U.S. Department of Energy

Oakland Operations Office, Oakland, California 94612

Lawrence Livermore National Laboratory

University of California Livermore, California 94551

UCRL-AR-126418

Action Memorandum for the Pit 6 Landfill Operable Unit Removal Action at Lawrence Livermore National Laboratory Site 300

May 1997

Author

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Environmental Protection Department

Environmental Restoration Program and Division

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United States Government **Department of Energy**

memorandum

DATE: JUN 12 1997

REPLY TO ATTN OF: Oakland Operations Office (ERD)

SUBJECT: Request for a Removal Action at the Lawrence Livermore National Laboratory (LLNL) Site 300 Pit 6 Landfill Operable Unit (OU)

TO: James T. Davis, AMEM

THRU: Roger Liddle, ERD
Mike Brown, ERD

The purpose of this Action Memorandum is to request and document approval of the proposed removal action described in the attached report for the LLNL Site 300 Pit 6 Landfill OU. Your approval of this request will signify the completion of the first Action Memorandum at Site 300 under the CERCLA Re-Engineering Process.

Should you have any questions, please call me at (510) 423-6718.

Donna Spencer
Site 300 Program Manager
Environmental Restoration Division

Approved: _____ 6/12/97
James T. Davis
Associate Manager
for Environmental
Management

Attachment

cc: Kathy Angleberger, EM-443
Roger Liddle, ERD
Michael Brown, ERD
Andrea Blohm, GLD

This copy of the Final Action Memorandum for the Pit 6 Landfill Operable Unit at Lawrence Livermore National Laboratory (LLNL) Site 300 is for distribution to parties already in possession of: (1) Appendix B (Pit 6 Engineering Evaluation/Cost Analysis initially released as the *Final Feasibility Study for the Pit 6 Operable Unit Lawrence Livermore National Laboratory Site 300*, December 1994) and (2) Appendix C (Addendum to the Pit 6 Engineering Evaluation/Cost Analysis, Lawrence Livermore National Laboratory Site 300, November 1996). Copies of this Final Action Memorandum including Appendices B and C are available in the LLNL information repositories.

Table of Contents

List of Figures

Appendix

Attachments

Attachment A. Tables B-7, B-8, 12-5, 12-81 of the Final Site-Wide Remedial Investigation Report Lawrence Livermore National Laboratory Site 300 (Webster-Scholten, April 1994)

Attachment B. Pit 6 Engineering Evaluation/Cost Analysis (Initially released as the: *Final Feasibility Study for the Pit 6 Operable Unit Lawrence Livermore National Laboratory Site 300* [R. Devany et al., December 1994])*

Attachment C. Addendum to the Pit 6 Engineering Evaluation/Cost Analysis Lawrence Livermore National Laboratory Site 300 (T. Berry, November 1996)*

*This copy of the Action Memorandum does not include Attachments B and C (previously released documents). However, a complete bound copy is available in the Lawrence Livermore National Labortory Repository and the Environmental Restoration Program and Division Library (T4302, Room 116; (510) 424-6505).

1. Purpose

The purpose of this Action Memorandum is to document the approval of the proposed removal action for the Pit 6 Landfill Operable Unit (OU) at Site 300, located in the Altamont Hills near Tracy, California. Site 300 is owned by the U.S. Department of Energy (DOE) and operated by the University of California.

Conditions currently exist at the site that if not addressed by implementing this removal action, may present a substantial endangerment to public health and the environment. In summary, the objectives for the removal action are to:

- Reduce the potential for future releases of materials in the landfill that could degrade ground water,
- Mitigate potential exposure to volatile organic compounds (VOCs) in soil, surface water, or ground water, and
- Protect ground water from additional degradation caused by previous releases from the Pit 6 Landfill.

The proposed removal action consists of installing a landfill cover over several solid waste burial trenches and small pits, as well as providing for continued ground water monitoring and contingencies for addressing existing ground water contamination.

This removal action is not intended as the final remedy for the Pit 6 OU. The status of the Pit 6 OU including the landfill and VOC plume will be addressed in the Site 300 Site-Wide Record of Decision (ROD). The Site-Wide ROD will contain cleanup standards and measures to meet them, if necessary. This proposed removal action will be executed by DOE in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA). In August, 1995 the Remedial Project Managers (RPMs) (DOE, U.S. Environmental Protection Agency [EPA], California Department of Toxic Substances Control [DTSC], and the Regional Water Quality Control Board-Central Valley Region [RWQCB]) agreed that this removal action meets the criteria of a 'non-time-critical removal action' under the National Oil and Hazardous Substances Contingency Plan (NCP) as prescribed in 40 CFR, Section 300.415, and is performed under the authority of Executive Order 12580 (confirmed in a letter from the EPA to DOE dated August 8, 1995). Because this removal action will be funded by DOE and not the EPA, it is not subject to the fund-financed duration and cost limitations of 12 months and $2 million prescribed in 40 CFR Section 300.415(a)(5).

The proposed removal action is based on information documented in the Administrative Record for Site 300 and presented at a public workshop on January 15, 1997. EPA, DTSC, and RWQCB concur with the proposed removal action.

This document also includes a Responsiveness Summary (Appendix A) addressing public comments on the removal action.

2. Site Conditions and Background

This non-time-critical removal action is designed to address environmental concerns related to buried waste in the Pit 6 Landfill and VOCs that have been released to the subsurface soils and ground water in the immediate vicinity. This section provides an overview of the Pit 6 Landfill OU.

2.1. Site Description

Between 1964 and 1973, waste from LLNL's Livermore Site and Lawrence Berkeley National Laboratory was buried in three solid waste trenches and six smaller animal pits. Records indicate that the solid waste (estimated volume of 1,762 yd^3) in the trenches primarily consist of shop and laboratory materials contaminated with residues of uranium and beryllium, capacitors, empty drums and tanks, compressed gas cylinders, pallets, and mercury-filled lamps and ignition tubes. The animal pits contain animal carcasses and waste from biomedical experiments (estimated volume of 149 yd^3). Records indicate that some animal carcasses retained small quantities at the microcurie level of mostly short-lived radionuclides at the time of burial. Tables B-7 and B-8 in Appendix B of the Final Site-Wide Remedial Investigation (SWRI) report (Webster-Scholten, 1994) provides an inventory of disposed waste, and lists radionuclides and their respective half-lives. These tables are included as Attachment A of this document. Although records do not specify disposal of VOCs, soil vapor survey, soil, and ground water data indicate that VOCs were released near the southeast corner of the landfill and therefore were likely to be in some of the buried waste. The trenches and animal pits were unlined, and the waste was covered with non-engineered native soil immediately after placement.

The only known instance of buried radioactive material (i.e., above background levels) in Pit 6, other than residues and the animal pit waste, was three shipments with depleted uranium (D-38). At the direction of LLNL management, this waste was exhumed in 1971 along with some waste containing mercury. Two subsequent radiation surveys detected no residual radioactivity. No evidence of anthropogenic releases of radioactive contaminants has been detected in soil or ground water samples collected during environmental investigations.

2.1.1. Removal Site Evaluation

The SWRI presents the details of site investigations from 1982 to 1991 and the methods used, nature and extent of contamination, and a baseline risk assessment. Ground water monitoring has continued since 1991. Based on the results of the remedial investigation, Remedial Action Objectives (RAOs) were identified in the *Pit 6 Engineering Evaluation/Cost Analysis* (EE/CA) *Lawrence Livermore National Laboratory Site 300,* which was initially released as the *Final Feasibility Study (FS) for the Pit 6 Operable Unit Lawrence Livermore National Laboratory Site 300* (Devany et al., 1994). The EE/CA presented an updated ground water plume map (for May–July 1993) and discussed the declining trend of VOC concentrations in ground water. More recent data were discussed in the *Addendum to the Pit 6 Engineering Evaluation/Cost Analysis Lawrence Livermore National Laboratory Site 300* (EE/CA Addendum) (Berry, 1996) and at a public workshop held on January 15, 1997. Currently, only two onsite monitor wells have concentrations of trichloroethylene (TCE) above the Maximum Contaminant Level (MCL).

Environmental concerns are further discussed in Section 3 of this Action Memorandum. The EE/CA (initially the FS) and the EE/CA Addendum are included as Attachments B and C of this document.

2.1.2. Physical Location

Site 300 is located in the eastern Altamont Hills about 17 miles southeast of Livermore, California and 8.5 miles southwest of Tracy, California (Fig. 1). The Pit 6 Landfill is located immediately north of Corral Hollow Road in the southwest portion of Site 300 (Fig. 2). The Carnegie State Vehicular Recreation Area (SVRA) is located across Corral Hollow Road to the south and is used for off-road motorcycles. Residential facilities for rangers who maintain the SVRA are located about 1,000 ft southeast of the Pit 6 Landfill on the north side of Corral Hollow Road.

2.1.3. Site Characteristics

The Pit 6 Landfill is located on a relatively flat terrace about 40 ft above Corral Hollow Road. It is sparsely vegetated with annual grasses. Waste buried in the trenches and pits within the Pit 6 Landfill was covered with native soil immediately after placement and the area was regraded when use of the landfill was discontinued in 1973. LLNL currently operates a rifle range on top of the Pit 6 Landfill for training security personnel.

The outer boundary of Site 300, including the vicinity of the Pit 6 Landfill, is fenced and patrolled by security personnel. The Pit 6 Landfill is accessed through a gate along Corral Hollow Road about two miles west of the Site 300 main entrance. This gate is locked requiring personnel to coordinate access with LLNL security a the main entrance except when the rifle/pistol range facility is operating. Rifle/pistol range operating hours are typically 7:00 a.m. to 3:00 p.m. weekdays except in January, February, July, and August when hours are 7:00 a.m. to 11:00 p.m.. During operating hours, personnel entering the area through the gate trigger an audible alarm at the rifle/pistol range facility and must check in with onsite security personnel. All personnel must be cleared and issued a badge by LLNL security (either at Site 300 or at the Livermore site) prior to gaining access to the Pit 6 area.

