U.S. Department of Energy

Oakland Operations Office, Oakland, California

WORK PLAN FOR REMOVAL ACTIONS IN THE SOUTHWEST TRENCHES, RA/SR TREATMENT SYSTEMS, AND DOMESTIC SEPTIC SYSTEM AREAS

at the

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

Prepared for:

United States Department of Energy
Oakland Operations Office
1301 Clay Street
Oakland, California 94612-5208

Prepared by:

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5801 Christie Avenue, Suite 600
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July 24, 2000
Rev. 0

DOE Oakland Operations Office Contract DE-AC03-96SF20686

Weiss Associates
Environmental Science, Engineering and Management

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ACRONYMS

AH	Animal Hospital
ALARA	As low as reasonably achievable
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
bgs	below ground surface
CA	Contamination Area
CalEPA	State of California Environmental Protection Agency
CB	cement-bentonite
CFR	Code of Federal Regulations
Ci/m^3	Curies per cubic meter
CLP	Contract Laboratory Program
COC	Constituents of Concern
Cs-137	cesium-137
DAC	Derived Air Concentration
D&D	decontamination and decommissioning
DOE	United States Department of Energy
DQO	data quality objective
EDE	effective dose equivalent
EE/CA	Engineering Evaluation/Cost Analysis
EMS	Environmental Management Services
EPA	United States Environmental Protection Agency
ER/WM	Environmental Restoration/Waste Management
EZ	Exclusion Zone
FC	Field Coordinator
GM	Geiger Müeller Detector
Hg	mercury
HPGe	High Purity Germanium
HSP	Health and Safety Plan
HWP	hazardous work permit

ID	identification
IDW	investigation-derived waste
IT	IT Corporation
ITEH	Institute of Toxicology and Environmental Health
LCL	lower confidence level
LEHR	Laboratory for Energy-Related Health Research
LF	linear feet
LFI	Limited Field Investigation
LLW	low-level waste
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
mCi	milliCuries
MCLs	maximum contaminant levels
MDA	minimum detectable activity
MLE	maximum likelihood estimated
mg/kg	milligrams per kilogram
NCP	National Contingency Plan
NESHAPs	National Emission Standards for Hazardous Air Pollutants
OSHA	Occupational Safety and Health Administration
pCi/g	picoCurie(s) per gram
PID	photoionization detector
PHSP	Project Health and Safety Plan
PPE	personal protective equipment
PQAS	Project Quality Assurance Specialist
PVC	poly vinyl chloride
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RA	removal action
RAO	removal action objective
Ra-226	radium-226
Ra/Sr	Radium-226/Strontium-90
RBAS	risk-based action standard
RCT	Radiological Control Technician
RI/FS	Remedial Investigation/Feasibility Study

RPM	Remedial Project Manager
RSO	Radiation Safety Officer
SHSC	Site Health and Safety Coordinator
SHSO	Site Health and Safety Officer
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
SQP	Standard Quality Procedure
Sr-90	strontium-90
TAT	turn-around time
TBD	To Be Determined
TSM	tailgate safety meeting
TWA	time-weighted average
UCL	upper confidence limit
$\mu g/m^3$	micrograms per cubic meter
USA	Underground Services Alert
USCS	Unified Soil Classification System
UCD	University of California, Davis
UCL	upper confidence level
VOC	volatile organic compound
WA	Weiss Associates
WMP	Waste Management Plan
WP	Work Plan
WRS	Wilcoxon Rank Sum

1. INTRODUCTION

This document is the Work Plan (WP) for the non-time-critical removal actions (RAs) in the Southwest Trenches Area, Ra-226/Strontium-90 (Ra/Sr) Treatment Systems Area, and Domestic Septic System Areas at the Laboratory for Energy-Related Health Research (LEHR) facility located at the University of California at Davis (UCD), California. The RAs are being implemented in accordance with the National Contingency Plan (NCP), 40 Code of Federal Regulation (CFR) Part 300.415. This WP was prepared by Weiss Associates (WA) under Department of Energy (DOE) Environmental Restoration/Waste Management (ER/WM) Contract No. DE-AC03-96SF20686.

This document describes the sequence of removal action activities that will be performed at each RA area along with the health and safety and quality assurance aspects that will be implemented. In addition, this WP includes a set of construction drawings and specifications for implementation of the RA. Specifications, along with project drawings, are presented in Appendix A. Specifications are prepared for construction related tasks such as excavation, backfilling, fence installation, and concrete work. They describe the performance requirements of each construction-related activity for the contractor.

Standard Operating Procedures (SOPs) are also referenced as needed in the WP. SOPs provide guidelines for the contractor to conduct work at the site safely and to appropriate quality standards. SOPs are detailed procedures for site-specific activities such as decontamination, waste sorting and screening, container loading, sampling, and radiation monitoring. SOPs are not attached to this WP, but are compiled in a separate document. A list of SOPs referenced in this WP is attached as Appendix B.

Two supporting documents provide further detail regarding the strategies and procedures proposed for the RA. These documents are attachments to this WP and include the Sampling and Analysis Plan (SAP) and the Waste Management Plan (WMP). The SAP is Attachment I and details the sampling and analysis strategies and methodologies selected for the RAs. The WMP is Attachment II and describes the waste management activities, including waste stream identification, handling, packaging, and storage methodologies for the removal actions.

This section of the WP summarizes background information for each RA area, lists the constituents of concern (COC), and presents the removal action objectives (RAOs). Project organization and contacts are also presented in this section. Additional information regarding background and previous investigations performed at each RA area may be found in the following documents:

- Final Engineering Evaluation/Cost Analysis (EE/CA) Report (WA, 1998a)
- Draft Final Site Characterization Summary Report (WA, 1997a)
- Draft Final Determination of Risk-Based Action Standards Report (WA, 1997b)

1.1 Site Background

The RA will be conducted at three DOE areas within the LEHR facility, namely the Southwest Trenches, Ra/Sr Treatment Systems, and the Domestic Septic System Areas. Background information for each area is described below.

1.1.1 Southwest Trenches Area

The Southwest Trenches Area is located in the southwest corner of the LEHR Facility as shown on Drawing C-1. During the 1960s and 1970s, LEHR-generated low-level radioactive waste, fecal material, and laboratory wastes were reportedly disposed in shallow pits and trenches (Dames & Moore, 1993). In this RA, these trenches are called "waste disposal cells." The locations and dimensions of the waste disposal cells are not known with certainty; however, the trenches were reportedly about 120 ft long, 2 ft wide, 8-10 ft deep, and oriented in a north-south and west-east direction (Dames & Moore, 1993). In addition, a chemical dispensing area, where chemicals were reportedly stored in an open wooden structure, was also present in the area.

1.1.2 Ra/Sr Treatment Systems Area

The structures associated with the Ra/Sr Treatment Systems Area are shown on Drawing C-5. The Radium-226 (Ra-226) Treatment System consists of two septic tanks, each with two compartments separated by a weir, and an effluent distribution box feeding three drywells and a leach trench via distribution pipelines. The two Ra-226 septic tanks, with a combined capacity of 14,400 gallons, are located between Animal Hospitals No. 2 and No. 1. The contents of the septic tanks were homogenized, pumped, solidified and shipped to the Hanford facility in the state of Washington for disposal as a low-level waste in 1992 (Chemical Waste Management, 1992). The tanks have accumulated some water however, from rainwater infiltration into the tanks.

The three Ra-226 drywells were installed to facilitate subsurface infiltration of wastewater. These drywells, each with a diameter of about 2.5 ft, consist of open boreholes filled with gravel to depths between about 6 and 40 ft below ground surface (bgs) (DOE, 1988). While the drywells reportedly received primarily wastewater from the Ra-226 treatment system, Sr-90 may also be present.

Because of frequent exceedances of the infiltration capacity of the original drywell system, a cobble-lined leach trench was added in 1965. The trench extends south from the drywells and is about 91 ft long, 3 ft wide, and 14 ft deep. A second leach trench extending north is shown on several engineering drawings of the area; however, its location has not been confirmed in the field (IT, 1996).

The Strontium-90 (Sr-90) Treatment System consists of a series of nine "Imhoff" tanks (tanks A through I), and a leach field (WA, 1997a). The tanks are concrete and coated with a plastic sealant. Chemical Waste Management in 1992 reportedly removed the plastic sealant (IT, 1996). The total capacity of these tanks is 46,000 gallons. In 1962, Building H-322 was built over the "original" leach field; therefore, a second leach field, referred to as the "existing leachfield," was

constructed to replace the original field. The location of the leachfields is shown on Drawing C-5. In 1995, Building H-322 was demolished.

In 1991 and 1992, liquids and sludge remaining in the tanks were removed, solidified, and disposed at the Hanford facility as low-level radioactive waste. Water has accumulated in several of the tanks and about 250 gallons of sludge remains in Tank A.

1.1.3 Domestic Septic System Areas

There are seven domestic septic tanks located throughout the LEHR facility, which collectively constitute the Domestic Septic System areas. A typical domestic septic system consists of a septic tank, leach field, and interconnecting piping. In 1971, Septic tank Nos. 1, 2, 3, 4, 5, and 6 were reportedly backfilled with sand and the influent/effluent lines for each tank were reportedly cut and capped (IT, 1996). Previous investigations have found no environmental concerns associated with Septic Systems Nos. 1, 4, 5, and 7 (WA, 1998a). Based on these data, no removal action is warranted. However, the data needs to achieve full closure of these tanks is currently under evaluation. Hence, Domestic Septic Systems No. 2, 3 and 6 are the focus of this RA.

Domestic Septic System No. 2 is located adjacent to the effluent distribution box for the Ra-226 tank (see Drawing C-5) and is addressed as part of the RA at that area. Domestic Septic System No. 2 reportedly received effluent from the Animal Hospital No. 2 during periods of backup in the Ra-226 Treatment System and was identified during an investigation in 1995 (IT, 1996). Based on the contaminants present in the effluent of the Ra-226 Treatment System, this septic system is considered a source of contamination and will therefore be removed as part of the RA at the Ra/Sr Treatment Systems Area.

Domestic Septic Systems No. 3 and 6 have been investigated during previous characterization activities (IT, 1996). No septic tank was observed in the area of Domestic Septic System No. 3, although the leachfield was found and sampled. Radium-226 was the only constituent detected at two times above background and therefore additional sampling is warranted in this area. No septic tank was discovered at Domestic Septic System No. 6 either, but mercury was detected in near surface soil at 50 times the background level.

1.2 Constituents of Concern

The COCs in each RA area were identified during previous environmental investigations and presented in the EE/CA. A list of compounds detected in each area above background concentrations is presented in the SAP. Compounds detected above background in each area are considered COCs for this RA. It should be noted that these COCs are identified based on existing data and, as such, are subject to change.

The frequency and magnitude of detection of each COC varies among the RA areas. Only a few COCs were consistently detected throughout each area and are associated with past operations and releases to the environment. The COCs detected consistently in each area that are known to have

been released to the environment are considered "driver COCs." Driver COCs will be used during the removal action to guide the excavation activities.

In the Southwest Trenches Area, the driver COCs include Ra-226, Sr-90, chlordane, hexavalent chromium, nitrate, and mercury. In the Ra/Sr Treatment Systems Area, the driver COCs are Ra-226, Sr-90, and nitrate. Ra-226 is the only COC at the Domestic Septic System No. 3 while mercury is the only COC in the Domestic Septic System No. 6.

1.3 Removal Action Objectives

The objectives of these non-time critical RAs as defined in the EE/CA are:

1. Lower the excess cumulative cancer risk to an individual from exposure to site contaminants to within a nominal range of 10^{-4} to 10^{-6}, using 10^{-6} as the point of departure;
2. Reduce the non-cancer hazard index to below 1;
3. Mitigate potential future impact to ground water;
4. Mitigate potential ecological risks during and after the RA; and
5. Minimize impact to on-site University research.

To achieve these objectives, the EE/CA evaluated several remedial technologies and recommended a removal action alternative consisting of excavation, offsite disposal of waste, and institutional controls for the Southwest Trenches Area and Ra/Sr Treatment Systems Area. Institutional controls along with additional investigation to define a Ra-226 detection was recommended at Domestic Septic System No. 3 while limited excavation and confirmation sampling was recommended for Domestic Septic System No. 6.

1.4 Cleanup Criteria

This WP utilizes three cleanup criteria to determine attainment of the RAOs and hence, successful completion of the RA at each area. These criteria include risk-based action standards, background soil concentrations, and ground water-protective designated level soil concentrations (hereafter referred to as designated levels). The SAP presents the data quality objectives and sampling design developed to ensure attainment of these criteria and therefore the RAOs. Each criterion is described below.

1.4.1 Risk-Based Action Standards

The Draft Final Determination of Risk-Based Action Standards Report (WA, 1997b) developed site specific soil concentrations, called risk-based action standards (RBASs), for both carcinogenic and non-carcinogenic COCs at the site. For carcinogenic compounds, the RBAS meets the excess upper bound lifetime cancer risk between 10^{-4} and 10^{-6}, and for systemic non-carcinogenic

compounds, the RBAS is equivalent to a hazard quotient of 1.0 (representing no significant adverse effect during a lifetime). Calculated RBASs represent single constituent concentrations, which if present throughout the horizontal and vertical extent of each area, might theoretically result in the specified maximum individual excess risk level (or hazard quotient) to an exposed individual.

Three risk exposure scenarios were developed, and for each scenario a set of RBAS values were calculated. The RBAS values for the 10^{-6} excess cancer risk and hazard quotient equal to one for all COCs under each risk scenario are presented in Tables 1-1 and 1-2. In cases where the calculated RBAS is less than the COC background concentrations, the action standard is set at background.

The RBAS values will be used as cleanup guidelines to help determine whether the first and second RAOs have been achieved. Confirmation samples will be collected from within the cleanup area and analyzed for all COCs. If residual COC concentrations exceed background, the confirmation sampling results will be used in a forward risk screening analysis to calculate the cumulative cancer risk and non-cancer hazard index posed by compounds detected in the cleanup area. The risk analysis will be performed for the three risk scenarios. The risk analysis approach and methodologies will be according to EPA guidance documents and existing risk calculations performed in the Draft Final Determination of Risk-Based Action Standards Report (WA, 1997b). If the cumulative risk from site soil following the RA is nominally 10^{-6} and the hazard index is less than 1, then the first and second RAOs (see pages 1-4) have been attained.

As discussed in the EE/CA Report, institutional controls are a potential component of these RAs. Institutional controls typically utilize land use restrictions to minimize exposure and reduce cumulative risk. In the case of radionuclides, specifically Ra-226, the residual concentration that remains in soil, and in turn the corresponding risk level, varies depending on the proposed future land use, depth of residual concentration, and type of cover. The EE/CA developed guidelines for soil cover thickness overlying residual Ra-226 concentrations as means of reducing risk. These parameters will be incorporated in determining an acceptable Ra-226 cleanup criteria at each area.

1.4.2 Background Concentrations

Background concentrations of COCs in soil have been calculated and are presented in Tables 1-1 and 1-2. Background concentrations were calculated using analytic results of off-site soil samples and were derived using statistical methods. Specifically, the 80% lower confidence limit of the 95th quantile was selected to represent the background values for all COCs. The derivation of background concentrations is presented in Appendix C. The background values have been updated from those presented in the EE/CA and RBAS reports to incorporate new background data. In cases where the RBAS value for a particular COC is less than the background concentration, then the background concentration will be used as the target cleanup criterion.

1.4.3 Ground Water-Protective Designated Levels

Vadose zone fate and transport modeling was performed to derive maximum residual concentrations for several COCs in site soil for different soil types and at varying depths that, if left

in place, will not result in a significant impact to ground water. The approach described in the Designated Level Methodology for Waste Classification and Cleanup Level Determination (CRWQCB, 1989) was used along with the numerical code NUFT to derive residual COC concentrations in soil called "designated levels." Appendix D presents the designated level calculation methodologies.

Residual soil concentrations were calculated for five indicator constituents, two lithology types, two infiltration rates, and two ground water protection goals, including background ground water concentrations and Maximum Contaminant Levels (MCLs). The calculated designated levels will be used as initial guidelines to help ensure attainment of the third RAO, protection of ground water. During the RA, designated levels derived from protection of MCLs will be used to support decisions regarding excavation limits. Upon completion of excavation activities, the confirmation sampling results will be used to evaluate whether additional removal and/or ground water monitoring are required.

1.5 Removal Action Sequence

The general scope of work for all three RA areas consists of removal of sources of contamination and associated contaminated soil, followed by confirmation sampling and analysis, backfilling and compaction of the excavation, and site restoration. All excavated waste and structures will be disposed at an appropriate facility after characterization. Waste shipment and disposal are not discussed in this WP. A separate waste management plan will be prepared at a later date to address waste shipment and disposal. The removal action sequence for each area is described in more detail below. Prior to commencing each RA, necessary pre-construction meetings such as readiness review will be conducted in preparation of the RA activities.

1.5.1 Southwest Trenches Area

The sequence of RA activities for the Southwest Trenches Area RA is summarized below.

- Mobilizing equipment and personnel to the site;
- Conducting site setup activities including a biological survey; site feature protection; and establishing storage, decontamination, and work zone areas;
- Surveying of underground utilities followed by relocating and/or protecting any utilities that interfere with removal activities;
- Removing pavement, fencing, and vegetation that interferes with removal activities;
- Establishing a grid system over the entire RA area;
- Sampling and field analysis to determine the extent of surface soil chlordane contamination;
- Excavating chlordane-contaminated surface soil;

- Sampling and off-site laboratory analysis of surface soil to verify that the chlordane contamination has been removed;
- Trenching in a grid pattern to locate the waste disposal pits;
- Excavating and removing waste disposal cells;
- Segregating and sorting excavated material;
- Sampling and field/off-site laboratory analysis within excavation limits (i.e. sidewalls and bottoms) for verification that waste has been adequately removed (concurrent with excavation and sorting);
- Sampling and field/off-site laboratory analysis to delineate the vertical and horizontal extent of contamination within the excavation (as necessary);
- Preliminary evaluation (Phase I) to determine whether RAOs have been attained and if necessary calculate approximate volume and rough order-of-magnitude cost for additional excavation;
- Interfacing between DOE and regulatory agencies on Phase I data evaluation results;
- Short-term stockpiling of waste;
- Waste characterization and designation;
- Loading of waste into containers for storage;
- Sampling and off-site laboratory analysis of excavation limits for confirmation of attainment of RAOs;
- Backfilling and compacting of the excavations;
- Restoring site features including paving and fencing;
- Demobilizing equipment and personnel from site; and,
- Evaluating the analytical results, performing Phase II data evaluation and interfacing with DOE and regulatory agencies on the need for any additional action at the Site.

1.5.2 Ra/Sr Treatment Systems Area

The sequence of RA activities at the Ra/Sr Treatment Systems Area is summarized below (note: work associated with Areas I and II may not be completed during the same mobilization. WA will act as the "contractor" referenced in the specifications associated with this scope of work).

- Site Specific Training for personnel;
- Readiness Review;
- Surveying underground utilities followed by relocating and/or protecting any utilities that interfere with removal activities;
- Surveying aboveground utilities and relocating and/or protecting utilities that interfere with removal activities;

- Mobilizing equipment and personnel to the site;
- Conducting site setup activities including site feature protection and establishing storage, work zone, and decontamination areas;
- Area I
    - Remove the radium leach trench;
    - Sampling and on-site laboratory analysis to define the horizontal extent of contamination around three drywells;
    - Drill out and remove the three radium drywells;
    - Removing the Domestic Septic System No. 2 and Ra-226 distribution box and associated piping (Radium piping will be removed to the east up to the fence separating Area I from Area II; piping to the east of the fence will be removed during Area II activities);
    - Segregating and sorting of excavated material including soil, gravel, lumber and concrete (concurrent with excavation);
- Area II
    - Removing the storm-water protection cover from the tanks, pavement, fencing, and vegetation that interferes with removal activities;
    - Excavating and removing all piping associated with the strontium (Imhoff) and radium tanks;
    - Liquid and sludge waste removal from tanks;
    - Excavating and removing the strontium leachfields;
    - Excavating and removing the strontium treatment tanks;
    - Excavating and removing the radium treatment tanks;
    - Segregating and sorting of excavated material including soil, gravel, lumber and concrete (concurrent with excavation);
    - Crushing and demolishing tanks and concrete structures (concurrent with excavation);
- Short-term storage of waste;
- Waste characterization (concurrent with waste generation) and designation;
- Loading of waste into containers for offsite transportation and disposal;
- Sampling and field/off-site laboratory analysis within excavation limits to determine whether driver COCs have been adequately removed (concurrent with excavation and sorting);
- Phase I data evaluation to determine whether RAOs have been achieved and, if necessary, calculate approximate volume and rough order-of-magnitude cost for additional excavation;

- Interfacing with DOE and regulatory agencies on results of Phase I data evaluation;
- Sampling and off-site laboratory analysis of excavation limits for confirmation of attainment of RAOs;
- Backfilling and compacting of the excavations;
- Restoring site features including paving and fencing;
- Demobilizing equipment and personnel from site, and,
- Evaluating the analytical results, performing Phase II data evaluation and interfacing with DOE and regulatory agencies on the need for any additional action at the Site.

1.5.3 Domestic Septic System Areas

As described in the EE/CA, only Septic Systems No. 3 and 6 require removal actions. Domestic Septic System No. 2 will be removed as part of the Ra/Sr Treatment System Area RA. The sequence of removal action activities at the two Domestic Septic System Areas is summarized below.

- Mobilizing equipment and personnel to the site;
- Conducting site setup activities including site feature protection and establishing storage, decontamination, and work zone areas;
- Surveying underground utilities followed by relocating and/or protecting any utilities that interfere with removal activities;
- Removing pavement that interferes with removal activities;
- Subsurface soil sampling and off-site laboratory analysis at Domestic Septic System No. 3 to confirm that no removal activities are required;
- Excavating and removing soil contamination associated with Domestic Septic System No. 6;
- Short-term stockpiling of soil;
- Waste characterization and designation;
- Loading soil into containers for disposal;
- Sampling and off-site laboratory analysis of excavation limits for confirmation of attainment of RAOs;
- Evaluating the analytical results and interfacing with DOE and regulatory agencies for the need of any additional action at the Site;
- Backfilling and compacting of the excavations;
- Restoring site features including paving and fencing; and,
- Demobilizing equipment and personnel from site.

1.6 Removal Action Uncertainty

The removal actions described above for each DOE area face several uncertainties associated with field conditions (i.e. volume, type, and extent of contamination) and logistical considerations. These uncertainties are summarized in Table 1-3. The proposed response measure in the event these uncertainty parameters are realized is also presented in Table 1-3.

1.7 Project Organization

Figure 1-1 presents the project organization chart for these RAs. The Quality Assurance Project Plan (WA, 1998b) presents the roles and responsibilities of the key personnel assigned to this project. The RA team consists of Weiss Associates (WA), its subcontractors including IT Corporation (IT) and Environmental Management Services (EMS), and other subcontractors. WA is responsible for the overall construction management, quality assurance and health and safety aspects of the project, while IT is responsible for performing the RA field activities safely and to appropriate quality standards. EMS provides waste management expertise and senior technical support in review of analytical data and overall quality of project.

1.8 Project Contacts

The following individuals are the contacts for this project:

Weiss Associates (WA)

Executive Sponsor – Richard B. Weiss, R.G., C.E.G.

Program Manager – Michael D. Dresen, R.G., C.E.G., C.H.G.

Project Manager – Robert O. Devany, R.G., C.E.G., C.H.G.

Project Task Leader – Alborz A. Wozniak, P.E.

Site Coordinator – James A. Martin

Project Health and Safety Manager – Jerry McHugh, P.E., C.I.H.

Project Quality Assurance Manager – Dolores Loll

IT Corporation (IT)

Program Manager – Gerhard Locke, P.E., Ph.D.

Task Manager – Kevin O'Leary

Radiological Safety Officer – Dave Ochs, OHST

Environmental Management Services (EMS)

Senior Technical Advisor – Salem Attiga, Ph.D.

Waste Specialist – Dawn Mitchell

1.9 Project Schedule

Figure 1-2 presents the planned RA activities in the Southwest Trenches, Ra/Sr Treatment Systems, and Domestic System Areas. Detailed schedules for the Southwest Trenches RA, the Ra/Sr Treatment Systems Area I RA, and the Ra/Sr Treatment Systems Area II RA are provided in Figures 1-3, 1-4, and 1-5, respectively.

Table 1-1. Summary of Risk-Based Action Standards for Carcinogenic Compounds in Surface Soil at the 10^{-6} Risk Level

		Risk-Based Action Standards			
Analyte	**Background Activity (mg/kg)[1]**	**Scenario 1 10^{-6} Risk (mg/kg)**	**Scenario 2 10^{-6} Risk (mg/kg)**	**Scenario 3 10^{-6} Risk (mg/kg)**	**1998 PRG Residential 10^{-6} risk (mg/kg)**
4,4'-DDD	None	7.9	9.4	70,000	2.4
4,4'-DDE	None	5.6	9.0	61,000	1.7
4,4'-DDT	None	5.6	30	23,000	1.7
Alpha-BHC	None	0.30	0.0075	8,400	0.086
Alpha-Chlordane	None	1.5	0.80	5.9	1.6 total
Aroclor-1260	None	0.25	4.9	120	0.2
Benzene	None	0.23	0.015	NC	0.62
Benzo(a)anthracene	None	2.6	1.2	30,000	0.56
Benzo(a)pyrene	None	0.26	0.24	1,300	0.056
Benzo(b)fluoranthene	None	2.6	3.3	12,000	0.56
Benzo(k)fluoranthene	None	26	27	100,000[2]	5.6
Bis(2-Ethylhexyl)phthalate	None	136	7.7	8.6	3.2
Cadmium (Cd)	0.51	4,800	100,000[2]	100,000[2]	9.0
Carbazole	None	95	2.2	100,000[2]	22
Carbon Tetrachloride	None	0.22	0.055	NC	0.23
Chlordane	**None**	**1.5**	**0.78**	**5.9**	**1.6 total**
Chromium (Cr)	199/125~~160~~	720	100,000[2]	100,000[2]	210
Chromium, Hexavalent (Cr+6)	**0.054**	**100**	**100,000[2]**	**23,000**	**0.2**
Chrysene	None	260	20	100,000[2]	6.1
Delta-BHC	None	0.30	0.013	0.21	0.30
Dibenzo(a,h)anthracene	None	0.26	0.54	260	0.056
Dieldrin	None	0.12	0.015	4,100	0.028
Formaldehyde	None	220	NC	NC	8200
Gamma-BHC	None	1.5	0.030	35,000	0.42
Gamma-Chlordane	None	1.5	0.81	6.4	1.6 total

Notes:

[1] Background concentration calculations are presented in Appendix C of the Work Plan. 199/125 represents stratified concentration by depth, 0-4ft/>4 ft bgs.

[2] Risk not exceeded for free-phase interstitial compound. Assumes 10% by weight (i.e., 100,000 mg/kg) as the maximum soil concentration.

None = Analyte is not present in background.
NC = Exposure pathway incomplete for compound.
+D = and Daughter Products
Scenario 1 - On-Site Researcher, Scenario 2 - East-Side Residential Farmer, and Scenario 3 - South-Side Residential Farmer.
Highlighted and Blocked Compounds are the Removal Action "Driver" Compounds.

Table 1-1. Summary of Risk-Based Action Standards for Carcinogenic Compounds in Surface Soil at the 10^{-6} Risk Level (continued)

		Risk-Based Action Standards			
Analyte	**Background Activity (pCi/g)[1]**	**Scenario 1 10^{-6} Risk (pCi/g)**	**Scenario 2 10^{-6} Risk (pCi/g)**	**Scenario 3 10^{-6} Risk (pCi/g)**	**1998 PRG Residential 10^{-6} risk (pCi/g)**
Radionuclides					
Americium-241	<0.014	17	0.092	16,000	1.9
Carbon-14	<0.13	4,200	9,500	7,000	770
Cesium-137+D	0.102/0.00695	0.10	200,000	25,000	0.020
Cobalt-60	<0.006	0.022	32,000	5,800	0.0043
Lead-210+D	1.6	9.6	40	40	0.78
Plutonium-241 +D	<0.50	600	3.2	2,200,000	150
Radium-226+D	**0.752**	**0.0042**	**1,100**	**1,100**	**0.0062**
Strontium-90+D	**0.056**	**10**	**290,000**	**34,000**	**14**
Thorium-228+D	0.627/0.771	0.032	2,000	1,600	0.041
Thorium-232	0.63/0.80	0.022	3,800	2,200	24
Thorium-234 (U-238+D)	0.78	3.2	88,000	63,000	0.69
Tritium	<1.2	130,000	5.4	2,500,000	11,000
Uranium-235+D	0.063	0.79	0.15	32,000	0.16

Notes:

[1] Background concentration calculations are presented in Appendix C of the Work Plan. 199/125 represents stratified concentration by depth, 0-4ft/>4 ft bgs.
[2] Risk not exceeded for free-phase interstitial compound. Assumes 10% by weight (i.e., 100,000 mg/kg) as the maximum soil concentration.
None = Analyte is not present in background.
NC = Exposure pathway incomplete for compound.
+D = and Daughter Products
Scenario 1 - On-Site Researcher, Scenario 2 - East-Side Residential Farmer, and Scenario 3 - South-Side Residential Farmer.
Highlighted and Blocked Compounds are the Removal Action "Driver" Compounds.

Table 1-1. Summary of Risk-Based Action Standards for Carcinogenic Compounds in Surface Soil at the 10^{-6} Risk Level (continued)

		Risk-Based Action Standards			
Analyte	**Background Activity (mg/kg)[1]**	**Scenario 1 10^{-6} Risk (mg/kg)**	**Scenario 2 10^{-6} Risk (mg/kg)**	**Scenario 3 10^{-6} Risk (mg/kg)**	**1998 PRG Residential 10^{-6} risk (mg/kg)**
Heptachlor	None	0.42	0.17	14,000	0.099
Heptachlor Epoxide	None	0.21	0.00057	1,800	0.049
Indeno(1,2,3-cd)pyrene	None	2.6	4.9	4,600	0.56
Lead (Pb)	9.5	3.0	0.044	19	130
Mercury (Hg)	**3.94/0.248**	**16,000**	**15**	**540**	**22**
Methylene Chloride	None	7.2	0.13	NC	8.5
Pentachlorophenol	None	16	13	100,000[2]	2.5

Notes:

[1] Background concentration calculations are presented in Appendix C of the Work Plan. 199/125 represents stratified concentration by depth, 0-4ft/>4 ft bgs.
[2] Risk not exceeded for free-phase interstitial compound. Assumes 10% by weight (i.e., 100,000 mg/kg) as the maximum soil concentration.
None = Analyte is not present in background.
NC = Exposure pathway incomplete for compound.
+D = and Daughter Products
Scenario 1 - On-Site Researcher, Scenario 2 - East-Side Residential Farmer, and Scenario 3 - South-Side Residential Farmer.
Highlighted and Blocked Compounds are the Removal Action "Driver" Compounds.

Table 1-2. Summary of Risk-Based Action Standards for Non-Carcinogenic Compounds in Surface Soil at a Hazard Index of 1.0

Analyte	Background Concentration (mg/kg)[1]	Risk-Based Action Standards Scenario 1 (mg/kg)	Scenario 2 (mg/kg)	Scenario 3 (mg/kg)
2-Butanone (MEK)	None	710	12	NC
Acenaphthene	None	41,000	250	100,000[2]
Acetone	None	830	1.7	1,900
Anthracene	None	100,000[2]	1,400	100,000[2]
Antimony (Sb)	1.4	680	0.30	100,000[2]
Barium (Ba)	211/294	100,000[2]	53	100,000[2]
Benzo(g,h,i)perylene	None	20,000	9,100	100,000[2]
Cadmium (Cd)	0.51	850	0.38	100,000[2]
Chromium (Cr)	199/125	100,000[2]	760	100,000[2]
Chromium, Hexavalent (Cr+6)	**0.054**	**8,500**	**3.8**	**740**
Copper (Cu)	48.8/61.8	63,000	28	610,000
Dibenzofuran	None	2,700	14	100,000[2]
Diethyl Phthalate	None	100,000[2]	220	100,000[2]
Di-n-Butylphthalate	None	68,000	890	3,300
Di-n-Octylphthalate	None	14,000	28,000	4,900
Endosulfan I	None	4,100	29	100,000[2]
Endosulfan Sulfate	None	4,100	26	100,000[2]
Ethyl Benzene	None	2,400	10	NC
Fluoranthene	None	27,000	1,800	100,000[2]
Fluorene	None	27,000	170	100,000[2]
Formaldehyde	None	100,000	1.7	10,000
Manganese (Mn)	750	52,000	36	100,000[2]
Mercury (Hg)	**3.94/0.248**	**510**	**0.22**	**6.4**
Methoxychlor	None	3,400	100	100,000[2]
Naphthalene	None	27,000	39	100,000[2]
Phenanthrene	None	20,000	1,200	100,000[2]
Pyrene	None	20,000	490	100,000[2]
Selenium (Se)	1.2	8,500	58	100,000[2]
Silver (Ag)	0.55	8,500	3.8	100,000[2]
Styrene	None	710	76	NC
Toluene	None	920	19	NC
Xylenes (Total)	None	1,700	700	NC
Zinc (Zn)	72.4/93.1	100,000[2]	3,400	100,000[2]

Notes:
[1] Background concentration calculations are presented in Appendix C of the Work Plan. 199/125 represents stratified concentration by depth, 0-4ft/>4 ft bgs.
[2] Risk not exceeded for free-phase interstitial compound. Assumes 10% by weight (i.e., 100,000 mg/kg) as the maximum soil concentration.
None = Analyte is not present in background.
Scenario 1 - On-Site Researcher, Scenario 2 - East-Side Residential Farmer, and Scenario 3 - South-Side Residential Farmer
Highlighted and Blocked Compounds are the Removal Action "Driver" Compounds.

Table 1-3. Uncertainty Matrix for Removal Actions in the Southwest Trenches, Ra/Sr Treatment Systems and Domestic Septic System Areas

Uncertainty Parameter	Condition	Impact	Proposed Response Measures
Waste volume	Waste volume is greater than currently estimated.	• Increase in waste volume will have a direct impact on RA budget and schedule. • Increase in waste volume will cause a shortage of space for waste handling and storage • Increase in waste volume will cause an increase in sampling and analysis and result in delays in backfilling of excavations	• Re-estimate the waste volume upon uncovering of disposal cells. • Inform DOE once 80% of estimate volume is reached, with cost and schedule projections in excess of 100% if estimated volume. • Re-evaluate cost, effectiveness, and implementability of RA beyond 100% of estimated volume and consider other RA technologies. • Continue RA if cost and schedule allow as decided by DOE/RPMs.
Lateral extent of contamination	The lateral extent of contamination is beyond the LEHR facility fenceline and/or undermines buildings.	• Schedule delays will result from coordination with the facility owners and in getting necessary permits for offsite excavation. • Contamination may be left in-place.	• Stop work in the area of the fenceline and buildings. • In the vicinity of the buildings: recommend no further excavation. • In the area of fenceline: re-evaluate contamination condition. Perform investigation offsite to delineate the vertical and lateral extent of contamination. This work will be performed under a separate scope of work.

Table 1-3. Uncertainty Matrix for Removal Actions in the Southwest Trenches, Ra/Sr Treatment Systems and Domestic Septic System Areas (continued)

Uncertainty Parameter	Condition	Impact	Proposed Response Measures
Vertical extent of contamination	The vertical extent of contamination is beyond the reach of conventional excavation equipment (20 feet below ground surface [bgs]).	• The project cost and schedule will be directly impacted due to work stoppage and technical complication described below. • Work will be stopped to mobilize more sophisticated equipment to the site. • The soil stability and material handling issues will become technically challenging.	• Stop work at 20 feet bgs and evaluate analytical results. • Collect confirmation samples based on the screening sample result evaluation. • Re-evaluate the RA alternative for other potential technologies.
Type of contamination	Mixed waste or hazardous waste is encountered during waste characterization.	• Schedule delays and cost increase will result from packaging, certification, and disposal of the mixed and hazardous waste.	• Store the waste onsite in accordance to DOE protocols and LEHR SOPs. • Recommend a disposal alternative and prepare waste manifests/certification forms. • Update the WMP and Site Treatment Plan as necessary.
Cultural and/or archeological resources	Cultural and/or archeological resources are encountered during excavation.	• The schedule of removal activities will be impacted.	• Follow provisions of CEQA Appendix K. • Contact local chapter of Native American Heritage Commission as applicable.
Stakeholders	Delay decision on completion of the RA.	• The excavation will remain open during the rainy season. • Rain may cause migration of residual contamination.	• Backfill all or part of excavation prior to the rainy season. • Rain proof and secure any remaining open excavations.

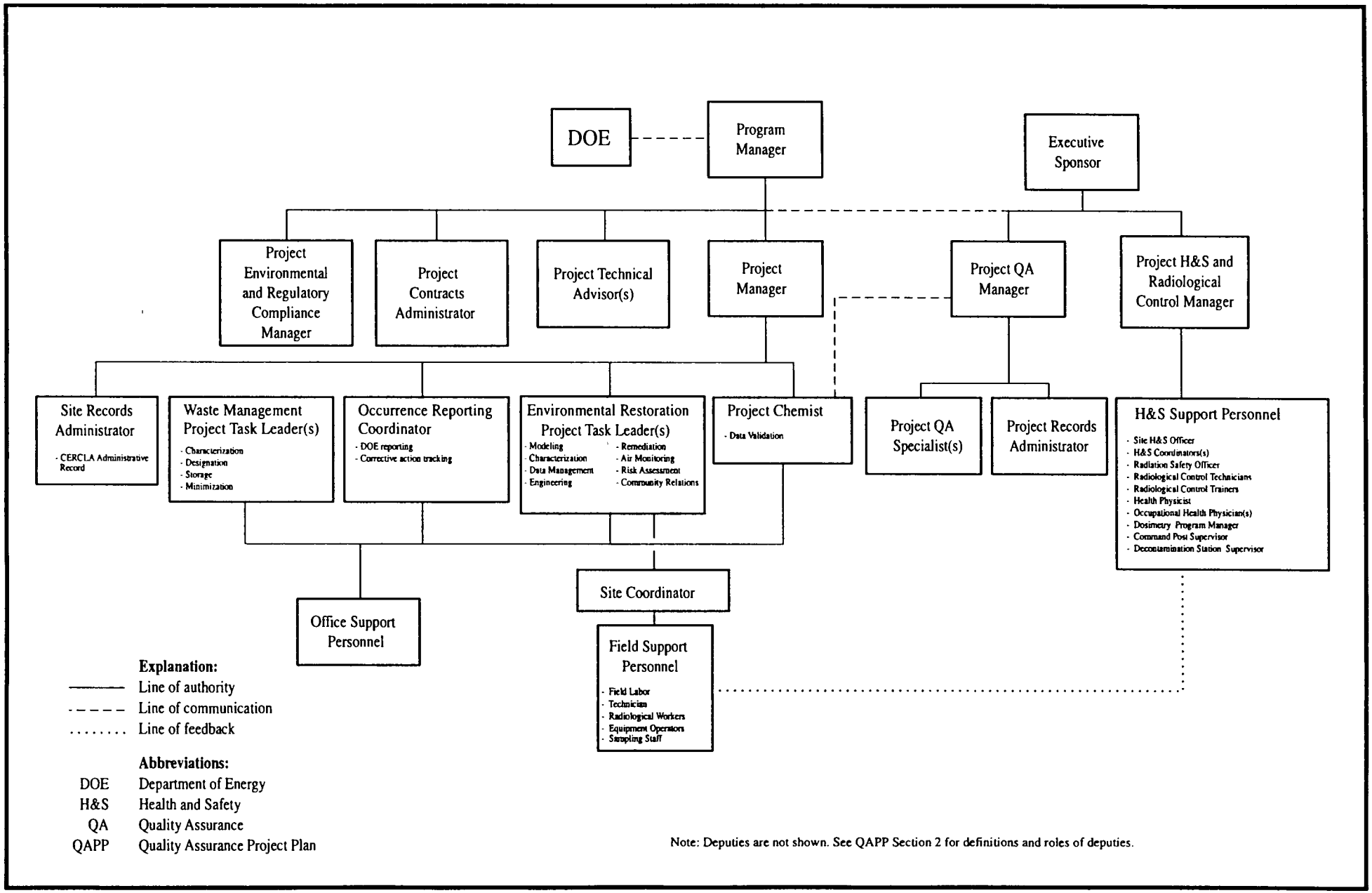

Figure 1-1. LEHR DOE Removal Action Organization Chart

(1) Waste Management, Shipment and Disposal Schedules and milestone do not include "Lab Pack" materials as described in the Waste Management Plan Update No. 1 that supports this Work Plan.

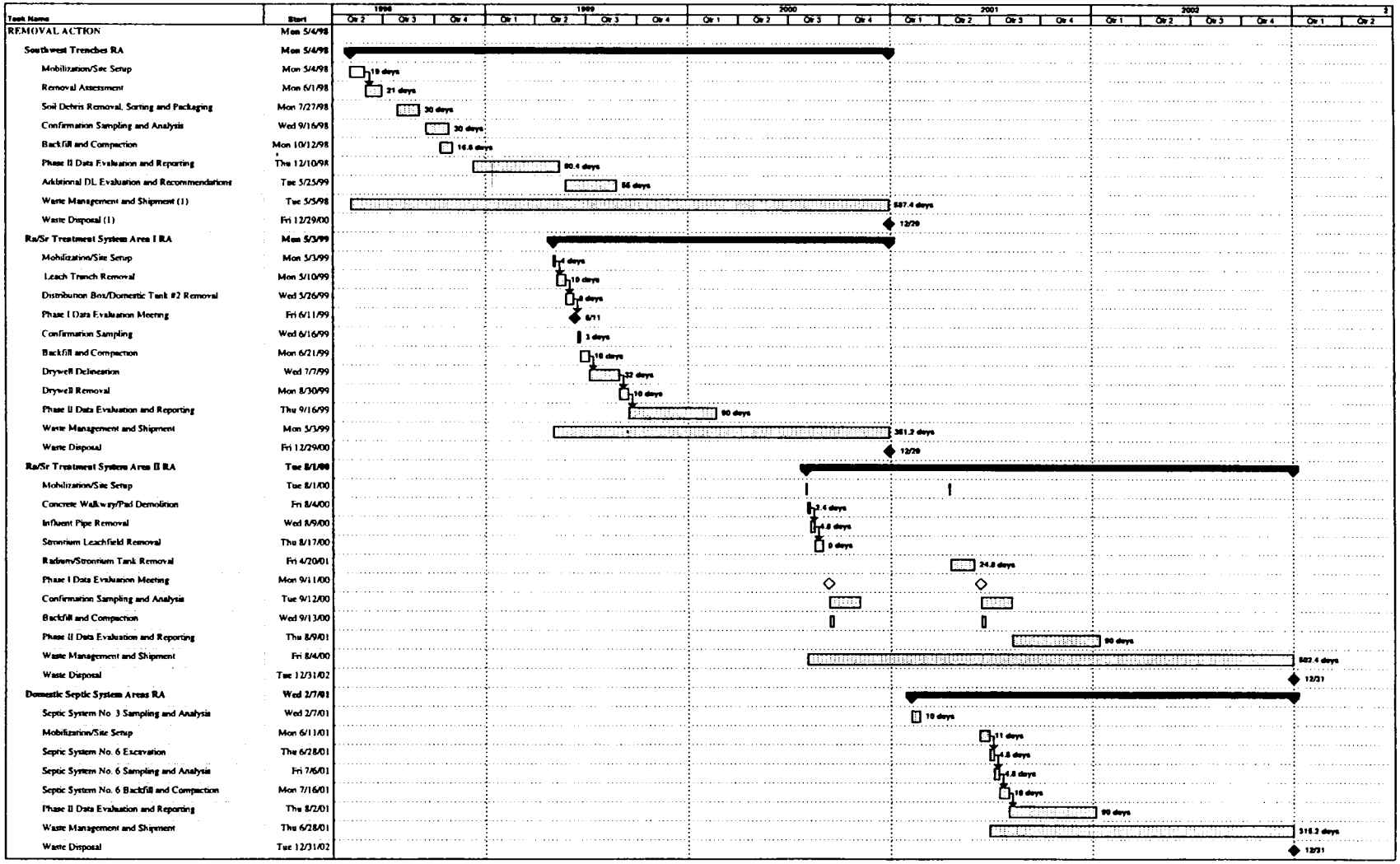

Figure 1-2. Planned RA Activities in the Southwest Trenches, Ra/Sr Treatment Systems, and Domestic System Areas

Task Name	Start	Finish
REMOVAL ACTION	Mon 5/4/98	Wed 12/9/98
Conduct RA at SW Trenches	Mon 5/4/98	Wed 12/9/98
Mobilization and Site Setup	Mon 5/4/98	Tue 7/7/98
Biological Survey	Mon 5/4/98	Thu 5/7/98
Mobilization	Mon 5/4/98	Tue 7/7/98
Site Setup	Mon 5/4/98	Thu 5/14/98
Clearing and Grubbing	Mon 5/4/98	Fri 5/22/98
Tree Trimming	Tue 5/12/98	Fri 5/15/98
Fence Demolition	Mon 5/11/98	Tue 5/12/98
Asphalt Removal	Mon 5/18/98	Fri 5/22/98
Utility Survey/Relocation	Mon 5/4/98	Thu 5/7/98
Protection of Site Features	Wed 5/20/98	Thu 5/21/98
Conduct Removal Assessment	Tue 5/26/98	Fri 6/26/98
Gridding	Tue 5/26/98	Wed 5/27/98
Chlordane Delineation	Thu 5/28/98	Mon 6/1/98
Chlordane Contamination Removal	Tue 6/2/98	Mon 6/8/98
Trenching for Waste Location	Mon 6/8/98	Fri 6/26/98
Trench Backfill and Compaction	Mon 6/8/98	Fri 6/26/98
Soil/Debris Removal	Mon 6/29/98	Tue 7/21/98
Soil/Debris Screening and Sorting	Mon 7/6/98	Mon 8/10/98
Waste Characterization	Mon 6/8/98	Tue 8/11/98
Soil/Debris Loading into Boxes and Packaging	Mon 7/13/98	Mon 8/17/98
Box Storage	Mon 7/13/98	Mon 8/17/98
Sampling and Analysis	Tue 6/30/98	Wed 12/9/98
Screening Sampling	Tue 6/30/98	Tue 7/21/98
Phase I Evaluation (Volume Analysis)	Mon 7/6/98	Fri 7/31/98
RPM/DOE Interface on Data Evaluation	Mon 8/3/98	Mon 8/3/98
Confirmation/Designated Level Sampling	Tue 8/4/98	Mon 8/10/98
Data Validation and Evaluation	Tue 8/11/98	Tue 10/13/98
Vadose Zone Modeling	Wed 10/14/98	Tue 10/27/98
Screening Risk Evaluation	Mon 10/12/98	Fri 10/30/98
Final Report Preparation (Phase II Evaluation)	Mon 10/5/98	Wed 12/9/98
RPM/DOE Interface on Data Evaluation	Mon 11/16/98	Mon 11/16/98
Utility Restoration	Fri 10/16/98	Fri 10/16/98
Backfill and Compaction	Thu 10/15/98	Thu 11/5/98
Site Restoration	Thu 11/5/98	Mon 11/9/98
Fence Installation	Thu 11/5/98	Mon 11/9/98
Pavement Repair	Thu 11/5/98	Mon 11/9/98
Site Grading	Thu 11/5/98	Thu 11/5/98
Demobilization	Mon 11/2/98	Mon 11/16/98
Removal Action Waste Management	Mon 5/4/98	Thu 11/5/98
Waste Disposal Plan Preparation	Tue 9/8/98	Mon 11/9/98

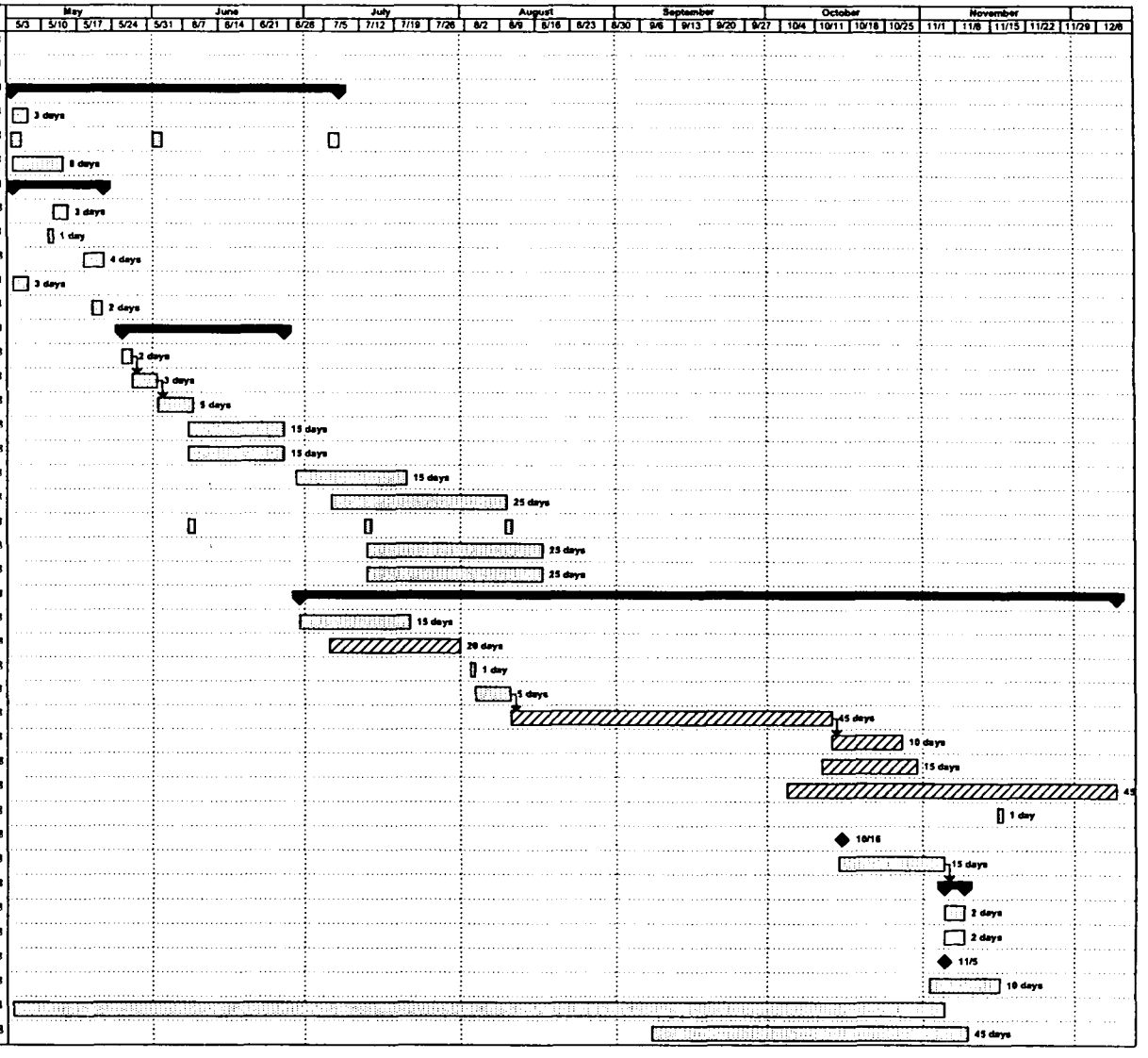

Figure 1-3 Removal Action Schedule for the Southwest Trenches Area

2. REMOVAL ACTION ACTIVITIES AT SOUTHWEST TRENCHES AREA

This section describes the field activities that will be performed during the RA at Southwest Trenches Area. Construction drawings in Appendix A are referenced as needed throughout this section.

2.1 Mobilization and Site Setup

The RA team will mobilize the equipment and personnel required for the RA to the site. All necessary utility connections and setup activities will also be conducted at this time. A description of equipment, list of personnel, and setup activities are presented below.

2.1.1 Equipment Mobilization

The RA team will mobilize all necessary equipment to complete the RA. Appropriate equipment will be selected, purchased or procured as necessary prior to mobilization. The expected construction equipment includes but is not limited to the following:

- Bobcat and wheel-mounted front-end loaders;
- 12 cubic yard dump truck;
- Pickup truck;
- Pickup truck with diesel fuel tank;
- Track-mounted hydraulic backhoe;
- Wheel-mounted hydraulic backhoe;
- 500 gallon water trailer with pump;
- Shaker screen;
- Remote/walk-behind sheepsfoot roller;
- Hydraulic trench shores and trench plates;
- All-terrain forklift;
- Air compressor;
- Vibratory plate attachment;
- Construction hand tools including miscellaneous shovels, picks, and saws; and,
- Air and radiological monitoring equipment.

The following equipment will be utilized during sampling and analysis activities:

- Hand augers, slide hammers, trowels, and post-hole diggers;
- Gamma spectroscopy field analytical instrument for radium analysis;

- Organic vapor monitoring equipment;
- Chlordane field analytical testing instruments; and
- Beta scintillation detector for strontium analysis.

In addition, subcontractors used for asphalt cutting, fence removal, tree cutting and shredding, and utility detection will mobilize necessary equipment for their activities.

2.1.2 Personnel Mobilization

The RA team will mobilize the following personnel:

- Site Health and Safety Officer (SHSO) (WA)
- Construction Engineer (WA)
- Project Quality Assurance Specialist (PQAS) (WA)
- Site Health and Safety Coordinator (SHSC) (WA/IT)
- Radiological Safety Officer (RSO) (IT)
- Field Engineer (IT)
- Construction Foreman (IT)
- Radiological Control Technicians (RCTs) (IT)
- Equipment Operators (IT)
- Laborers (IT)

These personnel will be responsible for performing the work and ensuring that work is being conducted according to the WP. While implementing the project activities, the following personnel may be mobilized to the site on an as needed basis but will not be present for the duration of field activities:

- Project Manager (WA)
- Project Task Leader (WA)
- Task Manager (IT)
- Senior Technical Consultant (IT)
- Field Technicians and Geologists (WA)
- Field Chemist (contractor)
- Waste Specialist (EMS)
- Senior Technical Advisor (EMS)
- Quality Assurance Specialist (IT/WA)
- Subcontractors (IT/WA)

2.1.3 Site Setup

In preparation for removal operations, all necessary setup activities will be performed. Setup activities will begin by establishing the boundaries of the “RA area.” Project Drawing C-1 shows the

proposed RA area. The Western Dog Pens define the eastern boundary of the RA area. The southern and western boundaries are defined by the Institute of Toxicology and Environmental Health (ITEH) facility fenceline. The northern boundary is defined by UCD research facilities (Building H215, Clinical Pathology and Building H216, Specimen Storage).

Setup activities will include securing the site perimeter using temporary fencing or other barricades; establishing temporary facilities such as a decontamination area, material and equipment storage area, soil/gravel/waste temporary stockpile areas, and parking areas; and implementing site security and dust control activities. In addition, work zones including the support zone, contamination reduction zone, and exclusion zone will be defined and secured. Site setup will be performed in accordance with Specifications Section 01010.

2.2 Site Preparation

Prior to conducting intrusive activities, environmental control measures including a biological survey will be implemented. In addition, the RA area will be surveyed for utilities, physical barriers and other structural constraints such as fences and trees. Features that are within the RA area will either be removed or protected. The following section describes the site preparation activities.

2.2.1 Environmental Protection Measures

In the Southwest Trenches Area, control measures will be implemented to minimize environmental pollution and damage that may result from the construction operations. Control measures shall conform to the Specifications Section 01410. These measures are briefly described below.

2.2.1.1 Water Resources

All construction activities will be conducted to minimize pollution of surface and ground waters. Since the RA is planned during the dry season, the threat of storm runoff is minimal. However, straw bales will be installed to control sediment runoff from the construction area.

2.2.1.2 Land Resources

A biological survey of the cleanup area will be performed to ensure that all identified sensitive habitats are clearly marked. The biological survey will consist of review of the existing Draft Final Ecological Scoping Assessment for DOE Areas Report (WA, 1997c) and a site survey. This work will be performed in accordance with Section 7(c) of the Endangered Species Act. A qualified entomologist and biologist will survey the site to locate and confirm the sensitive habitats identified in the Ecological Scoping Report. A summary report will be prepared that will propose protection measures in the event any habitats within the RA areas may be impacted by field activities. For example, in areas where sensitive vegetation is present, silt fences and hay bales will be used to minimize impact of storm runoff and erosion. A copy of the report will be submitted to the U.S. Fish and Wildlife Services.

Land resources that have been identified within the Southwest Trenches Area and will be protected during the RA activities include: three ground water monitoring wells, one fire hydrant, and the wash-down pad building. Fencing or other barricades will be used to protect these features during the RA.

All unprotected erodible soil, existing or generated during the RA, will be kept covered to an extent feasible without interfering with construction activities. To protect against storm runoff, berms will be installed as necessary to divert runoff and prevent excavations from filling with water.

2.2.1.3 Air Resources

Particulate air emissions estimation and modeling were performed to evaluate emission rates and COC concentrations in air associated with planned construction activities in the Southwest Trenches Area. The results of the modeling are presented in Appendix E. The modeling results are briefly summarized below.

Estimates of emissions of chlordane, radionuclides and metals resulting from excavation-related activities planned for the LEHR remediation efforts in the Southwest Trenches Area are presented in Tables E-1, E-2, and E-3 of Appendix E, respectively. The maximum, worst-case fence-line concentration of chlordane was estimated to be 1.7 x 10^{-3} micrograms per cubic meter ($\mu g/m^3$), assuming excavation activities, uncontrolled soil/waste stockpiling and soil loading for off-site transport all occur simultaneously. However, this concentration is below the US EPA Region 9 Preliminary Remediation Goal (PRG) of 5.2 x 10^{-3} $\mu g/m^3$, which was calculated assuming a 10^{-6} cancer risk resulting from a chronic inhalation exposure.

The maximum, worst-case fence-line concentration of radionuclides was estimated for the two radionuclides of most concern at the LEHR site, radium-226 and strontium-90. Concentrations were estimated for radium-226 and strontium-90 to be 1.4 x 10^{-15} Curies per cubic meter (Ci/m^3) and 1.3 x 10^{-14} Ci/m^3, respectively. The maximum, worst-case fence-line concentration were estimated assuming excavation activities, uncontrolled soil/waste stockpiling, soil screening/sorting, and soils loading for off-site transport occur simultaneously. The estimated committed effective dose equivalent based upon maximum estimated ambient air radionuclide concentrations were 3.3 x 10^{-3} mrem/yr for radium-226 and 4.6 x 10^{-3} mrem/yr for strontium-90 (Table E-4 and E-5). This results in an estimated committed effective dose equivalent for radium-226 and strontium-90 of 0.03% and 0.05% respectively. This is less than 1% of the standard prescribed in §61.02 of 0.1 mrem/yr. Therefore the Southwest Trenches area remediation activities are exempt from the application requirements 40 CFR Part 61 Subpart H under §61.98(b), regardless of the applicability of 40 CFR Part 61 Subpart H §61.96 “Applications to Construct or Modify” requirements to remediation activities.

The maximum, worst-case fence-line concentration was also estimated for the two metals of most concern at the LEHR site, lead and mercury. Concentrations were estimated to be 6.2 x 10^{-3} $\mu g/m^3$ and 2.9 x 10^{-3} $\mu g/m^3$, respectively. The maximum, worst-case fence-line concentrations were estimated using the same models and assumptions applied for the radionuclide estimates. The estimated concentration of lead is below the 8.3 x 10^{-2} $\mu g/m^3$ concentration for the 10^{-6} risk level calculated using the draft Unit Risk Factor for lead of 1.2 x 10-5 $(\mu g/m^3)^{-1}$, from "Proposed Identification of Inorganic Lead as a Toxic Air Contaminant" (Cal EPA, March 1997). The mercury

concentration is below the US EPA Region 9 PRG of 3.1 x 10^{-1} μg/m^3, which was calculated assuming a 10^{-6} cancer risk resulting from a chronic inhalation exposure (EPA, 1996).

It is important to note that the screening level models applied predict worst-case, 1-hour maximum concentrations, and that excavation activities will occur only for a limited time. Additionally, screening model results indicate that 1-hr contaminant particulate concentrations in air will be below levels of concern. Appropriate engineering controls, including dust suppression using water and sound construction practices, will be applied, however, to further reduce potential air impacts to on-site workers and facility researchers.

2.2.1.4 Archeological and Cultural Resources

No known cultural or archeological resources have been identified in the vicinity of the site during previous environmental and archeological investigations (UCD, 1996). However, animal bones have been observed among the waste buried in the Southwest Trenches Area (IT, 1996). If during excavation, any potential resources are discovered or found all activities that may damage or alter such resources will be temporarily suspended. A qualified anthropologist and archeologist will be on standby in the event of such a discovery to expedite characterization and data processing. In the event that cultural resources are uncovered, the mitigative measures identified in the California Environmental Quality Act (CEQA) Appendix K will be followed to the extent applicable. Excavation will resume only after proper removal and handling of the resource.

2.2.2 Clearing and Grubbing

In the Southwest Trenches Area, expected clearing and grubbing activities will consist of asphalt removal, fence demolition, tree trimming, and general surface grubbing, as described below.

2.2.2.1 Asphalt Removal

As shown on Drawing C-2, the pavement on the north and east side of the Southwest Trenches Area will be removed to facilitate trenching and excavation activities. Pavement will be cut, broken and removed along with associated aggregate base. Pavement removal activities will be conducted in accordance with Specification Section 02100. The removed asphalt will be crushed and mixed with the base coarse. This material will be stored at the Cobalt-60 field for use during future pavement repair work.

2.2.2.2 Fence Demolition

Approximately 160 linear ft (LF) of fenceline located along the northern side of the cleanup area will be removed to provide access for trenching and excavation equipment. Fence removal will be performed in accordance with Specification Section 02100.

2.2.2.3 Tree Trimming and Removal

Several trees located within the cleanup area may interfere with excavation activities. Drawing C-2 shows the location of these trees. Specifically, two trees on the northern side of the area are in the path of the exploratory trenching activities and will be removed. In addition, several trees located along the property fenceline to the south and west of the cleanup area will be trimmed

to allow for heavy equipment access. Downed trees and trimmed branches will be cut into manageable pieces, shredded and stored on-site for future use or disposal as necessary.

UCD Grounds Division personnel will perform tree and branch cutting. The necessary permit application will be completed to request UCD to remove the trees.

2.2.2.4 Grubbing

Vegetation and general debris from the surface of the Southwest Trenches Area will be cleared in preparation for removal activities. This work will be performed using an excavator and a front-end loader. Due to limited vegetation, this surface material will be stockpiled along with the overburden soil from excavation activities in the paved aisles within the Western Dog Pens. Drawing C-1 presents the stockpile locations in the Western Dog Pens area.

2.2.3 Utility Relocation

Underground utilities within the cleanup area will be marked prior to implementation of removal activities. Subsurface utility identification will be performed in three phases. First all available site utility drawings will be reviewed. Second, the Underground Services Alert (USA) system will be utilized to locate underground utilities in the field. Finally, UC Davis personnel will identify the locations of the utilities in the field. No intrusive activity will commence without prior utility clearance of the area.

As shown on Drawing C-2, a sanitary sewer line, a storm drain line, and an abandoned water line appear to be within the cleanup area. It is possible that other utilities also exist that may be impacted by the RA.

Active utility lines that will be impacted by the RA will be rerouted either temporarily or permanently prior to the initiation of the RA. Utility rerouting will be performed in accordance with Specification Section 02222.

2.3 Removal Assessment

Prior to conducting removal activities in the Southwest Trenches Area, two waste delineation tasks will be performed. The first task involves delineating the extent of chlordane contamination in surface soil and removing the contaminated soil. The second task involves locating the waste disposal cells throughout the cleanup area, as described below.

2.3.1 Surface Soil Contamination Delineation

Existing analytical results and information available on the historical practices at the site indicate that the southwest corner of the Southwest Trenches Area was used as a chlordane storage and dispensing area. Several detections of chlordane above the 10^{-6} RBAS of 0.78 mg/kg were identified in the southwest corner of the site, where chlordane was reportedly applied for flea control,

at depths of up to 3 ft below ground surface (bgs) (WA, 1998a). To better define the extent of chlordane contamination in the RA area, a sampling and analysis plan has been developed that will focus on collecting samples from the surface of the site and analyzing them for chlordane using field analytical methods. The SAP presents a detailed description of the sampling strategy for this task.

The extent of chlordane contamination requiring excavation will be determined by comparing the sampling results with the chlordane RBAS level. Any detection above the cleanup criteria will result in excavation.

In response to requests from DTSC, the surface soil samples collected in the 30 ft grid pattern will also be analyzed for Cesium-137 (Cs-137), Ra-226, and Sr-90. The on-site field instrumentation will be utilized to perform these analyses. The SAP presents the associated sampling and analysis procedures.

2.3.2 Surface Soil Contamination Excavation

Once the extent of chlordane contamination has been defined, a backhoe will be utilized to remove the soil to a maximum depth of 12 inches below detected contamination. The initial excavation area will be up to 10-foot by 10-foot square around the detection. This initial grid size is based on one-half the distance between grid nodes where delineation samples will be collected. Additional sampling may be used to more accurately define the extent of soil contamination and reduce the volume of excavated soil. No further excavation will be conducted so long as the surrounding sample results are below the RBAS. Excavation activities will be performed in accordance with Specification Section 02220.

Waste handling and stockpiling will be conducted according to the WMP. Excavated soil will be moved to the Western Dog Pens area where it will be placed on and covered with plastic sheeting. Material stockpiling is described in SOP 12.1.

2.3.3 Surface Soil Excavation Sampling and Analysis

Upon completion of excavation activities, sampling and analysis will be performed to verify that no additional excavation is required. Samples will be collected from all four sidewalls and the bottom of the excavation and analyzed for chlordane using the field analytical method. The construction engineer may request additional sampling based on actual field conditions. If the field results indicate that the chlordane cleanup criterion has been attained, then final confirmation samples will be collected from the excavation and analyzed for organochlorine pesticides using laboratory analytical methods. The SAP presents the details of this sampling and analysis activity.

Additional excavation will be performed in the direction of samples with detections of chlordane greater than the cleanup criterion. Additional excavation will be conducted by removing an additional foot of soil in the direction of contamination; five ft to either side of sidewall hits or in a 10 ft by 10 ft area around excavation bottom samples. The size of excavation is based on one-half the distance between sample locations.

No backfilling will be performed until the end of removal activities. The excavation will be leveled to the extent necessary to allow excavation equipment access for the next step of removal assessment.

2.3.4 Waste Disposal Cell Identification

The second removal assessment task is to identify the location of the waste disposal cells by performing a systematic grid-pattern of exploratory trenching. Drawing C-3 depicts this grid pattern. Based on previous exploratory trenching results, it appears that a grid size of 10 ft by 10 ft is of sufficient size to ensure waste is located.

A 24-inch wide trench will be dug along the grid lines in the north-south and east-west directions. Based on available data, the maximum depth of the trench (i.e. depth needed to expose buried waste) will not exceed 6 ft. The waste identification sequence is described below.

- A 24-inch wide trench will be excavated.
- Trenching will proceed in the horizontal direction until the limits of the cleanup area have been reached.
- Trenching will proceed in the vertical direction until the waste is encountered but no deeper than 6 ft below ground surface (bgs).
- Trench spoils will be temporarily placed next to the trench. Every effort will be made to ensure that each soil unit removed is returned to the same location.
- Waste locations will be surveyed and logged in a field notebook.
- An engineering stake will be placed in the ground when waste cells are identified to indicate the depth below ground surface, and type of waste encountered.
- At the completion of each trench line, trenches will be backfilled using the trench spoils.
- A 2x2 sodium iodide detector will be used to screen the soil piles for gamma emission prior to backfilling.
- In areas where no waste has been detected, the trench backfill will be compacted using a sheepsfoot roller.
- Compaction testing will be performed to ensure proper compaction.
- In areas where waste has been detected, no compaction will be performed.

Excavation, backfilling and compaction will be performed in accordance with Specification Section 02220.

2.4 Waste Removal and Handling

Waste removal and handling activities include waste excavation and removal, segregation and sorting, stockpiling, container loading and packaging, and storage. Each activity is described below. The WMP provides additional detail on waste management activities.

2.4.1 Excavation and Removal

Excavation will begin at waste disposal cells located in the southwest corner of the site and proceed in a northeasterly direction. To minimize mixing of the waste matrix with potentially uncontaminated native soil, the excavation and removal process will be performed in lifts. The following steps will be taken during excavation activities.

The first step will be to carefully remove the overburden soil from the top of the waste. The overburden material will be stored in a separate pile so that it can be characterized for possible reuse as backfill. The thickness of the overburden soil layer may vary from 2 to 5 ft and may be a significant volume of uncontaminated soil. A 2x2 sodium iodide detector will be utilized to screen the excavated soil as it is being stockpiled. The proposed area for overburden soil storage is the south side of the Western Dog Pens. If the screening of overburden soil indicates that it is contaminated, it will be properly contained (e.g., covered stockpile, B-25 box) and characterized for disposal.

The next step consists of removing the waste matrix. Previous investigations indicate that the waste may extend to a depth of 12 ft bgs and typically consists of gravel intermixed with laboratory wastes including sharps, bones, and other solid waste such as pipes, wood, and plastic bags. The excavator bucket will be used to bring all waste to the surface where it will be placed in a temporary stockpile near the excavation. Excavation activities will be performed according to Specification Section 02220.

Once the final extent of waste has been reached, the excavator will scrape the sides and floor of the excavation and remove an additional 6 inches of soil from the excavation to ensure that contaminated soil immediately adjacent to the waste is also removed. Screening sampling will be performed to guide the excavation activities beyond this point. The SAP describes the screening sampling and additional excavation decision process. Sample collection will be biased towards locations where waste containers or other suspect waste items are discovered.

Temporary shoring will be used as necessary to stabilize trench walls. The shoring system will be designed for personnel entry into the excavations. Temporary shoring of the excavations will be performed using hydraulic shoring systems which consist of heavy-duty hydraulic walers and timber or fiberglass panels sized according to trench dimensions. A shoring plan will be prepared by the construction contractor and approved by the field engineer prior to use on-site.

2.4.2 Segregation and Screening

Based on the requirements of the waste disposal facilities, laboratory waste items such as sharps, containers with liquids intact, and biological waste, require segregation and screening from the excavated gravel and soil. This step is performed to reduce disposal costs and minimize the possibility of rejection of waste streams sent to the disposal facilities. A dump truck or a front-end loader will transport waste removed from the excavation to a designated screening and sorting area. Prior to loading the dump truck, each excavator bucket load will be visually inspected to survey the waste material removed from the trenches. Large objects such as wood, pipes, and pumps will be removed manually and set aside. Bottles containing liquids will also be removed to avoid breakage. These materials will be segregated and stored separately for prior characterization and packaging.

The sorting area will consist of a temporary stockpiling area for pre-screened waste, the screening mechanism, and a temporary stockpiling area for post-screened material. The proposed sorting location is the area between the Western and Eastern Dog Pens as shown on Drawing C-1. This area will be properly prepared, paved if necessary, to provide a stable surface for material handling activities.

Waste segregation and sorting will be performed in a manner that achieves the following:

- Waste can be visually inspected and inventoried for disposal;
- Waste material can be separated from soil and gravel to the extent practical; and,
- Waste handling by laborers is minimized while achieving the goals above.

To meet these requirements, a two stage mechanical vibratory screening system will be used to screen and sort the material. Laborers who will visually inspect the screened material will also operate the screening machinery. A water mist system will be used to suppress dust, as necessary. Pre-screened waste will be transported from the excavation area to the sorting area through the southernmost paved aisle in the western dog pens as shown on Drawing C-2. Screened and sorted material will be stockpiled or directly loaded into containers for shipment.

Based on the requirements of Envirocare waste disposal facility, only containers with liquids intact and large objects (greater than 8 inches dimensionals) will require segregation from the excavated gravel and soil. Soil removal and segregation will be conducted as described above with the following exception:

- The two stage mechanical vibratory screening system will not be used to screen and sort the sharp items such as needles and broken glass material.

Visual inspection at the point of excavation will initially be used to identify waste make up. As the waste is taken from the excavation and placed in temporary stockpiles, large objects and glass containers will be separated from the waste matrix by hand.

Sorted material will be temporarily stockpiled on plastic sheeting or other appropriate containers to avoid spreading of contamination. Excavated waste may be placed directly into B-25 boxes after the sorting. The B-25 boxes will be transferred using a front-end loader equipped with forks to a designated area for addition of filler material, inventory logging, box top installation, and final weighing.

2.4.3 Stockpiling

Soil and waste material that is removed from the excavation will be temporarily stockpiled for either characterization or sorting and screening as appropriate. Four solid waste streams may be generated during the Southwest Trenches RA. These include: 1) chlordane-contaminated soil, 2) potentially clean overburden soil, 3) laboratory waste and debris segregated from gravel and soil, and 4) contaminated gravel and soil. Chlordane-contaminated and overburden soil will be stockpiled separately in designated areas. These materials will remain stockpiled until a disposal option has been selected for them. The contaminated soil and gravel will be temporarily stockpiled during sorting and packaging operations. The segregated laboratory waste items will be placed in appropriate containers. The WMP discusses the packaging and stockpiling of these waste streams in more detail. The Western Dog Pen aisles will be used for stockpiling soil as shown on Drawing C-3.

All stockpiles will be placed on and covered with plastic sheeting when not in use according to SOP 12.1. In addition, runoff control measures will be implemented as described in Section 2.2.

2.4.4 Loading

Contaminated waste and gravel/soil will be loaded into B-25 boxes for transportation to the disposal facility. SOP 34.1, *Waste Processing and Packaging*, will be followed when loading B-25 boxes. All material will be characterized according to the WMP and the SAP. Loading of excavated material will be coordinated with excavation and sorting activities to reduce the time for low level waste material to remain stockpiled.

2.4.5 Storage

Waste generated during the RA will be stored on-site until off-site disposal options have been selected and approval is obtained from the facilities. All waste material including laboratory wastes and gravel/soil will be stored in B-25 boxes and inventoried. The proposed storage areas for the B-25 boxes are the paved aisles in the Western Dog Pens area.

