAR YEAR 2003, LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH

I certify that the information submitted herein is true, accurate, and complete, based on my familiarity with the information and my inquiry of those individuals immediately responsible for obtaining the information.

Signature: Robt O. Devany Date: 8/20/04
Robert O. Devany, Project Manager

ANNUAL SITE ENVIRONMENTAL REPORT
READER SURVEY

To Our Readers:

Each Annual Site Environmental Report publishes the results of environmental monitoring at the former Laboratory for Energy-Related Health Research (LEHR) and documents our compliance with environmental regulations. In providing this information, our goal is to give our readership—whether they are regulators, scientists, or the public—a clear accounting of the range of environmental activities we undertake, the methods we employ, and the degree of accuracy of our results.

It is important that the information we provide is easily understood, is of interest, and communicates the Department of Energy National Nuclear Security Administration's effort to protect human health and the environment. We would like to know from you, our readers, whether we are successful in these goals. Your comments are welcome.

1. Is the technical level ☐ too high? ☐ too low? ☐ uneven? ☐ just right?
2. Is the writing ☐ too concise? ☐ too verbose? ☐ uneven? ☐ just right?

	Yes	**No**
3. Do the illustrations help you understand the text better?	☐	☐
Are there enough illustrations?	☐	☐
Is the background information sufficient?	☐	☐
4. Are the methodologies being described understandable?	☐	☐
Interesting?	☐	☐
5. Are the data tables of interest?	☐	☐
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Other comments:

_____

_____

A business reply envelope has been attached for returning these surveys to Jay Tomlin, DOE/NNSA, 1301 Clay Street, 700N, Oakland, CA 94612-5208.

OPTIONAL

Name: _____ Occupation _____

Address: _____

CONTENTS

TABLES

FIGURES

ACRONYMS AND ABBREVIATIONS

AH	Animal Hospital
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
cu yds	cubic yards
D&D	decontamination and decommissioning
DOE	United States Department of Energy
EPA	United States Environmental Protection Agency
HSU	hydrostratigraphic unit
km	kilometer
LEHR	Laboratory for Energy-Related Health Research
m	meters
mg/l	milligrams per liter
mrem/yr	millirem per year
MSDS	Material Safety Data Sheet
NNSA	National Nuclear Security Administration
No.	number
OSHA	Occupational Safety and Health Administration
PCD	Putah Creek Downstream
PCU	Putah Creek Upstream
PM_{10}	particulate matter with aerodynamic size less than or equal to 10 micrometers
rem	roentgen equivalent man
SARA	Superfund Amendments and Reauthorization Act
STPO	waste water [sewage] treatment plant outfall
TLD	Thermoluminesent dosimeter
UC Davis	University of California, Davis
WA	Weiss Associates

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EXECUTIVE SUMMARY

This Annual Site Environmental Report for the Laboratory for Energy-Related Health Research (LEHR) (the Site) at the University of California, Davis (UC Davis) summarizes the United States Department of Energy (DOE), National Nuclear Security Administration's (NNSA's) environmental performance at the Site in 2003, including environmental compliance; environmental monitoring data for air, soil, ground water, surface water, storm water and ambient radiation; and environmental management programs. DOE operation of LEHR as a research facility ceased in 1989 after three decades of research on the health effects of low-level radiation exposure (primarily strontium-90 and radium-226) on human health using beagle dogs as research subjects. Contamination from prior site use, including research activities, resulted in the addition of the Site to the National Priorities List in 1994. In 1997, DOE and UC Davis reached an agreement on the responsibilities for site clean up. During Calendar Year 2003, DOE/NNSA continued activities at the Site in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements.

Progress of Site Environmental Restoration

DOE/NNSA site restoration activities are conducted in accordance with a 1999 Federal Facility Agreement entered into by DOE and the United States Environmental Protection Agency (EPA), California Department of Toxic Substances Control, California Department of Health Services and the Central Valley Regional Water Quality Control Board. Under the Federal Facility Agreement, DOE is responsible for remediation of site facilities, including the radium-226 and strontium-90 leach fields and tanks, DOE Disposal Box, on-site domestic septic tanks and associated systems, DOE disposal trenches, and the former Dog Pens (Figure 1-2). Under an Administrative Order on Consent with the EPA, UC Davis is responsible for remediation of three landfills, disposal trenches located south and east of the Landfill number (No.) 2, 49 waste holes, an old waste water treatment plant, ground water impacted at the Site, and surface and storm water runoff impacted by UC Davis (Figure 1-2) (EPA, 2000).

DOE/NNSA activities at the Site in 2003 consisted primarily of shipment of low-level radioactive waste and radiologically-impacted materials generated during prior remediation and site research activities, and limited ground water investigation. Specific DOE/NNSA activities in 2003 included:

- **Ground Water Investigation at Drywells A-E:** A limited ground water investigation was conducted in 2003 in the vicinity of drywells A-E (Figure 1-1) to select a monitoring well location for collection of ground water samples down-gradient of the drywells. The investigation results did not indicate contamination significantly above background concentrations. The installation of a monitoring well near the former drywells is planned in 2004.

- **Disposal of Low-Level Waste From Removal Actions:** Approximately 350 cubic yards of low-level radioactive waste generated from removal actions at the Domestic Septic Systems 3 and 6 were shipped for off-site disposal at the Nevada Test Site as low-level radioactive waste. One shipment (1 cubic yard) of mixed low-level radioactive waste generated from a portion of Domestic Septic Systems 3 was sent for disposal at Envirocare of Utah.
- **Disposal of Low-Level Radioactive Legacy Waste:** DOE/NNSA disposed a legacy cylinder of thorium-228 at the Nevada Test Site.
- **Disposal of Radiologically-Impacted Equipment:** DOE/NNSA disposed of all contaminated equipment from decontamination and decommissioning activities at Animal Hospital-1. One intermodal container with the equipment was shipped to the Nevada Test Site for disposal as low-level radioactive waste.
- **Disposal of Lead Materials:** DOE/NNSA shipped all remaining lead shielding material with radioactive contamination to Envirocare of Utah as mixed low-level radioactive waste.
- **Shipment of Gravel for Reuse:** In 2003, DOE/NNSA shipped approximately 160 cubic yards of gravel from the Western Dog Pens to the Nevada Test Site for reuse. The remaining 1,660 yards of gravel were shipped to the Nevada Test Site in early 2004.
- **Custody Transfer of Office Trailer:** DOE/NNSA vacated an office trailer at the Site and transferred custody of the trailer to UC Davis.

Having completed all planned removal actions, DOE/NNSA is in the process of determining a final remedy for the Site that is protective of human health and the environment. The following documents were prepared or in the process of being prepared in 2003:

- **Remedial Investigation Report:** In September of 2003 a Final Remedial Investigation Report (WA, 2003a) was issued. It was subsequently approved by the EPA, Central Valley Regional Water Quality Control Board, Department of Health Services Radiologic Health Branch and the Department of Toxic Substances Control. The Remedial Investigation Report characterizes the current nature and distribution of contamination at the Site.
- **Feasibility Study:** DOE/NNSA began to develop a Feasibility Study for the DOE areas of the site. A Draft Feasibility Study was expected to be completed in early 2004, however, delays associated with the issuance and approval of a UC Davis site-wide human health and ecological risk assessment have delayed the development of the DOE/NNSA Feasibility Study. A draft is expected to be issued in late 2004.

Overview of 2003 Water and Air Environmental Monitoring Results

Per a Memorandum of Agreement with DOE (DOE, 1997), UC Davis is responsible for conducting ground water monitoring at LEHR. A report developed by Brown and Caldwell for UC Davis (Brown and Caldwell, 2004) provides a complete description of the ground water monitoring program and analytical results for 2003. Based on the findings presented by UC Davis, the 2003 ground water monitoring results were consistent with previous years.

UC Davis also reported that storm water and surface water samples collected and analyzed in 2003 were consistent with previous years, and no new trends or concerns were identified.

The only air monitoring conducted in 2003 consisted of occupational air monitoring during waste packaging activities. All airborne contaminants were below relevant occupational limits.

Radiological Impact Assessment of the LEHR Environmental Restoration Project

The 2003 radiological air and ambient data all indicate that detected radionuclide activities were near or below natural background levels, and do not pose a risk to Site workers or the general public.

1. INTRODUCTION

This Annual Site Environmental Report describes Calendar Year 2003 United States Department of Energy (DOE), National Nuclear Security Administration's (NNSA's) environmental restoration and waste management activities at the Laboratory for Energy-Related Health Research (LEHR) (the Site) at the University of California, Davis (UC Davis) (Figure 1-1). This report was prepared according to the requirements of DOE Order 231.1, Environmental Safety and Health Reporting. The purpose of this report is to summarize environmental data, confirm compliance with environmental standards and requirements, and highlight significant programs and efforts. This report describes activities conducted by DOE/NNSA during 2003 in support of the Site environmental restoration efforts, and provides information about the impact of these activities on the public and the environment. A ground, surface and storm water-monitoring program performed by UC Davis includes information important to the overall environmental restoration of the Site and is briefly summarized herein.

1.1 Site History

The Atomic Energy Commission first sponsored radiological studies on laboratory animals at UC Davis in the early 1950s. Initially situated on the main campus, LEHR was relocated to its present location in 1958 (Figure 1-1). Research at LEHR through the late 1980s focused on health effects from chronic exposure to radionuclides, primarily strontium-90 and radium-226, using beagles as research subjects. Other related research was conducted at the Site concurrent with these long-term studies. In the early 1970s, a cobalt-60 irradiator facility was constructed at the Site to study the effects of chronic exposure to gamma radiation on humans, again using beagles.

A campus landfill with two waste burial units that were used from the 1940s until the mid-1960s is located at the Site (Figure 1-2). Several low-level radioactive waste burial areas were also present at the Site, and campus and LEHR research waste was buried in these areas until 1974 in accordance with regulations in effect at the time. These radioactive burial areas have been remediated during several removal actions conducted at the Site since 1996.

In 1988, pursuant to a Memorandum of Agreement between DOE and the University of California, DOE's Office of Energy Research initiated activities to close out the research program at LEHR. Another Memorandum of Agreement between DOE and the University of California was issued in 1990 at the beginning of the environmental restoration program at LEHR. In 1997, a third Memorandum of Agreement divided the responsibility for environmental remediation between DOE and UC Davis.

Under the Federal Facility Agreement effective in December 1999, DOE is responsible for remediation of the Radium and Strontium Treatment Systems, a waste burial area known as DOE Disposal Box, on-site domestic septic tanks and associated leach fields and dry wells, DOE disposal trenches, and the former Dog Pens (Figure 1-2). UC Davis is responsible for remediation of three landfills, disposal trenches located south and east of Landfill No. 2, 49 waste holes (Figure 1-2), an old waste water treatment plant, ground water impacted by the Site, and surface and storm water runoff impacted by UC Davis.

DOE/NNSA activities at the Site in 2003 consisted primarily of the shipment of waste generated during prior removal actions, disposal of radiologically-impacted equipment from the decontamination and decommissioning of former Animal Hospitals (AH) 1 and 2 and a legacy cylinder of thorium-228 at the Nevada Test Site disposal site, and shipment of lead shielding materials for disposal at Envirocare of Utah.

1.1.1 Environmental Restoration

The DOE/NNSA Service Center manages the environmental restoration of the DOE-impacted areas of the site. From October 1989 through February 1990, an interim contract with UC Davis was implemented to begin site restoration. From 1990 to 1996, Battelle Environmental Management Operations managed the LEHR remediation project. In 1996, the project was transferred to Weiss Associates (WA) of Emeryville, California.

In May 1994, the United States Environmental Protection Agency (EPA) added the Site to the National Priorities List. A site Remedial Investigation and Feasibility Study work plan was developed to ensure that investigation and remediation were conducted in accordance with applicable regulatory requirements. Remedial Project Manager meetings are held every four to six weeks to evaluate the progress of remediation and identify actions needed to facilitate the process.

Primary DOE/NNSA restoration/remediation activities that have been performed at the Site include: soil and ground water characterization; building assessment; decontamination and decommissioning of above-ground structures; removal of contaminated underground tanks, trench structures, and contaminated soil; chemical and radiological risk assessment; preparation of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) documents; and waste management. In July 2002, DOE/NNSA completed the last removal action planned for the Site at Domestic Septic Systems 3 and 6 (Figure 1-2). Waste from this removal action was shipped to the Nevada Test Site in late 2002 through mid-2003. Legacy equipment, lead shielding material and a cylinder of thorium-228 were characterized, containerized and shipped for off-site disposal.