2.1.4. Release or Threatened Release of Hazardous Substances, Pollutants, or Contaminants

Soil, soil vapor, and ground water sampling indicates that the chlorinated solvent trichloroethylene (TCE) and trace concentrations of other VOCs were released to the subsurface from buried debris in the Pit 6 Landfill and have impacted ground water about 30 ft below ground surface. Ground water data updated since the issuance of the SWRI is presented in the EE/CA and EE/CA Addendum (Attachments B and C, respectively).

VOCs in soil, soil vapor, and ground water in the vicinity of the Pit 6 Landfill are classified as hazardous substances, as defined by Section 101(14) of CERCLA, 42 U.S.C. Section 9601 (14), and the National Contingency Plan (NCP), 40 CFR Part 300; and are pollutants or contaminants as defined by Section 101(33) of CERCLA, 42 U.S.C. Section 9601 (33). The presence of these substances in site soils and ground water indicates an actual release of hazardous substances into the environment, as defined by Section 101(22) of CERCLA, 42 U.S.C. Section 9601 (22).

Ground water elevation data collected since 1982 indicate that ground water has not reached a level higher than 15 ft below the deepest trenches or pits. These data indicate that VOCs were probably released from the waste trenches either during disposal activities or as a result of rainwater infiltration through the buried waste after disposal, and were not released from the waste as a result of high ground water levels.

As discussed in the EE/CA, VOC concentrations in ground water have naturally attenuated by almost two orders of magnitude over the past few years, and are close to dropping below MCLs in all wells. As of the second quarter of 1996, TCE, *cis*-1,2-dichloroethylene (*cis*-1,2-DCE), PCE, and chloroform were the only VOCs detected. Figure 3 shows the TCE ground water plume in the second quarter of 1996. The highest total VOC concentration in the second quarter of 1996 was 13 micrograms per liter (μg/L, or parts per billion [ppb]), all of which was TCE. Currently, the TCE plume extends about 500 ft east of the southern corner of Pit 6. Only two onsite wells (EP6-09 and K6-19) have concentrations above the 5 μg/L (ppb) MCL for TCE. *Cis*-1,2-DCE, PCE, and chloroform were detected in one well each at concentrations below MCLs.

Natural attenuation of VOCs in ground water is a reduction of the maximum concentrations detected in the contaminant plume. This reduction in concentrations can be attributed to one or more of the following mechanisms:

- Dilution (through ground water recharge)
- Dispersion (through advection and to a lesser degree, diffusion)
- Irreversible sorption to solid media (such as clayey soils)
- Evapotranspiration (volatilization through soil and plants)
- Biodegredation (breakdown of chemicals into other constituents as a result of biological processes)
- Chemical degradation (e.g., hydrolysis)

Dilution and dispersion result in lower concentrations by distributing contaminant mass into a large volume of water. Irreversible sorption, and evapotranspiration transfer mass from ground water to other media (onto solids and into the air, respectively). Biodegradation and chemical degradation reduce concentrations of one chemical by breaking it down into other chemicals. One monitor well in the vicinity of the Pit 6 Landfill (K6-01S) has shown low concentrations of *cis*-1,2-DCE, a biodegradation product of TCE. No other biodegredation breakdown products have been detected. The fact that concentrations are declining is evidence that natural attenuation is occurring. However, the relative contribution of individual attenuation mechanisms has not been quantified.

Soil and water samples confirmed that no significant concentrations of metals, high explosives compounds, radionuclides, poly-chlorinated biphenyls (PCBs), pesticides, phenols or aromatic hydrocarbons have been released to the environment. However, based on the inventory of buried waste (see SWRI Tables B-7 and B-8 in Attachment A), radionuclides, PCBs, and metals, may be present in the waste. While no release other than the VOCs mentioned above has been detected, and the waste has been buried for over 24 years, there is still a potential threat of future releases of VOCs or other contaminants that could leach into the ground water as a result of rainwater infiltration through the waste.

The baseline risk assessment results are presented in Chapter 6 of the SWRI and summarized in Section 3.1 of this document. Based on health risks identified by the baseline risk assessment and our understanding of the nature of the buried waste, a set of RAOs were developed and presented in Section 2.5 of the EE/CA. Additionally, occasional localized subsidence is observed due to collapse of void spaces in the buried waste, posing a safety concern for workers in the area.

2.1.5. National Priorities List Status

Site 300 was placed on the National Priorities List (NPL) in August of 1990. A Federal Facility Agreement (FFA) was signed by DOE, EPA, DTSC, and RWQCB in June 1992. Revisions to the FFA list of deliverables and schedule were made in November 1995 and November 1996. The Pit 6 Landfill is designated as Operable Unit 3 in the FFA. The Pit 6 Landfill is subject to the NCP requirement for a non-time-critical removal action.

2.1.6. Maps, Pictures, and Other Graphic Representations

The SWRI, EE/CA, and EE/CA Addendum provide additional background information including figures showing site location, features, and conceptual drawings of the removal action. This document includes figures showing the site location, ground water plume, and plan view of the removal action landfill cover with associated drainage ditches. Additionally, the EE/CA and EE/CA Addendum are included as Attachments B and C, respectively.

2.2. Other Actions to Date

2.2.1. Previous Actions

DOE/LLNL started site investigation in 1982 under guidance of the RWQCB. After being listed on the NPL, investigations and reporting were conducted in accordance with CERCLA.

To date, no facility upgrades have been made in the Pit 6 Landfill area other than construction of an unlined drainage ditch to the north of the landfill in late 1981 and early 1982. Maintenance has been performed to minimize the possibility of further infiltration of precipitation. Table 12-81 of the SWRI (included in Attachment A) summarizes these activities.

As discussed in Section 2.1 of this document, waste containing D-38 and mercury was exhumed in 1971.

Monitor well sampling started in 1984 to evaluate the nature and extent of contaminants in ground water.

An Administrative Record File has been established and is available for public review pursuant to the requirements set forth in the NCP. Information repositories for Site 300 are established at the following locations:

LLNL Visitors Center

Environmental Information Repository
Greenville Road
Livermore, CA 94550

Tracy Branch Library

20 East Eaton Avenue
Tracy, CA 95376

Summaries of key documents are also maintained at:

Central Branch Library

605 North El Dorado Street
Stockton, CA 95292

Information about public access to the Administrative Record can be obtained from:

Bert Heffner

LLNL Environmental Community Relations
P.O. Box 808 L-404
Livermore, CA 94550
Tel. (510) 424-4026, e-mail: heffner1@llnl.gov

Table 12-5 of the SWRI (included in Attachment A of this document) provides a chronological summary of remedial investigation and reporting activities for the Pit 6 Landfill through 1991. Since 1991, the following reports relating to the Pit 6 Landfill investigation and remediation have been issued:

April 1994: *Site-Wide Remedial Investigation Report* (Webster-Scholten, 1994)—most information is found in Chapter 12 of this report, but other Chapters and Appendices are also referenced.

December 1994: *Feasibility Study for the Pit 6 Operable Unit* (Devany et al., 1994)—in August 1995, this report was accepted by the regulatory agencies as an EE/CA and is referred to as the EE/CA in subsequent documents.

November 1996: *Addendum to the Pit 6 Engineering Evaluation/Cost Analysis* (Berry, 1996).

A fact sheet was issued in December 1996 describing the selected removal action and announcing a public comment period and workshop. The public comment period started December 17, 1996 and ended January 30, 1997. The public workshop was held January 15, 1997. Public comments concerning the proposed removal action have been considered and used, as appropriate, in the preparation of this Action Memorandum. Public comments are addressed in the Responsiveness Summary (Appendix A).

2.2.2. Current Actions

Inspections and periodic maintenance of the native-soil cover and drainage ditch is ongoing. Small subsidence areas that occasionally appear in the vicinity of the buried waste are filled with

native clean soil by Site 300 maintenance personnel to address onsite worker safety concerns. The removal action will address the concern of potential future void space collapse.

Ground water monitoring and spring inspections are ongoing to continue assessment of the contaminant plume and monitor for potential releases from the buried waste.

2.3. State and Local Authorities' Roles

2.3.1. State and Local Actions to Date

Pit 6 investigations by DOE/LLNL began in 1982 under the guidance of the RWQCB. After being listed on the NPL in 1990, environmental investigation activities continued under CERCLA. EPA, in conjunction with the DTSC and the Central Valley RWQCB, oversees investigations and cleanup activities performed by the University of California in accordance with Section 120 of CERCLA, as amended. As signatories to the FFA representing the State of California, the RWQCB and DTSC monitor and approve the progress of all site investigations and cleanup activities along with EPA.

2.3.2. Potential for Continued State/Local Response

No State or local response actions are anticipated other than continued oversight of site cleanup activities under CERCLA. DOE will provide the necessary funding and support for the removal action, future monitoring and maintenance, and any required future contingency actions related to any future releases from the buried waste in the Pit 6 Landfill or previously released contaminants from the Pit 6 Landfill.

3. Threats to Public Health or Welfare or the Environment

In accordance with the NCP, the following criteria must be considered in determining the appropriateness of a non-time-critical removal action (40 CFR, Section 300.415) in addressing threats to public health or welfare or the environment:

(i)* Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants,

(ii)* Actual or potential contamination of drinking water supplies or sensitive ecosystems,

(iii)* Hazardous substances or pollutants or contaminants in drums, barrels, tanks, or other bulk storage containers, that may pose a threat of release,

(iv)* High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface, that may migrate,

(v)* Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released,

(vi) Threat of fire or explosion,

(vii) The availability of other appropriate Federal or State response mechanisms to respond to the release, and

(viii)* Other situations or factors that may pose threats to public health or welfare or the environment.

Criteria indicated with an asterisk (*) are relevant in determining the appropriateness of the proposed removal action at the Pit 6 Landfill to protect public health and welfare and the environment and are discussed in Sections 3.1 and 3.2.

EPA, with the support of the State, agrees that implementing a non-time-critical removal action is appropriate for the Pit 6 Landfill.

3.1. Threats to Public Health or Welfare

The EPA (EPA, 1991) indicates that where the cumulative potential carcinogenic risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4}, and the Hazard Index (HI) is < 1, remedial action is generally not warranted unless there are adverse environmental impacts. If MCLs or non-zero MCL goals are exceeded, action generally is warranted. The 10^{-4} to 10^{-6} risk range is a target within which risks should be managed as part of a cleanup action. Once a decision has been made to undertake a cleanup, the preference is to achieve the more protective end of the range (i.e., 10^{-6}). Records of Decision (and ostensibly Action Memoranda) for cleanup actions taken at sites posing risks within the 10^{-4} to 10^{-6} risk range must have documentation supporting why the cleanup is warranted.