Chlordane-contaminated soil will remain in stockpiles until characterization results are available and an appropriate disposal option is selected. Plastic sheeting will be used to cover the piles and maintenance will be conducted to ensure adequate cover and protection of the piles. Berms will be integrated into the underlying and cover layers surrounding the stockpiles to control surface water erosion and to maintain the stockpiles within a controlled area. Similarly, the overburden soil will remain in stockpiles until a final use has been selected.

Liquid waste generated during decontamination of personnel and equipment will be contained in baker tanks, drums or other approved containers and stored within the Western Dog Pens until a proper disposal option has been selected for it.

2.5 Sampling and Analysis

Sampling and analysis activities associated with the Southwest Trenches Area RA are divided into the following categories:

- Sampling and field analysis to define the extent of chlordane contamination;
- Confirmation sampling and off-site laboratory analysis to verify removal of chlordane-contaminated soil;
- Screening sampling and field analysis to guide the excavation activities;
- Confirmation sampling and off-site laboratory analysis to ensure that cleanup criteria have been attained within the limits of the excavation (including "Hot Spot" sampling);
- Sampling and off-site laboratory analysis to determine whether designated levels have been attained; and
- Waste characterization sampling and analysis.

Each sampling and analysis activity has a specific objective and has been designed to achieve that objective. The SAP presents a detailed discussion of these objectives, sampling strategies, and methodologies. The first two sampling activities relate to chlordane contamination and are discussed in Section 2.3. The remaining sampling and analysis activities are summarized below.

2.5.1 Excavation Screening Sampling and Analysis

Sampling and analysis will be performed in conjunction with excavation activities to determine when excavation should cease. These samples are called "screening samples" and will be collected from the sidewalls and floor of the excavation on a systematic basis as described in the SAP. Sample locations will be selected based on field observations and trench dimensions. Sampling will be performed once visual observation indicates that the waste material and any visible soil contamination has been removed. Sample collection will include locations where waste containers or other suspect items are discovered.

Screening samples will be analyzed for six driver COCs, namely Ra-226, Sr-90, chlordane, nitrate, hexavalent chromium, and mercury (Hg). In order to minimize costs associated with equipment down time, screening samples will be analyzed using both field analytical instruments and off-site laboratory fast turn-around analytical methods. Soil samples will be analyzed on-site for Ra-226 and Sr-90 using a high purity germanium (HPGe) gamma spectroscopy and a beta scintillation detector, respectively. Chlordane will be analyzed using the same field analytical method described in Section 2.3. Mercury, nitrate, and hexavalent chromium will be analyzed by an off-site laboratory on a 24-hour turn-around-time (TAT) basis. Details on these analytical methods are presented in the SAP.

2.5.2 Excavation Confirmation Sampling and Analysis

Confirmation samples will be collected from within the excavation limits. These samples will be collected using the backhoe bucket or other sampling equipment as approved by the construction engineer. The number of samples and sampling locations are determined based on a stratified random sampling approach. Additional samples may be collected from areas previously identified by field screening or field observations as potential "Hot Spots". To ensure attainment of cleanup criteria and provide adequate data for future site-wide risk assessment, confirmation samples will be analyzed for all COCs. Sample collection methodologies and the proposed analyses are described in the SAP.

2.5.3 Designated Level Sampling and Analysis

An objective of the RA is to ensure that residual soil contamination will not impact the ground water above MCLs or background levels. Designated levels have been developed for several COCs and represent initial guidelines for allowable soil concentrations at different depths and for various soil types that, when left in place, will not impact the ground water beneath the site. To satisfy this objective, samples will be collected from five feet below the bottom of the excavation. These samples will be collected in conjunction with excavation activities at locations where hot spots were identified. Designated level samples will be analyzed for all COCs as described in the SAP. Analytic results of these samples, along with excavation confirmation samples, will be used to estimate whether any residual soil concentrations remain that may impact the ground water. The analytical data produced from these sampling activities will be used to evaluate whether additional removal and/or ground water monitoring are required.

2.5.4 Waste Characterization Sampling and Analysis

Excavated material will require proper characterization and disposal. The materials from the Southwest Trenches Area that require characterization are categorized as:

- Chlordane-contaminated soil;
- Contaminated gravel and soil;
- Contaminated waste material;
- Overburden material that will be stockpiled separately; and
- Liquid waste generated from decontamination activities.

Each waste stream will require characterization based on its proposed disposal requirements. Chlordane-contaminated soil will require sampling since it is likely not contaminated with radionuclides and can be disposed based on its chemical characteristics. The proposed sampling plan for this waste stream is presented in the SAP.

Contaminated gravel and soil removed from the waste disposal cells will be classified as low-level radioactive waste (LLW) based on the existing analytical results available on this waste stream. Review of existing data suggest that additional testing may be required for certain chemical

constituents to further characterize the soil and gravel to ensure compliance with the disposal facility requirements. The proposed sampling plan for this waste stream is presented in the SAP.

The waste material will be disposed at a LLW disposal facility such as Hanford or Envirocare. This material will be characterized as described in the SAP to ensure that it complies with the profiling requirements of the disposal facility.

Overburden soil will be likely free of contamination since it overlies the waste piles and should not have become contaminated by the underlying waste. This material will be used as backfill if its chemical characteristics are acceptable. To determine the chemical composition of the overburden soil, several composite samples will be collected from the pile and analyzed for all COCs. The SAP discusses the sampling methodologies and proposed analytical methods for overburden soil characterization.

Liquid waste will be sampled according to the SAP and will be disposed based on its characterization results.

2.6 Data Evaluation

Data evaluation will be conducted in two general phases, as analytical results (both field and laboratory) become available. Phase I will consist of a review of field analytical results generated from analysis of driver COCs in excavation screening samples. Phase II data evaluation will consist of a review of analytical results generated by all sampling activities. Each phase of data evaluation and the scope and level of complexity are described below.

2.6.1 Data Evaluation – Phase I

Phase I data evaluation occurs in the field and is based on field screening sample results. This data evaluation phase will be used to guide the excavation activities. Screening samples will be analyzed on-site for chlordane, Ra-226 and Sr-90 and by an off-site laboratory for nitrate, hexavalent chromium, and mercury on a 24-hour TAT basis in order to provide quick and reliable information for field decisions on the limits of excavation. These analytical results will be tabulated and compared to soil screening criteria that are established based on the cleanup criteria described in Section 1.4 (i.e. RBAS, designated levels, and soil cover) and the field analysis detection limits. Screening criteria for driver COCs are presented in the SAP. The decision to further excavate soil will be made during Phase I by reviewing these analytical results.

Figure 2-1 presents the Phase I data evaluation process which is the RA field excavation decision flowchart. As shown in the flowchart, the decision to excavate will hinge upon the results of screening samples, preliminary attainment status of RAOs, the remaining volume of contaminated soil following waste removal (if any), and the associated cost of additional excavation. Following removal of the waste from each disposal trench, the first round of screening samples will be collected and analyzed for driver COCs. If screening analytical results indicate that the screening criteria have been attained for the driver COCs, then excavation will cease and confirmation sampling will commence. If analytical results indicate that driver COC concentrations are above the screening criteria, then additional delineation sampling will be performed in the areas where elevated

concentrations of COCs were detected (hot spots). Figure 2-1 presents this delineation process. Based on the results of screening samples, the volume and cost of additional excavation will be calculated and submitted to DOE. DOE, in coordination with the RPMs, will determine whether additional excavation should be performed or if confirmation sampling can commence.

If the decision will be to remove soil containing elevated COC concentrations, hot spots, then excavation will continue in the direction of the hot spots. The extent of additional excavation will depend on the delineation sampling results. The maximum depth of excavation, however, will be 20 ft. This depth was selected based on accessibility and difficulties associated with excavating trenches to greater depths without specialized heavy equipment. It should be noted that based on existing analytical results, it is not very likely that any COCs will be detected above their respective cleanup criteria at greater depths.

Available data indicate that no waste is present at depths below 14 ft at the Southwest Trenches Area. If, during the RA, contamination is encountered to depths greater than 20 ft, other remedial alternatives such as capping will be evaluated due to the potential prohibitive costs associated with deeper excavations.

2.6.2 Data Evaluation – Phase II

Upon receipt of all analytical results including confirmation and designated level samples, data validation and management will be conducted to ensure data usability. Sampling results may be tabulated according to excavation areas, depth, and soil type. Phase II of data evaluation will then commence and include the following analyses:

- Screening risk evaluation;
- Designated level analysis; and,
- RA completion analysis.

These analyses will be used to determine whether RAOs have been attained and, if not, make recommendations on any additional actions required. The scope of each analysis is described below. Figure 2-2 presents the Phase II data evaluation process which is the RA decision flowchart.

2.6.2.1 Screening Risk Evaluation

Screening risk evaluation will help assess whether the first and second RAOs have been attained. For each COC, confirmation sampling results and, if appropriate, previous analytical results from sample locations other than excavated areas, will be used to develop a data distribution for each COC and to calculate the mean, standard deviation, and 95% upper confidence limit (UCL) on the mean.

The procedures outlined in Statistical Method for Evaluating the Attainment of Cleanup Standards, Vol. 3 (EPA, 1992) will be used to compare the cleanup unit sample data with the RBAS for each COC. For those COCs where the RBAS is set at background, specifically Ra-226, the Wilcoxon Rank Sum Test (WRS Test) and/or the Quantile Test will be used. For COCs where the RBAS is above the background concentration, the 95% UCL on the mean of the cleanup unit data will be compared to the RBAS.

A screening-level risk evaluation will then be completed. For each COC the 95% UCL on the mean will be divided by the RBAS at specified risk levels (10^{-4}, 10^{-5} or 10^{-6} detected above background). The sum of the ratios for all COCs will then be computed for the three risk scenarios. If the sum is less than 1, the screening level evaluation will conclude that the first RAO has been met. A similar ratio will be calculated for the HQ of non-carcinogenic COCs to determine whether the second RAO has been attained.

2.6.2.2 Designated Level Analysis

Appendix D presents the modeling tool developed to calculate designated levels for any COC detected at the Southwest Trenches Area. During this evaluation step, the confirmation and designated level sampling result for all COCs will be reviewed. A list of COCs with detectable residual concentrations will be compiled. The modeling tool presented in Appendix D will then be utilized to help evaluate whether residual COC concentrations in soil following the RA have potential to impact ground water above the MCLs or background concentrations. The results of this model will be evaluated with respect to the distribution of residual site contamination, hydrology and ground water monitoring data.

2.6.2.3 RA Completion Analysis

Upon completion of the screening risk evaluation and vadose zone modeling (if necessary), a comprehensive review and analysis of all RA activities, analytical results and decision processes will be performed to determine whether the RAOs defined in Section 1 have been attained. During this phase of data evaluation, all applicable and available input information including the following items will be compiled in preparation of RA completion analysis.

- A description of waste materials encountered.
- Volume calculations for all waste streams generated;
- Excavation dimensions;
- All field and laboratory analytical results from each sampling and analysis activity;
- Results of screening risk evaluation; and,
- Results of designated level analysis.

Based on a review of the above data, as well as previously collected site data, an evaluation will be performed to determine whether the RAOs have been attained. This evaluation will consider the use of institutional controls, if necessary, for risk reduction and RAO attainment. As shown in Figure 2-2, the results of Phase II data evaluation will be presented to DOE and regulatory RPMs for review and discussion. Based on these discussions, a determination will be made regarding the need for and scope of additional actions to achieve the RAOs. In compliance with RWQCB policy, if the completion analysis indicates that soil clean up is not protective of background ground water concentrations, an evaluation of technical and economic impacts of further mitigation will be conducted.

2.7 Backfill and Compaction

The excavations will be backfilled upon completion of all sampling activities and no later than the start of rainy season (assumed to be October 15, 1998). Backfill and compaction activities are described below.

2.7.1 Land Survey of Excavation Limits

Prior to backfilling the excavations, a land survey crew will survey the lateral and vertical extents of the excavations to accurately define their dimensions and position relative to at least three permanent bench marks. All final confirmation and designated level sample locations will also be surveyed.

2.7.2 Backfill

Excavation will be cleared of any loose and undesirable material prior to backfilling. A geotextile fabric will be placed at the bottom and sides of the excavation to mark the extent of excavation activities. Imported soil will be used to backfill the excavation. Import backfill material will be of the quality and type as described in Specification Section 02220. In general, a well-graded, low permeability soil type will be used to backfill the excavation areas. The import backfill will be tested to ensure it is free of contaminants and its naturally occurring constituents are below the site soil background concentrations. In addition, geotechnical testing results for the material will be reviewed to ensure compliance with backfill compaction requirements.

Stockpiled overburden soil will be evaluated for use as backfill in the upper 3 ft, where it was originally removed. If chemically and physically suitable as backfill, the overburden will be compacted in place according to Specification Section 02220. If overburden soil is deemed unsuitable as backfill based on physical characteristics, then the material will be evaluated for use for final grading. If the overburden soil is deemed unsuitable as backfill based on chemical characteristics, then an appropriate disposal option will be selected based on the characterization results.

2.7.3 Compaction

The backfill will be placed in regular lifts (8 inches of loose soil) and compacted using standard compaction equipment and techniques. A qualified individual using nuclear density testing equipment or an approved equivalent technique will test the compacted material. A combination of confirmation testing and compaction protocols will be used to ensure that all lifts of the excavation backfill meet the compaction requirements while limiting the need for persons to enter the excavation. Compaction will be completed according to Specification Section 02220.

2.8 Site Restoration

The area will be restored to conditions at least equal to the conditions prior to the RA. Restoration activities are expected to include, but not be limited to, utility restoration, paving, final grading, and fence installation, as described below.

2.8.1 Utility Restoration

No utility rerouting is anticipated for this RA and therefore no restoration work will be necessary. In the event that utilities are impacted during the RA, temporarily rerouted utilities will be restored to their original condition and location. Any permanently rerouted utilities will be documented with a written specification and a complete set of as-built design plans for issuance to UC Davis.

2.8.2 Paving

The paved area along the north side of the site will be repaired and repaved as necessary. Paving will comply with Specifications Section 02575. Crushed aggregate and asphalt from the original pavement will be reused for base as applicable.

2.8.3 Final Grading and Fence Installation

Backfilling of excavations will be followed by surface grading to mitigate ponding.

The 160 LF of fencing removed along the north side will be reinstalled. Fence installation will comply with Specification Section 02831.

2.9 Waste Shipping and Disposal

Waste shipping and disposal will commence once the waste has been inventoried, properly characterized, and approval from disposal facilities has been received. A separate Waste Management Plan update will be prepared at a later date to address the shipment and disposal of the waste.

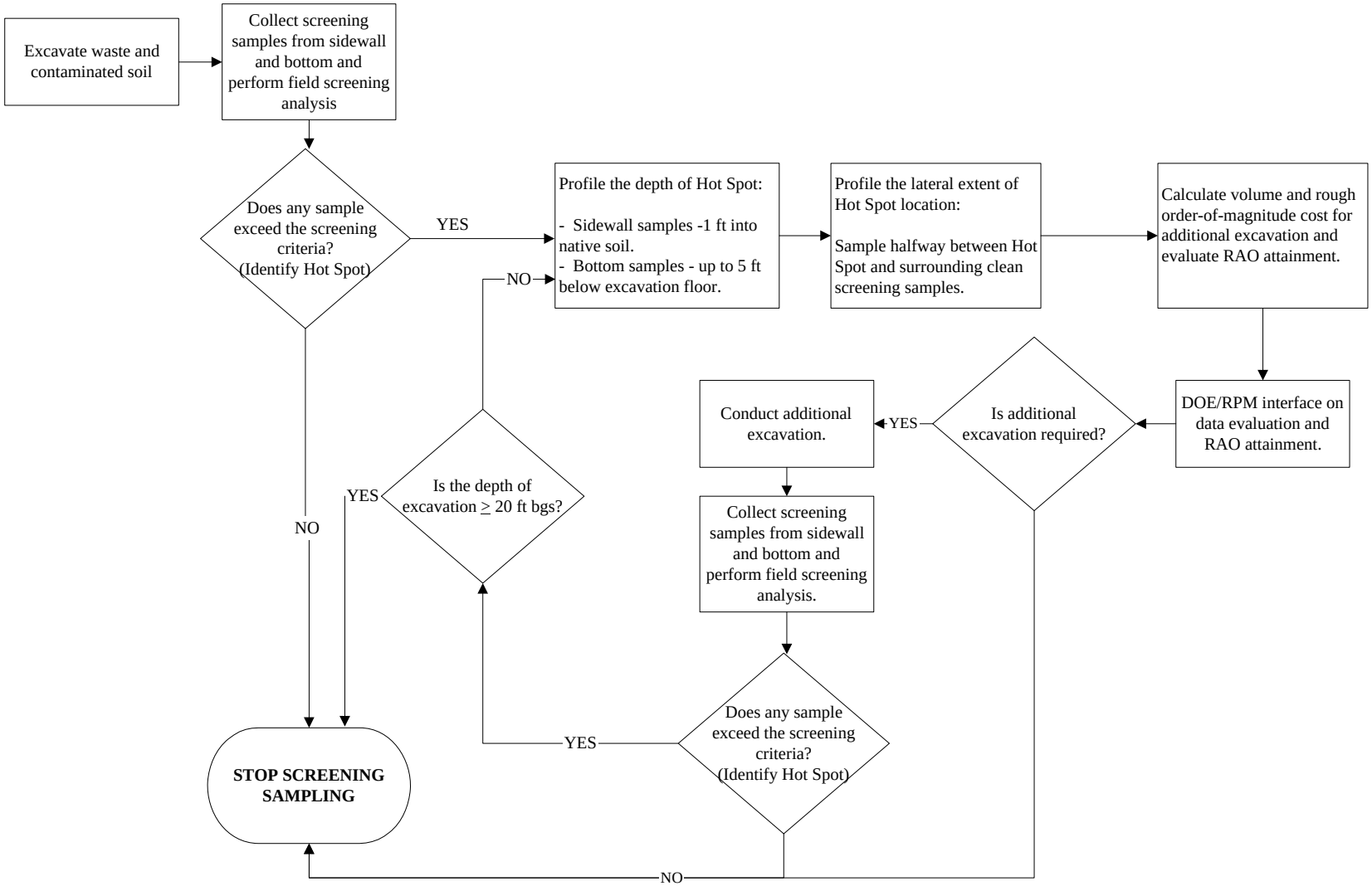

Figure 2-1. LEHR DOE Removal Action Field Excavation Decision Flowchart

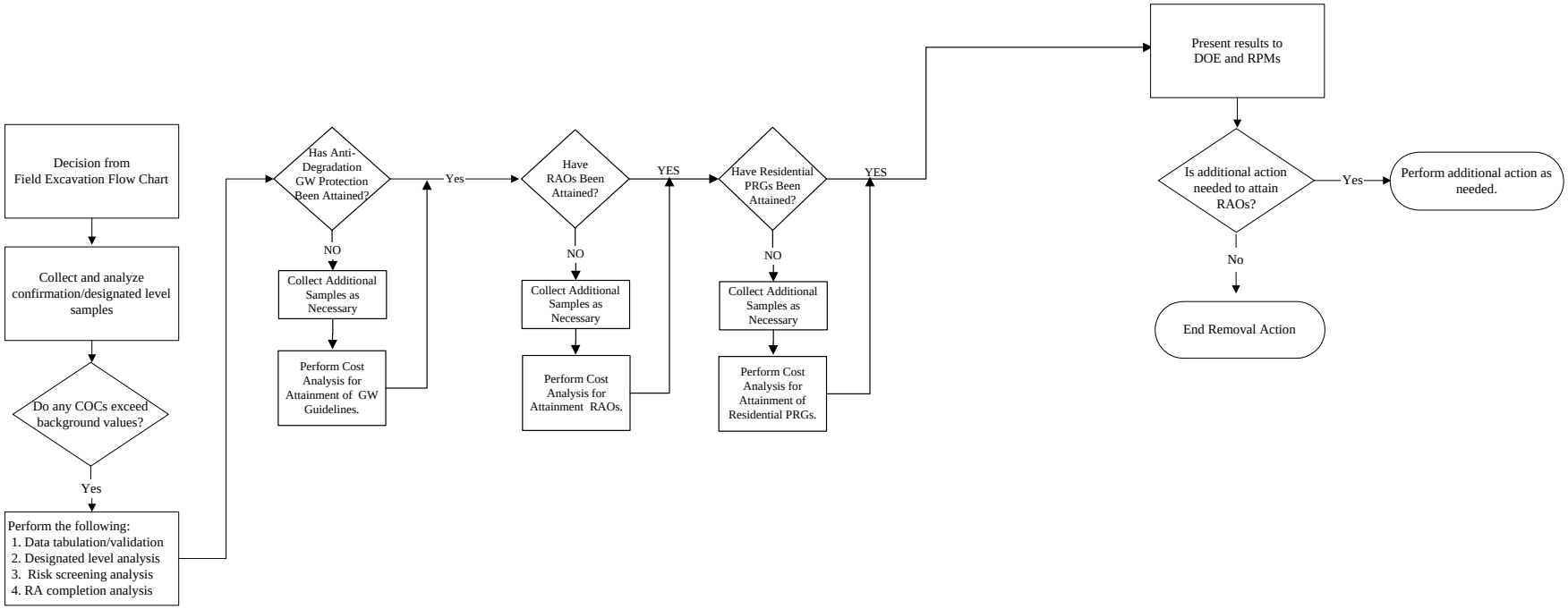

Figure 2-2. LEHR DOE Removal Action Decision Flowchart

3. REMOVAL ACTION ACTIVITIES AT THE RADIUM/STRONTIUM TREATMENT SYSTEMS AREA

The following section describes the field activities that will be performed during the RA at the Ra/Sr Treatment Systems Area. Specifications, SOPs, and other support documents including the SAP and WMP are referenced as necessary. Construction drawings in Appendix A are referenced throughout this section.

3.1 Work Areas

The RA will be completed in two areas as defined below:

1. Area I consists of the three (3) drywells, a cobble-filled seepage trench, Ra-226 effluent distribution box and piping, and Domestic Septic System Tank No. 2.

2. Area II consists of the Sr-90 and Ra-226 influent tank pipes, Sr-90 tank leach-field, Ra-226 tanks, and Sr-90 tanks.

3.2 Mobilization and Site Setup

The RA team will mobilize the required equipment and personnel separately for each RA area. Due to funding limitations, an additional mobilization may be required for the Area II RA. All necessary utility connections and setup activities will also be conducted at this time. A description of equipment, list of personnel, and setup activities is presented below.

3.2.1 Equipment Mobilization

The RA team will mobilize all necessary equipment at the appropriate point in the schedule to complete the RA. Appropriate equipment will be selected, purchased or procured as necessary prior to mobilization.

The equipment that will be used during the RA at Area I of the Ra/Sr Treatment Systems Area consists of:

- One backhoe (CAT 325L or equivalent) with an extension arm, 24 inch bucket and 1,500-lb hammer;
- One loader (CAT IT28 or equivalent) with a fork and bucket attachment;
- Two all-terrain forklifts;
- Two pickup trucks;
- One pickup truck with diesel fuel tank;
- One bucket auger drilling rig;

- A compactor and compaction equipment;
- Trench plates and shoring system;
- An air compressor;
- Construction hand tools including shovels, picks, and saws; and,
- Air and radiological monitoring equipment.

The equipment that will be used during the RA at Area II or the Ra/Sr Treatment Systems Area consists of:

- One articulated truck;
- One loader with fork and bucket attachments;
- Two skid-steer loaders with backhoe attachments;
- One all-terrain forklift;
- One water trailer;
- Light stands;
- One backhoe (CAT 325L or equivalent) with an extension arm and 24 inch bucket;
- One loader (CAT IT28 or equivalent) with a fork and bucket attachment;
- Two all-terrain forklifts;
- Two pickup trucks;
- One pickup truck with diesel fuel tank;
- One track-mounted hydraulic excavator with a universal processor (concrete crusher attachment);
- One compactor and compaction equipment;
- Trench plates;
- Construction hand tools including shovels, picks, and saws; and,
- Air and radiological monitoring equipment.

The following equipment will be utilized during sampling and analysis activities for both phases of work:

- Direct-push drilling rig;
- Hand augers with extensions, and trowels;
- 60-ft all-terrain boom;
- Gamma spectroscopy field analytical instrument for use in radium analysis;
- Organic vapor monitoring equipment; and,
- Beta scintillation detector for use in strontium analysis.

3.2.2 Personnel Mobilization

The personnel expected to mobilize to the site for the Ra/Sr Treatment System RA will be similar for both phases of work and will generally consist of the following personnel.

- Construction Engineer (WA)
- Project Quality Assurance Specialist (PQAS) (WA)

- Site Health and Safety Coordinator (SHSC) (WA)
- Field Waste Coordinator (WA)
- Sample Manager (WA)
- Superintendent (IT)
- Radiological Control Technicians (RCTs) (IT)
- Equipment Operators (IT)
- Laborers (IT)

The following personnel are assumed to have been previously assigned to the site.

- Radiological Safety Officer (RSO) (IT)
- Site Health and Safety Officer (SHSO) (WA)

These personnel will be responsible for performing the work and ensuring that work is being conducted according to the WP. While implementing the project activities, the following personnel may be mobilized to the site on an as-needed basis but will not be present for the entire duration of field activities:

- Project Manager (WA)
- Project Task Leader (WA)
- Task Manager (IT)
- Field Technicians and Geologists (WA)
- Field Chemist (WA)
- Waste Specialist (EMS)
- Senior Technical Advisor (EMS)
- Quality Assurance Manager (IT/WA)
- Subcontractors (IT/WA)

3.2.3 Site Setup

Setup activities will begin by establishing the boundaries of the "RA area." Project Drawing C-4 shows the planned RA area. The boundaries of the RA area are defined by Building H219 (Animal Hospital [AH]-1) on the east, Buildings H218 (AH-2) and H219 to the south and north boundaries, and by the ITEH facility fence-line to the west.

Setup activities at the Ra/Sr Treatment Systems Area will include securing the site perimeter using fencing and other barricades; establishing temporary facilities such as decontamination areas, equipment and material storage area, and a parking area; and implementing site security and dust control activities. Setup activities will be performed according to safe work practice and final setup activities will be determined in the field based on actual conditions and limitations at the time work is to be performed.

Setup activities at the Ra/Sr Treatment Systems Area will also include the setup of logistical supports. The logistical supports include set up of the onsite laboratory facilities, staging supplies,

staging contamination controls (PPE), field instrumentation and hand tools. Waste Management setup activities are discussed in the Waste Management Plan (Attachment II).

3.3 Site Preparation

Site preparation at the Ra/Sr Treatment Systems Area will consist of implementing environmental protection measures, clearing and grubbing, and utility relocation, as described below. Several activities will be performed in the same fashion as described in Section 2, Southwest Trenches RA and, therefore, are referenced below.

3.3.1 Environmental Protection Measures

Environmental control measures in the Ra/Sr Treatment Systems Area consist of protection of water, land, and air resources. No archeological or cultural resources are anticipated within the RA area. However, if archeological or cultural resources are encountered, the guidelines specified in Specification Section 01410 will be followed to address them.

All construction activities will be performed in a manner to mitigate the spread of contamination to surface and ground waters. Since the RA is planned during the dry season, the threat of storm runoff is minimal. Per the California and USEPA Storm Water Regulations, the dry season is defined as May to September. To address the unlikely event of significant precipitation while excavation is underway, the workplan requires that tarps be kept on site for use if necessary. These are covered in Specification 01010.

The site features located within or near the RA area consist of AH-1 and AH-2, two monitoring wells, and the air conditioning (AC) cooling tower unit is located along the west-side of the AH-2 building. Shoring and other engineering measures will be utilized during excavation activities to protect against structural damage to the buildings. A slope stabilization plan will be prepared by qualified registered professional and reviewed and approved by UCD prior to any intrusive activity near the buildings. Fencing and other barricades will be used to protect the monitoring wells and AC unit.

As discussed in Section 2.2, there is no concern associated with COC particulate concentrations associated with the RA activities at the DOE areas. Specifically, the anticipated level of dust generated during RA at the Ra/Sr Treatment Systems Area is less than that planned for the Southwest Trenches Area. This is based on the fact that the volume of material that will be removed in the Ra/Sr Treatment Systems Area is less than the Southwest Trenches Area. However, appropriate engineering controls, including modifications to AH-1 and AH-2 HVAC systems, dust suppression (during concrete crushing and material handling) using water and sound construction practice will be applied during the RA to minimize potential air impacts to on-site workers and facility researchers.

Prior to work in Area II, the rain cover will be removed from above the strontium and radium tanks and surrounding area. The cover was constructed with a plastic tarp that will likely be disposed as sanitary waste. A wood frame was built over the tarp to create proper drainage slopes and was

covered with a second plastic tarp used to prevent rain infiltration and direct run off away from the area. The wood frame and cover tarp will likely be disposed as sanitary waste. As a precautionary measure, all material will be radiologically surveyed.

3.3.2 Clearing and Grubbing

In the Ra/Sr Treatment Systems Area, clearing and grubbing activities will consist of asphalt removal, fence demolition, and tree removal, as described below.

3.3.2.1 Asphalt Removal

As shown on Drawing C-4, the pavement that overlies the radium distribution box, radium leach trench, and Domestic Septic System No. 2 will be removed during Area I activities. Pavement will be cut, broken and removed along with associated aggregate base. Pavement removal activities will be conducted according to Specification Section 02100. Asphalt waste will be sampled for characterization and handled according to the waste management plan based on the results of the characterization data. The generated asphalt will be stockpiled on plastic in the former Co-60 field.

No asphalt removal is planned for Area II activities.

3.3.2.2 Fence Demolition

Prior to working in Area II, approximately 70 LF of fence will be removed to allow heavy equipment access to the strontium leachfields and the tanks. Fence removal will occur according to Specification Section 02100. The fencing is assumed clean and will be replaced after the RA activities are complete.

3.3.2.3 Tree and Vegetation Removal

Two trees will be removed to allow heavy equipment access to excavate the radium leach trench for Area I activities (Drawing C-4). A tree located near the strontium leachfield will be removed to allow heavy equipment to excavate the radium tank piping and strontium leach field for Area II activities (Drawing C-4). UCD Grounds Division or their designee will remove the trees. The work areas will also be cleared of weeds. The tree and vegetative material will be handled according to the waste management plan.

3.3.2.4 Concrete Demolition

The sidewalk and the concrete pad overlying the strontium leachfield will be sawcut and removed according to Specification Section 02100. The concrete will be loaded onto pallets and stored in the former Cobalt-60 Field.

3.3.3 Utility Relocation

Underground utilities located within the removal action areas will be marked prior to implementation of removal activities as described in Section 2.2.3. Utility markings will include

paint pavement markings for underground utilities. Aboveground utilities are marked on drawing C-4 and will be field verified prior to start of work. No intrusive activity will commence prior to utility clearance of the areas. An independent geophysical survey contractor using the following techniques will clear the underground utilities: electromagnetic line locating (EMLL), electromagnetic terrain conductivity (TC), ground penetrating radar (GPR) and visual observations of surface structures. USA will also be notified prior to start of work.

As shown on Drawing C-4, several utility lines are located within the RA area. These utilities will either be permanently relocated or temporarily rerouted until the completion of the RA. Approval from UCD will be obtained prior to disturbance of any utility line. If the utility lines are to be permanently relocated, design plans and specifications will be prepared by UCD and UCD Grounds Division personnel will relocate the utilities. At this time, it is anticipated that the underground gas line and the underground water line will be permanently relocated. The underground sanitary sewer line will be temporary relocated. Utility rerouting will be performed in accordance with Specification Section 02222.

3.4 Drywells and Leach Trench Removal (Area I Activity)

The effluent from the radium tanks was released to the subsurface through a network of distribution pipes, drywells and a leach trench. Effluent from the Ra-226 tanks was direct to a wooden distribution box by a single cast iron pipe. Vitrified clay pipe directed the distribution box effluent to each of the three dry wells. Each drywell consists of a 36-inch wide concrete manway on top of a gravel-packed 30-inch diameter infiltration well extending to the water table. The total depth of the drywells is assumed to be 40-ft bgs.

The leach trench was constructed of cobbles and large diameter rocks. The depth of the leach trench is expected to be 12-ft bgs or less. The horizontal extent of the leach trench has not been completely defined. Previous investigation indicates that the trench extends approximately 90-ft south of the most northerly drywell (Drawing C-5). The previously confirmed presence of a pipe trending north of the northern most dry well suggests that a northern leach trench may also be present.

The leach trench will be excavated starting at the northernmost drywell and moving south. If a northern leach trench is confirmed it will be removed from the south to the north. The upper 4 to 6 ft of soil overlying the leach trench is not expected to be LLW and will be segregated and stored as overburden soil in the western dog pens in engineered storage cells and characterized for final disposition. Previous exploratory trenching indicates that the leach trench consists of cobbles and rocks greater than 2-inch diameter. This material is assumed to be LLW and will be segregated from native soil to the extent feasible. The SAP and WMP describe sampling and management of this waste stream. Based on field conditions temporary shoring may be performed using hydraulic shoring systems that consist of heavy-duty hydraulic walers and timber, ABS, or fiberglass panels sized according to trench dimensions, or sidewall sloping/benching may be implemented. During this activity, the concrete manways of the drywells will be removed. This material is assumed to be LLW and will be sampled according to the SAP and managed under the WMP.

The drywells will be excavated using a bucket-auger-drilling rig with up to a 6-foot diameter auger (auger size and final excavation method is dependent on characterization data to be collected during the trench removal). The drill rig will be mobilized to the site to remove the underlying gravel-packed infiltration wells. Following complete removal of each drywell, the boreholes will be filled with a cement-bentonite (CB) slurry mix to a depth of 5 ft bgs, providing a casing to prevent collapse. The cement mix design will be developed prior to commencement of work and approved by the construction engineer as described in Specification Section 02383. The mix design will be in accordance with Solano County Department of Environmental Management regulations. The final 5 feet will be filled with a compacted soil (per Specification Section 02220) and finished to match existing grade.

Once the leach trench and drywell removal has been completed, the distribution box and piping will be excavated. The distribution box area and piping are expected to be less than 6-ft bgs. Excavation and pipe removal will be performed in accordance with Specification Section 02220. This material is assumed to be LLW and will be sampled and managed according to the SAP and WMP.

3.5 Domestic Septic System No. 2 (Area I Activity)

Following partial removal of the drywells and the distribution box, Domestic Septic System No. 2 will be excavated. The location of Domestic Septic System No. 2 is shown in Drawing C-5. Due to its close proximity to the radium distribution box, Domestic Septic System No. 2 will be excavated concurrently with the distribution box. The tank in Domestic Septic System No. 2 was uncovered during a previous investigation and is constructed of concrete. Tank excavation activities will be performed accordance with Specification Section.

3.6 Radium and Strontium Influent Tank Piping Removal (Area II Activity)

All influent pipes to the radium and strontium tanks will be cut and removed. During previous decontamination and decommissioning (D&D) activities performed within AH-1 and AH-2, the piping systems leading out of the buildings were cleaned and abandoned via grouting in-place. This RA will remove all piping on the outside of the buildings that lead to the tanks.

The pipes are cast iron with lead joints, are located approximately 3 to 5 ft beneath the ground surface, and are covered with either soil and/or concrete. The surface coverings will be removed first and the pipes will be exposed. Pipes will be cut or dismantled at bends and joints or other locations as necessary, and will be handled according to the WMP. Pipe cutting will be performed using tools and equipment that will minimize the (airborne) spread of contamination.

3.7 Strontium Leachfield Removal (Area II Activity)

Historical records indicate that effluent from the strontium tanks released small amounts of radionuclides and other potential contaminant to the two leachfields. The first leachfield is located

on the east-side of the treatment system and is called the "original leachfield." A second leachfield was constructed further east of the original leachfield to replace the original leachfield that had become the site for a new laboratory building next to the tanks. Herein, this leachfield is called the "existing leachfield." The approximate location of these leachfields is shown on Drawing C-5. The combined leachfield removal area is approximately 1,260 square feet. The maximum depth of the leachfields is expected to be 7 ft bgs based on previous investigation (IT, 1996).

The objective of this RA is to remove the leachfield distribution systems and associated contaminated soil. A concrete pad that will also be demolished and removed as part of the RA covers a portion of the old leachfield. Leachfield removal activities will be conducted as described below.

- The concrete pad (4-inch thick reinforced) over the old leachfield will be demolished using a hydraulic hammer attached to the excavator, or other approved method;
- The effluent piping will be exposed at the eastern side of the strontium tanks;
- The excavation will follow the piping and gravel bed laterally and vertically until native soil is encountered; and,
- Based on a visual inspection and screening samples of the native soil, additional soil will be excavated and removed.

All the removed material is assumed to be LLW and will be sampled according to the SAP and managed according to the WMP. Excavation activities will be performed according to Specification Section 02220.

3.8 Strontium Tanks Removal (Area II Activity)

The strontium treatment system received wastewater from AH-1 and was constructed to allow for separation and settling of solids and other suspended contaminants prior to discharge into the leachfields. There are nine tanks (tanks A though I) within the strontium treatment system; the tank walls consist of reinforced concrete. The footprint of the strontium treatment system is approximately 25 ft wide by 45 ft long by 8 ft deep.

The tank top is constructed of wood and will be cut and removed. Prior to cover removal, access hatches will be used to examine the content of the tanks.

Prior to Tank A demolition, the sludge and debris will be solidified in-place, removed with a backhoe bucket and packaged in the appropriate containers. Liquid accumulated within the other tanks will likely be pumped and containerized for separate characterization prior to disposal. Once all the tanks have been emptied, the tanks will be demolished in-place.

The northern side of the strontium tanks' excavation will require an engineered system to prevent structural damage to AH-1. An engineered shoring and sloping system will be used to protect the northern excavation wall. The east and west sides of the excavation will be benched or

sloped for stability as needed. The excavation depth in the strontium tank system area is expected to be about 11 feet.

The Strontium tank excavation work will begin adjacent to three walls in the interior of the courtyard to provide access for demolition. The wall adjacent to Building AH-1 will not be excavated. This excavation work will include the removal of the soil between the Strontium tank and the Radium tank and the removal of any piping encountered. This material is assumed to be LLW and will be sampled according to the SAP and managed according to the WMP.

A tracked excavator with a concrete crusher and shears will be mobilized to the site to pulverize the concrete walls and shear the rebar. The machine will demolish the western wall of the Strontium tank and then enter the tank so it can sit on the floor slab of the tank. After the three exterior walls and all the interior walls of the Strontium tank have been demolished and loaded into boxes, the demolition work on the Radium tanks will begin.

3.9 Radium Tank Removal (Area II Activity)

The radium treatment system received wastewater from AH-2. It is comprised of two reinforced concrete tanks adjacent to each other. Each tank consists of two compartments separated by weirs. The thickness of the tank walls is approximately 8 inches. The overall dimensions of the radium tank are approximately 8 ft wide by 45 ft long by 7.5 ft deep. The tank is overlain with about 2-ft of soil that will be handled as clean overburden in accordance with the SAP and WMP. The concrete tanks and soils to the sides and below the tanks that are removed during these activities are assumed to be LLW and will be sampled and handled according to the SAP and WMP.

The tank cover contains access hatches that will be used to examine the tank contents. If liquid is present within the tanks it will be pumped out and analyzed to determine an appropriate disposal option.

First, the manhole risers and roof slab will be pulverized using the concrete crusher and then the tank walls will be demolished. If large sections of the tank can be removed as a unit, they will be pulled over to the Strontium tank slab to be pulverized.

After the removal of the Radium tank the work will return to the remaining Strontium tank slab and northern wall. The intent will be to roll the Strontium tank northern wall out of the excavation without removing the soil adjacent to Building AH-1. After the northern wall is demolished, the slab would be demolished working from the east to the west.

It is expected that the excavation will require slope stabilization to prevent sidewall collapse or sloughing. On the east, west, north and south sides of the excavation, sloping will used to stabilize the sidewalls. Stabilization of the north wall is discussed in the Section 3.8 Strontium Tank Removal. Prior to commencing work the construction contractor will prepare a slope stabilization and shoring plan. The eastern and western face of the excavation will be benched or sloped for stability as needed. On the northern side, the excavation will intersect the limits of the strontium tank excavation. The proposed excavation areas are shown on Drawing C-5.

3.10 Soil and Debris Handling

Excavated material is assumed to be LLW unless specified and will consist of soil, gravel, cobble, concrete, wood, sludge (possible mixed waste), asphalt, and piping. Each waste stream will be handled separately as described in the WMP. Excavated soil, concrete, debris and gravel will be placed in B-25 boxes or other approved containers, packaged and sealed, then stored in the Western Dog Pens or former Cobalt-60 Field prior to shipment offsite for disposal.

Concrete from tanks, pads, and drywell manways will be cut into manageable pieces per requirements of the disposal facility and placed in an appropriate container for transport. Wooden weirs and tank covers will be similarly managed.

All piping removed during the RA will be cut into manageable pieces and packaged for off-site disposal. The planned storage areas for these materials are discussed in the WMP.

Some assumed clean overburden soil will be generated. This soil will be temporally stockpiled in engineered cells in the Western Dog pens. The SAP and WMP detail the sampling and management of this material.

3.11 Sampling and Analysis

Sampling and analysis activities associated with the Ra/Sr Treatment Systems Area are divided into the following categories:

- Delineation sampling and field/off-site laboratory analysis to guide drywell excavation activities;
- Screening sampling and field analysis to guide all excavation activities;
- Confirmation sampling and off-site laboratory analysis to ensure that cleanup criteria have been attained within the limits of excavation (including Hot Spot sampling);
- Sampling and off-site laboratory analysis to determine attainment of designated levels; and ,
- Characterization sampling and analysis for waste disposal.

Each sampling and analysis activity has a specific objective and has been designed to achieve that objective. The SAP and WMP present a detailed discussion of these objectives, sampling strategies, and methodologies. Each sampling and analysis strategy is discussed below.

3.11.1 Drywell Delineation Sampling and Analysis

The details for the drywell delineation sampling and analysis are covered in the SAP. A general description of the scope is included in this section.

Following removal of the upper portion of the drywells, the horizontal and vertical extent of the contamination around each drywell will be defined. Delineation sampling will determine the size (diameter) of the excavation around each drywell. These samples will also serve as confirmation samples away from the sidewalls of the excavation.

Delineation samples for the lower portion of the drywells will be collected in a spiral pattern around each drywell using a direct-push sampling technique.

Sampling locations and frequency are presented in the SAP. Sampling and analysis will be performed in advance of the RA field crew mobilization to provide sufficient time for validation and evaluation of delineation results.

3.11.2 Excavation Screening Sampling and Analysis

Screening samples will be collected from each excavation to determine whether excavation activities should cease and final confirmation sampling should begin. Screening samples will be collected on a 2-dimensional grid pattern, dropped to fit the three dimensions of each excavation, with samples collected at grid nodes. The grid dimensions are 10 ft by 10 ft based on the expected dimensions of the excavations. Based on existing analytical results, the driver COCs at the Ra/Sr Treatment Systems Area are Ra-226, Sr-90, and nitrate. Field analytical instruments consisting of a HPGe detector and a beta scintillation detector will be used to provide real-time results of the screening samples. Nitrate will be analyzed by an off-site laboratory on a 48-hr TAT basis. Field screening sampling results will be compared to screening criteria as described in Section 2.6.

3.11.3 Excavation Confirmation Sampling and Analysis

Confirmation samples will be collected from within the excavation limits. The confirmation sampling and analytical program for this area is identical to the Southwest Trenches Area and is described in the SAP.

3.11.4 Designated Levels Sampling and Analysis

Designated levels sampling will be performed similar to the Southwest Trenches Area and is described in the SAP. Samples will be collected from a depth of 5 ft below the bottom of the excavation at locations where hot spots were identified during screening sampling.

3.11.5 Waste Characterization Sampling and Analysis

Waste material generated during the RA will require characterization prior to disposal. Waste material will consist of soil/gravel, concrete, wood, metal piping, lead joints, sludge and liquids. This material will be segregated and stored separately as described in the WMP. These

waste streams will be sampled and analyzed according to the WMP to verify that they meet the disposal facility's acceptance requirements.

3.12 Data Evaluation

The data evaluation process will be identical to the RA performed at Southwest Trenches Area, as described in Section 2.6.

3.13 Backfill and Compaction

All excavated areas will be backfilled and compacted in accordance with Specification Section 02220. Import backfill will comply with the standards described in Section 2.7. The exception to the backfill material is the cement-bentonite slurry that will be used to backfill the drywells as discussed in Section 3.7. For soil backfill, compaction testing will be performed to ensure compliance with requirements of Specification Section 02220. Compaction test requirements are presented in Specification Section 02220 (WA will act as the contractor under this task).

Similar to the Southwest Trenches Area, the excavation extent will be surveyed prior to backfilling to accurately define the dimensions of the final excavation. All confirmation and designated level sample locations will also be surveyed.

3.14 Site Restoration

Site restoration at the Ra/Sr Treatment Systems Area will consist of utility restoration, paving and fence installation. The cool room and the HVAC reroute duct that were built during the Area I RA will be dismantled following the Area II RA.

Utility restoration will be performed on temporarily relocated utility lines. Permanent utilities will remain intact.

In the areas where paving was damaged or removed, new asphalt will be placed. Paving will comply with Specification Section 02575 (WA will act as the contractor under this task). Crushed asphalt and aggregate base from the original pavement will be reused to the extent feasible.

The seventy linear feet of fence removed during the set up phase will be re-installed to match existing conditions.

3.15 Waste Shipping and Disposal

Waste shipping and disposal will occur once the waste has been characterized, and profiled to meet the off site disposal facility's waste acceptance criteria. Schedule of waste shipment and disposal is detailed in the WMP.

4. REMOVAL ACTION ACTIVITIES AT TWO DOMESTIC SEPTIC SYSTEM AREAS

The following section describes the field activities that will be performed at Domestic Septic Systems No. 3 and No. 6. Specifications, SOPs and other support documents including the SAP and WMP are referenced as necessary. Construction drawings in Appendix A are referenced as needed throughout this section.

4.1 Mobilization and Site Setup

The RA team will mobilize the equipment and personnel required for the RA to the site. Setup activities will also be performed at this time. Mobilization and setup activities are described below.

4.1.1 Equipment Mobilization

Equipment mobilization for the Domestic Septic System Areas will be limited to the sampling activity at Domestic Tank No. 3 and limited excavation and sampling at Domestic Tank No. 6. The anticipated equipment will include but is not limited to the following:

- Wheel-mounted front-end loader;
- Pickup truck with diesel fuel tank;
- Wheel-mounted hydraulic backhoe;
- Trench plates;
- Construction hand tools including shovels, picks and saws; and,
- Air and radiological monitoring equipment.

The following equipment will be utilized during sampling and analysis activities:

- Direct-push drilling rig;
- Hand augers, trowels and post-hole diggers; and
- Organic vapor monitoring equipment.

4.1.2 Personnel Mobilization

The personnel expected to mobilize for the Domestic Septic System Areas field activities will be similar to the staff listed in Section 2.1.2.

4.1.3 Site Setup

Site setup at the two domestic tank areas will consist of securing the site perimeter and establishing temporary facilities as described in Section 2.1.3. Because excavation and sampling activities will be close to on-site research facilities, site security and control measures for dust and noise will be emphasized.

4.2 Site Preparation

Site preparation activities will consist of a utility survey and clearing and grubbing. Utility clearance for both Septic System Areas will be performed prior to any intrusive activity. Boring locations and excavation areas will be defined to prevent impact to any subsurface utilities.

No clearing or grubbing is anticipated at Domestic Septic System No. 3. At Domestic Septic System No. 6, pavement will be removed prior to excavation. Asphalt removal will be performed in accordance with Specification Section 02100. Excavated pavement and aggregate base will be handled with the excavated soil and as described in Section 2.2.

4.3 Septic System No. 3

Review of existing analytical data from Domestic Septic System No. 3 indicate that, except for Ra-226, no COCs are present above the RBAS levels. Ra-226 at 1.5 pCi/g was detected in a composite sample from four borings at a depth of 15 ft bgs. This single detection does not warrant removal activities, however, confirmation sampling will be performed to more accurately define the extent of any Ra-226 contamination at Septic System No. 3.

4.3.1 Confirmation Sampling and Analysis

Five soil borings are proposed for Domestic Septic System No. 3. Boring locations are based on previous analytical results and are presented in the SAP. Samples will be collected in each boring at 5-foot intervals to a maximum depth of 20 ft bgs (five feet below the detection of Ra-226). A direct-push sampling technique will be utilized to collect the samples. All samples will be analyzed for the full suite of radionuclides and metals. The SAP provides further detail on the sampling and analysis strategy.

4.4 Septic System No. 6

At Domestic Septic System No. 6, mercury was detected above its RBAS in one sample from a depth of 5 ft. No other COCs were detected above their respective RBAS in any of the samples collected at Domestic Septic System No. 6. The scope of the RA at this septic system will consist of excavating the sample location where mercury was detected and collecting additional samples to further delineate the mercury extent in soil.

4.4.1 Soil Removal and Handling

A 5-foot by 5-foot area will be excavated to a depth of 5 ft around the sample location using a backhoe. This area will be excavated to a depth of 5 feet bgs and represents the expected volume of mercury contamination. Excavation activities will be performed according to Specification Section 02220.

Excavated soil will be transported to the Western Dog Pens area and placed on and covered with plastic sheeting. Soil stockpiling will be performed in accordance with SOP 12.1. This material will require characterization for proper disposal.

4.4.2 Sampling and Analysis

Two sampling activities are planned for Domestic Septic System No. 6, including excavation sampling and waste characterization sampling. Each is described below.

4.4.2.1 Excavation Sampling and Analysis

Sampling and analysis will be performed in conjunction with excavation activities to determine whether the mercury cleanup criteria has been attained. Screening samples will be collected from the sidewalls and floor of the excavation and analyzed for mercury by an off-site analytical laboratory on a 24-hour TAT basis. Given the small dimensions of the excavation (5 ft wide by 5 ft long by 5 ft deep), one sample will be collected from each sidewall and bottom of the excavation. Screening sample results will be compared to the RBAS values to determine whether the final extent of the excavation has been reached.

Additional excavation may be performed if analytic results indicate that the mercury RBAS value is still exceeded. Additional excavation will be performed in 12-inch lifts/cuts in the direction of the mercury detection.

Once the final excavation extent has been reached, final confirmation samples will be collected and analyzed for mercury using Contract Laboratory Program (CLP) method. The SAP presents the sampling and analysis strategy for Domestic Septic System No. 6.

4.4.2.2 Waste Characterization Sampling and Analysis

The excavated soil will be sampled and analyzed for all COCs to characterize it for disposal. Review of existing analytical results from this area suggest that the excavated material will not be contaminated with radionuclides and can be disposed based on its chemical characteristics. However, the soil pile will be sampled and analyzed for all radionuclides. The proposed sampling and analysis plan for this material is presented in the SAP.

4.4.3 Backfill and Compaction

Backfill and compaction at Domestic Septic System No. 6 will be performed as described in Section 2.7.

4.4.4 Site Restoration

Site restoration at Domestic Septic System No. 6 will consist of repaving the areas where pavement was damaged or removed as part of the RA activities. Paving will be performed in accordance with Specification Section 02575.

4.4.5 Waste Shipping and Disposal

Waste shipping and disposal will occur once the waste has been inventoried, properly characterized, and approval from the disposal facility obtained. A separate Waste Management Plan will be prepared at a later date to address the shipment and disposal of the waste.

5. HEALTH AND SAFETY CONSIDERATIONS

Health and safety considerations for the activities at the Southwest Trenches Area, Ra/Sr Treatment Systems Area, and Domestic Septic System Areas are covered by the following documents: the Project Health and Safety Plan (PHSP) (WA, 1998c); Health and Safety Procedures (HSPs) (WA, 1998f) and Standard Operating Procedures (SOPs)(WA, 1998g), as listed in Appendix B of this Work Plan; the Contingency Plan and General Emergency Response Procedures (CPGERP) (WA, 1998e); the As Low As Reasonably Achievable (ALARA) Program (WA, 1997d), and the Radiation Protection Program (RPP)(WA, 1998h). The health and safety considerations presented in this section of the Work Plan coupled with the foregoing listed documents represent the safety and health program required by 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response and 10 CFR 835, Occupational Radiation Protection, for these work activities.

5.1 Hazard Analysis

A job hazard analysis identifies potential safety, health and environmental hazards and provides for the protection of personnel. Hazard analysis helps to ensure that all excavation, demolition, waste handling, drilling and sampling safety concerns are met. The Activity Hazard Analysis (AHAs) relative to this project are in the Appendix of the PHSP. Required AHAs are: Field Survey; Contaminated Soil and Waste Excavation; and, Rig and Crane Operation. A hazard analysis for these activities, as well as specific additional control measures to be followed, are described in Section 5 of the PHSP. Specific sections describing hazard analysis and control have been included from the PHSP, where applicable.

During these activities, the Site Coordinator (SC), Site Health and Safety Officer (SHSO), Radiological Control Manager (RCM), Radiological Safety Officer (RSO), Radiological Control Technician (RCT), or Health and Safety Coordinator (HSC) will monitor the site for any changes in conditions that would require modification of work conditions (i.e., personal protective equipment [PPE]). In the event that changes arise in radiological or industrial health and safety conditions that are not covered by this Work Plan or referenced documents, this Work Plan will be modified in accordance with the procedures contained in Standard Quality Procedure 11.1 (SQP), "Fieldwork Variances/Request For Information" (WA, 1998d).

5.1.1 Underground Utilities

A contractor will clear utilities prior to commencement of any intrusive activity as described in Sections 2, 3, and 4 of the Work Plan. It should be noted, however, that the potential for encountering unmarked or mislocated underground utilities during the proposed field sampling activities still exists. In order to prevent encountering, and/or to minimize the dangers associated with accidental encounters with underground utilities, the following precautions will be followed during removal activities:

- Locating the main shutoff valve(s) or switch(es) for gas lines, water lines, and electric lines at each excavation and sampling location;
- Proceeding with excavation in 6-inch lifts during the first 4 ft of excavation in areas of concern;
- Hand excavating in areas of potential utility crossing; and
- Hand augering the first 5 ft of each boring. After utilities are cleared, shallow soil samples will be collected using a hand auger.

Hand augering is one of the least intrusive and safest sampling methods that can be employed to sample soil in areas containing utilities.

In the event a utility is encountered with a hand auger, no damage to the utility would be expected. Deeper samples will be collected in select previously hand augered holes, to insure no utilities are encountered.

5.1.2 Excavation Safety

During this RA, a large part of the work includes trench excavations and large moving equipment. There are many hazards associated with this work such as underground utility lines, trench wall stability, undermining of buildings, confined space entry, noise, slip, trip falls and visibility.

All personnel shall be aware of all site hazards and conditions. Barricades and warning devices will be posted around the excavations, as appropriate, and all moving equipment shall have operational horns when backing up.

An AHA covering trenching and excavation activities, Contaminated Soil and Waste Excavation, has been developed and is in the Appendix of the PHSP. Also, HSP 4.1-Trenching and Excavation, will be followed. If for any reason personnel need to enter the trench or excavation, the required permits and clearances must be approved prior to entry into the trench or excavation. The excavations may be shored, sloped or benched. As required, all activities will be in accordance with 29 CFR 1926.

5.1.3 Confined Space Entry

Confined space entry may be required during the performance of any planned RA activities. All activities have been planned such that confined space entry will be minimized. When a confined space entry becomes necessary, procedures specified in HSP 5.1, Confined Space Entry, will be followed.

5.1.4 Radiological Exposure

The excavated waste soils and materials may contain low-level radioactive material from prior animal research activities. The predominant radionuclides used during these activities were Ra-226 and Sr-90. Based on previous investigations and removal actions, the radionuclides of concern from an occupational exposure standpoint during the RA activities appear to be limited to Ra-226, Sr-90 Cesium-137 and Tritium. Occupational exposure to radionuclides appears to be a concern in both the Southwest Trenches Area and the Ra/Sr Treatment Systems Area, but not at the Domestic Septic Systems Area.

Waste material excavation, stockpiling, sorting, packaging and sampling may present exposure to radioactive materials through contact, ingestion and inhalation. Exposure to radionuclides will be evaluated and controlled by the RCTs in accordance to SOPs and HSPs established as part of the RPP. Gross alpha, gross beta, and gross gamma radioactivity readings will be collected by RCTs using field procedures/analysis and utilized as indicators of the presence of radionuclides above background levels that may pose an occupational hazard. Ingestion of radionuclides will be minimized by use of proper PPE and personal hygiene (e.g. – washing of hands and face). Occupational related air monitoring will be conducted to determine potential exposure to airborne radioactivity as discussed further in Section 5.2.10 of this Work Plan and Section 11 of the PHSP. Dosage limits for radiation exposure are listed in Table 1 of HSP 15.1-External Radiation Exposure Control. The action level for airborne radioactivity will be 10 % of the derived air concentration (DAC) as shown in Table 5-1 of this Work Plan and as discussed in Section 6 of the PHSP. Engineering controls will be used wherever possible to reduce the potential for internal and external exposure to As Low As Reasonably Achievable (ALARA) levels. Engineering controls are the preferred method to reduce airborne radioactivity exposure and will be utilized in lieu of respiratory protection whenever possible. The use of administrative procedures for the control of occupational radiological worker exposures is not anticipated for this project. Applicable ALARA procedures and principles to be followed for conducting this work are presented in the ALARA Program (WA, 1997d). Alarm procedures, as may be necessary, will be presented to the workforce during on-the-job training.

Personnel in the vicinity of the excavation shall wear modified Level D PPE as described in Section 5.2.4. The level of PPE will be modified if action levels dictate a need for a change in the personal protective equipment ensemble.

5.1.5 Chemical Exposure

The excavated waste soils and materials may contain chemicals (organic and inorganic) from prior animal research activities or waste disposal activities. Few chemicals are anticipated at levels that may present an occupational exposure concern. The predominant chemicals identified during waste characterization activities are chlordane and semi-volatile organic chemicals (SVOCs). The main SVOCs were detected in sludge with lesser concentrations in soil and include anthracene, phenanthrene, chrysene, and pyrene. The foregoing listed SVOCs are occupationally controlled as coal tar pitch volatiles. Exposure to SVOCs appears to be a potential occupational concern in only the Southwest Trenches Area and the Ra/Sr Treatment Systems Area. Exposure to chlordane appears to be a potential occupational concern in only the Southwest Trenches Area. A chlordane soils screening field test will be conducted to provide real time same-day data. This data will be used to

alert site personnel to any chlordane hotspots so that appropriate personnel protective measures can be implemented. The Domestic Septic Systems Area does not appear to have elevated chemicals (including metals) in Site areas proposed for removal actions that would be an occupational concern. Appropriate protective measures will be employed to limit worker exposure to chemicals. No VOCs of occupational concern have been identified in Site soils.

Waste material excavation, stockpile, sorting, packaging and sampling may present exposure to chemicals and nuisance dust through contact, ingestion and inhalation. Contact with chemicals will be evaluated and controlled by the proper use of PPE. Real time air monitoring of nuisance respirable dust, nuisance total dust, and volatile organic compounds (VOCs) will be collected using field procedures/analysis and evaluated as a potential occupational hazard. The maximum concentration of identified chlordane and SVOCs converted into air concentrations is well below the limit of air contaminants from table Z-1 in 29 CFR 1910.1000 and, therefore, respiratory protection is not warranted for chemicals if dust action levels are not exceeded. Ingestion of chemicals will be minimized by use of proper PPE and personal hygiene (e.g. – washing of hands and face). Occupational related air monitoring will be conducted to determine potential exposure to airborne nuisance dust as discussed further in Section 5.2.10 of this Work Plan and Section 11 of the PHSP. Permissible Exposure Limits (PELs) for chemical exposure are listed in Section 5 of the PHSP. Engineering controls will be used to reduce the potential exposure to chemicals, where practical.

Personnel in the vicinity of the excavation shall wear modified Level D PPE as described in Section 5.2.4. The level of PPE will be modified if action levels dictate a need for a change in the personal protective equipment ensemble.

During excavation and sampling activities, grab samples and direct instrumentation (PID and real time dust monitor) will be used to detect the presence and concentration of hazardous chemicals. The chemicals of occupational concern anticipated during the RA activities are chlordane and SVOCs, which are based on previous investigations. However, air monitoring will still be conducted and, if the PID concentrations or airborne dust levels are above the action levels denoted in the PHSP Section 6, then PPE will be modified accordingly and additional engineering controls to be implemented when feasible. Monitoring will continue throughout the project during excavation to reduce the likelihood of potential exposure to unanticipated chemicals.

No contact with ground or surface water is planned for these removal actions. However, occupational safety and health issues dealing with ground or surface water contact are covered in the PHSP should this situation arise.

5.1.6 Heat Stress

This activity is scheduled to be performed at a time between May and October when wearing PPE puts workers at considerable risk of heat stress. All workers will have medical clearance prior to working onsite and there will be an acclimation period for workers. Measurements with a Wet-Bulb-Globe-Temperature (WBGT) instrument will be conducted and working conditions will be evaluated to minimize heat stress. Based on weather conditions and the PPE used, a work regime will be established in accordance with the PHSP, Section 5.

Heat stress prevention will include the following mitigation measures: properly rested workers prior to work; scheduled breaks; appropriate water intake; and, rotation of heavy work tasks. Monitoring will also be conducted by body temperature measurements and visual observations of workers as discussed in Section 5 of the PHSP. Also, HSP 3.1, Working in Hot Environments, will be implemented for any work conducted during the hot weather months at LEHR

5.2 Hazard Controls

The following control measures will be implemented during the RA. These control measures are intended to supplement the PHSP.

5.2.1 Hazardous Work Permit

Hazardous Work Permits (HWPs) will be used to control work in the exclusion zone and other areas where hazardous conditions may exist. An HWP will be issued in accordance with the procedures specified in the PHSP (WA, 1998c) and in accordance with HSP 17.1, Hazardous Work Permits. The following information will be described or referenced in the HWP:

- Scope of work to be performed;
- Anticipated radiological, safety, and industrial hygiene conditions;
- PPE and respiratory protection requirements;
- Radiological and industrial hygiene monitoring requirements;
- Dosimetry requirements;
- Work Plan and/or Activity Hazard Analysis;
- Period for which the HWP is valid; and,
- Additional requirements for entry.

5.2.2 Boundaries

The work areas will be enclosed by boundary ropes or ribbons supported with stanchions. The placement of the stanchions and boundaries will be controlled by the RSO and/or the SHSO to facilitate access to the work area for equipment. The boundaries will be set up and signs posted in accordance with the PHSP and the RPP.

5.2.3 Heat Stress

To minimize the effects of heat related injuries, an area will be established to conduct entrance/exit activities, sample preparation and other support functions. This area will be covered with a portable tarp, when necessary, to provide the workers with shade. The controls associated with heat stress are specified in the PHSP. The SHSO shall ensure that all workers are aware of the

signs and symptoms of heat stress, engineering control measures, and the need to replenish body fluids during morning tailgate safety meetings (TSMs). The buddy system will also be used to help monitor heat stress symptoms while working. Integrated heat stress monitoring will be performed daily to determine the proper work/rest regiment.

5.2.4 PPE

Workers in the exclusion zone will wear modified Level D PPE in accordance with the PPE selection matrix in the PHSP unless otherwise specified in the HWP for the task.

Modified Level D PPE will consist of the following when specified in the HWP:

- Hard hat, American National Standards Institute (ANSI) approved;
- Steel-toed chemical resistant boots or boot covers;
- Chemical resistant coveralls;
- Safety glasses with side shields;
- Chemical resistant gloves inner and outer gloves;
- Full tape of wrists, and ankles; and,
- Leather work gloves.

5.2.5 Decontamination Procedures

The decontamination area will be set up adjacent to the exclusion zone (EZ) for equipment and personnel. The area will be delineated with traffic cones and/or radiological barrier tape. The decontamination zone will be posted with the appropriate warning sign.

Decontamination procedures will be conducted in accordance with Section 10 of the PHSP for personnel decontamination, equipment decontamination and PPE decontamination. For radiological hazard work decontamination the personnel will frisk themselves and, if contamination is found, the RCT will be notified to determine the extent of contamination and direct/supervise decontamination.

Equipment and respirators (if used) will be cleaned and, prior to removal from the decontamination area, will be survey by the RCT in accordance with Section 10 of the PHSP.

5.2.6 Training

Personnel performing activities associated with the RAs in the Southwest Trenches Area, Ra/Sr Treatment Systems Area, and Domestic Septic System Areas will receive training covering this Work Plan.

Applicable on-site project personnel shall have:

- Completed at least 40 hours of hazardous waste operations-related training, as required by Occupational Safety and Health Administration (OSHA) Regulation 29 CFR 1910.120;
- Completed an 8-hour refresher course within the past 12 months if they completed the 40-hour training more than 12 months prior to the start of the field activities;
- Training covering the Contingency Plan and General Emergency Response Procedures (WA, 1998e);
- A minimum of three days of actual field experience under the direct supervision of a trained, experienced supervisor. The SC shall have also completed an additional 8 hours of relevant supervisory health and safety training;
- Hazard Communications training in accordance with Section 15 of the PHSP;
- Site Hazard Briefing to include instructions on emergency response procedures, location of emergency equipment, and location of emergency notification list; and,
- Attend Tailgate Safety Meetings.

Applicable workers who will enter radiological control areas shall have:

- Successfully completed Radiological Worker II training in accordance with the RPP;
- Completed site-specific Radworker training in accordance with the RPP;
- Training in accordance with the requirements specified in SQP-3.2, "Indoctrination and Training" (WA, 1998d), for the specific job assignments; and,
- General Employee Radiological Training (GERT) for those workers that are not Radiological Worker II trained and routinely entering controlled areas encountering radiological barriers, postings or radioactive material.

Employees engaged with hazardous waste materials shall have:

- Initial Assignment training as defined in Section 14 of the PHSP;
- Training on the Health and Safety Planning Documents as defined in Section 14 of the PHSP;
- PPE Training;
- Verification of respirator fit test (if respirator usage is required);
- Medical Surveillance; and,
- Training on preparing hazardous materials for shipment.

All visitors entering the site areas that require Level A, B, or C PPE for entry will provide evidence of having completed the 40-hour HAZWOPER course. Visitors entering the CZ will be

escorted and required to complete GERT training. The PHSM may deny site access to any personnel with appropriate justification.

Two or more people certified in First Aid, CPR and Blood Born Pathogens will be on-site at all times when hazardous waste operations are conducted.

5.2.7 Buddy System

The buddy system will be utilized to protect personnel in the work area. At least two persons will be required to be in the work area when work is conducted in the exclusion zone, which might result in worker contamination or injury.

The buddy system is a method of organizing employees into work groups and is designed to provide those employees with assistance when needed. Each employee in a work group is designated to be observed by at least one other person. Assignment of designated partners should take place during the TSM.

The responsibility of the buddy is to:

- Provide assistance, if needed;
- Maintain line of sight contact or verbal contact with workers in the EZ;
- Observe for signs of chemical or physical trauma or heat stress such as:
  - changes in complexion and skin discoloration;
  - changes in coordination or demeanor;
  - excessive saliva and pupillary response; or,
  - changes in speech pattern;
- Periodically verify the integrity of all protective clothing; and,
- Notify the FC if emergency help is needed.

Entry to or exit from the EZ under the conditions described earlier without a designated partner is prohibited.

5.2.8 Safety Equipment

In addition to other equipment specified in this Work Plan, the following safety equipment will be staged in the support zone:

- First aid kit;
- Portable eyewash station and hand shower;
- Hearing protection;
- Spill kit;
- Air horn;

- Directions to medical facilities;
- Heat stress monitoring equipment;
- Portable radio for emergency communications; and,
- Fire extinguisher.

5.2.9 Spill Containment

In addition to the mitigation measures presented in this Work Plan, a spill and discharge control plan has been prepared to provide contingency measures for potential spills and discharges from handling and movement of potentially hazardous wastes such as contaminated soil and ground water encountered during field activities. This spill and discharge control plan is in the PHSP and the CPGERP.

5.2.10 Air Monitoring

Air monitoring is essential to ensure that all field personnel will be adequately protected from airborne contaminants. Air monitoring will be conducted in accordance with HSP 6.1-Air Monitoring, HSP 14.1-Airborne Radioactivity Monitoring and Section 11 of the PHSP and the RPP.

General area radiological air monitoring locations will be near/in the work area having the highest potential for generating airborne radioactive contaminants. This monitoring will be conducted daily as may be required by the RSO.

If the general area air samples indicate that workers may be exposed to airborne radioactive contaminants that are >10% of the derived air concentration (DAC), listed in 10 CFR 835, Appendix A, then personal air samples (8-hr TWA) may additionally be used to monitor worker exposure and the RSO will take steps to reduce exposure through engineering controls.

All personal, integrated air monitoring samples and direct reading instrumentation readings taken for the purpose of determining appropriate H&S precautions shall be collected/taken in the approximate “breathing zone” of site personnel and integrated over an appropriate time interval. As appropriate, selective monitoring of high-risk workers (i.e. those who are closest to the source of contamination generation) will be conducted.

Real-time continuous monitoring during waste excavation to assist in identification of hazards will consist of: visual inspection; radiological survey instrument readings; PID measurements; and, respirable dust monitor data. In addition, air monitoring for radionuclides will be conducted daily during the excavation and Time Weighted Average (TWA) monitoring will be conducted periodically for respirable dust, total, dust, and VOCs (diffusion badge). Use of Level C (or higher) protection will be utilized whenever justified by site conditions as presented in this RA Work Plan and the PHSP.

Direct read instruments (PID) will be used to monitor VOCs. VOCs are not likely to be encountered, however, if the PID has a reading above the action levels presented in the PHSP then the level of PPE in use will be assessed immediately and modified as necessary. A grab air sample

may be collected and analyzed to better define airborne constituents. All available data will be evaluated for selection of the PPE level and the HWP will be modified if necessary.

Dust will be monitored in the form of nuisance respirable dust and nuisance total dust and, if the action levels in Table 5-1 are exceeded, appropriate measures will be taken. Engineering controls, such as dampening the area with water, will be used where practical for maintaining acceptable dust concentration levels.

The appropriate air monitoring equipment will be acquired and assessed for suitability prior to the readiness review. All equipment will be maintained and calibrated in accordance with manufacturer's recommendations, SOP 25.1-Radiological Surveys and Instrumentation, and HSP 14-Airborne Radioactivity Monitoring.

Air monitoring will be conducted daily or until collected data is sufficient to predict exposures to airborne contaminants.

Table 5-1 Airborne Radiological and Chemical Action Levels

Compound	Action Level	Action
Radionuclides	10% DAC	Action for all action levels to include the following progressive steps: • Notify SHSO and RSO of concentrations; • SHSO or RSO to stop work or apply engineering controls, as necessary; • SHSO or RSO to decide if upgrade of PPE to Level C with full-face respirators with organic/HEPA cartridges is necessary; and, • Ensure 8-hr TWA exposure is below PELs.
Nuisance Respirable Dust	2.5 mg/m^3	
Nuisance Total Dust	7.5 mg/m^3	
VOCs	5 ppm	

Abbreviations:

DAC	Derived Air Concentration
HEPA	High-efficiency particulate air
hr	hour
mg/m^3	milligrams per cubic meter
PELs	Permissible Exposure Levels
PPE	personal protective equipment
ppm	parts per million
RSO	Radiation Safety Officer
SHSO	Site Health and Safety Officer
TWA	time-weighted average
VOCs	volatile organic compounds

6. QUALITY ASSURANCE

This section presents the quality assurance and control issues related to the scope of work described in this document. The objective of this section is to provide a framework to ensure that quality is integrated within every aspect of the project work. The section is prepared in conjunction with the Final Project Quality Assurance Plan (QAPP) (WA 1998b) by referencing applicable and appropriate sections of the QAPP.

Personnel involved in conducting or supervising the work presented in this work plan are responsible for certifying that they have been instructed in applicable sections of the work plan, including health and safety, as may effect their work. This certification will be obtained, documented and filed for each effected worker by the Project Task Leader, or designee, in accordance with the requirements outlined in the QAPP.

6.1 Organization and Responsibilities

Section 2 of the QAPP is applicable in its entirety. Figure 1-1 presents the project-specific organization chart. Roles and responsibilities of individuals in the organization chart are defined in the QAPP.

6.2 Quality Control Management

Section 3 of the QAPP is applicable in its entirety. The SOPs, Specifications and other supporting documents prepared for this work comply with specific requirements of the QAPP. This section serves as the Total Quality Control Plan for these removal actions. Inspections, construction meetings and RA team quality control meetings will be held to discuss all aspects of work that impact quality.

6.3 Document Control and Records Management

Section 4 of the QAPP is applicable in its entirety. The RA will result in development of a number of documents and records that are to be managed as set fourth in this section. Typical records that will be generated under this task include: bid requests, purchase orders, personnel qualifications, certifications and training records, health and safety records, field activity logs, photographs and negatives, etc. Specification Section 01300 contains the submittal register required from the contractor. The Construction Engineer will be responsible for maintenance and updates for the specified project submittals.

6.4 Personnel Training and Qualification

Section 5 of the QAPP is applicable in its entirety. The fieldwork will be conducted by individuals who are physically capable of performing the work; have demonstrated capability to perform the specific functions in accordance with the approved procedures and work plan; and are familiar with technical aspects of the equipment and procedures that are used. Field personnel will be trained to meet the requirements of the Health and Safety Plan and quality effecting tasks prior to commencement of work. Subcontracted services will be selected based on a demonstrated record of experience and certifications necessary to perform safely and accurately the assigned project tasks.

6.5 Instructions, Procedures, and Drawings

Section 6 of the QAPP is applicable in its entirety. The applicable SOPs and SQPs developed for the project and specific SOPs, SQPs, and Specifications were developed in accordance with this section of the QAPP. Additional SOPs and SQPs may be developed as needed according to the guidelines of the QAPP.

6.6 Procurement Quality Assurance Activities

Section 7 of the QAPP is applicable in its entirety. This section describes the requirements for the preparation, review, and approval of procurement documents and changes thereto to ensure that quality assurance controls are maintained.

6.7 Field Activities

Section 8 of the QAPP is applicable in its entirety. This section describes the field operations associated with the environmental investigation activities to assure that sampling strategies are implemented consistent with the project planning documents, including this work plan and its associated sampling and analysis plan.