In September 2003, DOE/NNSA issued a Final Remedial Investigation Report for the DOE areas, which characterizes the nature and distribution of site contamination (WA, 2003a). The report was approved by the regulatory agencies overseeing the CERCLA process at the Site. A Draft Remedial Investigation Report for the UC Davis areas of the site was published in January of 2003 (MW, 2003). The final Remedial Investigation Report is expected to be issued by UC Davis in mid-2004.

1.2 Site Management Transition

The management of remaining site activities was transferred from Weiss Associates to New World Technology in late 2003. The custody of the waste storage areas site, including remaining remediation-generated waste, was formally transferred to New World Technology on October 29, 2003. On November 13, 2003 New World Technology accepted custody of the remainder of the site, including buildings and government property. During the transition, New World Technology adopted existing programs and procedures appropriate to the reduced scope of work at the site, including the Radioactive Waste Management Program, Quality Assurance Project Plan, Project Health and Safety Plan, Radiation Protection Program, As-Low-As-Reasonably-Achievable program and associated standard operating procedures relevant to remaining site activities.

One of the two site office trailers was vacated by DOE/NNSA in 2003 and custody of this trailer was transferred to UC Davis.

1.3 Site Description

The Site is a 15-acre parcel owned by the Regents of the University of California. It is 1.5 miles south of the main UC Davis campus in a rural agricultural area (Figure 1-1), and is presently occupied by the UC Davis Center for Health and the Environment. Research at the Center for Health and the Environment includes toxicology, epidemiology, radiation biology and radiochemistry.

The Site facilities currently consist of 15 buildings, including a main administration and office building, two former animal hospitals, a laboratory and support buildings (Figure 1-2). Former facilities include: radioactive waste water treatment systems, an indoor/outdoor cobalt-60 irradiator, a radioactive waste burial area, and outdoor dog pens. Inactive campus landfill units and numerous inactive campus disposal sites (i.e., trenches and holes) were used to dispose low-level radioactive and chemical waste, and are being evaluated and/or remediated by UC Davis. Figure 1-2 shows areas that have potentially impacted the environment at the Site and those areas where DOE/NNSA removal actions have been completed.

1.4 Population Data

1.4.1 Site Population

The UC Davis Center for Health and the Environment conducts ongoing research in toxicology, epidemiology, radiation biology and radiochemistry with a staff of approximately 200 researchers and support personnel. Center for Health and the Environment staff have varying schedules and are not all present at the Site at the same time.

From January to October 2003, the LEHR remediation project was managed and staffed by WA and its subcontractors, and employed two part-time workers at the Site. This number increased to approximately six workers when on-site remediation and waste management activities were in progress in the summer months.

Beginning in October 2003, the site management was transferred to New World Technology, who does not maintain staff at the site on a regular basis. During scheduled site activities, New World Technology may deploy up to ten workers to conduct and oversee site work. Additionally, New World Technology employees perform weekly inspections of the site.

1.4.2 Local Population

The Site is located in a rural area in northeast Solano County on the UC Davis South Campus (Figure 1-1). The UC Davis campus has a student population of 30,229 and employs approximately 17,637 full-time faculty and staff (UC Davis News Service, Facts and Figures: 2003-2004).

The estimated 2003 population of the city of Davis is approximately 60,308 (U.S. Census Bureau, 2000), and the estimated total population of Yolo County is about 180,856 (U.S. Census Bureau, 2000). The more densely populated and metropolitan Sacramento area is approximately 12 miles east of the Site. The current population of Sacramento County is about 1,305,082 (United States Census Bureau, 2000), and approximately 407,018 people live in the city of Sacramento (U.S. Census Bureau, 2000).

1.5 Environmental Setting

The Site is located on a relatively flat plain bordered on the south by Putah Creek. The Site is mostly open, slopes gently to the east, and has a few trees and bushes. The Site lies outside the Putah Creek 100-year floodplain.

1.5.1 Land Use

The land within a one-mile radius of the Site is owned both privately and by UC Davis. It is used for animal research, agriculture and recreation (i.e., fishing and swimming). Privately owned lands south and east of the Site are used to produce wheat, tomatoes, corn, barley and oats and include permanent residences. Private property to the south is separated from the Site by the South Fork of Putah Creek, and private property to the east is adjacent to non-LEHR, UC Davis-owned research facilities. The property immediately west, north and south of the Site (Putah Creek Reserve) is owned by UC Davis and is currently used for various types of animal, agricultural and health research.

1.5.2 Hydrogeology

Unconsolidated Pliocene and Pleistocene sedimentary deposits are the major ground water sources for public and private water supplies in the Sacramento Valley (State of California Department of Water Resources, 1978), in which the Site is located. Both unconfined and confined fresh water aquifers are present in the uppermost 3,000 feet of the valley subsurface. Ground water generally flows from the valley sides toward the valley axis. In the site vicinity, regional ground water generally flows east from the Coast Ranges toward the Sacramento River (Dames & Moore, 1993).

At various depths beneath the valley floor, saline water is present as a result of entrapment during the deposition of sediments in a marine environment. The depth to the base of fresh water in the Sacramento Valley varies from 400 feet to over 3,000 feet, and is 2,600 feet to 3,100 feet below ground surface in the Davis area (State of California Division of Oil and Gas, 1982).

Previous investigations identified five hydrostratigraphic units (HSUs) beneath the Site (Dames & Moore, 1999). These include the vadose (unsaturated) zone and HSUs 1 through 4. The vadose zone extends from the ground surface to the top of ground water, which has historically ranged from 15 feet to 55 feet below ground surface. The vadose zone consists primarily of unsaturated clay and silt with lesser amounts of interbedded sand and gravel. HSU-1 extends from the bottom of the vadose zone to depths of approximately 76 feet to 88 feet below ground surface. This unit is lithologically similar to the vadose zone and consists primarily of silt and clay, with lesser amounts of sand and gravel. HSU-2 extends from the bottom of HSU-1 to depths of approximately 114 feet to 130 feet below ground surface. This unit is composed primarily of sand in the upper portion of the unit and gravel in the middle to lower portions. HSU-3, investigated in off-site areas, extends from the bottom of HSU-2 to a depth of about 250 feet below ground surface and is approximately 120 feet thick. The unit consists primarily of relatively fine-grained sediments varying from very fine-grained sandy silt to clayey silt and silty clay. HSU-4, also investigated in off-site areas, extends from the bottom of HSU-3 to a depth of about 280 feet below ground surface and is approximately 32 feet thick. This unit consists of coarse sand and gravel. Beneath HSU-4, a sharp contact with a bluish, dark gray silt was encountered 282 feet below ground surface in wells UCD4-41 and UCD4-43 (see Section 3 Figure 3-1 for monitoring well locations). The bottom of this unit has not been penetrated in any of the site borings (Dames & Moore, 1999).

The uppermost distinct aquifer beneath the Site consists of two HSUs (HSU-1 and HSU-2) based on the stratigraphy of the sediments at the Site and the associated ground water flow and contaminant migration characteristics (Dames & Moore, 1994). Well drillers' logs indicate that a 90-foot-thick clay unit separates HSU-2 from a second aquifer below (Dames & Moore, 1994).

Irrigation water, rainfall and Putah Creek recharge ground water in the Site vicinity (Dames & Moore, 1997). Ground water pumping associated with agriculture is responsible for the great majority of ground water withdrawal. Locally, UC Davis extracts ground water from HSU-2 and re-injects treated ground water near the southwest corner of the Site as part of its interim remedial action.

Generally, there is a 20- to 30-foot seasonal fluctuation in the water table beneath the Site caused predominantly by the lack of surface recharge and nearby agricultural pumping in the summer. Vertical gradients vary both temporally and spatially. The magnitude of the vertical gradient is greatest when ground water elevations are rising or falling sharply. Short-term activities such as local agricultural pumping can produce downward vertical gradients during periods of an otherwise rising water table.

The HSU-1 lateral gradient across the Site typically ranges from 0.01 foot/foot to 0.04 foot/foot, and the direction of ground water flow is predominantly northeast. Representative values of HSU-1 horizontal hydraulic conductivity are between 1×10^{-4} and 1×10^{-7} centimeters per second (Dames & Moore, 1999). The lateral gradient across the Site within HSU-2 typically ranges from 0.005 foot/foot to 0.015 foot/foot. The direction of flow appears to be predominantly northeast, although it can occasionally be east-southeast. Based on pumping tests, hydraulic conductivity in HSU-2 ranges from 0.26 centimeters per second to 0.43 centimeters per second (Dames & Moore, 1997).

Ground water in HSU-1, HSU-2 and HSU-4 has been impacted by site activities. Based on investigations to date (WA, 1997a and WA, 1999a), significant ground water impacts appear to be associated only with the UC Davis disposal areas.

1.5.3 Ground Water Supply and Quality

Ground water at depths of about 100 to 500 feet in the site vicinity is used for agricultural and domestic supply. Shallow ground water quality, at depths above 100 feet, has been impacted by nitrates, probably from agricultural sources, and has insufficient yield that precludes its extraction for domestic or agricultural use.

1.5.4 Sanitary Sewer Systems

The Site discharges its sanitary wastewater to the UC Davis Waste Water Treatment Plant. UC Davis operates the plant under the conditions specified in its National Pollutant Discharge Elimination System permit, granted by the Central Valley Regional Water Quality Control Board under agreement with the EPA.

1.5.5 Storm Drainage System

Storm water runoff at the Site is collected in an underground drainage system. Storm water from the paved area in the western part of the Site and around the southern buildings in the western area is collected in a storm water drainage system. This system drains to the site storm water lift station (LS-1 shown on Figure 3-1 in Section 3), and then to an outfall along the west side of Old Davis Road. Storm water in the northwestern area of the Site drains into a ditch along Old Davis

Road. Storm water in the eastern and non-paved southern portions of the Site percolates into the ground, except for a section of the former Cobalt-60 Field where dog pens were once located, and where drainage is connected to the sanitary sewer. Water ponds in some areas of the site during and after heavy rains.

1.5.6 Biological Resources

A number of sensitive biological resources were identified in an Ecological Scoping Assessment (WA, 1997b) as potentially occurring in the vicinity of the site. These species include the Giant Garter Snake, the Northern Harrier, the Coopers Hawk, the California Horned Lark, the Great Egret, the Burrowing Owl and the Valley Elderberry Longhorn Beetle, which lives in elderberry bushes. Although elderberry bushes are present at the Site, a focused biosurvey (IT Corp, 1998) found no sensitive species actually present on-site and concluded that the on-site elderberry bushes are not currently hosting the Valley Elderberry Longhorn Beetle.

Preparation of an Ecological Risk Assessment evaluating the impact of residual contamination at the site on ecological resources began in 2003 with an expected completion date of late 2004.