The primary objective of the proposed removal action is to adequately isolate the buried waste. This will eliminate potential exposure and safety threats to onsite workers and prevent further releases of contaminants from the buried waste as a result of rainwater infiltration, which could further degrade ground water. Inhalation risk from VOCs in soils will also be addressed by the landfill cover. Inhalation risks at spring 7 and the residence pond and the fate of VOCs in ground water will be addressed by institutional controls including monitoring.

As discussed earlier, this removal action is not intended as the final remedy for the Pit 6 OU. Cleanup standards and measures to meet them will be presented in the Site-Wide ROD.

Threats to public health or welfare are discussed below with respect to the criteria considered in determining the appropriateness of the selected removal action.

Criteria (i) and (viii):

The current status of the buried waste meets Criteria (i) and (viii) because it is not adequately isolated. Void spaces periodically cause a collapse of the overlying soil and pose a physical safety threat as well as a potential exposure threat to the onsite workers.

Also, the SWRI baseline risk assessment calculated an individual excess lifetime cancer risk of 4×10^{-5} for adults onsite (workers) from potential inhalation of VOCs volatilizing from the surface of spring 7 and a risk of 3×10^{-6} for offsite residents from inhalation of VOCs that volatilize from the surface of the SVRA residence pond. These two calculated risks do not currently have an exposure pathway because spring 7 is dry and VOCs have not migrated to the water-supply wells that are used to supply the residence pond. However, the risks are related to Criterion (i).

Criterion (ii):

Although no drinking water source is immediately threatened, VOCs have been released to ground water at concentrations above MCLs. Additionally, without proper isolation of the buried waste, there is a potential for further releases to ground water which may threaten drinking water sources.

VOC concentrations in ground water have been steadily declining since 1988 from a high of 250 μg/L (ppb) TCE in 1988 to 13 μg/L (ppb) in 1996 and have remained onsite. Two monitor wells currently have TCE concentrations above drinking water standards.

Criterion (iii):

Records suggest that the landfill was used for disposal of solid waste. However, some hazardous substances may be in buried containers. Therefore, the potential for release from containers is still present.

Criterion (iv):

The SWRI baseline risk assessment calculated an individual excess lifetime cancer risk of 5×10^{-6} for adults onsite (workers) from potential inhalation of VOCs volatilizing from soil in the immediate vicinity of the rifle range.

Criterion (v):

Currently, precipitation can infiltrate the buried waste. The potential for contaminants being leached from the waste into the ground water as a result of precipitation infiltration is the most likely mechanism for future releases from the buried waste.

3.2. Threats to the Environment

The SWRI baseline risk assessment calculated an ecological HI > 1 for juvenile ground squirrels and juvenile and adult kit fox from TCE and PCE in the vicinity of the rifle range, which meets Criteria (i). Although VOCs have been detected in the subsurface soil in this area, the ground squirrel population remains robust. There is no evidence that kit fox inhabit the area; however, data suggest that they could be at risk from exposure to VOCs should they establish a den in the vicinity of the rifle range. Continued ecological monitoring will indicate if species are threatened in the future.

4. Endangerment Determination

Actual or threatened releases of hazardous substances/pollutants and contaminants from this site, if not addressed by implementing the response action selected in this Action Memorandum, may present an imminent and substantial endangerment to public health, or welfare, or the environment.

5. Removal Action Description and Estimated Costs

5.1. Description of Action

The following section describes the components of the proposed removal action, contribution to remedial performance, and describes the alternatives considered. The EE/CA identified the following RAOs for remediation at the Pit 6 Landfill:

1. Prevent offsite ingestion of ground water containing VOC concentrations above the State and Federal drinking water Maximum Contaminant Levels (MCLs).
2. Reduce the potential for any future releases of or exposure to hazardous materials contained in Pit 6.
3. Mitigate potential worker inhalation exposure to VOCs that may volatilize from spring 7.
4. Mitigate potential residential inhalation exposure to VOCs that may volatilize from the SVRA residence pond.
5. Mitigate potential worker inhalation exposure to VOCs that may volatilize from subsurface soil beneath the rifle range.

Additionally, the removal action will address onsite worker physical safety hazard, associated with potential collapse of void spaces in the landfill waste.

5.1.1. Removal Action Components

The proposed removal action is described in detail as Alternative 3 in the EE/CA with revisions in the EE/CA Addendum.

The primary components of the removal action are:

- Installing a 2.4 acre multi-layered landfill cover over the waste surrounded by concrete-lined surface water diversion ditches (Fig. 4),
- Continued ground water monitoring and spring inspection,
- Provisions for contingency actions including ground water extraction and treatment, fencing, and/or point-of-use (POU) treatment, in the event that ground water or surface water-related exposure pathways pose unacceptable risk in the future, and
- Installing two additional monitor wells; one directly upgradient of the Pit 6 Landfill (installed in November 1996) to improve release detection analysis, and one immediately downgradient of the VOC plume to confirm the limit of VOC migration in ground water (Fig. 5).

Access controls to the site will be maintained, and maintenance will be performed as needed on the landfill cover, drainage system, and ground water monitor wells.

5.1.2. Contribution to Remedial Performance

The proposed removal action is intended to isolate the buried waste in the Pit 6 Landfill and stabilize the VOC release in ground water. It is not intended to be a final remedy for the Pit 6 OU. The status of the Pit 6 OU, including the landfill and the VOC plume will be evaluated in the Site-Wide ROD. The Site-Wide ROD will not only incorporate the status of the Pit 6 OU, but will contain cleanup standards and measures to meet them, if necessary, for all OUs at Site 300, including Pit 6. Monitoring, data evaluation, and reporting plans included or referenced in the Site-Wide ROD will contain a monitoring schedule, monitoring points, a lists of constituents to be monitored for, and statistical limits that, if exceeded, may trigger further remedial actions and contingency plans for those remedial actions.

The landfill cover and drainage ditches will address the concern of potential future releases by preventing precipitation from infiltrating into and through the waste. A component of the cover will be an impermeable high-density polyethylene liner, which along with preventing infiltration of water into the waste, will mitigate the potential for inhalation exposure of vapors volatilizing from subsurface soil in the vicinity of the rifle range. The landfill cover is designed with synthetic structural reinforcement layers to prevent future collapses into void spaces that may be in the buried waste.

A Post-Closure Plan will be submitted in conjunction with completion of the cover system. This plan will include a plan for cover inspection and maintenance and two ground water monitoring programs: 1) detection monitoring for the landfill to determine if any new releases to ground water occur, and 2) corrective action monitoring to determine if the VOC plume is attenuating sufficiently to meet cleanup standards and is not migrating beyond its present extent.

Subsequent to the submittal and approval of the Post-Closure Plan, the RWQCB will issue waste discharge requirements (WDR) which will implement the requirements of the California Code of Regulations, Title 23, Division 3, Chapter 15. The WDRs will include requirements for release detection and corrective action monitoring.

Figure 5 shows the location of ground water monitoring wells in the Pit 6 OU and identifies wells to be used as downgradient compliance point wells for the release detection monitoring program. The release detection monitoring program will continue until the buried waste in the Pit 6 Landfill no longer poses a threat to water quality.

All monitor wells shown in Figure 5 will be incorporated into the corrective action monitoring program to evaluate the VOC plume.

Continued ground water monitoring currently addresses the concerns related to VOCs in ground water because:

- VOC concentrations are naturally attenuating. The MCL contour is contracting with the highest TCE concentration being about 13µg/L (ppb) (MCL is 5 µg/L [ppb]),
- Spring 7 has been dry since 1992. Therefore, no unacceptable inhalation risk from VOCs in surface water exists at this location, and
- Detectable concentrations of VOCs have not migrated offsite and currently do not threaten the SVRA wells used to supply the residence pond.

Corrective action monitoring will continue at least until concentrations reach cleanup standards to be specified in the Site-Wide ROD. If VOCs do not reach cleanup standards by natural attenuation, or unacceptable inhalation risks become present at spring 7 or the SVRA residence pond, one or more of the following contingency actions may be implemented:

- Ground water extraction and treatment,
- Additional access restrictions to the vicinity of spring 7, consisting of fencing and warning signs, and
- POU treatment at the SVRA water-supply wells to remove VOCs before water enters the residence pond.

The Post-Closure Plan will provide criteria for implementation of contingency actions as described in this removal action.

5.1.3. Description of Alternative Technologies

The EE/CA screened out several alternative technologies including *in situ* solidification, and excavation. These alternative technologies were screened out based on effectiveness, implementability, and cost as discussed in Section 3 of the EE/CA.

After screening the available technologies, the following four alternatives were developed and evaluated in the EE/CA:

1. No action (continued monitoring),
2. Install a landfill cover with contingency actions for spring 7 and the residence pond,
3. The removal action presented in this Action Memorandum, which consists of installing the landfill cover, with contingencies for spring 7, the residence pond and ground water extraction and treatment, and
4. Installation of the landfill cover with the contingencies of Alternative 3, plus installation of subsurface permeability reduction barriers.

Alternative 3 was presented as the proposed removal action in the EE/CA Addendum. Alternative 1 was not selected because it would leave the buried waste inadequately isolated and had no provisions for addressing other elevated risks. Alternative 2 did not have adequate contingency for addressing VOCs in ground water. Alternative 4 was not selected because the added isolation of buried waste that the subsurface barriers would provide was not necessary and would significantly increase costs. Also, methods for placing such barriers are emerging technologies and therefore performance of these barriers is uncertain.

5.1.4. Engineering Evaluation/Cost Analysis (EE/CA)

The regulatory agencies accepted (EPA, 1995) the *Final Feasibility Study for the Pit 6 Operable Unit* as an EE/CA for the Pit 6 Landfill. In November 1996, DOE/LLNL submitted the *Addendum to the Pit 6 Engineering Evaluation/Cost Analysis*. These two documents were previously submitted to the regulators and are included as Attachments B and C and are available in the Administrative Record. As mentioned in Section 2.2.1 of this Action Memorandum, the

proposed removal action was presented to the public in a fact sheet and a public workshop for questions and comment in January 1997.