In addition to the field sampling activities, fieldwork activities will be conducted under this Quality Assurance section. The following sections describe the field operations associated with the environmental removal action activities to assure that fieldwork is implemented consistent with the project planning documents. The QA/QC will be implemented using the graded approach. Each subcontractor will be held responsible for their work, and shall perform all first-line acceptance inspections. The Project Engineer and Project Task Leader will be responsible for inspection and accepting completed work from subcontractors. The Project Quality Assurance Manager and Project Manager have final acceptance authority for the quality of all removal action work. A three-phase QC system consisting of preparatory, initial and follow-up phase inspections will be implemented as discussed in Section 13 of the QAPP. The Project Quality Assurance Specialist (PQAS) will be responsible for ensuring that testing and inspections are in accordance with accepted industry methods and practices. The PQAs will be on site periodically during fieldwork. Additional PQASs will be provided as necessary. PQAS responsibilities include but are not limited to: conducting inspections, reviewing schedules, conducting site surveillances, generating daily reports and

authorizing temporary work stoppage if work practices or procedures are determined to be incorrect or out of compliance and cannot be immediately corrected.

6.8 Analytical Activities

Section 9 of the QAPP is applicable in its entirety. This section of the QAPP describes the specifications and controls that the laboratories are required to perform in support of the project tasks. Laboratory pre-qualifications consistent with this section are stipulated in the procurement requirements.

6.9 Design Control

Section 10 of the QAPP is applicable in its entirety. This section of the QAPP describes the controls to be implemented during design activity and applies to each stage of development from conceptual design to final design. The term "design" used throughout the section refers to specifications, drawings, design criteria, and component performance requirements for items and engineered environmental systems that are used in performance of the removal actions.

6.10 Report Preparation

Section 11 of the QAPP is applicable in its entirety. This section describes the methods and requirements for the preparation, review, and approval of Project reports. The report types anticipated under this removal action include but are not limited to removal action completion reports, risk based modeling reports, soil compaction reports, and technical memorandums containing field data summary reports.

6.11 Review of Work Activities

Section 12 of the QAPP is applicable in its entirety. This section describes the technical and formal peer review required on end products of the project activities. These reviews include technical and peer review of all end products of project activities.

6.12 Inspections

Section 13 of the QAPP is applicable in its entirety. This section provides the criteria for the performance of inspection on removal action work. These inspections typically cover field activities that require planned inspections to assess that the quality of work meets project standards. A three-phase inspection system will be utilized during the RA activities. Preparatory and initial phase inspections will be conducted for each phase of work, and follow-up phase inspections will be conducted weekly for all tasks lasting more than one week.

6.13 Calibration and Maintenance of Measuring and Test Equipment

Section 14 of the QAPP is applicable in its entirety. This section of the QAPP describes the responsibilities and methods for the control, calibration, and preventative maintenance of measurement and test equipment, used in activities affecting quality to assure their proper operation.

6.14 Test Control

Section 15 of the QAPP is applicable in its entirety. This section of the QAPP describes the controls to be implemented for the performance of tests required to verify the acceptability of the environmental removal action for the project task.

6.15 Non-Conformance Control and Corrective Actions

Section 16 of the QAPP is applicable in its entirety. This section of the QAPP describes the responsibilities and methods for all personnel to promote and ensure continuous improvement of items and work processes thereby enhancing the effectiveness of the program or project tasks and resultant quality.

6.16 Change Control

Section 17 of the QAPP is applicable in its entirety. This section of the QAPP addresses the process to be implemented on a project task for changes from the Work Plan, procedures, SAP, WMP or specific requirements. In the case where actual field conditions result in a significant impact to the way work can be completed, a change can be made to the work process under this guidance.

6.17 Audits and Surveillance

Section 18 of the QAPP is applicable in its entirety. This section of the QAPP establishes the methods and responsibilities for planning, scheduling, and performing audits, surveillance, and management assessments. Planned and scheduled audits shall be performed by the PQAS or designee, and by the construction contractor's QA staff, to verify compliance with all aspects of the WP, SAP, WMP, and specifications. In addition, one external audit will be performed by a qualified independent auditor

7. REFERENCES

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WA, 1997d, Final As Low As Reasonably Achievable (ALARA) Program, Management, LEHR, University of California at Davis, California, June, 1997. WA, 1998a,

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WA, 1998b, Final Quality Assurance Project Plan for Environmental Waste Management, LEHR, University of California at Davis, California, Weiss Associates, Rev 1, February.

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WA, 1998f, Final Health and Safety Procedures, LEHR, University of California at Davis, California, Weiss Associates, January 1998.

WA, 1998g, Final Standard Operating Procedures, LEHR, University of California at Davis, California, Weiss Associates, March, 1998.

WA, 1998h, Final Radiological Protection Program, LEHR, University of California at Davis, California, Weiss Associates, January, 1998.

APPENDIX A

CONSTRUCTION SPECIFICATIONS AND DRAWINGS

Appendix A-1 Construction Specifications

Appendix A-2 Construction Drawings

APPENDIX A-1

CONSTRUCTION SPECIFICATIONS

CONTENTS

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SECTION 01010	SUMMARY OF WORK
SECTION 01330	SUBMITTAL PROCEDURES
SECTION 01410	ENVIRONMENTAL PROTECTION
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SECTION 02100	CLEARING AND GRUBBING
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SECTION 02831	CHAIN LINK FENCE
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SECTION 01010

SUMMARY OF WORK

1. GENERAL

1.1 REFERENCES

Uniform Building Code (UCB)	Uniform Building Code as Amended by the 1995 California Building Code, International Conference of Building Officials, 1994.
University of California at Davis (UC Davis)	Campus Standards and Design, University of California at Davis, 1997.
Weiss Associates (WA), 1998a	Final Quality Assurance Project Plan for Environmental Waste Management, Laboratory for Energy-Related Health Research (LEHR), University of California at Davis, California, Weiss Associates, Rev 1, February 1998.
WA, 1997b	Final Standard Quality Procedures for Environmental Restoration/Waste Management, Laboratory for Energy-Related Health Research (LEHR), University of California at Davis, California, Weiss Associates, January 1998.
WA, 1998c	Final Standard Operating Procedures, Laboratory For Energy-Related Health Research (LEHR), University of California at Davis, California, Weiss Associates, March 1998.
WA, 1998d	Final Project Health and Safety Plan for Environmental Restoration/Waste Management, Laboratory for Energy-Related Health Research (LEHR), University of California at Davis, California, Weiss Associates, January 1998.
WA, 1998e	Final Health and Safety Procedures, Laboratory For Energy-Related Health Research (LEHR), University of California at Davis, California, Weiss Associates, January 1998.

WA, 1998f — Final Radiological Protection Program, Laboratory For Energy-Related Health Research (LEHR), University of California at Davis, California, Weiss Associates, January 1998.

WA, 1998g — Final Work Plan For Removal Action at Southwest Trenches, Ra/Sr Treatment Systems, and Domestic Septic System Areas, Laboratory For Energy-Related Health Research (LEHR), University of California at Davis, California, Weiss Associates, May 1998.

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WA, 1998 — Final Contingency Plan and General Emergency Response Procedures Laboratory for Energy-Related Health Research (LEHR), University of California at Davis, California, Weiss Associates, March 1998.

WA, 1997a — Final As-Low-As-Reasonably-Achievable Program, Laboratory For Energy-Related Health Research (LEHR), University of California at Davis, California, Weiss Associates, June 1997.

1.2 DEFINITIONS

UC Davis – University of California, Davis

DOE – United States Department of Energy

LEHR – Laboratory for Energy-Related Health Research at University of California, Davis

ITEH – Institute of Toxicology and Environmental Health at University of California, Davis

Construction – Removal action activities related to environmental restoration of DOE areas at the LEHR Facility

Construction Documents – Project drawings, specifications, revisions, submittals, reports, and all other materials essential for the project.

Engineer – Weiss Associates, whose authority will be as stipulated in Paragraph 1.3.1.

Contractor – General Contractor responsible for the completion of the project work as specified in the Work Plan, project drawings and specifications.

Project – Removal of waste and contaminated materials as part the environmental restoration program at the LEHR Facility.

Site – Three DOE Areas at LEHR including the Southwest Trenches, Ra/Sr Treatment Systems, Domestic Septic System Areas.

... or approved equal, ... or approved equivalent – Designates an alternative to a construction product or detail called for in the project drawings/specifications, which is approved in writing by the Engineer.

... immediately – As soon as practical, giving the referenced activity the top priority in management or in performance of work.

... in a timely manner – Sufficient time in advance to allow for all necessary operations to be conducted prior to the time that the required activity must be completed.

WA – Weiss Associates

1.3 FIELD ENGINEERING

1.3.1 The Engineer

The Contractor under technical control of the Engineer shall perform all construction work associated with the removal of waste and contaminated materials. The extent of the Engineer's technical control shall be as defined in these specifications.

1.3.2 Field Engineering to be part of Contractor's Responsibility

Notwithstanding the overall Engineer's technical control of the Project, the Contractor shall be responsible for the following engineering activities:

a) Underground utilities location, protection, relocating and testing;

b) Drywell drilling; and,

c) Excavation shoring.

1.4 GENERAL SUBMITTALS

The Contractor shall submit the following to the Engineer in accordance with applicable sections of these specifications.

1.4.1 Pre-Construction Submittals

Commencement of work shall not occur until all preconstruction submittals, as specified herein, have been submitted to and reviewed by the Engineer, unless the Engineer makes specific exceptions.

Within 10 calendar days of the Notice to Proceed, the Contractor shall submit to the Engineer for review and approval the following required preconstruction submittals:

a) Construction Schedule, which shall be a time-scaled logic diagram displaying the project activities to comply with the contract schedule; and

b) Excavation Shoring Plan, which conforms to Section 02220.

1.4.2 Administrative Submittals

The following Administrative Submittals shall be made by the Contractor to the Engineer as specified in applicable sections of these specifications and within the time-frame outlined herein:

a) Submittals as required by each section of these specifications shall be made not less than 7 working days prior to the respective item of work to begin or to be ordered from the supplier, whichever applies;

b) The Engineer will review submittals and indicate deficiencies in the submittals within 5 calendar days of receipt. Following review and with the Engineer's concurrence, the Contractor may proceed with the subject work or order of materials;

c) Weekly Progress Reports shall be made as described in Paragraph 3.3.3;

d) Records of Materials and as-built drawings shall be submitted by the Contractor to the Engineer within 30 working days after the completion of the Project; and,

e) Utility replacement material (catalog data), connection details, and clean-out details.

1.5 GENERAL INTENTION

It is the declared and acknowledged intention and meaning to provide and secure for the removal of waste and contaminated materials and site environmental restoration at the LEHR Facility as shown on the project drawings and specified herein. These specifications do not address waste shipping or disposal. Waste materials shall be handled and stored on-site for future disposal in accordance with the Waste Management Plan.

1.6 LOCATION

The work shall be performed at the LEHR Facility, Davis, California, as shown on drawings G-1 and G-2.

1.7 GENERAL DESCRIPTION OF WORK

1.7.1 Southwest Trenches

The Contractor shall furnish the supply of all equipment and materials to perform the following:

a) Mobilizing equipment and personnel to the Site;

b) Verifying existing conditions, verification of underground utilities;

c) Installing temporary site access controls, including fencing;

d) Conducting site setup activities such as implementing environmental protection measures, protecting site features such as ground water monitoring wells, designated trees, and establishing storage areas;

e) Removing pavement, fencing, and surface vegetation that interferes with removal activities, trees will be removed by UC Davis;

f) Relocating and/or protecting any utilities that interfere with removal activities;

g) Excavating chlordane-contaminated surface soil;

h) Trenching in a grid pattern to locate the waste disposal pits;

i) Excavating and removing waste disposal cells;

j) Segregating and sorting excavated the waste;

k) Assisting the Engineer with sampling of excavation limits (i.e. sidewalls and bottoms) for verification that waste has been adequately removed (concurrent with excavation and sorting);

l) Stockpiling of the waste streams;

m) Loading of the waste streams into containers for storage;

n) Backfilling and compacting the excavations;

o) Restoring site including paving and fence installation;

p) Other incidental work as described on the project drawings and specifications and as may be later added in change orders; and,

q) Demobilizing and related work.

1.7.2 Ra/Sr Treatment Systems Area

The Contractor shall furnish the supply of all equipment and materials to perform the following:

a) Mobilizing equipment and personnel to the Site;

b) Verifying existing conditions, verification of underground utilities;

c) Installing temporary site access controls, including fencing;

d) Locating the underground utilities;

e) Conducting site setup activities such as implementing environmental protection measures, protecting site features such as ground water monitoring wells, and establishing storage areas;

f) Removing pavement, fencing and surface vegetation that interferes with removal activities;

g) Relocating and/or protecting any utilities that interfere with removal activities;

Area I

h) Excavating and removing the radium tank effluent pipe, distribution box and leach trench;

i) Assisting the Engineer with sampling to define the horizontal extent of contamination around three drywells;

j) Drilling out and removing three drywells and associated leach trench;

Area II

k) Excavating and removing all piping associated with the Imhoff and Radium tanks;

l) Excavating and removing the strontium leachfield;

m) Excavating and removing the radium tank;

n) Excavating and removing the Imhoff tanks;

o) Segregating and sorting of excavated soil/gravel (concurrent with excavation);

p) Crushing and demolishing tanks and concrete structures (concurrent with excavation);

q) Stockpiling of waste streams;

r) Loading of waste streams into containers for storage;

s) Assisting the Engineer with sampling of excavation limits for verification that contaminated soil has been adequately removed (concurrent with excavation and sorting);

t) Backfilling and compacting of the excavations;

u) Restoring site including paving, fence installation;

v) Other incidental work as described on the project drawings and specifications and as may be later added in change orders; and,

w) Demobilizing and related work.

1.7.3 Domestic Septic Systems Areas

Only Septic Systems No. 3 and 6 require removal actions. The sequence of removal action activities at these two Domestic Septic System Areas is summarized below. The Contractor shall supply all equipment and materials to perform the following:

a) Mobilizing equipment and personnel to the Site;

b) Verifying existing conditions, verification of underground utilities;

c) Installing temporary site access controls, including fencing;

d) Locating the underground utilities;

e) Conducting site setup activities such as implementing environmental protection measures, protecting site features such as ground water monitoring wells, and establishing storage areas;

f) Removing pavement that interferes with removal activities;

g) Relocating and/or protecting any utilities that interfere with removal activities;

h) Assisting Engineer with subsurface soil sampling at Domestic Septic System No. 3;

i) Excavating and removing soil contamination associated with Domestic Septic System No. 6;

j) Stockpiling of waste streams;

k) Loading of waste streams into containers for storage;

l) Assisting Engineer with sampling of excavation limits for confirmation of attainment of RAOs;

m) Backfilling and compacting of the excavations;

n) Restoring site including paving;

o) Other incidental work as described on the project drawings and specifications and as may be later added in change orders; and,

p) Demobilizing and related work.

1.8 SITE BACKGROUND

The Site was utilized by DOE from the 1950 through the 1980s to conduct radiological studies on laboratory animals. This research generated liquid and solid waste streams, which were stored on-site. The chemicals-on-concern in each RA area were identified during previous environmental investigations and presented in the Engineering Evaluation/Cost Analysis (EE/CA) Report (WA, 1998).

The RA will be conducted in three DOE areas within the LEHR Facility, described as the Southwest Trenches Area, Ra/Sr Treatment Systems Area, and the Domestic Septic System Areas. The RA at the Southwest Trenches is scheduled to begin in the spring of 1998. The RAs at the Ra/Sr Treatment Area and Domestic Septic System Areas are scheduled to begin in the spring of 1999.

The objectives of this non-time critical RA are to lower human health risks, mitigate ground water impacts, mitigate ecological risks, and restore the DOE areas for release to UC Davis. These objectives shall be met by the excavation and removal of waste materials and contaminated soil from the RA areas.

1.9 PROJECT INFORMATION

1.9.1 Contract Drawings and Specifications

One set of reproducible contract drawings and one copy of specifications will be furnished to the Contractor.

The work shall conform to the following contract drawings, all of which are part of these specifications.

Plan Sheet	Drawing Title
G-1	Title Sheet
G-2	Site Plan, Vicinity Map, List of Drawings, Abbreviations
G-3	General Notes and General Legend
C-1	Removal Activities Site Layout
C-2	Southwest Trenches, Existing Features
C-3	Southwest Trenches, Removal Activities
C-4	Ra/Sr Treatment Area, Exiting Features
C-5	Ra/Sr Treatment Area, Removal Activities
C-6	Ra/Sr Treatment Area, Tank Excavation Sections
C-7	Ra/Sr Treatment Area, Ra Drywell Excavation Sections
C-8	Domestic Septic Tanks No. 6, Plan
C-9	Construction Details

Plan Sheet	Drawing Title
C-10	Construction Details

1.10 PROJECT SCHEDULE, PHASING, AND TIME CONSTRAINTS

1.10.1 Commencement, Prosecution, and Completion of Work

Within 10 calendar days of the Notice To Proceed, the Contractor shall submit to the Engineer all required preconstruction submittals as defined in Paragraph 1.4.

Following approval of the preconstruction submittals by the Engineer, the Contractor shall be required to:

a) Commence work within five working days of final approval;

b) Prosecute the work diligently; and

c) Complete the entire work, except as noted in this Paragraph, within the approved project schedule including site restoration and demobilization.

1.10.2 Construction Schedule Control

The Contractor shall report to the Engineer on the schedule maintenance in the manner of submittals as stipulated in Paragraph 3.3.3.

1.11 LEGAL RELATIONS AND RESPONSIBILITIES

1.11.1 PARTIES INVOLVED IN REMOVAL ACTION

The roles of the Parties in the Removal Action at LEHR are as follows:

Weiss Associates – Engineer and DOE's representative on the removal actions at LEHR;

The Contractor – General Contractor responsible for the completion of the project work as specified in the project drawings and specifications; and,

Subcontractors – the Contractors and/or Vendors, who are contracted by the Contractor to perform specific tasks in the trades of their specialization as specified in the project drawings and specifications and as determined by the Contractor.

1.11.2 RESPONSIBILITIES OF PARTIES AND LIMITATIONS THEREOF

1.11.2.1 Engineer

1.11.2.1.1 Engineer will be responsible for the following:

a) Coordinating the combined effort of team contractors and subcontractors while maintaining relationships with DOE and the public:

   1) Relations with the public; and,

   2) Coordinating with DOE when changed conditions are encountered as described in Paragraph 1.11.2.1.1.c.

b) Monitoring the compliance of the work with the approved drawings and specifications by performing the following:

   1) Observing the work performed by the Contractor; and,

   2) Approving the Contractor's submittals as specified in the project specifications or rejecting the submittals and requiring re-submittal to achieve compliance with the project intent;

c) Addressing potential changes in field conditions by performing the following:

   1) Examining the field condition as it becomes apparent or as it is discovered by the Contractor or their subcontractors and identifying it as a change from the original approved drawings and specifications;

   2) Coordinating with the DOE engineering and economical decisions regarding the changed condition;

   3) Preparing revised drawings and specifications as required to address the changed condition; and,

   4) Reviewing the Contractor's change proposal, with either added cost or credit to the basic contract, coordinating the review of the change proposal with DOE and the Contract/Subcontract Administrator, and approval of the change proposal or requiring its revision by the Contractor.

d) Providing sampling and analytical services for the management of environmental protection, excavation limits and waste materials generated from removal action activities.

*1.11.2.1.2 Weiss Associates **will not be** responsible for the following:*

a) Selection of methods of work, tools and personal instruments by the Contractor's and their subcontractor's personnel, except as required for compliance with the project intent;

b) The Contractor's and their subcontractor's personnel Health and Safety training and medical surveillance;

c) The Contractor's and their subcontractor's personnel compliance to the Project Health and Safety Plan, their Personal Protective Equipment (PPE), their personal safety measures and safety measures for protection of surrounding personnel, public and property;

d) Any injury, damage or loss caused by the Contractor or their subcontractors, regardless or whether the Contractor or their subcontractors are found to be at fault, at negligence, or any other violation;

e) The Contractor and their subcontractors performance of their contractual duties, including their default(s) in terms of technical schedule, cost and other performance aspects; and

f) Any actions of the Contractor or their subcontractors made in bad faith or in violation of law;

1.11.2.2 The Contractor

The Contractor shall be responsible for the following:

a) Performance of the removal action work as specified in the project drawings and specifications;

b) Performance of the work within the specified construction schedule;

c) Direct supervision of construction work with physical presence of a qualified superintendent or foreman at the Site at all times during construction activities;

d) Safety of workers, people and property at and around the project site, including the following:

1) All of the Contractor's crew and personnel;

2) All of the subcontractors' crews and personnel;

3) All of the property affected by the construction;

4) Preventing any unauthorized exposure of the workers to hazardous or contaminated materials that are present at the construction site;

5) Ensuring that excavations shall be covered and secured by temporary fencing at all times when site safety personnel are not present;

6) Providing adequate security and access control measures to minimize the possibility of unauthorized approach to the construction site, such as fences, gates, barricades, warning signs, etc.;

7) Conforming to the guidelines set forth in the Project Health and Safety Plan, including emergency response measures;

8) Maintaining barricades around areas when security fencing has been removed to facilitate work activities;

9) Maintaining a copy of the Project Health and Safety Plan, together with appropriate safety and first aid equipment at the project site at all times during RA activities; and,

10) Assuring that all workers and personnel of the Contractor and subcontractors have Health and Safety training as required by governing regulations and Project documents.

e) Identifying any changed conditions, immediately bringing it to the attention of the Engineer and addressing the changed field conditions as specified herein;

f) The Contractor will provide training records to Weiss Associates.

g) Immediately notifying the Engineer of any unexpected or unusual developments in the course of construction and taking approved emergency response measures in case of occurrence of an emergency; and,

h) Providing all the submittals to the Engineer as specified herein.

2. PRODUCTS

Not Used

3. EXECUTION

3.1 FACILITIES AND SERVICES

3.1.1 Temporary Utilities Services for Construction

The Contractor shall provide temporary utility connections for construction and disconnections upon completion of work, as necessary. If applicable, the Contractor shall install reduced pressure backflow-preventing devices on connections to water lines.

Reasonable amounts of temporary electricity and potable water will be made available to the Contractor without charge. Temporary electrical and water connections and operation will be coordinated with the ITEH Facilities Engineering Staff by the Engineer.

All temporary utility connections shall be provided in accordance with all applicable codes and regulations, such as National Electrical Code (NEC), National Electrical Manufacturers Association (NEMA), Uniform Plumbing Code (UPC) UC Davis Guidelines, and all applicable Solano County regulations.

3.1.2 Utility Relocation

The Contractor shall coordinate all cutovers, disconnection and re-activation operations with the Engineer. The Contractor shall minimize the disruption of utility services.

3.1.3 Contractor's Storage Area

The usage of this area is contingent upon coordination with the facility staff and with the activities for the planned additional site investigation. The exact location of the storage area shall be confirmed with the Engineer in the field.

If requested by the Contractor, additional storage area may be available, the exact location of which will be determined by the Engineer. At the conclusion of construction activities, the Contractor shall restore the Site to its original condition.

3.2 RESTRICTIONS OF OPERATIONS

3.2.1 Work Outside Regular Hours

If the Contractor desires to carry on work outside regular hours (6 a.m. to 6 p.m.), including Saturdays, Sundays, and UC Davis holidays, a request shall be submitted to the Engineer. The Contractor shall allow for one work day to enable satisfactory arrangements to be made by the Engineer for reviewing the work in progress.

If work is to be conducted during periods of darkness, the areas where the work continues shall be lighted in a manner approved by the Engineer.

Utility cutovers may be required to be made after normal working hours or on Saturdays, Sundays, and UC Davis holidays. Determination of whether utility cutovers shall be made during or after normal hours will be determined by the Engineer.

3.2.2 Historical and Archaeological Resources

The Contractor shall carefully preserve and report immediately to the Engineer items having possible historical or archaeological interest which are discovered in the course of work. The Contractor shall protect existing monuments, markers and structures.

The Contractor shall stop work if artifacts are discovered, and shall not resume work in the immediate area of concern, until allowed to proceed by the Engineer.

The Contractor shall subcontract with a qualified Archeologist to be available on a stand-by status. Upon discovery of any artifacts the Contractor's Archeologist shall be brought on-site for an evaluation of artifacts and conference with the Contractor and the Engineer.

3.2.3 Special Operating Conditions

The Contractor shall conduct all construction operations in such a manner as to minimize interruptions to the ITEH traffic, utilities, and any other facility operation.

The Contractor shall develop and maintain continuous noise and dust control measures. The specifics of these measures shall be outlined in the Site Health and Safety Plan. These measures shall consider the occupants of the neighboring property and the presence of the facility workers on-site. The Contractor shall provide a dust/visual screen to surround the RA areas for the duration of the project. The Engineer shall approve the dust/visual screen installation.

Noise/dust control measures will be strictly enforced (i. e. the construction operation may be stopped in the event that the noise or dust levels are higher than stipulated in the control measures).

The Contractor shall schedule operations in such a manner as to avoid loud activities during times of concern as may be requested by neighboring property occupants. Timing of unscheduled special events, which would be affected by removal action activities, will be provided to the Contractor with a two-day notice.

3.3 ACTIONS REQUIRED OF THE CONTRACTOR

3.3.1 Permits and Approvals

The Contractor shall be responsible for obtaining all permits and approvals as required. Permits are required for but are not limited to, tree removal, earthwork, piping work, hazardous work, and entering controlled areas.

3.3.2 Preconstruction Meeting

Three to five days prior to the start of construction activities, as arranged between the Contractor and the Engineer, a Preconstruction Meeting shall be held at the construction site, which shall include the Engineer, the Contractor's personnel responsible for the project, and the key subcontractors responsible personnel.

The Preconstruction Meeting shall address the following issues:

- Personal introduction of the parties involved in construction;
- Verifying the Contractor's readiness for the start of construction;
- Addressing the necessary requirements for the start of construction, such as:
  - Site access and security;
  - Utilities and other site facilities available to the Contractor;

- Verification/clearance of existing underground utilities;
- Safety measures at the Site, including coordination of efforts of construction parties in case of any emergency;
- Establishing procedures for Weekly Progress Reports and Meetings and other issues of communication between the Engineer and the Contractor; and
- Addressing other issues, which may arise in connection with the start of construction.

The Preconstruction Meeting minutes will be taken by the Engineer and distributed to the meeting parties.

3.3.3 Weekly Progress Reports

The Contractor shall submit to the Engineer accurate Progress Reports on a weekly basis by the close of business (COB) on Monday of the following week as established at the Preconstruction Meeting. The Progress Reports shall include the following:

a) All items of work completed within the last Progress Report period;

b) All items of work completed up to date;

c) All items of work to be completed to satisfy the project drawings and specifications;

d) Changed conditions that may be encountered during construction;

e) Daily Field Activity reports and Logs; and,

f) Photographs of work in progress.

The identified amount of the pending work shall be approved by the Engineer. The item of the pending work shall remain on the Progress Report as a separate line item until the pending work is completed.

The format of the Weekly Progress Report shall be reviewed and approved by the Engineer.

3.3.4 Weekly Progress Meetings

The Contractor shall have weekly Progress Meetings with the Engineer as established at the Preconstruction Meeting unless the Engineer re-schedules the Meeting at his/her discretion. The purpose of the Progress Meetings will be physical examination and approval of the work described by the Contractor in the Progress Reports, addressing changed conditions (if any), and other issues which may arise in the course of construction.

The items of work that in the Engineer's judgment need completion or correction to comply with the project drawings and specifications shall be so corrected by the Contractor.

The Engineer will take the Weekly Progress Meeting minutes; a copy of the minutes will be distributed to the Contractor.

3.3.5 Storm Protection

If a severe storm warning is issued, the Contractor shall take precautions to minimize any danger to persons, and protect the work and any nearby property and conform to Section 01410. Precautions shall include, but are not limited to: 1) covering al open excavations; 2) removing loose materials, tools and equipment from exposed locations; and, 3) removing or securing all other temporary work. Close openings in the work area if storms of lesser intensity pose a threat to the work or property.

3.4 MAINTAINING DOCUMENTS ON-SITE

The Contractor shall be required to maintain at least one copy of all Construction Documents, as defined in Paragraph 1.2, at the Site, in possession of the Contractor's staff responsible for the project.

3.5 CONTRACTOR'S RESPONSIBILITIES IN CASE OF CHANGE IN FIELD CONDITIONS

If during the course of work in the field, a change in condition is discovered which requires a change in detail, material, or manner or work from that specified in the project drawings or specifications, then the Contractor shall be required to perform the following:

a) Notify the Engineer immediately of the change in condition;

b) Stop work at the area that affects the changed condition pending issuance of a revision by the Engineer;

c) Upon obtaining the revision from the Engineer, verify immediately if the change would affect the cost of construction to the Contractor, either in case of additional cost or a saving to the construction cost;

d) If the change in field condition does affect the construction cost, immediately submit to the Engineer and to the Contract/Subcontract Administrator a change proposal, either reflecting the added cost to the basic contract or the credit to the basic contract. In the change proposal, the Contractor shall itemize and justify each item affecting the cost per change order policy defined by the Engineer; and

e) Upon approval by the Engineer, and by the Contract/Subcontract Administrator, if addition to the cost is requested, proceed with the work affected by the change in accordance with the revision issued by the Engineer. The latest revision, including the affected drawings and/or

specifications, together with the original drawing/specification and all intermediate revisions (if any) shall be maintained at the Site at all times.

3.6 HEALTH AND SAFETY REQUIREMENTS

3.6.1 Compliance

a) The Contractor shall be solely responsible for the health, safety, and welfare of its employees and subcontractors as related to performance in this project, and shall strictly comply with all health and safety rules, regulations, and guidance provided, as set forth in the LEHR Project Health and Safety Plan (WA 1998a). All other applicable rules, regulations, and guidance required by the Prime Contract or applicable Government agencies relating to the performance of this subcontract.

b) In addition, all work shall be conducted in a safe manner and shall comply with the requirements described in FAR Clause 52.236-13 "Accident Prevention (APR 1984)" as incorporated by reference in Section I.

c) The work to be performed under the requirements of this specification will be conducted at hazardous sites. Nothing in this clause shall amend any safety or reporting requirements established elsewhere in this specification.

3.6.2 Hazardous Waste/Substance Health and Safety Program

In accordance with OSHA 29 CFR 1910.120, the Contractor must have and maintain on-site a written hazardous waste/substance health and safety program in which training and medical monitoring is required and conducted. The Contractor shall adopt the LEHR Health and Safety Project Requirements as outlined in the Work Plan, PHSP, HSPs, SOPs, RPP, and CPGERP.

3.6.3 Health and Safety Pre-Work Meeting

All personnel under the supervision of the Contractor will be required to attend a health and safety "kick-off" meeting before commencing work. Personnel will be required to sign a PHSP Acceptance Sheet documenting their attendance and certifying their voluntary compliance with the procedures and restrictions established in the PHSP.

3.6.4 Personal Protective Equipment (PPE)

The Contractor shall be responsible for providing personal protective equipment (PPE) for any of the Contractor's site personnel, and shall be responsible for ensuring that its subcontractors and other personnel under the Contractor's supervision provide for, and utilize, the appropriate PPE as stated in the PHSP.

3.6.5 Machinery and Mechanical Equipment

The Contractor's equipment, and equipment from its subcontractors, shall comply with applicable requirements for motor vehicles and material handling equipment (drill rigs, front-end loaders, backhoes, etc.) as per the OSHA Construction Standards, 29 CFR 1926, Subpart O; and the PHSP. The owner/operator of all heavy and mechanized equipment shall be responsible for daily inspections and routine maintenance to ensure it is in safe working order prior to placing it in operation.

a) The Contractor shall certify all machinery and mechanized equipment under its supervision to be in safe working order.

b) All machinery and mechanized equipment shall be inspected by the drilling foreman (or equivalent) each day prior to use; inspections shall be documented.

c) All deficiencies identified during safety inspections shall be corrected at the Contractor's, or as applicable subcontractor's expense prior to placing the equipment in operation.

d) Only the Contractor personnel that have received adequate instruction and training will operate heavy equipment.

3.6.6 Audits and Inspections

The Contractor's work site may be periodically audited or inspected. Response to audit findings submitted by the Engineer and/or abatement of violations cited by regulators will be the responsibility of the Contractor. If a complaint is filed with the Department of Labor, the Contractor will provide assistance to the Engineer and the Regulatory Occupational inspector.

3.6.7 Accident/Incident Reporting

The Contractor shall report to the Engineer exposure data and all accidents resulting in death, trauma, or occupational disease, or incidents resulting in occupational overexposure. All accidents must be reported within 24 hours of their occurrence. All "near miss" accidents/incidents shall also be recorded and discussed as part of the Contractor's accident prevention program. The Contractor shall also submit an Incident Report of damage to property and/or equipment by the Contractor or their subcontractor personnel. All damage reports shall be submitted to the Engineer and the Contracts/Subcontracts Administrator within 24 hours of the occurrence.

END OF SECTION

SECTION 01330

SUBMITTAL PROCEDURES

1. GENERAL

1.1 SUBMITTAL CLASSIFICATION

Submittals are classified as follows:

1.1.1 Engineer Approved

Engineer approval is required for extensions of design, critical materials, deviations, equipment whose compatibility with the entire system must be checked, and other items as designated by the Engineer.

1.1.2 Information Only

All submittals not requiring Engineer approval will be for information only. They are not considered to be "shop drawings" within the terms of the Contract Clause referred to above.

1.2 APPROVED SUBMITTALS

The Engineer's approval of submittals shall not be construed as a complete check, but will indicate only that the general method of construction, materials, detailing and other information are satisfactory. Approval will not relieve the Contractor of the responsibility for any error which may exist, as the Contractor is responsible for dimensions, the design of adequate connections and details, and the satisfactory construction of all work. After submittals have been approved by the Engineer, no resubmittal for the purpose of substituting materials or equipment will be considered unless accompanied by an explanation of why a substitution is necessary.

1.3 DISAPPROVED SUBMITTALS

The Contractor shall make all corrections required by the Engineer and promptly furnish a corrected submittal in the form and number of copies specified for the initial submittal. If the Contractor considers any correction indicated on the submittals to constitute a change to the contract, a notice in accordance with the Contract Clause "Changes" shall be given promptly to the Engineer.

2. PRODUCTS

Not Used

3. EXECUTION

3.1 GENERAL

The Contractor shall make submittals as required by the specifications. The Engineer may request submittals in addition to those specified when deemed necessary to adequately describe the work covered in the respective sections. Units of weights and measures used on all submittals shall be the same as those used in the contract drawings. Each submittal shall be complete and in sufficient detail to allow ready determination of compliance with contract requirements. Proposed deviations from the contract requirements shall be clearly identified. Submittals shall include items such as: Contractor's, manufacturer's, or fabricator's drawings; descriptive literature including (but not limited to) catalog cuts, diagrams, operating charts or curves; test reports; test cylinders; samples; O&M manuals (including parts list); certifications; warranties; and other such required submittals. Submittals requiring Engineer approval shall be scheduled and made prior to the acquisition of the material or equipment covered thereby. Samples remaining upon completion of the work shall be picked up and disposed of in accordance with manufacturer's Material Safety Data Sheets (MSDS) and in compliance with existing laws and regulations.

3.2 SUBMITTAL REGISTER (ENG FORM 4288)

At the end of this section is one set of ENG Form 4288 listing items of equipment and materials for which submittals are required by the specifications; this list may not be all inclusive and additional submittals may be required. The approved submittal register will become the scheduling document and will be used to control submittals throughout the life of the contract. The submittal register and the progress schedules shall be coordinated.

3.3 SCHEDULING

Submittals covering component items forming a system or items that are interrelated shall be scheduled to be coordinated and submitted concurrently. Certifications to be submitted with the pertinent drawings shall be so scheduled. Adequate time, a minimum of 7 calendar days exclusive of mailing time, shall be allowed and shown on the register for review and approval. No delay damages or time extensions will be allowed for time lost in late submittals.

3.4 SUBMITTAL PROCEDURE

Submittals shall be made as follows:

3.4.1 Procedures

Submittals shall be delivered to Engineer by mail in accordance with the Submittal Register schedule accompanied by completed transmittal forms.

3.4.2 Deviations

The Contractor shall set forth in writing the reason for any deviations and annotate such deviations on the submittal. The Engineer reserves the right to rescind inadvertent approval of submittals containing unnoted deviations.

3.5 CONTROL OF SUBMITTALS

The Contractor shall carefully control his procurement operations to ensure that each individual submittal is made on or before the Contractor scheduled submittal date shown on the approved "Submittal Register".

3.6 ENGINEER-APPROVED SUBMITTALS

Upon completion of review of submittals requiring Engineer approval, the submittals will be identified as having received approval by being so stamped and dated. Two copies of the submittal will be retained by the Engineer and two copies of the submittal will be returned to the Contractor.

3.7 INFORMATION-ONLY SUBMITTALS

Normally submittals for information-only will not be returned. Approval of the Engineer is not required on information-only submittals. Engineer reserves the right to require the Contractor to resubmit any item found not to comply with the contract. This does not relieve the Contractor from the obligation to furnish material conforming to the plans and specifications; will not prevent the Engineer from requiring removal and replacement of nonconforming material incorporated in the work; and does not relieve the Contractor of the requirement to furnish samples for testing by the Engineer laboratory or for check testing by the Engineer in those instances where the technical specifications so prescribe.

3.8 STAMPS

Stamps used by the Contractor on the submittal data to certify that the submittal meets contract requirements shall be similar to the following:

CONTRACTOR

(Firm Name)

_____ Approved

_____ Approved with corrections as noted on submittal data and/or attached sheet(s).

SIGNATURE: _____

TITLE: _____

DATE: _____

Table 1. Submittal Register (Engineering Form 4288)

Item	Description	Date Due	Distribution	Remarks
1.	Biological Survey Report			
2.	Construction Schedule			
3.	Excavation Shoring Plan			
4.	Weekly Progress Report			
5.	Catalog Data			
6.	As – Built Drawings			
7.	Accident/Incident Reports			
8.	Fill Physical Test Results (LAB)			
	- Gradation /Sieve Analysis			
	- Classification			
	- Compaction Proctor (Moisture/Max Dens)			
	- Atterburg Limits			
	- Permeability Test			
9.	Fill Chemical Test Results. (LAB)			
	- Full Suite Rads			
	- EPA Metals			
	- Volatile Organics			
	- Semi volatile Organics			
	- PCBs/ Pesticides			
10.	Trench Shoring Drawings			
	- Stamped by P.E.			
11.	Asphalt Mix Design			
12.	Concrete Mix Design			
13.	Drilling Subcontractor Qualifications			
14.	Cement Grout Mix Design for Ra-Drywell Abandonment.			
15.	Ra-Drywell Report/Log			
16.	Base Course Lab Reports			
	- Sieve Analysis			
17.	Fence Manufacturer Product Data			

END OF SECTION

SECTION 01410

ENVIRONMENTAL PROTECTION

1. GENERAL

1.1 REFERENCES

Final Standard Operating Procedures (SOPs), (WA, 1998), Laboratory For Energy-Related Health Research (LEHR), University of California at Davis, California, Weiss Associates, March 1998.

Yolo-Solano Air Quality Management Districts Rules and Regulations, the State's Health and Safety Code (Section 41700

Federal National Emissions Standards for Hazardous Air Pollutants (40 CFR 61 Subpart H).

Federal Noise Control Act of 1972, as amended by the Quiet Communities Act of 1978 (40 CFR 204, 205 and 211).

1.2 RESPONSIBILITIES

1.2.1 Engineer

The Engineer shall monitor the Contractor’s work for compliance with the guidelines for Environmental Protection included in this specification.

1.2.2 Contractor

The Contractor shall ensure compliance with this section by subcontractors. The Contractor shall be responsible for the following:

a) Knowledge of Federal, State, and local laws, regulations, and permits concerning environmental protection, pollution control and abatement that are applicable to the Contractor's proposed operations and the requirements imposed by those laws, regulations, and permits;

b) Methods for protection of features to be preserved within authorized work areas like trees, shrubs, vines, grasses and ground cover, landscape features, air and water quality, fish and wildlife, soil, historical, archaeological, and cultural resources;

c) Procedures to be implemented to provide the required environmental protection, to comply with the applicable laws and regulations, and to correct pollution due to accident, natural causes, or failure to follow the procedures of the environmental protection plan;

d) Traffic control measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather, and the amount of mud transported onto paved public roads by vehicles or runoff;

e) Methods of protecting surface and ground water during construction activities; and

f) Training for Contractor's personnel during the construction period.

1.2.3 Meetings

The Contractor shall meet with the Engineer to alter the environmental protection methods as needed for compliance with the environmental pollution control measures outlined herein.

1.2.4 Notification

The Engineer will notify the Contractor in writing of any observed noncompliance with all applicable Federal, State or local laws or regulations, permits, and other elements of the Contractor's environmental protection responsibilities. The Contractor shall, after receipt of such notice, inform the Engineer of proposed corrective action and take such action when approved. If the Contractor fails to comply promptly, the Engineer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions shall be granted or costs or damages allowed to the Contractor for any such suspensions.

2. PRODUCTS

Not Used.

3. EXECUTION

3.1 GENERAL

The Contractor shall perform the work minimizing environmental pollution and damage as the result of construction operations. Environmental pollution and damage is the presence of chemical, physical, or biological elements or agents, which adversely affect human health or welfare. Environmental pollution and damage unfavorably alters ecological balances of importance to human life; affect other species of importance to humankind; or degrade the utility of the environment for aesthetic, cultural and/or historical purposes. The control of environmental pollution and damage requires consideration of land, water, and air, and includes management of visual aesthetics, noise,

solid water, as well as other pollutants. The environmental resources within the project boundaries and those affected outside the limits of permanent work shall be protected during the entire duration of this project.

3.2 LAND RESOURCES

The Contractor shall confine all activities to areas defined by the drawings and specifications. Prior to the beginning of any construction, the Contractor shall identify the land resources to be preserved within the work area. Except in areas indicated on the drawings or specified to be cleared, the Contractor shall not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, topsoil, and land forms without permission. No ropes, cables, or guys shall be fastened to or attached to any trees for anchorage unless specifically authorized. Where such emergency use is permitted, the Contractor shall provide effective protection for land and vegetation resources at all times as defined in the following subparagraphs. Stone, earth or other material displaced into uncleared areas shall be removed.

3.2.1 Work Area Limits

Prior to any construction, the Contractor shall mark the areas that need not be disturbed under this contract. Isolated areas within the general work area which are to be saved and protected shall also be marked or fenced. Monuments and markers shall be protected before construction operations commence. Where construction operations are to be conducted during darkness, the markers shall be visible. The Contractor's personnel shall be knowledgeable of the purpose for marking and/or protecting particular objects.

3.2.2 Landscape

Trees, shrubs, vines, grasses, land forms and other landscape features indicated and defined on the drawings to be preserved shall be clearly identified by marking, fencing, or wrapping with boards, or any other approved techniques. Trees within the project site, which might be damaged demolition and which are indicated to be left in place shall be protected by a six ft high fence. The fence shall be securely erected a minimum of five ft from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Any tree designated to remain that is damaged during the work under this contract shall be replaced in kind or as approved by the Engineer.

3.2.3 Unprotected Erodible Soils

Earthwork brought to final grade shall be finished as indicated. Side slopes and back slopes shall be protected as soon as practicable upon completion of rough grading. All earthwork shall be planned and conducted to minimize the duration of exposure of unprotected soils. Except in cases where the constructed feature obscures borrow areas, quarries, and waste material areas, these areas shall not initially be totally cleared. Clearing of such areas shall progress in reasonably sized increments as needed to use the developed areas as approved by the Engineer.

3.2.4 Stabilization Practices

Structural practices shall be implemented to divert flows from exposed soils, temporarily store flows, or otherwise limit runoff and the discharge of pollutants from exposed areas of the Site. Structural practices shall be implemented in a timely manner during the construction process to minimize erosion and sediment runoff.

3.2.4.1 Diversion Dikes

Diversion dikes shall have a maximum channel slope of two percent and shall be adequately compacted to prevent failure. The minimum height measured from the top of the dike to the bottom of the channel shall be 18 inches. The minimum base width shall be 1.8 m (six ft) and the minimum top width shall be two ft. The Contractor shall ensure that the diversion dikes are not damaged by construction operations or traffic. Diversion dikes shall be located as determined in the field by the Engineer.

3.2.5 Contractor Facilities and Work Areas

The Contractor's field offices, staging areas, stockpile storage, and temporary buildings shall be placed in areas designated on the drawings or as directed by the Engineer. Temporary movement or relocation of Contractor facilities shall be made only when approved. Temporary excavation and embankments for work areas shall be controlled to protect adjacent areas from despoilment.

3.3 THE WATER RESOURCES

The Contractor shall keep construction activities under surveillance, management, and control to avoid pollution of surface and ground waters. Toxic or hazardous chemicals shall not be applied to soil or vegetation when such application may cause contamination of the fresh water reserve. Monitoring of water areas affected by construction shall be the Engineer’s responsibility. Water areas affected by construction activities shall be monitored by the Engineer.

3.3.1 Washing and Curing Water

Waste waters directly derived from construction equipment decontamination and other construction activities shall not be allowed to enter water areas. Waste waters shall be collected, placed in 55-gallon drums or other approved containers, and stored on-site for future characterization and disposal. Waste water collection handling shall be in accordance with the Waste Management Plan.

3.3.2 Fish and Wildlife

The Contractor shall minimize interference with, disturbance to, and damage of fish and wildlife. Species that require specific attention along with measures for their protection shall be listed in the preconstruction biological survey report.

3.4 AIR RESOURCES

Equipment operation and activities or processes performed by the Contractor in accomplishing the specified construction shall be in accordance with the Yolo-Solano Air Quality Management Districts Rules and Regulations, the State's Health and Safety Code (Section 41700), the Federal National Emissions Standards for Hazardous Air Pollutants (40 CFR 61 Subpart H) and the Federal Noise Control Act of 1972 as amended by the Quiet Communities Act of 1978 (40 CFR 204, 205 and 211). Ambient Air Quality Standards set by the Environmental Protection Agency shall be maintained. Monitoring of air quality shall be the Engineer's responsibility. The Engineer shall monitor all air areas affected by the construction activities. Monitoring results will be periodically reviewed by the Engineer to ensure compliance with applicable State and Federal rules and regulations.

3.4.1 Particulates

Dust particles; aerosols and gaseous by-products from construction activities; and processing and preparation of materials, such as from excavation activities, soil handling and waste segregation screen shakers; shall be controlled at all times, including weekends, holidays and hours when work is not in progress. The Contractor shall maintain excavations, stockpiles, haul roads, permanent and temporary access roads, spoil areas, and other work areas within or outside the project boundaries free from particulates which would cause the air pollution standards to be exceeded or which would cause a hazard or a nuisance. Wet suppression methods will be permitted to control excavation and material handling particulates in the work area. Wet suppression, to be efficient, must be repeated to keep the disturbed areas and active storage piles damp at all times. The Contractor must have sufficient, competent equipment available to accomplish these tasks. Inactive storage piles will be kept covered at all times to prevent particulate emissions. Particulate control shall be performed as the work proceeds and whenever a particulate nuisance or hazard occurs.

3.4.2 Hydrocarbons and Carbon Monoxide

Heavy equipment and vehicles shall not be allowed to run idling unattended or more than 10 minutes. Hydrocarbons and carbon monoxide emissions from equipment shall be controlled to Federal and State allowable limits at all times.

3.4.3 Odors

Odors shall be controlled at all times for all construction activities, processing and preparation of materials.

3.4.4 Sound Intrusions

The Contractor shall keep construction activities under surveillance and control to minimize environment damage by noise. The Contractor shall comply with the provisions of the Federal, State of California and local rules.

3.5 WASTE DISPOSAL

Segregation and handling of waste generated by construction activities shall be as specified in the Waste Management Plan.

3.6 HISTORICAL, ARCHAEOLOGICAL, AND CULTURAL REASOURCES

Existing historical, archaeological, and cultural resources within the Contractor's work area will be so designated by the Engineer if any has been identified. The Contractor shall take precautions to preserve all such resources as they existed at the time they were first pointed out. The Contractor shall provide and install protection for these resources and be responsible for their preservation during the life of the contract. If during excavation or other construction activities any previously unidentified or unanticipated resources are discovered or found, all activities that may damage or alter such resources shall be temporarily suspended. Resources covered by this paragraph include but are not limited to: any human skeletal remains or burials; artifacts; shell, midden, bone, charcoal, or other deposits; rocks or coral alignments, pavings, wall, or other constructed features; and any indication of agricultural or other human activities. Upon such discovery or find, the Contractor shall immediately notify the Engineer. While the waiting for instructions the Contractor shall record, report, and preserve the finds. The Contractor’s qualified Archeologists shall examine any discoveries and meet with the Contractor and the Engineer to discuss his findings and a plan of action.

3.7 POST CONSTRUCTION CLEANUP

The Contractor shall clean up all areas used for construction. The Contractor shall restore landscape features damaged or destroyed during construction operations outside the limits of the approved work areas.

3.8 MAINTENANCE OF POLLUTION MEASURES

The Contractor shall maintain permanent and temporary pollution control measures for the duration of the contract or for that length of time construction activities create the particular pollutant. The Contractor shall inspect the construction site for evidence of, or the potential for, pollutants entering the environment once every seven calendar days. For each inspection conducted, the Contractor shall prepare a report summarizing the scope of the inspection, name(s) and qualifications of personnel making the inspection, the date(s) of the inspection, major observations relating to the maintenance performed, and actions taken. The report shall be furnished to the Engineer within 24 hours of the inspection as a part of the Contractor's Daily Field Activity Report. A copy of the inspection report shall be maintained on the job site.

3.9 TRAINING OF CONTRACTOR PERSONNEL

The Contractor's personnel shall be trained in all phases of environmental protection. The training shall include methods of detecting and avoiding pollution, familiarization with pollution standards,

both statutory and contractual, and installation and care of devices, vegetative covers, and instruments required for monitoring purposes to ensure adequate and continuous environmental pollution control.

END OF SECTION

SECTION 02050

UNDERGROUND STRUCTURE DEMOLITION AND REMOVAL

1. GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

Weiss Associates (WA), 1998d, Final Project Health and Safety Plan for Environmental Restoration/Waste Management, Laboratory for Energy-Related Health Research (LEHR), University of California at Davis, California, Weiss Associates, January 1998.

1.2 GENERAL REQUIREMENTS

The work includes demolition of identified items and materials, and removal of resulting rubble and debris. Rubble and debris shall be stored in areas specified by the Engineer. In the interest of occupational safety and health, the work shall be performed in accordance with the HSP. The contractor shall decontaminate, demolish, and remove underground structures and their respective associated piping and contaminated surrounding soil. Prior to structure demolition and removal, any free standing liquid or sludge contained within the structure shall be removed and handled in accordance with the Waste Management Plan. The structures designated for removal include the following:

a) Strontium Tank

b) Radium Tanks

c) Ra-Effluent Distribution Tank

d) Domestic Septic Tank No. 2

e) Manways of Radium-Drywells

These structures are constructed primarily of reinforced concrete with some elements of timber and steel. The structures were part of the LEHR radiation research and domestic waste water treatment and disposal systems. Ground water is not expected to be encountered.

1.3 DUST CONTROL

The amount of dust resulting from demolition shall be controlled to prevent the spread of dust to occupied portions of the construction site and to avoid creation of a nuisance in the surrounding area. Use of water will not be permitted when it will result in, or create, hazardous or objectionable conditions such as ice, flooding and pollution.

1.4 PROTECTION

1.4.1 Protection of Personnel

During the demolition work the Contractor shall continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the demolition site. No area, section, or component of floors, roofs, walls, columns, pilasters, or other structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate area.

Floors, roofs, walls, columns, pilasters, and other structural components that are designed and constructed to stand without lateral support or shoring, and are determined to be in stable condition, may be allowed to remain standing without additional bracing, shoring, of lateral support until demolished. The Contractor shall ensure that no elements determined to be unstable are left unsupported and shall be responsible for placing and securing bracing, shoring, or lateral supports as may be required as a result of any cutting, removal, or demolition work performed under this contract.

1.4.2 Protection of Existing Property

Before beginning any demolition work, the Contractor shall survey the Site and examine the drawings and specifications to determine the extent of the work. The Contractor shall take necessary precautions to avoid damage to existing items to remain in place, to be reused, or to remain the property of the UC Davis; any damaged items shall be repaired or replaced as approved by the Engineer. The Contractor shall coordinate the work of this section with all other work and shall construct and maintain shoring, bracing, and supports as required. The Contractor shall ensure that structural elements are not overloaded and shall be responsible for increasing structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under this contract.

1.4.3 Environmental Protection

The work shall comply with the requirements of Section 01410.

1.5 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

1.6 USE OF EXPLOSIVES

Use of explosives will not be permitted.

2. PRODUCTS

2.1 BACKFILL MATERIAL

Backfill material shall conform to the guidelines established in Section 02220.

3. EXECUTION

3.1 SHORING

Shoring requirements shall be provided in accordance with the Contractors Shoring Plan and Section 02220.

3.2 CLEARING AND GRUBBING

Cleaning and grubbing shall be in accordance with Section 02100 CLEARING AND GRUBBING. Areas designated for clearing and grubbing as required and directed by the Engineer shall be cleared of all trees, stumps, down timber, brush, rubbish, roots larger than three inches in diameter, and matted roots prior to commencing operations. Concrete or asphalt pavement shall be saw cut at the limits of removal, broken and removed with the resulting debris and handled in the Waste Management Plan. Chain-link fence shall be removed and stored on-site for future disposal.

3.3 PREPARATIONS FOR EXCAVATION

Pumpable liquids and sludge shall be removed from the tanks, contained, and stored on-site, prior to disposal. The Contractor shall provide approved containers, vehicles, equipment, labor, signs, labels, necessary for accomplishment of the work, including materials necessary for cleaning up spills that could occur from liquid removal operations. Liquid waste handling shall be in accordance with the Waste Management Plan.

3.4 DEMOLITION AND EXCAVATION

Excavation areas, as well as work near roadways, shall be marked in accordance with Section 01010.1.11.2.2.e.

3.4.1 Underground Structure

Excavation shall be performed as necessary to remove underground structures and contaminated soil in accordance with Section 02220 and the project drawings. The underground structure elements shall be exposed and broken up into dimensions, which can be easily excavated. Excavation around the perimeter of the structure shall be performed limiting the amount of potentially contaminated soil that could be mixed with previously uncontaminated soil. Concrete, rubber, debris and contaminated soil shall be segregated in separate stockpiles. Sheeting, bracing, or shoring shall be installed as needed to prevent excavation sidewalls cave ins and any undermining of adjacent structural foundations. Surface water shall be diverted to prevent direct entry into the excavation.

3.4.2 Piping Excavation

Solid piping and leach line trench excavations shall be performed as necessary to remove all piping, drain rock, bedding materials, and contaminated soil in accordance with Section 02220 and the project drawings.

3.4.3 Open Excavations

Open excavations and stockpile areas shall be secured while awaiting confirmation test results from the soil excavation limits. The excavation shall be backfilled as soon as possible after contaminated soil results have been confirmed by the Engineer. The Contractor shall divert surface water around excavations to prevent water from directly entering into the excavation.

3.5 UTILITIES

Existing utilities shall be handled as specified in Section 02222. When utility lines are encountered that are not indicated on the drawings, the Engineer shall be notified prior to further work in that area.

3.6 BACKFILL AND COMPACTION

Backfill and compaction for underground structure demolition and removal shall conform to the requirements of specification 02220.

END OF SECTION

SECTION 02100

CLEARING AND GRUBBING

1. GENERAL

1.1 REFERENCES

UNIVERSITY OF CALIFORNIA DAVIS (UC DAVIS)

UC Davis 1997	Campus Standards and Design, Office of Architects and Engineers, University of California at Davis, 1997

1.2 WORK INCLUDED

Clearing shall consist of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including down timber, snags, brush, and rubbish occurring in the areas to be cleared.

Grubbing shall consist of the removal and disposal of stumps, roots larger than 75 mm (three inches) in diameter, and matted roots from the designated grubbing areas.

Fence removal shall consist of cutting the Fence line as called out in the Work Plan and as shown on the project drawing.

Pavement removal shall consist of sawcutting and excavating asphalt or concrete material as needed to complete removal action activities.

2. PRODUCTS

Not Used

3. EXECUTION

3.1 CLEARING/TRIMMING

Trees, stumps, roots, brush, and other vegetation in areas to be cleared shall be cut off flush with or below the original ground surface, except such trees and vegetation as may be indicated or directed to

be left standing. Trees designated to be left standing within the cleared areas shall be trimmed of all branches as indicated or directed by the Engineer. Limbs and branches to be trimmed shall be neatly cut close to the bole of the tree or main branches. Cuts more than 1½ inches in diameter shall be painted with an approved tree-wound paint. Trees and vegetation to be left standing shall be protected from damage incident to clearing, grubbing, and construction operations by the erection of barriers or by such other means as the circumstances require. Clearing shall also include the removal and disposal of structures, fences, or other materials that obtrude, encroach upon, or otherwise obstruct the work.

3.2 GRUBBING

Material to be grubbed, together with logs and other organic or metallic debris, shall be removed to a depth of not less than 18 inches below the original surface level of the ground in areas indicated to be grubbed and in areas indicated as construction areas, such as areas to be paved. Depressions made by grubbing shall be filled with suitable material and compacted to make the surface conform to the original adjacent surface of the ground.

3.3 FENCE REMOVAL

The contractor shall cut and disconnect the fence fabric, tension wire, braces, rails, and accessories from the section of fence designated for removal, fence posts shall be cut flush to the ground surface. Post foundations shall remain in place unless this interferes with other construction activities.

3.4 PAVEMENT REMOVAL

Asphalt and concrete pavements to be removed shall be sawcut and jackhammered or otherwise broken up and excavated with the required heavy machinery to facilitate Removal Action activities.

The contractor shall temporarily stockpile the removed asphalt, aggregate base, and concrete rubble material on-sit for reuse as pavement repair aggregate base. The contractor shall use a portable material crusher machine to break up the asphalt and concrete rubble into an acceptable aggregate base gradation and in accordance to Section 02570.

3.5 DISPOSAL OF MATERIALS

Materials generated during clearing and grubbing activities shall be handled and disposed of according to the Waste Management Plan. Burning of materials shall not be permitted.

END OF SECTION

SECTION 02220

EXCAVATION, BACKFILLING, AND COMPACTION

1. GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 33	Concrete Aggregates
ASTM C 136	Sieve Analysis of Fine and Coarse Aggregates
ASTM C 117	Test Method for Materials Finer than 75 [mu]m (No. 200) Sieve in Mineral Aggregates by Washing
ASTM D 422	Method for Particle size Analysis of Soils
ASTM D 448	Classification for Sizes of Aggregates for Road and Bridge Construction
ASTM D 1140	Test Method for Amount of Soil Finer than the No. 200 (% Micrometer) Sieve
ASTM D 1557	Test Method for Moisture-Density Relations of Soils and Soil - Aggregate Mixture Using 10-lb. Rammer and 18-inch Drop
ASTM D 2216	Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures.
ASTM D 2487	Test Method for Classification of Soils for Engineering Purposes
ASTM D 2922	Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (shallow depth)
ASTM D 3017	Water Content of Soil and Rock in Place by Nuclear Methods (shallow depth)

ASMT D 4318	Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 4643	Test Method for In-Place Moisture by Moisture by Microwave Oven
ASTM D 5084	Laboratory Permeability Test

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR Part 1910	Occupational Safety and Health Administration (OSHA), Occupational Safety and Health Standards
29 CFR Part 1926	OSHA, Safety and Health Regulations for Construction

NATIONAL INSTITUTE OF OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

NIOSH 1985	Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, (document prepared by NIOSH, OSHA, US Coast Guard and US EPA, October 1985)

WEISS ASSOCIATES (WA)

WA 1998h	Final Standard Operating Procedures (SOPs) For Removal Action at Southwest Trenches, Ra/Sr Treatment Systems and Domestic Septic System Areas, Laboratory For Energy-Related Health Research (LEHR). University of California at Davis, California, Weiss Associates, May 1998.

1.2 DEFINITIONS

Backfill – Native or imported material used in refilling of a trench, placed at a specified degree of compaction.

Berm – A fill having a top that is higher than adjoining ground.

Compaction – The process of mechanically stabilizing a material by increasing its density at a controlled moisture condition. "Degree of Compaction" is expressed as a percentage of the maximum density obtained by the test procedure described in ASTM D 1557 for general soil types.

Excavation – Removal of soil, rock, waste or hard material to obtain a specified depth or elevation.

Excess Soil – Soil from trench or other excavation and drill cuttings, not used as backfill, which requires handling and disposal as specified in Waste Management Plan.

Fill – A specified non-native materials used at a specified location, above existing surface grade, placed at a specified degree of compaction.

Hard Materials – Weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock" but which usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.

Imported Material – Off-site soil used as backfill or fill, placed at a specified degree of compaction.

Lift – A layer (or course) of soil placed on top of a previously prepared or placed soil.

Native Material – Soil which has been present at the location of excavation or grading work for a period of at least two years.

Rock – solid, homogeneous, interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement, exceeding ½ cubic yard in volume. Removal of "hard material" will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

Soil – The surface material of the earth's crust resulting from the chemical and mechanical weathering of rock and organic material.

Subgrade – The material in excavation (cuts) and fills (embankments) immediately below any sub-base, base, pavement, or other improvement. Also, as a secondary definition, the level below which work is referenced.

Surplus Material – excess soil and other material not required or suitable for filling or backfilling removed during excavation or grading, which will require off-site disposal.

Topsoil – In natural or undisturbed soil formations, the fine-grained, weathered material on the surface or directly below any loose or partially decomposed organic matter. Topsoil may be a dark-colored, fine, silty, or sandy material with a high content of well-decomposed organic matter, often containing traces of the parent rock material. Gradation and material requirements specified herein apply to all topsoil references in this contract. The material shall be representative of productive soils in the vicinity.

1.3 SUBMITTALS

1.3.1 Test Reports

a) Analytical results for all imported fill and backfill chemical composition tests as required in Paragraph 2.1.2; and,

b) Analytical results for all imported fill and backfill material physical tests as required in Paragraph 2.1.1.

1.3.2 Manufacturer Catalog Data

a) Product Data sheet: Polyethylene Sheeting; and

b) Product Data Sheet: Geotextile Fabric.

1.3.3 Trench Shoring Plan, including loading calculations, drawings, details, and installation procedures, prepared and stamped by a Professional Civil Engineer.

1.4 WORK INCLUDED

Work specified in this section includes site preparation; excavation, backfilling, compaction, and related operations for the removal of wastes and contaminated materials as described in the Work Plan, these specifications, and as shown on the project drawings.

1.5 SITE CONDITIONS

The Contractor shall conduct all excavation, backfilling and compaction operations in such a manner as to minimize interruption to the facility traffic, utilities, and any other facility operations.

2. PRODUCTS

2.1 BACKFILL

2.1.1 Imported Fill and Backfill Physical Requirements

Contractor shall provide an imported fine-grain material that would conform to material classified by ASTM 2487, ML, and ML/CL, which is also free of trash, debris, organic matter, or stones larger than three inches in diameter. The material shall be of such quality that it will compact thoroughly without the presence of excessive voids when compacted by mechanical means. The source of the fill should be either in the Coast Range Physiographic Province or in an area where sediments are derived from the CRPP (e.g., western Central Valley area). The backfill should also have a saturated hydraulic conductivity of less than 10^{-4} cm per second.

Unsatisfactory materials include but are not limited to those materials containing roots and other organic matter, trash, debris and stones larger than three inches. Unsatisfactory materials also include manmade fills, refuse, or debris from previous construction as well as existing, in-situ soil or other material which can be identified as having insufficient strength characteristics or stability to carry intended loads in fill or embankment without excessive consolidation or loss of stability. Materials classified as PT, OH, or OL by ASTM D 2487 are unsatisfactory.

The Contractor shall provide tests and certification of compliance for the backfill material based on the gradation test and other requirements as set forth here within. The test results and certification

shall be submitted to the Engineer for review. Imported backfill material shall also conform to the requirements of Paragraph 2.1.2. Non-conforming material shall be classified as excess soil and shall be handled by the Contractor as specified in the Waste Management Plan.

2.1.2 Imported Fill and Backfill Chemical Requirements

The Contractor shall sample and analyze all imported fill and backfill material prior to import to evaluate its chemical composition and acceptability. Fill and backfill shall be analyzed for: EPA priority pollutant metals; volatile Organics using EPA Method 8240; semi-volatile Organics using EPA Method 8270; and polychlorinated biphenyls/pesticides using EPA Method 8080; and full suite of radionuclides. One sample for every 1000 cubic yards of fill or backfill from a source shall be analyzed. Backfill must not contain any chemical or radiological compounds in concentrations above the Site background concentrations as described in the Work Plan.

2.1.3 Native Backfill Material

Native soil generate during excavation activities, that are free of obvious contamination shall be stockpiled on-site and used as excavation backfill whenever possible. The Engineer shall sample and analyze the native material prior to use as a backfill in accordance with paragraphs 02220.2.1.2.

2.2 GEOTEXTILE

The limits of excavation marking geotextile layer shall consist of a non-woven geotextile fabric. The non-woven geotextile fabric shall be made of polypropylene, be chemically and biologically inert, resist puncture, rot, tear, and mildew. The geotextile fabric shall provide separation between the excavation backfill and the surrounding soil. The geotextile shall have a minimum tensile strength of 350 pounds in the strong direction and 200 pounds in the weak direction. The geotextile shall have a maximum elongation at failure of 35% and a minimum burst strength of 520 psi. Acceptable materials for the filter geotextile include Polyfelt TS 650, Trevira 1120 or equivalent.

2.3 POLYETHYLENE SHEETING

The temporary waste material stockpile liner and cover material shall have the following properties:

a) Density: 94 grams/cubic centimeter (minimum);

b) Thickness: 20 mil minimum;

c) Tensile strength at break: 80 pounds/inch width; and

d) Elongation at break: 750%.

3. EXECUTION

3.1 SITE PREPARATION

3.1.1 Clearing and Grubbing

Unless otherwise indicated and where applicable, the Contractor shall remove debris, trees, stumps, roots, brush and other vegetation, existing foundations, pavements, structures, fences, and other items as required to perform the work in accordance with Section 02100. Tree trimming shall be performed as necessary following approval from the Engineer. Materials removed shall be handled in accordance with the Waste Management Plan.

3.1.2 Underground Utilities

Prior to any excavation at the Site, the Contractor shall physically verify the location and depth of the existing piping, utilities, and any type of underground obstruction not specified to be removed. If utility lines are encountered that are not shown on the project drawings, the Contractor shall contact the Engineer for further instructions.

The Contractor shall report damage to utility lines or subsurface construction immediately to the Engineer. The Contractor shall repair or remove and provide new pipe replacement for the pipe that has been displaced or damaged.

The Contractor shall protect, relocate, or restore all utilities encountered during earthwork activities in accordance with Section 02222.

3.2 PROTECTION

3.2.1 Shoring of the Trench Walls

The Contractor shall provide shoring, bracing, or other approved means of protection of the trench walls, where the trench depth equals or exceeds 4 feet below existing adjacent grade, or as may be required to support the sides of the excavation walls and to prevent movement or damage to adjacent structures.

The Contractor shall submit to the Engineer a shoring plan prepared and stamped by a licensed Professional Civil Engineer, addressing the shoring location, construction, installation procedure and other related requirements. No Shoring shall be performed without prior approval of the Shoring Plan by the Engineer.

In addition the Contractor shall meet the following:

a) Prevent undermining of pavements, foundations, slabs, and any portions of adjacent structures;

b) Slope banks where space permits; and,

c) Where shoring materials remain in place in completed work areas to prevent settlements or damage to adjacent structures or as directed, backfill the excavation to 3 ft below the finished grade and remove the remaining exposed portion of the shoring before completing the backfill.

3.2.2 Protection at the Excavation Boundary

The Contractor shall be responsible for protection of people and property by providing appropriate barriers, barricades, and signs to prevent unauthorized approach and danger of fall near the trench edges and other excavations in accordance with the Health and Safety Plan. The Contractor shall support uncovered lines or other existing work as affected by the excavation until backfilling.

3.2.3 Protection and Restoration of Surfaces

The Contractor shall protect newly graded areas from traffic, erosion, and settlements. The Contractor shall repair and re-establish damaged or eroded slopes, elevations, or grades and restore surface construction prior to acceptance.

3.2.4 Protection of Existing Site Elements

The Contractor shall protect all site elements which are not being removed, such as but not limited to the following: storm drains, catch basins, concrete pads, facility fences, all elements at adjacent properties, trees and tree roots, groundwater monitoring wells, fire hydrants, and other elements as directed by the Engineer.

3.2.5 Site Drainage

The Contractor shall collect and dispose of surface and subsurface water encountered in the course of construction in accordance with the Waste Management Plan.

3.2.5.1 Surface Drainage

The Contractor shall completely drain construction site during work to keep soil materials sufficiently dry. Provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new soil material as specified herein.

3.2.5.2 Subsurface Drainage

Prior to placement of fill and backfill or when directed by the Engineer, the Contractor shall remove perched ground water and storm run-off (if any encountered) by pumping or other methods to prevent the softening of surfaces exposed by excavation. The Contractor shall advise the Engineer of any perched ground water encountered.

3.2.6 Building Clearance

Campus Fire Department trucks must have uninterrupted access on hard surface, all weather new or existing roads to all new buildings, additions to buildings, or any other developed area on campus at all times. All locked construction gates and permanent gates must be accessible to the Campus Fire Department (UC Davis 97).

3.3 EXCAVATION

The Contractor shall remove all surplus material not required or suitable for filling or backfilling, including but not limited to, excess soil, brush, refuse, debris, and timber removed during excavation or grading to the waste material storage area. In handling of surplus materials, the Contractor shall comply with the requirements of the Waste Management Plan.

The Contractor shall perform excavation work to the projected trench depth, width, and alignment based on the project drawings and the Work Plan. The actual extents of trench excavations shall be determined in the field by the Engineer.

Grading shall be done as necessary to prevent surface water from flowing into the excavation.

The Contractor shall keep excavated areas free of water while work is in progress. Perched zones may be encountered during excavation of deeper trenches. It shall be the responsibility of the Contractor, to dewater the trench and assure dry conditions for the duration of the project. The Contractor shall collect and handle the water collected during the trench excavation in accordance with the Waste Management Plan.

3.3.1 Handling Excavated Materials

The Contractor shall place excavated waste material and overburden material onto temporary stockpiles prior to removal of the material from the active excavation area to the material sorting or storage area. These temporary stockpiles shall be lined with polyethylene sheeting in order to prevent this material from mixing with ground surface materials.

The Contractor shall handle excavated materials in accordance with the requirements of the Work Plan and Waste Management Plan.

3.4 BACKFILLING

3.4.1 Placement of Geotextile Fabric

The geotextile fabric shall be placed along the bottom and the side walls of excavations prior to and/ or during the placement of backfill soils. The geotextile fabric shall provide a distinctive physical separation between the excavation backfill and the surrounding soil.

3.4.2 Placement of Backfill Soil

Trench horizontal and vertical limits shall be confirmed with the Engineer prior to commencement of backfill activities. Satisfactory materials shall be used in bringing backfills to the grades indicated on the project drawings. Material shall not be placed on surfaces that contain debris, trash, loose soil, excessively wet soil, or excessively dry soil. Satisfactory materials shall be placed in horizontal layers not exceeding 8 inches in loose thickness. Prior to compaction, fill material shall be broken up, thoroughly mixed, moisture conditioned, or otherwise prepared to optimize material compaction.

3.5 COMPACTION

Compaction shall be accomplished with vibratory plate compactors, sheepsfoot rollers, or other approved equipment well suited to the soil being compacted and the site conditions. Each layer of backfill shall be compacted to not less than the percentage of maximum density specified below:

PERCENTAGE OF THE ASTM D 1557 MAXIMUM DENSITY

	Cohesive Materials	Cohesionless Materials
Under Structures, Building slabs, steps, pavements, top of backfill 4 ft	95%	95%
Lawn or Unpaved Areas, top 4 ft of backfill	85%	90%
Walkways top 4 ft of backfill	90%	95%

3.6 TESTING OF BACKFILL

Testing shall be the responsibility of the Engineer. Testing shall be performed by an approved commercial testing laboratory. Field in-place density and moisture content shall be determined in accordance with ASTM D 2922 and ASTM D 3017. The following number of tests, if performed at the appropriate time, shall be the minimum acceptable for each type operation.

3.6.1 In-Place Densities

3.6.1.1 In-Place Density of Backfills

The Engineer shall perform one test per 5,000 square ft or fraction thereof of each lift for fill or backfill areas compacted by other than hand or hand-operated machines. The density for each lift of backfill materials for trenches, pits, or areas less than 10 ft in width, which are compacted with hand or hand-operated machines shall be tested as follows: One test per each area less than 2,000 square ft or one test for each 100 linear ft of long narrow fills 50 ft or more in length.

3.6.2 Optimum Moisture and Laboratory Maximum Density

Tests shall be made for each type material or source of material to determine the optimum moisture and moisture and laboratory maximum density values. One representative test per 200 cubic yards of backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density, will be made.

3.6.3 Acceptance

Acceptance of the compacted materials shall be determined in each unit by the results of the field in-place density tests. Methods of in-place tests shall be in accordance with Paragraph 3.6.1. Each test shall equal or exceed the specified density requirement.

3.7 GRADING

Areas disturbed during construction shall be constructed true-to-grade, shaped to drain, and shall be maintained free of trash and debris until final inspection has been completed and the work has been accepted. Settlement or washing that occurs in graded, topsoiled, or backfilled areas prior to acceptance of the work shall be repaired and grades reestablished to the required elevations and slopes.

END OF SECTION

SECTION 02222

EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS

1. GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2487	(1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System
ASTM D 2922	(1991) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R 1993) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D	(1997) Campus standards and Design, Office of Architects and Engineers. University of California at Davis

UNIVERSITY OF CALIFORNIA DAVIS (UC DAVIS)

UC Davis 97	University of California Davis 1997 Campus Standards and Design, Office of Architects and Engineers

1.2 DEFINITIONS

1.2.1 Degree of Compaction

Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557.