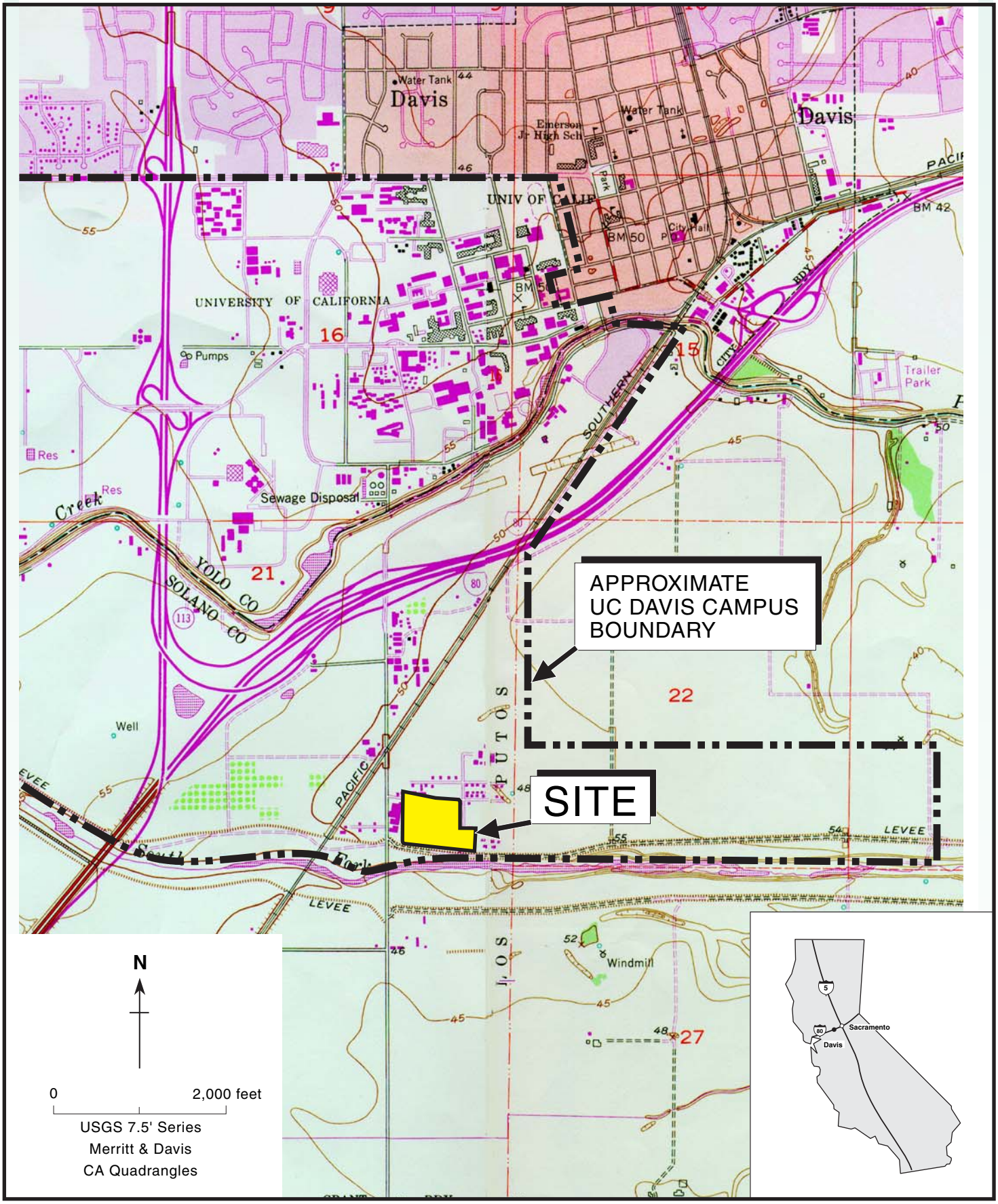

Figure 1-1. Location of the LEHR Site, UC Davis, California

Weiss Associates

Figure 1-2. Site Features and Areas of Potentially Known Contamination Source Areas

Weiss Associates

4108-137-01.ai

8/20/04

2. COMPLIANCE SUMMARY

This section summarizes the LEHR site's environmental regulatory compliance status during the environmental restoration and waste management activities conducted in Calendar Year 2003. No violations, fines or penalties were issued for the Site in 2003.

2.1 Environmental Restoration and Waste Management

Environmental restoration and waste management activities at LEHR are conducted in compliance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund) and the National Contingency Plan, and include compliance with applicable or relevant and appropriate requirements and DOE Orders, as described below.

2.1.1 Comprehensive Environmental Response, Compensation and Liability Act as Amended by the Superfund Amendments and Reauthorization Act

In 1995, a streamlined remediation process was initiated at the Site using the CERCLA non-time critical removal action approach. This approach enables expedited response to contamination problems without requiring the time-consuming investigations and preparation of lengthy documents required otherwise. By 2003, DOE/NNSA had finished all removal actions planned for the LEHR site.

In September 2003, a Final Remedial Investigation Report for the DOE Areas of the LEHR site was submitted to and approved by the regulatory agencies: the EPA, Central Valley Regional Water Quality Control Board, Department of Health Services Radiologic Health Branch and the Department of Toxic Substances Control. The DOE Remedial Investigation Report compares the current levels of contamination at the Site to the cleanup goals and evaluates the success of the remedial approaches in meeting those goals.

In 2003, DOE/NNSA provided data to UC Davis for inclusion in the Draft Human Health and Ecological Risk Assessment planned for submittal to regulatory agencies in August 2003. Data from this risk assessment is needed to determine the final set of remedial alternatives for the Site. The draft risk assessment was not issued until March of 2004 and substantial comments from the EPA required major revisions to the document, which is now expected to be issued in June 2004. This has delayed the development of a feasibility study for both the DOE/NNSA and UC Davis areas of the site.

2.1.2 Resource Conservation and Recovery Act

In 2003, approximately 15,485 pounds of shielding material from past research activities and pipe joints from the domestic septic system were designated as mixed low-level radioactive waste and shipped to Envirocare of Utah for disposal by encapsulation and land burial. Efforts to recycle the shielding items were unsuccessful due to the very high costs of recycling lead-containing metals with residual radiological contamination. The lead rendered the waste a hazardous waste under the Resource Conservation and Recovery Act and the radiological contamination required a low-level radioactive waste classification. The waste characterization is documented in the Radioactive Waste Profile Record for Lead Waste, April 2003 (WA, 2003b).

2.1.3 Federal Facilities Compliance Act

The Federal Facilities Compliance Act amends the Solid Waste Disposal Act and states that all federal agencies are subject to all substantive and procedural requirements of federal, state, and local solid and hazardous waste laws in the same manner as any private party. The act requires that a site treatment plan be prepared for each DOE site that generates or stores mixed radioactive waste. A final site treatment plan for LEHR was approved and issued in October 1995. No revisions have been made to this plan. The Site continues to be in compliance with the Federal Facilities Compliance Act.

2.1.4 National Environmental Policy Act

Consistent with DOE policy and guidance, environmental considerations for proposed removal actions and alternatives are evaluated during the Engineering Evaluation/Cost Analysis process, allowing integration of National Environmental Policy Act requirements with the CERCLA process, thereby eliminating the need for a separate National Environmental Policy Act analysis and streamlining the clean-up process.

Shipments of low-level radioactive waste completed in 2003 were categorically excluded from National Environmental Policy Act Requirements, under Title 10 Code of Federal Regulations 1021.410(b)(2).

2.1.5 Toxic Substances Control Act

Concern over the toxicity and persistence in the environment of polychlorinated biphenyls led Congress in 1976 to enact Section 6(e) of the Toxic Substances Control Act that included, among other things, prohibitions on the manufacture, processing, and distribution in commerce of polychlorinated biphenyls. The Toxic Substances Control Act legislates management of polychlorinated biphenyls from manufacture to disposal. On May 20, 2003, a 30-gallon drum of polychlorinated biphenyl-containing light ballasts was accepted by the UC Davis Department of

Environmental Health and Safety for disposal as hazardous waste at a permitted hazardous waste disposal facility via the UC Davis hazardous waste disposal contract.

2.1.6 Federal Insecticide, Fungicide and Rodenticide Act

The EPA, under the Federal Insecticide, Fungicide and Rodenticide Act, regulates the sales, distribution, and use of pesticides by requiring their registration. Registration includes approval by the EPA of the pesticide's label, which must give detailed instructions for its safe use. The EPA must classify each pesticide as either "general use," "restricted use," or both. Only registered general use herbicides are applied at the Site by the UC Davis Agricultural Services Department to control weeds. The herbicides are used in accordance with the safe use instructions and in compliance with UC Davis campus requirements, and local, state and federal laws.

2.2 Radiation Protection

In 2003, all activities at the Site were conducted in compliance with Title 10 of the Code of Federal Regulations Part 835, Occupational Radiation Protection, and applicable DOE Orders, as discussed below.

2.2.1 DOE Order 5400.5, Radiation Protection of the Public and the Environment

The Report on the Radiation Protection of the Public and the Environment (WA, 2001g) was developed in 2001. The purpose of this report was to evaluate LEHR operations and document their compliance with DOE Order 5400.5, Radiation Protection of the Public and the Environment. LEHR operations continued to be in compliance with DOE Order 5400.5 in 2003.

2.2.2 DOE Order 5400.1, Environmental Protection Program

In 2001, an Environmental Protection Program (WA, 2001j) was developed which defines environmental protection activities and monitoring conducted at LEHR, including radiological controls and monitoring requirements. This program complies with DOE Order 5400.1, Environmental Protection Program.

In January 2003, DOE Order 5400.1 was cancelled by DOE Order 450.1, Environmental Protection Program. DOE 450.1 requires DOE sites to implement Environmental Management Systems. The cancellation did not, by itself, modify or otherwise affect any contractual obligation to comply with DOE Order 5400.1. Cancelled orders that are incorporated in a contract remain in effect until the contract is modified to delete the requirements of the cancelled orders.

Given LEHR's inactive status and focus on finalizing the clean-up activities, DOE did not modify the existing requirements of the LEHR environmental restoration and waste management contract to reflect the cancellation of DOE Order 5400.1 by DOE Order 450.1. Activities conducted at LEHR in 2003 continued to be in compliance with DOE Order 5400.1.

2.2.3 Atomic Energy Act of 1954, as Amended

Under the Atomic Energy Act of 1954, as amended, DOE has the responsibility of controlling the activities of its contractors and operations in a manner that protects the public and the environment from radiation hazards associated with its operations.

All work at LEHR is performed in compliance with the LEHR Radiation Protection Plan (WA, 1999b) and the As-Low-As-Reasonably-Achievable Plan (WA, 2001a), which comply with Title 10 of the Code of Federal Regulations Part 835. The Radiation Protection Plan and As-Low-As-Reasonably-Achievable Plan require that all work performed at LEHR be conducted in a manner that protects the public and the environment from radiological hazards.

In addition to the Radiation Protection Plan and the As-Low-As-Reasonably-Achievable Plan, the LEHR Quality Assurance Project Plan (WA, 2000a) requires that environmental monitoring aspects of all operations and activities at LEHR be addressed in the work plans developed for specific activities. All activities at LEHR complied with the Radiation Protection Plan, the As-Low-As-Reasonably-Achievable Plan, and the LEHR Quality Assurance Project Plan in 2003.

2.2.4 DOE Order 435.1, Radioactive Waste Management

A comprehensive Radioactive Waste Management Basis (WA, 2001b) and Radioactive Waste Management Plan (WA, 2001c) were developed and approved in 2001, and at that time existing standard operating procedures for waste management were updated to meet the requirements of DOE Order 435.1. All waste management activities in 2003 were carried out in compliance with these documents and were conducted in a manner that protects the public, the workers and the environment from radiological hazards.

2.3 Air Quality and Protection

2.3.1 Clean Air Act

Under the Clean Air Act, the EPA defined six criteria pollutants: carbon monoxide, nitrogen dioxide, lead, ozone, particulate matter, and sulfur dioxide, and set National Ambient Air Quality Standards for these pollutants. Of these, the only air pollutant emitted at the Site is particulate matter

with aerodynamic size less than or equal to 10 micrometers (PM_{10}) from uncovered soils in the Eastern and Western Dog Pens. The Site is not a major source of air emissions.

Verification of site compliance with the Clean Air Act is accomplished through air monitoring during project activities. Dust monitoring was conducted during the loading of gravel onto trucks for shipment for off-site disposal. The Site was in compliance with all Clean Air Act requirements in 2003 as administered by the Yolo-Solano Air Quality Management District.

Additionally, ambient air monitoring has been conducted since 1995, and computer simulations indicate that surface soil contamination does not impact air quality at the Site.

2.3.2 National Emission Standards for Hazardous Air Pollutants

Subpart H of Title 40 Code of Federal Regulations Part 61 protects the public and the environment from the hazards of radionuclide emissions, other than radon, from DOE facilities. It sets a limit on the emission of radionuclides that ensures that no member of the public in any year receives an effective dose equivalent of more than 10 millirem per year (mrem/yr).

The National Emission Standards for Hazardous Air Pollutants requirements primarily target point source/stack emissions. There are currently no point sources of radionuclide emissions at the Site. However, a Memorandum of Understanding between DOE and the EPA (DOE, 1995) applies the point source criteria to potential diffuse area sources at the Site.

The 2003 estimated dose to the public from the Site's diffuse area sources was calculated using surface soil radioactive contamination concentrations and assuming that wind-blown fugitive dust from the Western and Eastern Dog Pens, including re-entrainment and dispersion of surface soil dust, was the only potential sources of emissions. The analysis of potential diffuse airborne radiological effluent sources at the Site is included in the 2003 Calendar Year Radionuclide Air Emission Annual Report (under Subpart H of Title 40 Code of Federal Regulations Part 61) (WA, 2004). Emissions modeling indicated that the maximum annual credible dose equivalent to a member of the public from residual site contamination was 1.4×10^{-4} mrem/yr for an off-site exposure, and 1.4×10^{-3} mrem/yr for an on-site exposure, far below the 10 mrem/yr effective dose equivalent limit. This analysis is discussed in more detail in Section 4 of this report.