5.1.5. Applicable or Relevant and Appropriate Requirements

An analysis of Federal and State ARARs was performed and presented in Section 2.1[1] of the EE/CA to develop chemical-, location-, and action-specific ARARs. The proposed removal action is based on Alternative 3 of the EE/CA. Revisions to Alternative 3 presented in the EE/CA Addendum do not affect the ARARs analysis. The EE/CA and EE/CA Addendum are included as Attachments B and C, respectively.

5.1.6. Project Schedule

Title II design for the landfill cover and associated drainage ditches was completed December 1996, with minor edits made in February 1997 in response to EPA comments. Construction is scheduled to start in June/July of 1997 with completion by December 1, 1997 in accordance with the Site 300 FFA. A Post-Closure Plan will be submitted by December 1, 1997. A Construction Quality Assurance report will be submitted in early 1998.

5.2. Estimated Cost

Estimated cost for the proposed removal action is $3.28 million in 1997 dollars. Of this, $1.95 million is for the landfill cover design and construction, including $0.36 million to replace the existing rifle range. Estimated cost for landfill cover maintenance, release detection monitoring, and corrective action monitoring is $1.33 million assuming a 30-yr life cycle. The actual length of time for landfill cover maintenance and release detection monitoring is dependent on how long the buried waste poses a threat to ground water. Corrective action monitoring will continue until the VOC plume reaches cleanup standards.

An additional $2.29 million is estimated if the contingency actions of ground water extraction and treatment, fencing around spring 7, and POU treatment need to be implemented. Costs associated with contingency action are less certain because conditions may be different at the time of implementation than those assumed for the cost estimate.

A detailed cost estimate for the removal action was presented in Table 3 of the EE/CA Addendum.

6. Expected Change in the Situation Should Action be Delayed or not Taken

If the proposed removal action is delayed or not taken, the buried waste will remain inadequately isolated, which increases the chances of future releases to ground water. Void space collapse or erosion of the existing soil cover could expose buried waste at the surface.

[1] The EE/CA references ARARs from CCR Title 23, subchapter 15, 2510-2559, 2580-2601. This reference should be CCR Title 23, chapter 15, 2510-2550.12, 2580-2601.

Additionally, worker safety in the vicinity of the rifle range may continue to be compromised by periodic collapses of void spaces. Elevated inhalation risk due to VOC vapors volatilizing from subsurface soil in the vicinity of the rifle range may persist without implementation of the removal action.

7. Outstanding Policy Issues

This removal action is not intended to be the final remedy for the Pit 6 OU. The final remedy for the Pit 6 OU will be presented in the Site-Wide ROD which will include final cleanup standards and measures to meet them, as necessary.

8. Enforcement

DOE is committed to performing the proposed removal action in entirety. The removal action will be undertaken in compliance with CERCLA and the FFA signed in 1992 and in accordance with the deliverables and schedule as revised in the FFA Addendum 2 signed by the RPMs in November 1996 as shown below:

Title I Cap Design	August 15, 1996
Title II Cap Design	December 18, 1997
Public Workshop	January 15, 1997
Draft Action Memorandum	March 24, 1997
Draft Final Action Memorandum	May 8, 1997 (May 12, 1997)[2]
Final Action Memorandum	May 22, 1997
Complete cap construction	December 1, 1997

The signatories to the FFA are DOE, EPA, DTSC, and RWQCB.

[2] On April 22, 1997, the RPMs agreed to revise the due date for the Draft Final Action Memorandum to May 12, 1997.

9. Recommendation and Approval

This decision document represents the selected removal action for the Pit 6 Landfill (Operable Unit 3) at LLNL Site 300, Tracy, California developed in accordance with CERCLA as amended, and not inconsistent with the NCP. Conditions at the site meet the NCP, 40 CFR Section 300.415(b)(2) criteria for a removal action. This decision is based on the administrative record for the site. The estimated total cost for the removal action, including 30 years of monitoring is $3.28 million, which will be funded in entirety by DOE.

The selected removal action is protective of human health and the environment, complies with Federal, State, and local requirements that are legally applicable or relevant and appropriate to the removal action, and are cost-effective. While the final remedy for this OU will be determined in the Site-Wide ROD, the selected removal action utilizes permanent solutions and alternative treatment technology, to the maximum extent practicable, and satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element.

The undersigned approves implementation of the selected removal action for the Pit 6 Landfill OU.

_____ _____

James T. Davis Date
Associate Manager for Environmental Management
Oakland Operations Office
U.S. Department of Energy

10. References

Berry, T. (1996), *Addendum to the Pit 6 Engineering Evaluation/Cost Analysis Lawrence Livermore National Laboratory Site 300*, Lawrence Livermore National Laboratory, Livermore, Calif. (UCRL-AR-113861 Add).

Devany, R., R. Landgraf, and T. Berry (1994), *Final Feasibility Study for the Pit 6 Operable Unit Livermore National Laboratory Site 300*, Lawrence Livermore National Laboratory, Livermore, Calif. (UCRL-AR-113861). Note: In August 1995, this document was accepted as an Engineering Evaluation/Cost Analysis.

U.S. Environmental Protection Agency (EPA) (1990), *Superfund Removal Procedures Action Memorandum Guidance*, Office of Emergency and Remedial Response, Washington, D.C., December 1990 (EPA/540/P-90/004).

U.S. Environmental Protection Agency (EPA) (1991), *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions*, Directive 9355.0-30, Office of Solid Waste and Emergency Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA) (1995), Letter to Donna Sutherland (U.S. DOE), Environmental Restoration Division Site 300 Remedial Project Manager, from Lida Tan (U.S. EPA) regarding the Site 300 Proposed Revised Federal Facility Agreement Schedule, dated August 8, 1995.

Webster-Scholten, C. P. Ed. (1994), *Final Site-Wide Remedial Investigation Report*, Lawrence Livermore National Laboratory Site 300, Lawrence Livermore National Laboratory, Livermore, Calif. (UCRL-AR-21010).

Figures

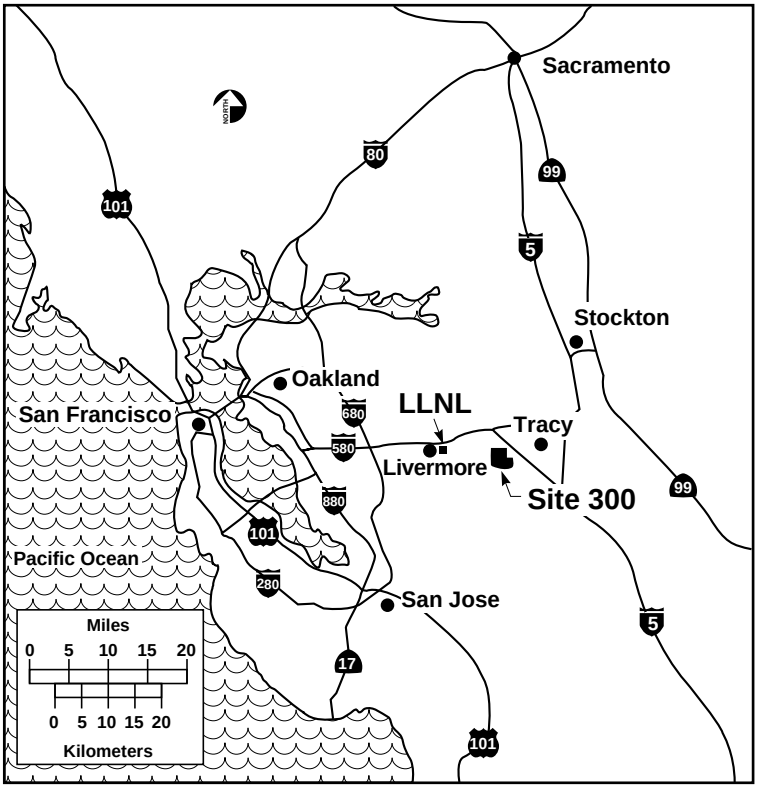

Figure 1. Locations of LLNL Livermore Site and Site 300.

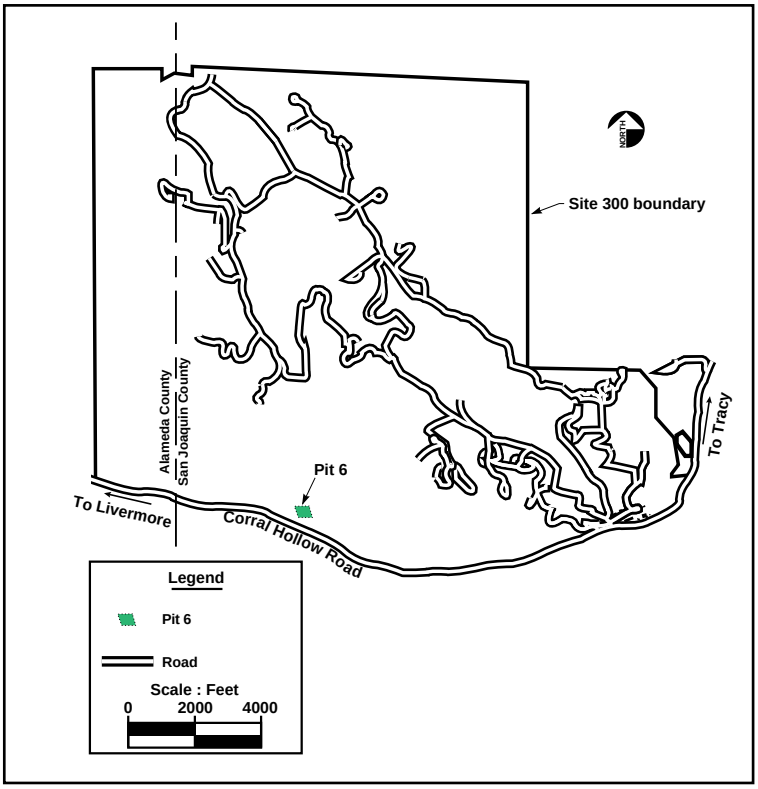

Figure 2. Location of Pit 6 at LLNL Site 300.