1.3 WORK INCLUDED

Work specified in this section includes site preparation; excavation, backfilling, compaction, and related operations for the relocation, and/or restoration of site utilities impacted by the Removal Action as described in the Work Plan, these specifications, and as shown on the project drawings.

2. PRODUCTS

2.1 MATERIALS

2.1.1 Satisfactory Materials

Satisfactory materials shall consist of any material classified by ASTM D 2487 as GW, GP, and SW.

2.1.2 Unsatisfactory Materials

Unsatisfactory materials shall be materials that do not comply with the requirements for satisfactory materials. Unsatisfactory materials include but are not limited to those materials containing roots and other organic matter, trash, debris, frozen materials and stones larger than 3 inches and materials classified in ASTM D 2487 as PT, OH, and OL. Unsatisfactory materials also include man-made fills, refuse, or backfills from previous construction.

2.1.3 Cohesionless and Cohesive Materials

Cohesionless materials shall include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic.

2.1.4 Rock

Rock shall consist of boulders measuring ½ cubic yard or more and materials that cannot be removed without systematic drilling and blasting such as rock material in ledges, bedded deposits unstratified masses and conglomerate deposits and below ground concrete or masonry structures, exceeding ½ cubic yard in volume except that pavements will not be considered rock.

2.1.5 Unyielding Material

Unyielding material shall consist of rock and gravelly soils with stones greater than one inch in any dimension or as defined by the pipe manufacturer, whichever is smaller.

2.1.6 Unstable Material

Unstable material shall consist of materials too wet to properly support the utility pipe, conduit, or appurtenant structure.

2.1.7 Select Granular Material

Select granular material shall consist of well-graded sand, gravel, crushed gravel, crushed stone or crushed slag composed of hard, tough and durable particles, and shall contain not more than 10 percent by weight of material passing a 0.075 mm (No. 200) mesh sieve and no less than 95 percent by weight passing the 25 mm (one inch) sieve. The maximum allowable aggregate size shall be ¾ inches or the maximum size recommended by the pipe manufacturer, whichever is smaller.

2.1.8 Initial Backfill Material

Initial backfill shall consist of select granular material or satisfactory materials free from rocks one inch or larger in any dimension or free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller. When the pipe is coated or wrapped for corrosion protection, the initial backfill material shall be free of stones larger than one inch in any dimension or as recommended by the pipe manufacturer, whichever is smaller.

2.1.9 Plastic Marking Tape

Plastic marking tape shall be acid and alkali-resistant polyethylene film, six inches wide with minimum thickness of 0.004 inch. Tape shall have a minimum strength of 1750 psi lengthwise and 1500 psi crosswise. The tape shall be manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to three ft deep. The tape shall be of a type specifically manufactured for marking and locating underground utilities. The metallic core of the tape shall be encased in a protective jacket or provided with other means to protect it from corrosion. Tape color shall be as specified in TABLE 1 and shall bear a continuous printed inscription describing the specific utility.

Table 1. Marking Tape

Color	Type of Utility Line
Red	Electric
Yellow	Gas, Oil, Dangerous Materials
Orange	Telephone, Telegraph, Television, Police, and Fire Communications
Blue	Water Systems
Green	Sewer Systems

3. EXECUTION

3.1 EXCAVATION

Excavation shall be performed to the lines and grades as determined in the field. Rock excavation shall include removal and disposition of material defined as rock in paragraph MATERIALS. Earth excavation shall include removal and disposal of material not classified as rock excavation. During excavation, material satisfactory for backfilling shall be stockpiled in an orderly manner at a distance from the banks of the trench equal to ½ the depth of the excavation, but in no instance closer than two ft. Excavated material not required or not satisfactory for backfill shall be removed from the site and disposed according to the Waste Management Plan. Grading shall be done as may be necessary to prevent surface the water from flowing into the excavation, and any the water accumulating therein shall be removed to maintain the stability of the bottom and sides of the excavation. Unauthorized excavation shall be backfilled in accordance with paragraph BACKFILLING AND COMPACTION at no additional cost to the Engineer.

The trench shall be excavated as recommended by the manufacturer of the pipe to be installed. Trench walls below the top of the pipe shall be sloped, or made vertical, and of such width as recommended in the manufacturer's installation manual. Where no manufacturer's installation manual is available, trench walls shall be made vertical. Trench walls more than four ft high shall be shored, cut back to a stable slope or provided with equivalent means of protection for employees who may be exposed to moving ground or cave in. Vertical trench walls more than six ft high shall be shored. Trench walls which are cut back shall be excavated to at least the angle of repose of the soil. Special attention shall be given to slopes which may be adversely affected by weather or moisture content. The trench width below the top of pipe shall not exceed 24 inches plus pipe outside diameter for pipes of less than 24 inches inside diameter and shall not exceed 36 inches plus pipe outside diameter for sizes larger than 24 inches inside diameter. Where recommended trench widths are exceeded, the Contractor shall utilize re-design, stronger pipe, or special installation procedures. The cost of re-design, stronger pipe, or special installation procedures shall be borne by the Contractor without any additional cost to the Engineer.

3.1.1 Bottom Preparation

The bottoms of trenches shall be accurately graded to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Bell holes shall be excavated to the necessary size at each joint or coupling to eliminate point bearing. Stones of 3 inches or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, shall be removed to avoid point bearing.

3.1.2 Removal of Unyielding Material

Where depth is not indicated and unyielding material is encountered in the bottom of the trench, such material shall be removed 4 inches below the required grade and replaced with suitable materials as provided in paragraph BACKFILLING AND COMPACTION.

3.1.3 Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, such material shall be removed to the depth directed and replaced to the proper grade with select granular material as provided in paragraph BACKFILLING AND COMPACTION. When removal of unstable material is required due to the fault of neglect of the Contractor in his performance of the work, the resulting material shall be excavated and replaced by the Contractor without additional cost to the Engineer.

3.1.4 Excavation for Appurtenances

Excavation for manholes, catch-basins, inlets, or similar structures shall be sufficient to leave at least 12 inches clear between the outer structure surfaces and the face of the excavation or support members. Rock shall be cleaned of loose debris and cut to a firm surface either level, stepped, or serrated, as shown or as directed. Loose disintegrated rock and thin strata shall be removed. Removal of unstable material shall be as specified above. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before the concrete or masonry is to be placed.

3.1.5 Jacking, Boring, and Tunneling

Unless otherwise indicated, excavation shall be by open cut except that sections of a trench may be jacked, bored, or tunneled if, in the opinion of the Engineer, the pipe cable, or duct can be safely and properly installed and backfilled can be properly compacted in such sections.

3.1.6 Stockpiles

Stockpiles of satisfactory, unsatisfactory, and the waste materials shall be placed and graded as specified. Stockpiles shall be kept in a neat and well-drained condition, giving due consideration to drainage at all times. The ground surface at stockpile locations shall be cleared, grubbed, and sealed by rubber-tired equipment, excavated satisfactory and unsatisfactory materials shall be separately stockpiled. Stockpiles of satisfactory materials shall be protected from contamination that may

destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, such material shall be removed and replaced with satisfactory material from approved sources at no additional cost to the Engineer. Locations of stockpiles of satisfactory materials shall be as shown and subject to field approval by the Engineer.

3.2 BACKFILLING AND COMPACTION

Backfill material shall consist of satisfactory material, select granular material, or initial backfill material as required. Backfill shall be placed in layers not exceeding six inches loose thickness for compaction by hand operated machine compactors, and eight inches loose thickness for other than hand operated machines, unless otherwise specified. Each layer shall be compacted to at least 95 percent maximum density for cohesionless soils and 90 percent maximum density for cohesive soils unless otherwise specified.

3.2.1 Trench Backfill

Trenches shall be backfilled to the grade shown. The trench shall not be backfilled until all specified tests are performed.

3.2.1.1 Replacement of Unyielding Material

Unyielding material removed from the bottom of the trench shall be replaced with select granular material or initial backfill material.

3.2.1.2 Replacement of Unstable Material

Unstable material removed from the bottom of the trench or excavation shall be replaced with select granular material placed in layers not exceeding six inches loose thickness.

3.2.1.3 Bedding and Initial Backfill

Initial backfill material shall be placed and compacted with approved tampers to a height of at least one ft above the utility pipe or conduit. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe.

3.2.1.4 Final Backfill

The remainder of the trench, except for special materials for roadways, railroads and airfields, shall be filled with satisfactory material. Backfill material shall be placed and compacted as follows:

a) Roadways: Backfill shall be placed up to the elevation at which the requirements in Section 02570 control. Water flooding or jetting methods of compaction will not be permitted.

b) Sidewalks, Turfed, or Seeded Areas and Miscellaneous Areas: Backfill shall be deposited in layers of a maximum of 12 inch loose thickness, and compacted to 85 percent maximum density for cohesive soils and 90 percent maximum density for cohesionless soils. Compaction by the

water flooding or jetting will not be permitted. This requirement shall also apply to all other areas not specifically designated above.

3.2.2 Backfill for Appurtenances

After the manhole, catch basin, inlet, or similar structure has been constructed and the concrete has been allowed to cure for seven days, backfill shall be placed in such a manner that the structure will not be damaged by the shock of falling earth. The backfill material shall be deposited and compacted as specified for final backfill, and shall be brought up evenly on all sides of the structure to prevent eccentric loading and excessive stress.

3.3 SPECIAL REQUIREMENTS

Excavation Backfill, and Construction for all utilities shall conform to the requirements set forth in the UC Davis Standard Specifications for utility line construction.

Additional Special requirements for both excavation and backfill relating to the specific utilities are as follows:

3.3.1 Gas Distribution

Trenches shall be excavated to a depth that will provide not less than 18 inches of cover in rock excavation and not less than 24 inches of cover in other excavation.

3.3.2 Water Lines

Trenches shall be of a depth to provide a minimum cover of three ft from the existing ground surface, or from the indicated finished grade, whichever is lower to the top of the pipe. For fire protection yard mains or piping, an additional 12 inches of cover is required.

3.3.3 Heat Distribution System

Initial backfill material shall be free of stones larger than 1.4 inch in any dimension.

3.3.4 Electrical Distribution System

Direct burial cable and conduit or duct line shall have a minimum cover of 24 inches from the finished grade, unless otherwise indicated.

3.3.5 Plastic Marking Tape

Warning tapes shall be installed directly above the pipe, at a depth of 12 inches below finished grade unless otherwise shown.

3.4 TESTING

Testing of the utility line materials and operation shall be the responsibility of the Contractor. Testing shall be performed in accordance with UC Davis standard Specifications for Utility Line Construction. Testing of utility backfill material shall be the responsibility of the Engineer.

3.4.1 Testing of Backfill Materials

Characteristics of backfill materials shall be determined in accordance with particle size analysis of soils ASTM D 422 and moisture-density relations of soils ASTM D 1557. A minimum of one particle size analysis and one moisture-density relation test shall be performed on each different type of material used for bedding and backfill.

3.4.2 Field Density Tests

The Engineer shall perform in-place density and moisture tests of backfill material.

Tests shall be performed in sufficient numbers to ensure that the specified density is being obtained. A minimum of one field density test per lift of backfill for every 100 ft of installation shall be performed. One moisture density relationship shall be determined for every 1500 cubic yards of material used. Field in-place density shall be determined in accordance, and ASTM D 2922. ASTM D 2922 results in a wet unit weight of soil and when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil.

The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job, on each different type of material encountered, at intervals as directed by the Engineer. The Engineer shall review copies of calibration curve results and field and laboratory density tests. Trenches improperly compacted shall be reopened to the depth directed then refilled and compacted to the density specified.

3.4.3 Displacement of Sewers

After other required tests have been performed and the trench backfill compacted the finished grade surface the pipe shall be inspected to determine whether significant displacement has occurred. This inspection shall be conducted in the presence of the Engineer. Pipe sizes larger than 36 inches shall be entered and examined, while smaller diameter pipe shall be inspected by shining a light or laser between manholes or manhole locations or by the use of television cameras passed through the pipe. If, in the judgement of the Engineer, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, the defects shall be remedied as directed at no additional cost to The Engineer.

END OF SECTION

SECTION 02383

DRYWELL ABANDONMENT

1. GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

WEISS ASSOCIATES (WA)

WA, 1998h	Final Standard Operating Procedures For Removal Action at Southwest Trenches, Ra/Sr Treatment Systems, and Domestic Septic Areas, Laboratory for Energy-Related Health Research (LEHR), University of California at Davis, California, Weiss Associates, May 1998.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 5299	Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities (1992)
ASTM C 150	Portland Cement (1995)
ASTM C 387	Packed, Dry, Combined Materials for Mortar and Concrete

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330.

1.2.1 Cement Grout Mix Design

1.2.2 Subcontractor Statement of Qualifications including Drill Rig Specifications

1.3 WORK INCLUDED

Work specified in this section includes labor and materials for the abandonment of three drywells within the Ra/Sr Treatment Systems Area as shown on the project drawings. The wells shall be

overexcavated to remove all contaminated materials and soil. Once the removal is completed the excavations shall be backfilled with cement grout.

1.4 QUALIFICATIONS

1.4.1 Specialty Subcontractor

A specialty subcontractor, specializing in large boring drilling techniques and having experience in caisson drilling under similar subsurface conditions shall perform the work. Drywell drilling equipment shall have the minimum torque capacity, boring diameter capacity, downward force capacity for the site conditions.

1.5 SITE CONDITIONS

The three Ra drywells were installed to facilitate subsurface infiltration of waste water generated from radiation research. These drywells, each with a diameter of approximately 2.5 ft, consist of open boreholes filled with gravel and cobbles from six ft to 40 ft below ground surface (bgs). Each well is capped by a 36 inch reinforced precaste concrete pipe and manhole section. Drywell locations and details are shown on the project drawings. The ground water table varies in depth from approximately 15 to 40 ft bgs, depending on the season. Drywell depth is unknown.

1.5.1 Subsurface Data

The subsurface investigation report and sample of materials, as taken from subsurface investigations, are available for examination at the LEHR Site Library.

1.6 SEQUENCE OF WORK

1.6.1 Drywell Excavation

The Contractor shall abandon the drywells according to the requirements of ASTM D 5299, and the requirements of these specifications. Well abandonment includes the removal of all materials left in the borehole/well, including backfill materials, casing, screen, and any other material placed into the hole. The Contractor shall maintain a well abandonment record. Ground water levels, if encountered, shall be measured in all borings prior to backfilling. These water levels shall be included in the well abandonment records.

1.6.2 Acceptance

Backfill shall be placed after the limit of contamination sampling has been completed and approved by the Engineer.

1.7 SUPERVISION

1.7.1 Contractor Supervision

The Contractor shall provide for the supervision of all phases of well abandonment. Each well excavation shall be checked by the Engineer for vertical and horizontal extent, water removal, cleanup, workmanship, and for all requirements before any cement grout backfill is placed.

1.7.2 Safety Precautions for Workmen and Inspectors

The Contractor shall provide all necessary temporary barrier materials, including fencing, flagging, postings, to ensure on-site worker health and safety. These preventative measures shall comply with the PHSP.

1.8 TRAINING REQUIREMENTS

Radiation Worker Level II training will be required for all personnel entering the exclusion zone unescorted. In addition, review and compliance with the PHSP will be required of all subcontractors entering the work area.

2. PRODUCTS

2.1 CEMENT GROUT

Cement grout shall be a mixture of a maximum of eight gallons of approved water per 94 lb. bags of Portland cement, which conforms to ASTM C 150, Type [II]. Not more than five percent by weight of bentonite powder shall be added to reduce shrinkage and to hold the cement in suspension prior to the grout set.

3. EXECUTION

3.1 PROTECTION OF EXISTING CONDITIONS

The Contractor shall maintain existing survey monuments, monitoring wells, surrounding site features, and protect them from damage from equipment and vehicular traffic. The Contractor shall repair any items damaged by the Contractor. Prior to excavation the Contractor shall identify all underground utilities within the excavation area.

3.2 PREPARATION

3.2.1 Decontamination

The drill rig, drill rods, drill bits, augers, temporary casing, tremie pipes, grout pumping lines, and other associated equipment shall be cleaned with high-pressure hot water/steam prior to drilling at each drywell location. Decontamination shall be performed at a central decontamination station. Cleaning shall be performed in an area that is remote from, and cross-or down-gradient from the well being drilled.

3.2.2 Decontamination Station

The Contractor shall construct a temporary decontamination pad on-site. The pad shall be bermed and slightly inclined towards a sump located in one of the back corners of the pad. Plastic sheeting shall line the pads and berms to contain decontamination water. Plywood sheeting, exterior grade, shall be place over the plastic sheeting to prevent damage to the plastic and allow the drill rig and heavy equipment to use the pad. The minimum dimensions of the pad shall be the length and width of the drill rig, plus four ft per side to allow access and steam cleaning. Yellow ribbon shall be used to encircle the decontamination pad. The water collected in the sump shall be pumped using a "trash" pump to transfer water to a 55-gallon drum labeled "Decontamination Pad Sump Water." Solid waste shall be transferred to a separate 55-gallon drum labeled "Decontamination Pad Sump Sludge."

3.3 EXCAVATION

The Contractor shall excavate each drywell to the depth and horizontal extent as determined in the field by the Engineer based upon the results from the contamination delineation sampling analysis. Excavated material shall be handled in accordance with the Waste Management Plan.

3.3.1 Shoring out the drywells

In drilling, the surrounding soil and the earth walls shall be adequately and securely protected against cave-ins, displacement of the surrounding earth, and retention of ground water by means of temporary steel casings. Casings shall have outside diameters not less than indicated shaft sizes, shall be a minimum of ¼ inch thick, and shall not be removed if the structural integrity of the caisson will be impaired, as determined by the Engineer. Temporary steel casings shall be withdrawn, as the concrete is being placed, maintaining sufficient head of concrete within the casing to prevent extraneous material from falling in from the sides and mixing with the concrete. Casings may be jerked upward a maximum of four inches to break the bottom seal but thereafter remove with a smooth, continuous motion. The inside of steel casings shall be thoroughly cleaned and oiled before reuse. The temporary casing shall be in place from the caisson top to the ground surface until the concrete has set if the elevation of the top of the caisson is below the adjacent ground surface.

3.3.2 Dewatering

Water that flows into the excavations shall be continuously removed and all water shall be removed from the excavation bottom, to the extent possible, prior to concrete placement. The maximum permissible depth of water will be 50 mm. (two inches.) In the event of a severe water condition that makes it impossible or impractical to dewater the excavation, concrete shall be placed using underwater tremie after water movement has stabilized.

3.3.3 Inspection

Each drywell excavation will be inspected and approved by the Engineer prior to placing cement grout backfill. A record of all inspection with related construction changes in connection therewith, shall be kept by the Contractor.

3.4 GROUT PLACEMENT

Grout shall fill the excavation space up to within 18 inches of the finish grade.

Grout shall be continuously placed by methods that insure against segregation and dislodging of excavation sidewalls and shall comply with ASTM D 5092. Concrete shall be placed by pumping or drop chutes in dry holes and by tremie or pumping in wet holes. The tremie pipe shall be thoroughly cleaned with high pressure hot water/steam before use in each well. The bottom of the tremie pipe shall be constructed so as to direct the discharge to the sides rather than downward. The discharge end of the tremie pipe shall be submerged at all times. Additional grout shall be added from the surface to maintain the level of the grout at the land surface as settlement occurs. Drilling of boreholes or driving of casings shall not be within 20 ft of concrete placed within three days.

3.5 PAVEMENT

The Contractor shall finish the top 18 inches of the excavation area with base course and asphalt in accordance with specifications 02570 and 02575.

END OF SECTION

SECTION 02570

ASPHALT CONCRETE AGGREGATE BASE

1. GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 33	Concrete Aggregates
ASTM C 131	Resistance to Degradation of Small-Size Coarse Aggregates by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	Sieve Analysis of Fine and Coarse Aggregates
ASTM C 117	Test Method for Materials Finer than 75 µm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM D 75	Sampling Aggregates
ASTM D 422	Method for Particle size Analysis of Soils
ASTM D 448	Classification for Sizes of Aggregates for Road and Bridge Construction
ASTM D 1140	Test Method for Amount of Soil Finer than the No. 200 (% Micrometer) Sieve
ASTM D 1557	Test Method for Moisture-Density Relations of Soils and Soil - Aggregate Mixture Using 10-lb. Rammer and 18 –inch Drop
ASTM D 2216	Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures
ASTM D 2487	Test Method for Classification of Soils for Engineering Purposes
ASTM D 2922	Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (shallow depth)

ASTM D 3017	Water Content of Soil and Rock in Place by Nuclear Methods (shallow depth)
ASTM D 4318	Liquid Limit, Plastic Limit, and Plasticity Index of Soils

STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

CALTRANS	1988 Standard Specifications for Road and Bridge Construction

1.2 WORK INCLUDED

Work specified in this section includes labor and materials for asphalt concrete base course installation within the extent of the asphalt pavement repair area as shown on the project drawings.

1.3 TESTING

1.3.1 Field Density and Moisture Tests

ASTM D 2922 and ASTM 3017. The Engineer shall take one field density test for each 10,000 square feet of each lift or at least one test per lift of base course.

1.3.2 Laboratory Density and Moisture Tests

The Engineer shall perform laboratory tests in accordance with ASTM D 1557 and ASTM 2216, for each separate source of II material.

1.4 DELIVERY, STORAGE, AND HANDLING

The Contractor may stockpile aggregate and binder material but only after receiving the Engineer's approval of the storage site. Material obtained from different sources shall be stockpiled separately.

1.5 PROTECTION

The Contractor shall protect areas of completed base course against detrimental effects. Recondition, reshape, and recompact areas of completed base course that are damaged by rainfall or other weather conditions. Provide line and grade stakes, suitably spaced, as necessary for control.

1.6 ENVIRONMENTAL REQUIREMENTS

The Contractor shall not construct base course when weather conditions will detrimentally affect the quality of the base course.

1.7 CONSTRUCTION EQUIPMENT

Equipment, tools, and machines used in the performance of the work shall be subject to the Engineer's approval and shall be maintained in proper working condition.

1.8 TRAINING REQUIREMENTS

Contractor shall ensure proper training and familiarity of its subcontractors with the PHSP. All subcontractor personnel shall receive, at a minimum, the General Employee Radiation Training.

2. PRODUCTS

2.1 AGGREGATE

Aggregate base thickness shall be as called for on the project drawings. A mixture of either crushed stone, crushed coral, crushed slag, or crushed or uncrushed gravel together with sand, sand-gravel, soil, or other approved materials having similar characteristics, combined as necessary to give a mixture conforming to the specified requirements. Aggregates shall be free from limbs and balls of clay, organic matter, or other objectionable matter, and shall be durable and sound.

2.1.1 Coarse Aggregate

Gravel, or crushed stone or slag and that material which is retained on the Standard No. 4 sieve. Aggregate shall have a percentage of wear not exceeding 40 when tested in accordance with ASTM C 131. Slag shall be an air-cooled, blast furnace product, having a dry weight of not less than 65 pounds per cubic ft and shall consist of angular fragments reasonable uniform in density and quality and shall be reasonably free from elongated pieces, dirt, and other objectionable materials.

2.1.2 Binder Material

Screenings, sand, soil, or other approved finely divided mineral matter, exclusive of clay, obtained from approved sources, and only that material which passes a Standard No. 4 sieve. Clay deposits, or deposits found with clay-gravel, will not be permitted as binder material except as otherwise specified. Binder material shall be free from vegetable or other objectionable material. Binder material, whether naturally combined with coarse aggregate or obtained separately and mixed therewith, shall be of such character that composite material will conform to requirements specified herein. The fraction of material passing the No. 20 sieve shall be less than one-half that of the fraction passing the No. 40 sieve. The portion of material passing the No. 40 sieve shall have a liquid limit of not more than 25 and a plasticity index of not more than five as determined by ASTM D 4318. Binder material complying with the following requirements may be used in lieu of that specified above.

a) Binder material produced by crushing material meeting the requirements specified for coarse aggregate.

b) Binder material determined to be non-plastic (NP) when tested in accordance with ASTM D 4318.

2.1.3 Composition of Mixture

The gradation of coarse aggregate and binder material shall conform to CALTRANS Section 26.

2.2 MIXING

The Contractor shall thoroughly mix materials so that when compacted, materials are uniform and homogeneous. The Contractor shall proportion aggregates by weight or by volume in such quantities that specified gradation, liquid limit, and plasticity index requirements are met after the base course has been placed and compacted. Water shall be applied as directed by the Engineer to provide the necessary moisture content to achieve the specified compaction.

2.3 RECYCLED ASPHALT

The Contractor to the extent possible shall recycle the asphalt and concrete pavement rubble generated during site clearing and grubbing activities, by crushing these materials into an acceptable aggregate base material using a portable material crusher.

3. EXECUTION

3.1 PREPARATION

Prior to construction of asphaltic concrete base course, the Contractor shall complete grading of the subgrade area and clean the area of foreign substances.

3.2 COMPACTING AND FINISHING

Immediately following mixing, the Contractor shall uniformly spread finished mixture and compact to at least 95 percent of the maximum density determined in accordance with ASTM D 1557. The Contractor shall determine in-place density in accordance with or ASTM D 2922. Surface shall be smooth and free from waves and inequalities. Thickness of base shall be as called for on the project drawings.

3.3 MAINTENANCE

After construction is completed, the Contractor shall maintain base throughout, except where portions of the succeeding course are under construction thereon. Maintenance includes drainage, rolling, shaping, and watering, as necessary to maintain the course in proper condition. The Contractor shall correct deficiencies in thickness, composition, construction, smoothness, or density, which develop during maintenance to conform to specified requirements. The Contractor shall maintain sufficient moisture at the surface by light sprinkling with water, to prevent a dusty condition.

END OF SECTION

SECTION 02575

ASPHALT PAVEMENT REPAIR

1. GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 136	Sieve Analysis of Fine and Coarse Aggregates
ASTM D 1559	Resistance to Plastic Flow of Bituminous Mixtures using Marshall Apparatus
ASTM D 2172	Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D 2950	Density of Bituminous Concrete in Place by Nuclear Methods

STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

CALTRANS	1988 Standard Specifications for Road and Bridge Construction

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 30-93	Mechanical Analysis of Extracted Aggregate
AASHTO M 226-80	Viscosity Graded Asphalt Cement
AASHTO T 230-68	Determining Degree of Pavement Compaction of Bituminous Aggregate Mixtures

1.2 SUBMITTALS

1.2.1 Design Data, Mix formula for asphalt concrete

Submit a job-mix formula for each type of bituminous mixture seven days before asphalt concrete placement. Ensure formula is within the design range specified in CALTRANS Section 39.

1.2.2 Statements

a) Asphalt concrete. Submit copies of Weigh Master's certificates or certified delivery tickets for each truck load of material; and

b) Materials and material sources. Obtain approval from the Engineer for materials and material sources 2 days prior to the use of such material in the work.

1.2.3 Factory Test Reports

a) Trial Batch Reports. Submit current bituminous design reports for all mix types proposed for use on the project; and

b) Mix Design. Submit results of laboratory tests performed on each mix design. Testing shall not have been accomplished more than one year prior to date of material placement.

1.2.4 Certificates

a) Aggregates for asphalt concrete;

b) Asphalt cement; and

c) Asphaltic emulsion.

1.3 WORK INCLUDED

1.3.1 Pavement Repair

The Contractor shall repair existing pavement with new asphaltic concrete at all new trenches, and other areas of work where existing pavement will be removed or damaged.

1.4 PROTECTION

After final rolling, the Contractor shall not permit vehicular traffic on the pavement until pavement has cooled and hardened and in no case less than 24 hours.

1.5 EQUIPMENT

Mixing plant and construction equipment shall conform to CALTRANS Section 39 standards.

1.6 ENVIRONMENTAL CONDITIONS

Bituminous materials shall not be applied when the temperature is below 60° F, on any surface that has free-standing water, unless otherwise specified, or when other conditions shall otherwise prevent proper construction.

2. PRODUCTS

2.1 MATERIALS

2.1.1 Aggregates

Aggregates for asphalt concrete shall conform to CALTRANS Section 39 and consist of no greater than ¾-inch maximum size gradation.

2.1.2 Asphalt Cement

Viscosity graded asphalt cement shall conform to the requirements of AASHTO M 226.

2.1.3 Liquid Asphalt

The prime coat shall consist of a medium curing liquid asphalt, Grade MC-30, conforming to CALTRANS Section 93.

The tack coat shall consist of slow-setting emulsified asphalt, Type SS-1, or Type SS-1h, conforming to CALTRANS Section 94.

3. EXECUTION

3.1 PREPARATION

3.1.1 Subgrade

Prior to construction of asphaltic concrete pavement, the Contractor shall complete the construction of asphalt concrete base course in the area of pavement and clean the base course of foreign substances.

3.1.2 Asphalt Concrete Preparation

The Contractor shall uniformly mix mineral aggregate with liquid bituminous material in a central plant. The percentage of asphalt cement binder shall be between five and seven percent.

3.2 INSTALLATION

3.2.1 Prime Coat

Prior to application of asphaltic concrete, the Contractor shall apply a prime coat to all existing or backfilled surfaces against which new asphalt concrete pavement will be inlayed. Unless otherwise directed, the prime coat shall be applied at a rate of 0.05 gallons per square yard and be applied by pressure distributors. The Contractor shall allow sufficient time before placing asphalt concrete to permit prime coat penetrate base, in accordance with CALTRANS Section 93.

3.2.2 Tack Coat

The Contractor shall apply a tack coat to all base course and existing asphalt concrete surfaces against which new asphalt concrete pavement will be inlayed. Unless otherwise directed, the tack coat shall be applied at a rate of 0.05–0.15 gallons per square yard, according to the Engineer's instructions. The Contractor shall allow sufficient time before placing asphalt concrete to permit tack coat to penetrate base, in accordance with CALTRANS Section 94.

3.2.3 Asphalt Concrete Installation

3.2.3.1 Placing

The Contractor shall deliver bituminous mixtures to the roadbed at specified temperatures in an even manner in accordance with CALTRANS Section 39.

3.2.3.2 Compaction

The Contractor shall perform initial or breakdown rolling by making one pass over asphalt pavement with a two-axle or three-axle tandem steel wheel roller or a three-wheel steel roller with rollers weighing at least 12 tons. The Contractor shall commence rolling at the lower edge and progress toward the highest portion. Under no circumstances shall the center be rolled first. Rolling shall be performed with the drive wheel of the tandem roller forward with respect to the direction of spreading operations. The Contractor shall follow the initial or breakdown rolling with three complete passes of a pneumatic-tired roller while the temperature of the mixture is at least 175° F. The Contractor shall perform final rolling of the uppermost layer of asphalt concrete using an eight-ton, two-axle tandem roller in a manner that will avoid cracking, shoving and/or displacement.

3.2.3.3 Joining Pavement

The Contractor shall carefully create joints between old and new pavements in such manner as to ensure a continuous bond between old and new sections of the course. The Contractor shall expose and clean edges of existing pavement and cut edges straight to vertical surfaces. Joints shall be

painted with a uniform coat of tack coat before the fresh mixture is placed. Joints in the new pavement shall be prepared in accordance with CALTRANS Section 39.

3.3 FIELD QUALITY CONTROL

3.3.1 Pavement Smoothness

The finish surface shall be tested by the Contractor for uniformity of slope and shall not deviate more than ¼-inch from the bottom of 10-ft straight edge laid in every direction.

END OF SECTION

SECTION 02831

CHAIN-LINK FENCE

1. GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 121	(1992a) Zinc-Coated (Galvanized) Steel Barbed Wire
ASTM A 153	(1995) Zinc-Coated (Hot Dip) on Iron and Steel Hardware
ASTM A 176	(1994) Stainless and Heat-Resisting Chromium Steel Plate, sheet, and Strip
ASTM A 392	(1996) Zinc-Coated Steel Chain-Link Fence Fabric
ASTM A 478	(1995a) Chromium-Nickel Stainless and Heat-Resisting Steel Weaving and Knitting Wire
ASTM A 491	(1996) Aluminum-Coated Steel Chain-Link Fence Fabric
ASTM A 585	(1992) Aluminum-Coated Steel Barbed Wire
ASTM A 666	(1994) Austentitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
ASTM A 780	(1993a) Repair of Damaged and Uncoated Areas of Hot-dipped Galvanized Coatings
ASTM A 824	(1992) Metallic-Coated Steel Marcelled Tension Wire for Use with Chain-Link Fence
ASTM C 94	(1996) Ready-Mixed Concrete
ASTM D 4541	(1995) Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM F 626	(1996) Fence Fittings

ASTM F 883	(1990) Padlocks
ASTM F 900	(1994) Industrial and Commercial Swing Gates
ASTM F 1043	(1995) Strength and Protective Coatings on Metal Industrial Chain-Link Fence Framework
ASTM F 1083	(1996) Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures

1.2 SUBMITTALS

1.2.1 Manufacturer's Catalog Data

a) Product Data Sheet: Submit Product Data Sheet for Permanent Chain-Link Posts, Fence Fabric, Fittings, and Hardware; and,

b) Product Data Sheet: Submit Product Data Sheet for Permanent Chain-Link Pedestrian and Drive Gate.

1.2.2 Details of the temporary fence base support construction.

1.3 WORK INCLUDED

Work specified in this section includes selection and approval, delivery, labor and materials for the following:

a) Permanent Chain-Link Fence with pedestrian and drive gates at the location shown on the project drawings or as directed by the Engineer; and

b) Temporary Chain-Link Fence at the location shown on the project drawings or as directed by the Engineer.

2. PRODUCTS

2.1 MATERIALS

Materials shall conform to the following:

2.1.1 Chain-Link Fence Fabric

ASTM A 392, Class 1, Class 2, Zinc-coated steel wire with minimum coating weight of 1.2 ounces of zinc per square ft of coated surface, or ASTM A 491, Type I, aluminum-coated steel wire. Fabric

shall be fabricated of 9-gauge wire woven in two-inch mesh. Fabric height shall be six ft. Fabric shall be twisted and barbed on the top selvage and knuckled on the bottom selvage.

2.1.2 Gates

ASTM F 900 and/or ASTM F 1184. Gate shall be the type and swing shown. Gate frames shall conform to strength and coating requirements of ASTM F 1083 for Group IA, steel pipe, with external coating Type A, nominal pipe size (NPS) 1-1/2. Gate frames shall conform to strength and coating requirements of ASTM F 1043, for Group IC, steel pipe with external coating Type a or type B, nominal pipe size (NPS) 1½. Gate fabric shall be as specified for chain-link fabric. (Each end member of gate frames shall be extended sufficiently above the top member to carry three strands of barbed wire in horizontal alignment with barbed wire strands on the fence.) Gate leaves more than eight ft wide shall have either intermediate members and diagonal truss rods or shall have tubular members as necessary to provide rigid construction, free from sag or twist. Gate leaves less than eight ft wide shall have truss rods or intermediate braces. Gate fabric shall be attached to the gate frame by method standard with the manufacturer except that welding will not be permitted. Latches, hinges, stops, keepers, rollers, and other hardware items shall be furnished as required for the operation of the gate. Stops shall be provided for holding the gates in the open position.

2.1.3 Posts

ASTM F 1083, zinc-coated, Group IA, with external coating Type A steel pipe. Group IC steel pipe, zinc-coated with external coating Type A or Type B and Group II, formed steel sections, shall meet the strength and coating requirements of ASTM F 1043. Group III, ASTM F 1043 steel H-section may be used for line posts in lieu of line post shapes specified for the other classes. Sizes shall be as shown on the drawings. Line posts and terminal (corner, gate, and pull) posts selected shall be of the same designation throughout the fence. Gatepost shall be for the gate type specified subject to the limitation specified in ASTM F900 and ASTM F 1184.

2.1.4 Braces and Rails

ASTM F 1083, zinc-coated, Group IA steel pipe, size NPS 1¼. Group IC steel pipe, zinc-coated, shall meet the strength and coating requirements of ASTM F 1043. Group II, formed steel sections, size 1.66 inch, conforming to ASTM F 1043, may be used as braces and rails if Group II line posts are furnished.

2.1.5 Tension Wire

Tension wire shall be Type I or Type II, Class 2 coating, in accordance with ASTM A 824.

2.1.6 Accessories

ASTM F 626. Ferrous accessories shall be zinc or aluminum coated. Truss rods shall be furnished for each terminal post. Truss rods shall be provided with turnbuckles or other equivalent provisions for adjustment. Barbed wire shall be two-strand, 12½ gauge wire, zinc-coated, Class 3 in accordance with ASTM A 121 or aluminum coated Type I in accordance with ASTM A 585. Barbed wire shall

be four-point barbed type steel wire. Barbed wire support arms shall be the (single) (V) arm type and of the design required for the post furnished. Tie wire for attaching fabric to rails, braces, and posts shall be 9-gauge steel wire and match the coating of the fence fabric. Miscellaneous hardware coatings shall conform to ASTM A 153 unless modified herein.

2.1.7 Concrete

ASTM C 94, using maximum size aggregate, and having minimum compressive strength of 3000 psi at 28 days. Grout shall consist of one part Portland cement to three parts clean, well-graded sand and the minimum amount of water to produce a workable mix.

2.1.8 Temporary Chain-Link Fence Base Support

The Contractor shall provide the temporary chain-link fence base support, such that it will ensure the stability of the fence. The Contractor shall use base support common for temporary fence installations in the Project location. Details of the temporary fence base support details shall be submitted to the Engineer for review. The temporary fence base support shall allow for the access to the clean-up areas, see Paragraph 3.9.

3. EXECUTION

3.1 GENERAL

Fence shall be installed to the lines and grades indicated. The area on either side of the fence line shall be cleared to the extent indicated. Line posts shall be spaced equidistant at intervals not exceeding 10 ft. Terminal (corner, gate, and pull) posts shall be set at abrupt changes in vertical and horizontal alignment. Fabric shall be continuous between terminal posts; however, runs between terminal posts shall not exceed 500 ft. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A 780.

3.2 EXCAVATION

Post holes shall be cleared of loose material. Waste material shall be spread where directed. The ground surface irregularities along the fence line shall be eliminated to the extent necessary to maintain a one-inch clearance between the bottom of the fabric and finish grade.

3.3 POSTS

Posts shall be set plumb and in alignment. Except where solid rock is encountered, posts shall be set in concrete to the depth indicated on the drawings. Where solid rock in encountered with no overburden, posts shall be set to a minimum depth of 18 inches in rock. Posts set in concrete shall be set in holes not less than the diameter shown on the drawings. Concrete and grout shall be thoroughly consolidated around each post, shall be free of voids and finished to form a dome.

Concrete and grout shall be allowed to cure for 72 hours prior to attachment of any item to the posts. Group II line posts may be mechanically driven, for temporary fence construction only, if rock is not encountered. Driven posts shall be set to a minimum depth of three ft and shall be protected with drive caps when being set. Fence post rigidity shall be tested by applying a 50-pound fore on the post, perpendicular to the fabric, at five ft above ground. Post movement measured at the point where the force is applied shall be less than or equal to ¾ inch from the relaxed position. Every tenth post shall be tested for rigidity. When a post fails this test, further tests on the next four posts on either side of the failed post shall be made.

3.4 RAILS

3.4.1 Top Rail

Top rail shall be supported at each post to form a continuous brace between terminal posts. Where required, sections of top rail shall be joined using sleeves or couplings that will allow expansion or contraction of the rail.

3.5 BRACES AMD TRUSS RODS

Braces and truss rods shall be installed as indicated and in conformance with the standard practice for the fence furnished. Horizontal (compression) braces and diagonal truss (tension) rods shall be installed on fences over six ft in height. A center brace or two diagonal truss rods shall be installed on 12-ft fences. Braces and truss rods shall extend from terminal posts to line posts. Diagonal braces shall form an angle of approximately 40 to 50 degrees with the horizontal. No bracing is required on fences six ft high or less if a top rail is installed.

3.6 TENSION WIRES

Tension wires shall be installed along the bottom of the fence line and attached to the terminal posts of each stretch of the fence. Bottom tension wire shall be installed within the bottom six inches of the installed fabric. Tension wire shall be pulled taut and shall be free of sag.

3.7 CHAIN-LINK FABRIC

Chain-link fabric shall be installed on the side of the post to match the existing fence on-site. Fabric shall be attached to terminal posts with stretcher bars and tension bands. Bands shall be spaced at approximately 15-inch intervals. The fabric shall be installed and pulled taut to provide a smooth and uniform appearance free from sag, without permanently distorting the fabric diamond or reducing the fabric height. Fabric shall be fastened to line posts at approximately 15-inch intervals and fastened to all rails and tension wires at approximately 24-inch intervals. Fabric shall be cut by untwisting and removing pickets. Splicing shall be accomplished by weaving a single picket into the ends of the rolls to be joined. The bottom of the installed fabric shall be two inches (plus or minus ½ inch) above the ground. After the fabric installation is complete, the fabric shall be exercised by applying a 50-pound push-pull force at the center of the fabric between posts. The use of a 30 pound

pull, at the center of the panel, shall cause fabric deflection of not more than 2.5 inches when pulling fabric from the post side of the fence. Every second fence panel shall meet this requirement.

3.8 GATES

Gates shall be installed at the locations shown on project drawings or as directed by the Engineer. Hinged gates shall be mounted to swing as required. Latches, stops, and keepers shall be installed as required. Padlocks shall be attached to gates or gate posts with chains. Hinge pins, and hardware shall be welded or otherwise secured to prevent removal.

3.9 INSTALLATION OF TEMPORARY CHAIN-LINK FENCE

The Contractor shall provide temporary fence as shown on the project drawings or as directed by the Engineer. The location of the fence shall be confirmed with the Engineer in the field.

The temporary fence shall be installed prior to the commencement of construction activities on-site. The temporary fence shall be dismantled and removed from the Site when the construction activities have been completed.

END OF SECTION

SECTION 03001

CAST-IN-PLACE CONCRETE

1. GENERAL

1.1 REFERENCES

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 301	1989 Structural Concrete

UNIFORM BUILDING CODE

UBC 1994	Chapter 19 Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C33	1990 Concrete Aggregates
ASTM C 94	1990 Specifications for Ready-Mixed Concrete
ATSM C 143	1990 (Revision A) Slump of Hydraulic Cement Concrete
ASTM C 150	1990 Specifications for Portland Cement
ASTM A 615	1990 Reinforcing Bars in Concrete
ASTM A 185	1990 Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 497	1990 (Rev. B) Steel Welded Wire Fabric, Deformed for Concrete Reinforcement

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS

AASHTO M 6-93	Fine Aggregate for Portland Cement Concrete
AASHTO M 43-88	Sizes of Aggregate for Road and Bridge Construction
AASHTO M 80-87	Coarse Aggregate for Portland Cement Concrete

AASHTO T 26-79 Quality of Water to be Used in Concrete

AASHTO M 85-93 Portland Cement

1.2 SUBMITTALS

1.2.1 Concrete Mix Design

1.2.2 Certificates of Compliance

a) Cement;

b) Aggregates; and,

c) Ready Mix.

1.3 WORK INCLUDED

Work specified in this section includes delivery, labor, materials, and finish for the following:

a) Cast-in-place concrete sidewalks and curb at the edge of pavement as required as part of removal action site restoration;

b) Fence post foundations as specified in Section 02831; and,

c) Drywell abandonment back fill as specified in Section 02383.

1.4 CONCRETE TRANSPORTATION AND HANDLING

If ready-mixed concrete is used, the concrete shall be transported to the Site only in an approved revolving drum truck mixer.

If concrete is mixed at the Site, only an approved stationary revolving mixer shall be used. No manual mixing is allowed. The mixer shall be located as close to the area of the concrete placement as possible. The mixer type and location shall be approved by the Engineer.

Concrete shall be loaded directly into wheel barrels or other transporting equipment and delivered to the area of placement as rapidly as possible.

1.5 TESTING AND SPECIAL INSPECTIONS

a) The Contractor shall provide slump test in accordance with ASTM C 143; and

b) All reinforcement and inserts shall be inspected and approved by the Engineer prior to placing the outside form.

1.6 PROTECTION

The Contractor shall protect wet concrete after placement for a minimum of 24 hours. Barricades and other means shall be provided to prevent unauthorized entry or tampering in the area of wet concrete. The Contractor shall refinish surface of completed concrete, if damaged by rain or other weather conditions.

1.7 ENVIRONMENTAL REQUIREMENTS

The Contractor shall not place concrete when weather conditions may detrimentally effect the quality of concrete.

Concrete placement work in unusual weather conditions, such as rain, strong wind, or extreme heat shall only be done upon the Engineer's approval.

2. PRODUCTS

2.1 AGGREGATE MATERIALS

2.1.1 Fine Aggregate

a) Fine aggregate shall be natural sand or other inert materials with similar characteristics conforming to AASHTO M 6-93;

b) Wash fine aggregates in the processing operations;

c) The material from which the fine aggregate is processed shall have a maximum wear of 40% by the Los Angeles test; and

d) Deleterious substances shall not exceed 0.5% by weight for clay lumps, coal and lignite and 3.0% for material passing the No. 200 sieve.

2.1.2 Coarse Aggregate

a) Coarse Aggregate shall be crushed stone, crushed slab, gravel, or a combination thereof, or other inert material with similar characteristics, having hard strong durable pieces free from adherent coatings conforming for AASHTO M 43-88, except as specified otherwise;

b) Coarse aggregate for structural concrete shall have maximum size ¾ of an inch or as otherwise approved by the Engineer; and

c) Coarse aggregate shall conform to AASHTO M 80-87.

2.2 CEMENT

Portland Cement shall be used unless otherwise specified. Portland Cement shall conform to AASHTO M 85-93 or ASTM C 150.

2.3 WATER

Either potable or reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable matter, sewage or other injurious foreign matter. Water not known to be potable shall be tested in accordance with AASHTO T 26-79.

2.4 REINFORCEMENT

Steel bars for reinforcement of concrete structures shall be deformed steel bars conforming to the requirements of ASTM A 615, grade 40 or higher.

Welded steel wire fabric for reinforcement of concrete structures shall conform to the requirement of ASTM A 497 or ASTM A185 6 by 6, W2.9 by W2.9.

2.5 CONCRETE MIX

ASTMC94, except as modified herein. Ready-mixed.

2.5.1 Require Compressive Strength

Concrete shall have a minimum compressive strength of 3,000 psi at 28 days.

2.5.2 Slump Requirements

Slump shall be between three and five inches in accordance with ASTM C 143.

Concrete is defined as concrete produced regularly by a commercial establishment and delivered to the purchaser in the plastic state.

2.5.3 Cement Content

Cement content per cubic yard of concrete shall be between 5.0 and 6.5 sacks (94 lbs. sacks), unless directed otherwise by the Engineer.

2.5.4 Water Content

Nominal water content per sack of cement shall be between 4.0 gallons to 5.5 gallons per sack. Deduct moisture content of the aggregate from the amount of water required.

2.6 FORMWORK

Form material shall conform to the following requirements, unless approved otherwise by the Engineer.

a) Wood forms shall be dressed at least on one side and two edges;

b) Metal ties or anchors shall be used to permit removal to a depth of at least one inch from the face without damage to the concrete; and

c) Forms shall be treated with an approved coating to prevent the adherence of concrete. No material shall be used that will adhere to or discolor the concrete.

3. EXECUTION

3.1 PREPARATION

3.1.1 Coordination with Related Work

a) The Contractor shall backfill and grade the area of concrete placement in accordance with Section 02220;

b) The Contractor shall prepare drilled or excavated holes for the fence posts in accordance with Section 02831; and

c) The Contractor shall prepare drywell excavations in accordance with Section 02383.

3.1.2 Preparation for Placement of Concrete

The Contractor shall clean the area of concrete placement from all foreign materials and debris, such as pieces of wood, plastic, litter, mud, and water.

3.2 INSTALLATION OF FORMS

The Contractor shall erect forms which shall be:

a) True to line, grade and cross-section;

b) Cleaned and adequately coated with form release oil;

c) Mortar tight and sufficiently rigid to prevent distortion due to the pressure of the concrete and construction operations; and,

d) Held-in place with studs or uprights, sufficiently braced and tied to prevent the opening of formwork joints.

3.3 REINFORCEMENT PLACEMENT

The Contractor shall provide reinforcement placement according to the following requirements, unless otherwise directed by the Engineer.

a) Accurately bend, without heating, reinforcing steel to the forms and dimensions shown on the drawings, if required;

b) Bend in one place, unless otherwise specified;

c) Uncoated reinforcement bars, which have single bends, can be bent in the field. Perform all other bending in the shop prior to shipment;

d) Furnish reinforcement in full lengths without splices as shown on the drawings, unless otherwise indicated;

e) Provide dowels at Construction Joints. The length of the dowels shall be a minimum 40 diameters of the doweled bar. Protect the dowels with approved protective plastic cups where dowels can pose danger to workers. See Paragraph 3.5.f. for additional Construction Joint requirements;

f) Where splicing is approved, the splice shall have a length of at least 40 diameters of the spliced reinforcement bars. Fasten spliced re-bars with wire clips or wire at eight inches maximum;

g) Clean all reinforcement of all foreign matter which may reduce bond, prior to placing concrete; and,

h) Accurately place reinforcement and firmly hold in place:

   1) Fasten with wire clips or wire at each intersection;

   2) Securely space reinforcement from forms and adjacent reinforcement with precast concrete or mortar blocks, metal spacers or approved devices; and,

   3) Do not use wood, brick or gravel for spacers.

3.4 INSERT PLACEMENT

Place and secure inserts in position before concrete placement. Plumb inserts and check location and elevation.

3.5 CONCRETE PLACEMENT

Concrete placement shall conform to the following requirements:

a) The Contractor shall provide slump measurement prior to placement of concrete. Concrete with slump outside of the limits specified herein, or concrete with reduced plasticity shall be rejected. Water shall not be added to mixed concrete at the Site, unless approved by the Engineer;

b) The Contractor shall approve concrete placement equipment with the Engineer;

c) No concrete shall be dropped from the height of more than six ft unless authorized otherwise by the Engineer;

d) Concrete shall be placed in one pour (no more than one-hour interruption) for each independent structure. Interruption of the pour longer than one hour shall not be allowed unless special measures are taken and approved by the Engineer;

e) The Contractor shall use approved vibrating equipment during placement of concrete in a manner approved by the Engineer; and

f) In case of an interruption in concrete placement for more than two hours, a construction joint shall be provided along the entire line of the concrete surface where the pour is interrupted. The construction joint shall have the following elements:

    1) Key formed out of beveled 2x4 along the entire length of the seam; the key shall be removed as soon at the concrete sets;

    2) All reinforcement bars which cross the construction joint, shall be extended beyond the construction joint as dowels of a minimum of 40 diameters of the reinforcement bars; and,

    3) The construction joint surface shall be cleaned with pressure hose water or other approved means prior to continuation of the pour.

NOTE: If the pour is interrupted without a proper construction joint, the concrete near the area of interruption shall be rejected. In such a case, the concrete shall be broken back as far as needed to allow for making of a construction joint as described herein.

3.6 CONTROL JOINTS

The Contractor shall provide control joints to allow for expansion and contraction of concrete in the curb and side walks. The control joint shall be a ¼ inch wide by ¼ inch deep groove, which is sawed in wet concrete surface at 10 ft intervals.

3.7 CONCRETE CURING

The Contractor shall provide the following measures for concrete curing as required and as directed by the Engineer in the field:

a) Concrete shall be protected from rapid evaporation by placing a wet burlap over the entire area of concrete pour, if water conditions so require. The burlap shall be kept wet continuously for a minimum of four days;

b) Fresh concrete shall be protected from unauthorized interference by providing barricades, protective tape and/or other approved method; and,

c) Fresh concrete shall be protected from hard rain by placement of an impermeable liner if weather conditions so require.

3.8 REMOVAL OF FORMS

a) Forms for vertical surfaces not carrying loads shall be removed between 24 and 72 hours after the concrete placement;

b) The Contractor shall remove forms with care not to mar or strain the concrete;

c) The Contractor shall remove or cut metal form ties in a neat manner; and

d) All repairs shall be filled with cement mortar mixed in the same proportions as the concrete used.

3.9 FINISHING CONCRETE

Concrete surfaces shall be given a lightly broomed finish and sloped as required for crown. The Contractor shall start finishing concrete surfaces immediately after completion of placement. Concrete finishes, shall be approved by the Engineer.

3.10 BASIS FOR CONCRETE REJECTION

The Contractor shall remove and replace (at his own expense) all concrete which:

a) Is bulged, uneven, and/or shows honeycombing that cannot be repaired;

b) Has a 28-day strength less than the minimum specified; or

c) Pour is interrupted without proper construction joint.

END OF SECTION

APPENDIX A-2

CONSTRUCTION DRAWINGS

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH

(LEHR)

REMOVAL ACTION WORKPLAN DRAWINGS

Prepared by

Weiss Associates

Environmental Science, Engineering and Management

July 24, 2000
REV. 0

REV.	DATE	DESCRIPTION	BY	CHKD.	APPVD.
C	4/6/98				
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SCALE: AS NOTED
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WA PROJECT NUMBER: 128-4001
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PROJECT TITLE
LEHR
REMOVAL ACTION WORKPLAN
DOE Contract No.
DE-AC03-96SF20686

DRAWING TITLE
TITLE SHEET

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LIST OF ABBREVIATIONS

ABBREVIATIONS					
@	AT	EST.	ESTIMATED	N.T.S.	NOT TO SCALE
A.C.	ASPHALTIC CONCRETE	EX. EL.	EXISTING ELEVATION	R.A.	REMOVAL ACTION
A.G.	ABOVEGROUND	EXIST.	EXISTING	REF. EL.	REFERENCE ELEVATION
APPROX.	APPROXIMATE	FIN. EL.	FINISH ELEVATION	S.D.	STORM DRAIN
B.G.	BELOW GROUND	FT.	FEET	S.S.	SANITARY SEWER
B.G.S.	BELOW GROUND SURFACE	HORIZ.	HORIZONTAL	THK.	THICK
BLDG.	BUILDING	HT.	HEIGHT	TYP.	TYPICAL
B.M.	BENCH MARK	IN.	INCHES	U.G.	UNDERGROUND
C.A.B.	COURSE AGGREGATE BASE	INFO.	INFORMATION	UNK.	UNKNOWN
CONC.	CONCRETE	LEHR	LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH	U.O.N.	UNLESS OTHERWISE NOTED
CONST.	CONSTRUCTION			VERT.	VERTICAL
D.MH.	DRAIN MANHOLE	LFI	LIMITED FIELD INVESTIGATION	V.I.F.	VERIFY IN FIELD
D.B.	DISTRIBUTION BOX	L.F.	LINEAR FEET	VOL.	VOLUME
DOE	DEPT. OF ENERGY	MAX.	MAXIMUM	Ra	RADIUM
DW	DRY WELL	MIN.	MINIMUM	Sr	STRONTIUM
EA.	EACH	M.S.L.	MEAN SEA LEVEL		
EL.	ELEVATION				
E.P.	ELECTRIC POLE				

LIST OF DRAWINGS

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2 OF 13	G-2	SITE PLAN, VICINITY MAP, LIST OF DRAWINGS, ABBREVIATIONS
3 OF 13	G-3	GENERAL NOTES AND GENERAL LEGEND
4 OF 13	C-1	REMOVAL ACTIVITIES SITE LAYOUT
5 OF 13	C-2	SOUTHWEST TRENCHES, EXISTING FEATURES
6 OF 13	C-3	SOUTHWEST TRENCHES, REMOVAL ACTIVITIES
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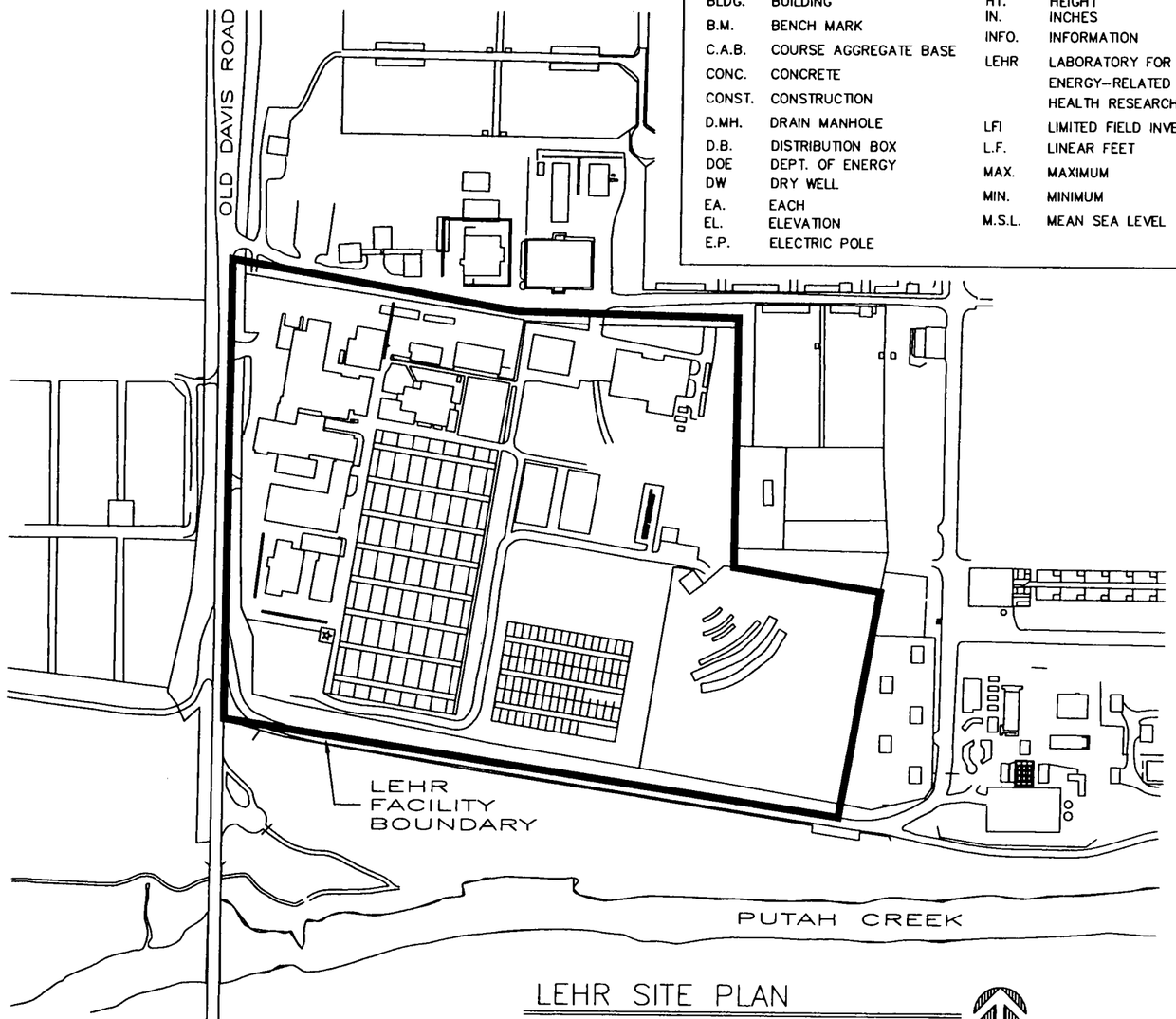
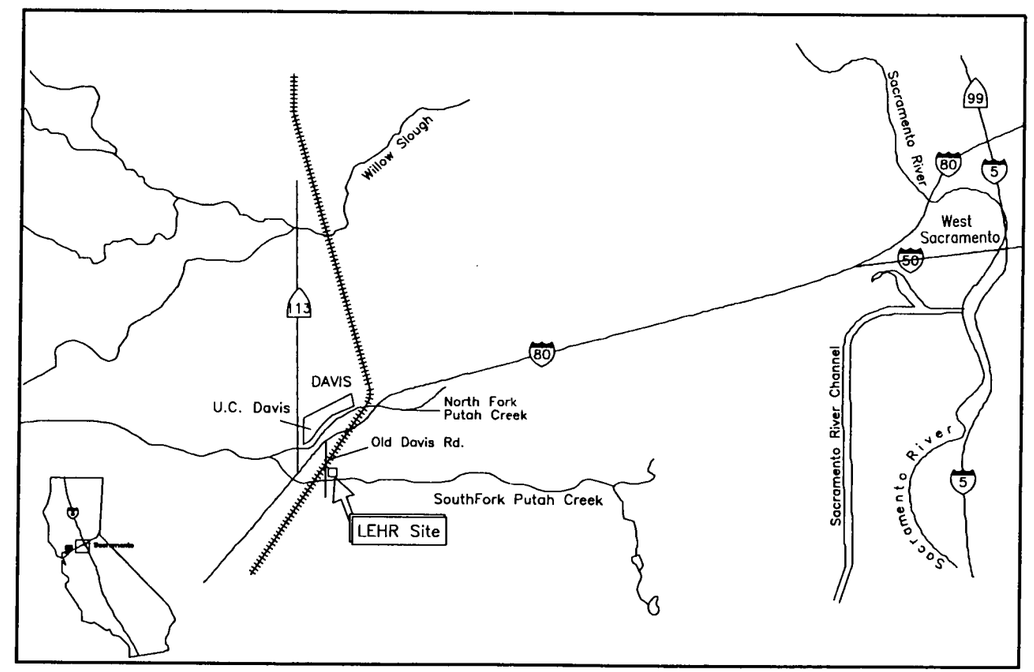
8 OF 13	C-5	Ra/Sr TREATMENT AREA, REMOVAL ACTIVITIES
9 OF 13	C-6	Ra/Sr TREATMENT AREA, TANK EXCAVATION SECTION
10 OF 13	C-7	Ra/Sr TREATMENT AREA, DRYWELL EXCAVATION SECTION
11 OF 13	C-8	DOMESTIC SEPTIC TANKS NO. 6, PLAN
12 OF 13	C-9	CONSTRUCTION DETAILS
13 OF 13	C-10	CONSTRUCTION DETAILS



LEHR SITE PLAN



VICINITY MAP

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DRAWING TITLE
SITE PLAN, VICINITY MAP LIST OF DRAWINGS, AND ABBREVIATIONS

PLAN SHEET
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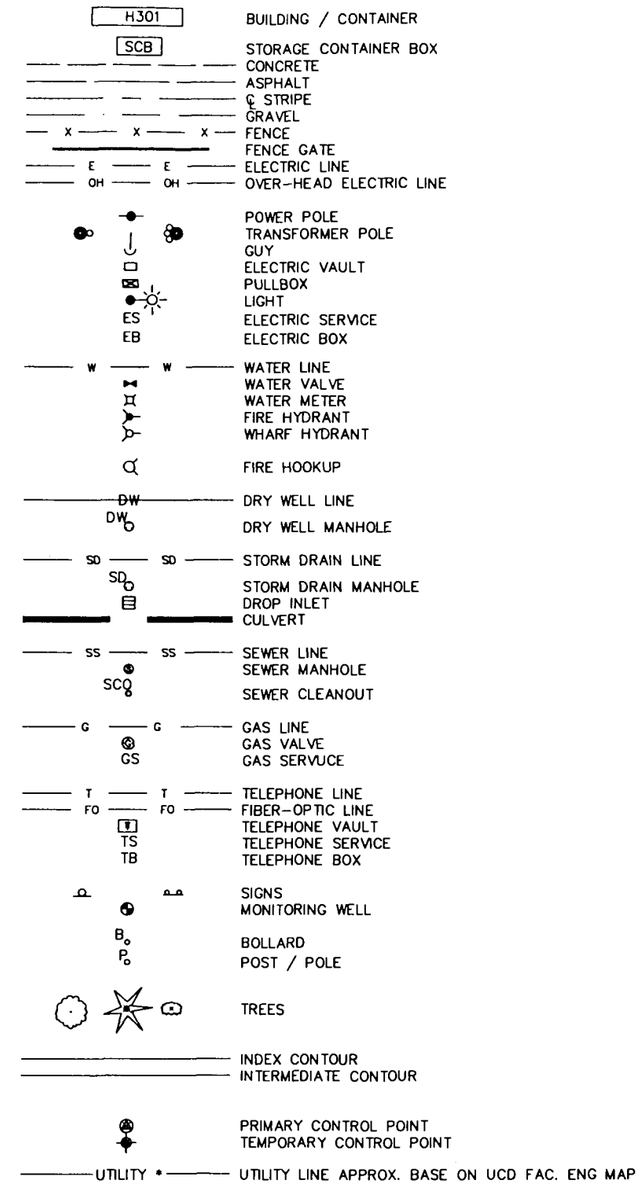
GENERAL NOTES

1. BASIS OF BEARING & ELEVATION: HORIZONTAL COORDINATES AND BEARINGS ARE BASED ON UCD LEHR FACILITY ENVIRONMENTAL RESTORATION BRASS CAPS, MONUMENTS 620 AND 666, NAD 83 HORIZONTAL DATUM, CALIFORNIA COORDINATE SYSTEM, ZONE 2. VERTICAL ELEVATIONS ARE BASED ON UCD LEHR FACILITY ENVIRONMENTAL RESTORATION BRASS CAPS, MONUMENTS 620 AND 666, USC&GS DATUM.
2. PERFORM ALL WORK IN ACCORDANCE WITH APPLICABLE FEDERAL, STATE, AND LOCAL REGULATIONS/CODES AND DOE ORDERS.
3. FURNISH TEMPORARY FENCING AROUND THE REMOVAL ACTION AREAS AND DESIGNATED EXCLUSION ZONES. THE MINIMUM DISTANCE FROM THE FENCE LINE TO THE EXCAVATION LIMIT SHALL BE 6 FEET. ALL WORK AREAS SHALL BE SECURED AT THE END OF EACH WORKING DAY. PROVIDE TRAFFIC BARRICADES WITH FLASHING LIGHTS, DELINEATOR CONES, TRAFFIC PLATES, FLAGMEN OR OTHER APPLICABLE CAUTIONARY DEVICES AS NECESSARY TO SAFELY CONTROL AND PROTECT FROM BOTH PEDESTRIAN AND VEHICULAR TRAFFIC.
4. CONTRACTOR SHALL VERIFY ALL EXISTING CONDITIONS PRIOR TO WORK PRIOR TO BEGINNING REMOVAL OF UNDERGROUND STRUCTURES, PIPING, AND/OR ACCESSORIES, FIELD VERIFY EXACT HORIZONTAL AND VERTICAL LOCATIONS OF ALL EXISTING UTILITIES AND SITE-SPECIFIC CONDITIONS WHICH WILL AFFECT THE WORK. LOCATIONS OF THE EXISTING TANKS, PIPING, APPURTENANCES, UTILITIES, AND BELOW-GRADE STRUCTURES SHOWN ON DRAWINGS ARE APPROXIMATE. CONTRACTOR SHALL HAND EXCAVATE AROUND UTILITY LINES.
5. PROTECT EXISTING ITEMS WHICH ARE TO REMAIN IN PLACE, BE REUSED, OR REMAIN THE PROPERTY OF UCD. REPAIR ITEMS WHICH ARE TO REMAIN AND/OR WHICH ARE DAMAGED DURING PERFORMANCE OF THE WORK TO THEIR ORIGINAL CONDITION, OR REPLACE WITH NEW. DO NOT EXCEED LOADING CAPACITIES OF SITE PAVEMENTS. RESTORE OR PROVIDE ARCHITECTURAL FINISHES IN AREAS AFFECTED BY DEMOLITION, TO INCLUDE VENT PIPE REMOVAL PAINTING, PAVEMENT/CURB PAINTING, SEALS, STUCCO, AND PATCHES. SURFACE IRREGULARITIES GREATER THAN 1/2-INCH CREATED BY CONSTRUCTION OPERATIONS SHALL BE REPAIRED.
6. PROTECT ELECTRICAL AND MECHANICAL SERVICES AND UTILITIES. WHERE REMOVAL OF EXISTING UTILITIES AND PAVEMENT IS INDICATED. PROVIDE APPROVED BARRICADES, TEMPORARY COVERING OF EXPOSED AREAS, AND TEMPORARY SERVICES OR CONNECTIONS FOR ELECTRICAL AND MECHANICAL UTILITIES. UTILITIES MAY BE TEMPORARILY REMOVED, TAKEN OUT OF SERVICE, DISCONNECTED OR RELOCATED, ONLY WITH PRIOR APPROVAL OF THE ENGINEER. IN CASE OF A UTILITY BASED EMERGENCY DURING CONSTRUCTION IMMEDIATELY CONTACT THE ENGINEER. CONTACT THE ENGINEER IN WRITING 15 CALENDAR DAYS PRIOR, TO ALLOW ADVANCE NOTIFICATION AND REVIEW OF OUTAGE REQUESTS.
7. PROVIDE STORMWATER RUN-ON AND RUN-OFF CONTROLS FOR TEMPORARY STOCKPILES OF SOIL AND OPEN EXCAVATIONS.
8. BACKFILLING OF EXCAVATION SHALL NOT COMMENCE UNTIL PERMISSION TO DO SO HAS BEEN OBTAINED FROM THE ENGINEER.
9. REPAINT ALL BUILDING SURFACES AND PAVEMENT MARKINGS TO MATCH PRE-CONSTRUCTION CONDITIONS.
10. ALL BELOW-GRADE METAL PIPES AND FITTINGS ARE TO BE COATED AND/OR WRAPPED PRIOR TO BURIAL.
11. SITE TO BE RETURNED TO A CONDITION MEETING PRE-CONSTRUCTION CONDITIONS AT COMPLETION OF PROJECT.
12. CONTRACTOR SHALL INFORM THE ENGINEER AT LEAST 7 CALENDAR DAYS IN ADVANCE OF INTENT TO MOVE EQUIPMENT AND MATERIALS TO THE WORK SITE. COORDINATE LOCATION OF CONSTRUCTION MATERIALS AND ALL SITE WORK WITH THE ENGINEER PRIOR TO THE COMMENCEMENT OF WORK.
13. WORK SHALL BE COORDINATED WITH THE ENGINEER TO ALLOW CONCURRENT OPERATIONS TO PROCEED AT THE SITE. IF NECESSARY, ACCESS SHALL BE MAINTAINED FOR OTHER OPERATIONS DESIGNATED BY THE ENGINEER.
14. SITE INFORMATION IS BASED ON SURVEY BY HUNTER SURVEYING, INC., DATED FEBRUARY 9, 1998.
15. PROTECT ALL IDENTIFIED BIOLOGICAL RESOURCES PER BIOLOGICAL SURVEY AND SECTION 01410.
16. PROJECT DRAWINGS SHALL BE USED IN CONJUNCTION WITH PROJECT SPECIFICATIONS. WHEN SECTION XXXX (X BEING DEGIT) IS REFERENCED ON DRAWINGS, SECTIONS OF PROJECT SPECIFICATIONS ARE IMPLIED, U.O.N.
17. CONTRACTOR SHALL BE RESPONSIBLE FOR SAFETY OF PEOPLE AND PROPERTY AT THE AREA OF WORK. ALL CONSTRUCTION PERSONNEL SHALL BE TRAINED AS REQUIRED BY PERTINENT REGULATIONS.
18. CONTRACTOR SHALL COORDINATE TRADES, DELIVERIES, INSTALLATIONS, DISPOSAL AND ALL OTHER OPERATIONS AS CALLED FOR IN PROJECT SPECIFICATIONS.