2.4 Water Quality and Protection

2.4.1 Clean Water Act

As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. The Site discharges its sanitary waste to the UC Davis Waste Water

Treatment Plant, which is subject to the conditions in National Pollutant Discharge Elimination System Permit CA0077895, issued to UC Davis, and Waste Discharge Requirement Order No. 92-040, granted by the Central Valley Regional Water Quality Control Board. No waste water, other than sanitary waste, was discharged from LEHR to the waste water treatment plan in 2003.

Under the Clean Water Act, EPA also controls polluted storm water runoff. In California, this function is delegated to the California Regional Water Quality Control Board, under state-wide National Pollutant Discharge Elimination System General Permits for Storm Water Discharges Associated with Industrial and Construction Activities. A storm water sampling program described in the Revised Field Sampling Plan (Dames & Moore, 1998) is implemented at the Site and meets the state General Permit requirements. Best management practices are also used at the Site to mitigate any potential contamination in storm water runoff.

Under the Revised Field Sampling Plan (Dames & Moore, 1998), storm water samples are usually collected twice a year, once near the beginning of the rainy season after the first significant storm of the season, and once near the end of the season. Surface water samples are also collected and analyzed in accordance with the Revised Field Sampling Plan. Details of the sampling and analyses are provided in the Draft 2003 Comprehensive Annual Water Monitoring Report (Brown and Caldwell, 2004) and are summarized in Section 3.

2.4.2 Drinking Water Requirements

Under the Safe Drinking Water Act, EPA sets standards to protect drinking water quality and drinking water sources, including rivers, lakes, reservoirs, springs, and ground water wells. The California Porter-Cologne Water Quality Act authorizes the State Water Quality Board and Regional Water Quality Control Boards to coordinate and control water quality in the state. The regional boards establish and enforce water quality standards for both surface and ground water by issuing permits for discharges of waste water into state water bodies. The Safe Drinking Water and Toxics Enforcement Act prohibits discharge or release of chemicals known to the State of California to cause cancer or reproductive toxicity into water, or onto or into land where such chemical passes or probably will pass into any source of drinking water.

Historically, contaminated liquid waste was discharged from DOE research activities to the Imhoff Treatment Facility, the Domestic Septic Tanks and the Radium and Strontium Treatment System and associated leach fields, which resulted in hazardous releases to site soils. These structures and associated contaminated soils have been removed and shipped off-site for disposal, with the final shipment of pipe joints shipped in 2003. Current DOE/NNSA activities at LEHR do not discharge contaminants to any drinking water sources.

According to a Memorandum of Agreement between UC Davis and DOE (DOE, 1997), potential impacts to ground water from past site activities are to be addressed by UC Davis. UC Davis is conducting a ground water interim remedial action. Quarterly ground water and surface water monitoring has been conducted since November 1990. Monitoring activities conducted in 2003 are summarized in Section 4.

2.5 Other Environmental Statutes

2.5.1 Endangered Species Act

In 1997, an Ecological Scoping Assessment (WA, 1997b) was conducted to support the Draft Final Determination of Risk-Based Action Standards for DOE Areas (WA, 1997c). The Ecological Scoping Assessment identified special status species that have a high potential to exist in or near Putah Creek, including two plant species, five invertebrates, nineteen birds, two reptiles, one amphibian and four mammals.

Habitat for the Valley Elderberry Longhorn Beetle, a threatened species under the Endangered Species Act, was identified in the Western Dog Pens, Eastern Dog Pens and the former Cobalt-60 Field. The LEHR staff are trained to recognize the habitat of this threatened beetle species and are required to protect the habitat from any interference or damage. No habitat modifications or adverse effects on the species resulted from the 2003 site activities.

The Draft Human Health and Ecological Risk Assessment will provide updated and detailed information on species and habitat present at the Site. UC Davis plans to issue this report in 2004.

2.5.2 National Historic Preservation Act

All areas affected by activities conducted at the site in 2003 involved existing structures located on previously graded and developed land. An archeological evaluation was conducted during the Phase II Soil and Ground Water Characterization of the Site (DOE, 1992a). No evidence of cultural resources, historical or archeologically sensitive areas was encountered in 2003.

2.5.3 Migratory Bird Treaty

The Migratory Bird Treaty Act governs the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts and nests. No activities resulting in taking of any migratory birds, their eggs, parts or nests occurred at the Site in 2003.

2.6 Executive Orders

2.6.1 Executive Order 13148, "Greening the Government through Leadership in Environmental Management"

Executive Order 13148 requires compliance with the Emergency Planning and Community Right-to-Know Act, also known as the Superfund Amendment and Reauthorization Act (SARA) Title III. SARA Title III requires facilities to provide information on the presence of hazardous chemicals and on the releases, both accidental and routine, of such chemicals into the environment. This information is used by state and local emergency agencies, hospitals, police and fire departments, and emergency response teams in responding to chemical emergencies, and is also available to the public to inform them of chemical hazards present in their neighborhood. The toxic release inventory requirements of SARA apply to facilities that use large amounts of certain chemicals.

The amounts of chemicals stored and used at LEHR are minimal and include such items as gasoline and propane fuels, paints, thinners, and one dewar of liquid nitrogen. The storage, use, handling, and emergency response activities associated with these chemicals were covered by the following LEHR program documents, which meet the Emergency Planning and Community Right-to-Know Act requirements:

- Project Health and Safety Plan (WA, 2001k), which contains a hazard communication program, including requirements for maintaining a chemical inventory and Material Safety Data Sheets;
- Contingency Plan and General Emergency Response Procedures (WA, 2001d), which cover planning, notification requirements and release notification procedures; and
- Occurrence Reporting Plan (WA, 2000b), which addresses the release notification process.

Since only small amounts of chemicals are used at the Site, LEHR is not required to submit a toxic release inventory under Emergency Planning and Community Right-to-Know Act Section 313, Toxic Release Inventory Reporting. The Site compliance with Emergency Planning and Community Right-to-Know Act reporting requirements is summarized in Table 2-1.

Table 2-1. Status of Emergency Planning and Community Right-to-Know Act Reporting

EPCRA Section	Description of Reporting	Status
302-303	Planning Notification	Compliant
304	Extremely Hazardous Substance Release Notification	Compliant
311-312	MSDS/Chemical Inventory	Compliant
313	Toxic Release Inventory Reporting	Not Applicable

Abbreviations
EPCRA Emergency Planning and Community Right-to-Know Act
MSDS Material Safety Data Sheet

Executive Order 13148 also requires the development and implementation of Environmental Management Systems to ensure that strategies are established to support environmental leadership programs, policies and procedures and that agency senior level managers explicitly and actively endorse these strategies. The order specifies the implementation of an Environmental Management Systems by 12/31/05 at all appropriate facilities. LEHR was determined not to be an appropriate facility due to its small size, types of environmental aspects associated with the facility operations, and scheduled closure of the site prior to the implementation deadline.

2.6.2 Executive Order 11988, "Floodplain Management"

The Site is not on a 100-year floodplain as defined by the Federal Emergency Management Agency.

2.6.3 Executive Order 11990, "Protection of Wetlands"

No portion of the Site is designated as a wetland.

2.7 Other Major Environmental Issues and Actions

In 2003, remaining waste from prior removal actions was shipped off-site for disposal at sites approved by the EPA to receive CERCLA waste. Table 2-2 summarizes waste shipments completed in 2003.

No violations, compliance orders or negative audit findings were issued to LEHR in 2003.

No new environmental programs and procedures were developed, approved, or implemented in 2003.

A compliance audit conducted in 2003 according to Title 10 Code of Federal Regulation Part 835, Radiation Protection, identified no findings.

2.8 Continuous Release Reporting

In accordance with CERCLA, non-permitted hazardous substance releases in quantities exceeding the CERCLA reportable quantity must be reported to the National Response Center. No such releases occurred at the Site in 2003.

2.9 Unplanned Releases

No unplanned releases occurred at the Site in 2003. No reports of unusual or off-normal occurrences under DOE Order 232.1 were made in 2003.

2.10 Summary of Permits

DOE/NNSA is not required to obtain any environmental permits for remediation and waste management activities conducted under CERCLA at LEHR.

Table 2-2. Waste Shipped for Off-Site Disposal in 2003

Waste Type	Contents	Origin	Volume cu yd	Disposal Site
LLRW	Soil, debris	Domestic Septic Systems 3 and 6	350	Nevada Test Site
LLRW	Gravel	Western Dog Pens	160	Nevada Test Site
LLRW	Thorium-228	Legacy material from inhalation studies	0.15	Nevada Test Site
LLRW	Intermodal container with equipment and misc. items	Pre-1996 D&D	47.4	Nevada Test Site
Mixed LLRW	Soil, gravel	Distribution Box	1	Envirocare of Utah
Mixed LLRW	Lead bricks, sheets, and other material	Shielding used in labs and pipe joints from DSS	5.78	Envirocare of Utah
Hazardous Waste	PCB-containing light ballasts	Site facilities	0.15	via UC Davis Campus-wide Disposal Contract
Hazardous Waste	Used hydraulic oil	D&D equipment	0.07	via UC Davis Campus-wide Disposal Contract

Abbreviations
cu yds cubic yards
D&D decontamination and decommissioning
LLRW low-level radioactive waste

3. ENVIRONMENTAL PROGRAM INFORMATION

Each year DOE monitors the air, water, and soil conditions at the Site by collecting environmental samples and evaluating relevant sample data obtained from UC Davis. This section describes the LEHR environmental monitoring program and summarizes the environmental monitoring activities conducted in 2003. The analytical results generated by this monitoring program are discussed in Sections 4, 5 and 6.

3.1 Environmental Management

In 2003, the LEHR environmental management was integrated into the overall management framework of site environmental restoration and waste management activities. It included evaluation of applicable environmental requirements, incorporation of these requirements into the CERCLA process, implementation of defined environmental controls, ongoing environmental compliance monitoring, corrective action and self-assessment procedures, and an annual management audit of the overall effectiveness of the LEHR environmental restoration and waste management program. The LEHR Quality Assurance Project Plan (WA, 2000a) defines this management and program approach, and explicitly incorporates the protection of the environment into site activities.

3.2 Environmental Protection and Monitoring Programs

The 2003 LEHR Environmental Management System included the following programs and documents designed to ensure environmental protection:

- Environmental Protection Program (WA, 2001f);
- Report on Radiation Protection of the Public and the Environment (WA, 2001g);
- Radiation Protection Program (WA, 1999b);
- As-Low-As-Reasonably-Achievable Program (WA, 2001a);
- Radioactive Waste Management Program and Standard Operating Procedures (WA, 2001c);
- Hazard Category Evaluation (safety basis documentation) (WA, 2001e);
- Standard Operating Procedure 42.1, Environment, Safety and Health Reporting (WA, 2001h);
- Occurrence Reporting Plan (WA, 2000b);

- National Environmental Policy Act Environmental Assessments (WA, 1998 and WA, 2001i); and
- Revised Field Sampling Plan (Dames & Moore, 1998) implemented by UC Davis for ground water, surface water, soil, sediment, air and biota monitoring.

With the decrease in scope of site activities and the transition of site management to a small business, the scope of environmental and other compliance programs implemented at the site has been scaled back proportionately.

3.3 Environmental Monitoring and Surveillance

In 2003, most of the environmental monitoring at LEHR was managed and performed by WA and its subcontractors, with the exception of ground, surface and storm water monitoring, which has been performed by UC Davis. Environmental monitoring conducted by Weiss in 2003 was undertaken in accordance with DOE Order 5400.1 as described in Section 7 of the Final Environmental Protection Program (WA, 2001f).

Environmental monitoring at LEHR is composed of two activities: effluent monitoring and environmental surveillance. Effluent monitoring involves the collection and analysis of liquid and gaseous effluent samples to characterize and quantify contaminants released to the environment. These data are used to assess the exposure of and risk to the public and to demonstrate compliance with applicable regulations. Environmental surveillance involves the collection and analysis of air, water, soil, terrestrial foodstuffs, biota, and other media on or near DOE sites, and the measurement of external radiation. These data are used to assess potential exposure to the public, evaluate impacts on the environment, and demonstrate compliance with applicable regulations. Because activities at the Site are conducted under Superfund requirements, water, soil, and biota monitoring is integrated into the Superfund process, as discussed in the following sections.

3.3.1 Pre-Operational Monitoring

In accordance with the LEHR Environmental Protection Program (WA, 2001f), an environmental study must be conducted prior to start of any new process which has the potential for significant adverse environmental impact. The study should be not less than one year, and preferably two years, before the start of any new process to evaluate seasonal changes and be consistent with National Environmental Policy Act requirements. The study shall:

- Characterize existing physical, chemical and biological conditions that could be affected;
- Establish background levels of radioactive and chemical components;
- Characterize pertinent environmental and ecological parameters;
- Identify potential pathways for human exposure or environmental impact; and

- Provide a basis for developing routine operational and emergency effluent monitoring and environmental surveillance programs.