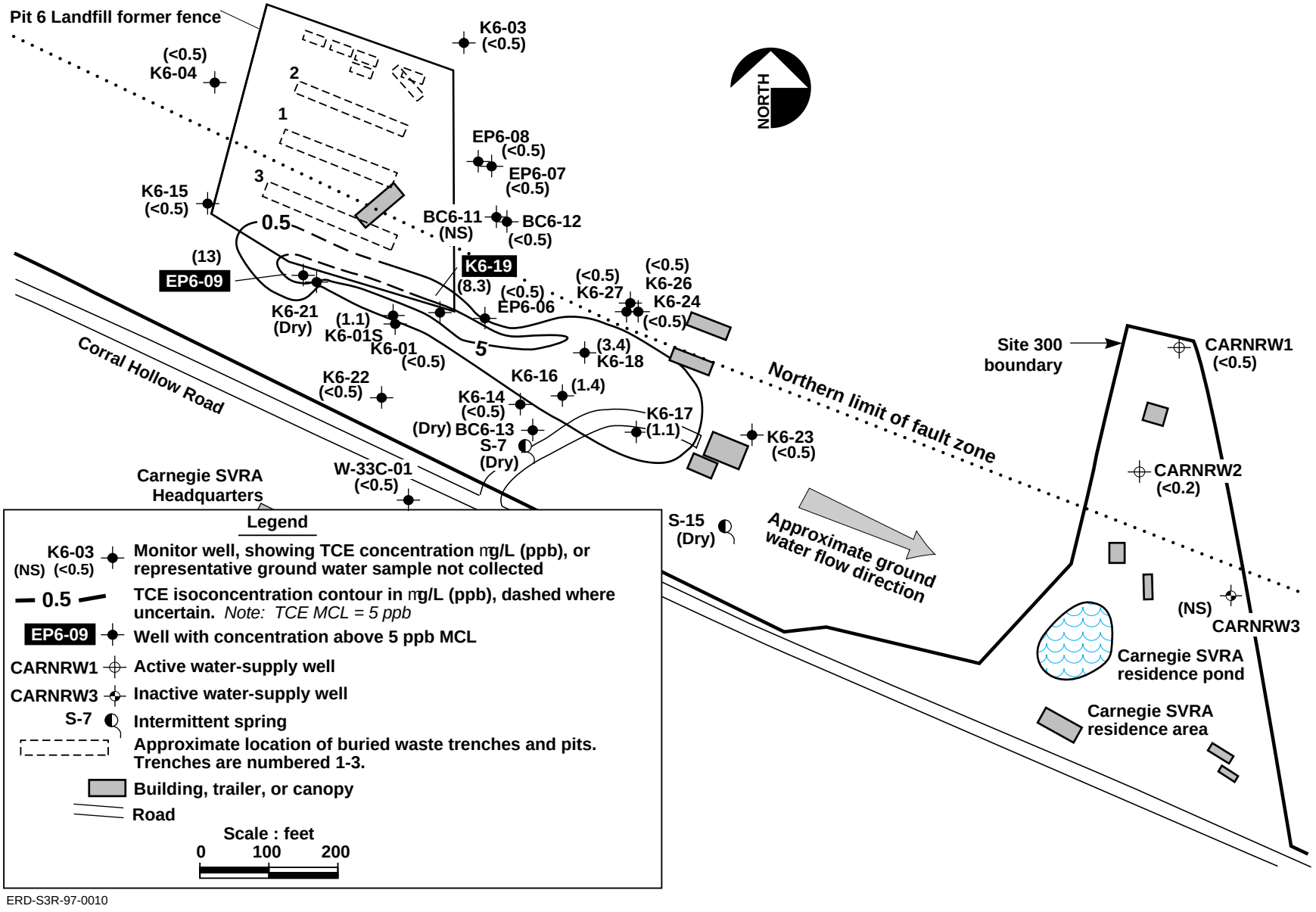

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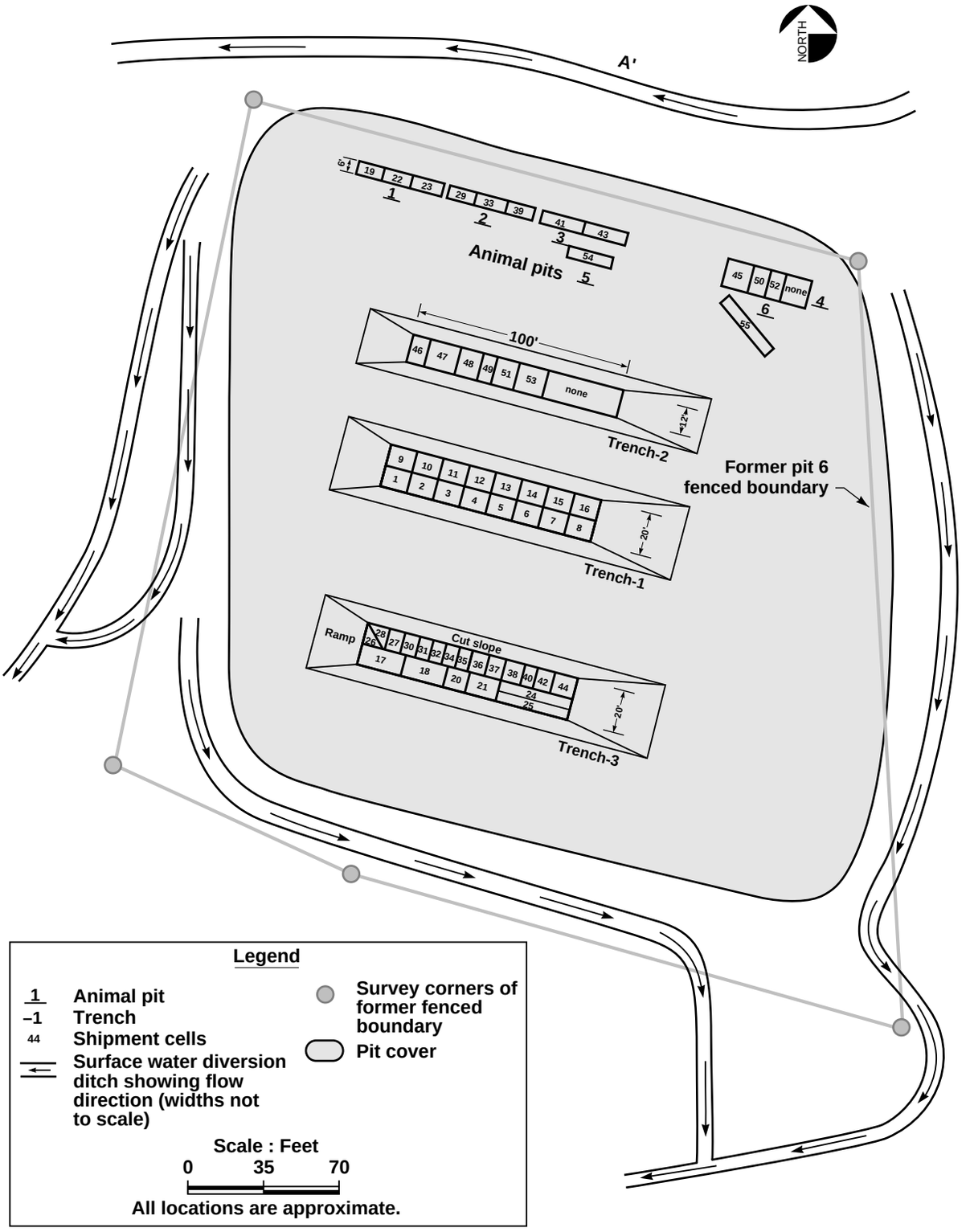
Figure 3. Distribution of TCE in ground water (Qt - Tmss hydrologic unit), 2nd quarter 1996, Pit 6 landfill area.



ERD-S3R-97-0011

Figure 4. Proposed location of Pit 6 Landfill cover and surface water diversion ditches.

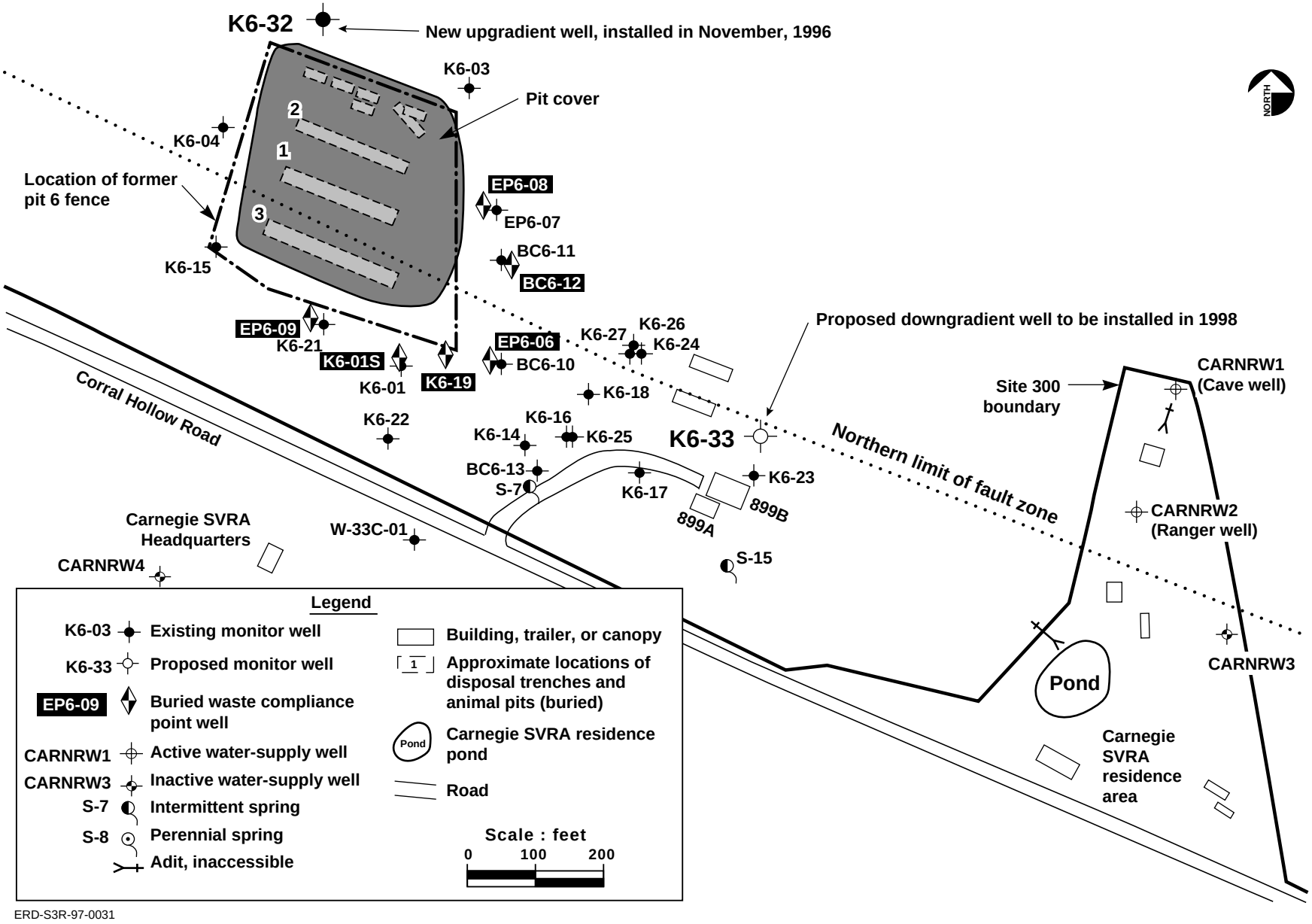


Figure 5. Ground water monitor well locations.