GENERAL LEGEND



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PROJECT TITLE
LEHR
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DOE Contract No.
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DRAWING TITLE
GENERAL NOTES AND GENERAL LEGEND

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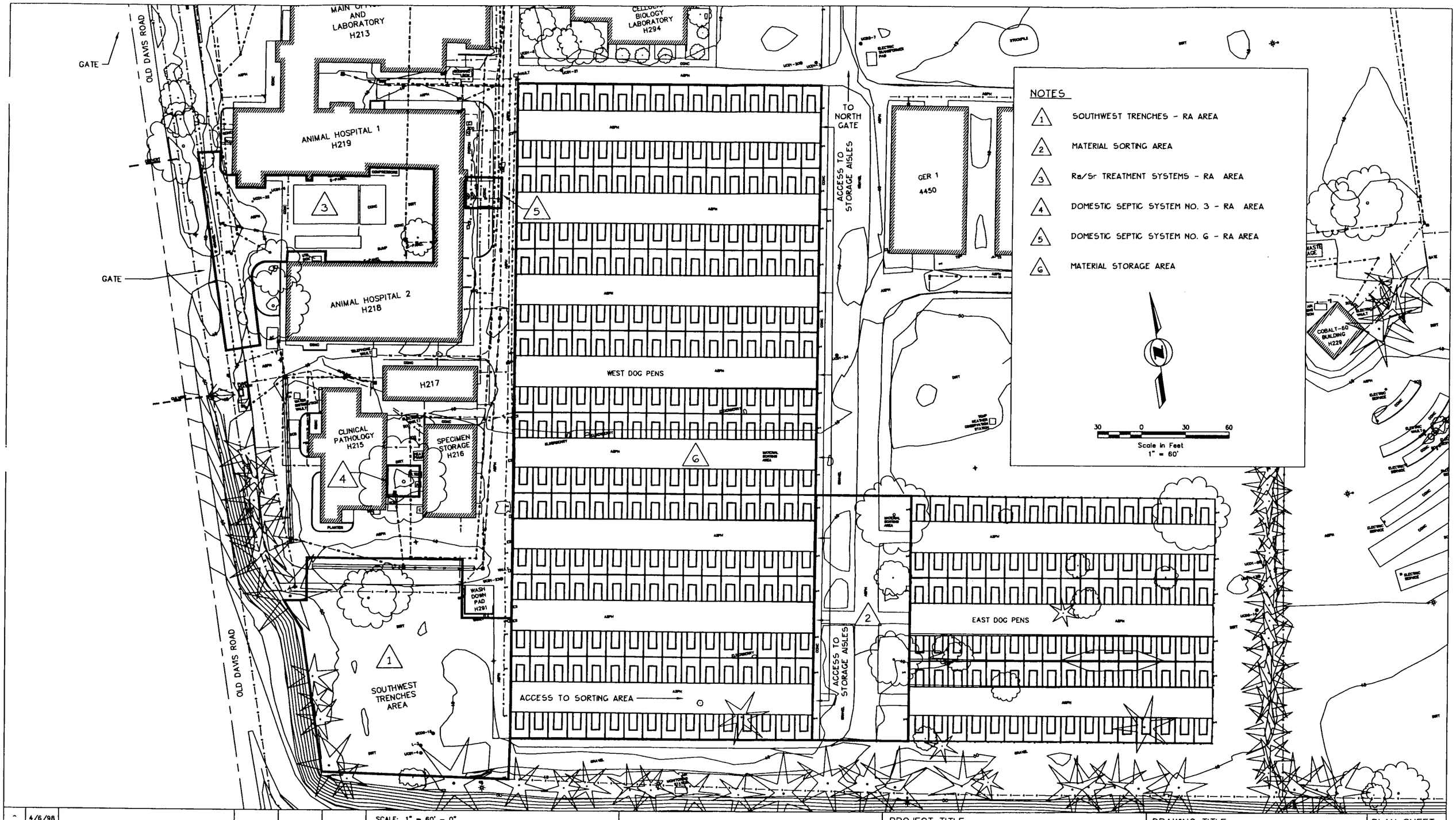

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DE-AC03-96SF20686

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LEHR DOE REMOVAL ACTION AND SUPPORT AREAS

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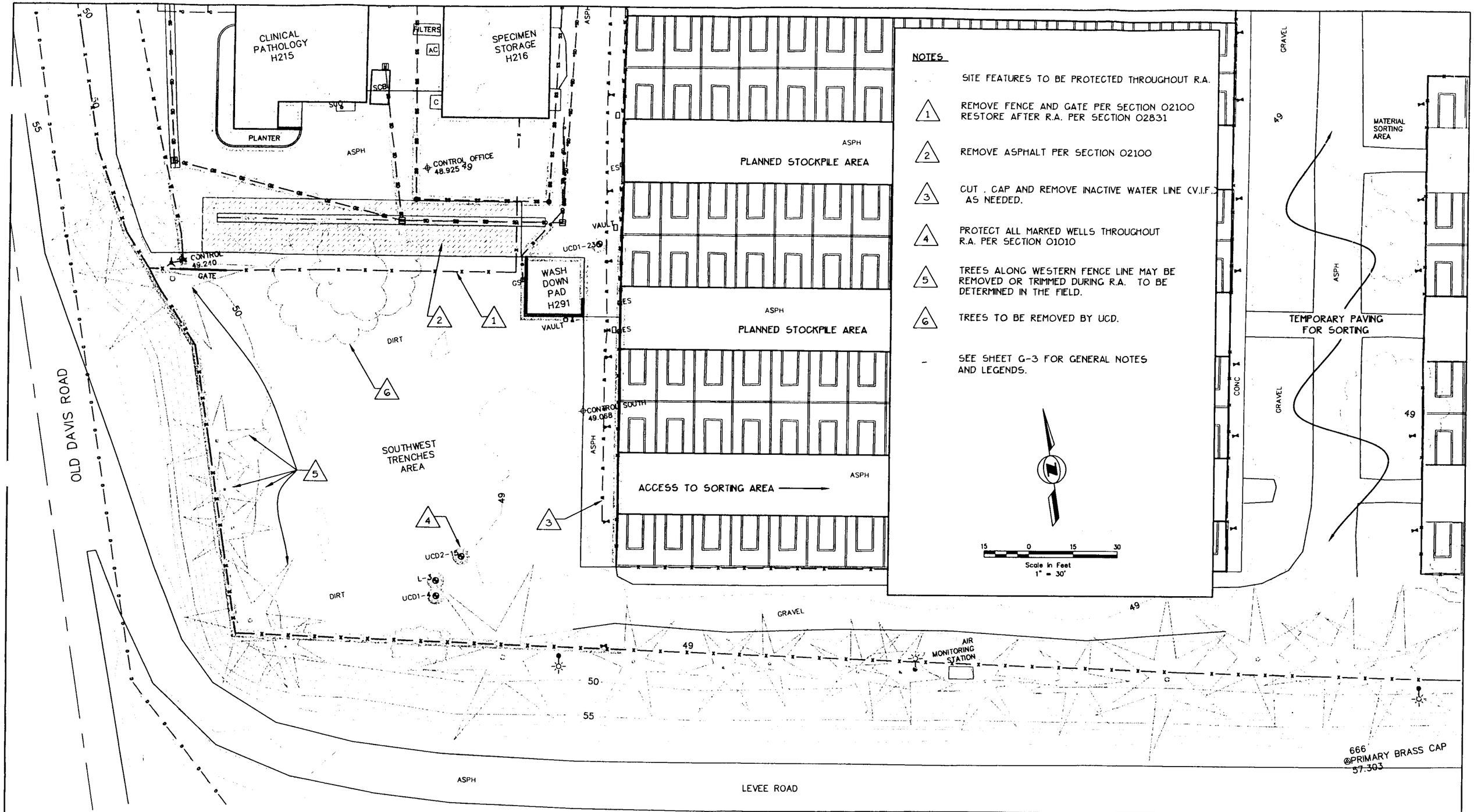

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PROJECT TITLE
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DOE Contract No.
DE-AC03-96SF20686

DRAWING TITLE
SOUTHWEST TRENCHES CLEARING & GRUBBING

PLAN SHEET
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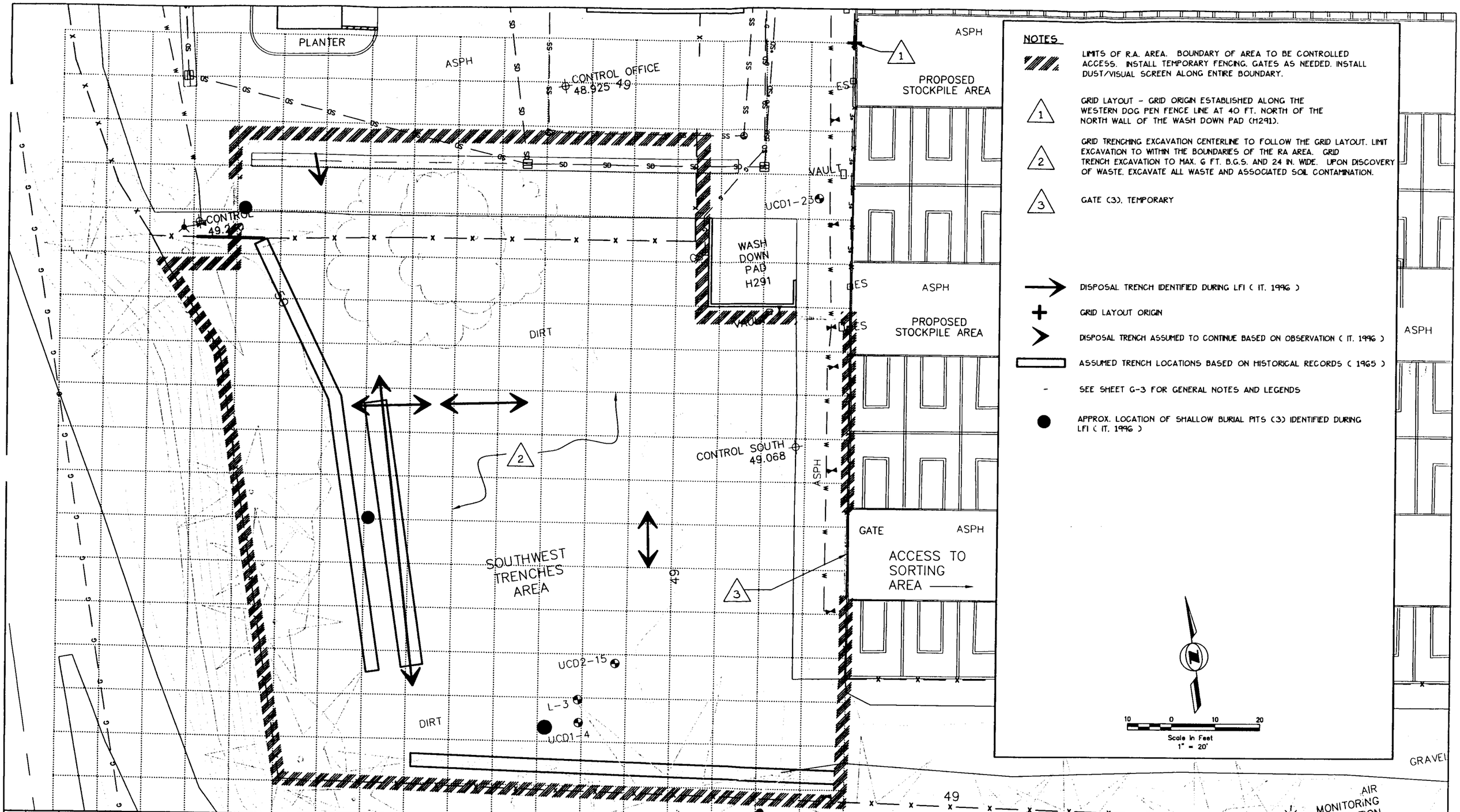

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PROJECT TITLE
LEHR
REMOVAL ACTION WORKPLAN
DOE Contract No.
DE-AC03-96SF20686

DRAWING TITLE
SOUTHWEST TRENCHES REMOVAL ACTIVITIES

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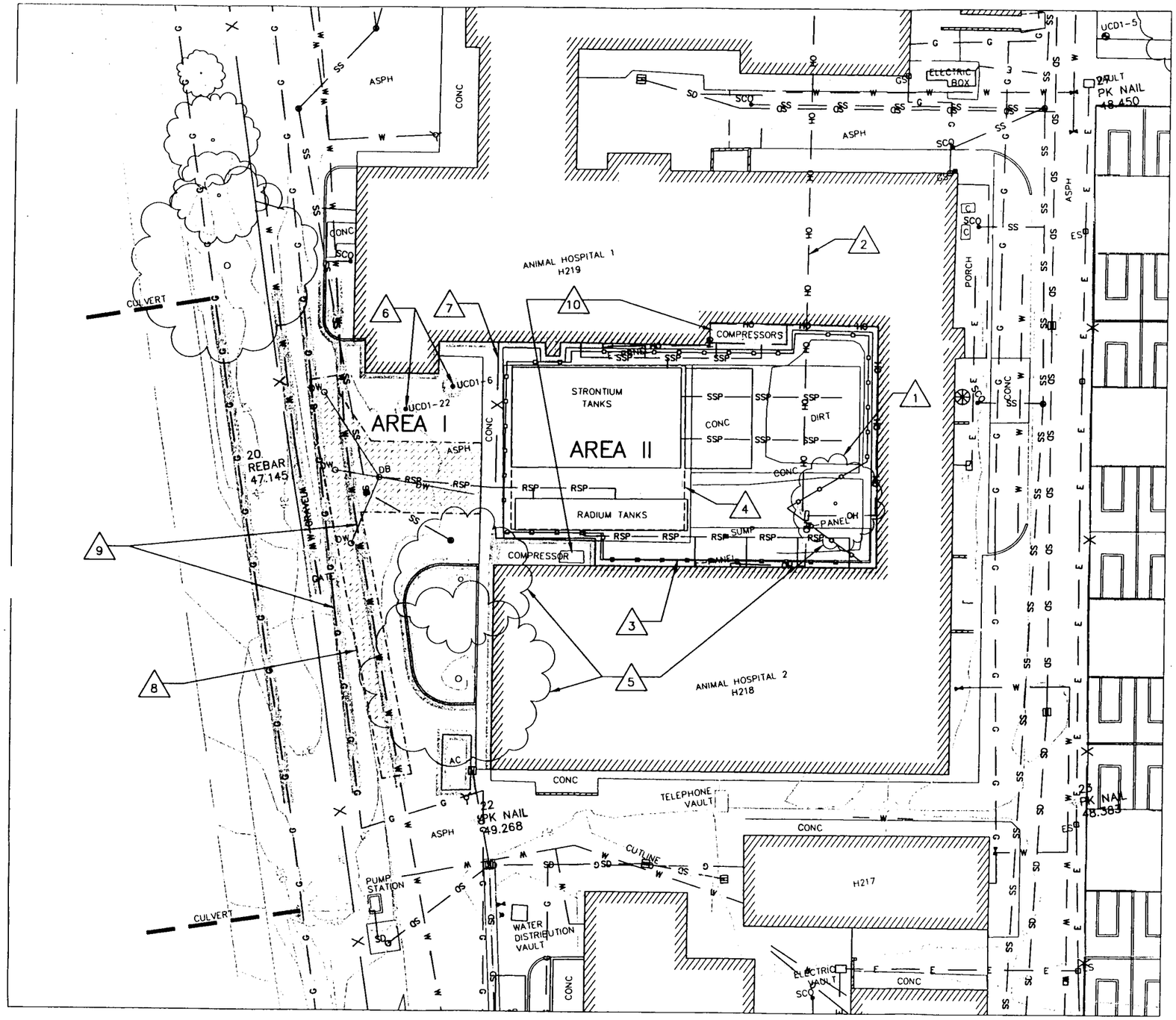

LEGEND

	PROTECT SITE FEATURES THROUGHOUT R.A.
1	REMOVE TREE PER SECTION 02100 AS NECESSARY.
2	REMOVE OVERHEAD LINES AND POLE AS NECESSARY.
3	REMOVE IMPERMEABLE LINER MATERIAL WITH SANDBAGS.
4	REMOVE TEMPORARY RAIN DECK.
5	UCD TO REMOVE TREES PER SECTION 02100.
6	PROTECT MONITORING WELLS THROUGHOUT R.A.
7	REMOVE FENCE PER SECTION 02100 AS NEEDED.
8	REMOVE ASPHALT PER SECTION 02100 RESTORE AFTER R.A. PER SECTION 02575.
9	GAS/WATER LINE TO BE RELOCATED BY UCD
10	RELOCATE COMPRESSORS AS NECESSARY
RSP	RADIUM SYSTEM PIPING (V.I.F.)
SSP	STRONTIUM SYSTEM PIPING (V.I.F.)
	IMPERMEABLE LINER WITH SANDBAGS
	TEMPORARY WOODEN RAIN DECK
	PAVING TO BE REMOVED

A. STORMWATER PROTECTION FEATURES INCLUDING IMPERMEABLE LINER, SANDBAG ANCHORS, SUMP, GEOTEXTILE MATERIAL AND WOODEN SUPPORT DECK MATERIALS TO BE REMOVED PRIOR TO COMMENCEMENT OF REMOVAL ACTION FIELD ACTIVITIES.

B. LOCATIONS OF ALL RADIUM AND STRONTIUM SYSTEM PIPING ARE APPROXIMATE (V.I.F.)

0' 15' 30' 60'

REV.	DATE	DESCRIPTION	BY	CHKD.	APPVD.
C	04/05/98				
	05/21/98				
D	07/22/98				
E	02/11/99				

SCALE: 1" = 30'
SHEET 7 OF 13
WA PROJECT NUMBER: 128-4001-271
DESIGNED: PES DRAWN: CPA CHECKED: –
ZOOM FACTOR: –
DATE: 04/22/99
FILE: 271-002.DWG

Weiss Associates
Environmental Science, Engineering and Management
5500 SHELLMOUND STREET, SUITE 100
EMERYVILLE, CALIFORNIA 94608

LEHR
REMOVAL ACTION WORKPLAN
DOE CONTRACT NO. DE-AC03-96SF20686

DRAWING TITLE
Ra/Sr TREATMENT AREA CLEARING & GRUBBING

PLAN SHEET
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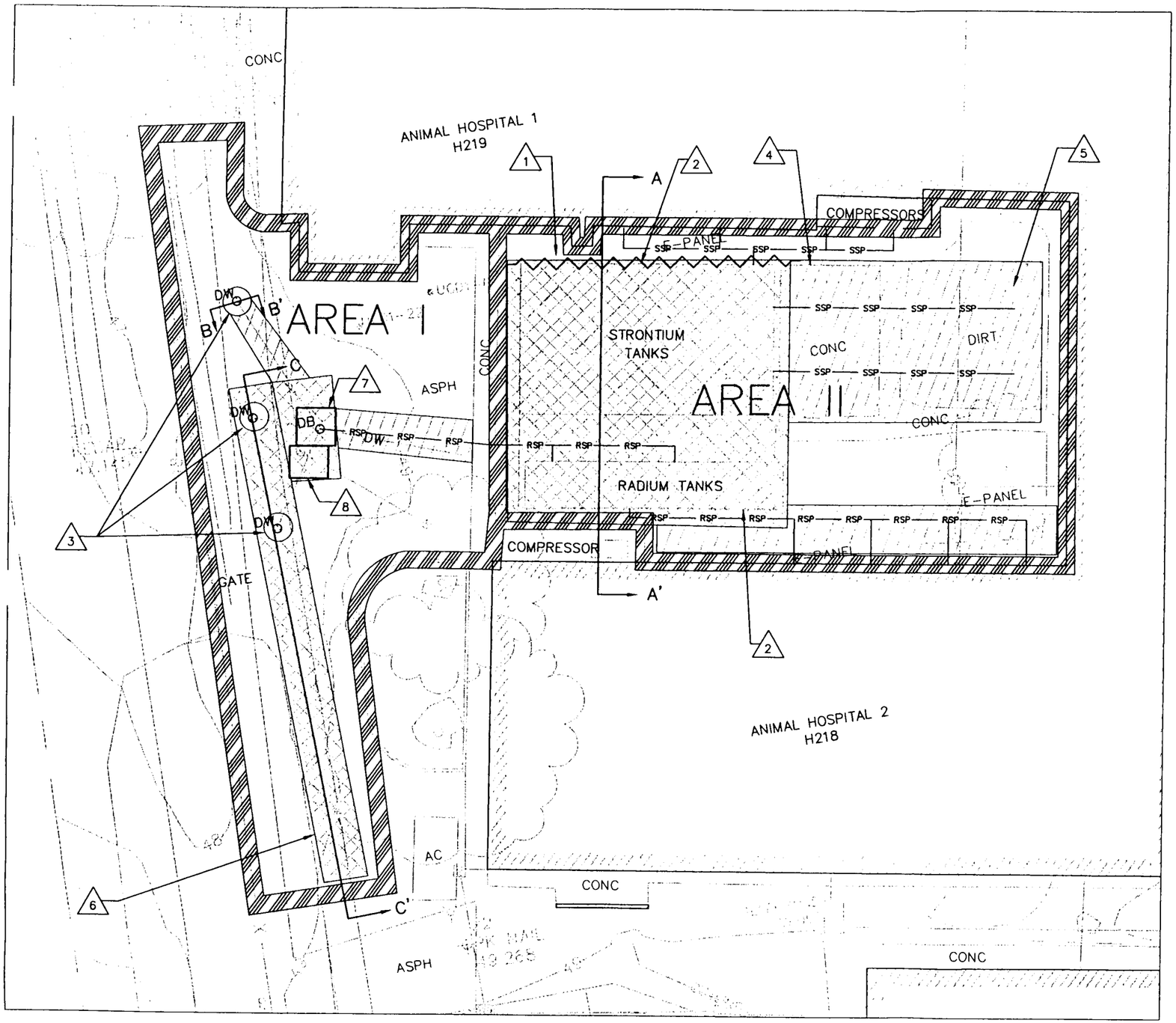
SHEET 7 OF 13



LEGEND

- BOUNDARY OF Ra/Sr TREATMENT SYSTEMS CLEAN-UP AREA (AREA 1 AND AREA II) TO BE CONTROLLED ACCESS. INSTALL TEMPORARY FENCING, GATES AS NEEDED, DUST/VISUAL SCREEN INSTALLED ALONG ENTIRE BOUNDARY.
- 1 — SHORE EXCAVATION PER SHORING PLAN.
- 2 — DEMOLISH AND REMOVE UNDERGROUND STRUCTURES INCLUDING RADIUM AND STRONTIUM TANKS, DOMESTIC TANK NO. 2, Ra DRY WELL MANWAY SECTION, Ra SYSTEM DISTRIBUTION BOX, & OVER EXCAVATE PER SECTIONS 02050 & 02220.
- 3 — DRILL OUT Ra-DRY WELLS (5' DIA. x 40' DEPTH MAX.) PER SECTION 02383. VERIFY DEPTH OF DRY WELL IN FIELD.
- 4 — DEMOLISH AND REMOVE CONCRETE SLAB AND WALKWAYS.
- 5 — EXCAVATE STRONTIUM SYSTEM LEACHFIELDS. VERIFY DIMENSION IN FIELD.
- 6 — EXCAVATE RADIUM LEACH TRENCH. VERIFY DEPTH AND LENGTH IN FIELD.
- 7 — REMOVE Ra SYSTEM DISTRIBUTION BOX.
- 8 — REMOVE DOMESTIC SEPTIC SYSTEM NO. 2
- EXCAVATION TO 12" BELOW STRUCTURE/FEATURE AS REQUIRED BY FIELD SCREENING DATA (EST. 5' BGS)
- EXCAVATION TO 36" BELOW STRUCTURE/FEATURE AS REQUIRED BY FIELD SCREENING DATA (EST. 12' BGS)
- RSP — RADIUM SYSTEM PIPING
- SSP — STRONTIUM SYSTEM PIPING
- ALL ASPHALT/CONCRETE AREAS DISTURBED BY R.A. SHALL BE REPAIRED PER SECTIONS 02570, 02575, AND 03301.
- LOCATIONS OF ALL (RADIUM AND STRONTIUM) SYSTEM FEATURES AND PIPING ARE APPROXIMATE (V.I.F.)
- BACKFILL AND COMPACT ALL EXCAVATION PER SECTIONS 02220 AND 02222.
- SHORING SYSTEM

0' 5' 10' 20' 40'

REV.	DATE	DESCRIPTION	BY	CHKD.	APPVD.
C	04/05/98				
	3/21/98				
D	07/22/98				
E	02/10/99				

SCALE: 1" = 20'
SHEET 8 OF 13
WA PROJECT NUMBER: 128-4001-271
DESIGNED: PES DRAWN: CPA CHECKED: -
ZOOM FACTOR: -
DATE: 03/16/99
FILE: 271-001.DWG

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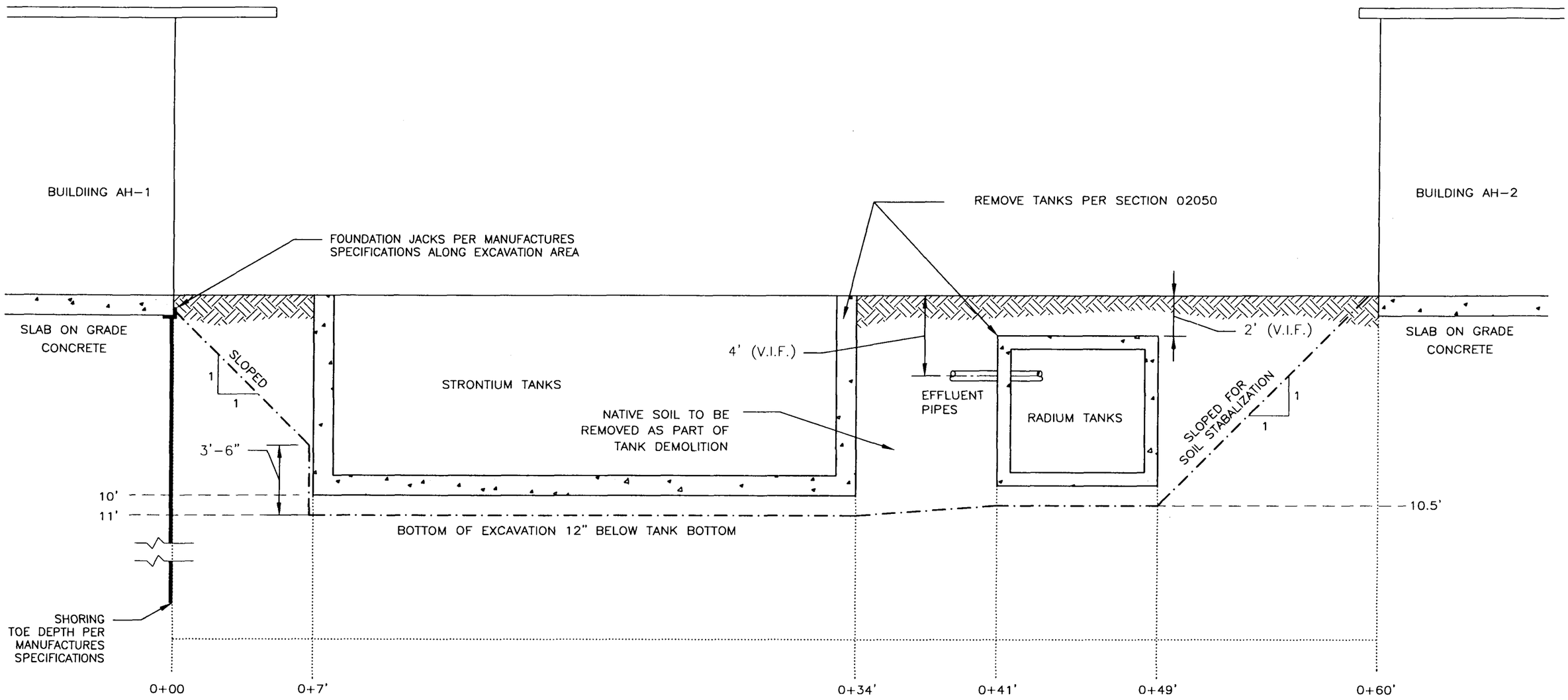
LEHR

REMOVAL ACTION WORKPLAN
DOE CONTRACT NO. DE-AC03-96SF20686

DRAWING TITLE
Ra/Sr TREATMENT AREA REMOVAL ACTIVITIES

PLAN SHEET
C-5
SHEET 8 OF 13



SECTION A-A'
1" = 5'

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	05/21/98				
	07/22/98				
E	02/11/99				

SCALE: 1" = 5'
SHEET — OF —
WA PROJECT NUMBER: 128-4001-271
DESIGNED: PES DRAWN: CPA CHECKED: -
ZOOM FACTOR: -
DATE: 07/24/00
FILE: 271-005.DWG

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DOE CONTRACT NO. DE-AC03-96SF20686

DRAWING TITLE
Ra/Sr TREATMENT AREA
TANK EXCAVATION
CROSS SECTION

PLAN SHEET
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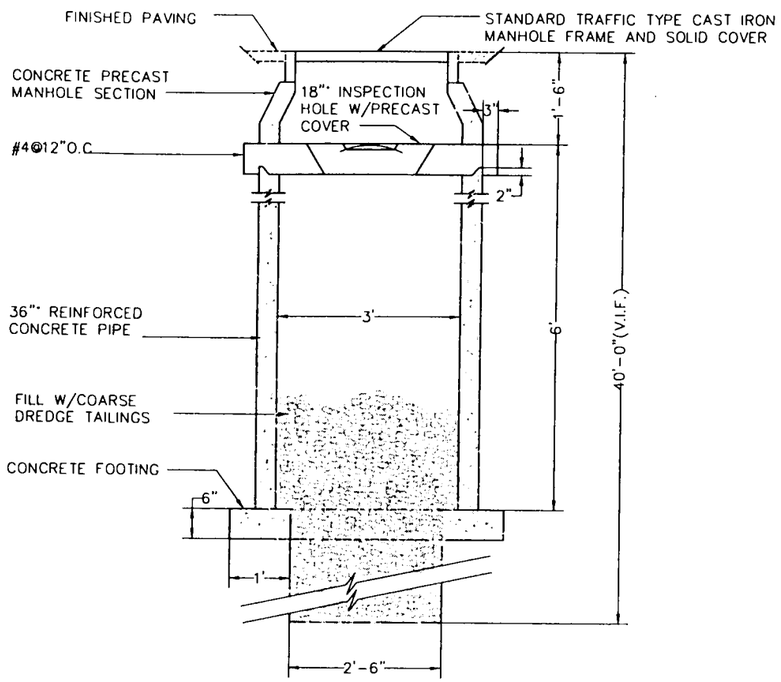
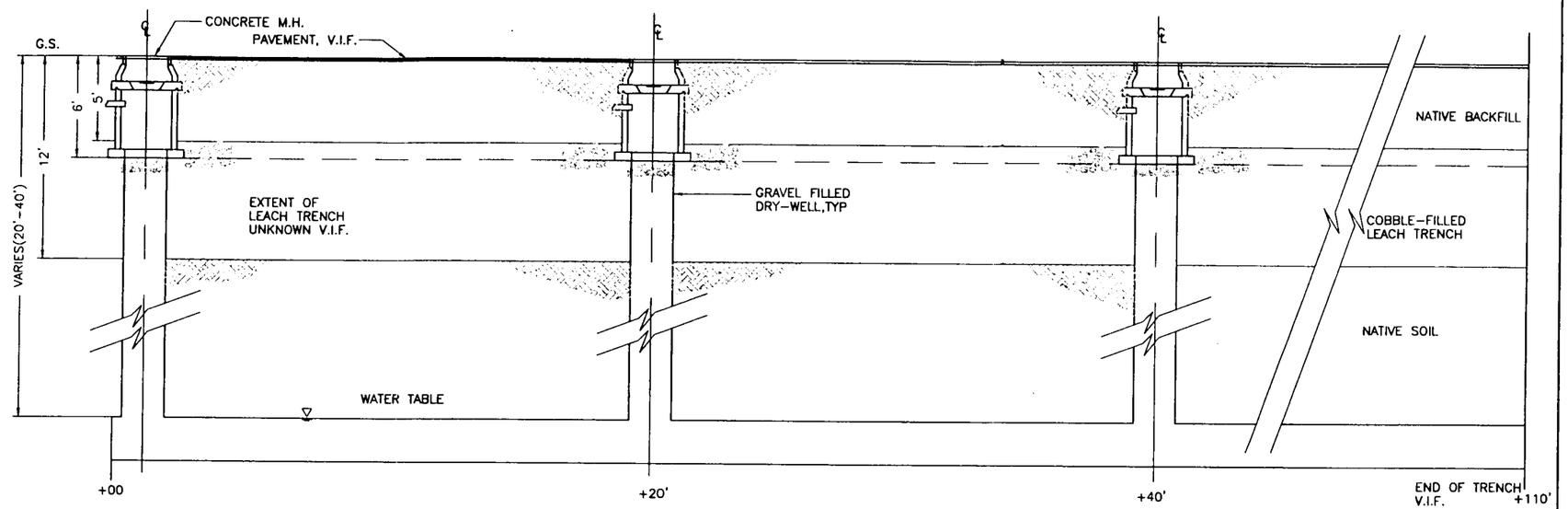
SHEET 9 OF 13



SECTION B'-B'
SCALE: 1"=30'



SECTION C'-C'
SCALE: 1"=100'

REV.	DATE	DESCRIPTION	BY	CHKD.	APPVD.
C	4/6/98				
	71/98				
	2/98				

SCALE: AS NOTED
SHEET 10 OF 13
WA PROJECT NUMBER: 128-4001
DESIGNED: PES DRAWN: DD CHECKED: AAW
ZOOM FACTOR: 1/ XP
DATE: JULY 22, 1998 4001-004C7.DWG

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PROJECT TITLE
LEHR
REMOVAL ACTION WORKPLAN
DOE Contract No.
DE-AC03-96SF20686

DRAWING TITLE
Ra/Sr
TREATMENT AREA, DRY WELL EXCAVATION SECTIONS

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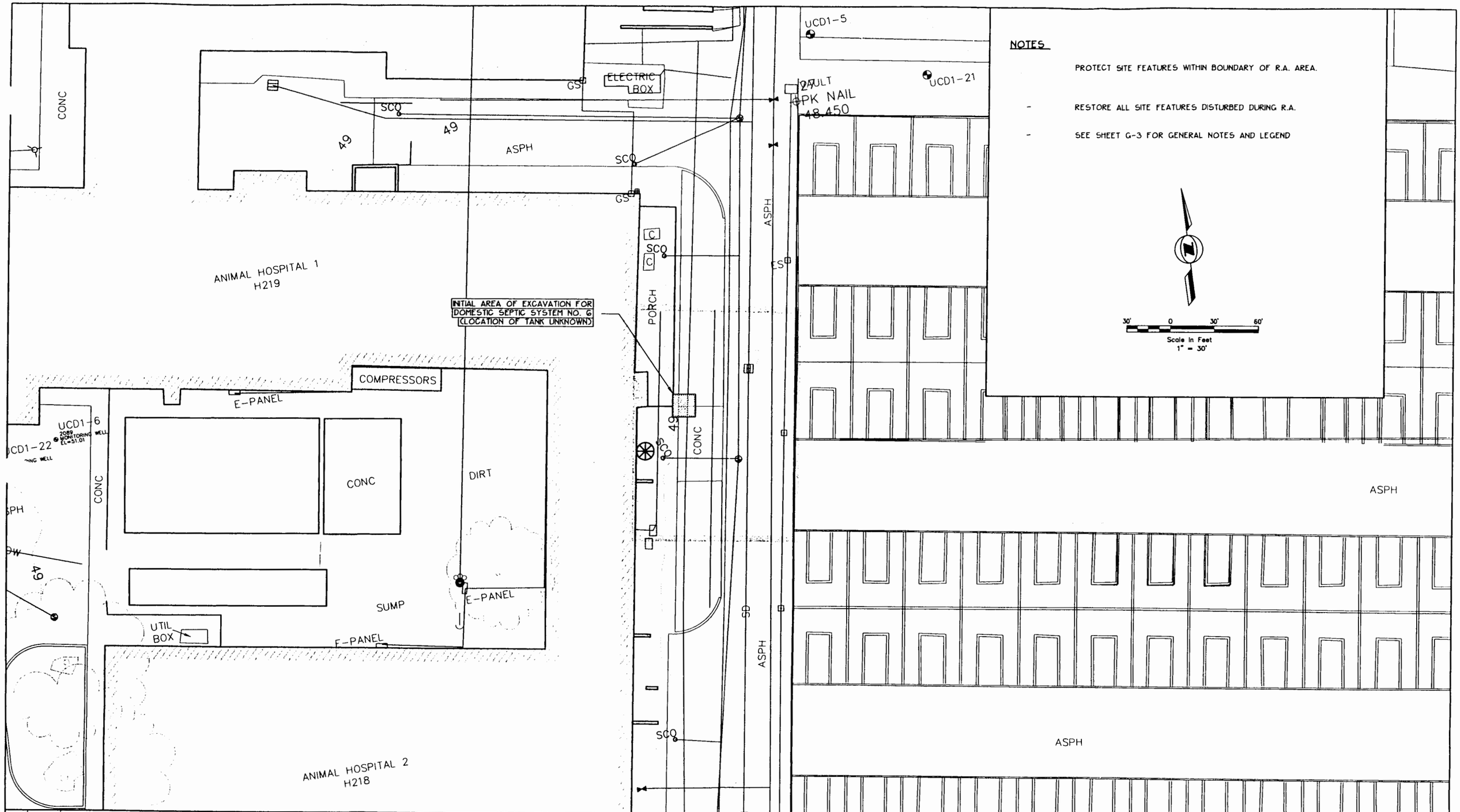

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C	4/6/98				
	/21/98				
	2/98				

SCALE: 1" = 20' - 0"
SHEET 11 OF 13
WA PROJECT NUMBER: 128-4001
DESIGNED: PES DRAWN: KDC CHECKED: AAW
ZOOM FACTOR: 1/20XP
DATE: JULY 22, 1998 4001-004C8.DWG

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PROJECT TITLE
LEHR
REMOVAL ACTION WORKPLAN
DOE Contract No.
DE-AC03-96SF20686

DRAWING TITLE
DOMESTIC SEPTIC SYSTEM NO. 6

PLAN SHEET
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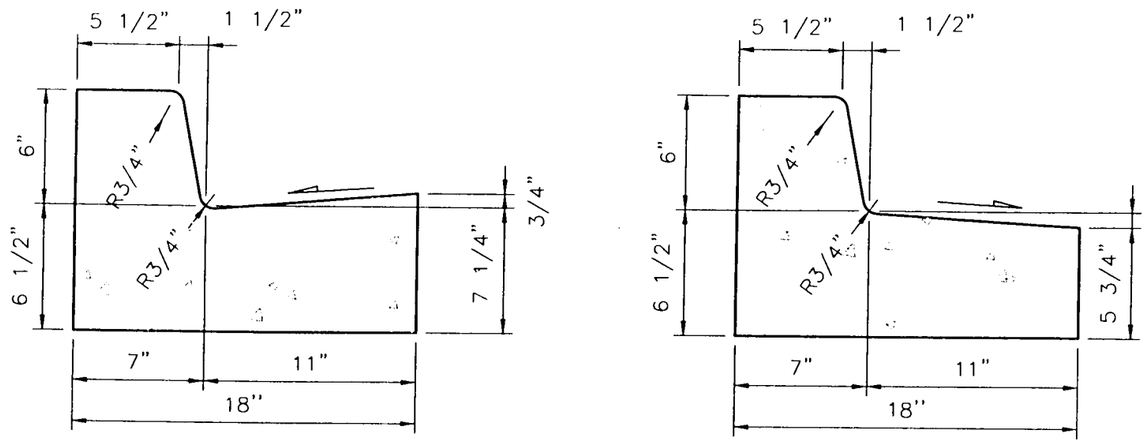
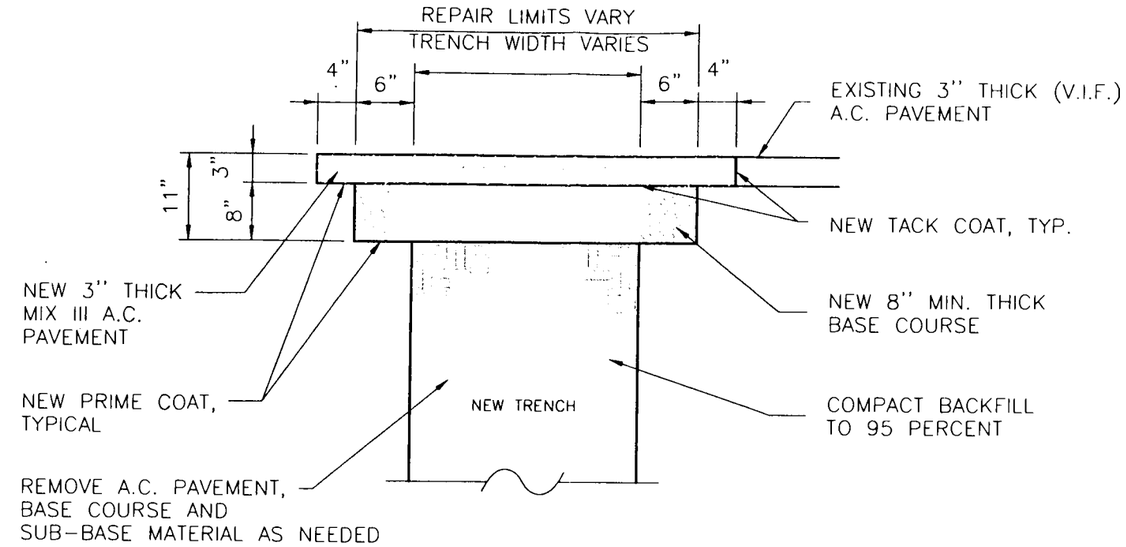
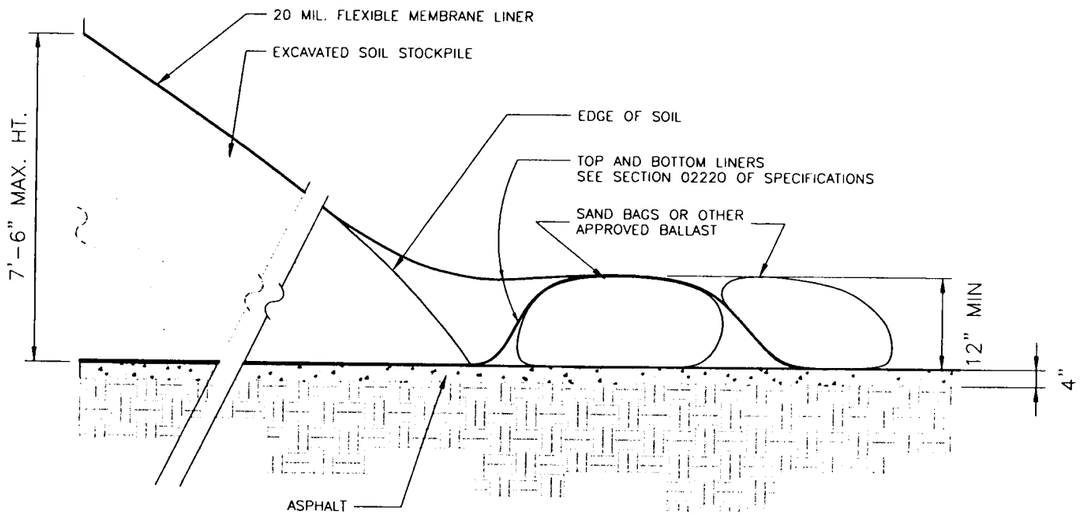


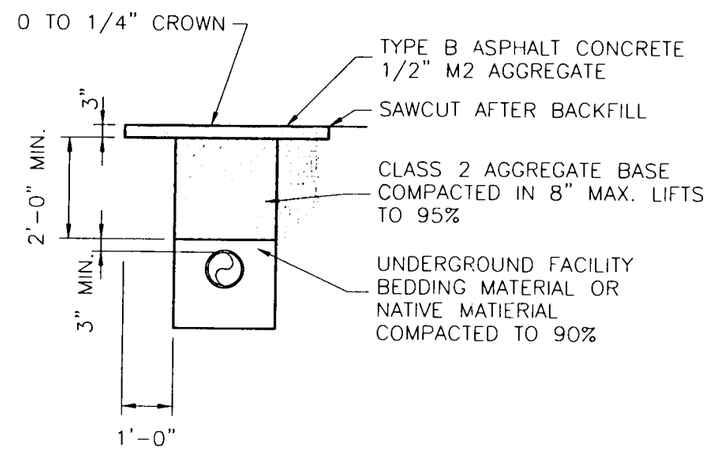
CURB AND GUTTER
1-1/2"=1'-0"



PAVEMENT REPAIR SECTION
3/4"=1'-0"



SOIL STOCKPILE AND BERM DETAIL
3/8"=1'-0"



UTILITY TRENCHES
3/8"=1'-0"

REV.	DATE	DESCRIPTION	BY	CHKD.	APPVD.
C	4/6/98				
	1/98				
	2/98				

SCALE: AS NOTED
SHEET 12 OF 13
WA PROJECT NUMBER: 128-4001
DESIGNED: PES DRAWN: KDC CHECKED: AAW
ZOOM FACTOR: Varies
DATE: JULY 22, 1998
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PROJECT TITLE
LEHR
REMOVAL ACTION WORKPLAN
DOE Contract No.
DE-AC03-96SF20686

DRAWING TITLE
CONSTRUCTION DETAILS

PLAN SHEET
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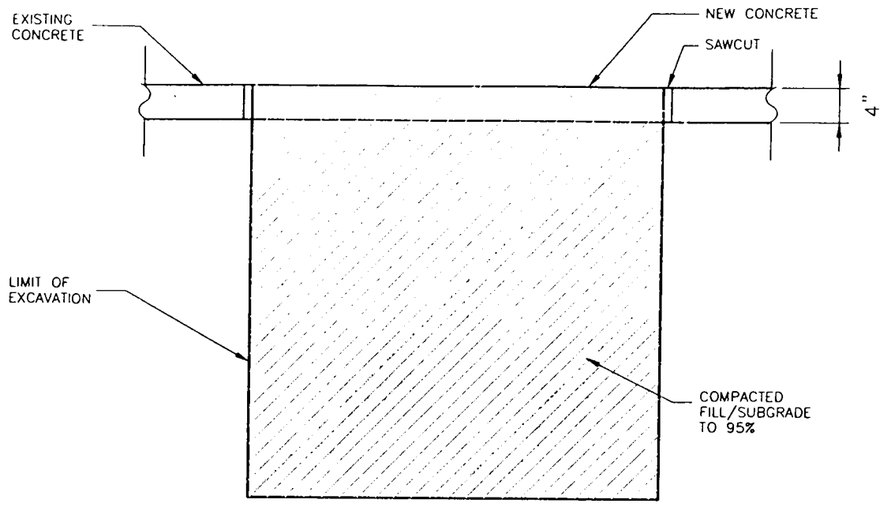

TYPICAL CONCRETE SIDEWALK SECTION
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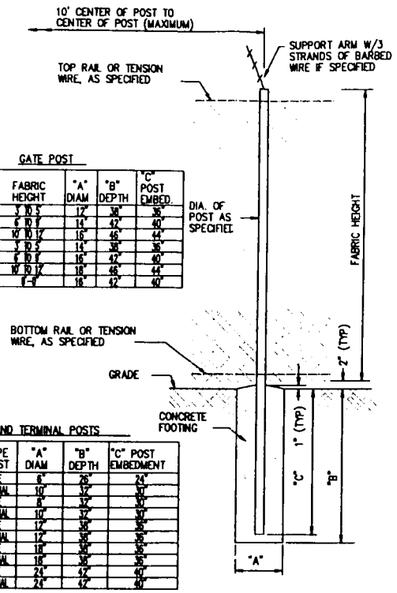

GATE POST

GATE LEAF WIDTH	GATE POST (OD)	FABRIC HEIGHT	"A" DIAM	"B" DEPTH	"C" POST EMBED.
5' TO 6'	2.785"	3' TO 5'	12"	38"	36"
		6' TO 9'	14"	42"	40"
		10' TO 12'	16"	46"	44"
7' TO 12'	4.000"	3' TO 5'	14"	38"	36"
		6' TO 9'	16"	42"	40"
		10' TO 12'	18"	46"	44"
13'	6.625"	8'-6"	18"	42"	40"

LINE AND TERMINAL POSTS

FABRIC HEIGHT	TYPE POST	"A" DIAM	"B" DEPTH	"C" POST EMBEDMENT
3'-6" TO 6'-6"	LINE	8"	26"	24"
	TERMINAL	10"	32"	30"
5'-0"	LINE	8"	32"	30"
	TERMINAL	10"	32"	30"
8'-6" TO 9'-6"	LINE	12"	36"	35"
	TERMINAL	12"	36"	35"
10'-6" TO 12'-6"	LINE	18"	36"	35"
	TERMINAL	18"	36"	35"
13'-6" TO 18'-6"	LINE	24"	42"	40"
	TERMINAL	24"	42"	40"

NOTE: TERMINAL POSTS INCLUDE END, CORNER, AND PULL POSTS

CHAIN LINK FENCE FOUNDATION
NO SCALE

REV.	DATE	DESCRIPTION	BY	CHKD.	APPVD.
B	3/16/98				
	'98				
Ø	6/21/98				
0	7/22/98				

SCALE: AS NOTED
SHEET 13 OF 13
WA PROJECT NUMBER: 128-4001
DESIGNED: PES DRAWN: KDC CHECKED: AAW
ZOOM FACTOR: Varies
DATE: JULY 22, 1998
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EMERYVILLE, CALIFORNIA 94608

PROJECT TITLE
LEHR
REMOVAL ACTION WORKPLAN
DOE Contract No.
DE-AC03-96SF20686

DRAWING TITLE
CONSTRUCTION DETAILS

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APPENDIX B

LIST OF PROPOSED WORK PLAN PROCEDURES

LIST OF PROPOSED WORK PLAN PROCEDURES

RADIATION/HEALTH AND SAFETY

No.	Title
SOP 24.1	Radiological Areas and Postings
SOP 25.1	Radiological Surveys and Instrumentation
SOP 25.2	Radiological Survey Forms
SOP 32.1	Contamination Control
SOP 38.2	Personnel and Visitor's Dosimetry Issuance
SOP 38.3	Internal and External Dosimetry and Radiation Protection Records
SOP 38.4	Radiological Protection Program Audits
SOP 38.5	Personnel Exposure Reports
SOP 40.1	Ambient Radiation Monitoring Program
HSP 1.1	Health and Safety Forms
HSP 2.1	Handling Drums and Containers
HSP 3.1	Working in Hot Environments
HSP 4.1	Trenching and Excavation
HSP 5.1	Confined Space Entry Requirements
HSP 6.1	Air Monitoring
HSP 7.1	Fire Prevention and "Hot Work" Permitting
HSP 8.1	Use of Liquid Nitrogen
HSP 9.1	Control of Hazardous Energy (Lockout/Tagout)
HSP 10.1	Manual Lifting Procedures
HSP 12.1	Safety and Health Signs and Labels
HSP 13.1	Electrical Safety
HSP 14.1	Airborne Radioactivity Monitoring
HSP 15.1	External Radiation Exposure Control
HSP 16.1	Internal Radiation Monitoring
HSP 17.1	Hazardous Work Permits
HSP 18.1	Personnel Contamination
HSP 19.1	Embryo/Fetus Protection
HSP 20.1	Worker Safety and Radiation Protection Training

SAMPLING

No.	Title
SOP 1.1	Chain of Custody
SOP 2.1	Sample Handling, Packaging and Shipping
SOP 3.1	Surface and Shallow Subsurface Soil Sampling
SOP 3.2	Subsurface Soil Sampling While Drilling
SOP 6.1	Sampling Equipment and Well Material Decontamination
SOP 15.1	Lithologic Logging
SOP 17.1	Sample Labeling
SOP 17.2	Sample Numbering
SOP 18.1	Field QC Sampling
SOP 19.1	On-Site Sample Storage
SOP 20.1	Sample Containers, Preservation, Holding Times

WASTE MANAGEMENT

No.	Title
SOP 12.1	Soil Stockpiling
SOP 29.1	Drum Crusher Operation and Servicing
SOP 31.1	Lead Characterization, Packaging and Shipping
SOP 34.1	Waste Processing and Packaging
SOP 34.2	Low-Level Radioactive Waste Storage
SOP 34.4	Clean Waste Handling
SOP 35.1	Waste Certification

MISCELLANEOUS

No.	Title
SOP 6.2	Drilling and Heavy Equipment Decontamination
SOP 7.1	Surface and Subsurface Geophysics
SOP 13.2	Ambient Air Monitoring
SOP 21.1	Data Validation
SOP 23.1	Land Surveying
SOP 38.1	Check-In and Orientation for Contractors and Visitors

MISCELLANEOUS

No.	Title
SOP 41.1	Document Review Procedures

PROJECT QUALITY

No.	Title
SQP 3.2	Indoctrination and Training
SQP 5.1	Preparation, Revision and Approval of Plans and Procedures
SQP 7.1	Quality Inspections and Inspection Records
SQP 7.2	Receipt Inspection
SQP 8.1	Calibration and Maintenance of Measuring and Test Equipment
SQP 10.1	Nonconformance Control
SQP 10.2	Corrective Action
SQP 10.3	Stop Work Order
SQP 11.1	Field Work Variance

Abbreviations and Notes:

SOP = Standard Operating Procedure
SQP = Standard Quality Procedure
HSP = Health and Safety Procedure
Note: The above list represents SOPs, SQPs and HSPs that are proposed to be used during the Removal Actions at the Southwest Trenches, Ra/Sr Treatment Systems, and the Domestic Septic System Areas.

APPENDIX C

BACKGROUND CONCENTRATION CALCULATIONS

CONTENTS

SUMMARY S-1

1.1 Introduction C-1

1.2 General Technical Approach for Statistical Analysis C-1

1.3 Stratified Statistical Analysis of “Old” Data C-3

1.4 Stratified Statistical Analysis of “New” and “Old” Data C-5

1.5 Incorporation of ’99 Data C-7

1.6 Calculation Procedure for Background Concentrations C-7

1.7 References C-10

SUMMARY

Three soil sampling programs have been implemented at the LEHR site to obtain data for estimating background concentrations of naturally occurring constituents. The "old" program was completed by Dames and Moore in 1994. The program comprised six 40-ft borings both proximal and distant to the site. The "new" program was initiated by Weiss Associates in October 1997 and consisted of six 40-ft borings proximal to the site. "Old" and "new" soil samples were analyzed for the full suite of potential contaminants of concern. The "'99" program consisted of twenty two-ft borings The "99" samples were only analyzed for constituents identified as having significantly different contaminant levels in shallow and deep soils.

A statistical testing approach was developed to establish background concentrations of naturally occurring constituents and to establish whether constituents were stratified with depth and/or soil type using the "old" and "new" data sets. The vertical stratified analysis of "old" data indicated that 11 out of 20 metals and 13 out of 20 radionuclides showed significant differences between shallow and deep soil groups. A comparison of the soil type groupings and the depth-stratified groupings revealed a high degree of correlation between depth and soil type. Results of comparison tests between "old" and "new" data sets indicated that these data sets could be consolidated for four metals and six radionuclides. Vertical stratified analysis of consolidated "old" and "new" data indicated significant differences between shallow and deep soil groups for nine metals and 12 radionuclides. No significant difference was detected for 10 metals and nine radionuclides.

WA determined that not enough surface and near-surface data existed for 12 depth-stratified constituents for meaningful background calculations using the "old" and "new" data. The collection of additional background data in the '99 program was necessary to determine background concentrations for these constituents and to meet data quality objectives outlined in the Final Work Plan for the Western Dog Pens, Background, and Off-Site Investigations. In order to reflect depth stratification, WA included the '99 program data to recalculate background values of constituents previously determined as soil type stratified. Results of current and previous background value calculations are presented in Tables C-5 and C-6.

STATISTICAL ANALYSIS OF BACKGROUND SOIL BORING DATA

1.1 Introduction

Three sampling programs have been implemented at the LEHR site to obtain data for estimating background concentrations or activities[1] of constituents that occur naturally in soils at the site. One program, called the "old" program in this appendix, was implemented by Dames and Moore in November 1994, and consisted of six borings (labeled BGL-1 through BGL-6). Samples from these borings were taken at depths of 0, 4, 19 and 39 ft. Two of the borings (BGL-1 and BGL-2) were located south of the South Fork of Putah Creek and were relatively far from the LEHR site. The other four borings were located north of the South Fork in relative proximity to the site.

The second sampling program, called the "new" program in this appendix, was implemented by Weiss Associates in October 1997, and also consisted of six borings (labeled WA-1 through WA-6). Samples from these borings were taken at approximately the same depths as samples in the "old" program, and also at intermediate depths to provide additional stratigraphic information on the background concentration data. All "new" borings were collected north of the South Fork in relative proximity to the site. The "old" and "new" background soil samples were analyzed for the full suite of metals and radionuclides considered potential contaminants of concern at LEHR (Table C-1).

The third program, called the '99 program, consisted of 20 borings (labeled WA-7 through WA-26) collected within the vicinity of the "new" borings. Soil samples from these borings were collected at depths of zero and two ft. Unlike the "old" and "new" soil samples, the '99 samples were only analyzed for constituents identified as having significantly different contaminant levels in shallow (<4.0 ft bgs) and deeper (>4.0 ft bgs) soils.

1.2 General Technical Approach for Statistical Analysis

The "old" and "new" data sets described above were used to develop a technical approach for establishing background concentrations of naturally occurring soil constituents at the LEHR site. Weiss Associates consulted a professional statistician to develop the statistical testing approach and background cutoff value calculations presented here. WA used the statistical testing approach to group the data if statistical tests indicated the data were stratified. It was appropriate to consider stratifying the data into various groups for comparative statistical analysis because different groupings of soil boring samples could indicate potentially significant differences in background

[1] In the interest of using compact terminology in this appendix, background activities of naturally occurring radionuclides will be grouped with background concentrations of naturally occurring non-radioactive constituents, which will be generally described as "background levels".

concentrations. The various groups considered for stratified statistical analysis of "old" and "new" data were as follows:

- **Vertical stratified analysis:** Soil sample laboratory analysis results from the 0 and 4 ft depths (called "shallow soils") were compared to sample laboratory analysis results from the 19 (±3) and 39 (±3) ft depths (called "deep soils")[2] to understand whether stratigraphic factors could have caused significant differences in background concentrations;
- **Lateral stratified analysis:** Soil sample laboratory analysis results in the "old" program from BGL-1 and BGL-2 (called "cross-creek soils") were compared to sample analysis results from BGL-3 through BGL-6 (called "proximate soils") to understand whether different locations and distances of borings from the site, and hence potential stratigraphic differences associated with those distances and locations, could cause significant differences in background concentration estimates;
- **Soil type stratified analysis:** Based on soil boring log information from the "old" and "new" programs, soil samples were grouped into two broad classes—"sands", or relatively coarse-grained soils with few fines, and "silts and clays", or relatively fine-grained soils of low sand content. These groups could be compared to establish whether naturally occurring factors such as organic content or grain size could influence background concentration estimates; and,
- **Analytical stratified analysis:** "Old" and "new" data could be compared to establish whether laboratory analytical techniques or other factors could cause significantly different estimates of background concentrations.

The general procedure for implementing the stratified statistical analysis was as follows:

1) Vertical and lateral stratified analysis was performed on "old" data. Those constituents in the "old" data showing vertically significant differences were grouped by depth for lateral stratified analysis, whereas constituents not showing vertically significant differences were consolidated over all four depths for lateral stratified analysis. Constituents in cross-creek soils showing laterally significant differences were assumed to be unrepresentative of the native condition at the LEHR site and were eliminated from further statistical analysis.

2) Both "old" and "new" data sets were screened for *outliers*. Outliers were concentrations that were below the first quantile, or above the 99th quantile, of the data set (also referred to as the *1/99 interquantile range*, or "1/99 IQR"). It was possible for various reasons that these outliers did not represent true background concentrations, so they were generally eliminated from analysis when they were about 20 percent higher or lower than the extremes of the 1/99 IQR. However, outliers were retained for analysis in

[2] Soil samples from the new program that were collected within three ft of the 19 and 39 ft sample depths of the old program were classified as "deep soils" for comparative statistical analysis.

approximately two percent of the cases because, probabilistically, two percent of the outliers should be naturally occurring.

3) Analytical stratified analysis was performed on "old" and "new" data. "Old" data were eliminated from further statistical analysis if tests showed significant differences between the data sets. The "new" data were retained in all cases because improved analytical precision was required for laboratory analysis of the "new" data. "Old" data were consolidated with "new" data when tests did not show significant differences.

4) Soil type stratified analysis was performed on the remaining data.

5) Based on the results of the soil type stratified analysis, constituents were either consolidated, or grouped as sands and clays. Sand and clay background concentrations were calculated for data groups showing soil type stratification. In addition, soil type stratified data were consolidated to calculate a consolidated background concentration. Constituent data not showing soil type stratification were consolidated to calculate a single background concentration.

6) "New" data sets with some concentrations below the detection limit (called *censored data sets*) were tested for soil type stratification only. Only "new" data with greater than about five to ten detected concentrations were tested for soil type stratification. Censored, "new" data sets were not consolidated with "old" data because analytical sensitivity was not comparable for the "old" data. Background concentrations for censored data sets were calculated using the Maximum Likelihood Estimator procedure (described below).

7) Background concentrations were not calculated for constituents that had fewer than five detections. Instead, it was concluded that "the background concentration is very near to (or below) the detection limit."

1.3 Stratified Statistical Analysis of "Old" Data

Stratified analysis of "old" data was performed prior to receiving the "new" data. Several "nonparametric" statistical tests were performed on the "old" data to establish whether significant differences exist between constituent concentrations in shallow and deep soils. These tests are called nonparametric because they do not make assumptions about the distribution (and hence the statistical parameters) of the population from which the data are drawn.

1.3.1 Procedures

A *runs test* was performed on grouped data for each constituent. The test was used to decide if ranked data for shallow and deep soils followed a pattern (i.e., if there were lengthy "runs" of shallow or deep data) or if the ranked data were random (that is, if the runs were short). Because the runs test may oversimplify data analysis and its results can be too conservative, another nonparametric test was created, called the *assigned indicator sum test*, for comparison to the runs test results. This test was also performed on grouped and ranked data, but each datum was assigned one

of the binary indicators "0" (for the 0 and four ft group) or "1" (for the 19 and 39 ft group). The indicators were summed for the upper and lower 50th quantiles, and means and variances of the indicator sums were calculated. A normally distributed *z* statistic for the difference in the quantile indicator sum means was formed to decide whether these means were significantly different.

A similar test, the *Wilcoxon rank sum test*, was also performed on concentration-ranked data for each constituent. This test was used to decide whether the mean of the rank of the first group of data (the shallow soils) was significantly different from the mean of the rank of the second group of data (the deep soils). The results of this test should be similar to the assigned indicator sum test results.

A parametric statistical test, the *Student's t test*, was used for both the vertical and lateral stratified analysis of "old" data. The assumption made for the Student's t test is that the data are drawn from a normal distribution (the test is "parametric" because the parameters of the normal distribution can be calculated and used for statistical analysis). Considerable evidence exists that laterally distributed concentrations of naturally occurring constituents can be modeled by lognormal density functions (Ellgas, 1996; USEPA, 1992). Thus, the Student's *t* test could be performed on log-transformed constituent data. If the lognormality assumption were valid, the *t* test would be statistically more *powerful* than the nonparametric tests. Lognormality is a strong assumption that was made only for the lateral stratified analysis. Because this assumption was not proven for vertically distributed constituents in the "old" data, the Student's *t* test results were used only to confirm the nonparametric test results for the vertical stratified analysis. If the Student's *t* test results contradicted the nonparametric test results, the nonparametric test results took precedence.

1.3.2 Results and Conclusions Drawn From Stratified Statistical Analysis of "Old" Data

The results of vertical stratification tests on the "old" data and the overall conclusions drawn from the test results are summarized in Table C-1. The vertical stratified analysis of "old" data indicated that 11 out of 20 metals and 13 out of 20 radionuclides showed significant differences between shallow and deep soil groups. Vertical stratified analysis was inconclusive for three out of 20 metals and one out of 20 radionuclides. We concluded that the "old" data did not indicate vertical stratification for the remaining six metals and six radionuclides.

Soil boring logs were reviewed to determine whether a correlation might exist between soil type (sands and clays) and depth stratified groups (shallow and deep) for constituents showing vertical stratification. A comparison of the soil type groupings and the depth-stratified groupings revealed a high degree of correlation between depth and soil type:

- Eleven out of thirteen samples classified as sands were from the shallow (0 to 4 ft) depth range; and,
- Ten out of eleven samples classified as clays were from the deep (19 to 39 ft) depth range.

Based on this observation, WA decided to replace depth-stratified groupings with soil type stratified groupings for statistical tests to be performed upon receipt of the "new" background data.

The results of Students tests on the "old" data for lateral stratification are summarized in Table C-2. Only results from tests on hexavalent chromium, mercury (deep grouping), and uranium-238 (shallow grouping) indicated a significant difference between lateral groups. Cross-creek soil data showing a significant lateral stratification was removed from the constituent data sets.

The statistical analysis procedures that were used to incorporate the "new" and "old" background data are described below.

1.4 Stratified Statistical Analysis of "New" and "Old" Data

Upon receipt of the "new" data, outliers were removed from both "new" and "old"[3] data sets. Outliers were identified as data points with concentrations significantly outside of the 1/99 IQR. Data were eliminated when they were about 20 percent higher or lower than the extremes of the 1/99 IQR or if they were obvious outliers based on inspection of the constituent histogram. Some outliers were retained for analysis because two percent of the outliers should be naturally occurring.

1.4.1 Procedures

The "new" analytical results were grouped by equally sized concentration ranges, and frequencies were plotted versus concentrations to obtain histograms. Histograms of "new" data were tested to decide whether the underlying population could be modeled by the normal or the lognormal distribution. Because there were less than 50 sample results[4] in the "new" data sets, the *Shapiro-Wilk* (*W* test) (Gilbert, 1987) was used to establish normality. If the untransformed data passed the *W* test at the five-percent significance level, it was likely that the untransformed data were drawn from a normal population. If the natural log transformed (ln-transformed) data passed the *W* test at a five-percent significance level, it was likely that the ln-transformed data were drawn from a lognormal population. If both the nontransformed and the ln-transformed data passed the *W* test, then the highest calculated *W* was used to conclude whether the data were drawn from a normal or lognormal population. If neither data set passed the *W* test, then it was concluded that neither the nontransformed nor the ln-transformed data were drawn from a normal population.

Analytical stratified analysis ("new" vs. "old" data testing) was performed on the "new" and "old" data sets. If significant differences were found in the analytical stratified analysis, then the "old" and "new" data were not consolidated for background calculations. Instead, the "new" data

[3] The above described tests on old data were performed without removal of outliers. Old data set outliers were removed for five out of 20 metals and eight out of 20 radionuclides. Vertical and lateral stratified analysis was redone for constituents with outliers in the old data set. No change from the previous conclusions for vertical and lateral stratified testing was found.

[4] There were less than 50 sample results for all constituents in the new data set due to averaging of field duplicate concentrations. All four pairs of field duplicate sample concentrations were averaged to provide a maximum of 48 data points available for statistical analysis.

were considered to be more representative[5] of the true background concentrations for these constituents, and background concentrations were calculated only on the "new" data.

Soil type stratified analysis was performed on the remaining data. If significant differences were found in the soil type stratified analysis, then WA grouped the sample data by soil type for background calculations.

The Runs test, Indicator test, Wilcoxon rank sum test and Student's *t* test were used for establishing significant differences in stratified data.

1.4.2 Results and Conclusions Drawn From Stratified Statistical Analysis of "New" and "Old" Data

The results of outlier removal, distribution type analysis, tests of "old" vs. "new" data and soil type stratification tests are summarized for metals and radionuclides in Table C-3 and Table C-4 respectively. "New" or "old" data were not available for some constituents. A summary of the data sets available for each constituent is also presented in Tables C-3 and C-4. The "new" samples were not analyzed for nine metals and five radionuclides. However, the "new" samples were analyzed for five radionuclides that had not been analyzed in the "old" samples.

Outliers were removed from "old" and/or "new" sets for six metals and 14 radionuclides.

Based on the results of the Shapiro Wilk Test we assumed that 10 out of 20 metals and two out of 26 radionuclides were drawn from lognormal distributions and one out of 20 metals and 10 out of 26 radionuclides were drawn from normal distributions. The Shapiro-Wilk W test indicated that three metals and six radionuclides were not drawn from lognormal or normal distributions (these constituents were labeled nonparametric). We assumed constituents with censored data sets were drawn from lognormal distributions. No distribution type assumptions were made for the remaining constituents due to the lack of detected concentration data.

Tests of "old" vs. "new" data sets indicated that these groups could be consolidated for 4 metals and six radionuclides. The "old" data were discarded and "new" data retained for one metal and five radionuclides. "Old" vs. "new" comparisons did not apply to the remaining constituents due to a lack of detected concentrations, or because only one data set ("old" or "new") was available.

Results of comparison tests indicated significant differences between soil type groupings for nine metals and 12 radionuclides. We did not find significant differences between soil type groupings for 10 metals and nine radionuclides. Soil type comparison tests did not apply for the remaining six constituents due to a lack of detected concentration data.

All outliers, cross-creek soil and "old" data showing significant differences in concentration were removed. Soil type stratified data were grouped by soil type and unstratified data were

[5] The new data was considered more representative of the true background concentrations because improved analytical sensitivity was required for laboratory analysis of the new data.

consolidated. Background data were ready for calculation of background values as described in the procedures presented in section 1.6.

1.5 Incorporation of '99 Data

The primary objective of collecting additional background data was to assist in establishing cleanup goals for certain metals and radionuclides at the site. Based on statistical analysis of the "old" and "new" data, it was determined that unlike the majority of the other contaminants of concern, 12 constituents are distinctly stratified with depth: barium (Ba), beryllium (Be), chromium (Cr), mercury (Hg), nickel (Ni), cesium-137 (Cs-137), thorium-228 (Th-228), Th-230, Th-232, uranium-233/234 (U-233/234), U-235, and U-238. Because of this stratification, there were not enough data for these constituents from surface or near-surface locations for meaningful background calculations. Additional sampling was necessary to determine background concentrations for the aforementioned constituents and to meet the data quality objectives presented in the Final Work Plan for the Western Dog Pens, Background, and Off-Site Investigations (WA, 1997a).

Results of comparison tests of "old" and "new" data sets were used to integrate previous soil data with '99 data (Tables C-3 and C-4). If tests of "old" vs. "new" data sets indicated that these groups could be consolidated, then all three data sets were used for calculation of background values. If comparison tests indicated significant differences between "old" and "new" data sets, then only the "new" and '99 data were consolidated for background calculations. If only "old" data was available, then the "old" and '99 data sets were combined for calculation of background values.

As part of the stratified statistical analysis of "old" data, a comparison of soil type groupings and depth-stratified groupings revealed a high degree of correlation between depth and soil type. Based on this observation, soil type groupings were used for background calculations. WA has subsequently decided that depth stratification is a more statistically useful classification. Background values of constituents previously determined as stratified, including but not limited to the constituents listed in this section, have been recalculated to reflect depth stratification rather than soil type (Tables C-5 and C-6).

1.6 Calculation Procedure for Background Concentrations

Several cases existed for calculating background concentrations after completing the preliminary statistical analysis of the background data. One case was that the normal model was appropriate for the nontransformed or ln-transformed data set. A second case was that the normal model was not appropriate for either the nontransformed or the ln-transformed data set[6]. The final case was that the data set for the constituent was censored (or had some or all concentrations below the detection limit), and therefore the normal model could not be tested.

[6] However, if the calculated *W* was close to the cutoff *W*, a decision was then made to consider the data set "near normal," and likely able to be modeled as a normal distribution.

If the normal model was appropriate for the nontransformed or ln-transformed data set, two sample statistics of the normal distribution, the sample mean, $\overline{X}$, and the sample standard deviation, S_x, were calculated. These statistics were used to estimate quantiles (or percentiles) $\hat{X}_p$ of the nontransformed or ln-transformed population distribution by the following formulas:

$$\hat{X}_p = \overline{X} + Z_p S_x \qquad \text{(Eq. 1)}$$

for the nontransformed data set, or

$$\hat{X}_p = \exp(\overline{X} + Z_p S_x) \qquad \text{(Eq. 2)}$$

for the ln-transformed data set, where Z_p cuts off 100(1-p)% of the upper tail of the normal distribution.

It is proposed to use the 95th percentile to establish the cutoff value for background concentrations. This value is chosen to present a reasonably low probability of making decision errors. If a sample from a cleanup unit has a concentration greater than this cutoff value, it will be falsely concluded about five percent of the time that the sample has constituent concentrations greater than background, when in fact the sample comes from soils with background concentrations (called a "Type I error" in statistical hypothesis testing). The Z_p value cutting off 5% of the upper tail of the normal distribution is 1.645.

Sample data are used to estimate the true 95th percentile of the background distributions. The upper confidence limit (UCL) on the estimated 95th percentile of the normal distribution is (Gilbert, 1987):

$$UCL_{1-\alpha}(\hat{X}_p) = \overline{X} + K_{1-\alpha},\rho S_x \qquad \text{(Eq. 3)}$$

where

α = confidence level

ρ = 95%

$K_{1-\alpha},\rho$ = estimating factor for specified α and ρ (such as Table A3 in Gilbert [1987])

The lower confidence limit (LCL) on the estimated 95th percentile of the normal distribution can be approximated by assuming that, at the tail of the normal distribution, interpolation and extrapolation are approximately linear; therefore,

$$\begin{aligned} LCL_{1-\alpha}(\hat{X}_\rho) &= \overline{X} + Z_\rho S_x - \left[\overline{X} + K_{1-\alpha,\rho} S_x - (\overline{X} + Z_\rho S_x)\right] \\ &= \overline{X} + S_x(2Z_\rho - K_{1-\alpha,\rho}) \end{aligned} \qquad \text{(Eq. 4)}$$

It is proposed to use the 80% LCL (α = 0.2) on the 95th percentile as the cutoff value for background concentrations. In other words, 20% of sample realizations of the 95th percentile will be less than the 80% LCL, or there is a 20% error in sample estimation of the 95th percentile. The 80% LCL is not a *lower bound* on an 80% range of the sample realizations of the 95th percentile, but rather a specified value above which a sample concentration is considered not to be background. Therefore, the *one-sided* 80% LCL (as opposed to the *two-sided* 80%LCL) is the appropriate background cutoff concentration. Gilbert (1987) presents one-sided 90% LCLs of the 95th percentile for various sample sizes; tables of one-sided 80% tolerance limits of the 95th percentile from Owen (1958) were adapted to calculate one-sided 80% LCLs.

If the normal distribution analysis is performed on the ln-transformed space, then converting transformed confidence limits back into the original nontransformed space introduces a bias into the statistics. The approximate percent bias is (Gilbert, 1987):

$$100\left\{1-\exp\left[\left(\frac{1-n}{2_n}\right)S_x^2\right]\right\} \qquad \text{(Eq. 5)}$$

where

n = sample size

The bias was considered to be acceptable if it was less than five to ten percent.

If the normal model was not appropriate for the nontransformed or ln-transformed data set, then a nonparametric one-sided 80% LCL (80% NPLCL) on the 95th percentile was calculated from order statistics on the data sets with n>20 as follows (Gilbert, 1987):

$$NPLCL_{1-\alpha}(\hat{X}_p) = \rho(n+1) - Z_{0.8}\left[n\rho(1-\rho)\right]^{1/2} \qquad \text{(Eq. 6)}$$

where

ρ = 0.95

n = sample size

$Z\rho$ = 0.8418 (cumulative normal to 80th percentile)

The truncated 80% NPLCL gives the number of the lower bound order statistic. The decimal fraction of the calculated 80% NPLCL was used for linear interpolation between the lower bound order statistic and the next order statistic.

Finally, if the data set was censored, another procedure, called the *maximum likelihood estimator* (MLE) procedure (Gilbert, 1987), was used to calculate $\overline{X}$ and S_x for estimating the 80% LCL. This procedure relies upon making a "best estimate" of the mean and variance based on the proportion of sample measurements below the detection limit. Nontransformed and ln-transformed histograms were developed for the detected values in the data set and inspected to decide whether the

distribution was near normal or near lognormal. The MLE procedure was then used to calculate estimates of $\overline{X}$ and S_x which remained either nontransformed or were converted back into the nontransformed space. $\overline{X}$ and S_x were then used as described above to estimate the parametric one-sided 80% LCL.

1.6.1 Results of Background Value Calculations

Tables C-5 and C-6 summarize background values (as the one-sided 80% LCL or 80% NPLCL for the 95th quantile) for metals and radionuclides, respectively. The tables show both the previous (1998) background levels calculated from the "old" and "new" data (WA, 1998), as well as the updated background levels which include the '99 data. Background values were calculated for 0 to 4 ft bgs and >4 ft bgs if the data were found to be stratified. If data were not significantly different with depth, a single consolidated background value was calculated.