No activities with potential for significant adverse environmental impacts were conducted at the site in 2003. All transportation and disposal activities completed in 2003 were categorically exempt from environmental analysis.

3.3.2 Surface and Storm Water Monitoring

There are currently no active process-based effluent discharges from LEHR facilities to the environment, which would require effluent stream monitoring. Surface and storm water runoff are the only potential liquid effluent sources of contamination.

Certain storm drains on the LEHR site are directed into the UC Davis combined storm and sanitary sewer system and subsequently treated by the UC Davis Waste Water Treatment Plant. The plant operates under National Pollutant Discharge Elimination System Permit No. CA0077895, which contains the waste water discharge requirements for the facility. Environmental monitoring and surveillance of the UC Davis Waste Water Treatment Plant is conducted by UC Davis and is discussed in Sections 4.3 and 5.3 of this report.

Surface water monitoring is conducted by UC Davis in accordance with a Revised Field Sampling Plan (Dames & Moore, 1998) developed to comply with EPA and DOE requirements for chemical and radiological analyses, respectively. Samples are collected at three locations along the South Fork of Putah Creek (Figure 3-1). The Putah Creek Upstream (PCU) monitoring point is located upstream of the LEHR site. The Putah Creek Downstream (PCD) monitoring point is located downstream of the LEHR site and UC Davis property. The waste water treatment plant outfall (STPO) monitoring station is located at the outfall of the UC Davis Waste Water Treatment Plant, which discharges into the South Fork of Putah Creek between PCU and PCD (Figure 3-1).

Surface water runoff samples are collected quarterly to coincide with ongoing LEHR project activities and are analyzed for radioactive and hazardous materials. The types of analyses are based upon those contaminants historically present at the LEHR site and are monitored as part of ongoing LEHR activities.

In accordance with the Memorandum of Agreement between DOE and UC Davis (DOE, 1997), DOE/NNSA collects storm water samples from a lift station located on the western border of the site (LS-1 on Figure 3-1), and UC Davis collects samples from the UC Davis areas of the site (LF-1 and LF-3 on Figure 3-1). The LS-1 collection point is a lift station located on the west side of the site, which pumps runoff to a ditch along the west side of Old Davis Road. All of the storm water monitoring data collected by UC Davis and DOE are included in an annual report prepared by UC Davis. In accordance with the Revised Field Sampling Plan (Dames & Moore, 1998), sampling is conducted for two separate rainfall events: (1) the first significant storm event of the rainy season to sample runoff that may carry material that accumulated on the ground surface during the summer months; and (2) a large storm event late in the rainy season. Storm water samples are analyzed for

the following possible contaminants: selected radionuclides (tritium, carbon-14, strontium-90, radium-226), metals, chromium, nitrate, acute aquatic toxicity, alkalinity, other cations and anions, volatile organic compounds, chloroform, semi-volatile organic compounds, pesticides, polychlorinated biphenyls, total oil and grease, suspended and dissolved solids, and total organic carbon.

In 2003, UC Davis performed all surface water monitoring and monitored storm water runoff from the UC Davis areas of the site. DOE/NNSA monitored storm water runoff from the DOE areas only. The surface water monitoring results are discussed in detail in Sections 4.3 and 5.3.

3.3.3 Ground Water Monitoring

DOE and UC Davis signed a Memorandum of Agreement (DOE, 1997) to divide responsibility for site areas of contamination according to historical site use and operation. UC Davis has assumed responsibility for ground water monitoring and remediation activities. The locations of ground water monitoring wells are shown on Figure 3-1.

In 2003, UC Davis performed all site ground water monitoring. The ground water monitoring results are discussed in Section 6.

3.3.3.1 Ground Water Protection

In addition to ground water remediation conducted by UC Davis, ground water protection in 2003 was achieved through spill prevention measures implemented during waste management activities, such as covering stockpiles, and minimizing the dispersion of dust by water suppression.

3.3.4 Air Monitoring

There are currently no point sources of radionuclide or chemical emissions at LEHR. The only potential sources of air emissions in 2003 were areas with exposed soil, such as the Eastern and Western Dog Pens, and soil/gravel stockpiles in the Western Dog Pens and the Southwest Trenches. Under realistic conditions, airborne effluent from these sources does not require sampling for hazardous materials because there are no appreciable quantities of uncontained hazardous materials in the surface soil (Dames & Moore, 1992; Bechtel Environmental Inc., 1991).

Radioactive and non-radioactive materials in air had been monitored at a number of locations at and near the Site since August 1995 through 2002, during site remediation activities. The majority of radionuclide analytical results for samples collected during this period were close to or below the minimum detectable activity for the laboratory analysis methods. Due to the completion of remediation activities DOE/NNSA discontinued air monitoring at the Site at the end of 2002.

Airborne emissions of radioactive and hazardous materials from DOE-controlled facilities are subject to EPA regulations. The primary regulatory driver for air monitoring programs at DOE

facilities is Title 40 Code of Federal Regulations Part 61, Subpart H, National Emission Standards for Hazardous Air Pollutants for Emissions of Radionuclides from DOE Facilities. Subpart H of the National Emission Standards for Hazardous Air Pollutants requirements primarily target point source/stack emissions. However, a Memorandum of Understanding between the DOE and the EPA (DOE, 1995) applies the same criteria to potential diffuse area sources that are required of point sources. The National Emission Standards for Hazardous Air Pollutants regulations require that radionuclide emissions not exceed levels that would result in an effective dose equivalent of 10 mrem/yr. Measurement of emission rates is required for all release points with the potential to release radionuclides into the air that would cause an effective dose equivalent in excess of 1% of the standard (i.e., an effective dose equivalent >0.1 mrem/yr) and all radionuclides which could contribute to >10% of the potential effective dose equivalent for a release point. A discussion of compliance with Subpart H of the National Emission Standards for Hazardous Air Pollutants is provided in Section 4.1.1.

3.3.5 Environmental Dosimetry

Thermoluminescent dosimeters are used to quantify the exposure of on- and off-site personnel to penetrating gamma radiation. Currently, 28 locations are monitored for penetrating radiation (Figure 3-2). Thermoluminescent dosimeters are placed near perimeter fence lines, radioactive waste storage areas and various work areas around the Site. The thermoluminescent dosimeters are analyzed quarterly, and an annual gamma radiation dose is calculated for each location. The thermoluminescent dosimeter data are normalized by subtracting site background activity from each location. The results of the ambient radiation monitoring program are discussed in Section 4.4.

3.4 Site Environmental Training

Site-specific environmental training has been conducted annually to instruct project personnel on environmental policies, programs and procedures; project-specific environmental controls; pollution prevention goals; and waste minimization requirements. This training is normally conducted as part of the site orientation. Additional training is provided prior to any new activity that could potentially impact the environment. Daily safety meetings reinforce this training and specify the steps needed to assure adequate environmental protection during that day's activities.

Before a worker is allowed to begin hazardous site work, he or she must complete a 40-hour Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations Training. In addition, each worker receives hazard communication training. This training ensures that the worker is aware of proper handling, usage and disposal of chemicals used on the job. It covers spill prevention and control, as well as proper storage and chemical disposal methods. Workers are also trained in radiological control methods to prevent the spread of radioactive contamination to the environment, and emergency response and reporting procedures to ensure proper response in the event of an incident.

3.5 Waste Minimization and Pollution Prevention

The LEHR waste management program is committed to minimizing waste volumes by giving preference to source reduction, material substitution, decontamination, and recycling. Applicable waste minimization activities include:

- Avoiding the use of porous materials that cannot be decontaminated;
- Minimizing personal protective equipment waste through effective planning;
- Using real-time analyses to delineate the extent of contamination;
- Optimizing waste container utilization and recycling;
- Removing surface contamination from subsurface structures and pipes; and
- Reusing uncontaminated soil and materials on-site.

3.5.1 Waste Minimization Using Expedited Data Feedback

In 2003, radiologically-contaminated D&D equipment slated for disposal at the Nevada Test Site as low-level radioactive waste was inspected for the presence of hazardous materials, such as used oil, PCB transformers, Freon and other similar materials. Used hydraulic oil was removed from the equipment, characterized as hazardous waste (not mixed waste) and shipped off-site for disposal to avoid unnecessary off-site disposal of uncontaminated material as low-level radioactive waste.

3.5.2 Recycling

A recycling program instituted in 2001 continued at LEHR in 2003. To the extent practicable, all paper, plastic, and cardboard waste generated by the project were recycled. Gravel generated during the Western Dog Pens removal action in 2001 was shipped to the Nevada Test Site for reuse at the site in lieu of landfill disposal. A portion of the gravel was shipped in late 2003, with the shipment being completed in 2004.

3.6 Protection of Biota

DOE Order 5400.5 and the interim DOE Technical Standard, "A Graded Approach for Evaluating Radiation Dose to Aquatic and Terrestrial Biota" (DOE, 2000) provide guidance on monitoring aquatic biota and terrestrial foodstuffs, a broad category that includes vegetation and fauna. Surveillance of terrestrial foodstuffs is required to quantify radioactive materials and chemicals, and to demonstrate that radioactive and hazardous materials are not accumulating in the environment. Currently, no sampling of terrestrial foodstuffs is planned at LEHR. A site-wide risk assessment evaluating the site ecological risks is being developed by UC Davis. Surveillance

requirements will be evaluated and/or developed based on the information obtained in this risk assessment.