Appendix A

Responsiveness Summary

Appendix A

Responsiveness Summary

This section responds to public comments directed to DOE, LLNL, EPA, and the State of California regarding the selected removal action at the Pit 6 Landfill. Responses to community comments and concerns have been incorporated into the selected removal action as appropriate. Some issues will be addressed in the forthcoming Site-Wide Record of Decision (ROD).

The public comment period on the proposed removal action began December 17, 1996, and ended January 30, 1997. On January 15, 1997, DOE/LLNL and the regulatory agencies held a public workshop at the Tracy Inn in Tracy, California to present the proposed removal action, answer questions from the public, and allow the public to provide comments. A representative from LLNL summarized the background, environmental concerns, and technical approach for the Pit 6 Landfill and associated ground water plume. Following an informal question and answer period to clarify the presentation, the public presented formal comments. All formal comments were from representatives of the Tri-Valley Citizens Against a Radioactive Environment (CAREs). The majority of these comments were also submitted in writing (Comments 1 through 6). Comment 7 is a summary of a verbal recommendation.

A-1. Public Comment and Responses

Comment 1:

In our opinion, the success or failure of using non-time-critical removal action depends on the definition of a Site-wide Record of Decision (ROD). At this time, there has not been definition a (of the) *Site-wide ROD that has been adopted for Site 300, although the EE/CA does refer to the 'Site-wide OU ROD'. In April 1996, Tri-Valley CAREs submitted a proposed definition of the Site 300 ROD to the regulators and to DOE. Although we have been told that the regulators and DOE agree with Tri-Valley CAREs' definition of a Site-wide ROD for Site 300, it has not been formally adopted by any party. Until a definition is adopted, Tri-Valley CAREs strongly opposes using the EE/CA for this OU. A formal definition of the Site-wide ROD is a prerequisite for the organization's support.*

Response to Comment 1:

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) allows for use of removal actions to implement remedial measures quickly. The proposed removal action is intended to isolate the buried waste in the Pit 6 Landfill and stabilize the VOC release in ground water. It is not intended to be a final remedy for the Pit 6 OU. The status of the Pit 6 OU, including the landfill and the VOC plume, will be evaluated in the Site-Wide Record of Decision

(ROD). There will be opportunity for public comment on the final remedy and cleanup standards for the Pit 6 OU during the Site-Wide ROD process.

Although the final definition of the Site-Wide ROD is still being negotiated between the Remedial Project Managers (RPMs), the Site-Wide ROD will not only incorporate the status of the Pit 6 OU, but will contain cleanup standards and measures to meet them, if necessary, for all OUs at Site 300. Monitoring, data evaluation, and reporting plans included or referenced in the Site-Wide ROD will contain a monitoring schedule, monitoring points, a lists of constituents to be monitored for, and statistical limits that, if exceeded, may trigger further remedial actions and contingency plans for those remedial actions.

Comment 2:

The plan for Pit 6 leaves an uncontrolled plume of volatile organic compounds (VOCs) above the maximum contaminant level (MCL), while preventing 'offsite ingestion of groundwater containing VOC concentrations above the State and Federal drinking water' standards. We believe that this approach to cleanup is fundamentally wrong. It has been the prevailing policy of this State and EPA that contaminated groundwater underlying a site should be cleaned to drinking water standards. There are hundreds of sites in the U.S. which are being cleaned up to those standards (including the main site at LLNL), and it is not at all clear why this is waived at Pit 6, or any other sites at Site 300. Therefore, it is Tri-Valley CAREs' position that the groundwater underlying the Pit 6 plume should be cleaned up to drinking water standards.

Response to Comment 2:

As discussed in the Response to Comment #1, this removal action is not intended to be the final remedy for the Pit 6 OU which includes the VOC plume. Cleanup standards and measures for meeting them will be presented in the Site-Wide ROD. Because concentrations are low, are continuing to decline, and there is no current exposure pathway, monitoring is appropriate until a final remedy is determined.

Comment 3:

A premise for the Pit 6 remedial strategy is that the TCE plume will be subject to natural attenuation prior to it affecting an active drinking water source. Although concentrations have historically decreased at the plume edge, we think that what you define as natural attenuation includes significant dilution and dispersion, practices that are not acceptable cleanup remedies. There has been no conclusive evidence that biodegredation is taking place. In fact, the baseline health risk assessment does not include an assessment of vinyl chloride, a daughter product of TCE, because it has not been found at Site 300. We would expect to see modest concentrations of vinyl chloride at Pit 6 if natural breakdown were occurring, as TCE has been in the ground and groundwater for some time.

Response to Comment 3:

Although dilution and dispersion have probably already occurred, the regulatory agencies have agreed that considering the low concentrations of VOCs, limited extent of the plume, and declining concentration trend that continued monitoring is appropriate at this time. This removal action may

not be the final remedy. The status of the VOC plume will be evaluated in the Site-Wide ROD, including whether or not additional cleanup measures are to be implemented.

Comment 4:

Regarding the monitoring plan for Pit 6, we think it needs to be articulated prior to acceptance of the EE/CA. We would like to see the location and number of wells being proposed, the frequency of monitoring, and what constituents will be sampled. We would also like you to explain how LLNL proposes to prove or disprove the occurrence and rate of natural attenuation.

Response to Comment 4:

A ground water monitoring plan is presented as Table 2 of the EE/CA Addendum. Monitor well locations and function are also shown in the same document on Figure 7. A Post-Closure Plan will be prepared and issued upon completion of the landfill cover (December 1, 1997), which will detail monitoring plans for detecting potential future releases from the landfill and to track the existing VOC plume. Procedures to be used for evaluating the monitoring data will include statistical analysis of sampling data to determine if conditions have changed.

The natural attenuation rate of contaminants in ground water will be monitored by evaluating maximum VOC concentrations, extent of detectable concentrations, distribution of concentration contours, total detectable dissolved contaminant mass, and ground water gradient.

Comment 5:

The EE/CA Addendum at page 3 states that contingency action described in Alternatives 2 and 3 will be used. Alternative 3 has a contingency of groundwater extraction. However, before committing to this course of action, 'the natural attenuation would be monitored for at least five years after the acceptance of the ROD.' This statement raises several questions. First, how long will natural attenuation be monitored, since there will be no ROD for Pit 6? Also, how will the monitoring data and a future decision regarding the contingency action be documented? We are also very concerned about the elimination of some monitoring wells. We (DOE, LLNL, regulators and the community) are losing the ability to detect early leaks from the trenches by locating all of the monitoring wells outside of the cap. Although the EE/CA Addendum states that it is incorporating contingency actions described 'in Alternatives 2 and 3 of the Pit 6 EE/CA (formerly the Pit 6 Feasibility Study)', the elimination of some wells described in the Pit 6 FS would severely alter the effectiveness of those contingency actions.

Response to Comment 5:

The third sentence of this comment refers to a statement made in Section 4.3.1, page 4-6 of the EE/CA. While a Pit 6 Landfill-specific ROD will not be issued, the pending Site-Wide ROD will ensure long-term monitoring of the Pit 6 Landfill and continued protection of human heath and the environment. The Post-Closure Plan to be issued upon the completion of cover construction (December 1, 1997) will include the release detection monitoring plan. Monitoring of the ground water plume will also continue until cleanup standards, to be determined in the Site-Wide ROD, are reached in all wells. The Post-Closure Plan will include procedures for reporting monitoring results and for interpreting the data.

A discussion of the rationale for eliminating five initially proposed wells is presented in the EE/CA Addendum. It is common practice to place monitoring wells along the outer edge of landfill covers and to avoid installing wells that penetrate the cover. The concern of potential long-term compromise of cover integrity by installing wells that penetrate the synthetic liners as well as potential safety concerns during installation are overriding considerations. DOE/LLNL feel that the monitoring network in the vicinity of the cover will provide adequate early warning of any future release from the buried waste and that the effectiveness of potential future contingency actions is not significantly compromised by not installing these wells at this time.

Comment 6:

The EE/CA Addendum states that the landfill cover will be expanded to approximately 2.4 acres, due to a further review of geophysical and historical data that suggested some buried wastes may be further east than was presented previously. The basis for this expansion (i.e. re-analysis of information) has not been presented to us in the Pit 6 EE/CA or the EE/CA Addendum. We think that a fundamental step in designing a cost-effective landfill remedy is to carefully delineate the areal extent of the landfill, and to characterize the wastes properly. This saves money both at the design phase and in long term O&M costs. It also provides more accurate monitoring well location(s)*, and will free up land for unrestricted use. This last point is important, in that it is not clear that DOE will retain possession of the entire Site 300 facility in the future. We might add that our experience (in particular Peter's experience as technical advisor at other sites) with old landfills at other Superfund sites has been that there had been lots of wasted money spent on the design of landfill caps, only to find that it is unneeded or must be revised due to improper characterization and delineation of the landfill.*

Response to Comment 6:

The landfill cover was expanded to cover the area overlain by the current rifle range firing station. When the initial geophysical surveys were performed to determine the extent of buried waste, the metal roof and walls of the firing station interfered with the resolution of the survey equipment. The initial interpretation of the geophysical survey results presented as Figure 12-6 of the Site-Wide Remedial Investigation Report excluded the area under the firing station as a location for buried waste. Records from the LLNL surveyors department indicate that Trenches 2 and 3 extend under the rifle range firing station.