- The number of samples used to calculate each background value of each constituent is also presented in Tables C-5 and C-6. The number of samples varies from constituent to constituent due to the possible elimination of outliers, the possible elimination of cross-creek samples, and the number of data sets used.
- Comparing 1998 backgrounds with background levels computed following the '99 sampling program, beryllium (>4 ft bgs), mercury (0-4 and >4 ft bgs), cesium-137 (0-4 ft bgs), thorium-230 (0-4 ft bgs), and uranium-235 (0-4 and >4 ft bgs) experienced significant increases. Significant decreases in updated background levels are noted for beryllium (0-4 ft bgs), chromium (0-4 and >4 ft bgs), nickel (0-4 ft bgs), cesium-137 (>4 ft bgs), and uranium-233/234 (0-4 ft bgs). Slight changes from 1998 to 1999 values exist for arsenic, barium, copper, vanadium, zinc, actinium-228, bismuth-212, lead-212, lead-214, radium-226, radium-228, thallium-208, thorium-232, and uranium-238.
- Background values were not calculated for molybdenum, americium-241, carbon–14, cobalt-60, plutonium-241 and tritium due to a lack of detected concentration data.

1.7 References

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Table C-1. Statistical Test Conclusions for Vertically Stratified Background Sample Data

Constituent	Runs[1]	Indicator[2]	Rank Sum[2]	t-Test[3]	Overall Conclusion[4]
Metals:					
Antimony	3	5	3	3	B
Arsenic	3	1	1	3	A
Barium	3	1	1	1	A
Beryllium	3	2	1	0	A
Cadmium	3	5	3	3	C
Chromium	1	1	1	1	A
Hexavalent Chromium	3	5	5	3	C
Cobalt	3	4	3	2	B
Copper	3	1	1	1	A
Iron	2	4	3	3	B
Lead	3	1	1	0	A
Manganese	3	1	1	0	A
Mercury	2	1	1	1	A
Molybdenum	3	5	5	5	C
Nickel	1	1	1	1	A
Selenium	4	4	3	3	C
Silver	3	5	4	3	C
Thallium	3	5	3	3	C
Vanadium	3	1	1	1	A
Zinc	3	1	1	1	A
Radionuclides:					
Actinium-228	0	0	1	1	A
Bismuth-214	2	5	3	2	B
Carbon-14	3	4	5	5	C
Cesium-137	3	1	1	1	A
Cobalt-60	3	2	1	1	A
Gross Alpha	3	2	1	2	A
Gross Beta	3	5	5	5	C
Lead-212	2	1	1	1	A
Lead-214	3	1	1	1	A
Potassium-40	3	2	2	3	A
Radium-226	4	5	4	3	C
Strontium-90	3	5	4	3	C
Thallium-208	2	2	1	1	A
Thorium-228	2	1	1	1	A
Thorium-230	3	5	4	3	C
Thorium-232	3	1	1	1	A
Tritium	2	1	1	1	A
Uranium-233/234	2	1	1	1	A
Uranium-235	3	5	5	4	C
Uranium-238	3	2	1	1	A

Notes:

(Percentages are approximate probabilities associated with the calculated statistic)

[1] The following decision scale was used for the Runs Test:

1 = 0%-10% = Non-random statistical sample
2 = 10%-30% = Probably non-random sample
3 = 30%-70% = No conclusion

Table C-1. Statistical Test Conclusions for Vertically Stratified Background Sample Data (continued)

Notes: Continued

4	=	70%-90%	=	Probably random sample
5	=	90%-100%	=	Random sample

[2] The following decision scale was used for both the Assigned Indicator and Wilcoxon Rank Sum Tests:

1	=	90%-100%	=	Significant difference in indicator or rank sum means
2	=	80%-90%	=	Probably a significant difference
3	=	60%-80%	=	No conclusion
4	=	20%-60%	=	Probably no significant difference
5	=	0%-20%	=	No significant difference

[3] The following decision scale was used for the Student's t-test:

1	=	0%-10%	=	Very unlikely that t will be as large (i.e., very likely that means are different)
2	=	10%-20%	=	Unlikely that t will be as large (likely that means are different)
3	=	20%-80%	=	No conclusion
4	=	80%-90%	=	Unlikely that means are different
5	=	90%-100%	=	Very unlikely that means are different

[4] A: Vertically stratify background data for lateral stratification testing into 0 and 4 ft sample groups and 19 and 39 ft sample groups for each boring.

B: Test results inconclusive: no basis for vertically stratifying background data in each boring for lateral stratification testing.

C: Do not vertically stratify data: consolidate all vertical measurements in each boring for lateral stratification testing.

Table C-2. Statistical Test Conclusions for Laterally Stratified Background Sample Data

Group[1] & Constituent	Student's-t Test Decision[2] B1&2 vs.B3,4,5,6 @ 0 & 4 ft:	Student's-t Test Decision[2] B1&2 vs.B3,4,5,6 @ 19 & 39 ft:	Student's-t Test Decision[2] B1&2 vs.B3,4,5,6 @ all depths:
Group A Metals[1]:			
Arsenic	3	3	
Barium	3	3	
Beryllium	1	3	
Chromium	5	3	
Copper	3	3	
Lead	3	2	
Manganese	2	3	
Mercury	3	1	
Nickel	3	3	
Vanadium	3	3	
Zinc	2	3	
Group A Radionuclides[1]:			
Actinium-228	2	4	
Cesium-137	4	3	
Cobalt-60	3	3	
Gross Alpha	4	3	
Lead-212	3	4	
Lead-214	2	3	
Potassium-40	3	3	
Thallium-208	5	4	
Thorium-228	3	3	
Thorium-232	3	4	
Tritium	3	3	
Uranium-233/234	2	3	
Uranium-238	1	3	
Groups B&C Metals[1]:			
Antimony			3
Cadmium			3
Hexavalent Chromium			1
Cobalt			3
Iron			3
Molybdenum			5
Selenium			3
Silver			3
Thallium			3
Groups B&C Radionuclides[1]:			
Bismuth-214			3
Carbon-14			3
Gross Beta			3
Radium-226			3
Strontium-90			2
Thorium-230			3
Uranium-235			4

Table C-2. Statistical Test Conclusions for Laterally Stratified Background Sample Data (continued)

Notes:

(Percentages are approximate probabilities associated with the calculated statistic)

[1] Groups were determined by statistical analyses of vertically stratified background data. Groups were defined as follows:

A: Vertically stratify background data for lateral stratification testing into 0 and 4 ft sample groups and 19 and 39 ft sample groups for each boring.
B: Test results inconclusive: no basis for vertically stratifying background data in each boring for lateral stratification testing.
C: Do not vertically stratify data: consolidate all vertical measurements in each boring for lateral stratification testing.

[2] The following decision scale was used for the t-test results:

1 = 0%-10% =Very unlikely that t will be as large (*i.e.*, very likely that means are different)
2 = 10%-20% =Unlikely that t will be as large (*i.e.*, likely that means are different)
3 = 20%-80% =No conclusion
4 = 80%-90% =Unlikely that means are different
5 = 90%-100% =Very unlikely that means are different

Table C-3. Results of Tests Performed on Old and New Background Soil Data, Metals and Nitrate

Compound	Available Data[f] Sets	Number of Outliers[a] Removed	Distribution Type	Results of Data Set Comparison Tests Old vs. New Data	Results of Soil Type Comparison Tests (Sand and Clay)	Results of Previous Lateral Analysis[e] Old Background Data
Antimony	New and Old Data	0	Censored	N/A[b]	Not Stratified	Inconclusive
Arsenic	Old Data Only	(1)Old data	Lognormal	N/A[c]	Stratified	Inconclusive
Barium	Old Data Only	0	Lognormal	N/A[c]	Stratified	Inconclusive
Beryllium	Old Data Only	(1)Old data	Lognormal	N/A[c]	Stratified	Conclusive Shifted Means
Cadmium	New and Old Data	0	Censored	N/A[b]	Not Stratified	Inconclusive
Chromium	New and Old Data	0	Lognormal	Old and New Consolidated	Stratified	Conclusive Like Means
Hexavalent Chromium	New and Old Data	(1)Old, (1)New data	Censored	N/A[b]	Stratified[d]	Conclusive Shifted Means
Cobalt	Old Data Only	0	Lognormal	N/A[c]	Not Stratified	Inconclusive
Copper	New and Old Data	0	Lognormal	Old and New Consolidated	Stratified	Inconclusive
Iron	Old Data Only	0	Lognormal	N/A[c]	Not Stratified	Inconclusive
Lead	New and Old Data	(1)Old, (2)New data	Normal	New Retained, Old Discarded	Not Stratified	Inconclusive
Manganese	Old Data Only	(2)Old data	Lognormal	N/A[c]	Not Stratified	Inconclusive
Mercury	New and Old Data	(2)New data	Nonparametric	Old and New Consolidated	Stratified	Conclusive Shifted Means
Molybdenum	New and Old Data	N/A[g]	N/A[g]	N/A[g]	N/A[g]	N/A[g]
Nickel	New and Old Data	0	Nonparametric	Old and New Consolidated	Stratified	Inconclusive
Selenium	Old Data Only	0	Nonparametric	N/A[c]	Not Stratified	Inconclusive
Silver	New and Old Data	0	Censored	N/A[b]	Not Stratified	Inconclusive
Thallium	New and Old Data	0	Censored	N/A[b]	Not Stratified	Inconclusive
Vanadium	Old Data Only	0	Lognormal	N/A[c]	Stratified	Inconclusive
Zinc	Old Data Only	0	Lognormal	N/Ac	Stratified	Inconclusive
Nitrate	New and Old Data	0	Lognormal	Old and New Consolidated	Not Stratified	Inconclusive

Table C-3. Results of Tests Performed on Old and New Background Soil Data, Metals and Nitrate (continued)

Notes:

Old Data	=	Background soil samples collected on November 1 through November 4, 1994, from soil boring locations BGL0001 through BGL0004.
New Data	=	Background soil samples collected on October 6 through October 8, 1997, from soil boring locations WA-1 through WA-6.
(#) Old Data	=	# outliers removed from Old Data.
N/A	=	Not Applicable
Not Stratified	=	Statistical tests indicated sample means of clay and sand soil type data were not significantly different.
a	=	Some data were removed from statistical analysis of the background data sets if the data were significantly above the 99th quantile or significantly below the 1st quantile. Some data above the 99th quantile and below the 1st quantile were retained for statistical analysis because they did not lie significantly outside of the interquantile range based on visual inspection of the histogram.
b	=	Only new data was used for statistical tests and background value calculations for censored data sets.
c	=	Old vs. New tests do not apply. No new data was collected for this metal.
d	=	Soil type stratification tests indicate data may be stratified, but sample means were not significantly different. Stratified background cutoff values were not calculated.
e	=	Soil samples collected from boring locations B1 and B2 were located south of Putah Creek and a significantly greater distance from the LEHR site than all other background borings. The sample population from boring locations B1 and B2 were tested for a shift in concentration in comparison to the remaining samples.
f	=	Field duplicate sample concentrations were averaged. The averaged concentration was used in statistical tests.
g	=	Insufficient concentration data were available to perform statistical tests.

Table C-4. Results of Tests Performed on Old and New Background Soil Data, Radionuclides

Compound	Available Data[a] Sets	Number of Outliers[b] Removed	Distribution Type	Results of Data Set Comparison Tests Old vs. New Data	Results of Soil Type Comparison Tests (Sand and Clay)	Results of Previous Lateral Analysis[f] Old Background Data
Actinium-228	New and Old Data	(2)Old, (2)New data	Nonparametric	New Retained, Old Discarded	Stratified	Inconclusive
Americium-241	New Data Only	0	N/A[g]	N/A[c]	N/A[e]	N/A[c]
Bismuth-212	New Data Only	0	Normal	N/A[c]	Stratified	N/A[c]
Bismuth-214	New and Old Data	(2)Old, (1)New data	Nonparametric	Old and New Consolidated	Not Stratified	Inconclusive
Carbon-14	New and Old Data	(2)Old, (0)New data	N/A[g]	N/A[d]	N/A[e]	Inconclusive
Cesium-137	New and Old Data	0	Censored	N/A[d]	Stratified	Inconclusive
Cobalt-60	New and Old Data	0	N/A[g]	N/A[d]	N/A[e]	Inconclusive
Gross Alpha	New and Old Data	0	Normal	New Retained, Old Discarded	Stratified	Inconclusive
Gross Beta	New and Old Data	(0)Old, (1)New data	Normal	New Retained, Old Discarded	Not Stratified	Inconclusive
Lead-210	New Data Only	0	Censored	N/A[c]	Not Stratified	N/A[c]
Lead-212	New and Old Data	(2)Old, (1)New data	Nonparametric	Old and New Consolidated	Stratified	Inconclusive
Lead-214	New and Old Data	(2)Old, (1)New data	Normal	New Retained, Old Discarded	Stratified	Inconclusive
Potassium-40	New and Old Data	(2)Old, (0)New data	Lognormal	Old and New Consolidated	Not Stratified	Inconclusive
Plutonium-241	New Data Only	0	N/A[g]	N/A[c]	N/A[e]	N/A[c]
Radium-226	New and Old Data	(0)Old, (1)New data	Normal	Old and New Consolidated	Not Stratified	Inconclusive
Radium-228	New Data Only	(1)New data	Nonparametric	N/A[c]	Stratified	N/A[c]
Strontium-90	New and Old Data	(0)Old, (1)New data	Censored	N/A[d]	Not Stratified	Inconclusive
Thallium-208	New and Old Data	(2)Old, (2)New data	Normal	Old and New Consolidated	Stratified	Conclusive Like Means
Thorium-228	Old Data Only	0	Normal	N/A[c]	Stratified	Inconclusive

Table C-4. Results of Tests Performed on Old and New Background Soil Data, Radionuclides (continued)

Thorium-230	Old Data Only	(4)Old data	Normal	N/A[c]	Not Stratified	Inconclusive
Thorium-232	Old Data Only	0	Lognormal	N/A[c]	Stratified	Inconclusive
Thorium-234	New and Old Data	(2)Old, (0)New data	Nonparametric	New Retained, Old Discarded	Not Stratified	Inconclusive
Tritium	New and Old Data	0	N/A[g]	N/A[d]	N/A[e]	Inconclusive
Uranium-233/234	Old Data Only	0	Normal	N/A[c]	Stratified	Inconclusive
Uranium-235	New and Old Data	(0)Old, (1)New data	Nonparametric	Old and New Consolidated	Not Stratified	Inconclusive
Uranium-238	Old Data Only	0	Normal	N/A[c]	Stratified	Conclusive Shifted Means

Notes:

Old Data	=	Background soil samples collected on November 1 through November 4, 1994, from soil boring locations BGL0001 through BGL0004.
New Data	=	Background soil samples collected on October 6 through October 8, 1997, from soil boring locations WA-1 through WA-6.
(#) Old Data	=	# outliers removed from Old Data.
N/A	=	Not Applicable
Not Stratified	=	Statistical tests indicated sample means of clay and sand soil type data were not significantly different.
a	=	Field duplicate sample concentrations were averaged. The averaged concentration was used in statistical tests.
b	=	Some data were removed from statistical analysis of the background data sets if the data were significantly above the 99th quantile or significantly below the 1st quantile. Some data above the 99th quantile and below the 1st quantile were retained for statistical analysis because they did not lie significantly outside of the interquantile range based on visual inspection of the histogram.
c	=	Old vs. New tests do not apply. Only one data set was collected for this radionuclide.
d	=	All concentrations were below the detection limit in one or both data sets. Old vs. New tests could not be conducted.
e	=	Insufficient concentration data were available to conduct soil type stratified testing.
f	=	Soil samples collected from boring locations B1 and B2 were located south of Putah Creek and a significantly greater distance from the LEHR site than all other background borings. The sample population from boring locations B1 and B2 were tested for a shift in concentration in comparison to the remaining samples.
g	=	Insufficient concentration data were available to determine distribution type.

Table C-5. Updated Background Cutoff Values and Number of Measurements, Metals and Nitrate

Metal	1998 Background Value (mg/kg)				Updated 1999 Background Value (mg/kg)			
	0-4 ft bgs (sand)	n	>4 ft bgs (clay)	n	0-4 ft bgs	n	>4 ft bgs	n
Antimony	1.4	48*	1.4	48*	1.4	48*	1.4	48*
Arsenic	8.5	13	10	10	8.14	12	10.9	12
Barium	210	13	290	11	211	52	294	12
Beryllium	0.62	9	0.72	10	0.564	52	0.924	12
Cadmium	0.51	48*	0.51	48*	0.51	48*	0.51	48*
Chromium	218	30	130	42	199	64	125	48
Hexavalent Chromium	0.054	47*	0.054	47*	0.054	47*	0.054	47*
Cobalt	31	24*	31	24*	31	24*	31	24*
Copper	52	30	62	42	48.8	26	61.8	52
Iron	44,000	24*	44,000	24*	44,000	24*	44,000	24*
Lead	9.5	46*	9.5	46*	9.5	46*	9.5	46*
Manganese	750	22*	750	22*	750	22*	750	22*
Mercury	0.65	26	0.23	40	3.94	64	0.248	48
Molybdenum	ND < 0.26	NA	ND < 0.26	NA	ND < 0.26	NA	ND < 0.26	NA
Nickel	370	30	250	42	334	64	246	48
Selenium	1.2	24*	1.2	24*	1.2	24*	1.2	24*
Silver	0.55	48*	0.55	48*	0.55	48*	0.55	48*
Thallium	1.6	48*	1.6	48*	1.6	48*	1.6	48*
Vanadium	69	13	80	11	66.8	12	80.3	12
Zinc	64	8	93	11	72.4	12	93.1	12
Nitrate	36	72*	36	72*	36	72*	36	72*

Notes:
Background values are the 80% lower confidence limit on the 95th percentile for the sample data set.
n = Number of sample concentrations used to calculate background cutoff value.
* = Indicates constituent is NOT STRATIFIED; n = total number of samples used in calculation.
NA = Not Applicable
ND < # = All sample concentrations were below a detection limit of #.

Table C-6. Updated Background Cutoff Values and Number of Measurements, Radionuclides

Radionuclide	1998 Background Value (pCi/g)				Updated 1999 Background Value (pCi/g)			
	0-4 ft bgs (sand)	n	>4 ft bgs (clay)	n	0-4 ft bgs	n	>4 ft bgs	n
Actinium-228	0.66	17	0.63	31	0.633	12	0.642	40
Americium-241	ND < 0.014	NA	ND < 0.014	NA	ND < 0.014	NA	ND < 0.014	NA
Bismuth-212	0.41	17	0.43	31	0.388	12	0.434	40
Bismuth-214	0.54	69*	0.54	69*	0.54	69*	0.54	69*
Carbon-14	ND < 0.13	NA	ND < 0.13	NA	ND < 0.13	NA	ND < 0.13	NA
Cesium-137	0.012	48*	0.012	48*	0.102	64	0.00695	48
Cobalt-60	ND < 0.006	NA	ND < 0.006	NA	ND < 0.006	NA	ND < 0.006	NA
Gross Alpha	7.4	17	9.0	31	7.42	12	8.85	40
Gross Beta	15	47*	15	47*	15	47*	15	47*
Lead-210	1.6	48*	1.6	48*	1.6	48*	1.6	48*
Lead-212	0.69	29	0.73	40	0.691	26	0.684	40
Lead-214	0.56	16	0.58	31	0.55	11	0.581	39
Potassium-40	14	70*	14	70*	14	70*	14	70*
Plutonium-241	ND < 0.50	NA	ND < 0.50	NA	ND < 0.50	NA	ND < 0.50	NA
Radium-226	0.70	29	0.75	42	0.752	72*	0.752	72*
Radium-228	0.66	17	0.63	30	0.63	12	0.655	39
Strontium-90	0.056	47*	0.056	47*	0.056	47*	0.056	47*
Thallium-208	0.21	29	0.22	39	0.204	26	0.223	52
Thorium-228	0.63	13	0.76	11	0.627	52	0.771	11
Thorium-230	0.79	20*	0.79	20*	1.04	64*	1.04	64*
Thorium-232	0.60	13	0.80	11	0.63	52	0.80	11
Thorium-234	0.78	48*	0.78	48*	0.78	48*	0.78	48*
Tritium	ND < 1.2	NA	ND < 1.2	NA	ND < 1.2	NA	ND < 1.2	NA
Uranium-233/234	0.59	13	0.71	11	0.559	52	0.706	11

Table C-6. Updated Background Cutoff Values and Number of Measurements, Radionuclides (continued)

Radionuclide	1998 Background Value (pCi/g)				Updated 1999 Background Value (pCi/g)			
	0-4 ft bgs (sand)	n	>4 ft bgs (clay)	n	0-4 ft bgs	n	>4 ft bgs	n
Uranium-235	0.039	47*	0.039	47*	0.038	88*	0.038	88*
Uranium-238	0.56	8	0.65	11	0.565	52	0.645	11

Notes:
Background values are the 80% lower confidence limit on the 95th percentile for the sample data set.
n = Number of samples used to calculate background cutoff value.
* = Indicates constituent is NOT STRATIFIED; n = total number of samples used in calculation.
NA = Not Applicable
ND < # = All sample concentrations were below a detection limit of #.

APPENDIX D

ONE-DIMENSIONAL VADOSE ZONE MODELING TO DETERMINE RESIDUAL SOIL CONCENTRATIONS PROTECTIVE OF GROUND WATER USING THE DESIGNATED LEVEL METHODOLOGY

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SUMMARY

A one-dimensional vadose zone model was developed to calculate the maximum residual concentrations/activities of constituents of concern (COCs) in soil that will not adversely impact the ground water beneath the Laboratory for Energy-Related Health Research (LEHR) facility, UC Davis, California. For this purpose, the previous one-dimensional vadose zone model (Weiss Associates, 1997a) used to determine potential impact to ground water from measured concentrations of COCs at the site was augmented using the methodology described in Designated Level Methodology for Waste Classification and Cleanup Level Determination, California Regional Water Quality Control Board (CRWQCB), Central Valley Region (1989).

The objectives of this modeling were to calculate designated levels for COCs in soil at several depth intervals. The designated levels are those concentrations/activities that will not impact the ground water above background concentrations/activities or State of California Maximum Contaminant Levels (MCLs) as a result of infiltration. A secondary objective of the modeling was to develop a decision-support tool that will allow assessment of potential impact to ground water once removal action (RA) commences and new COC data are collected. This decision-support tool was designed to ensure protection of ground water resources in the vicinity of the LEHR site while aiding time critical RA decisions.

The modeling tool consists of a computer program written to interface with the multiphase fate and transport modeling code NUFT (Non-isothermal, Unsaturated Flow and Transport, Nitao 1996). The tool allows iterative execution of the model with a new soil concentration in each run until peak concentration reaching the ground water converges to the selected ground water goal (background or MCL). Upon convergence, the input soil concentration may be designated as the designated level.

The modeling tool was used to determine designated levels for five indicator constituents (ICs), assuming residual contamination at six different depth intervals, using two infiltration rates, two different lithologies and two ground water goals. The five ICs are nitrate, radium-226 (Ra-226), strontium-90 (Sr-90), chlordane, and hexavalent chromium. The two infiltration rates are 10.8 cm/year and 21.5 cm/year corresponding to 25% and 50%, respectively, of the average annual precipitation rate in the LEHR site area. The two lithologies are, (1) a soil column representing the current soil profile, and (2) a soil column consisting of a clayey-sandy-silt fill to the bottom of the assumed excavation, simulating post-remediation conditions. The selected ground water goals were background levels and MCLs.

Results of the modeling demonstrate the application of the methodology under a set of conservative assumptions regarding the site conditions and for the given ICs. During the RA, other residual COCs detected at the site can also be evaluated as necessary and designated levels can be

computed using the same approach. Also, any significant differences from the modeled lithologies that are encountered in the field can be incorporated into the model for different removal action locations.

A total of 48 soil concentrations were calculated for each of the five ICs. The 48 results correspond to six assumed depth intervals, two infiltration rates, two lithologies and two ground water goals. The soil cleanup goals were found to be sensitive to the infiltration rate and the ground water goals. The results were not very sensitive to the changes in lithology. The model results are summarized in Tables 3 and 4.

1. INTRODUCTION

A one-dimensional vadose zone model was developed to calculate the maximum residual concentrations/activities of COCs in soil that will not adversely impact the ground water beneath the LEHR facility, at UC Davis, California (Figure 1). The approach described in the Designated Level Methodology for Waste Classification and Cleanup Level Determination (CRWQCB, 1989) was used with the numerical code NUFT to determine the role of environmental fate processes. Designated levels were calculated for COCs in soil that may remain at the conclusion of RAs at the U.S. Department of Energy (DOE) areas of the LEHR Site. This report presents the modeling approach, assumptions, and input parameter values used in the simulations.

The purpose of this modeling was to develop a decision-support tool for determining designated levels for each DOE RA area. The methodology described in the CRWQCB report requires calculation of attenuation factors for each COC. These attenuation factors can be adsorption, covalent binding, chemical or biological degradation, volatilization, dispersion and dilution. The combined effect of all these environmental fate processes and their complex interactions determine the degree of attenuation at a site. The designated level methodology describes a generic attenuation factor calculation based on known values of attenuation factors from laboratory, field and modeling data. However, it also states “Whenever sufficient site- and waste-specific data can be obtained, a more thorough analysis of environmental fate should be substituted for this ‘generic’ attenuation factor approach.”

The modeling methodology results and conclusions are presented in the following sections.

2. METHODOLOGY

This section presents the methodologies, assumptions, and rationale used to develop the RA decision-support tool. The details of the model, such as the generalized lithology for the conceptual model, selection of COCs, selection of input parameter values and model setup, are unchanged from the previous modeling (Weiss Associates, 1997a). Parameters are only discussed below if changes were made for this modeling effort. The iterative calculation approach as it applies to this tool is also described below.

The scope of this modeling was limited to developing a model where a single representative soil profile is used with two different conservative infiltration rates and five ICs distributed at different depth intervals to calculate designated levels.

2.1 Soil Profile

Two conceptual soil profiles were modeled to determine designated levels for COCs. The first conceptual model (Figure 2) was the soil profile developed in the previous modeling for the Southwest Trenches Area (Weiss Associates, 1997a). The first conceptual model represents a composite of the most permeable sediments found in the Southwest Trenches Area of the LEHR site. This composite is conservative due to the sediments selected. The second conceptual model is a modification of the first where a clayey sandy silt fill is assumed to replace the existing materials at specific depths below ground surface. The second soil profile was constructed to represent post-RA conditions. The fill is depicted in Figure 3 and is assumed to range from 0 feet thick (lithology “a”) to 25 feet thick (lithology “f”). The varying depths of fill represent the possible extent of excavation activities and the backfill of engineered and/or native materials. The clayey sandy silt fill material was selected as a typical clean fill that may be used at the LEHR site. The depth of excavation, the fill thickness, soil classification and soil physical parameters may be changed for future decision making purposes as appropriate.

2.2 Indicator Constituents

Five ICs were selected from the set of COCs known to be present in soil at the LEHR site. The ICs are nitrate, hexavalent chromium, Sr-90, Ra-226, and chlordane. All of the ICs except hexavalent chromium were previously selected (Weiss Associates, 1997a) based on their presence in the Southwest Trenches Area, widespread detection, and physical characteristics that are representative of similar COCs from a transport-and-fate perspective.

To be conservative, each IC was homogeneously distributed within one of the six lithological intervals as depicted in Figures 2 and 3. These intervals are based on lithological changes in the soil profile and the COCs are distributed homogeneously throughout the entire underlying lithological

unit starting from the base of excavation. Excavation activities in the Southwest Trenches Area are expected to remove all waste. Most COCs remaining in soil below the waste trenches and burial pits are likely to attenuate rapidly in concentration with depth. Therefore, the homogenous distribution used herein conservatively overestimates the total contaminant mass in selected intervals.

2.3 Parameter Value Estimation

The assumptions and data used to develop the input parameters for modeling calculations are described in detail in Weiss Associates (1997a). We used the same vadose zone thickness, partitioning coefficients (Kd), radiological half-lives and soil physical and hydraulic properties, that were used previously to model the Southwest Trenches Area. The physical, chemical and hydraulic input parameter values are summarized in Tables 1 and 2. Conservative assumptions regarding the selected parameters are described below:

- Depth to ground water: The smallest depth to the water table (30 ft) observed at the site was used in the model.

- Infiltration: Infiltration rates of 10.8 cm/year and 21.5 cm/year corresponding to 25% and 50%, respectively, of the mean annual precipitation rate (Dames and Moore, 1994) were selected. The infiltration was assigned to the model at constant rates resulting in continuous vertical flux towards the water table. This is a very conservative assumption since there are periods when the direction of flux is reversed due to evapotranspiration.

- Permeability and porosity: The highest measured values for each soil type are used in the model.

- Volatility: No volatilization was used for any of the COCs.

- Dispersion: No dispersion was used for any of the COCs.

- Partitioning coefficients: The smallest measured or reported partitioning coefficients were used for each soil type to minimize attenuation due to adsorption.

- Initial concentration distribution: ICs are uniformly distributed throughout the entire extent of the selected interval thereby significantly overestimating the total mass for that interval.

- Dilution: A thin aquifer thickness at the bottom of the model was used to represent the top of the water table as a receptor. Dilution is therefore negligible and this assumption overestimates the concentrations of ICs that may reach the water table.

2.4 Model Setup and Initialization

This section describes the boundary conditions, initialization and iterative approach used for the Southwest Trenches Area NUFT model. The details of the conceptual model, boundary conditions and the initial flow conditions are described in the Weiss Associates (1997a).

The top of the model, the ground surface, was fixed at atmospheric conditions and a continuous flux of water was applied to represent infiltration. The assumed water table is located 30 ft below ground surface and a four-foot thick saturated zone extends beneath the simulated water table to represent the uppermost portion of the ground water system (Figures 2 and 3). The uppermost saturated finite-difference cell (0.25 m thick) is used to calculate the predicted IC concentration at the water table. Therefore, the results presented in this report are not dependent upon the total thickness of the simulated saturated zone.

As shown in Figures 2 and 3, the distribution of ICs conservatively overestimates contaminant distributions after the RA is complete. The contaminant distributions are assumed to be homogeneous in concentration and extend throughout the vertical extent of the uppermost remaining lithological unit.

2.4.1 Iterative Modeling Approach

An Excel/Visual Basic program was developed to interface with the NUFT code for the iterative calculation of residual COC concentrations in vadose zone soil that ensure attainment of ground water quality goals. The ground water quality goals are the State of California MCLs, and previously determined background values[1] (PNNL, 1995) for ground water at the LEHR site. The interface allows us to select a ground water goal and simulate maximum concentrations of COCs reaching the water table starting from a high initial soil concentration assigned to a given interval. If the maximum concentration reaching the water table is higher than the selected ground water quality goal, NUFT calculation and DESIGNATED LEVEL estimation are repeated with a smaller initial soil concentration until the peak ground water concentration converges to within 1% of the ground water quality goal.

An attenuation factor approach was used for previous vadose zone modeling (Weiss Associates, 1997b) for the Southwest Trenches Areas. An initial concentration was assumed and the Southwest Trenches Area model was run to determine the peak concentration of COCs in ground water at the water table. The attenuation factor was then equal to the quotient of the initial soil concentration and the peak ground water concentration. A designated level is the product of the ground water quality goal and the environmental attenuation factor. This simplistic approach was not used in the calculations presented here because it does not account for the non-linear relationship

[1] No background value was available for concentrations of chlordane in ground water. Concentrations of chlordane in upgradient well UCD1-18 (background well for hydrostatic unit 1) was below the lowest laboratory detection limits for all samples collected. The laboratory detection limit was selected as the chlordane background value.

between the concentration in vadose zone soil and the peak concentration in ground water at the water table.

2.5 Parameter Sensitivity Analyses

The sensitivity of the Southwest Trenches Area model to infiltration rate, lithology, dispersion, grid-cell spacing, and initial contaminant mass inventory and distribution was discussed in detail in Weiss Associates (1997a). Additional conclusions about model sensitivity with respect to post-RA lithology, infiltration rate and the selected ground water goal are discussed below.

We compared lithology sensitivity by reviewing results corresponding to the same infiltration rate and ground water goal for two different lithologies. The first lithology is the generalized Southwest Trenches Area soil column depicted in Figure 2. The second lithology (Figure 3) is a modification of the generalized Southwest Trenches Area soil column where varying depths of fill extend from the ground surface to the bottom of an assumed excavation depth. The lithology types were selected to determine whether results are sensitive to assumptions about the presence of fill material.

The results corresponding to the two lithologies are presented adjacent to each other in Tables 3 and 4. Differences between the results for the two lithologies are not significant, indicating peak ground water concentration is not particularly sensitive to differences in lithology resulting from the placement of trench backfill. The similar results are due to the hydraulic properties of the selected fill material, which are similar to those of the native soil.

Changes in the infiltration rate have little influence on the peak concentration observed in ground water unless the contaminant is assumed to degrade with time. The peak concentration of degradable compounds was found to be considerably lower for small infiltration rates due to the loss of contaminant mass during long travel times (Weiss Associates, 1997a).

The plots shown in Figures 4 and 5 were constructed to evaluate the sensitivity of results (DESIGNATED LEVEL values) to the ground water goal for Ra-226. Each set of five connected points corresponds to modeling results for an assumed contaminated interval given different ground water goals. The ground water goals correspond to background (0.27 pCi/L), the MCL (5 pCi/L), 0.1 pCi/L, 1 pCi/L and 2 pCi/L. The 0.1 pCi/L, 1 pCi/L and 2 pCi/L ground water goals were arbitrarily selected to provide additional data in the range of magnitude of background and the MCL. The plots are based on unchanging lithology and 21.5 cm/yr infiltration rate. Review of the plots indicates that the relationship between the result (DESIGNATED LEVEL) and the ground water goal is linear between the range of 0.1 pCi/L and 5 pCi/L. The relationship may not be linear outside of the 0.1 pCi/L and 5 pCi/L range.

3. MODEL RESULTS

Residual soil concentration calculations were performed for two lithology types, two infiltration rates and two ground water goals. In addition, the post-RA distribution of contaminated soil was assumed to be located at six different depth intervals. The locations of the six distributions of contaminated soil in the two lithology types are shown on Figures 2 and 3. A total of 48 designated levels for each of the ICs were calculated using the designated level methodology through an iterative process resulting in ground water concentrations within 1% of the ground water goal. The modeling results are presented in Tables 3 and 4 for background and MCL ground water goals, respectively.

In general, designated levels decrease at deeper contaminated depth intervals due to the proximity to ground water. However, designated levels calculated for the depth interval case "d" (18 to 21 ft-bags) are greater than case "c" (11 to 18 ft-bags) for non-degrading ICs. Interval "d" (18 to 21 ft-bags) are greater because the interval is thin (3 ft), therefore containing less mass, and has a high normalized Kd value (low mass partitioning into the aqueous phase). The designated levels for decaying ICs, Ra-226 and Sr-90, decrease with depth. The calculated value for interval "d" is less than interval "C" for Ra-226 and Sr-90 due to radiological decay and short travel time to ground eater with increasing depth.

The model results presented here are intended for guidance in estimating residual soil levels for five ICs in the Southwest Trenches Area. However, the modeling process and code can be used in the future for all COCs in all RA areas at the LEHR site. The values presented in the tables were calculated according to a series of conservative assumptions and represent the worst-case scenario for the conceptual model.

4. CONCLUSIONS

The modeling results indicate that:

- The numerical code NUFT combined with the designated level methodology is a useful decision-support tool for calculating designated levels for the LEHR Site.
- The tool can be used during the RA to guide the depth and extent of removal, based on new analytical data.
- The methodology is extremely conservative. Designated levels can be calculated using this approach based on approved model input parameters and conceptual setup.
- Designated level results are very sensitive to assigned infiltration rates and selected ground water goals.
- This decision-support tool is ready for use in time critical decision making during RAs. Model is setup flexible enough to incorporate actual excavation depth and observed lithology.
- The relationship between ground water goals and designated level values are linear within the range of 0.1pCi/L and 5.0pCi/L for Ra-226.

These conclusions may change if the model assumptions change.

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6. ACKNOWLEDGMENTS

The following LEHR Project personnel worked on the preparation of the Vadose Zone Modeling Report:

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Cathy Courtney LAN Manager	Computer programming
David Buckey Technical Assistant	Computer programming
Craig Adams Graphics, WA	Figures
Nerissa de Jesus Administrative Assistant, WA	Word processing

Table D1. Summary of Vadose Zone Model Indicator Constituents, Associated Levels, and Input Parameter Values.

RADIOLOGICAL COMPOUNDS

Indicator Constituent	Background in water[a]	MCL[b]	Maximum soil activity reported at site[c]	Partitioning coefficient (K_c)	Molecular weight	Decay rate half-life
	(pCi/L)	(pCi/L)	(pCi/g)	(L/kg)	(g/mole)	(y)
Radium-226	0.272	5	15	100	226.0254	1,600
Strontium-90	1.63	8	23	10	87.62	29

NON-RADIOLOGICAL COMPOUNDS

Indicator Constituent	Background in water[a]	MCL[b]	Maximum soil concentration reported at site[c]	Partitioning coefficient (K_c)	Molecular weight	Henry's Law constant
	(mg/L)	(mg/L)	(mg/kg)	(L/kg)	(g/mole)	(atm-m^3/mole)
Chlordane	NA	0.0001	15	650/1230[d]	409.8	1.9E-03[e]
Hexavalent Chromium	0.0229	0.05	7	10	52	0
Nitrate (as N)	25.2	10	390	0	14.0067	0

Notes:

[a]Based on analytical results of ground water samples from HSU-1. UTL = Upper Tolerance Limit (Stewart *et al.*, 1996, *1995 Annual Water Monitoring Report*, LEHR Environmental Restoration, University of California at Davis).
[b]MCL = EPA Region 9, Maximum Contaminant Level, Drinking Water Standards and Health Advisory Table, 1996.
[c]Based on analytical results of soil samples from the LEHR site reported in the Final Site Characterization Summary Report (Weiss Associates, 1997c).
[d]Values assuming 10% and 20% organic carbon content, respectively (Strenge *et al.*, 1989).
[e]Calculated from vapor pressure (VP) and solubility (S) [H=VP/S].
NA = Not Applicable

Table D2. Summary of Physical and Hydraulic Properties for Representative Vadose Zone Model Soil Types at the LEHR Facility.

Model Soil Type Name	Sediment Description	Porosity[a]	Saturated Hydraulic Conductivity[a]	Dry Bulk Density[a]	Particle Density[a]	van Genuchten Parameters	
						alpha	N
		(-)	(cm/s)	(g/cm^3)	(g/cm^3)	(cm^{-1})	(-)
NCLYSLT	clayey sandy silt	0.35	7.08E-05	1.7	2.57	2.11E-02	1.03
GEO1	sandy gravel	0.29	4.70E-03	1.9	2.71	8.50E-02	1.90
GRVLFLL	gravel fill	0.25	1.00E-02	2.1	2.70	1.20E-01	1.90
NGEO6	silty clay	0.39	5.56E-06	1.6	2.70	2.41E-02	1.17
GEO2	sandy clay	0.37	6.70E-05	1.7	2.68	3.30E-02	1.30

Notes:

[a]Daniel B. Stephens and Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples.

Table D3. Summary of Designated Levels, Ground Water Goal = Background, LEHR Site, Davis, CA

		Unchanging Lithology				Changing Lithology			
	Contaminated	Infiltration Rate = 10.8 cm/yr		Infiltration Rate = 21.5 cm/yr		Infiltration Rate = 10.8 cm/yr		Infiltration Rate = 21.5 cm/yr	
COC	**Depth Interval (ft)**	D Level (mg/kg) or (pCi/g)	Time to Peak (yr)	D Level (mg/kg) or (pCi/g)	Time to Peak (yr)	D Level (mg/kg) or (pCi/g)	Time to Peak (yr)	D Level (mg/kg) or (pCi/g)	Time to Peak (yr)
Nitrate (mg/kg)	a: 0-6.0ft	13	27	12	17	12	27	12	17
	b: 6.0-11.0ft	14	25	13	16	14	30	13	18
	c: 11.0-18ft	11	23	10	14	11	28	10	17
	d: 18-21ft	20	17	18	11	21	24	18	13
	e: 21-25ft	12	13	11	9	13	17	11	9
	f: 25-30ft	6.9	6	6.4	5	7.9	12	6.9	6
Hexavalent Chromium (mg/kg)	a: 0-6.0ft	2.1	4,715	1.8	2,194	2.1	4,722	1.8	2,194
	b: 6.0-11.0ft	2.0	3,577	1.8	1,683	2.0	3,510	1.8	1,685
	c: 11.0-18ft	1.3	2,484	1.2	1,157	1.3	2,527	1.2	1,177
	d: 18-21ft	2.3	1,671	2.0	793	2.3	1,615	2.0	791
	e: 21-25ft	1.4	1,069	1.3	524	1.4	1,077	1.3	530
	f: 25-30ft	0.72	327	0.69	171	0.74	347	0.71	138
Ra-226 (pCi/g)	a: 0-6.0ft	48	12,522	1.2	6,069	48	12,481	1.2	6,069
	b: 6.0-11.0ft	11	9,497	0.62	4,703	11	8,990	0.62	4,671
	c: 11.0-18ft	1.9	8,641	0.20	2,660	1.8	4,690	0.21	3,257
	d: 18-21ft	1.1	4,699	0.22	1,578	1.0	4,287	0.22	1,634
	e: 21-25ft	0.27	2,617	0.10	1,471	0.30	3,396	0.15	1,816
	f: 25-30ft	0.042	648	0.033	430	0.043	683	0.033	426
Sr-90 (pCi/g)	a: 0-6.0ft	9,203,809	483	6,851	371	9,763,705	483	6,707	374
	b: 6.0-11.0ft	99,573	355	450	292	113,337	391	477	296
	c: 11.0-18ft	677	272	17	206	789	275	19	211
	d: 18-21ft	74	202	4.7	148	87	208	5.2	154
	e: 21-25ft	3.6	129	0.63	98	4.12	140	0.61	93
	f: 25-30ft	0.061	32	0.046	29	0.065	33	0.041	27
Chlordane (mg/kg)	a: 0-6.0ft	0.42	451,547	0.26	240,392	0.37	595,510	0.26	306,539
	b: 6.0-11.0ft	0.34	386,542	0.22	217,180	0.36	653,222	0.23	191,876
	c: 11.0-18ft	0.19	438,229	0.14	155,378	0.19	247,780	0.14	141,711
	d: 18-21ft	0.27	215,785	0.22	88,343	0.29	247,051	0.22	111,048
	e: 21-25ft	0.14	140,443	0.13	74,740	0.16	178,494	0.13	76,611
	f: 25-30ft	0.061	30,216	0.052	20,269	0.063	29,411	0.059	25,092

Notes:

D Level = Designated Level
Time to Peak = Time from contaminant release in soil to peak concentration in ground water at the water table.
Background = 95% Upper Tolerance Limit for ground water concentrations in upgradient well UCD1-18.
COC = Chemical of Concern

Table D4. Summary of Designated Levels, Ground Water Goal = MCL, LEHR Site, Davis, CA

		Unchanging Lithology				Changing Lithology			
	Contaminated	Infiltration Rate = 10.8 cm/yr		Infiltration Rate = 21.5 cm/yr		Infiltration Rate = 10.8 cm/yr		Infiltration Rate = 21.5 cm/yr	
COC	**Depth Interval (ft)**	D Level (mg/kg) or (pCi/g)	Time to Peak (yr)	D Level (mg/kg) or (pCi/g)	Time to Peak (yr)	D Level (mg/kg) or (pCi/g)	Time to Peak (yr)	D Level (mg/kg) or (pCi/g)	Time to Peak (yr)
Nitrate (mg/kg)	a: 0-6.0ft	23	26	20	17	21	27	20	17
	b: 6.0-11.0ft	26	26	23	16	26	30	23	18
	c: 11.0-18ft	19	22	17	15	19	28	17	17
	d: 18-21ft	35	17	31	11	37	24	31	13
	e: 21-25ft	22	13	19	9	23	17	20	9
	f: 25-30ft	12	6	11	5	14	12	12	7
Hexavalent Chromium (mg/kg)	a: 0-6.0ft	5.8	4,588	4.0	2,198	5.8	4,950	4.0	2,198
	b: 6.0-11.0ft	5.3	3,710	3.9	1,681	5.4	3,643	3.9	1,678
	c: 11.0-18ft	3.4	2,485	2.5	1,174	3.3	2,503	2.5	1,171
	d: 18-21ft	5.6	1,691	4.4	753	5.6	1,613	4.5	790
	e: 21-25ft	3.3	1,051	2.8	527	3.4	1,023	2.8	522
	f: 25-30ft	1.6	317	1.5	169	1.6	300	1.5	167
Ra-226 (pCi/g)	a: 0-6.0ft	884	12,687	23	6,072	884	11,549	23	5,273
	b: 6.0-11.0ft	214	7,924	11	4,687	210	9,500	11	4,684
	c: 11.0-18ft	30.0	6,339	3.8	2,571	32	4,953	3.8	3,238
	d: 18-21ft	21.0	5,549	4.1	2,228	20	3,364	4.1	2,225
	e: 21-25ft	5.1	2,847	1.8	1,476	5.4	2,740	1.8	1,468
	f: 25-30ft	0.77	558	0.61	293	0.80	734	0.67	303
Sr-90 (pCi/g)	a: 0-6.0ft	41,967,348	462	32,891	373	49,076,237	461	33,120	377
	b: 6.0-11.0ft	470,951	376	2,235	291	579,900	362	2,340	294
	c: 11.0-18ft	3305	269	85	205	3,945	272	94	208
	d: 18-21ft	364	200	23	149	429	207	26	151
	e: 21-25ft	17.7	128	3.1	97	20	138	3.0	95
	f: 25-30ft	0.30	32	0.23	28	0.32	33	0.20	27
Chlordane (mg/kg)	a: 0-6.0ft	1.9	582,192	1.2	286	3.0	442,035	2.4	242,104
	b: 6.0-11.0ft	1.8	529,871	1.2	206,780	2.3	479,769	2.1	214,866
	c: 11.0-18ft	1.1	327,879	0.73	139,460	1.3	272,292	0.73	150,843
	d: 18-21ft	1.6	213,217	1.2	98,776	2.3	156,012	1.2	100,742
	e: 21-25ft	1.0	146,531	0.76	64,434	1.1	139,840	0.77	61,961
	f: 25-30ft	0.44	31,006	0.37	14,196	0.44	41,032	0.41	20,494

Notes:

D Level = Designated Level
Time to Peak = Time from contaminant release in soil to peak concentration in ground water at the water table.
MCL = State of California Maximum Contaminant Level for Ground Water
COC = Chemical of Concern

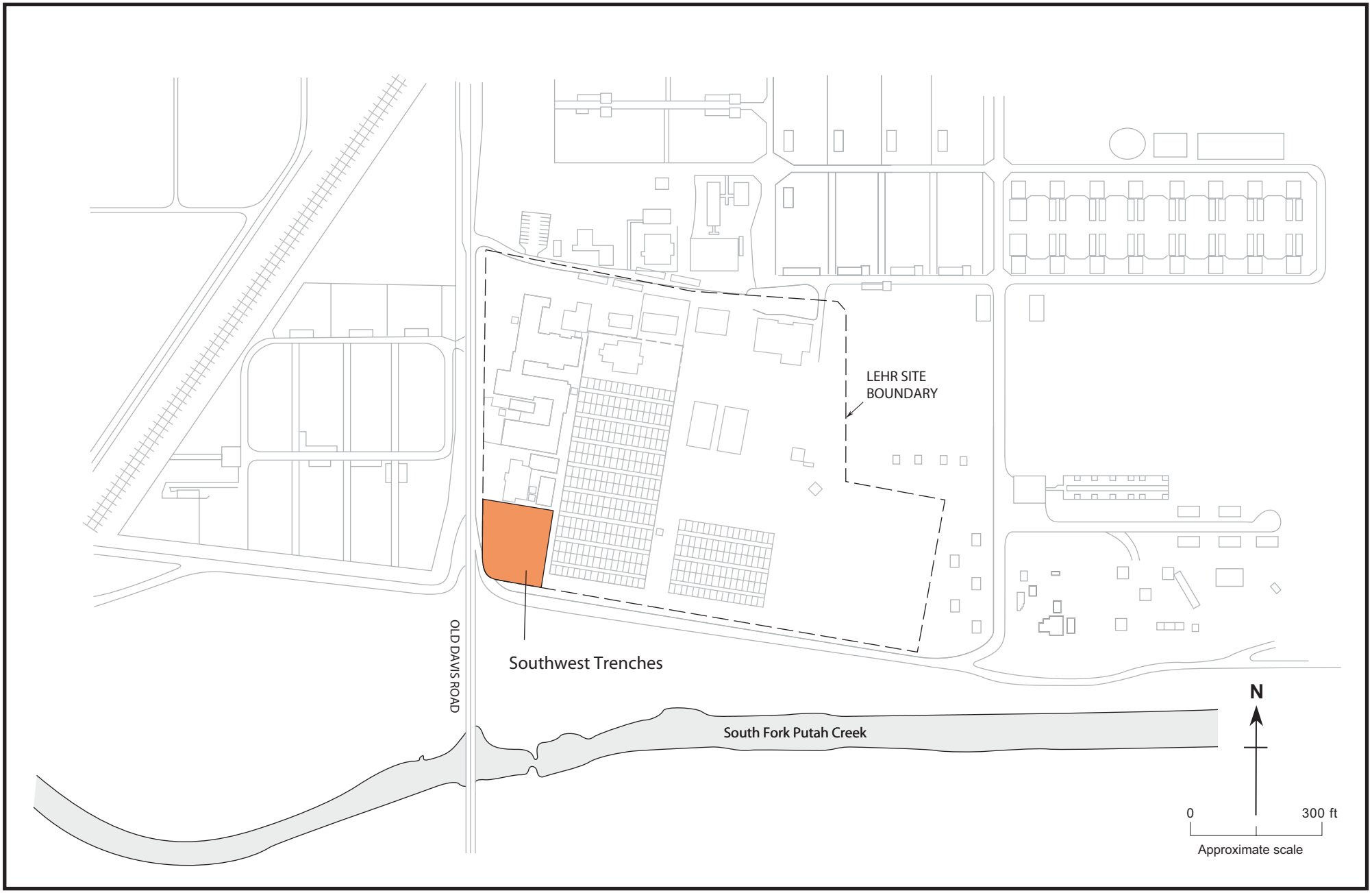

Figure D1. LEHR Site Map Showing Southwest Trenches Area

Weiss Associates

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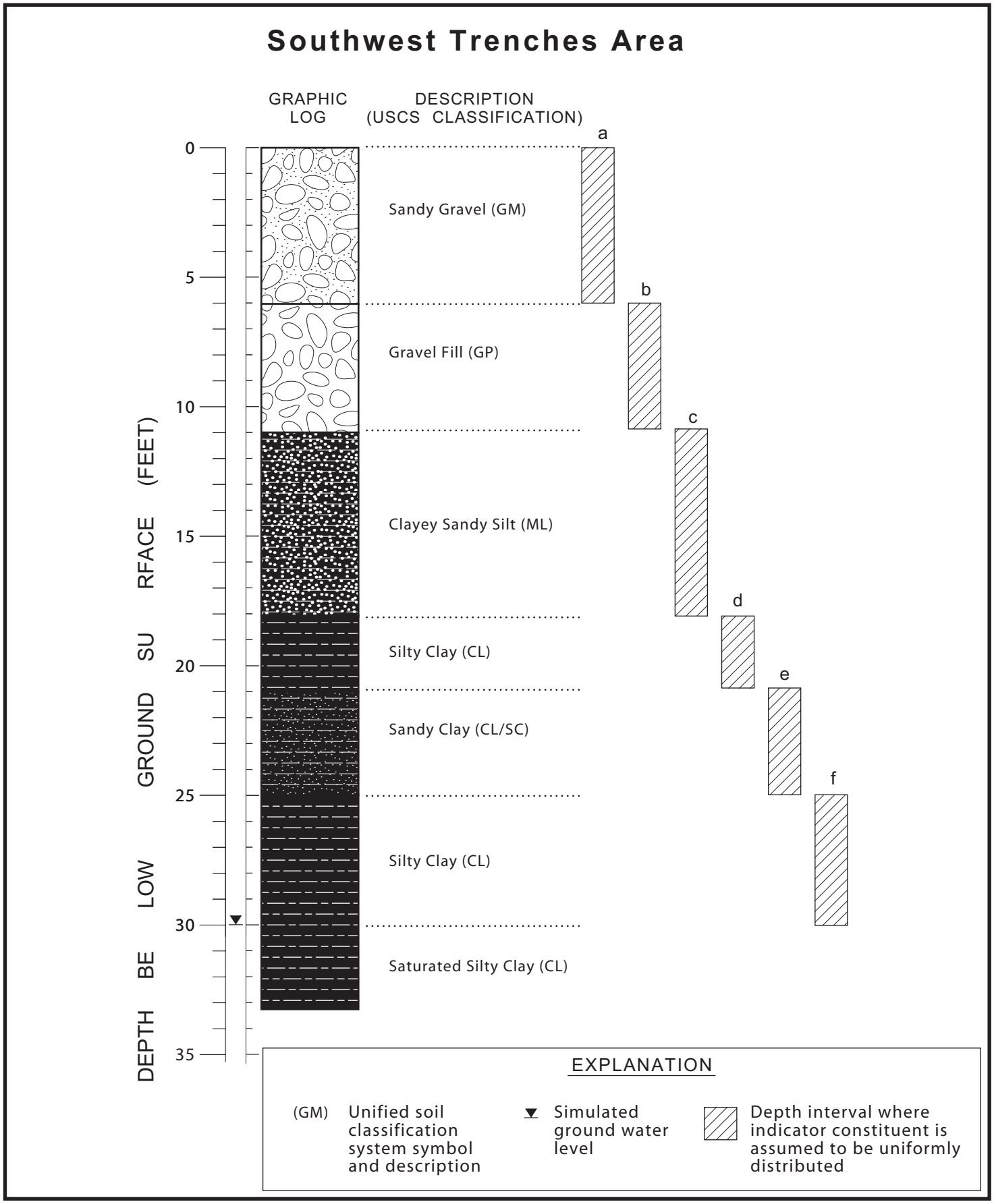

Figure D2. Generalized Lithology for Sediments Beneath the Southwest Trenches Area

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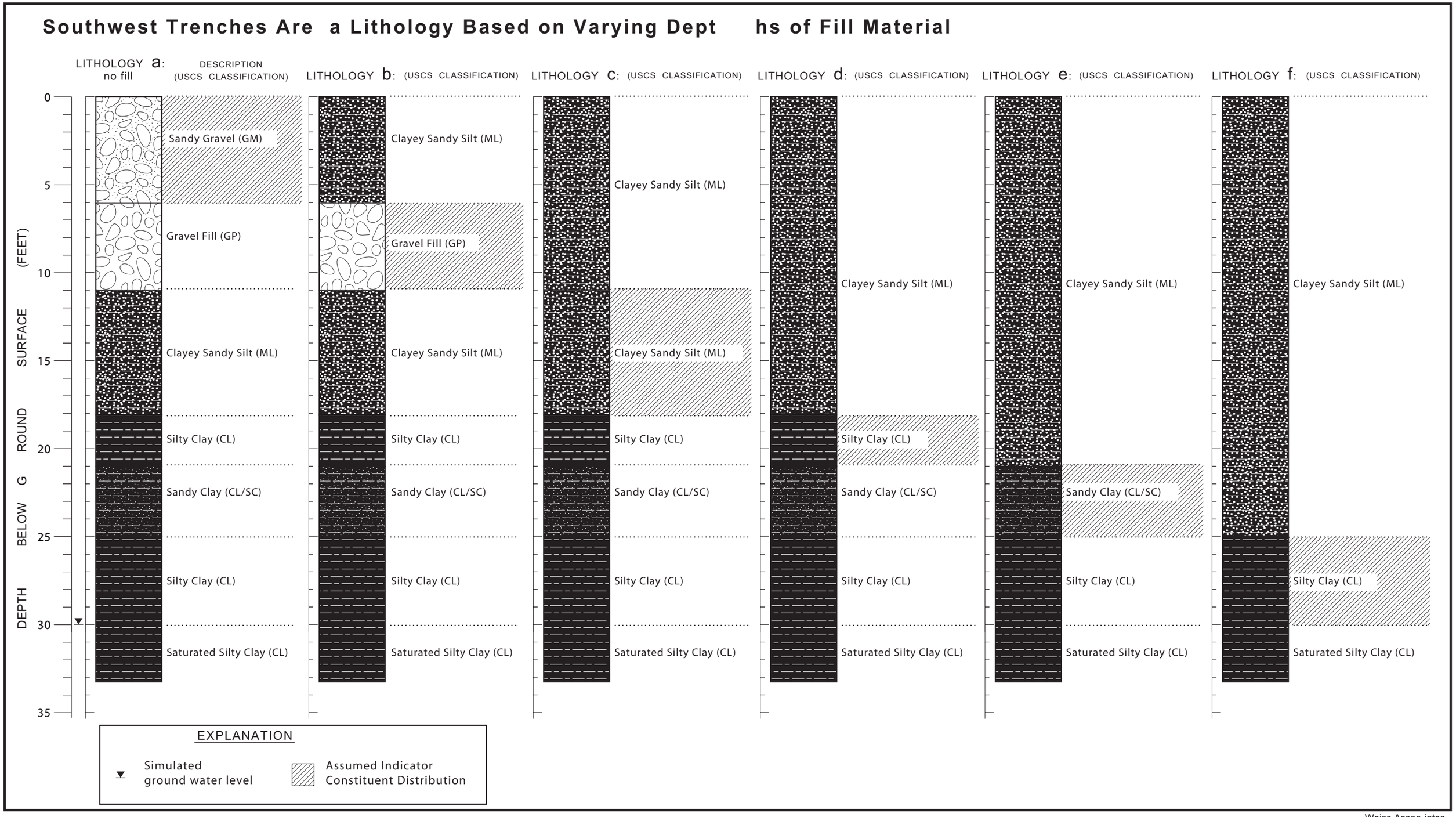

Figure D3. Generalized Lithology for Potential Post-Removal Action Sediments Beneath the Southwest Trenches Area

Weiss Associates

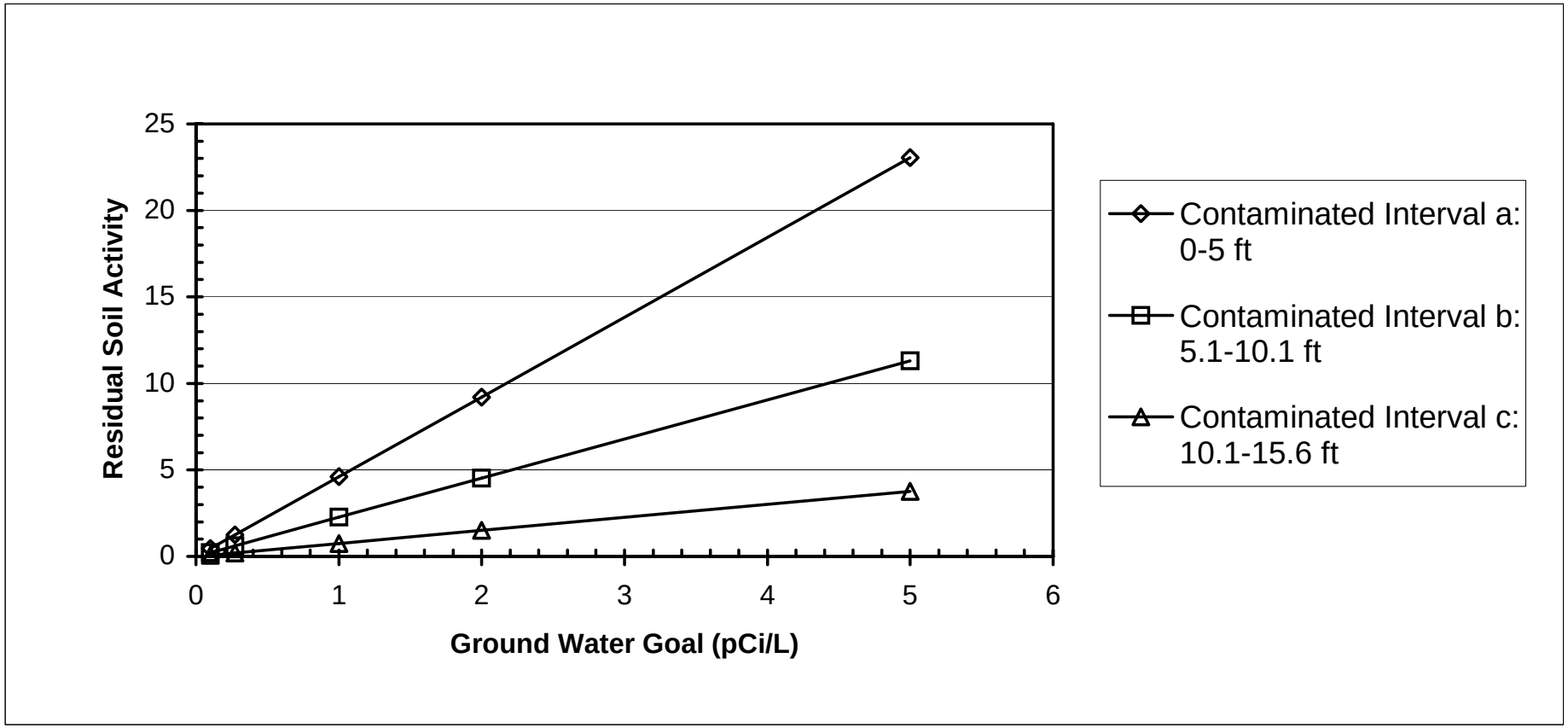

Figure D4. Plot of Ground Water Goal vs. Soil Remediation Standard, Southwest Trenches Soil Column, Ra-226

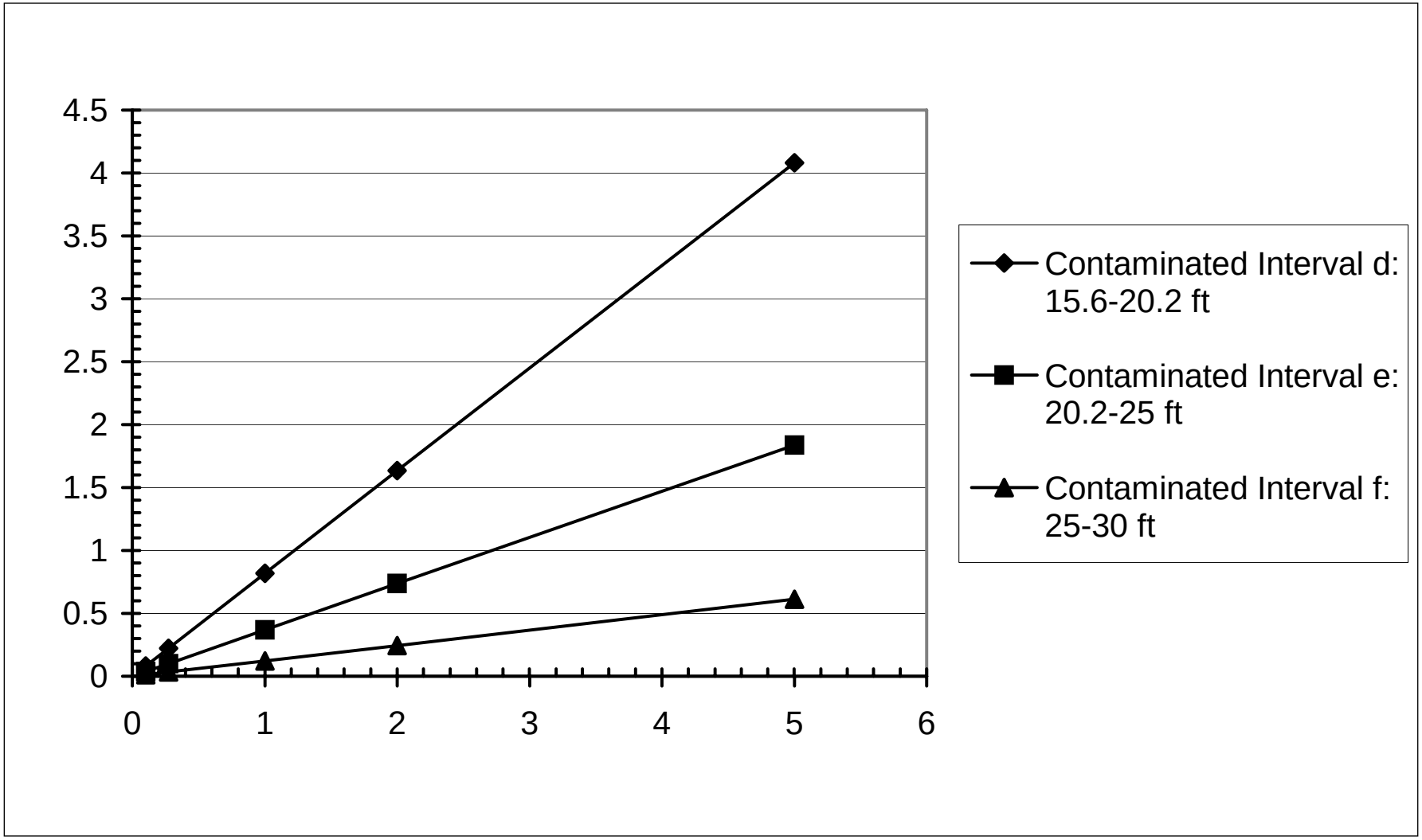

Figure D5. Plot of Ground Water Goal vs. Soil Remediation Standard, Southwest Trenches Soil Column, Ra-226

APPENDIX E

PARTICULATE MODELING RESULTS

1. INTRODUCTION

Potential emission of chlordane, radionuclides and metals at the LEHR site may result from resuspension of contaminated soils as a result of excavation related activities planned as a part of LEHR remediation efforts. Resuspended contaminants of concern (COCs) may be dispersed by the wind and result in exposure through inhalation of fugitive dust. A strict interpretation of 40 CFR Part 61 Subpart H §61.96 "Applications to Construct or Modify" could require an application for approval under §61.07 or notification of startup under §61.09 for the planned LEHR remediation efforts. The intent of §61.96 is to require construction permits for new emission sources with the potential of releasing radionuclides on a continuous/long term basis, and is not directly applicable to fugitive emissions during a removal action. However, exemption from the application requirement can be demonstrated under §61.98(b):

> "…an application for approval under §61.07 or notification of startup under §61.09 does not need to be filed for any new construction of or modification within an existing facility if the effective dose equivalent, caused by all emissions from the new construction or modification, is less than 1% of the standard prescribed in §61.02 [10 mrem/yr]."

To estimate outdoor exposure-point concentrations of COCs in air, an exposure model must be applied to estimate the resuspension rate of contaminated soils resulting from excavation-related activities, and their subsequent dispersion. The modeled ambient outdoor concentrations may then be used to estimate the potential hazard from inhalation of these compounds. This appendix presents the results and summary of the methodology for the following estimates:

- The resuspension rate of contaminated soils resulting from planned remediation activities, including excavation, on-site excavated soil storage piles, contaminated soil screening/sorting and loading for off-site transport; and,
- Estimated maximum on-site exposure-point concentrations in ambient air using a simple box model.
- Estimated committed effective dose equivalent based upon maximum estimated on-site ambient air radionuclide concentrations for comparison with the 0.1 mrem/yr NESHAP standard.

The excavation particulate resuspension modeling was completed for planned Southwest Trenches area removal actions of chlordane, radionuclides and metals contaminated soils. Other remediation activities planned for the LEHR site will result in more limited impacts due to the nature of the materials to be excavated and the limited excavation volumes required.

2. SOUTHWEST TRENCHES AREA REMEDIATION ACTIVITIES

Particulate emissions modeling of potential COC emissions was performed for remediation activities planned for the Southwest Trenches area. Particulate emissions models were constructed for the following two remediation activities:

1. excavation and removal of chlordane contaminated soil; and
2. excavation, screening and removal of radionuclide and metals contaminated soils from the Southwest Trenches Area.

Assumptions and models developed for the two remediation activities are summarized in this section.

2.1 Chlordane Contaminated Soils Remediation

Estimated emissions associated with excavation activities include particulate resuspension during soils excavation, wind blown fugitive dust emissions from storage piles, and emissions associated with the loading of contaminated soils onto trucks using a backhoe for off-site transport and disposal. Soils will be assumed to be uniformly contaminated with chlordane from the surface to a depth of 4-ft (total in-place volume = 4 ft x 1350 sq-ft = 200 cu yd = 153 m^3). It is assumed no COC emissions will result from backfilling activities during this phase and that no COC emissions will be associated with truck traffic on-site, or with contaminated soils after they have been loaded onto the trucks for transport off-site.

2.2 Radionuclide and Metals Contaminated Soils Remediation

Estimated emissions associated with radionuclide and metals contaminated soils remediation activities include particulate resuspension during soil excavation, wind blown fugitive dust emissions from storage piles, soil/debris screening and sorting, and loading of contaminated soils into bins using a backhoe for off-site transport and disposal. For the purposes of this modeling, soils are assumed to be clean to a depth of 3 ft and uniformly contaminated with radionuclides and metals from 3 ft to a depth of 14 ft (total volume = 1550 cu yd = 1185 m^3). It is assumed that no COC emissions will result from backfilling activities during this phase. The excavated soils are assumed to be stored prior to screening in 15 stockpiles of 32 ft x 22 ft for a total area of 10,560 sq-ft (981 m^2). The volume of soil that is screened will be assumed to be 925 cu-yd (707 m^3).

Following screening activities, it is assumed that emission will result from loading the soil from storage piles into boxes using a backhoe. The volume of contaminated soils in storage piles requiring loading into boxes for off-site transport is assumed to be 310 cu-yd (237 m^3). It is assumed there will be no emissions associated with further handling of the boxed waste.

3. DESCRIPTION OF EMISSION RATE MODELS

To estimate outdoor exposure-point concentrations of COCs in air, an exposure model must be applied to estimate the resuspension rate of contaminated soils resulting from of excavation related activities, and their subsequent dispersion. Based upon the assumptions outlined above, emissions factors are required for:

(1.) general excavation activities using a backhoe;

(2.) wind blown particulate resuspension from contaminated soil storage piles;

(3.) loading of the soil from storage piles into boxes or onto trucks using a backhoe for off-site transport and disposal; and,

(4.) contaminated soil screening and sorting activities.

The particulate emissions models developed for planned remediation activities at the Southwest Trenches area are outlined below.

(a) General excavation activities:

To estimate PM_{10} particulate emission rates from excavation activities, we apply the following formula from Table 24 of the *Air/Superfund National Technical Guidance Series - Volume III - Estimation of Air Emissions from Cleanup Activities at Superfund Sites* (EPA, 1989):

$$E_{15} = 0.0029 \times d^{(0.7)} \times M^{(-0.3)} \qquad (1)$$

where:

E_{15} = PM_{15} emission factor from excavation activities per cubic meter removed, kg/m^3;

d = Drop Height (m);

M = Excavated soil moisture content (%).

The emission factor is expressed in units of PM_{15}, defined as airborne particles equal to or smaller than 15 micrometers (μm) aerodynamic diameter. This particle size assumption is conservative and will be assumed to be present entirely as PM_{10}.

This emission factor assumes an emission rate of PM_{15} for "dragline" excavation activities. Draglines are typically used for very large excavations, however, since emissions are primarily a function of moisture content and drop height, they can reasonably be applied to backhoe excavations. The same emission factor is found in AP-42, Chapter 11-Mineral Products Industry, Section 11.9 Western Surface Coal Mining, Table 11.9-1 (EPA, 1997). This emission factor is given an Emission

Factor Rating of "B" in the compilation[1], but should be downgraded because of differences in operating equipment as discussed in Chapter 13 Miscellaneous Sources, Section 13.2.3. Heavy Construction Activities (EPA, 1997).

(b) Soil storage pile emissions:

To estimate PM_{10} particulate emission rates from on-site excavated soil storage, the short-term (24-hr) active storage piles formula from Table 21 of the Guidance is applied (EPA, 1989). This equation assumes emissions of Total Suspended Particulates (TSP), and therefore an adjustment is made for particulate size distribution less than 30 μm using adjustment factors presented in Table 25 of the guidance (EPA, 1989). No adjustment factor is available for particulate size distributions less than 10 μm, however using the 30 μm distribution is conservative for estimating respirable particulate emissions. The formula has the following form (EPA, 1989):

$$E_{30} = 1.8 \times U_w \times 0.53 \qquad (2)$$

where:

E_{30} = PM_{30} emission factor from active storage piles per hectare of ground covered, kg/hectare/hr;

U_w = 95% UCL of the mean windspeed for 1995-1997, between May and August (1.86 m/s);

0.53 = Fraction of particulate emissions <30 μm.

The same emission factor is found in AP-42, Chapter 11-Mineral Products Industry, Section 11.9 Western Surface Coal Mining, Table 11.9-1 (EPA, 1997). This emission factor is given an Emission Factor Rating of "C" in the compilation. AP-42, Chapter 13 Miscellaneous Sources, Section 13.2.5. Industrial Wind Erosion provides an approach for calculating emissions from open aggregate storage piles (EPA, 1997). However, this approach is intended for very large storage piles (on the order of 10 m in height), and is believed to be less conservative than the simple model presented above.

(c) Boxes / truck loading:

To estimate PM_{10} particulate emission rates from the loading of contaminated soil from storage piles onto trucks or into B-25 waste containers for transport off-site, we apply the following empirical formula from Table 21 of the Guidance (EPA, 1989):

1 Each AP-42 emission factor is given a rating from A through E, with A being the best. A factor's rating is a general indication of the reliability, or robustness, of that factor. This rating is assigned based on the estimated reliability of the tests used to develop the factor and on both the amount and the representative characteristics of those data (US/EPA, 1997).

$$E_{10} = k(0.0016)\frac{\left(\frac{U}{2.2}\right)^{13}}{\left(\frac{M}{2}\right)^{14}}(kg/Mg) \qquad (3)$$

where:

E_{10}	=	PM emission factor from excavation activities per 10^6 grams removed, kg/Mg;
k	=	Particle size multiplier (0.35 for PM_{10});
U	=	Mean wind speed (m/s);
M	=	Excavated soil moisture content (%).