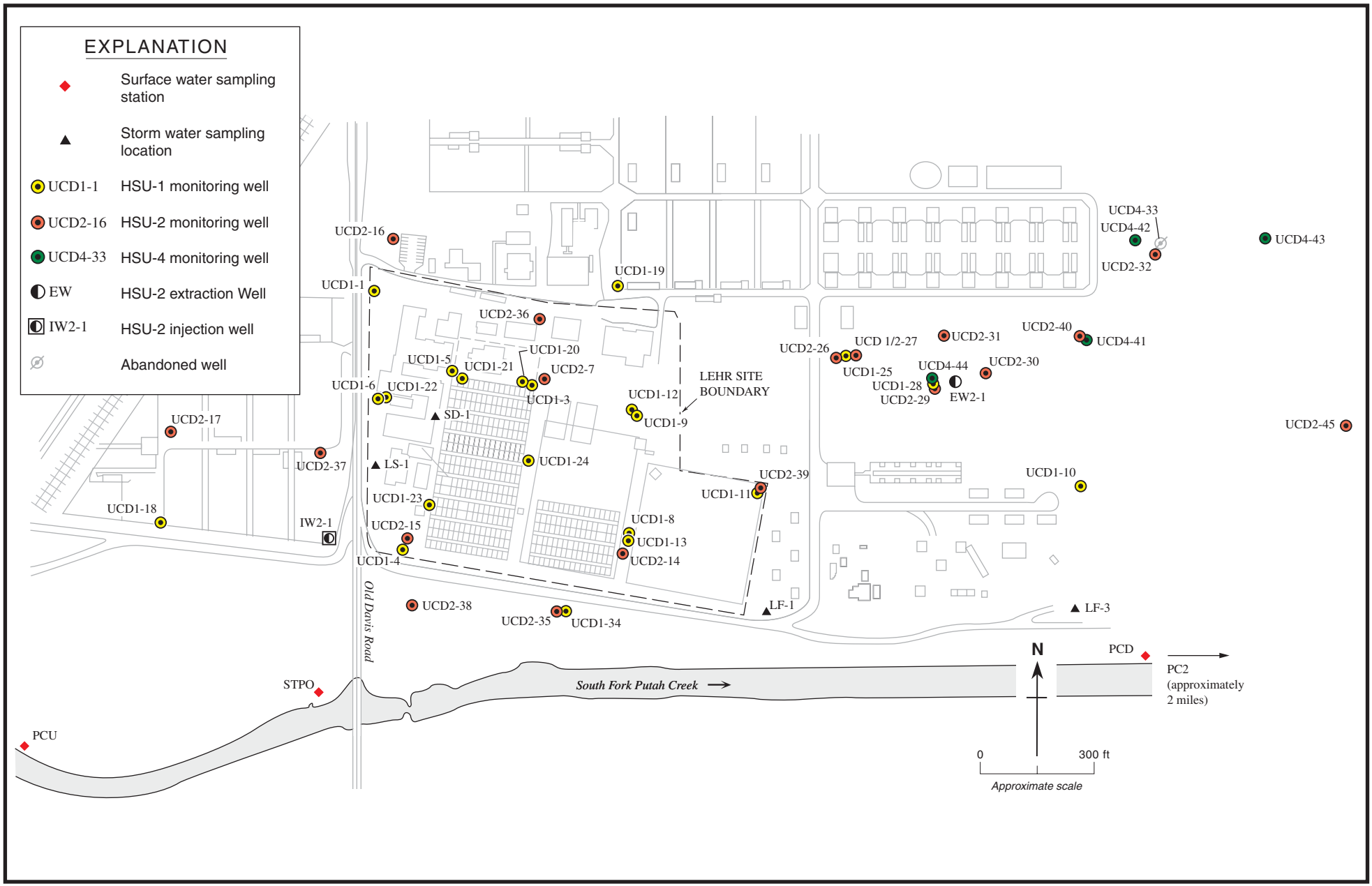

Figure 3-1. Ground Water, Storm Water and Surface Water Monitoring Locations

Weiss Associates

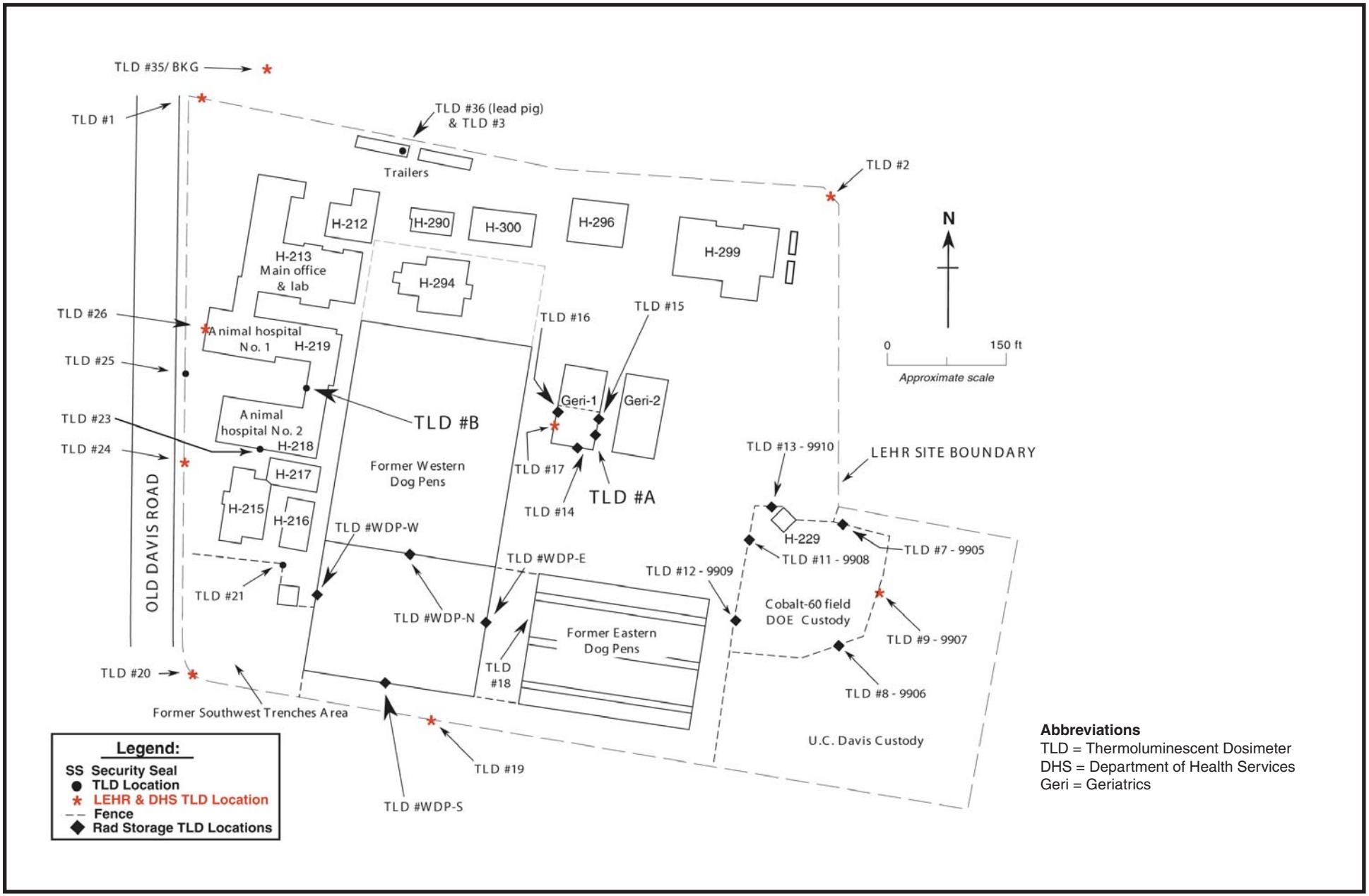

Figure 3-2. Thermoluminescent Dosimeter Location Map

Weiss Associates

4. ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

This section summarizes significant results and trends in radiological air, soil, and water monitoring data for 2003. The majority of radionuclide sample results for samples collected at the Site in 2003 were close to or below the minimum detectable activity for the laboratory analysis methods. Table 4-1 provides a summary of public radiological dose exposure from DOE/NNSA activities at the Site.

4.1 Radiological Air Monitoring

Radioactive and non-radioactive materials in air have been monitored at a number of locations at and around the Site since August 1995 through 2002 during remediation activities. This monitoring indicated that all of the maximum concentrations of air contaminants of concern were well below their respective derived concentration guide values and did not pose any health risks to site workers or laboratory personnel at LEHR. The concentrations only marginally exceeded the concentrations at the background monitoring station. Since the completion of removal actions in 2002, air monitoring at the Site was discontinued.

4.1.1 National Emission Standards for Hazardous Air Pollutants Dose Estimation Calculations

Calculations were performed to determine the estimated radiation dose from site sources to the public. During 2003, the Western and Eastern Dog Pens were identified as the only remaining potential sources of non-point diffuse radionuclide emissions. Radionuclide air emissions could potentially by generated by wind-blown, fugitive dust containing residual radioactivity above the site background concentrations.

Compliance with the National Emission Standards for Hazardous Air Pollutants requirements for diffuse, non-point source emissions was assessed using the EPA atmospheric dispersion/radiation dose calculation computer code, CAP88-PC Version 1.0. This code was used to calculate the effective dose equivalent to individual receptors at various distances from the Western and Eastern Dog Pens. "Individual receptor" CAP88-PC runs were executed for each non-point source area to model the fugitive dust emission sources. For each of the potential radionuclide emission non-point sources, a human receptor was identified in each of the north, south, east and west quadrants relative to the source.

The CAP88-PC computer code was then used to calculate the effective dose equivalent to individual receptors at various distances and from each of the potential LEHR facility radionuclide

emission sources. The reported effective dose equivalent to a maximally exposed individual at the LEHR facility includes contributions from the two potential radionuclide emission non-point sources. Based on the combined non-point source exposures, the maximally exposed individual at the LEHR facility is located in the Inter-Regional Project No. 4 Building (Building H-217) (Figure 1-2). The results of the assessment are shown in Table 4-2.

Conservative radionuclide emission rates in fugitive dust were estimated using maximum soil radionuclide activities above the Western and Eastern Dog Pens backgrounds and were used to calculate the total estimated contribution to the effective dose equivalent. The total contribution to the effective dose equivalent for an on-site maximally exposed individual resulting from non-point source emissions was estimated to be 1.4×10^{-3} mrem/yr (1.0×10^{-5} milliSieverts per year), far below the 10 mrem/yr standard. The results are presented in Table 4-3.

The CAP88-PC computer code was also used to calculate the collective population dose as required by DOE Order 5400.5. The collective dose equivalent to Davis residents was 4.5×10^{-4} person-roentgen equivalent man per year, and the effective dose equivalent for the off-site maximally exposed individual was 1.4×10^{-4} mrem/yr, as estimated by CAP88-PC. The calculated effective dose equivalent for the off-site maximally exposed individual is several orders of magnitude below the 10 mrem/yr standard, as required by Title 40 of the Code of Federal Regulations Part 61, Subpart H.

4.2 Radiological Soil Measurements

No soil sampling for radiological analyses was performed in 2003.

4.3 Radiological Surface and Storm Water Monitoring

Quarterly surface water sampling has been conducted at the Site since 1990 for an extensive list of analytes. In 1997, in accordance with the Memorandum of Agreement, responsibility for surface water sampling was transferred to UC Davis. DOE/NNSA retained responsibility for storm water runoff sampling in the DOE areas of the site. Trends and conclusions drawn from the surface and storm water monitoring results are briefly discussed below. A detailed discussion of results, including tables summarizing the analytic data, can be found in the Draft 2003 Comprehensive Annual Water Monitoring Report (Brown and Caldwell, 2004).

4.3.1 Surface Water Monitoring

In 2003, UC Davis collected six surface water samples from three locations: PCU, STPO, and PCD (Figure 3-1). Samples were collected during two rainfall events on February 13, 2003 and December 23, 2003. The samples that were collected were analyzed for carbon-14, radium-226, strontium-90 and tritium. None of these radionuclides were detected above the contract-required detection limits.

4.3.2 Storm Water Monitoring

Storm water samples were collected from two locations at the Site: LF-1 and LS-1 (Figure 3-1). UC Davis collected samples at location LF-1 on February 12, 2003 and December 23, 2003. The samples were analyzed for carbon-14, radium-226, strontium-90 and tritium. All of the sample results were below the contract-required detection limits.

DOE/NNSA collected samples at location LS-1 on April 12, 2003 and November 15, 2003. These samples were analyzed for actinium-228, bismuth-212, bismuth-214, carbon-14, cesium-137, cobalt-60, lead-210, lead-212, lead-214, potassium-40, sodium-22, thalium-208, thorium-234, uranium-235, uranium-238, strontium-90, radium-226, gross alpha and gross beta. Of these, only gross beta exceeded the contract-required detection limits. All other radionuclides, including tritium and carbon-14, were below the contract-required detection limits.

4.4 Ambient Radiation Monitoring Program

The LEHR ambient radiation monitoring program uses passive thermoluminescent dosimeters to monitor gamma radiation throughout the site. The thermoluminescent dosimeters are placed near perimeter fence lines, radioactive waste storage areas and various work areas around the Site (Figure 3-2). The thermoluminescent dosimeters are collected quarterly, and an annual gamma radiation dose is calculated for each location. In 2003, thermoluminescent dosimeters and analyses were provided by Radiation Detection Company, which is certified by the National Voluntary Laboratory Accreditation Program. TLD-35, located at the equine center to the north of the Site, is used to monitor background activity.

The annual background dose near the Site measured by TLD-35 was 80 mrem/yr, which is consistent with previous years. The annual dose at the Site slightly exceeded the background at one location, TLD-37, by 2 mrem. TLD-37 was located near the location of the legacy thorium-228 source for part of 2003. After the removal of the thorium-228 source, the dose measured at this location in the last quarter of 2003 was below background. The total dose measured at this location is below the DOE limit for public exposure.

In all other locations the radiation dose was consistent with the site background. The DOE limit for exposure of members of the public as a consequence of routine DOE activities is 100 mrem/yr. Calendar Year 2003 thermoluminescent dosimeter results show that ambient radiation detected at the Site is either at background levels or well below the DOE dose limit for the general public. Table 4-4 provides all gamma radiation dose data for 2003.

Table 4-1. LEHR Radiological Dose Reporting Table for Calendar Year 2003

Pathway	Dose to Maximally Exposed Individual [1]		% of DOE 100 mrem/yr Limit	Estimated Population Dose		Population within 80 km[2]	Estimated Background Radiation Population Dose
	(mrem)	(mSv)	%	(person-rem)	(person-Sv)		(person-rem)
Air	1.4E-04	1.4E-06	1.4E-06	4.5E-04	4.5E-06	111,228[3]	N/A
Water[4]	-	-	-	-	-	-	N/A
Other Pathways[5]	N/A	N/A	N/A	N/A	N/A	N/A	N/A
All Pathways	1.4E-04	1.4E-06	1.4E-06	4.5E-04	4.5E-06	111,228[3]	Not Available

Notes

[1] The maximum total dose is the sum of effective dose equivalents modeled for each maximally exposed individual receptor from potential radionuclide fugitive dust emission non-point sources. The location of the receptor modeled is 250 m north of the Eastern and Western Dog Pens, which is the approximate location of UC Davis research facilities. Additional information may be found in the 2003 NESHAPS Report (WA, 2004).