To safely and more accurately investigate the extent of the trenches under the rifle range, a structure called the firing station would need to be removed. This additional investigative work would need to be conducted before finalizing the cover design, and subsequently procuring construction contractors. As a result, the period of time that security personnel would be without on onsite rifle range would extend to the point where they would need find another facility offsite that meets strict DOE safety criteria to conduct required training. DOE elected to be more health-conservative and more cost-effective by assuming that the trenches extended under the firing station and extending the cover over this area of uncertainty.

With respect to future land use, DOE currently has no plans to transfer Site 300 property ownership. However, as an additional measure to ensure protection of public health and welfare,

the Site 300 Federal Facility Agreement includes a section addressing "Transfer of Real Property Interest" which states:

"The Department of Energy shall retain liability in accordance with CERCLA, notwithstanding any change in ownership or possession of the real property interests comprising the Federal Facility. The Department of Energy shall not transfer any real property interests comprising the Federal Facility except in compliance with Section 120(h) of CERCLA, 42 U.S.C. Section 9620 (h). Prior to any transfer of any portion of any real property interest comprising the Federal Facility which includes an area within which any release of hazardous substance has come to be located, or of property which is necessary for performance of the remedial action, the Department of Energy shall give written notice of that condition to the recipient of such real property interest. At least thirty (30) days prior to any transfer subject to Section 120(h) of CERCLA, the Department of Energy shall notify all Parties of the transfer of any real property interest subject to the Agreement and the provisions made for any additional remedial actions, if required."

Also, the Post-Closure Plan will incorporate the requirements for proper notification of zoning officials and notices to the property deed which help ensure that future land use of the Pit 6 Landfill will be appropriately restricted.

Comment 7:

The commentor verbally recommended that DOE-prepared documents which are currently available to the public only by paying for them through the National Technical Information Service should be made available on the World Wide Web.

Response to Comment 7:

DOE appreciates and encourages continued public interest and participation in the process of environmental restoration. DOE appreciates the comment regarding the usefulness of the World Wide Web as a powerful tool to increase the availability of information about environmental restoration activities across the DOE-complex and is working to increase the amount of available information. Information about work being conducted by the Lawrence Livermore National Laboratory Environmental Restoration Division can be found on their web page (address: www-erd.llnl.gov). Additional information regarding accessibility of documents can be obtained by contacting the LLNL Community Relations Department at (510) 424-4026.

Attachment A

Tables B-7, B-8, 12-5, 12-81 of the Final Site-Wide Remedial Investigation Report Lawrence Livermore National Laboratory Site 300

(Webster-Scholten, April 1994)

Table B-7. Inventory of waste disposed of in pit 6 (LLNL, 1973b).

Shipment no.	Date	Load	Contents[a]
1	07/01/64	1 truckload	Miscellaneous dry waste drums, cargo pallets, metal parts 1 metal tank 2 glove boxes 2 shell furnaces
2	07/08/64	1 truckload	1 large glove box 2 small glove boxes 1 degreaser 2 pallets of filters Miscellaneous dry waste drums 1 large u-shaped ducting and other ducting waste lumber and metal parts
3	07/15/64	1 truckload	8 pallets of dry nonradioactive waste 1 metal tank 2 drums full of varnish [solidified polymer] 4 pallets of capacitors 1 pallet electron tubes 1 pallet nonradioactive waste paper Miscellaneous ducting
4	07/22/64	1 truckload	4 pallets sewer pipe and concrete 1 pallet of gas bottles 1 pallet of filters 1 stack old pallets pallets of 5-in. piping
5	07/29/64	1 truckload	3 pallets of capacitors (2 small and 2 large) 1 pallet of gas bottles 18 pallets of empty oil drums 2 stacks old pallets
6	08/05/64	1 truckload	24 pallets of empty oil drums
7	08/12/64	1 truckload	24 pallets of empty oil drums
8	08/19/64	1 truckload	1 pallet of capacitors 1 pallet of waste drums 22 pallets of empty oil drums
9	08/26/64	1 truckload	22 pallets of oil drums
10	09/02/64	1 truckload	22 pallets of oil drums
11	09/09/64	1 truckload	One 2,000-gal tank 20 pallets of waste drums and waste oil drums
12	09/16/64	1 truckload	One 824-gal tank full of waste paper and green basket waste 8 stacks of 4 ft × 4 ft cargo pallets 2 pallets of capacitors 2 pallets of waste drums

Table B-7. (Continued)

Shipment no.	Date	Load	Contents[a]
13	09/23/64	1 truckload	One 2,000-gal tank full of empty carboys and lard cans (not contaminated), and miscellaneous parts 2 pallets of wooden boxes of miscellaneous chemicals One 500-gal tank 1 pallet with two 55-gal and two 30-gal waste drums full of assorted chemicals 1 wooden box full of waste paper 4 pallets of waste oil drums 8 pallets of dry waste drums full of cans, boards, trash and miscellaneous parts 2 stacks of 4 ft × 4 ft cargo pallets 1 pallet of capacitors 2 small glove boxes
14	09/30/64	1 truckload	Two 2,000-gal tanks full of empty carboys (not hot), empty cans, and miscellaneous parts 8 pallets of empty waste drums (black) 2 stacks of pallets
15	10/07/64	1 truckload	1 steel tank 4 ft × 2 ft × 20 ft (rack) 5 small tanks (1 ft × 3 ft × 4 ft) (w/lids) 7 stacks cargo pallets 2 pallets of miscellaneous parts
16	10/12/64	1 small trailer	1 glove box (10 ft × 4 ft × 8 ft) 2 stacks of cargo pallets 1 pallet of empty 5-gal cans 2 filters (2 ft × 1 ft) 2 pallets of 3-in. pipe
17	12/15/64	1 truck and 2 trailers	2 pallets of chips (18 drums) 3 pallets of empty oil and waste drums 1 pallet of dry chemicals 2 pallets of capacitors 5 aluminum shelves 1 sink 3 filters (2 ft × 2 ft × 2 ft) 5 glove boxes 2 furnaces and hardware 1 large enclosure (8 ft × 8 ft × 5 ft) 1 glove box (4 ft × 4 ft × 4 ft) w/vacuum cleaner 1 metal rack, hood, and table Ducting 1 large wooden box full of miscellaneous trash
18	02/24/65	1 truckload and 2 trailers	2 glove boxes 1 bench 1 PVC hood 5 pallets of ducting 6 pallets of filters 2 stacks of old pallets 2 pallets of capacitors 2 small furnaces 4 pallets of waste drums 1 large mercury-contaminated manifold

Table B-7. (Continued)

Shipment no.	Date	Load	Contents[a]
19	03/22/65	[not listed]	4 lard cans and 1 package of animal waste (rats)
20	05/04/65	1 truckload with 2 trailers	5 pallets of capacitors 7 pallets of filters 1 enclosure (4 ft × 4 ft × 6 ft) 1 furnace (3 ft × 4 ft × 5 ft) 1 small glove box 5 pallets of trash cans 1 pallet of dollies
21	06/08/65	2 trailers	2 pallets of drums 6 pallets of capacitors 3 glove boxes 1 shop table 3 pallets of pumps 1 pallet of transformers miscellaneous ducting 2 pallets of ducting
22	06/08/65	[not listed]	2 lard cans containing animal waste
23	06/18/65	[not listed]	Five 55-gal drums of animals (rats, dogs, and rabbits) Two 55-gal drums of animals (rats)
24	07/20/65	[not listed]	One 2,000-gal empty truck tanker
25	07/27/65	1 truck and 2 trailers	1 large work table 5 pallets of capacitors 1 empty 500-gal water tanker 3 pallets of empty drums 1 pallet of filters 1 pallet of small cans 20 pallets (4 ft × 4 ft)
26	08/06/65	1 truck and 2 trailers	16 pallets of empty drums 4 pallets of capacitors
27	09/17/65	1 truck and 1 trailer	6 pallets of capacitors 1 pallet of drums 1 pallet of filters 2 pallets of miscellaneous cans 1 pallet of carboys 1 pallet of pipe
28	10/22/65	1 truck and 1 trailer	1 large glove box 3 small glove boxes 1 work table 1 pallet of filters and ducting 1 pallet of capacitors 2 large boxes 1 pallet of drums
29	02/25/66	[not listed]	1 drum animal waste (ram) [and one ram]

Table B-7. (Continued)

Shipment no.	Date	Load	Contents[a]
30	03/01/66	1 truck and 1 trailer	3 pallets of drums 13 pallets of capacitors 1 large wooden box 15 pallets (4 ft × 4 ft)
31	03/28/66	1 truck and 1 trailer	2 large wooden boxes of trash 1 pallet of pipe and ducting 1 pallet of trash One 1,000-gal portable tank 5 pallets of capacitors 3 stacks of pallets
32	04/19/66	1 truck and 1 trailer	8 pallets of capacitors 3 glove boxes 2 pallets of drums 2 pallets of miscellaneous and pipe 2 boxes mercury lights
33	05/10/66	[not listed]	3 cows 5 bags of lime to cover animals
34	06/21/66	1 truck and 1 trailer	1 large wooden box 3 pallets of ducting and tubing 4 pallets of large filters 5 pallets of capacitors 1 pallet of miscellaneous metal bracing
35	07/01/66	1 truck and 1 trailer	1 vent hood 3 pallets of capacitors 1 glove box 10 drums 3 pallets of filters 1 pallet of filter fittings 1 pallet miscellaneous 1 metal stand 1 pallet of piping ductwork
36	09/09/66	1 trailer load	5 glove boxes 6 pallets of capacitors Two 55-gal drums One 55-gal drum of small capacitors 1 pallet assorted miscellaneous 1 pallet of round capacitors
37	09/28/66	1 trailer load	1 pallet of 7.5-gal carboys 1 box capacitors 2 pallets miscellaneous Ten 55-gal drums 1 roll flooring Two 30-gal waste cans 2 pallets of capacitors 2 pallets of filters One 300-gal gas tank