This emission factor estimates an emission rate of PM_{10} for continuous and batch "drop" activities and are recommended for use with both truck loading and unloading. The same emission factor is found in AP-42, Chapter 13- Miscellaneous Sources, Section 13.2.4 Aggregate Handling and Storage Piles, Equation 1 (EPA, 1997), and is recommended for use in AP-42 Chapter 13 Miscellaneous Sources, Section 13.2.3. Heavy Construction Activities (EPA, 1997). This emission factor is given an Emission Factor Rating of “A” in the compilation.

(d) Screening and sorting activities:

No emissions estimates were provided in the EPA Air/Superfund guidance for sorting and screening activities. AP-42 Chapter 13 Miscellaneous Sources, Section 13.2.3. Heavy Construction Activities (EPA, 1997) recommends using emissions factors found in Chapter 11 - Mineral Products Industry. AP-42 Chapter 11, Section 11.19.2 Crushed Stone Processing provides the following emissions factors for PM_{10} (EPA, 1997):

Screening (coarse):	0.0076 kg/Mega Gram (Mg)	
Primary Crushing (TSP):	0.00035 kg/Mg	(4)
Fines Screening:	0.036 kg/Mg	

These emission factors are given an Emission Factor Rating of “E” in the compilation. However, because of differences in operating equipment, Chapter 13 Miscellaneous Sources, Section 13.2.3. Heavy Construction Activities recommends that the emission factor should be downgraded by 1 or 2 depending on whether variables are within the correct ranges (EPA, 1997). To be conservative, the emissions factor provided for “Fines Screening” was used, assuming no controls, for the LEHR remediation activities particulate modeling.

4. DESCRIPTION OF AIR DISPERSION MODEL

A simple box model is applied to estimate maximum, worst-case outdoor air exposure-point concentrations of COCs in the vicinity of remediation activities resulting from resuspension of contaminated soil. This approach is applicable to the prediction of local short- and long-term exposure-point concentrations resulting from any area source. The box model used to estimate on-site chlordane, radionuclide and metals exposure point concentrations in outdoor air is taken from the American Society for Testing and Materials (ASTM) *Emergency Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites* (ASTM, 1995) and recommended by the EPA (1992b). The ASTM box model has the form:

$$C_{on-site} = \frac{F \times L}{U_w \times H_m}, \tag{7}$$

where

$C_{on\text{-}site}$ = on-site COC concentration in air resulting from the particulate emission sources, $\mu g/m^3$;

F = average particulate emission rate per unit contaminated surface, $\mu g/(m^2\text{-sec})$;

L = maximum downwind length of the COC emission source (site specific), m;

U_w = average wind speed within the mixing zone, (95% upper confidence limit of the mean wind speed for the LEHR meteorological station between May and August over the last three years) 1.86 m/s; and,

H_m = ambient air mixing zone height, 1.6 m.

Although the ASTM box model is simple to apply, it is also very conservative. As a result, it is used as a screening method only. Actual average air concentrations corresponding to measured particulate emissions are expected to be lower than those estimated by application of this model.

5. SITE SPECIFIC MODELING INPUTS

The Attachments 1 and 2 provide the spreadsheets used in estimating emissions for each of the activities planned as a part of LEHR remediation efforts which have the potential to result in the resuspension of contaminated soils. The spreadsheets detail the site specific modeling inputs chosen to develop emissions estimates for chlordane, radionuclides and metals, and the box model parameters used to estimate on-site exposure point concentrations. The results are displayed in Tables E-1, E-2, and E-3, respectively.

6. RADIONUCLIDE EFFECTIVE DOSE EQUIVALENT ESTIMATION

To estimate an effective dose equivalent based upon estimated worst-case ambient air radionuclide concentrations, WA applied the committed effective dose equivalent per unit intake dose coefficient ($h_{E,50}$) for Ra-226 (Class=W; f_1=2.0e-01) and Sr-90 (Class=Y; f_1=1.0e-02), from Federal Guidance Report No. 11: Table 2.1. Inhalation Intakes (FRG11) (EPA-1988).

The FRG11 coefficients are in units of [mrem/pCi]. The dose can therefore be calculated assuming the worst-case ambient air radionuclide concentration, the estimated duration of the remediation phase resulting in the fugitive emissions, and an inhalation rate of 20 m^3/day. Table E-4 calculates the dose based upon the FRG11 coefficients for each planned soil-handling phase. Table E-5 uses the estimated worst-case ambient air radionuclide concentration and estimated duration for each planned soil handling phase, to estimate a worst-case total annual average PM-10 concentration. This worst-case total annual average ambient air radionuclide concentration is then used to estimate a dose for the Southwest Trenches area source removal activities.

Although RA-226 and Sr-90 are not the only radionuclides with potential to be found in fugitive emissions, they are the radionuclides of most concern, and clearly are well below the §61.98(b) exemption level.

7. RESULTS SUMMARY

Emission of chlordane, radionuclides and metals resulting from excavation related activities planned as a part of LEHR remediation efforts in the Southwest Trenches Area were estimated. The results are displayed in Tables E-1, E-2, and E-3, respectively. The maximum, worst-case fence-line concentration of chlordane was estimated to be 1.7 x 10^{-3} micrograms per cubic meter ($\mu g/m^3$), assuming excavation activities, uncontrolled soil/waste stockpiling emissions and soil loading for off-site transport all occur simultaneously. This concentration is below the U.S. Environmental Protection Agency (EPA) Region 9 Preliminary Remediation Goal of 5.2 x 10^{-3} $\mu g/m^3$, which is calculated assuming a 10^{-6} cancer risk resulting from a chronic inhalation exposure (EPA, 1996).

The maximum, worst-case fence-line concentration was also estimated for the two metals of most concern at the LEHR site, lead and mercury. Concentrations were estimated to be 6.2 x 10^{-3} $\mu g/m^3$ and 2.9 x 10^{-3} $\mu g/m^3$, respectively. The maximum, worst-case fence-line concentrations were estimated using the same models and assumptions applied for the radionuclide estimates. The estimated concentration of lead is below 8.3 x 10^{-2} $\mu g/m^3$ 10^{-6} risk level calculated using the draft Unit Risk Factor for lead of 1.2 x 10^{-5} $(\mu g/m^3)^{-1}$, from "Proposed Identification of Inorganic Lead as a Toxic Air Contaminant", Cal EPA, March 1997. The mercury concentration is below the EPA Region 9 Preliminary Remediation Goal of 3.1 x 10^{-1} $\mu g/m^3$, which is calculated assuming a 10^{-6} cancer risk resulting from a chronic inhalation exposure.

The maximum, worst-case fence-line concentration of radionuclides was estimated for the two radionuclides of most concern at the LEHR site, radium-226 and strontium-90. Concentrations were estimated for radium-226 and strontium-90 to be 1.4 x 10^{-15} Curies per cubic meter (Ci/m^3) and 1.3 x 10^{-14} Ci/m^3, respectively. The maximum, worst-case fence-line concentration were estimated assuming excavation activities, uncontrolled soil/waste stockpiling, soil screening/sorting, and soils loading for off-site transport occur simultaneously. The estimated committed effective dose equivalent based upon maximum estimated ambient air radionuclide concentrations were 3.3 x 10^{-3} mrem/yr for radium-226 and 4.6 x 10^{-3} mrem/yr for strontium-90. This results in an estimated committed effective dose equivalent for radium-226 and strontium-90 of 0.03% and 0.05% respectively. This is less than 1% of the standard prescribed in §61.02 of 0.1 mrem/yr. Therefore the Southwest Trenches area remediation activities are exempt from the application requirements 40 CFR Part 61 Subpart H under §61.98(b), regardless of the applicability of 40 CFR Part 61 Subpart H §61.96 “Applications to Construct or Modify” requirements to remediation activities.

8. REFERENCES

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Table E-1. Southwest Trenches Chlordane Excavation Particulate Modeling Results

Chemical Name	Max Soil Concentration[1] (mg/kg)	Resuspension Factor[2] (ug/m^3) / (mg/kg)	Excavation Modeling Result PM-10 Inhalation Loading ($\mu g/m^3$)	(g/m^3)
Chlordane	3.6	9.9E-05	3.6E-04	3.6E-10

Chemical Name	Max Soil Concentration (mg/kg)	Resuspension Factor[3] (ug/m^3) / (mg/kg)	Onsite Excavation Storage Piles Modeling Result PM-10 Inhalation Loading ($\mu g/m^3$)	(g/m^3)
Chlordane	3.6	3.3E-04	1.2E-03	1.2E-09

Chemical Name	Max Soil Concentration (mg/kg)	Resuspension Factor[4] (ug/m^3) / (mg/kg)	Excavation Soil Loading Modeling Result PM-10 Inhalation Loading ($\mu g/m^3$)	(g/m^3)
Chlordane	3.6	2.9E-05	1.0E-04	1.0E-10

Notes:

1 = Maximum LFI soil concentrations for the South West Trenches Area (Figure 3-5: Draft Final EE/CA).

2 = PM-10 excavation particulate resuspension factor estimated using the Air/Superfund National Technical Guidance Series Volume III - Estimation of Air Emissions from Cleanup Activities at Superfund Sites (Jan, 1989), (Assuming emission rate of PM-15 particulates for "dragline" in Table 24 of reference)

3 = PM-10 storage pile particulate resuspension factor estimated using the Air/Superfund National Technical Guidance Series Volume III - Estimation of Air Emissions from Cleanup Activities at Superfund Sites (Jan, 1989), (Assuming emission rate of Total Suspended Particulates for short-term (24hr) active storage piles in Table 21 of reference. Adjustment made for particulate size distribution less than 30 um from Table 25)

4 = PM-10 loading of radionuclide contaminate soil particulate resuspension factor estimated using the USEPA AP-42 Chapter 13 - Aggregate Handling and Storage Piles. Equation 1 - Quantity of particulate emissions generated by drop operations.

Table E-2. Southwest Trenches Radionuclide of Concern Excavation Particulate Modeling Results

Chemical Name	Max Soil Concentration[1] (pCi/g)	Resuspension Factor[2] (pCi/m^3) / (pCi/g)	Excavation Modeling Result PM-10 Inhalation Loading (pCi/m^3)	(Ci/m^3)
Radium-226	2.44	4.6E-05	1.1E-04	1.1E-16
Strontium-90	22.3	4.6E-05	1.0E-03	1.0E-15

Chemical Name	Max Soil Concentration (pCi/g)	Resuspension Factor[3] (pCi/m^3) / (pCi/g)	Onsite Excavation Storage Piles Modeling Result PM-10 Inhalation Loading (pCi/m^3)	(Ci/m^3)
Radium-226	2.44	1.6E-04	3.8E-04	3.8E-16
Strontium-90	22.3	1.6E-04	3.5E-03	3.5E-15

Chemical Name	Max Soil Concentration (pCi/g)	Resuspension Factor[4] (pCi/m^3) / (pCi/g)	Excavation Soil Screening Modeling Result PM-10 Inhalation Loading (pCi/m^3)	(Ci/m^3)
Radium-226	2.44	3.6E-04	8.7E-04	8.7E-16
Strontium-90	22.3	3.6E-04	7.9E-03	7.9E-15

Chemical Name	Max Soil Concentration (pCi/g)	Resuspension Factor[5] (pCi/m^3) / (pCi/g)	Excavation Soil Loading Modeling Result PM-10 Inhalation Loading (pCi/m^3)	(Ci/m^3)
Radium-226	2.44	3.8E-06	9.2E-06	9.2E-18
Strontium-90	22.3	3.8E-06	8.4E-05	8.4E-17

Notes:

1 = Maximum LFI soil concentrations for the South West Trenches Area (Figure 3-5: Draft Final EE/CA).

2 = PM-10 excavation particulate resuspension factor estimated using the Air/Superfund National Technical Guidance Series Volume III - Estimation of Air Emissions from Cleanup Activities at Superfund Sites (Jan, 1989), (Assuming emission rate of PM-15 particulates for "dragline" in Table 24 of reference)

3 = PM-10 storage pile particulate resuspension factor estimated using the Air/Superfund National Technical Guidance Series Volume III - Estimation of Air Emissions from Cleanup Activities at Superfund Sites (Jan, 1989), (Assuming emission rate of Total Suspended Particulates for short-term (24hr) active storage piles in Table 21 of reference. Adjustment made for particulate size distribution less than 30 mm from Table 25)

4 = PM-10 screening of radionuclide contaminate soil particulate resuspension factor estimated using the USEPA AP-42 Chapter 11, Section 11.19.2 Crushed Stone Processing. Table 11.19.2-1: Emission Factors for Crushed Stone Processing. PM-10 loading of radionuclide contaminate soil particulate resuspension factor estimated using the USEPA AP-42 Chapter 13 - Aggregate Handling and Storage Piles. Equation 1 - Quantity of particulate emissions generated by drop operations.

Table E-3. Southwest Trenches Metals of Concern Excavation Particulate Modeling Results

Chemical Name	Max Soil Concentration[1] (mg/kg)	Resuspension Factor[2] (ug/m^3) / (mg/kg)	Excavation Modeling Result PM-10 Inhalation Loading ($\mu g/m^3$)	(g/m^3)
Lead	11	4.6E-05	5.0E-04	5.0E-10
Mercury	5.2	4.6E-05	2.4E-04	2.4E-10

Chemical Name	Max Soil Concentration (mg/kg)	Resuspension Factor[3] (ug/m^3) / (mg/kg)	Onsite Excavation Storage Piles Modeling Result PM-10 Inhalation Loading ($\mu g/m^3$)	(g/m^3)
Lead	11	1.6E-04	1.7E-03	1.7E-09
Mercury	5.2	1.6E-04	8.1E-04	8.1E-10

Chemical Name	Max Soil Concentration (mg/kg)	Resuspension Factor[4] (ug/m^3) / (mg/kg)	Excavation Soil Screening Modeling Result PM-10 Inhalation Loading ($\mu g/m^3$)	(g/m^3)
Lead	11	3.6E-04	3.9E-03	3.9E-09
Mercury	5.2	3.6E-04	1.9E-03	1.9E-09

Chemical Name	Max Soil Concentration (mg/kg)	Resuspension Factor[5] (ug/m^3) / (mg/kg)	Excavation Soil Loading Modeling Result PM-10 Inhalation Loading ($\mu g/m^3$)	(g/m^3)
Lead	11	3.8E-06	4.1E-05	4.1E-11
Mercury	5.2	3.8E-06	2.0E-05	2.0E-11

Notes:
1 - Maximum LFI soil concentrations for the South West Trenches Area (Figure 3-5: Draft Final EE/CA).
2 - PM-10 excavation particulate resuspension factor estimated using the Air/Superfund National Technical Guidance Series Volume III - Estimation of Air Emissions from Cleanup Activities at Superfund Sites (Jan, 1989), (Assuming emission rate of PM-15 particulates for "dragline" in Table 24 of reference)
3 - PM-10 storage pile particulate resuspension factor estimated using the Air/Superfund National Technical Guidance Series Volume III - Estimation of Air Emissions from Cleanup Activities at Superfund Sites (Jan, 1989), (Assuming emission rate of Total Suspended Particulates for short-term (24hr) active storage piles in Table 21 of reference. Adjustment made for particulate size distribution less than 30 µm from Table 25)
4 - PM-10 screening of radionuclide contaminate soil particulate resuspension factor estimated using the USEPA AP-42 Chapter 11, Section 11.19.2 Crushed Stone Processing. Table 11.19.2-1: Emission Factors for Crushed Stone Processing.
5 - PM-10 loading of radionuclide contaminate soil particulate resuspension factor estimated using the USEPA AP-42 Chapter 13 - Aggregate Handling and Storage Piles. Equation 1 - Quantity of particulate emissions generated by drop operations.

Table E-4. Southwest Trenches Radionuclide of Concern Excavation Particulate Modeling Results and 10 CFR 61 Construction Exemption Calculation

Chemical Name	Excavation Modeling Result PM-10 Inhalation Loading (pCi/m^3)	(Ci/m^3)	Phase Duration (Hours)	% of Total Contribution	FGR 11 Table 2.1 Inhalation Intakes (mrem/pCi)	Dose Based upon FGR 11 Table 2.1 (mrem)	% of 40 CFR61 Standard of 10 mrem/yr (%)
Radium-226	1.1E-04	1.1E-16	150	3.6%	8.57E-03 (6)	1.2E-04	0.001%
Strontium-90	1.0E-03	1.0E-15	150	3.6%	1.30E-03 (7)	1.7E-04	0.002%

Chemical Name	Onsite Excavation Storage Piles Modeling Result PM-10 Inhalation Loading (pCi/m^3)	(Ci/m^3)	Phase Duration (Hours)	% of Total Contribution	FGR 11 Table 2.1 Inhalation Intakes (mrem/pCi)	Dose Based upon FGR 11 Table 2.1 (mrem)	% of 40 CFR61 Standard of 10 mrem/yr (%)
Radium-226	3.8E-04	3.8E-16	840	69%	8.57E-03 (6)	2.3E-03	0.02%
Strontium-90	3.5E-03	3.5E-15	840	69%	1.30E-03 (7)	3.2E-03	0.03%

Chemical Name	Excavation Soil Screening Modeling Result PM-10 Inhalation Loading (pCi/m^3)	(Ci/m^3)	Phase Duration (Hours)	% of Total Contribution	FGR 11 Table 2.1 Inhalation Intakes (mrem/pCi)	Dose Based upon FGR 11 Table 2.1 (mrem)	% of 40 CFR61 Standard of 10 mrem/yr (%)
Radium-226	8.7E-04	8.7E-16	149	28%	8.57E-03 (6)	9.2E-04	0.01%
Strontium-90	7.9E-03	7.9E-15	149	28%	1.30E-03 (7)	1.3E-03	0.01%

Chemical Name	Excavation Soil Loading Modeling Result PM-10 Inhalation Loading (pCi/m^3)	(Ci/m^3)	Phase Duration (Hours)	% of Total Contribution	FGR 11 Table 2.1 Inhalation Intakes (mrem/pCi)	Dose Based upon FGR 11 Table 2.1 (mrem)	% of 40 CFR61 Standard of 10 mrem/yr (%)
Radium-226	9.2E-06	9.2E-18	50	0.1%	8.57E-03 (6)	3.3E-06	0.00003%
Strontium-90	8.4E-05	8.4E-17	50	0.1%	1.30E-03 (7)	4.5E-06	0.00005%

Notes:

1 = Maximum LFI soil concentrations for the South West Trenches Area (Figure 3-5: Draft Final EE/CA).

2 = PM-10 excavation particulate resuspension factor estimated using the Air/Superfund National Technical Guidance Series Volume III - Estimation of Air Emissions from Cleanup Activities at Superfund Sites (Jan, 1989), (Assuming emission rate of PM-15 particulates for "dragline" in Table 24 of reference).

3 = PM-10 storage pile particulate resuspension factor estimated using the Air/Superfund National Technical Guidance Series Volume III - Estimation of Air Emissions from Cleanup Activities at Superfund Sites (Jan, 1989), (Assuming emission rate of Total Suspended Particulates for short-term (24hr) active storage piles in Table 21 of reference. Adjustment made for particulate size distribution less than 30 mm from Table 25).

4 = PM-10 screening of radionuclide contaminated soil particulate resuspension factor estimated using the USEPA AP-42 Chapter 11, Section 11.19.2 Crushed Stone Processing. Table 11.19.2-1: Emission Factors for Crushed Stone Processing.

5 = PM-10 loading of radionuclide contaminated soil particulate resuspension factor based upon AP-42 Chapter 13 - Aggregate Handling and Storage Piles. Equation 1 - Quantity of particulate emissions generated by drop operations.

6 = Committed effective dose equivalent per unit intake ($h_{E,50}$) for Ra-226 (Class=W; f_1=2.0e-01), computed using w_T from ICRP-26. From "Federal Guidance Report No. 11" : Table 2.1. Inhalation Intakes (EPA-5201/1-88-020).

7 = Committed effective dose equivalent per unit intake ($h_{E,50}$) for Sr-90 (Class=Y; f_1=1.0e-02), computed using w_T from ICRP-26. From "Federal Guidance Report No. 11" : Table 2.1. Inhalation Intakes (EPA-5201/1-88-020).

Table E-5. Southwest Trenches Radionuclide of Concern Excavation 10 CFR 61 Construction Exemption Calculation Summary

Chemical Name	Total Annual Average (1) PM-10 Inhalation Loading		FGR 11 Table 2.1 Inhalation Intakes	Dose Based upon FGR 11 Table 2.1	% of 40 CFR61 Standard of 10 mrem/yr
	(pCi/m^3)	(Ci/m^3)	(mrem/pCi)	(mrem)	(%)
Radium-226	5.3E-05	5.3E-17	8.57E-03 (2)	3.3E-03	0.03%
Strontium-90	4.9E-04	4.9E-16	1.30E-03 (3)	4.6E-03	0.05%

Notes:

1 = Total annual average PM-10 loading based upon maximum 1-hr concentrations resulting for each phase of the Southwest Trenches remediation and the estimated duration of each phase from Table 1.

2 = Committed effective dose equivalent per unit intake ($h_{E,50}$) for Ra-226 (Class=W; f_1=2.0e-01), computed using w_T from ICRP-26. From "Federal Guidance Report No. 11" : Table 2.1. Inhalation Intakes (EPA-5201/1-88-020).

3 = Committed effective dose equivalent per unit intake ($h_{E,50}$) for Sr-90 (Class=Y; f_1=1.0e-02), computed using w_T from ICRP-26. From "Federal Guidance Report No. 11" : Table 2.1. Inhalation Intakes (EPA-5201/1-88-020).

ATTACHMENT I

SOUTHWEST TRENCHES AREA – CHLORDANE EXCAVATION

Southwest Trenches Area - Resuspension Factors Resulting From Chlordane Contaminate Soil Remediation

Box model assuming emission rates estimated on "Excavation", "Storage" and "Loading" spreadsheets, and ASTM RBCA 1996 box model, adjusted for site specific data.

Excavation PM-10 Emission Rate =	4.76E-02	(g/m^2-hr)	=	1.32E-05	(g/m^2-sec)
Storage pile PM-10 Emission Rate =	1.77E-01	(g/m^2-hr)	=	4.92E-05	(g/m^2-sec)
Loading Emission Rate =	1.53E-02	(g/m^2-hr)	=	4.26E-06	(g/m^2-sec)
Total PM-10 Emission Rate =	2.40E-01	(g/m^2-hr)	=	6.67E-05	(g/m^2-sec)

Uw = 1.86 95% UCL mean windspeed for 1995-1997 between May and August (m/s)

Hb = 1.6 Height of breathing zone (m)

Excavation Modeling Result

L = 73 Downwind length of area source (ft)
= 22.3 Downwind length of area source (m)

PM-10 Exposure point concentration = 9.9E-05 g/m^3
99.03 $\mu g/m^3$

Excavation Resuspension Factor = 9.90E-05 ($\mu g/m^3$) / (mg/kg)

Onsite Excavation Storage Piles Modeling Result

L = 66 Downwind length of area source (ft)
= 20.1 Downwind length of area source (m)

PM-10 Exposure point concentration = 3.3E-04 g/m^3
333.19 $\mu g/m^3$

Storage Pile Resuspension Factor = 3.33E-04 ($\mu g/m^3$) / (mg/kg)

Excavated Soil Loading Modeling Result

L = 66 Downwind length of area source (ft)
= 20.1 Downwind length of area source (m)

PM-10 Exposure point concentration = 2.9E-05 g/m^3
28.82 $\mu g/m^3$

Soil Loading Resuspension Factor = 2.88E-05 ($\mu g/m^3$) / (mg/kg)

Southwest Trenches Area - Excavation of Chlordane Contaminate Soil

Excavation PM-10 emissions model based upon Air/Superfund National Technical Guidance Series
Volume III - Estimation of Air Emissions from Cleanup Activities at Superfund Sites
(Assuming emission rate of PM-15 particulates for "dragline" in Table 24 of reference)

Excavation Volume =	5,400	ft^3	(1350 sq-ft x 4ft: 200 Yd^3 in place))
=	152.9	m^3	
Moisture Content (M)=	10	wt. %	(model developed assuming range of 0.2 to 16.3%)
Drop Height (d) =	5	ft	(model developed assuming range of 5-100 ft)
=	1.52	m	(Typical value for front-end loader in Table 29 of reference)
Backhoe Excavation Emissions Factor (E_{15}) =	1.95E-03	kg/m^3	$E_{15} = 0.0029 \times d^{0.7} \times M^{-0.3}$
Excavation Time =	50	hours (5 days x 10 hrs/day)	
Backhoe Emission rate=	5.97	g/hr	
Excavation area =	1,350	ft^2	
=	125.4	m^2	
PM-10 Emission Rate =	4.76E-02	(g/m^2-hr) =	1.32E-05 (g/m^2-sec)

Southwest Trenches Area - Storage of Chlordane Contaminate Soil

Storage pile particulate emissions model based upon Air/Superfund National Technical Guidance Series
Volume III - Estimation of Air Emissions from Cleanup Activities at Superfund Sites
(Assuming emission rate of Total Suspended Particulates for short-term (24hr) active storage piles in
Table 21 of reference. Adjustment made for particulate size distribution less than 30 um from Table 25)

Storage pile area =	2,112	ft^2	(3 storage piles @ 22' x 32')
=	196.2	m^2	
=	1.96E-02	hectare	
Uw =	1.86		95% UCL mean windspeed for 1995-1997 between May and August (m/s)
Storage Pile Emission factor =	3.34	kg/hectare/hr	$E_{TSP} = 1.8 \times u$
TSP Emission Rate =	65.57	g/hr	$E_{30} = 1.8 \times u \times 0.53$
PM-30 Emission Rate =	34.75	g/hr	
PM-30 Emission Rate =	1.77E-01	(g/m^2-hr) =	4.92E-05 (g/m^2-sec)

Southwest Trenches Area — Loading of Chlordane Contaminate Soil Onto Trucks for Off-Site Transport

PM-10 emissions model based upon AP-42 Chapter 13 - Aggregate Handling and Storage Piles.
Equation 1 - Quantity of particulate emissions generated by drop operations.

Storage pile volume =	7,020	ft^3	(200 Yd^3 in place x 1.3 fluff)
=	198.78	m^3	
Storage pile area =	2,112	ft^2	(3 storage piles @ 22' x 32')
=	196.2	m^2	
Soil Bulk Density =	1.7	g/cm^3	(model developed assuming silt content range of 0.44 to 19%)
Soil Mass =	337.9	Mg	
Particle Size Multiplier (PM-10) =	0.35		
Moisture Content =	5	wt. %	(model developed assuming range of 0.25 to 4.8%)
Mean annual windspeed (Uw) =	1.86	(m/s)	(model developed assuming range of 0.6- to 6.7 m/s)
Truck loading emission Factor =	1.25E-04	kg/Mg	
Loading Time =	14	hours (140 m^3/ 10 hr-day)	
Truck loading emission rate=	3.0	g/hr	
PM-10 Emission Rate =	1.53E-02	(g/m^2-hr) =	4.26E-06 (g/m^2-sec)

$$E = k(0.0016)\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}(kg/Mg)$$

ATTACHMENT II

SOUTHWEST TRENCHES AREA – RADIONUCLIDE AND METALS WASTE EXCAVATION

Southwest Trenches Area - Resuspension Factors Resulting From Radionuclide and Metals Contaminate Soil Remediation

Box model assuming emission rates estimated on "Excavation", "Storage", "Screening" and "Loading" spreadsheets, and ASTM RBCA 1996 box model, adjusted for site specific data.

Excavation Emission Rate =	5.20E-02	(g/m^2-hr)	=	1.44E-05	(g/m^2-sec)
Storage pile Emission Rate =	1.77E-01	(g/m^2-hr)	=	4.92E-05	(g/m^2-sec)
Screening Emission Rate =	4.04E-01	(g/m^2-hr)	=	1.12E-04	(g/m^2-sec)
Loading Emission Rate =	4.26E-03	(g/m^2-hr)	=	1.18E-06	(g/m^2-sec)
Total PM-10 Emission Rate =	2.33E-01	(g/m^2-hr)	=	6.48E-05	(g/m^2-sec)

Uw =	3	95% UCL of mean annual windspeed at 7 m (m/s)
Hb =	1.6	Height of breathing zone (m)

Excavation Modeling Result

L =	50	Downwind length of area source (ft)
=	15.2	Downwind length of area source (m)
PM-10 Exposure point concentration =	4.6E-05	g/m^3
	45.88	$\mu g/m^3$
Excavation Resuspension Factor =	4.59E-05	(ug/m^3) / (mg/kg)

Onsite Excavation Storage Piles Modeling Result

L =	50	Downwind length of area source (ft)
=	15.2	Downwind length of area source (m)
PM-10 Exposure point concentration =	1.6E-04	g/m^3
	156.22	$\mu g/m^3$
Storage Pile Resuspension Factor =	1.56E-04	($\mu g/m^3$) / (mg/kg)

Excavated Soil Screening Modeling Result

L =	50	Downwind length of area source (ft)
=	15.2	Downwind length of area source (m)
PM-10 Exposure point concentration =	3.6E-04	g/m^3
	356.09	$\mu g/m^3$
Soil Screening Resuspension Factor =	3.56E-04	($\mu g/m^3$) / (mg/kg)

Excavated Soil Loading Modeling Result

L =	50	Downwind length of area source (ft)
=	15.2	Downwind length of area source (m)
PM-10 Exposure point concentration =	3.8E-06	g/m^3
	3.76	$\mu g/m^3$
Soil Loading Resuspension Factor =	3.76E-06	($\mu g/m^3$) / (mg/kg)

Southwest Trenches Area - Excavation of Radionuclide and Metals Contaminate Soil

Excavation PM-10 emissions model based upon Air/Superfund National Technical Guidance Series
Volume III - Estimation of Air Emissions from Cleanup Activities at Superfund Sites
(Assuming emission rate of PM-15 particulates for "dragline" in Table 24 of reference)

Excavation Volume =	41,850	ft^3	(1,550 cu-yd)
=	1,185.0	m^3	
Moisture Content (M)=	10	wt. %	(model developed assuming range of 0.2 to 16.3%)
Drop Height (d) =	10	ft	(model developed assuming range of 5-100 ft)
=	3.05	m	(Low value for Dragline in Table 29 of reference)
Backhoe Excavation Emissions Factor (E_{15}) =	3.17E-03	kg/m^3	$E_{15} = 0.0029 \times d^{0.7} \times M^{-0.3}$
Excavation Time =	150	hours (103 Yd^3/10 hr-day)	
Backhoe Emission rate=	25.05	g/hr	
			PM-10 Inhalation Loading
Excavation area =	5,184	ft^2	(72' x 72')
=	481.6	m^2	
PM-10 Emission Rate =	5.20E-02	(g/m^2-hr)	= 1.44E-05 (g/m^2-sec)

Southwest Trenches Area - Storage of Radionuclide and Metals Contaminate Soil

Storage pile particulate emissions model based upon Air/Superfund National Technical Guidance Series
Volume III - Estimation of Air Emissions from Cleanup Activities at Superfund Sites
(Assuming emission rate of Total Suspended Particulates for short-term (24hr) active storage piles in
Table 21 of reference. Adjustment made for particulate size distribution less than 30 um from Table 25)

Storage pile area =	10,560	ft^2	(15 storage piles @ 22' x 32')
=	981.1	m^2	
=	9.81E-02	hectare	
Uw =	1.86	95% UCL mean windspeed for 1995-1997 between May and August (m/s)	
Storage Pile Emission factor =	3.34	kg/hectare/hr	$E_{TSP} = 1.8 \times u$
TSP Emission Rate =	327.87	g/hr	
PM-30 Emission Rate =	173.77	g/hr	$E_{30} = 1.8 \times u \times 0.53$
PM-30 Emission Rate =	1.77E-01	$(g/m^2\text{-hr})$	= 4.92E-05 $(g/m^2\text{-sec})$ PM-10 Inhalation Loading

Southwest Trenches Area - Screening of Radionuclide and Metals Contaminate Soil

PM-10 emissions model based upon AP-42 Chapter 11, Section 11.19.2 Crushed Stone Processing.
Table 11.19.2-1: Emission Factors for Crushed Stone Processing

Storage pile volume =	24,975	ft^3	(925 cu-yd)
=	707.21	m^3	
Storage pile area =	7,744	ft^2	(11 stockpiles @ 22' x 32')
=	719.4	m^2	
Soil Bulk Density =	1.7	g/cm^3	
Soil Mass =	1202.3	Mg	
Fines Screening emission Factor =	3.60E-02	kg/Mg	
Screening Time =	149	hours (62 Yd^3/10 hr-day)	
Soil screening emission rate=	290.5	g/hr	PM-10 Inhalation Loading
PM-10 Emission Rate =	4.04E-01	(g/m^2-hr) =	1.12E-04 (g/m^2-sec)

Southwest Trenches Area - Loading of Radionuclide and Metals Contaminate Soil Onto Trucks for Off-Site Transport

PM-10 emissions model based upon AP-42 Chapter 13 - Aggregate Handling and Storage Piles.
Equation 1 - Quantity of particulate emissions generated by drop operations.

Storage pile volume =	8,370	ft^3	(310 cu-yd)
=	237.01	m^3	
Storage pile area =	2,534	ft^2	(3.6 stockpiles @ 22' x 32')
=	235.5	m^2	
Soil Bulk Density =	1.7	g/cm^3	(model developed assuming silt content range of 0.44 to 19%)
Soil Mass =	402.9	Mg	
PM-10 Particle Size Multiplier (k) =	0.35		
Moisture Content (M)=	5	wt. %	(model developed assuming range of 0.25 to 4.8%)
Mean annual windspeed (U) =	1.86	(m/s)	(model developed assuming range of 0.6- to 6.7 m/s)
Truck loading emission Factor (E) =	1.25E-04	kg/Mg	
Loading Time =	50	hours (62 Yd^3/10 hr-day)	
Truck loading emission rate=	1.0	g/hr	
PM-10 Emission Rate =	4.26E-03	(g/m^2-hr) =	1.18E-06 (g/m^2-sec)

PM-10 Inhalation Loading

$$E = k(0.0016)\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}(kg/Mg)$$

SOUTHWEST TRENCHES REMOVAL ACTION WORK SCOPE VARIANCES

FIELD WORK VARIANCE

PROJECT NO.: 128-4002	DATE: 5/26/98	VARIANCE NO.: 1
PROJECT NAME: Removal Action at Southwest Trenches, LEHR		
Originator: Alborz Wozniak		

PRESENT REQUIREMENTS:

This variance has been initiated in response to the need for additional information for waste designation and certification as part of the removal action (RA) activities in the Southwest Trenches Area. Originally, it was assumed that the Limited Field Investigation (LFI) analytical results would be sufficient for designation of the expected soil/gravel excavated during the RA.

PROPOSED CHANGE:

In recent correspondence with Hanford Disposal Facility, the facility requested Toxicity Characteristic Leaching Procedure (TCLP) analytical results for several constituents detected in site soils. To gather this information, the field personnel were mobilized to the site to collect 5 soil samples from five LFI sample locations. Two samples will be analyzed for chromium (total and hexavalent), two samples will be analyzed for chlordane, and one sample will be analyzed for mercury.

TECHNICAL JUSTIFICATION:

This effort was required as part of the waste designation process for the RA activities at the Southwest Trenches Area.

COST/SCHEDULE IMPACT:

The need for additional data collection will impact the waste designation schedule. This impact is approximately a month delay from the projected date.
The cost impacts are associated with collection and analysis of five additional samples. Cost estimate is $3,442.

COST ESTIMATE REQUIRED: ___ No _X_ Yes _____ Task Revision No.

____X__ Addition _____ Deletion

FIELD WORK VARIANCE

PROJECT NO.: 128-4002	DATE: 5/26/98	VARIANCE NO.: 2
PROJECT NAME: Removal Action at Southwest Trenches, LEHR		
Originator: _Alborz Wozniak; WA Project Task Leader		

PRESENT REQUIREMENTS:

This Variance has been initiated to record the changes in the area of asphalt removed at the Southwest Trenches. The current requirements in Task Plan 7.1 specify removal of 7700 square feet (SF) of pavement.

PROPOSED CHANGE:

Review of historical records and conversation with IT/EMS/WA managers support the decision to reduce the asphalt removal to 1000 SF. The paved road along the east side of southwest trenches will not be removed.

TECHNICAL JUSTIFICATION:

There is no evidence that chlordane contamination or waste disposal had occurred in the paved road along the east side of the Southwest Trenches Area. Therefore, the paved road will not be disturbed at this time, unless future waste removal indicates otherwise.

COST/SCHEDULE IMPACT:

The reduction in surface area requiring asphalt removal will reduce this task's duration by one day.

COST ESTIMATE REQUIRED: ___ No _X_ Yes _____ Task Revision No.

_____ Addition ___X__ Deletion

FIELD WORK VARIANCE

PROJECT NO.: 128-4002	DATE: 5/26/98	VARIANCE NO.: 4
PROJECT NAME: Removal Action at Southwest Trenches, LEHR		
Originator: Alborz Wozniak; WA Project Task Leader		

PRESENT REQUIREMENTS:

This Variance has been initiated to record the changes in the number of samples collected during chlordane delineation activities. The Draft Work Plan, Revision C, planned for an initial round of sampling that would require collecting 97 soil samples.

PROPOSED CHANGE:

Following collection and analysis of the 97 samples as described in the Draft Work Plan, Rev. C, several detections of chlordane were noted. To further delineate these detections for the purpose of refining the extent of excavation, additional samples are collected and analyzed for chlordane. The additional number of samples is 65 (sample SSDTF098 to SSDTF163).

TECHNICAL JUSTIFICATION:

Additional sampling and analysis is necessary in order to define the vertical and horizontal extent of chlordane contamination at the site. Samples are being collected from the established grid nodes at either two or three depths depending on the location and extent of contamination.

COST/SCHEDULE IMPACT:

The cost for this additional sampling and analysis is estimated at $22,811.
There are no schedule impacts to the start date of task 2.9.3.3 – Chlordane Excavation, since the delineation sampling was started in advance of the schedule.

COST ESTIMATE REQUIRED: ___ No _X_ Yes _____ Task Revision No.

__X__ Addition _____ Deletion

FIELD WORK VARIANCE

PROJECT NO.: 128-4002	DATE: 5/26/98	VARIANCE NO.: 5
PROJECT NAME: Removal Action at Southwest Trenches, LEHR		
Originator: Alborz Wozniak; WA Project Task Leader		

PRESENT REQUIREMENTS:

This Variance has been initiated to record the changes in the number of laboratory confirmation analyses that will be performed during chlordane delineation activities. The Draft Work Plan, Revision C, planned for confirmation of 10% of soil samples collected and analyzed by the chlordane immunoassay-based field analytical method.

PROPOSED CHANGE:

In order to establish an immediate correlation between the field and laboratory analytical methods for chlordane analysis and thus obtain greater confidence in the field analytical results, this variance proposes to increase the rate of confirmation analysis to 20%.

TECHNICAL JUSTIFICATION:

According to EPA Quality Control (QC) guidance on use of field analytical methods for the purpose of delineating soils, a minimum of 10% of field analytical results should be verified by an offsite laboratory analytical method. Due to the chemical properties of chlordane and the relative sensitivity of the field immunoassay test kit to other organopesticides, it is recommended that the rate of confirmation of field results be increased to 20%.

COST/SCHEDULE IMPACT:

The cost for this additional confirmation analysis is $6,240 associated with 24 more samples. The cost is included as part of Work Variance No. 4 cost estimate.
There are no schedule impacts associated with this work variance.

COST ESTIMATE REQUIRED: ___ No _X_ Yes _____ Task Revision No.

___X_ Addition _____ Deletion

FIELD WORK VARIANCE

PROJECT NO.: 128-4002	DATE: 6/02/98	VARIANCE NO.: 6
PROJECT NAME: Removal Action at Southwest Trenches, LEHR		
Originator: Alborz Wozniak; WA Project Task Leader		

PRESENT REQUIREMENTS:

This Variance has been initiated to record the changes in the use of straw bales as erosion control measures onsite. The Work Plan indicates that the perimeter of the site should be lined with silt fences or straw bales for sediment control as necessary.

PROPOSED CHANGE:

A walk through the site and a review of drainage patterns during a storm event indicate that there is no flow from the site to offsite areas. Due to relative flat topography at the site and the fact that the west and southern boundaries of the site actually drain toward the site, the need for erosion control is not required. Therefore, the straw bales currently placed around the site should be removed prior to establishing the area as a Controlled Area.

TECHNICAL JUSTIFICATION:

The topography of the site and adjacent areas are such that no water flows offsite, rather there is localized ponding within the site. In order to minimize the potential for straw bales to become contaminated during the removal action, it is recommended that the bales be removed from the perimeter of the site.

COST/SCHEDULE IMPACT:

The cost associated with this variance includes the cost of removing the bales from the southwest trenches and loading them for offsite disposal. The cost for this variance is $2,649. There will be no schedule impacts from this activity.

COST ESTIMATE REQUIRED: ___ No _X_ Yes _____ Task Revision No.

___X__ Addition _____ Deletion

FIELD WORK VARIANCE

PROJECT NO.: 128-4002	DATE: 6/02/98	VARIANCE NO.: 7
PROJECT NAME: Removal Action at Southwest Trenches, LEHR		
Originator: Alborz Wozniak; WA Project Task Leader		

PRESENT REQUIREMENTS:

This Variance has been initiated to record the changes in the excavation of chlordane contaminated soil. The Work Plan requires that chlordane contaminated soil excavated from the southwest trenches be stockpiled in the Dog Pens Area.

PROPOSED CHANGE:

This work variance provides additional specifications for the excavation and stockpiling of chlordane-contaminated soil. Excavation shall proceed in 1 foot lifts. Each lift, shall be stockpiled separately in the Western Dog Pens Area.

TECHNICAL JUSTIFICATION:

Based on the chlordane delineation sampling results, a concern was raised regarding the potential for encountering hazardous waste and perhaps mixed waste (in the event radionuclides are detected in the soil piles during characterization). As a precaution and a waste minimization practice, it is proposed that each 1-foot layer of soil be stockpiled separately. Good engineering practice dictates that excavations proceed in one-foot lifts and that excavated materials remain separated in the stockpiling area.

COST/SCHEDULE IMPACT:

The cost associated with this variance is $12,714. Two days will be added to the schedule due to this variance.

COST ESTIMATE REQUIRED: ___ No _X_ Yes _____ Task Revision No.

_____ Addition _____ Deletion

FIELD WORK VARIANCE

PROJECT NO.: 128-4002	DATE: 6/02/98	VARIANCE NO.: 9
PROJECT NAME: Removal Action at Southwest Trenches, LEHR		
Originator: Alborz Wozniak; WA Project Task Leader		

PRESENT REQUIREMENTS:

This Variance has been initiated to record the work performed by IT Corp. to prepare the onsite laboratory area. Pacific National Laboratory (PNL) under contract with DOE is providing field analytical instruments consisting of a gamma spectroscopy and beta scintillation detector along with technician support during the removal action. No costs were included in Task Plan 7 for constructing the onsite laboratory.

PROPOSED CHANGE:

An onsite laboratory was constructed for the gamma/beta detectors in building AH-1. The onsite laboratory consists of a 30'x30' area the boundaries of which are defined by a 4 foot high plywood wall. The entire surface of the lab is covered with plastic sheeting.

TECHNICAL JUSTIFICATION:

Since potentially contaminated soil samples will be brought to the onsite laboratory for analysis, the lab area is defined as a contamination area. Therefore, proper control and decontamination measures are required for the onsite laboratory.

COST/SCHEDULE IMPACT:

The cost for this variance is $6,209 and is linked with Work Breakdown Structure (WBS) 2.9.1.4. No schedule impacts are associated with this variance.

COST ESTIMATE REQUIRED: ___ No _X_ Yes _____ Change Proposal No.

___X_ Addition _____ Deletion

FIELD WORK VARIANCE

PROJECT NO.: 128-4002	DATE: 7/02/98	VARIANCE NO.: 10
PROJECT NAME: Removal Action at Southwest Trenches, LEHR		
Originator: Alborz Wozniak; WA Project Task Leader		

PRESENT REQUIREMENTS:

This Variance has been initiated to record the changes to scope of work based on detection of tritium during grid trenching operations. Previous investigation data did not indicate that tritium would be present within the waste matrix at high levels.

PROPOSED CHANGE:
During grid trenching along Grid W4 at S15, several laboratory glass bottles were uncovered at a depth of 2-3 feet bgs. The glassware were intact and contained a clear liquid. Upon examination by the radiological control technicians (RCT), high beta activity was recorded on the bottles. Smears were collected from one of the bottles and analyzed by the Liquid Scintillation Counter (LSC). LSC results indicated the presence of tritium.

Detection of tritium called for a re-evaluation of the health and safety and operational procedures that are currently in-place for the removal action. Additional real-time monitoring equipment is required for testing the work area breathing zone for tritium. In addition, waste segregation and handling procedures will be modified to ensure that tritium is not released to the environment given its mobility in soil and air.

TECHNICAL JUSTIFICATION:

Tritium is a highly mobile contaminant that causes both environmental and health and safety concerns at the site. It is important to be able to monitor the breathing zone for tritium to ensure that workers are not exposed to this contaminant. In addition, waste segregation procedures require modification to ensure that tritium is not released to the soil since it can be easily transported and contaminate a large portion of the site.

COST/SCHEDULE IMPACT:

The cost impact associated with this variance is $15,732 and is related to preparing health and safety guidelines, segregation procedures, and meetings to review field conditions and develop contingency plans. Schedule impact is approximately 1 week for re-evaluation of H&S concerns with regards to excavating the waste potentially contaminated with tritium. In addition, excavation and sorting of waste will proceed at a slower pace to minimize the potential spread of tritiated waste.

COST ESTIMATE REQUIRED: ___ No _X_ Yes _____ Change Proposal No.

___X_ Addition _____ Deletion

FIELD WORK VARIANCE

PROJECT NO.: 128-4002	DATE: 7/05/98	VARIANCE NO.: 11
PROJECT NAME: Removal Action at Southwest Trenches, LEHR		
Originator: Alborz Wozniak; WA Project Task Leader		

PRESENT REQUIREMENTS:

This Variance has been initiated to record the changes to the scope of waste delineation and characterization. This scope variance impacts WBS element 2.9.3. The RA Work Plan Rev. C planned on trenching across the site along 10'x10' grids to locate the waste. Trench dimensions were described as 2 feet wide and 6 feet deep.

PROPOSED CHANGE:

Following excavation of chlordane contaminated soil in the southwest corner of the site to a depth of 3.5 feet bgs, waste was encountered at several locations within the excavation. In these areas, no further chlordane soil removal was performed in order to minimize the potential for generating mixed waste without proper characterization. In addition, trenching was halted outside the excavation area to avoid mixing clean soil with waste within the excavation.

The waste delineation and characterization in the chlordane excavation consists of using a drill rig to advance borings on 5 foot grid centers. Two objectives were defined for this task: 1) to locate the vertical and lateral extent of waste, and 2) to determine the chlordane concentrations within the waste matrix and assess whether a mixed waste problem exists at the Southwest Trenches Area.

TECHNICAL JUSTIFICATION:

Trenching to locate waste in an area suspect of containing mixed waste was considered improper due to the increased chance of spreading contamination. Using a drilling rig such as a Geoprobe would allow for less intrusive method for both determining the physical extent of waste and the chemical characteristic of the waste from a chlordane contamination standpoint.

COST/SCHEDULE IMPACT:

The cost impact associated with this variance is $51,256 and is linked to WBS element 2.9.3. The schedule impact associated with this variance is 9 days of drilling and sampling in the southwest corner of the site.

COST ESTIMATE REQUIRED: ___ No _X_ Yes _____ Change Proposal No.

___X_ Addition _____ Deletion

FIELD WORK VARIANCE

PROJECT NO.: 128-4002	DATE: 7/05/98	VARIANCE NO.: 12
PROJECT NAME: Removal Action at Southwest Trenches, LEHR		
Originator: Alborz Wozniak; WA Project Task Leader		

PRESENT REQUIREMENTS:

This Variance has been initiated to record the changes to the scope waste sorting and screening. This scope variance impacts the Work Breakdown Structure (WBS) 2.9.5. Task Plan 7 was prepared under the assumption that all waste should be shipped to Hanford Disposal Facility in the state of Washington. Per requirements of Hanford, the waste matrix would have to be sorted to ensure that all sharps including needles, syringes, and broken glass were separated from the soil and gravel. To expedite separation of sharps and minimize injury to workers, a sorting equipment consisting of a shaker screen was included in the scope of work. Excavated waste would be processed through the shaker to remove sharps from the soil and gravel mix.

PROPOSED CHANGE:

Based on changes in the disposal facility, specifically the option for disposal of waste at Envirocare rather than Hanford, the waste sorting and screening process was revised. In addition, the potential for encountering mixed waste in the southwest corner of the site and tritium along the southern disposal cells make sorting activities more laborious, arduous, and critical. A specific technical guideline was prepared to address waste segregation according to requirements of Envirocare. Since sharps do not require separation from the waste matrix, a new waste handling and segregation procedure was developed. The shaker screen is no longer required for this task.

TECHNICAL JUSTIFICATION:

The decision for disposing of the waste at Envirocare was made by DOE. One factor for not going to Hanford is the fact that the EPA offsite rule does not allow for disposal of CERCLA waste at that facility.

COST/SCHEDULE IMPACT:

The cost impact associated with this variance is $40,341 and is linked to WBS element 2.9.5. The schedule impact associated with this variance is 2 weeks of additional waste removal and sorting. Changes in waste removal and sorting operations require the two activities to occur simultaneously. The overall schedule for waste sorting will change by two weeks due to the presence of tritium and chlordane impacted mixed waste.

COST ESTIMATE REQUIRED: ___ No _X_ Yes _____ Change Proposal No.

___X_ Addition _____ Deletion

FIELD WORK VARIANCE

PROJECT NO.: 128-4002	DATE: 7/05/98	VARIANCE NO.: 13
PROJECT NAME: Removal Action at Southwest Trenches, LEHR		
Originator: Alborz Wozniak; WA Project Task Leader		

PRESENT REQUIREMENTS:

This Variance has been initiated to record the changes associated with removal assessment. This scope variance impacts the Work Breakdown Structure (WBS) 2.9.3. A grid trenching operation was implemented to locate the buried waste within the Southwest Trenches Area.

PROPOSED CHANGE:

The results of 10x10 grid trenching identify two areas in the eastern and northern section of the site that contain surface gravel and shallow cobble-lined drainage features. No laboratory waste or other indication of disposal was noted in the area. The proposed change to the waste removal activity is to perform in-situ characterization sampling in the cobble/gravel areas to determine whether a removal action is warranted for these features. A two-phased sampling activity is planned for the cobble/gravel area. First, 18 soil samples will be collected directly beneath the cobble/gravel area and analyzed using the onsite laboratory for Ra-226 and Sr-90. Based on the field analytical results, certain samples will be transferred to an offsite laboratory for analysis of driver COCs as described in the Work Plan. In the second phase, if necessary, cobble samples will be collected and sent to the offsite laboratory to be tested for driver COCs.

TECHNICAL JUSTIFICATION:

Removal of the gravel and cobbles from the northern and eastern section of the site may not be required if no evidence of contamination is present. A more cost effective measure is to perform in-situ characterization of the soil beneath these features and determine if contamination has been released to the site from these features.

COST/SCHEDULE IMPACT:

The cost impact associated with this variance is $61,315 and is linked to WBS element 2.9.3, Removal Assessment. The schedule impact associated with this variance is 4 days of sampling, which will be performed in concurrence with waste removal.

COST ESTIMATE REQUIRED: ___ No _X_ Yes _____ Change Proposal No.

___X_ Addition _____ Deletion

FIELD WORK VARIANCE

PROJECT NO.: 128-4002	DATE: 7/05/98	VARIANCE NO.: 14
PROJECT NAME: Removal Action at Southwest Trenches, LEHR		
Originator: Alborz Wozniak; WA Project Task Leader		

PRESENT REQUIREMENTS:

This Variance has been initiated to record the changes associated with B-25 box refurbishment. The original assumption in Task Plan 7.1 consisted of purchasing 600 new B-25 boxes. However, in April 1998 an opportunity arose where used B-25 boxes from other DOE facilities could be acquired. 593 used B-25 boxes were transported to the site from Savannah River Site and Oak Ridge in May.

PROPOSED CHANGE:

The used B-25 boxes require refurbishment in order to prepare them for storage and disposal. Refurbishment activities for each box consist of removing rust from joints, painting over old labels and markings, and replacing the seals and clips for the box lid. Other activities include moving boxes from the storage area to the refurbishing area, labeling each box following refurbishment, and replacing the boxes back to the Western Dog Pen aisles upon completion of refurbishment.

TECHNICAL JUSTIFICATION:

To maintain the structural integrity of each box, rusted areas will be sanded off and repainted. In addition, to eliminate confusion and misinformation, previous labels and markings will be covered over with a coat of matching paint.

COST/SCHEDULE IMPACT:

The cost impact associated with this variance is $81,363 and is linked to WBS element 2.9.7. The schedule impact associated with this variance is 30 days of refurbishment of 593 boxes.

COST ESTIMATE REQUIRED: ___ No _X_ Yes _____ Change Proposal No.

___X_ Addition _____ Deletion

FIELD WORK VARIANCE

PROJECT NO.: 128-4002	DATE: 7/05/98	VARIANCE NO.: 15
PROJECT NAME: Removal Action at Southwest Trenches, LEHR		
Originator: Alborz Wozniak; WA Project Task Leader		

PRESENT REQUIREMENTS:

This Variance has been initiated to record the changes associated with waste characterization. The assumption in Task Plan 7.1 was that no mixed waste would be encountered at the site. Therefore, soil and gravel matrix would be characterized by collecting a 4-point composite sample from every 50 CY of waste and analyzing the samples for a full suite of COCs.

PROPOSED CHANGE:

Based on a review of chlordane delineation and in-situ waste characterization results from the southwest corner of the site, mixed waste may be encountered during excavation of Gridline W10 and W8. The proposed change is associated with refining the waste characterization sampling in this area. Excavated waste that will be placed in B-25 boxes will be sampled to determine whether chlordane has impacted the waste and if so, whether hazardous levels are exceeded as defined by TCLP analysis. The proposed change consists of sampling each B-25 and analyzing the samples for chlordane by Method 8080 and TCLP if necessary

TECHNICAL JUSTIFICATION:

To minimize the volume of potential mixed waste, each B-25 box will be sampled and tested for chlordane.

COST/SCHEDULE IMPACT:

The cost impact associated with this variance is $24,807 and is linked to WBS element 2.9.6. There are no schedule impacts associated with this activity.

COST ESTIMATE REQUIRED: ___ No _X_ Yes _____ Change Proposal No.

___X_ Addition _____ Deletion

FIELD WORK VARIANCE

PROJECT NO.: 128-4002	DATE: 10/26/98	VARIANCE NO.: 16
PROJECT NAME: Removal Action at Southwest Trenches, LEHR		
Originator: Alborz Wozniak; WA Project Task Leader		

PRESENT REQUIREMENTS:

This Variance has been initiated to record the changes to scope of work based on detection nitrate during the removal action screening sampling. Excavation screening samples were collected from the sidewalls and floor of the excavation and analyzed for nitrate along with several other constituents of concern. Nitrate concentrations exceeded the cleanup criteria in the western excavations.

PROPOSED CHANGE:
This variance is being prepared to address the nitrate contamination at the site. Several specific activities will be performed to delineate the nitrate soil contamination. The first activity will consist of collecting several soil samples from the floor and sidewalls of the excavation where the maximum detections were observed. A profile of the nitrate contamination will then be presented to the DOE and the remedial project managers (RPMs). Based on the results of the initial assessment, a sampling plan will be prepared to address the nitrate delineation in the Southwest Trenches Area. Finally, the delineation plan will be implemented in the field. In addition, a storm protection measure will be installed over the nitrate-impacted area to prevent rainwater infiltration and further migration of the nitrate in the subsurface.

TECHNICAL JUSTIFICATION:

Nitrate concentrations in soil are such that there is a potential for impact to the groundwater if the nitrate levels are not reduced to background levels. In order to provide information for excavation of the nitrate impacted soil, delineation sampling must be performed. In addition, during the winter months, it is important to prevent further migration of nitrates by infiltrating rainwater. Therefore, a storm protection measure consisting of grading and an impermeable cover will be installed over the areas of concern.

COST/SCHEDULE IMPACT:

The cost impact associated with this variance is $63,577 and is related to preparing a delineation sampling plan, collecting samples, reviewing analytical results and preparing a report. In addition, a storm protection measure will also be required. The schedule for this activity is as follows: two days for initial sampling, 5 weeks for sampling plan preparation, 2 weeks for delineation sampling, and one week for storm protection measure installation.

COST ESTIMATE REQUIRED: ___ No _X_ Yes _____ Change Proposal No.

___X_ Addition _____ Deletion

FIELD WORK VARIANCE

PROJECT NO.: 128-4002	DATE: 10/26/98	VARIANCE NO.: 17
PROJECT NAME: Removal Action at Southwest Trenches, LEHR		
Originator: Alborz Wozniak; WA Project Task Leader		

PRESENT REQUIREMENTS:

This Variance has been initiated to record the changes to scope of work for the confirmation sampling. In the original scope of work, it was assumed that samples would be collected from the sidewalls and floor of the excavation using the backhoe bucket or hand augers by entering the excavation.

PROPOSED CHANGE:
Following completion of the waste removal activities, it became apparent that the excavations were too unstable for either entry or sampling with the excavator bucket. The excavation dimensions were such that a shoring system could not be installed. The alternative proposed for sample collection consists of using a manlift to access the excavations and collect samples with hand auger and necessary extensions.

TECHNICAL JUSTIFICATION:

For safety reasons, it is important to stay clear of the excavations while collecting samples. Using a manlift, the sampler can be placed over the excavation in a safe manner to collect samples from sidewall or the floor of the excavation.

COST/SCHEDULE IMPACT:

The cost impact associated with this variance is $7,052 and is related to renting a manlift, and operating the unit. The schedule for this activity is two weeks for collecting 65 samples.

COST ESTIMATE REQUIRED: ___ No _X_ Yes _____ Change Proposal No.

___X_ Addition _____ Deletion

RADIUM/STRONTIUM TREATMENT SYSTEMS AREA I REMOVAL ACTION WORK SCOPE VARIANCES

FIELD WORK VARIANCE

PROJECT NO.: 128-4005	DATE: 6/21/1999	VARIANCE NO.: 3
PHASE NO: 530		(HVAC Rerouting and Modification)
TASK NAME: Ra/Sr Area I Facility Coordination – (WBS 2.5.3)		

PRESENT REQUIREMENTS:

During Task Plan 10.1 preparation it was assumed that rerouting of the HVAC system in Building AH-2 would not be required.

PROPOSED CHANGE:

The proposed change was brought about following an evaluation of RA activities and their potential impact to air quality within Building AH-2. The change included detail evaluation of the HVAC system within AH-2, coordinating an air intake reroute plan with UCD and implementing the air rerouting plan. The air intake reroute consisted of building a wooden duct around the air intake closet located on the west side of Building AH-2 and extending the duct to the central portion of the roof.

TECHNICAL JUSTIFICATION:

Due to the uncertainty about the contaminant levels in fugitive dust this is proposed as a conservative measure to eliminate any potential for impact to onsite personnel from the RA.

COST/SCHEDULE IMPACT:

Construction of the reroute air duct caused a two-day delay in the RA. The estimated cost for this variance is $21,113.

FIELD WORK VARIANCE

PROJECT NO.: 128-4005	DATE: 6/21/1999	VARIANCE NO.: 4
PHASE NO: 552		(Site Setup Modifications)
TASK NAME: Ra/Sr Area I Site Setup - (WBS 2.5.5.2)		

PRESENT REQUIREMENTS:

Several tasks that need to be performed as part of the site setup activities, prior to start of the RA, were either not included in Task Plan 10.1 or their effort was deemed insufficient. Tree removal was assumed to have occurred as part of Area II RA. Western Dog Pen (WDP) aisles were assumed to have been cleared and ready for soil stockpiling, and the area requiring asphalt removal was assumed to be smaller.

PROPOSED CHANGE:

The proposed change involves three tasks. Each task is described below.

- Tree removal was scoped under WBS 2.4.4.2 – Area II RA, which was scheduled before Area I RA. However, Area I RA was implemented first and therefore, the tree removal scope had to be performed during WBS 2.5.5.2 for Area I Site Setup.
- The WDP aisles were assumed to be clear of debris and no preparation effort was allotted for this task. However, the northern WDP aisle required clearing of fence post stubs and vegetation.
- The asphalt removed from the RA area had to be pulverized so that it could be sampled and analyzed to determine its suitability for use onsite. Therefore specialized asphalt removal equipment (pulverizer) was utilized to complete the task.

TECHNICAL JUSTIFICATION:

See above.

COST/SCHEDULE IMPACT:

Schedule impacts associated with this task include three additional days for site setup activities. The estimated cost for this variance is $37,775.

FIELD WORK VARIANCE

PROJECT NO.: 128-4005	DATE: 6/21/1999	VARIANCE NO.: 5
PHASE NO: 553		(Hand excavation around water/gas line)
TASK NAME: Ra/Sr Area I Removal Action - (WBS 2.5.5.3)		

PRESENT REQUIREMENTS:

The water and gas lines that are located near (on the west side) of the drywells and leach trench were to be relocated by UCD prior to excavation activities.

PROPOSED CHANGE:

The water and gas lines were not relocated by UCD for several reasons including the fire department requirements, the potential disruptions in the UCD research and logistical/cost reasons. UCD did provide a shut-off valve for the water line (upstream) and identified the downstream use of both the gas and water lines.

In order to identify the exact location of these lines relative to the excavation areas, two hand-excavated cross trenches (in the east-west direction) were made, one north of drywell #1 (most northerly drywell) and one south of drywell # 3 (the most southerly drywell). Excavation was made by hand to avoid damage to the lines. The water line was an 8-inch transite pipe (80-90 psi) while the gas line was a 2-inch black iron pipe (5 psi).

TECHNICAL JUSTIFICATION:

Hand excavation was warranted to identify the location and alignment of both utility lines. No as-built drawings were available for the lines. Excavation with heavy equipment was deemed unsafe.

COST/SCHEDULE IMPACT:

Schedule impacts associated with this task include two additional days for line location, excavation and water shutoff valve installation. The estimated cost for this variance is $18,379.

FIELD WORK VARIANCE

PROJECT NO.: 128-4005	DATE: 6/21/1999	VARIANCE NO.: 6
PHASE NO: 553		(Domestic Tank # 2 Excavation)
TASK NAME: Ra/Sr Area I Waste Removal (WBS 2.5.5.3)		

PRESENT REQUIREMENTS:

The domestic septic tank # 2 (DT2) was to be removed as part of the RA. The tank dimensions and excavation were estimated based on previous investigation information.

PROPOSED CHANGE:

Upon excavation around DT2 it was determined that the tank was larger and more reinforced with steel than originally estimated. In addition, the soil to the north and east of the tank consisted of sand fill associated with sewer installation. Therefore trench shoring was required to protect the surrounding soil from cave-in and collapse.
DT2 demolition proceeded with slower pace due to heavy concentration of rebar. The tank was mostly filled with gravel, which also had to be removed and increased the estimated volume of material excavated as low-level waste (LLW).

TECHNICAL JUSTIFICATION:

See above.

COST/SCHEDULE IMPACT:

Schedule impacts associated with this task include five additional days for concrete/rebar demolition, additional soil handling, and shoring placement. The estimated cost for this variance is $71,582.

FIELD WORK VARIANCE

PROJECT NO.: 128-4005	DATE: 6/21/1999	VARIANCE NO.: 8
PHASE NO: 553		(Northern Leach Trench)
TASK NAME: Ra/Sr Area I Removal Action – (WBS 2.5.5.3)		

PRESENT REQUIREMENTS:

Task Plan 10.1 cost estimate for excavation of subsurface structures at Radium/Strontium (Ra/Sr) Area I, had no provisions for a leach trench north of Drywell #1 (the most northerly drywell).

PROPOSED CHANGE:

The changes proposed in this variance are due to the discovery of a leach trench north of drywell #1. The leach trench was discovered during excavation and removal of drywell #1. The dimensions of the leach trench appear to be approximately 3 feet wide and 3 to 4 feet thick. The length of the trench is unknown at this time. The top of the trench starts at 3.5 feet bgs. Fifteen hand-augered boreholes were completed to investigate the extent of the leach trench. Northern leach trench removal is scheduled to begin at the completion of the southern leach trench excavation.

TECHNICAL JUSTIFICATION:

See above.

COST/SCHEDULE IMPACT:

Schedule impacts associated with this task include approximately 10 additional days for investigation and removal of the northern leach trench. The estimated cost for this variance is $102,199.

FIELD WORK VARIANCE

PROJECT NO.: 128-4005	DATE: 6/21/1999	VARIANCE NO.: 12 (Add. Excavation along Southern Leach Trench)
PHASE NO: 553		
TASK NAME: Ra/Sr Area I Waste Removal (WBS 2.5.5.3)		

PRESENT REQUIREMENTS:

Task Plan 10.1 cost estimate assumed that the southern leach trench (SLT) would extend 70 linear feet (LF) south of Drywell #3 (the most southern drywell). This length was selected arbitrarily since no as-built drawings or other historical information was available regarding the exact length of the SLT.

PROPOSED CHANGE:

The removal action at the SLT continued approximately 140 feet south of Drywell #3 and therefore the scope of the work had increased by 70 LF. In addition, 5 utility lines (one gas, three water, and one storm drain) had to be crossed. Three of these lines were not shown in any drawings. A water line was accidentally broken during excavation activities.

TECHNICAL JUSTIFICATION:

See above.

COST/SCHEDULE IMPACT:

Schedule impacts associated with this task include approximately 10 days. The estimated cost for this variance is $128,851.

FIELD WORK VARIANCE

PROJECT NO.: 128-4005	DATE: 7/26/99	VARIANCE NO.: 15
PHASE NO: 553		Exploratory Trenching of Northern Leach Trench
TASK NAME: Ra/Sr Treatment System Removal		

PRESENT REQUIREMENTS:

None. The scope of this activity was not included in the original Task plan 10.1 cost estimate.

PROPOSED CHANGE:

The Northern Leach Trench (NLT) which was identified during the RA and extended north of Drywell #1 (see variance #8) appeared to terminate approximately 50 feet north of Drywell #1. The termination point of the NLT was not clearly defined in the field due to interference from utility lines. In addition, facility drawings indicate that the trench may be connected to another leach system in the north. Several utilities including sewer and water lines installed during a site-wide upgrade program in the 1970s cross the NLT. To confirm the termination point of the NLT and verify whether it is connected to a secondary leach system, several exploratory trenches were performed.

The exploratory trenching has uncovered two drywells thus far. It has also shown that these drywells and their leach system are not connected to the NLT.

TECHNICAL JUSTIFICATION:

See above.

COST/SCHEDULE IMPACT:

The cost associated with this variance is approximately $59,894. The schedule impact for this variance includes one additional week of work.

FIELD WORK VARIANCE

PROJECT NO.: 128-4005	DATE: 7/26/99	VARIANCE NO.: 16
PHASE NO: 553		Domestic Septic System No. 1/5 Removal and Investigation
TASK NAME: Removal Action		

PRESENT REQUIREMENTS:

None. The scope of this activity was not included in the original Task plan 10.1 cost estimate.

PROPOSED CHANGE:

The exploratory trenching performed under Variance No. 15 in the northern section of the Ra/Sr Treatment System Area leach trench identified a leachfield that is likely associated with the Domestic Septic System No. 1/5. This variance proposes removal of the leachfield structures including the concrete distribution box (DB) and 5 concrete drywell manways. In addition all piping between the DB and the drywells will be removed. At one drywell location, the excavation will continue to 20 ft bgs to determine the bottom of the drywell. Following excavation activities, 10 soil samples will be collected from beneath each structure and analyzed for the full suite of COCs.

Following sampling, the excavations will be backfilled and compacted to grade and the site restored.

TECHNICAL JUSTIFICATION:

It is recommended that these structures be removed at this time to allow for better investigation of the leachfield. In addition, if removal becomes necessary in the future, the concrete structures will have been removed and drilling of the drywells can be easily implemented.

COST/SCHEDULE IMPACT:

The cost associated with this variance is approximately $113,926. The schedule impact for this variance includes two additional weeks of work.

FIELD WORK VARIANCE

PROJECT NO.: 128-4005	DATE: 8/6/99	VARIANCE NO.: 17
PHASE NO: 555		Gas/Water Utility Reroute
TASK NAME: Site Restoration		

PRESENT REQUIREMENTS:

Task plan 10.1 cost estimate assumed that if necessary, UCD would reroute the gas/water lines prior to start of the RA.

PROPOSED CHANGE:

Due to critical University research operations, the gas and water lines were not rerouted prior to start of the RA. However, when the lateral extent of contamination around each drywell was identified it was apparent that the utilities would interfere with the excavation of contaminated soil/cobble-filled drywells. It is therefore recommended that WA reroute the utilities in a permanent fashion prior to removal of the drywells.

TECHNICAL JUSTIFICATION:

The utility lines (water and gas) are currently located on top of the contaminated soil that requires excavation. It is recommended that the utilities be moved to the west in order to expedite removal of the drywells using large-diameter auger drilling equipment.

COST/SCHEDULE IMPACT:

The cost associated with this variance is approximately $46,461. The schedule impact for this variance includes two additional weeks of work.

FIELD WORK VARIANCE

PROJECT NO.: 128-4005	DATE: 9/6/99	VARIANCE NO.: 18
PHASE NO: 553		Drywell Removal
TASK NAME: Site Restoration		

PRESENT REQUIREMENTS:

Task plan 10.1 cost estimate assumed that the drywell removal would take place using 6-ft diameter augers and that B-25 boxes would be used for material loading and packaging.

PROPOSED CHANGE:

Following delineation of the drywells, it is apparent that the drywell removal will require up to 10-ft diameter augers. In addition, direct loading of B-25 boxes is not practical or feasible using the drilling rig. Therefore, a staging area will be prepared and 1-CY Supersacks will be loaded rather than B-25 boxes. In addition, drilling time will be expanded since the volume of material requiring excavation and handling has increased significantly.

TECHNICAL JUSTIFICATION:

See above.

COST/SCHEDULE IMPACT:

The cost associated with this variance is approximately $153,100. The schedule impact for this variance includes two additional weeks of work.

FIELD WORK VARIANCE

PROJECT NO.: 128-4005	DATE: 10/6/99	VARIANCE NO.: 19
PHASE NO: 555		Sewer Replacement
TASK NAME: Site Restoration		

PRESENT REQUIREMENTS:

Task plan 10.1 cost estimate assumed that the sewer line would not be damaged during the RA.

PROPOSED CHANGE:

The sewer line, which was removed as part of the RA, has to be replaced. Approximately 170 linear feet of the sewer line was located along the distribution box, drywell #1, and the northern leach trench. It was therefore removed during excavation activities. The proposed plan is to replace the line in-kind to the satisfaction of the University personnel.

TECHNICAL JUSTIFICATION:

See above.

COST/SCHEDULE IMPACT:

The cost associated with this variance is approximately $110,319. The schedule impact for this variance includes two additional weeks of work.

RADIUM/STRONTIUM TREATMENT SYSTEMS AREA II REMOVAL ACTION WORK SCOPE VARIANCES

FIELD WORK VARIANCE/MODIFICATION

Project No.: 128-4006	Date: 6/14/00	Variance No.: 4
Phase No: 225		☐ Task assignment revision required
Task Name: Sample Steam Conduit Insulation		Requested by: DDL

PRESENT REQUIREMENTS:

The steam conduit was not identified in the *Draft Final Work Plan for Removal Actions in the Southwest Trenches, Ra/Sr Treatment Systems, and Domestic Septic System Areas*, Revision F, Section 3.3, Site Setup, and was therefore not included in the budget for Task Plan 11.1, Revision 0.

PROPOSED CHANGE:

Subcontract a commercial service to collect samples from the steam conduit insulation for asbestos analysis. Provide an escort and health and safety oversight during sampling. Review the data report.

TECHNICAL JUSTIFICATION:

Sampling will be done to determine if the steam conduit insulation contains asbestos.

COST/SCHEDULE IMPACT: (not necessary for modifications)

Cost: Approximately $1,200

Schedule: Less than 5 days (no impact to critical path)

FIELD WORK VARIANCE/MODIFICATION

Project No.: 128-4006	Date: 7/21/00	Variance No.: 5
Phase No: 410		☐ Task assignment revision required
Task Name: Sample Tank A		Requested by: DDL

PRESENT REQUIREMENTS:

The Strontium Treatment System Tank A sampling was not identified in the *Draft Final Work Plan for Removal Actions in the Southwest Trenches, Ra/Sr Treatment Systems, and Domestic Septic System Areas*, Revision F or included in the budget for Task Plan 11.1, Revision 0. However, this tank was previously sampled according to the *Final Visual Inspection and Sampling Plan for the Underground Radium and Strontium Treatment System Tanks*. During the review of the characterization data, it was determined that there were data gaps for Toxicity Characteristic Leaching Procedure and Soluble Threshold Limit Concentration for semi-volatile organic compounds and metals.

PROPOSED CHANGE:

Collect additional sludge and wood samples from Tank A to determine if the tank contents are mixed waste. Prepare the required pre-job documents (P3G, AHA, HWP, and SAP addendum), validate data, and review the data summary.

TECHNICAL JUSTIFICATION:

Determination of the waste category will dictate how the tank contents are handled, packaged, and managed.