[2] The total population used in calculating the population dose included receptors within a distance of 10 kilometers (km) (6.2 miles) from the Site, rather than 80 km (49 miles) as specified in DOE guidance. This modification was necessary to avoid including the large number of receptors in the Sacramento area whose exposure to radionuclides resulting from the Site would be negligible, but whose population numbers would have a large effect on the collective population dose results. This approach is appropriate for calculating the collective population dose for the primarily rural LEHR facility surroundings.

[3] Pathway-specific population is not significantly different from total population.

[4] The water pathway was not measured.

[5] There are no other exposure pathways contributing to a radiological dose at LEHR.

Abbreviations

km	kilometer
LEHR	Laboratory for Energy-Related Health Research
mrem/yr	millirem per year
N/A	not applicable
NNE	north by northeast
NNW	north by northwest
rem	Roentgen equivalent man
mSv	milliSievert
Sv	Sievert

Table 4-2. Summary of On-Site Effective Dose Equivalent to Maximally Exposed Individual Resulting from Radionuclide Emissions from Each Potential Fugitive Dust Emission Non-Point Source

MEI Receptor Description	Western Dog Pens Area (mrem/yr)[1]	Western Dog Pens Area Location[2]	Eastern Dog Pens Area (mrem/yr)[1]	Eastern Dog Pens Area Location[2]	Maximum Total Dose (mrem/yr)[3]
Specimen Storage Building (Building H-216)	1.1E-03	48 m W	1.8E-04	132 m W	1.3E-03
UC Davis Building E of LEHR Site	6.1E-05	300 m E	2.7E-05	180 m E	8.8E-05
Off-Site Receptor S of Putah Creek	5.4E-05	1,200 m S	2.6E-06	1,000 m S	5.7E-05
Off-Site Receptor W of LEHR Site	7.0E-05	400 m W	1.3E-05	500 m W	8.3E-05
Animal Hospital Building No. 1 (Building H-219)	6.6E-04	65 m W	1.1E-04	165 m W	7.7E-04
Inter-Regional Project No. 4 Building (Building H-217)	1.2E-03	52 m W	1.5E-04	143 m W	**1.4E-03**
Animal Hospital Building No. 2 (Building H-218)	6.6E-04	65 m W	1.1E-04	165 m W	7.7E-04
Cellular Biology Laboratory (Building H-294)	8.5E-04	65 m N	1.3E-04	150 m NNE	9.8E-04
Clinical Pathology (H-215)	3.1E-04	99 m W	1.4E-04	150 m W	4.5E-04
Main Office (H-213)	7.5E-04	65 m NW	1.2E-04	187 m NW	8.7E-04

Notes

[1] The EDE to the MEI is taken as the maximum modeled dose within a 45° sector in the direction and at the distance indicated in the "Location" column. For example, the dose 65 m north of the Western Dog Pens Area would be the maximum modeled dose at 65 m N, 65 m NNE and 65 m NNW.

[2] The distance from an area source to a receptor is defined by CAP88-PC as the distance from the centroid of the area source to the receptor (US EPA, 1992). For the LEHR facility CAP88-PC modeling, the distance from an area non-point source to a receptor is measured as the approximate distance from the centroid of the area non-point source to the centroid of the building assumed to house the receptor.

[3] The maximum total dose is the sum of the EDEs modeled for each MEI receptor from the four potential radionuclide fugitive dust emission non-point sources. Value in **boldface** is the maximum total dose for the site.

Abbreviations

EDE	effective dose equivalent	NNW	north by northwest
E	east	NW	northwest
m	meters	No.	number
MEI	Maximally Exposed Individual	S	south
mrem/yr	millirem per year	UC Davis	University of California, Davis
N	north	W	west
NNE	north by northeast		

Table 4-3. Summary of Estimated Collective Population Dose Resulting from Radionuclide Emissions from Each Fugitive Dust Emission Non-Point Source

Potential Emission Source	**Off-Site Maximally Exposed Individual**		**Collective Population Dose**
	(mrem/yr)	**Location**	**(person-rem/yr)**
Western Dog Pens Area	6.4E-05	250 m North[1]	2.1E-04
Eastern Dog Pens Area	7.8E-05	250 m North[1]	2.5E-04
Total LEHR Site	**1.4E-04**		**4.5E-04**

Notes
Source of data: CAP88-PC Version 1.0 modeling output files.
The collective population dose is for receptors within a 10-km radius.
[1]The approximate location of UC Davis research facilities.

Abbreviations

km	kilometer(s)
m	meter(s)
mrem/yr	millirem per year
person-rem/yr	person-roentgen equivalent man per year
rem	roentgen equivalent man
UC Davis	University of California, Davis

Table 4-4. LEHR Thermoluminescent Dosimeter Monitoring Results for Calendar Year 2003

Sample Location Number[1]	Total Annual Dose (mrem)	Dose Associated with DOE Activities[2] (mrem)
TLD-01	79	-1
TLD-02	78	-2
TLD-03[3]	67	-13
TLD-09	74	-6
TLD-17	71	-9
TLD-19	78	-2
TLD-20	79	-1
TLD-24	74	-6
TLD-26	72	-8
TLD-35 (Background)[4]	80	0
TLD-36	61	-19
TLD-37	82	2

Notes

[1] Location corresponds to Figure 3-2.

[2] Measured dose, less background.

[3] Data for April – June is not available. The total annual dose reflects an extrapolated value assigned to this time period, calculated as an average of the dose values measured during the remainder of the reporting year.

[4] Background is collected at TLD-35.

Abbreviations

DOE United States Department of Energy
TLD thermoluminescent dosimeter
mrem millirem

5. ENVIRONMENTAL NON-RADIOLOGICAL PROGRAM INFORMATION

This section summarizes significant results and trends in 2003 non-radiological LEHR site air, soil and water monitoring.

5.1 Non-Radiological Air Monitoring

Air monitoring for non-radiological constituents was performed only during shipment activities to ensure that worker exposure to particulate matter less than 10 microns in aerodynamic diameter (PM_{10}) and lead did not exceed the Occupational Safety and Health Administration's permissible exposure limits for these air contaminants.

All monitoring indicated that worker exposure to PM_{10} and lead was well below the Occupational Safety and Health Administration's permissible exposure limit.

5.2 Non-Radiological Soil Monitoring

No soil monitoring was performed in 2003.

5.3 Non-Radiological Surface and Storm Water Monitoring

In 2003, surface water sampling was conducted and reported by UC Davis. Trends and conclusions drawn from the surface and storm water monitoring results are discussed briefly below. A detailed discussion of results and tables summarizing the analytical data can be found in the Draft 2003 Comprehensive Annual Water Monitoring Report (Brown and Caldwell, 2004).

5.3.1 Surface Water Monitoring

In 2003, UC Davis collected six surface water samples from three locations: PCU, STPO, and PCD (Figure 3-1). Samples were collected during two rainfall events on February 12, 2003 and December 23, 2003. The samples that were collected were analyzed for chronic aquatic toxicity, metals, nitrate, pesticides, polychlorinated biphenyls, total dissolved solids, and volatile organic compounds. Only metals, nitrate and total dissolved solids were detected above the contract-required detection limits. Nitrate was detected in concentrations ranging from 1.6 milligrams per liter (mg/l)

at PCU to 9.45 mg/l at STPO. Total dissolved solids were detected in concentrations ranging from 243 mg/l at PCU to 656 mg/l at STPO. These concentrations are similar to concentrations detected in 2002. The metals detected were arsenic, barium, boron, copper, iron, manganese, vanadium, and zinc.

5.3.2 Storm Water Monitoring

All storm water samples were collected at two monitoring locations, LF-1 and LS-1, during numerous storms throughout the rainy season in 2003 (Figure 3-1). Monitoring location LF-1 was sampled on February 12, 2003 and December 23, 2003 by UC Davis; and monitoring location LS-1 was sampled by DOE/NNSA on April 12 and 25 and November 15, 2003.

The sample collected from LF-1 was analyzed for field parameters, acute aquatic toxicity, metals, nitrate, oil and grease, pesticides, polychlorinated biphenyls, radionuclides, total dissolved solids, total organic carbon, total suspended solids and volatile organic compounds. The following constituents were detected above the contract-required detection limits: acetone, metals, nitrate, total organic carbon, and total dissolved solids. All of the compounds, except for nitrate, which was slightly above the historical high, were within the historical ranges.

The samples collected from LS-1 were analyzed for metals, nitrate, oil and grease, pesticides, polychlorinated biphenyls, radionuclides, total dissolved solids, total organic carbon, total suspended solids and volatile organic compounds. Analytical results were similar to previous years. Significant results include:

- Chloroform was not reported above the contract-required detection limit in any storm water samples collected from the Site in 2003, nor in the previous five years.
- Chromium and nitrate concentrations were within historical ranges.
- Concentrations of total dissolved solids were above historical ranges at 91 mg/L and 118 mg/L in April and November, respectively.

5.3.3 National Pollutant Discharge Elimination System Data

The Site discharges its sanitary waste to the UC Davis Waste Water Treatment Plant according to National Pollutant Discharge Elimination System permit requirements. Current DOE/NNSA activities do not contribute to hazardous discharges.

6. WATER MONITORING AND PUBLIC DRINKING WATER PROTECTION PROGRAM

Ground water monitoring has been conducted at the Site since November 1990 and has been the responsibility of UC Davis since 1997. UC Davis submits quarterly and annual reports on ground water monitoring to DOE/NNSA for review and comment.

6.1 Uses of Ground Water in the LEHR Vicinity

As discussed in Section 1.5.3, local ground water is utilized for both domestic supply and agricultural purposes. The major ground water sources for both public and private water supplies in the Sacramento Valley are unconsolidated deposits of Pliocene and Pleistocene age, and older alluvium (DOE, 1992b). Water from the first HSU is not used for drinking or irrigating purposes due to inadequate yield. A number of domestic and irrigation wells in the site vicinity produce water from HSU-2.

6.2 Potential Sources of Ground Water Pollution

Sources contributing to ground water pollution at the Site include the UC Davis Landfill No. 2 (source of volatile organic compounds) and the UC Davis Waste Burial Holes (Figure 1-2) (source of tritium and carbon-14 contamination). UC Davis landfills and the former animal handling facilities at LEHR may be potential sources of nitrate contamination in the site ground water.

6.3 Ground Water Monitoring

UC Davis continued to monitor ground water at the Site. In the 2002 Draft Comprehensive Annual Water Monitoring Report (Brown and Caldwell, 2003), UC Davis recommended major changes to the ground water monitoring program. These changes were approved by the EPA in October 2003 and will be implemented in 2004. The 2003 ground water monitoring program followed the program outlined in the 2001 annual water monitoring report.

The ground water monitoring program and the 2003 sampling results are discussed in detail in the Draft 2003 Comprehensive Annual Water Monitoring Report (Brown and Caldwell, 2004). UC Davis reported no significant changes in the ground water contaminant concentrations in monitoring samples collected from DOE areas in 2003.

In addition to continued ground water monitoring by UC Davis, DOE/NNSA conducted a limited ground water investigation in 2003 in the vicinity of drywells A-E (Figure 1-2) to select a monitoring well location to collect ground water data down-gradient of the drywells. The results of a preliminary ground water impact evaluation (DOE, 2003) indicated that maximum concentrations of hexavalent chromium, chromium, mercury, molybdenum, silver, cesium-137, and strontium-90 could result in localized ground water impact above background concentrations. The investigation consisted of lithologic logging and grab ground water sampling at four locations east of the Dry Wells Area. Site lithology was recorded using cone penetration and piezometric techniques. The lithologic data was used to select hydropunch sample locations. Six hydropunch ground water samples were collected and analyzed for hexavalent chromium, chromium, mercury, molybdenum, silver, cesium-137, and strontium-90. The hydropunch sample results did not indicate contamination significantly above background. The lithology data and ground water results were used to select a monitoring well location for the Dry Wells Area. Monitoring well installation is planned for 2004 (DOE, 2003).

6.4 Off-Site Supply Well Sampling

Private wells south, north, and east of the Site have been sampled since 1989. Monitoring of radiological constituents in private wells ceased in 1996 after adequate monitoring wells and hydrologic information had been established to ensure that no radioactive materials were migrating off-site in ground water. UC Davis continues to monitor off-site wells for non-radiological constituents, including chloroform and nitrates, among others contaminants. Results of this monitoring are reported annually by UC Davis to the Regional Water Quality Control Board.