Table B-7. (Continued)

Shipment no.	Date	Load	Contents[a]
38	01/13/67	1 trailer	2 chemical (sink type) lab work benches 4 pallets of ducting 2 hood vent tops 3 large filters 2 pallets of capacitors 3 pallets of miscellaneous cans and containers 1 pallet of drums (4) 4 hood tops 2 wooden glove boxes 1 large furnace 1 pallet metal sheets (sections)
39	01/16/67	[not listed]	3 cows
40	05/10/67	1 trailer	1 pallet small plastic pipes 1 pallet of glass doors 1 pallet of filters 1 pallet of large plastic pipes 1 pallet of ventilating ducting 2 pallets of canvas and pipes 1 large pallet of filters, motors, pipe 1 box pallet of capacitors, filters 12 pieces rectangular ducting
41	05/13/67	[not listed]	1 cow
42	08/11/67	One 40-ft trailer	1 glove box 6 pallets of lard cans One 1000-gal tank 10 pallets of capacitors 1 box pallet of miscellaneous capacitors 1 pallet of red (non-rad) chemical drums 1 pallet of miscellaneous pieces of equipment 1 pallet of flexible tubing of various sizes several large (>15-ft) pieces of pipe and ducting
43	09/01/67	[not listed]	2 cows
44	10/25/67	One 40-ft trailer	6 pallets of capacitors 6 carboys Two 10-ft wooden boxes 14 drums miscellaneous 2 pallets of filters 2 pallets of concrete blocks One 3-ft wooden box 4 lard cans of miscellaneous gas bottles
45	11/01/67	[not listed]	4 technically contaminated calves

Table B-7. (Continued)

Shipment no.	Date	Load	Contents[a]
46	04/12/68	One 40-ft trailer	9 pallets of capacitors 1 glove box 4 pallets of drums 1 pallet of wooden case filters 2 pallets of wood planks 1 large wood box 1 pallet of styrofoam 6 pieces aluminum ducting 1 pallet of large electrical coils
47	04/26/68	One 40-ft trailer	4 pallets of wood from pit covers 4 pallets of drums 2 pallets of capacitors 2 pallets of miscellaneous ducting One 20-ft section of aluminum ducting 1 pallet of miscellaneous metal (Fe) parts
48	07/19/68	One 40-ft trailer	9 retention tanks—no activity using portable alpha meter, no alpha/beta readings with Geiger counter E-400 1 pallet of technically contaminated waste (aluminum brackets and cross-braces for storage shelves)
49	07/02/69	One 40-ft trailer	1 box (3 ft ×6 ft × 4.5 ft) miscellaneous small junk 2 boxes of approximately 200 small capacitors 2 large boxes of approximately 50 small capacitors 1 ignition tube filled with Hg 3 mercury tubes 1 pallet of PVC pipe 87 capacitors 1 large pallet of soil samples 2 boxes [drums] of depleted U^{238} (drums exhumed on June 14-15, 1971) 166 drums of 55-gal, compressed 1 pallet of air ducting 1 mercury lamp
50	08/29/69	[not listed]	3 drums of biomedical waste calf: carcass, feces, urine cow: feces, urine, milk, blood
51	09/17/69	[not listed]	28 ignition tubes 8 lid-filled drums 2 boxes small capacitors 25 capacitors approximately 100 boxes of S.E.D.A.N. dirt 1 filter/depleted U^{238} 1 drum Hg waste (drum exhumed on June 14-15, 1971) 3 boxes of prefilters 19 drums/depleted U^{238} [drums exhumed on June 14-15, 1971] 1 drum/Mulberry [depleted U^{238}](drum exhumed on June 14-15, 1971)
52	09/24/69	[not listed]	1 cow

Table B-7. (Continued)

Shipment no.	Date	Load	Contents[a]
53	09/01/70	[not listed]	1 mercury stripper 34 drums of depleted U^{238} (drums exhumed on June 14-15, 1971) 771 capacitors
54	04/28/71	[not listed]	2 cows
55	02/20/73	[not listed]	5 cows and 1 ram

Notes:

[a] **Contents are summarized from LLNL (1973b) except where data shown in brackets are revised using Decker (1971).**

S.E.D.A.N. denotes Project Sedan which was a nuclear excavation and cratering experiment conducted at the Nevada Test Site (LRL, 1963). Shipment 51 lists S.E.D.A.N. dirt.

Mulberry probably refers to a metallurgy experiment.

Table B-8. Isotopes and respective physical half-lives for biomedical experiment waste disposed of in pit 6.

Isotope	Physical half-life[a]
Ag^{110}	24 sec
As^{74}	18 day
Au^{198}	2.7 day
Be^{7}	53.6 day
Cd^{109}	470 day
Ce^{141}	32.5 day
Ce^{144}	284 day
Co^{60}	5.26 day
Cr^{51}	27.8 day
Cs^{137}	30 yr
Cu^{64}	12.8 hr
Fe^{59}	45 day
H^{3}	12.26 yr
Hg^{203}	47 day
I^{131}	8.06 day
Ir^{192}	74 day
Mn^{54}	280 day
Mo^{99}	67 hr
Na^{22}	2.58 yr
P^{32}	14.3 day
Ra^{212b}	18 sec
Rb^{86}	18.7 day
Re^{186}	89 hr
Ru^{103}	40 day
S^{35}	87 day
Sb^{124}	60 day
Sb^{125}	2.7 yr
Se^{75}	120 day
Sr^{90}	29 yr
Ta^{182}	115 day
W^{181}	126 day
W^{185}	74 day
W^{187}	24 hr
Zn^{65}	245 day
Zr^{95}	65 day

a Friedlander *et al.*, (1964)

b The source memorandum for this entry (Kloepping, 1971) listed Ra^{106}. We know this entry is not correct and have substituted Ra^{212}.

Table 12-5. Previous investigations in the Pit 6 Area study area.

Date	Location	Purpose	Scope	Reference
Phase 1				
1982–1985	Pit 6	Begin geologic and hydrogeologic assessments. Evaluate landfill contents.	Conducted geologic mapping, terrain conductivity and GPR surveys; installed monitor wells K6-01, K6-03, K6-04, EP6-06, EP6-07, EP6-08, and EP6-09; drilled boreholes K6-02, EP6-05; logged fault trench T-2.	Raber and Carpenter,1983; Carpenter and Peifer, 1983; CH2M Hill, 1985; Carpenter and Peifer, 1983.
Phase 2				
1986–1988	Pit 6	Evaluate ground water monitoring network; conduct geologic mapping, magnetics surveying, hydraulic testing; release site definition; SVS[a]; prepare SWAT report.	Installed monitor wells K6-01S, EP6-09S, BC6-10, BC6-11, BC6-12, BC6-13; K6-14, K6-15, K6-16, K6-17, K6-18, and K6-19; drilled borehole K6-19A; sampled 39 SVS locations.	Brown and Caldwell, 1987; Taffet and Lamarre, 1988; Vonder Haar *et al.*, 1989; Rezowalli, 1988.
	Paper Canyon	Make geologic, hydrogeologic, and radiation assessments.	Installed monitor wells W-34-01 and W-34-02; conducted FIDLER[b] survey.	Ruggieri *et al.*, 1987; McIlvride *et al.*, 1988; Lamarre *et al.*, 1990a.
	Carnegie area	Conduct field survey.	Conducted FIDLER and magnetometer surveys.	Ruggieri *et al.*, 1987; McIlvride *et al.*, 1988; Lamarre *et al.*, 1990a, b.
Phase 3				
1989–1990	Pit 6	Make additional hydrogeologic evaluation; prepare RI report; conduct geologic mapping; log Carnegie fault trenches.	Installed monitor wells K6-21, K6-22, K6-23, K6-24, K6-25, K6-26, K6-27, and W-33C-01; drilled boreholes K6-20, K6-28, and K6-29; plugged and abandoned monitor well EP6-09S; hydrophysically logged monitor well BC6-12 and borehole K6-26; conducted infiltration testing of soil cover; logged fault trenches TR-P6-01, TR-P6-02, TR-P6-02A, and TR-P6-03; and fault test pits TP-P6-01 and TP-P6-02.	Taffet, 1990; GZA, 1990.
Phase 4				
1991	Pit 6	Continue ground water monitoring and sampling; prepare FS and Carnegie fault reports.	Continued ground water sampling and measurement of water elevations; evaluated emission of VOC soil vapors; collected vegetation samples; conducted 3-wk logging of water levels in well CARNRW3.	Carlsen, 1991a, b; Taffet *et al.*, 1991; Carpenter *et al.*, 1991.

[a] Soil Vapor Survey.

[b] A radiation detection instrument that indicates the presence of depleted uranium or other alpha-emitting radionuclides.

Table 12-81. Remedial actions in the Pit 6 Area study area.

Date	Remedial action	References
1964–1973	Spread native soil over the trenches in the landfill as they were filled to minimize infiltration; compacted the soil cover by a series of passes by a bulldozer.	Taffet, 1990
June 14–15, 1971	Exhumed 57 drums of Hg and depleted uranium waste; materials shipped offsite, location unspecified.	Decker, 1971
Post-1973	Capped the landfill with a 1- to 3-ft-thick soil cover composed of native adobe clay loam.	Taffet, 1990
Late 1981–mid-1982	Located a drainage ditch north of the landfill to divert any intermittent rainfall and to drain the slope to the north away from the landfill.	Taffet, 1990
Ongoing	Inspect and periodically maintain the native-soil cover and drainage ditch.	

Attachment B

Pit 6 Engineering Evaluation/Cost Analysis

Initially released as the:
Final Feasibility Study for the Pit 6 Operable Unit Lawrence Livermore National Laboratory Site 300 (R. Devany et al., December 1994)

Attachment C

Addendum to the Pit 6 Engineering Evaluation/Cost Analysis Lawrence Livermore National Laboratory Site 300

(T. Berry, November 1996)