7. QUALITY ASSURANCE

Quality assurance is a key element of the environmental protection program for the Site. A Quality Assurance Project Plan (WA, 2000a) that describes the requirements for all quality-related work on the LEHR project has been prepared and is fully implemented. The Quality Assurance Project Plan and other quality-assuring documents, such as standard quality procedures, standard operating procedures and task-specific work plans, govern all phases of the LEHR program, including site characterization, investigation, risk assessments, decontamination and decommissioning, waste management and site restoration. The purpose of the Quality Assurance Project Plan and the other documents is to identify the specifications and methods employed to establish technical accuracy, precision and validity of measurements and statistics, and to provide a sound basis for management decisions based on environmental information collected for the Site. The Quality Assurance Project Plan for the LEHR project was prepared in accordance with EPA QA/R-5 (EPA, 2001) and National Quality Assurance specifications. It also conforms to DOE Order 414.4a, the Nuclear Safety Management Quality Assurance Requirements in Title 10 of the Code of Federal Regulations, Part 830, and incorporates requirements of DOE Order 5400.1, General Environmental Protection, to ensure that DOE quality and environmental goals are met.

Environmental samples collected by DOE/NNSA that are discussed in this report were collected, analyzed, reviewed and validated according to the Quality Assurance Project Plan and other relevant standard operating procedures and/or task-specific work plans. To assure quality, quality control is integrated into all aspects of environmental sampling. Included in the Quality Assurance Project Plan and related documents are sections identifying quality control for sample collection requirements and specific quality assurance objectives for the measurement data. Quality control samples are run with each sample batch at the analytical laboratory to validate the method of analysis and the proficiency of the analyst. Because holding times are important to sample quality, they are carefully controlled. To ensure comparability of analytical data, all samples are analyzed by EPA-approved methods when available. When analytical results are received, they are reviewed according to the appropriate data quality objectives and data review procedures. All of the 2003 site air, soil, and water monitoring data have been presented in other reports. The specific review and validation process for each data set are presented in these reports, and are not discussed in detail here.

7.1 Field Quality Assurance

Quality assurance for field sampling is accomplished by collecting field duplicates, decontamination rinseates, trip blanks and field blanks, as appropriate. For each round of sampling, duplicate samples are collected from a selected sample point at the same location as the original sample to check for consistency in the sampling process. The duplicate sample serves as a check on the precision of the sampling and analytical procedures. Decontamination rinseates are analyzed

whenever the potential exists for cross-contamination from sampling equipment. Trip blanks are sent with each shipment of water samples requiring analysis for volatile organic compounds. Field blanks are collected to check for contamination during the water sampling process. Calibration records for each field instrument are maintained in the project files.

7.2 Laboratory Quality Assurance

Contracted laboratories providing analytical services for the LEHR project were evaluated by Weiss Associates, New World Technology, or UC Davis to ensure compliance with the quality assurance program requirements. Laboratory quality assurance is analyzed externally by submitting split samples, spiked samples, and blanks to the laboratories analyzing environmental samples. Laboratories must submit their analytical procedure for review if it differs from standard procedures. Each contract laboratory is required to maintain participation, as applicable, in DOE, State of California, and/or EPA-approved inter-laboratory quality assurance programs such as DOE's Environmental Measurement Laboratory Inter-Laboratory Comparison Program or EPA's Water Pollution/Water Supply Program.

7.3 Compliance Audits

Aspects of the LEHR program are audited periodically to ensure compliance with project standards. Several health and safety and quality assurance audits or surveillances with an Integrated Safety Management System component, and a Radiation Protection Program audit were performed in 2003. All findings and observations identified during the audits have been resolved.

7.4 Summary of Quality Control Data Validation

The overall LEHR quality assurance objective is to collect and analyze environmental samples from the Site in a manner that ensures technical data are accurate and representative, are able to withstand scientific and legal scrutiny, and are useful for evaluating site conditions and remedial actions. The criteria used to specify quality assurance goals are precision, accuracy, representativeness, completeness and comparability for evaluation of quality control data. These parameters are evaluated through data validation. Table 7-1 summarizes the components used to monitor and evaluate the quality of LEHR environmental data.

Table 7-1. Components of the LEHR Quality Control Program in Support of Data Quality Objectives

Data Quality Objective	Quality Control Component	Evaluation Criteria
Precision	• Field duplicate • Matrix spike • Matrix spike duplicate	Relative percent difference
Accuracy	• Matrix spike • Matrix spike duplicate • Surrogate spikes	Percent recovery
Representativeness	• Trip blanks • Field duplicate • Method blanks	Qualitative degree of confidence
Completeness	• Holding time • Valid data points	Percent valid data
Comparability	• Analytical methods • Field duplicates	Qualitative degree of confidence

8. DEFINITIONS[1]

Term	Definition
absorbed dose	The energy imparted to matter by ionizing radiation per unit mass of irradiated material at the place of interest in that material. The absorbed dose is expressed in units of rad (or gray) (1 rad = 0.01 gray).
as-low-as-reasonably-achievable (ALARA)	A phrase (acronym) used to describe an approach to radiation protection to control or manage exposures (both individual and collective to the work force and the general public) and releases of radioactive material to the environment as low as social, technical, economic, practical, and public policy considerations permit. As used in United States Department of Energy (DOE) Order 5400.5, ALARA is not a dose limit, but rather it is a process that has as its objective the attainment of dose levels as far below the applicable limits of the Order as practicable.
collective dose equivalent and collective effective dose equivalent	The sums of the dose equivalents or effective dose equivalents of all individuals in an exposed population within an 80-kilometer (km) radius, for the purposes of DOE Order 5400.5, expressed in units of person-Roentgen equivalent, man (rem), (or person-sievert). When the collective dose equivalent of interest is for a specific organ, the units would be organ-rem (or organ-Sievert). For purposes of DOE Order 5400.5, the 80-km distance shall be measured from a point located centrally with respect to major facilities or DOE program activities.
committed dose equivalent	The predicted total dose equivalent to a tissue or organ over a 50-year period after a known intake of a radionuclide into the body. It does not include contributions from external dose. Committed dose equivalent is expressed in units of rem (or sievert).

[1] Definitions are adapted from Department of Energy Order 5400.5, and United States Environmental Protection Agency.

Term	Definition
committed effective dose equivalent	The sum of the committed dose equivalents to various tissues in the body, each multiplied by the appropriate weighting factor. Committed effective dose equivalent is expressed in units of rem (or Sievert).
confirmation samples	Analysis for metals, nitrate, pesticides/polychlorinated biphenyls, semi-volatile organic compounds, volatile organic compounds and hexavalent chromium.
Curie (Ci)	A unit of radioactivity equal to 3.7×10^{10} disintegrations per second.
derived concentration guide	The concentration of a radionuclide in air or water that, under conditions of continuous exposure for one year by one exposure mode (i.e., ingestion of water, submersion in air, or inhalation), would result in an effective dose equivalent of 100 millirem (1 millisievert). Derived concentration guides do not consider decay products when the parent radionuclide is the cause of the exposure (derived concentration guide values are presented in Chapter III of DOE Order 5400.5).
designated level	Cleanup levels for specific constituents of a waste that provide a site specific indication of the water quality impairment potential of the waste. Designated levels are calculated by first determining the bodies of water that may be affected by a waste and the present and probable future beneficial uses of these waters. Next, site-specific "water quality goals" are selected, based on background water quality or accepted criteria and standards, to protect those beneficial uses. Finally, these water quality goals are multiplied by factors that account for environmental attenuation and leachability. The result is a set of Soluble and Total Designated levels that are applicable to a particular waste and disposal site and which, if not exceeded, should protect the beneficial uses of waters of the State. Wastes having constituent concentrations in excess of these designated levels are assumed to pose a threat to water quality and are, therefore, classified as 'designated wastes' and directed to waste management units that isolate these wastes from the environment.
DOE Orders	DOE directives intended to direct, guide, inform, and instruct DOE employees in the performance of their jobs, and enable them to work effectively within the DOE and with agencies, contractors, and the public.

Term	Definition
dose equivalent	The product of absorbed dose in rad (or gray) in tissue and a quality factor. Dose equivalent is expressed in units of rem (or sievert).
effective dose equivalent	The summation of the products of the dose equivalent received by specified tissues of the body and a tissue-specific weighting factor. This sum is a risk-equivalent value and can be used to estimate the health-effects risk of the exposed individual. The tissue-specific weighting factor represents the fraction of the total health risk resulting from uniform whole-body irradiation that would be contributed by that particular tissue. The effective dose equivalent includes the committed effective dose equivalent from internal deposition of radionuclides and the effective dose equivalent due to penetrating radiation from sources external to the body. Effective dose equivalent is expressed in units of rem (or sievert).
effluent monitoring	The collection and analysis of samples or measurements of liquid and gaseous effluents for purposes of characterizing and quantifying contaminants, assessing radiation exposures of members of the public, and demonstrating compliance with applicable standards.
environmental surveillance	The collection and analysis of samples of air, water, soil, foodstuffs, biota, and other media from DOE sites and their environs, and the measurement of external radiation for purposes of demonstrating compliance with applicable standards, assessing radiation exposures of members of the public, and assessing effects, if any, on the local environment.
hazard index	The health impact of the non-carcinogenic compounds is quantified through the hazard index, which is the ratio of the expected concentration of a compound to the acceptable concentration of the compound. When more than one toxic compound is emitted, the hazard indices of the compounds are summed to give the total hazard index. A total hazard index of 1.0 or less is considered to be not significant and the resulting impact on public health is deemed acceptable.
maximally exposed individual	The maximally exposed individual is the representative member of the public who receives the highest estimated effective dose equivalent based on the sum of the individual pathway doses.

Term	Definition
members of the public	Persons who are not occupationally associated with a DOE facility or operations (i.e., persons whose assigned occupational duties do not require them to enter the DOE site). Also see: public dose.
picoCurie(pCi)	A unit of radioactivity equal to 1 x 10^{-12} curies or 2.2 disintegrations per minute.
preliminary remediation goal	Initial clean-up goals that (1) are protective of human health and the environment and (2) comply with applicable or relevant and appropriate requirements. Preliminary remediation goals are developed early in the remedy selection process based on readily available information and are modified to reflect results of the baseline risk assessment. They also are used during analysis of remedial alternatives in the remedial investigation/feasibility study.
public dose	The dose received by member(s) of the public from exposure to radiation and to radioactive material released by a DOE facility or operation, whether the exposure is within a DOE site boundary or off-site. It does not include dose received from occupational exposures, doses received from naturally occurring "background" radiation, doses received as a patient from medical practices, or doses received from consumer products.
quality factor	The principal modifying factor used to regulate the dose equivalent from the absorbed dose. For the purposes of DOE Order 5400.5, quality factors taken from DOE Order 5480.11 are to be used.
rad	Historical unit of measurement of the radiation energy absorption (dose) in matter. The rad is defined as the amount of radiation required for absorption of 100 ergs (1 erg = 10-7 joule) per gram of irradiated material.
radioactivity	Property or characteristic of radioactive material to spontaneously "disintegrate" with the emission of energy in the form of radiation. The unit of radioactivity is the curie (or becquerel).

Term	Definition
reference man	A hypothetical aggregation of human (male and female) physical and physiological characteristics arrived at by international consensus (International Council for Radiation Protection Publication 23). These characteristics may be used by researchers and public health workers to standardize results of experiments and to relate biological effects from ionizing radiation to a common base. The "reference man" is assumed to inhale 8,400 cubic meters of air in a year and to ingest 730 liters of water in a year.
remedial action	Those actions consistent with permanent remedy taken instead of, or in addition to, removal action in the event of a release or threatened release of a hazardous substance into the environment, to prevent or minimize the release of hazardous substances so that they do not migrate to cause substantial danger to present or future public health or welfare or the environment.
residual radioactive material	Any radioactive material which is in or on soil, air, equipment, or structures as a consequence of past operations or activities.
RESRAD	Residual Radioactivity model. Argonne National Laboratory computer model for evaluating radioactively contaminated sites. (Argonne National Laboratory)
risk-based action standard	Site-specific soil contaminant-specific concentrations above which an unacceptable risk to human health is predicted to exist. An unacceptable risk to human health is defined as exceeding a one-in-one million excess cancer risk over a 60-year exposure period.
roentgen	A unit of radiation exposure equal to the quantity of ionizing radiation that will produce one electrostatic unit of electricity in one cubic centimeter of dry air at 0°C and standard atmospheric pressure.
roentgen equivalent man (rem)	The dosage of ionizing radiation that will cause the same biological effect as one roentgen of x-ray or one gamma-ray dosage.

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