COST/SCHEDULE IMPACT: (not necessary for modifications)

Cost: Approximately $25,000

Schedule: Eight days (no impact to critical path)

ATTACHMENT I

SAMPLING AND ANALYSIS PLAN

U.S. Department of Energy

Oakland Operations Office, Oakland, California

SAMPLING AND ANALYSIS PLAN FOR REMOVAL ACTIONS IN THE SOUTHWEST TRENCHES, RA/SR TREATMENT SYSTEMS, AND DOMESTIC SEPTIC SYSTEM AREAS

at the

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

Prepared for:

United States Department of Energy
Oakland Operations Office
1301 Clay Street
Oakland, California 94612-5208

Prepared by:

Weiss Associates
5801 Christie Avenue
Emeryville, California 94608-1827

July 24, 2000
Rev. 0

DOE Oakland Operations Contract DE-AC03-96SF20686

Weiss Associates
Environmental Science, Engineering and Management

SAMPLING AND ANALYSIS PLAN FOR REMOVAL ACTIONS IN THE SOUTHWEST TRENCHES, RA/SR TREATMENT SYSTEMS, AND DOMESTIC SEPTIC SYSTEM AREAS

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Approvals Page

SAMPLING AND ANALYSIS PLAN FOR REMOVAL ACTIONS IN THE SOUTHWEST TRENCHES, RA/SR TREATMENT SYSTEMS, AND DOMESTIC SEPTIC SYSTEM AREAS

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APPENDIX

Appendix A Removal Action Confirmation Sampling Design

ATTACHMENT

Attachment 1 Sampling and Analysis Plan Addenda

1. INTRODUCTION

This Sampling and Analysis Plan (SAP) is for the removal actions (RAs) in the Southwest Trenches Area, Radium-226/Strontium-90 (Ra/Sr) Treatment Systems Area, and Domestic Septic System Areas at the Laboratory for Energy-Related Health Research (LEHR) facility located at the University of California at Davis (UCD), California. Figure 1-1 presents the location of the RA areas within the LEHR facility.

This SAP supports the attached RA Work Plan (WP) and describes the sampling strategy and analytical program that will be utilized during the RA in each area. The sampling strategy includes the development of specific sampling objectives for each area followed by selection of an appropriate number of samples and sample locations required to satisfy those objectives. The analytical program developed for each RA specifies the analytical methods, detection limits, and quality control measures required to satisfy the sampling objectives. This SAP also describes the procedures and methodologies that will be utilized during the RA sampling and analysis activities. Attachment 1 presents the SAP addenda that were prepared and utilized for the removal actions.

General sampling objectives along with cleanup criteria are described below.

1.1 Sampling Objectives

Sampling objectives are developed with the goal of satisfying the removal action objectives (RAOs) presented in Section 1 of the Work Plan. Four general sampling objectives have been developed for the RAs:

1. Identify and delineate hot spots within the RA area;
2. Guide excavation activities in contaminant source removal;
3. Support the excavation confirmation/risk assessment evaluation; and,
4. Support the ground water protection designated level analysis.

Hot spots in sampling objective No. 1 are defined as any area (sample location) with elevated contaminant concentrations relative to adjacent areas (sample locations). The first three sampling objectives are designed to satisfy RAOs No. 1 and 2 (human health risk-based objectives). The fourth sampling objective is designed in response to RAO No. 3 (ground water protection objective). Waste sampling and characterization are described in Section 2.3 of the Waste Management Plan (Attachment II of the Work Plan).

1.2 Cleanup Criteria

Three cleanup criteria are utilized in conjunction with the sampling objectives to ensure attainment of the RAOs. These criteria include risk-based action standards (RBAS), background soil concentrations, and ground water-protective designated level soil concentrations. Sampling objectives No. 1, 2, and 3 utilize the RBAS and background concentrations as cleanup criteria. These values are presented in Section 1 of the WP. In general, the RBAS will be used as the cleanup criterion, unless the calculated RBAS value is less than the background concentration, at which point the background will become the cleanup criterion. Designated level soil concentrations are used to determine attainment of sampling objective No. 4. Designated level values are presented in Section 1 of the WP.

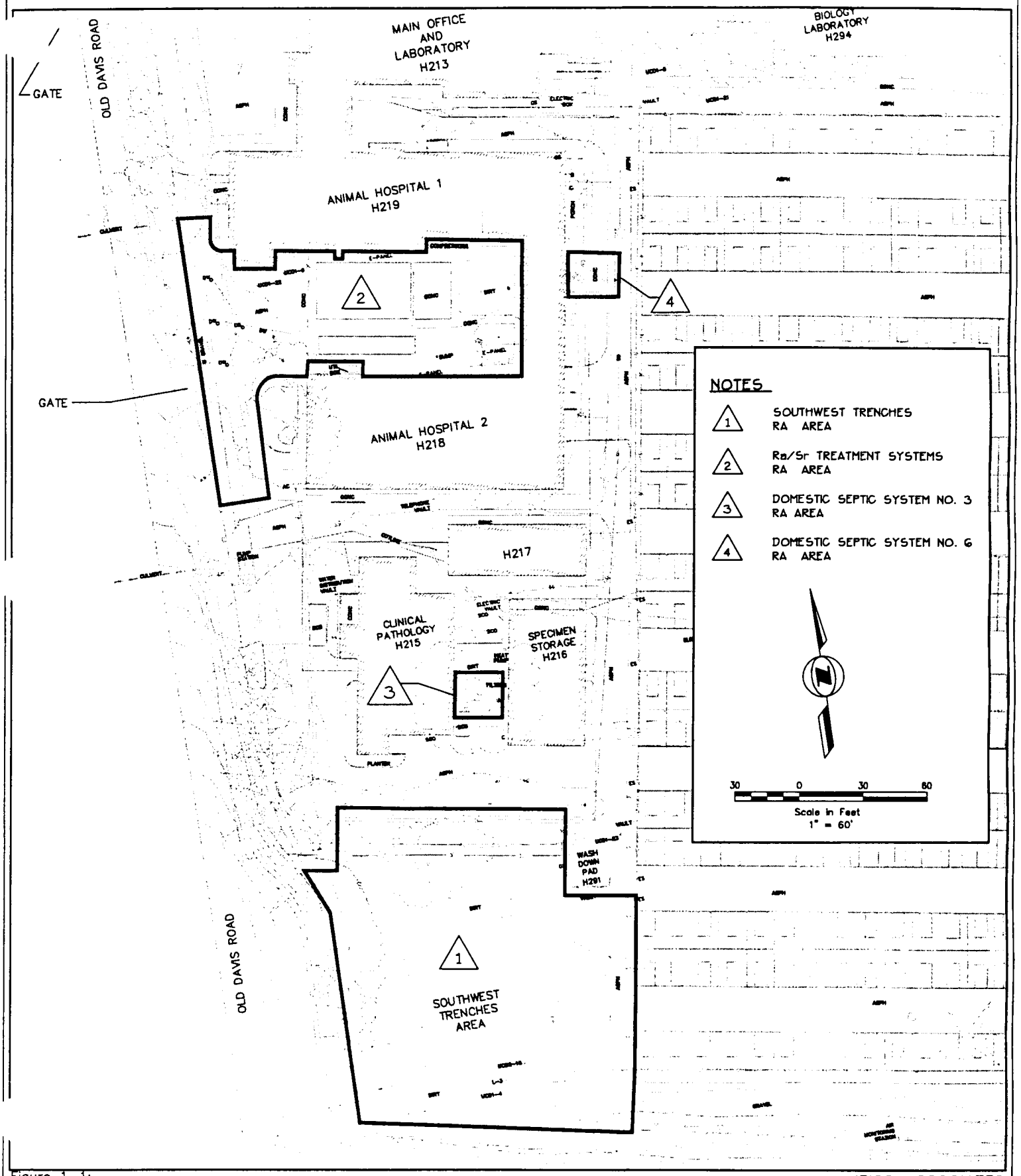

Figure 1-1:
Removal Action Areas;DOE Areas of LEHR, UC Davis, California

WEISS ASSOCIATES

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2. SAMPLING AND ANALYSIS STRATEGY

This section presents the sampling strategy and analytical methods planned for attainment of the RAOs in the Southwest Trenches Area, Radium/Strontium (Ra/Sr) Treatment Systems Area, and Domestic Septic System Areas. The sampling and analysis strategy is described in terms of sampling objectives, location, frequency and analytical methods.

2.1 Southwest Trenches Area

The constituents of concern (COCs) in the Southwest Trenches Area were released to the surface via the use of chlordane for flea control and to the subsurface through buried laboratory wastes. To achieve the RAOs in the Southwest Trenches Area (i.e. confirm adequate removal of wastes and soil impacted by COCs) sampling and analysis activities have been designed in conjunction with the sampling objectives described in Section 1.1. These sampling and analysis activities include:

- Delineation sampling and field analysis to define the extent of chlordane in soil (satisfies Sampling Objective 1);
- Confirmation sampling and off-site laboratory analysis to verify removal of chlordane-contaminated soil (satisfies Sampling Objective 2);
- Screening sampling and field/off-site laboratory analysis to guide the excavation activities (satisfies Sampling Objective 2);
- Confirmation/risk assessment sampling and off-site laboratory analysis to ensure that cleanup criteria have been attained within the limits of the excavation (satisfies Sampling Objective 3); and,
- Sampling and off-site laboratory analysis to determine whether designated levels have been attained (satisfies Sampling Objectives 4).

2.1.1 Constituents of Concern

A COC is defined as any constituent detected in soil above its corresponding background or RBAS concentration. Table 2-1 presents a list of COCs detected in the Southwest Trenches Area. Background and RBAS concentrations for these COCs are presented in the WP. There are several COCs that were detected consistently during previous investigations and/or are known to have been released at the site. These compounds are called “driver COCs”, and the Southwest Trenches Area driver COCs include chlordane, radium-226 (Ra-226), strontium-90 (Sr-90), hexavalent chromium, nitrate and mercury. Although chromium and mercury were not known to have been released, they

have been detected in the waste disposal cells at concentrations slightly above background. Driver COCs will be used to guide the excavation activities and it is believed that if the soil with the driver COCs are cleaned up, soil contaminated with other COCs will also be removed in the process.

Driver COCs will be analyzed on a quick turn-around-time using either field analytical instruments or by an off-site laboratory. In this way, real time data will be available to allow for rapid field decision making and reduce costs associated with equipment downtime. At the conclusion of excavation activities, confirmatory samples will be analyzed for all COCs using Contract Laboratory Program (CLP) methods. Table 2-2 presents the field and laboratory analytical methods planned for the RA in this area.

2.1.2 Surface Soil Delineation Sampling

Based on previous investigations, chlordane in soil in the southwest corner of the Southwest Trenches Area exceeds the chlordane RBAS. Soil sampling and analysis will be performed to delineate the vertical and horizontal extent of chlordane in the Southwest Trenches Area. A two-dimensional 10 ft by 10 ft grid system will be overlain on the Southwest Trenches Area. Samples will be collected at grid nodes, with sampling frequency and depth dependent on the location in the Southwest Trenches Area. Figure 2-1 presents the planned locations of these samples within the grid system. For the purposes of chlordane delineation, the site has been divided into two areas:

- *Area 1* – The southwest corner of the site, where the chemical dispensing and storage pad was located and chlordane has been detected in the past. Samples will be collected every 10 ft at three depth intervals. The samples will be collected from each location at 0.5, 1.5, and 3 ft bgs (Figure 2-1).
- *Area 2* – The area outside the southwest corner, where chlordane was not known to have been used. The sampling frequency in this area is every 30 ft at two depths. The samples will be collected from each location at a depth of 0.5 and 1.5 ft bgs (Figure 2-1).

Initially, these sample locations are planned to delineate chlordane in soil. Based on the analytical results of the first round of sampling, additional samples may be taken at other grid nodes to confirm that the vertical and horizontal extent of chlordane has been defined.

In response to comments from DTSC, the surface soil samples collected from Area 2 will also be analyzed for Cesium-137 (Cs-137), Ra-226, and Sr-90. These constituents will be analyzed using the field analytical instruments described in Section 2.1.4.

During the initial surface delineation of chlordane, shallow soil borings will be drilled using a hand auger and the soil samples will be collected using a disposable trowel. After sampling, each borehole will be backfilled with native soil and tamped to form a small mound.

Soil samples will be analyzed for chlordane using an immunoassay-based field method, the Millipore Envirogard™ test kit. This method has been approved by the United States Environmental Protection Agency (EPA) as a semi-quantitative analytical method 4041(SDI, 1997). Chlordane can

be detected below the proposed chlordane cleanup criterion of 780 ppb (see Table 1-1 in WP). The test kits are based on the use of polyclonal antibodies that bind either to chlordane or chlordane-enzyme conjugates. These antibodies are immobilized to the walls of the test tubes. When chlordane is present in the sample, it competes with the chlordane-enzyme conjugate for a limited number of antibody sites and preferentially binds to these sites. The tests are read by colorimetry and provide a semi-quantitative result.

Duplicate samples will be collected at a rate of 10% and analyzed using the field Method 4041. In addition, duplicate samples will be collected at a rate of 10% and sent to an off-site analytical laboratory for confirmation analysis of the field analytical method. Table 2-3 summarizes the chlordane delineation sampling program.

2.1.3 Chlordane Excavation Confirmation Sampling

After the areas with chlordane have been identified and excavated, field screening samples will be collected from each of the sidewalls and from the bottom of the excavation. These samples will be analyzed using the field analytical method to determine if the chlordane cleanup criterion has been achieved. If the results indicate that the chlordane cleanup criterion has not been attained additional excavation will be conducted. If the results indicate that the chlordane cleanup criterion has been attained, then confirmation samples will be collected as shown in Figure 2-2. The total number of confirmation samples cannot be determined until the excavation dimensions have been defined. Confirmation samples will be analyzed by an off-site analytical laboratory for organochlorine pesticides using CLP Method.

Soil samples from the excavation will be collected by hand augering and placing the soil from the auger into pre-sterilized glass sample jars using pre-sterilized disposable scoops. Sample handling, packaging, and shipping are described in SOP 2.1. Duplicate samples will be collected for quality control (QC) purposes. The number of duplicate samples will be 10% of the field screening samples and confirmation samples collected. These samples will be sent to an off-site analytical laboratory to be analyzed for organochlorine pesticides using CLP Methods.

2.1.4 Disposal Cell Excavation Field Screening Sampling

Waste disposal cells will be excavated in the Southwest Trenches Area to remove waste and associated contaminated soil. Waste disposal cell locations and the limits of the excavation are not well defined at present. Exploratory trenching will be performed as described in the WP to locate the waste disposal cells. Previous investigations performed at the site suggest that waste disposal cells are shaped as trenches and individual pits.

During waste disposal cell excavation, screening soil samples will be collected and analyzed for driver COCs including Ra-226, Sr-90, chlordane, hexavalent chromium, nitrate and mercury to guide the excavation activities. Table 2-3 presents the planned sampling and analysis program for this activity. The field screening samples will be collected approximately every 20 ft (based on the estimated length of waste disposal cells encountered during previous investigations) along the length

of the trench from the sidewall and bottom of the excavation. Figure 2-3 presents a schematic of planned screening sample locations within the excavation limits. Sidewall samples will be collected at two depths, which will be determined based on field observations, preferably at the top and bottom of the disposal cell and will penetrate the sidewall by approximately 6 inches. The samples from the bottom of the excavation will be collected approximately 12 inches below the excavation.

A combination of field and laboratory screening will be utilized to provide real-time data to assist in making decisions where to excavate and when to cease excavation in a given area. Field analytical methods consist of field gamma spectroscopy for measurement of activity to determine Ra-226 and a field beta scintillation detector for measurement of activity to determine Sr-90. Mercury, chromium and nitrate will be analyzed at an off-site laboratory. Chlordane will be analyzed for using the immuno-assay field analytical method.

A field gamma spectroscopy system that utilizes a high purity germanium (HPGe) detector will be used to screen soil for Ra-226. A field laboratory will be established which includes a HPGe detector housed in a lead shield, a multichannel analyzer, computer equipment and software and sample preparation equipment. Sample preparation for field analysis is relatively simple and consists of removing any debris such as roots and large diameter gravel (over 0.25 inches) from the required sample volume of 1 to 2 pounds. Freshly excavated soil samples are prepared and placed in the counting apparatus and the gamma rays emitted by the Ra-226 decay daughter, Bismuth-214 (Bi-214), are measured. Empirically derived equilibrium constants are used to estimate the Ra-226 activity from its Bi-214 daughter product. It is currently anticipated that the equipment can provide Minimum Detectable Activities (MDAs) of 1 pCi/g for Ra-226 with a 30-minute count time (BetaScint, 1998). Instrument calibration to determine MDA, count time, and approximate counting error will be completed prior to commencement of the RA. It should be noted that the gamma spectroscopy will also detect other gamma emitters that may be present in the soil sample. The results of all detected gamma emitters will be reported for each screening sample and the data will be used in conjunction with the cleanup criteria to evaluate attainment of RAOs.

A field beta scintillation detector (BSD) will be used to screen soil samples for the presence of Sr-90. BetaScint Inc. has successfully demonstrated this instrument on site-specific soil samples at LEHR. Sr-90 can be detected in soil to levels of 10 pCi/g (cleanup criterion) within minutes (Beta Scint, 1998). Sample preparation for this analysis is identical to the HPGe detector.

As shown in Figure 2-4, the screening and delineation sample results will be used to calculate the volume of additional soils as necessary. The cost for any additional excavation will also be determined. Based on screening results, volume and cost of additional excavation, a decision will be made on whether further excavation is required. Additional sampling will be performed according to the same sample screening procedure described above.

Soil samples from each trench will be collected by placing soil from the backhoe bucket or hand auger into pre-sterilized glass sample jars using pre-sterilized disposable scoops. Sample handling, packaging, and shipping are described in SOP 2.1. Duplicate samples will be collected for QC purposes. The number of duplicate analysis will be 10% of the field screening samples collected, and will be analyzed on-site for Ra-226, Sr-90 and chlordane. Also, 10% of the field screening

samples collected will be sent to an off-site analytical laboratory for analysis of chlordane. Ra-226 and Sr-90 field analyses will be confirmed at a rate of 10% using an off-site analytical laboratory.

2.1.5 Excavation Confirmation Soil Sampling

Once it is believed that the final excavation limits have been reached based on the field screening sample results, confirmation samples will be collected to verify that the cleanup criteria for all COCs have been attained. Table 2-3 summarizes the anticipated confirmation sampling and analysis plan. The confirmation sample frequency and location are discussed in Appendix A. All the confirmation samples will be analyzed for the full suite of COCs that consist of radionuclides, pesticides, metals, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and nitrate (NO_3). Table 2-2 presents the analytical methods that will be used to perform the analyses.

Confirmation soil samples will be collected by using pre-sterilized disposable scoops to place soil from the backhoe bucket or hand auger into pre-sterilized glass sample jars. Sample handling, packaging, and shipping are described in SOP 2.1. Duplicate samples will be collected for QC purposes. The number of duplicate samples will be 10% of the confirmation field samples collected, and will be sent to an off-site laboratory for analysis of the full suite of COCs.

Based on the heterogeneous nature of the waste in the disposal cells, it is possible that COCs other than driver COCs are present within the final excavation limits. A contingency has been developed to collect additional samples at locations where screening samples indicate a potential hot spot. The locations of these samples will be identified based on visual observations of the nature of the waste at or near the extent of excavation, or based on field instrument readings and will be established at the discretion of the construction engineer. These samples will be collected and sent to an off-site laboratory for analysis of the full suite of COCs.

2.1.6 Designated Level Sampling

Soil samples will be collected throughout the Southwest Trenches Area to attain designated level concentrations in the soil. Soil samples will be collected within the excavation where field observations, field screening results or other analytical results indicate an area of potentially higher concentration. Designated level sample collection will begin once the field screening sample results indicate that the final limits of excavation have been reached. Designated level soil samples will be collected 5 ft below the trench bottom.

The number of designated level soil samples cannot be determined until the initial fieldwork is completed and the extent of excavation areas determined. These samples will be collected using a slide hammer with necessary extensions to reach the required depths. Sample handling, packaging, and shipping are described in SOP 2.1.

The soil samples will be sent to an off-site analytical laboratory and analyzed for the modified suite of COCs. Modified suite of COCs include the full range of radionuclides, pesticides,

metals, VOCs, SVOCs, and nitrate (NO_3) in addition to total Kjeldahl nitrogen (TKN), ammonia and total organic carbon (TOC). Table 2-3 summarizes the anticipated designated level sampling program.

2.2 Ra/Sr Treatment Systems Area

The COCs in the Ra/Sr Treatment Systems Area were released to the subsurface through operation of the radium and strontium tanks, effluent distribution box, and associated drywells and leach trench. In addition, Domestic Septic System No. 2 which is located next to the effluent distribution box, received effluent from AH-2 during sewer backup associated with the Ra-226 system and is considered a potential source of contamination in the Ra/Sr Treatment System Area. To achieve the RAOs in the Ra/Sr Treatment Systems Area, i.e. confirm adequate removal of these structures and impacted soil, sampling and analysis activities have been designed in conjunction with the sampling objectives in Section 1.1. These sampling and analysis activities include:

- Delineation sampling and on-site laboratory analysis to define the extent of drywell contamination (satisfies Sampling Objective 1);
- Screening sampling and on-site analysis to guide excavation activities (satisfies Sampling Objective 2);
- Confirmation/risk assessment sampling and off-site laboratory analysis to ensure that cleanup criteria have been attained within the limits of the excavation (satisfies Sampling Objective 3); and,
- Sampling and off-site laboratory analysis to determine whether designated levels have been attained (satisfies Sampling Objective 4).

2.2.1 Constituents of Concern

The COCs in the Ra/Sr Treatment Systems Area are presented in Table 2-5. Driver COCs in this area are Ra-226, Sr-90 and nitrate, which will be used to guide the excavation activities. Field analytical instruments will be used in the same manner as in the Southwest Trenches Area to analyze for Ra-226 and Sr-90 and provide real-time decision making data. Nitrate will be analyzed on a 48-hour TAT (Turnaround Time) using an off-site laboratory. Table 2-2 summarizes the analytical methods and detection limits planned for use during this RA.

2.2.2 Drywell Delineation Sampling

Following utility relocation and removal activities of the upper drywell, the extent of contamination surrounding the three radium drywells will be defined. Each drywell has a diameter of 2.5 ft and is filled with gravel. The total depth of the drywells is unknown, however, it is not expected to exceed 40 ft bgs (the water table during the summer months). To delineate the lateral and vertical extent of contamination, soil samples will be collected from boreholes drilled in all four

compass directions from each drywell to the water table. This approach will determine the extent of contamination and the area of excavation around each drywell. Table 2-6 presents the sampling and analytical program for the drywell delineation sampling.

Delineation sample locations will be placed laterally in a spiral pattern around the drywells in one-foot contour intervals. Figure 2-6 presents a schematic of the planned delineation boring locations for a typical drywell. The first borehole location will be one foot from the north of the drywell. The second location will be 2 ft west of the drywell. The third borehole location will be 3 ft south of the drywell, and the fourth borehole location will be 4 ft east of the drywell.

Samples will be collected in spiral 1-foot depth intervals from 12 to 40 ft. depth, for a total of 29 samples for each drywell. Figure 2-7 presents a schematic of the planned sample depths and locations for delineation samples. If on-site results show that contamination is present beyond the 4 ft radius shown in Figure 2-7, the sample radius will be expanded until the extent of contamination is identified.

Samples will be collected using a direct-push drill rig. This technique produces high quality core, has good recovery and generates minimal cuttings. All samples will be analyzed for Ra-226 and Sr-90 using the on-site analytical laboratory. Duplicate samples to be sent off-site will be placed in a presterilized container for shipment. Samples analyzed on-site for Ra-226 and Sr-90 will require the material to be sifted and placed into a large baggie and Marinelli Beaker.

Sample handling, packaging, and shipping procedures are described in SOP 2.1. 10% duplicate samples will be collected for QC purposes. In addition, 10% of the field screening samples collected will be sent to an off-site laboratory for Ra-226 and Sr-90 analysis. IDW such as cuttings and decon water will be drummed and sampled for disposal.

2.2.3 Excavation Field Screening Sampling

The sequence of excavation activities in the Ra/Sr Treatment Systems Area is described in the WP. Structures that will be removed include the strontium leach field, radium tanks, strontium tanks, the distribution box and associated piping, and the drywells. As each structure is demolished and removed and the excavation area exposed, field screening samples will be collected and analyzed for Ra-226, Sr-90 and nitrate. The planned field screening sampling and analysis program for this activity is presented in Table 2-6.

A two-dimensional grid system will be overlain onto each excavation area. Excavation areas will vary for each structure; a 10-ft by 10-ft grid size is appropriate for most excavations (based on the estimated dimensions of the excavations). Field screening samples will be collected from the bottom and sidewalls of each excavation/trench at the grid node locations. Figure 2-8 presents the planned screening sample locations within the excavation areas. Visual observation and field monitoring instruments will also be used to select screening sample locations. Soil below pipe joints and visibly stained areas not located at a grid node will also be sampled. Screening sample analytical results will be compared against the screening criteria shown in Table 2-4. Screening criteria have

been selected based on the cleanup criterion of each driver COC and within the range of detection of the field instrumentation.

The decision process to determine the extent of excavation is presented in Figure 2-4. Once all structures and associated piping have been removed and the first round of screening samples collected and analyzed, the data will be reviewed and location of elevated concentrations (hot spots) identified. As shown in Figure 2-5, additional screening samples will be collected to further define the extent of contamination around hot spot samples. Specifically, in the lateral direction samples will be collected halfway between hot spot samples and samples with results below screening criteria. In the vertical direction, samples will be collected in depth intervals of 12 inches or less to five feet below the bottom of the trench. Screening samples will be analyzed for all driver COCs.

Sidewall samples will be collected 6 to 12 inches into the native soil. In locations where shoring is required to protect the excavation walls, sidewall samples will be collected prior to shoring installation. The samples from the bottom of the excavation will be collected approximately 12 inches below the excavation. Sample collection will be performed in the same manner that is described for the Southwest Trenches Area. Sample handling, packaging, and shipping are described in SOP 2.1. Duplicate samples will be collected for QC purposes. The number of duplicate analysis will be 10% of the field screening samples collected and will be analyzed on-site for Ra-226 and Sr-90. In addition, 10% of the field screening samples collected will be sent to an off-site laboratory for Ra-226 and Sr-90 analysis.

All screening samples will be analyzed for Ra-226 and Sr-90 using the HPGe and BSD instruments described in Section 2.1.4. The results of the screening analyses will be compared to the screening criteria presented in Table 2-4. As for the Southwest Trenches Area, the decision to perform additional excavation will be made according to the flowchart presented in Figure 2-4.

As shown in Figure 2-5, additional screening samples will be collected to further define the extent of contamination around hot spot samples. Screening samples will be analyzed for driver COCs and the results will be utilized to determine whether to continue excavation in a given area.

2.2.4 Confirmation Soil Sampling

Once it is believed that the final excavation limits have been reached based on the field screening sample results, confirmation samples will be collected to verify that the cleanup criteria for all COCs have been attained. The confirmation sample frequency and location will be determined using a random stratified sampling approach as described in Appendix A. Confirmation samples will be analyzed for the full suite of COCs described in Table 2-6.

Confirmation soil samples from the excavations will be collected by hand augering from an extendable boom or using the backhoe bucket to retrieve soil samples and placing the soil into pre-sterilized glass sample jars using pre-sterilized disposable scoops. Sample handling, packaging, and shipping are described in SOP 2.1. QC sampling will be performed as described in Section 2.1.5.

2.2.5 Designated Level Sampling

Soil samples will be collected from the excavations in the Ra/Sr Treatment Systems Area to attain designated level residual soil concentrations. Soil samples will be collected within the excavation where field observations, field screening results, or elevated concentrations are found. Designated level sample collection will begin once the field screening sample results indicate that the final limits of excavation have been reached. Designated level soil samples will be collected 5 ft below the bottom of the excavation.

The number of soil samples can not be determined until the initial fieldwork is completed and the final excavation dimensions defined. Sample collection will be performed as described in Section 2.2.4. Sample handling, packaging, and shipping are described in SOP 2.1.

The soil samples will be sent to an off-site analytical laboratory and analyzed for the modified suite of COCs as described in Table 2-6.

2.3 Domestic Septic System Areas

Previous investigations have been conducted in each of the seven Domestic Septic System Areas. As discussed in the EE/CA and in the WP, only three Domestic Septic Systems require further investigation and/or removal. Specifically, Domestic Septic System No. 2 will be removed as part of the Ra/Sr Treatment Systems Area RA due to its close proximity to the structures in that area. Domestic Septic System No. 3 will require additional soil sampling to determine whether no further RA is necessary in the area. Finally, limited soil removal and confirmation sampling will be performed at Domestic Septic System No. 6. The sampling and analysis plan for Domestic Septic System No. 2 was discussed in Section 2.2. The sampling and analysis plans for Domestic Septic Systems No. 3 and 6 are described below.

2.3.1 Domestic Septic System No. 3

Due to a Ra-226 detection of 1.5 pCi/g at 15 ft bgs in a previous sampling event, additional investigative sampling is warranted in the Domestic Septic System No. 3 Area. The objective of this sampling will be to determine whether localized Ra-226 contamination exists. Analytic results will be used to determine whether a RA is necessary for this area.

Five soil borings will be drilled in this area to a depth of 20 ft (5 feet below the radium detection) using a direct-push technique. Figure 2-10 presents the planned sampling locations in this area. Soil samples will be collected every 5 ft starting at ground level. Soil samples from Domestic Septic System No. 3 will be collected using pre-sterilized liners in the direct-push sampling equipment. Sample cores will be screened in the field for VOCs using a PID, and for radiologic activity using a GM counter and SCIN detector to guide sample selection. Sample handling, packaging, and shipping are described in SOP 2.1. Duplicate samples will be collected for QC purposes. The number of duplicate samples will be 10% of the field samples collected.

All samples (including QC samples) will be submitted to an off-site analytical laboratory and analyzed of the full suite of radionuclides and metals as presented in Table 2-7.

2.3.2 Domestic Septic System No. 6

Based on a mercury detection of 25 mg/kg at a depth of 5 ft bgs, limited excavation and confirmation sampling will be performed in the Domestic Septic System No. 6 Area. The locations of the previous mercury detection and planned excavation area are shown in Figure 2-9. A 5-foot wide area will be excavated around the mercury detection to a depth of 5 ft bgs before collecting screening samples from the excavation sidewalls and bottom. The locations of the sidewall samples (one sample per sidewall) will be collected based on field observations, about 6 inches into the native soil. The sample from the bottom of the excavation will be collected approximately 12 inches below the excavation. Table 2-7 presents the screening sampling and analysis plan for the Domestic Septic System No. 6.

An off-site laboratory will be utilized to provide quick TAT results to assist in making decisions regarding where to excavate and when to cease excavation. Screening samples will be analyzed for mercury. Screening results will be compared to the mercury screening criteria presented in Table 2-4. If all screening results are below the criterion, then excavation will cease and confirmation samples will be collected and sent to an off-site laboratory and analyzed for mercury using CLP methods.

2.3.2.1 Confirmation Soil Sampling

Confirmation soil samples will be collected from the sidewalls and the bottom of the excavation. One soil sample will be collected from each sidewall and bottom of the excavation. Sample collection will be the same as described in Section 2.3.1. These samples will be submitted to an off-site analytical laboratory to be analyzed for mercury using the CLP method. Duplicate samples will be collected for QC purposes. The number of duplicate samples will be 10% of the field samples collected and will be sent to an off-site laboratory for analysis of mercury.

Table 2-1. Constituents of Concern (COCs) in the Southwest Trenches Area

Analyte	Maximum Activity/ Concentration	Sample No.	Sample Matrix	Location of Maximum Detection	Depth (ft bgs)	Sample Date
Radionuclides (pCi/g)						
Cs-137	23.0	S-350	Soil	Grid 7-9	5	Jul-96
Sr-90	16,700	S-340	Sludge	T-2, T-6	6.5	Jul-96
Ra-226	7.06	S-338	Gravel	T-2	6.5	Jul-96
Gross alpha	16.7	S-357	Soil	T-6, Pit No. 2	14.5	Jul-96
Gross beta	34,700	S-340	Sludge	T-2, T-6	6.5	Jul-96
Tritium (pCi/l)	91.1	S-347	Gravel	T-5	1.5	Jul-96
Pb-214	4.3	S-342	Plastic Bag	T-2	3.5	Jul-96
U-235	2.6	S-362	Wood	T-6, Pit No. 1	12	Jul-96
Ac-228	5.5	S-342	Plastic Bag	T-2	3.5	Jul-96
C-14	117.0	S-339	Bone	T-2	6	Jul-96
Tl-208	0.6	S-340	Sludge	T-2, T-6	6.5	Jul-96
K-40	16.7	S-473	Soil	SB-7	21	Aug-96
Bi-214	1.68	S-356	Soil	T-6	1	Jul-96
Co-60	0.04	S-340	Sludge	T-2, T-6	6.5	Jul-96
Th-234	39.5	S-362	Wood	T-6, Pit No. 1	12	Jul-96
Metals (mg/kg)						
Arsenic	9.7	S-481	Soil	SB-8	30	Aug-96
Barium	270	S-336	Soil	T-2	3.5	Jul-96
Beryllium	4.80	---	Soil	SB-20	0.0	Mar-90
Chromium VI	1.2	---	Soil	SB-19	0.0	Mar-90
Total Chromium	250	S-349	Soil	T-5	4	Jul-96
Cobalt	35.00	---	Soil	SB-21	10.0	Mar-96
Copper	890	S-340	Sludge	T-2	6.5	Jul-96
Iron	46,000	S-352	Soil	Grid 7-9	3.5	Jul-96
Lead	49	S-340	Sludge	T-2	6.5	Jul-96
Manganese	1,000	S-357	Soil	T-6	14.4	Jul-96
Mercury	5.2	S-483	Soil	SW Corner of Site	3	Aug-96
Nickel	420	S-495	Soil	Washdown Pad	3-4.5	Aug-96
Selenium	1.5	S-340	Sludge	T-2	6.5	Jul-96
Vanadium	82	S-481	Soil	SB-8	30	Aug-96
Zinc	730	S-340	Sludge	T-2	6.5	Jul-96
VOCs (mg/kg)						
Benzene	0.001	S-359	Gravel	7-6, Pit No. 1	12	Jul-96
Carbon tetrachloride	0.044	S-352	Soil	Grid 7-9	3.5	Jul-96
Ethylene benzene	1.2	S-362	Wood	T-6, Pit No. 1	12	Jul-96
2-Hexanone	0.075	S-362	Wood	T-6, Pit No. 1	12	Jul-96
Methylene Chloride	0.03760	---	Soil	UCD1-15	N/A	Mar-96

Table 2-1. Constituents of Concern (COCs) in the Southwest Trenches Area (continued)

Analyte	Maximum Activity/ Concentration	Sample No.	Sample Matrix	Location of Maximum Detection	Depth (ft bgs)	Sample Date
Radionuclides (pCi/g)						
Toluene	0.49	S-362	Wood	T-6, Pit No. 1	12	Jul-96
Styrene	0.80	S-362	Wood	T-6, Pit No. 1	12	Jul-96
Xylenes	6.2	S-362	Wood	T-6, Pit No. 1	12	Jul-96
SVOCs (mg/kg)	30,947	S-362	Wood	T-6, Pit No. 1	12	Jul-96
Pesticides (mg/kg)						
Chlordane	2,000	---	Soil	T-06	N/A	1988
DDD	0.26	S-484	Soil	Shallow soil	3.5	Aug-96
DDE	0.014	S-378	Soil	T-3	2.5	Aug-96
DDT	0.0037	S-490	Soil	Shallow soil	4	Aug-96
Dieldrin	0.07	S-484	Soil	Shallow soil	3	Aug-96
Heptachlor	0.10	S-486	Soil	Shallow soil	3	Aug-96
Endosulfan I	0.011	S-485	Soil	Shallow soil	3	Aug-96
Endosulfan-SO[4]	0.011	S-485	Soil	Shallow soil	3	Aug-96
Heptachlorepoxide	0.0013	S-490	Soil	Shallow soil	4	Aug-96
Methoxychlor	0.0011	S-490	Soil	Shallow soil	4	Aug-96
PCB-1260	1.0	S-340	Sludge	T-2	6.5	Jul-96
Pyrene	0.033	S-333	Soil	T-1	6	Jul-96
Others (mg/kg)						
Chloride	470	S-331	Soil	T-1	2	Jul-96
Formaldehyde	530.0	---	Soil	SSL00001	0.4	Jun-95
Hexanol	660.00	---	Soil	SSL00003	0.5	Jun-95
Nitrate (as N)	390.0	S-357	Soil	T-6, Pit No. 2	14.4	Jul-96
Nonanol	340.0	---	Soil	SSL00002	0.4	Jun-95
Sulfate	5,700	S-340	Sludge	T-2, T-6	6.5	Jul-96

Notes:

Reference Final Engineering Evaluation/Cost Analysis Report (WA, 1998c) for sample locations.
N/A = Not Applicable (Background Level) or Not Available (location)
--- = Sample number unknown

Table 2-2. Field and Laboratory Analytical Methods Planned for LEHR Removal Actions

Parameter	Analytical Method	Required Detection Limit (pCi/g for radionuclides, mg/kg for chemicals)
Driver COCs	**Field**	
Radium-226	Gamma Spectroscopy/HPGe Screening	1
Strontium-90	Proprietary Beta Scint, Inc. Scintillation	10
Chlordane	Immuno-assay, EPA Method 4041	0.7
	Laboratory	
Mercury	Cold-Vapor Atomic Absorption	0.2
Chromium (+6)	EPA Method 7196	0.05
Nitrate	EPA Method 300.0	1
Full Suite of COCs	**Laboratory**	
Radionuclides:		
Americium-241	Lab SOP	0.01
Carbon-14	Lab SOP	0.1
Gamma Emitters	EPA Method 901.1	
Actinium-228	EPA Method 901.1	0.1
Bismuth-212	EPA Method 901.1	0.1
Bismuth-214	EPA Method 901.1	0.1
Cesium-137	EPA Method 901.1	0.01
Cobalt-60	EPA Method 901.1	0.005
Lead-210	EPA Method 901.1	0.5
Lead-212	EPA Method 901.1	0.1
Lead-214	EPA Method 901.1	0.1
Potassium-40	EPA Method 901.1	1
Radium-223	EPA Method 901.1	2
Radium-228	EPA Method 901.1	0.1
Radium-226	EPA Method 901.1	0.1
Thallium-208	EPA Method 901.1	0.05
Thorium-228	Lab SOP	0.1
Thorium-230	Lab SOP	0.05
Thorium-232	Lab SOP	0.05
Thorium-234	EPA Method 901.1	0.5
Gross Alpha	EPA Method 9310	1
Gross Beta	EPA Method 9310	1
Plutonium-241	Lab SOP	0.5
Strontium-90	EPA Method 905.0	0.05
Tritium	EPA Method 906.0	1
Uranium-233/234	Lab SOP	0.025
Uranium-235	Lab SOP	0.01
Uranium-238	Lab SOP	0.025
Metals/Other Inorganics:		
Antimony	CLP SOW ILM 02.1	0.5
Arsenic	CLP SOW ILM 02.1	2

Table 2-2. Field and Laboratory Analytical Methods Planned for LEHR Removal Actions (continued)

Parameter	Analytical Method	Required Detection Limit (pCi/g for radionuclides, mg/kg for chemicals)
Barium	CLP SOW ILM 02.1	40
Beryllium	CLP SOW ILM 02.1	1
Cadmium	CLP SOW ILM 02.1	0.25
Chromium (total)	CLP SOW ILM 02.1	1
Chromium (+6)	EPA Method 3060A/7196	0.05
Cobalt	CLP SOW ILM 02.1	10
Copper	CLP SOW ILM 02.1	0.25
Iron	CLP SOW ILM 02.1	20
Lead	CLP SOW ILM 02.1	0.3
Manganese	CLP SOW ILM 02.1	3
Mercury	CLP SOW ILM 02.1	0.1
Molybdenum	CLP SOW ILM 02.1	0.1
Nickel	CLP SOW ILM 02.1	1
Selenium	CLP SOW ILM 02.1	1
Silver	CLP SOW ILM 02.1	0.1
Thallium	CLP SOW ILM 02.1	0.5
Vandium	CLP SOW ILM 02.1	1
Zinc	CLP SOW ILM 02.1	4
General Chemistry		
Nitrate	EPA Method 300.0	1
TOC	EPA Method 415.1	100
Ammonia	EPA Method 350.1	1
Total Kjeldahl Nitrogen	EPA Method 351.2	2
Organics:		
Volatile Organic Compounds	CLP SOW OLM 03.0	Exhibit C of SOW OLM 03.0
Semi-Volatile Organic Compounds	CLP SOW OLM 03.0	Exhibit C of SOW OLM 03.0
Organochlorine Pesticides (and PCBs)	CLP SOW OLM 03.0	Exhibit C of SOW OLM 03.0

Abbreviations:

CLP SOW = Contract Laboratory Program Statement of Work
OLM 03.0 = Organic Laboratory Method 03.0.
ILM 02.1 = Inorganic Laboratory Method 02.1.

Table 2-3. Summary of Sampling and Analysis Plan in the Southwest Trenches Area Removal Action

Sampling Activity	Sampling Strategy	Sampling Frequency	Sampling Method	Method of Analysis (1)	Analytical Parameters
Chlordane Delineation and Excavation					
Surface soil delineation sampling	Hot spot grid sampling	Area 1: 19 locations, samples collected at 0.5, 1.5 and 3 ft bgs Area 2: 20 locations, samples at 0.5 and 1.5 ft bgs	Hand auger	Field	Chlordane, Cs-137, Ra-226, and Sr-90
Chlordane excavation screening sampling	Systematic sampling	Samples from sidewalls and floor of excavation	Hand auger/ trowel	Field	Chlordane
Chlordane excavation confirmation sampling	Systematic sampling	Samples from sidewalls and floor of excavation	Hand auger/ trowel	Lab	Pesticides only
Duplicate samples (Field QC)	NA	10% of all field samples analyzed in field	Hand auger/ trowel	Field	Chlordane
Duplicate samples (Laboratory QC)	NA	10% of field/ lab samples analyzed at lab	Hand auger/ trowel	Lab	Pesticides only
Disposal Cell Excavation					
Disposal cell excavation screening sampling	Systematic sampling	Samples every 20 feet from sidewalls and floor as necessary (5 locations/20 linear feet).	Backhoe bucket	Field/Lab	Driver COCs
Screening hot spot sampling (as necessary)	Systematic sampling	Hot spot sampling as shown in Figure 2-5.	Backhoe bucket/hand auger	Field/Lab	Driver COCs
Additional confirmation sampling	Hot spot sampling	Any screening hot spots will be evaluated and sampled.	Backhoe bucket	Lab	Full Suite of COCs
Excavation confirmation/risk assessment sampling	Stratified random sampling	Random sampling within the excavation from sidewalls and floor.	Backhoe bucket/ hand auger	Lab	Full Suite of COCs

Table 2-3. Summary of Sampling and Analysis Plan in the Southwest Trenches Area Removal Action (continued)

Sampling Activity	Sampling Strategy	Sampling Frequency	Sampling Method	Method of Analysis (1)	Analytical Parameters
Designated level sampling	Hot spot sampling	Samples from 5 feet beneath the trench bottom based on visual observations.	Slide hammer	Lab	Modified Full Suite of COCs
Duplicate samples (Field QC)	NA	10% of all field samples analyzed in field	Backhoe bucket	Field	Ra-226, Sr-90, chlordane
Duplicate samples (Laboratory QC)	NA	10% of field/lab samples analyzed at lab	Backhoe bucket	Lab	Full Suite of COCs

Notes:

NA = not applicable; Full Suite of COCs = Radionuclides, metals, VOCs, SVOCs, pesticides, and nitrate; Driver COCs = Ra-226, Sr-90, chlordane, hexavalent chromium, mercury, nitrate; Modified Full Suite of COCs = same as Full suite of COCs plus organic nitrogen, TOC, ammonia analysis
COCs = Constituents of Concern
(1) = See Table 2-2

Table 2-4. Screening Criteria for Driver Constituents of Concern

Driver COC [1]	Screening Criteria [2]	Background Concentration	RBAS [3] (10^{-6} Risk or HQ=1)	Designated Levels by Depth [4]
Ra-226	1 pCi/g	0.75 pCi/g	0.0042 pCi/g (<Background)	a = 23; b = 11; c = 3.8; d = 4.1
Sr-90	10 pCi/g	0.056 pCi/g	10 pCi/g	a = 32,891; b = 2,235; c = 85; d = 23
Hg	0.63 mg/kg	3.94/0.248/kg	0.22 mg/kg	None
Chlordane	0.8 mg/kg	None	0.78 mg/kg	a = 1.2; b = 1.2; c = 0.73; d = 1.2
Chromium (+6)	3.8	0.054	3.8	a = 4.0; b = 3.9; c = 2.5; d = 4.4
Nitrate	36	36	None	a = 20; b = 23; c = 17; d = 31

Notes:

(1) Driver COCs are COCs detected consistently during previous investigations and/or are known to have been released at the site (Section 2.1.1)
For the Southwest Trenches Area, Driver COCs are Ra-226, Sr-90, mercury, chlordane, chromium (+6) and nitrate.
For the Ra/Sr Treatment Systems Area, Driver COCs are Ra-226, Sr-90 and nitrate.
For the Domestic Septic System No- 3, the Driver COC is Ra-226.
For the Domestic Septic System No. 6, the only COC is mercury.

(2) Screening criteria are determined based on cleanup criteria and field analytical instrument detection limits.

(3) Risk-based Action Standard (RBAS) value is the lowest of all three risk scenarios for either excess cancer risk of 10-6 or hazard quotient (HQ) of 1.

(4) Designated levels presented are derived assuming infiltration rate = 21.5 cm/yr, unchanged lithology, and protective of MCLs. See Appendix D of Work Plan for detail assumptions.
Depth intervals are as follows: "a" = 0 – 6 ft bgs;
"b" = 6 – 11 ft bgs;
"c" = 11 – 18 ft bgs; and,
"d" = 18 – 21 ft bgs.

Table 2-5. Constituents of Concern (COCs) in the Ra/Sr Treatment Systems Area

Analyte	Maximum Activity/ Concentration	Location of Maximum Detection	Depth (ft bgs)	Sample Date
Radionuclides (pCi/g):				
Actinium-228	0.93	SB-4	25-27	Aug-96
Bismuth-214	6.52	SB-1	18-20	Aug-96
Cesium-137	6.2	SB-13	N/A	Oct-87
Carbon-14	16	SB-5	6.5-8	Aug-96
Gross alpha	185	Distribution Box	9.5	Aug-96
Gross beta	156	Distribution Box	9.5	Aug-96
Lead-212	0.94	SB-5	19-20	Aug-96
Lead-214	7.73	SB-1	18-20	Aug-96
Potassium-40	17.24	SB-28	10.0	Mar-90
Radium-226	106.2	Distribution Box	9.5	Aug-96
Strontium-90	37.6	SB-2	15-17	Aug-96
Thallium-208	0.25	SB-5	19-20	Aug-96
Thorium-228	2.1	Beneath Ra Tank B	N/A	Mar-92
Thorium-232	1.66	Beneath Ra Tank B	N/A	Mar-92
Thorium-234	1.41	SB-5	19.20	Aug-96
Tritium (pCi/l)	230	Distribution Box	9.5	Aug-96
Uranium-235	0.15	SB-2	15-17	Aug-96
Metals (mg/kg):				
Beryllium	2.40	SB-26	10.0	Mar-90
Chromium VI	7.00	SB-24	1.0	Mar-90
Cobalt	38.4	SB-28	6.5	Mar-90
Copper	160	SB-5	23-25	Aug-96
Lead	19.3	UCD1-22	5.0	Oct-90
Manganese	870	SB-4	29-31	Aug-96
Vanadium	75	SB-5	13-15/28.5-30	Aug-96
Zinc	165	SB-25	5	Mar-90
VOCs (mg/kg):				
Methylene chloride	0.044	SB-28	10	Mar-90
SVOCs (mg/kg)	243	SB-3	7-10	Aug-96
Pesticides (mg/kg)	0.0021	SB-5	23-25	Aug-96
Others (mg/kg):				
Nitrate (as N)	736.00	SB-28	15.0	Mar-90

Notes:

Reference Final Engineering Evaluation/Cost Analysis Report (WA, 1998c) for sample locations.
N/A = Not Applicable (Background Level) or Not Available (location)
--- = sample number unknown

Table 2-6. Summary of Sampling and Analysis Plan in the Ra/Sr Treatment Systems Area Removal Action

Sampling Activity	Sampling Strategy	Assumptions	Sampling Method	Method of Analysis[1]	Analytical Parameters
DryWell Delineation and Excavation					
Drywell delineation sampling	Systematic sampling	Sampling around three drywells, 4 borehole locations/ drywell, 5-foot sample interval, to water-table	Direct-push technique	Field	Ra-226, Sr-90, Nitrate
Duplicate samples (Laboratory QC)	NA	10% of field samples analyzed at contract lab	Direct-push technique	Lab	Ra-226, Sr-90, Nitrate
Radium/Strontium Area Excavation					
Screening sampling	Systematic sampling	Samples from excavation sidewalls and floor in a 10-ft x 10-ft grid system.	Backhoe bucket/ Hand Auger	Field	Driver COCs
Screening hotspot sampling (as necessary)	Systematic sampling	Hot spot sampling as shown in Figure 2-5.	Backhoe bucket/ Hand Auger	Field	Driver COCs
Confirmation hot spot sampling	Hot spot sampling	Any screening hot spots will be evaluated and sampled.	Backhoe bucket	Lab	Full Suite of COCs
Excavation confirmation/ risk assessment sampling	Stratified random sampling	Random sampling within the excavation from sidewalls and floor.	Backhoe bucket/ Hand Auger	Lab	Full Suite of COCs
Designated level sampling	Systematic sampling	Samples from 5 feet beneath the trench bottom.	Backhoe bucket/ Hand Auger	Lab	Modified Full Suite of COCs
Duplicate samples (Field QC)	NA	10% of all field samples analyzed in field	Backhoe bucket	Field	Ra-226, Sr-90
Duplicate samples (Laboratory QC)	NA	10% of field and lab samples analyzed at lab	Backhoe bucket	Lab	Full Suite of COCs

Notes:

NA = not applicable; Full Suite of COCs = Radionuclides, metals, VOCs, SVOCs, pesticides, and nitrate; Driver COCs = Ra-226, Sr-90 and nitrate.
Modified Full Suite of COCs = same as Full suite of COCs plus organic nitrogen, TOC, ammonia analysis
COCs = Constituents of Concern
[1] = See Table 2-2

Table 2-7. Summary of Sampling and Analysis Plan in the Domestic Septic System No. 3 and No. 6 Areas

Sampling Activity	Sampling Strategy	Assumptions	Sampling Method	Method of Analysis[1]	Analytical Parameters
Domestic Septic System No. 3					
Confirmation Sampling	Systematic Sampling	Five boreholes to 20 ft bgs, sample at 5-foot intervals	Direct-push technique	Lab	Radionuclides, metals
Duplicate samples (Laboratory QC)	NA	10% of samples analyzed at lab	Direct-push technique	Lab	Radionuclides, metals
Domestic Septic System No. 6					
Excavation screening sampling	Systematic sampling	Sample all excavation sidewalls and bottom, one sample per face	Hand auger/trowel	Lab	Mercury
Excavation confirmation sampling	Systematic sampling	Sample all excavation sidewalls and bottom, one sample per face	Hand auger/trowel	Lab	Mercury
Duplicate samples (Laboratory QC)	NA	10% of samples analyzed at lab	Hand auger/trowel	Lab	Mercury

Notes:
NA = not applicable
QC = Quality control
[1] = See Table 2-2

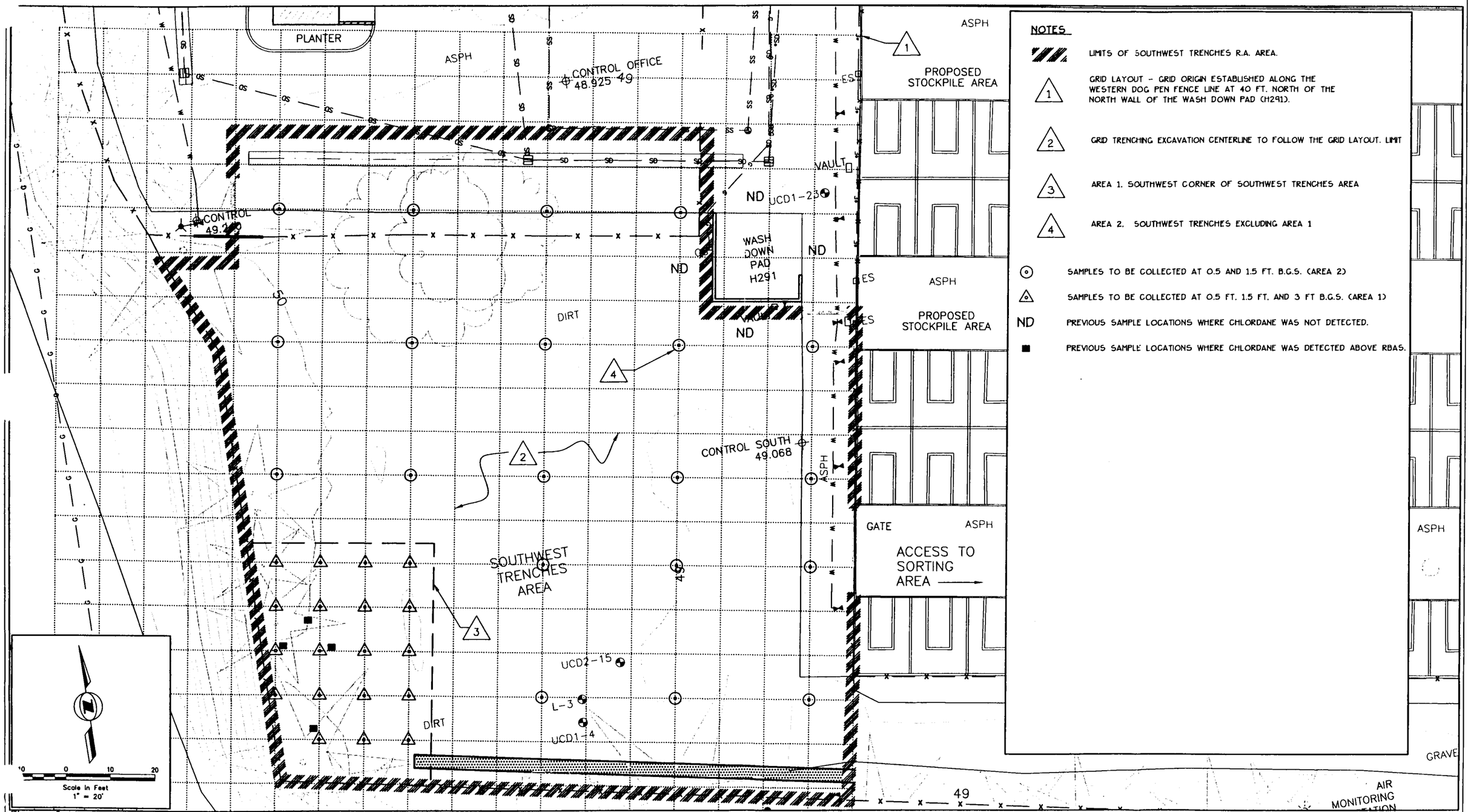

Figure 2-1:
Planned Chlordane Delineation Grid Sampling in the Southwest Trenches Area

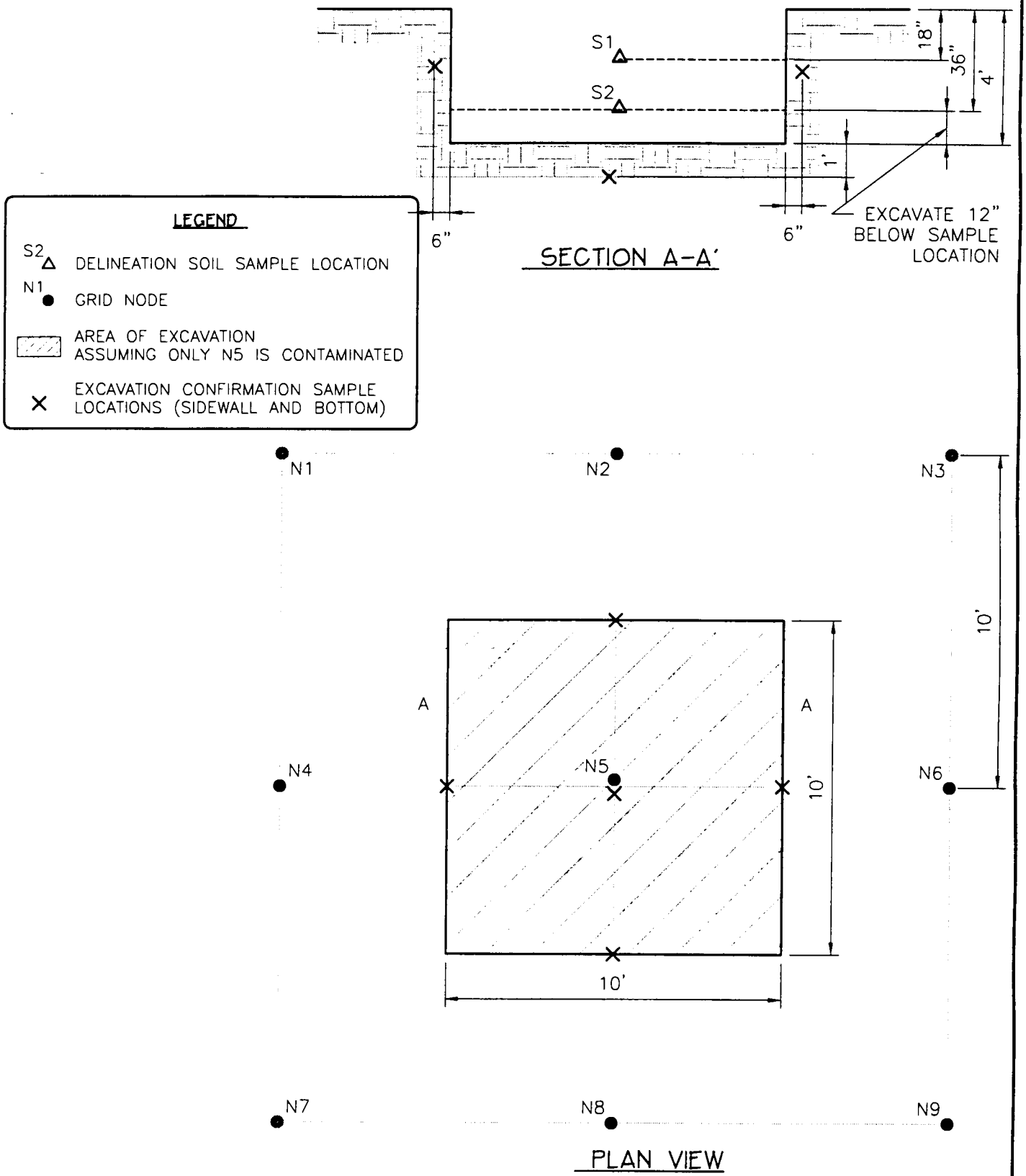

Figure 2-2:
Chlordane Excavation Limits and Planned Confirmation Sample Locations in the Southwest Trenches Area

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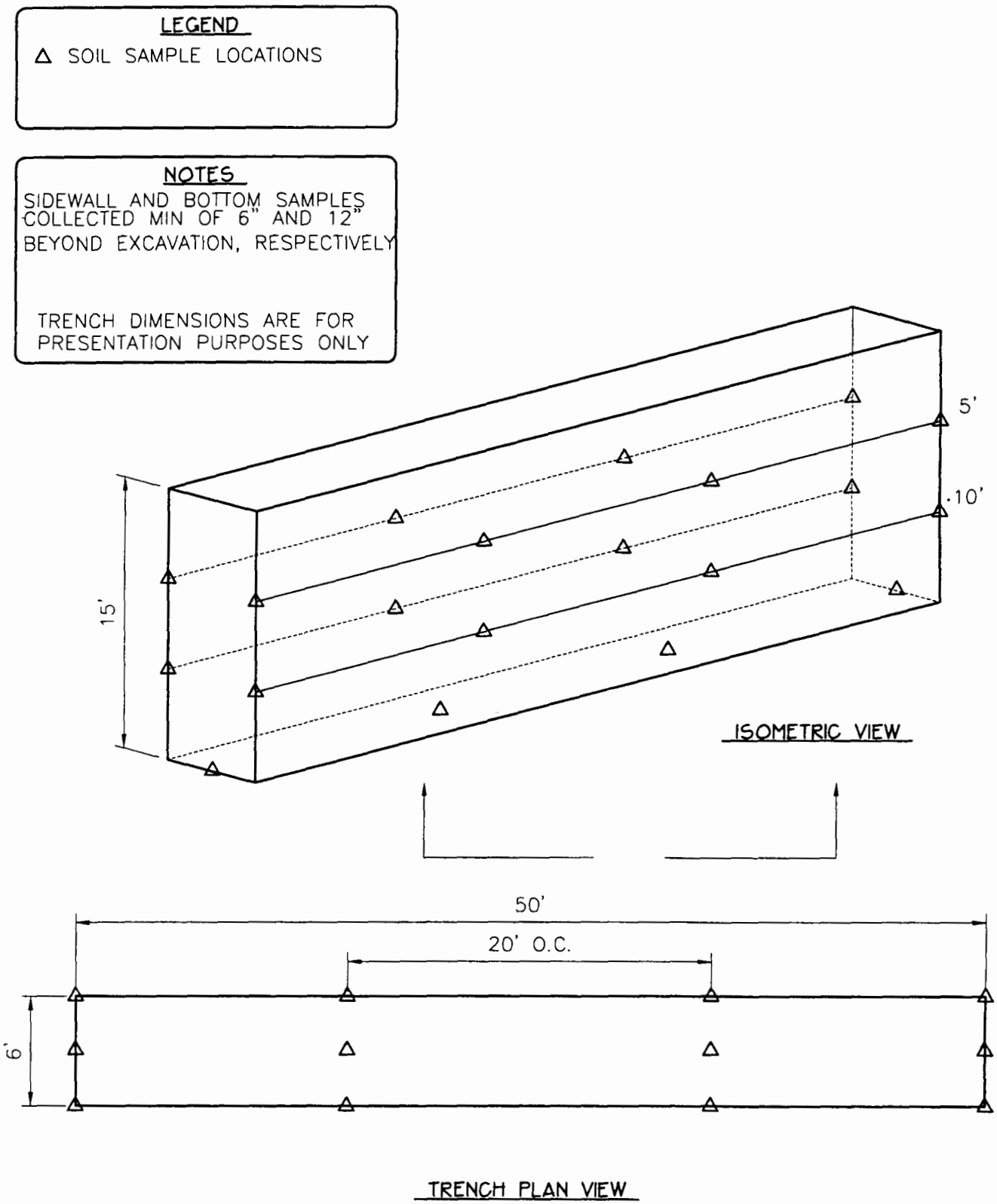

Figure 2-3:
Planned Trench Screening Sample Locations in the Southwest Trenches Area

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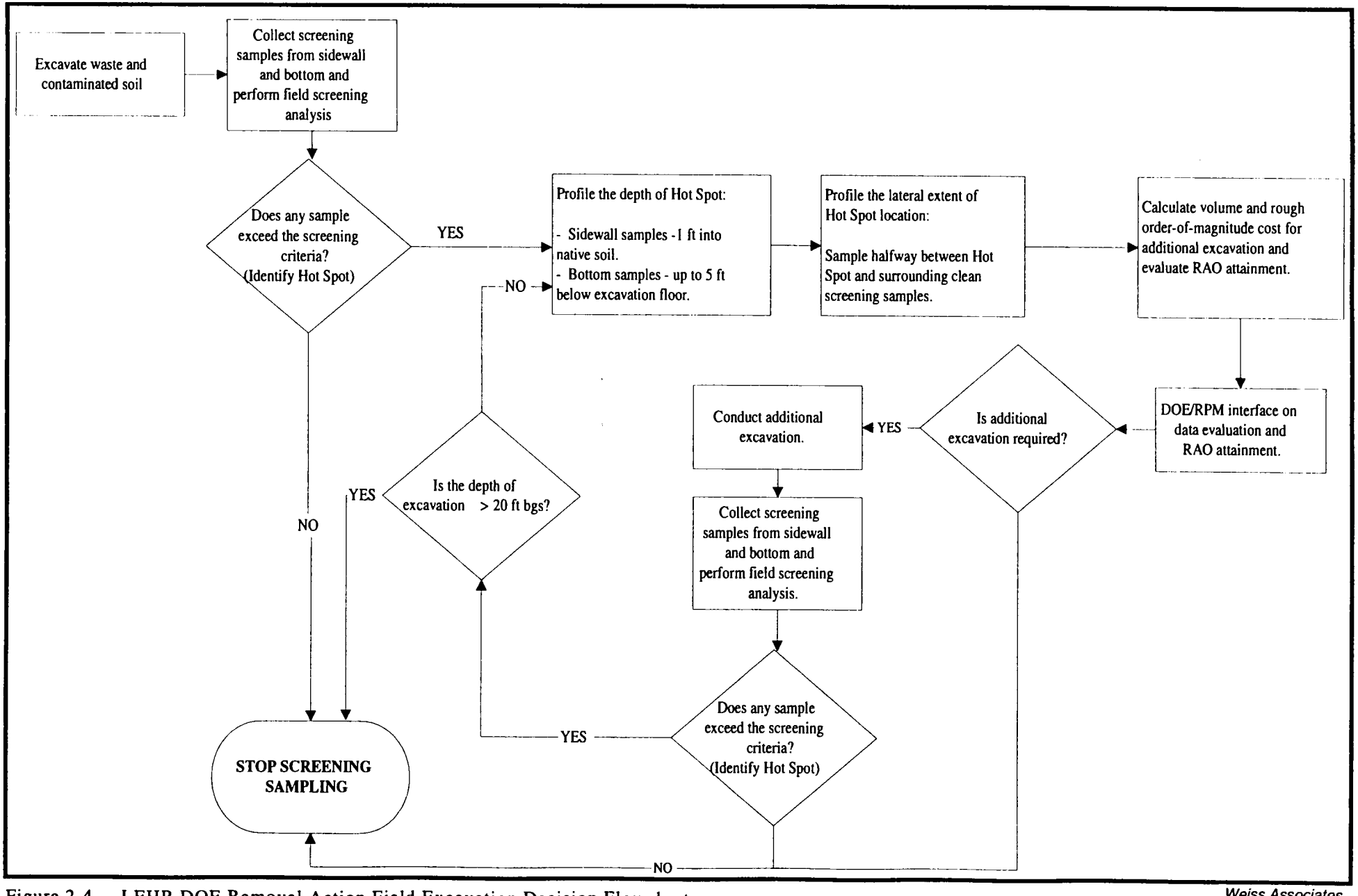

Figure 2-4. LEHR DOE Removal Action Field Excavation Decision Flowchart

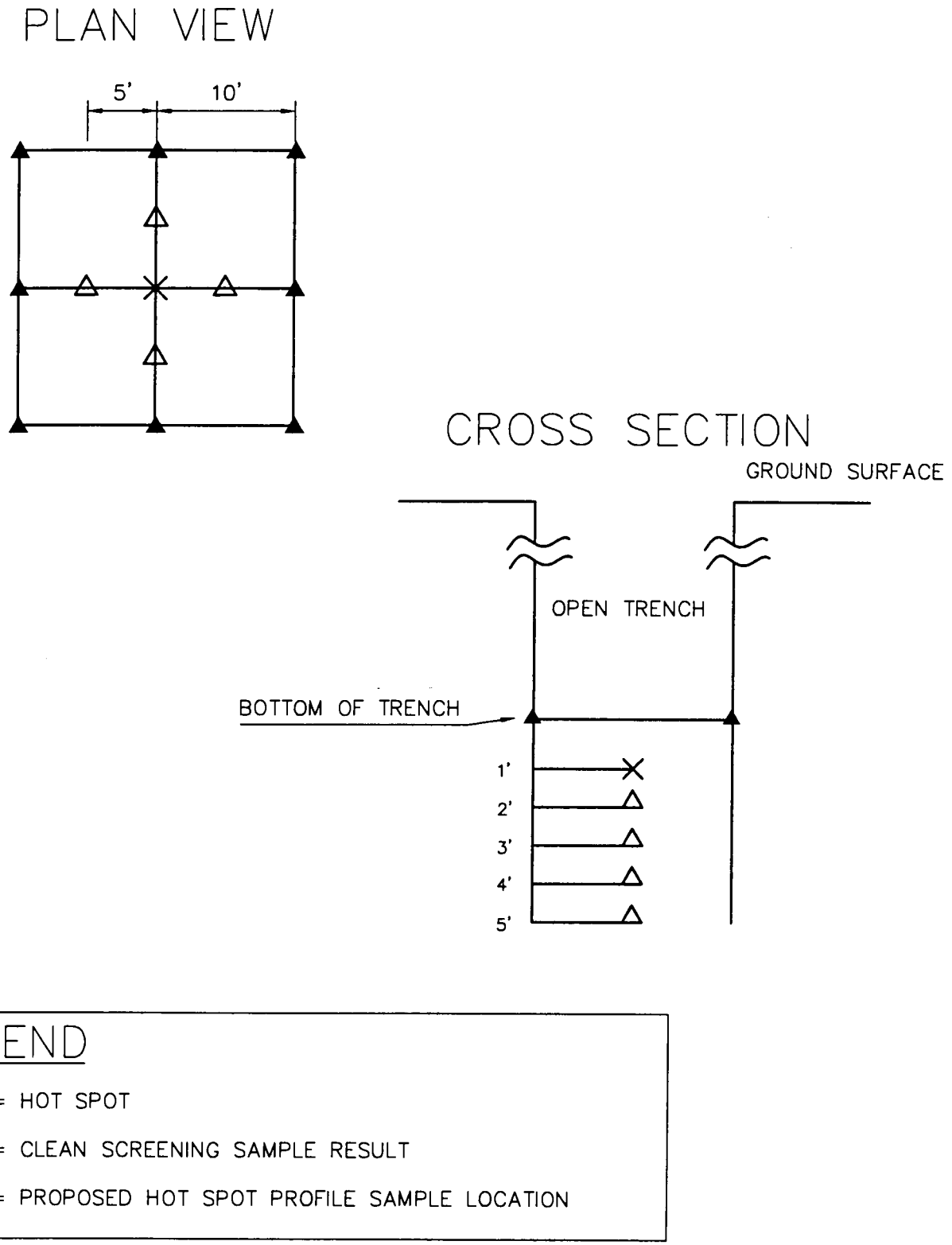

Figure 2-5:
Planned Screening Hot Spot Sample Locations

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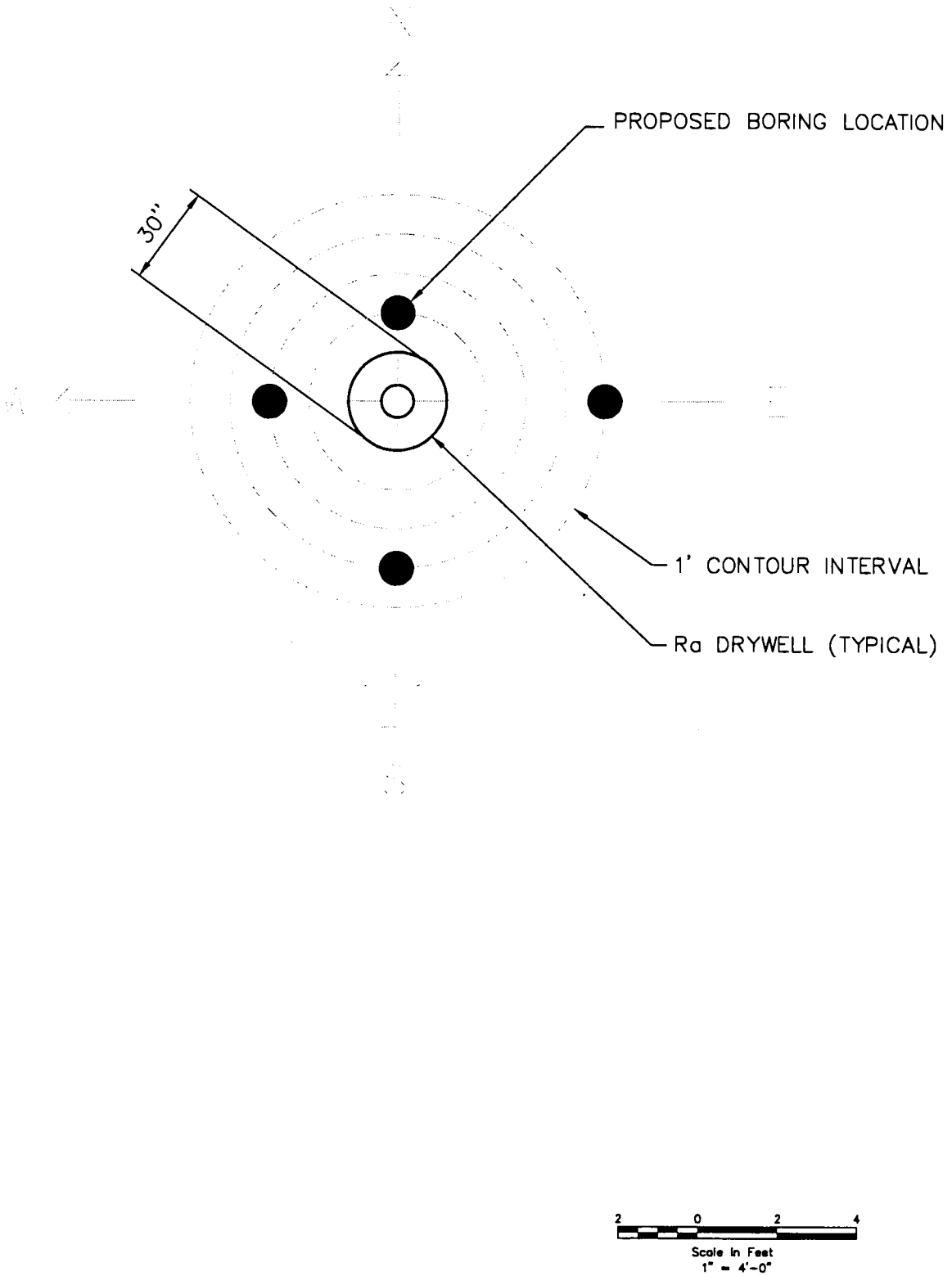

Figure 2-6:
Planned Drywell Delineation Surface Sample Locations in the Ra/Sr Treatment Systems Area

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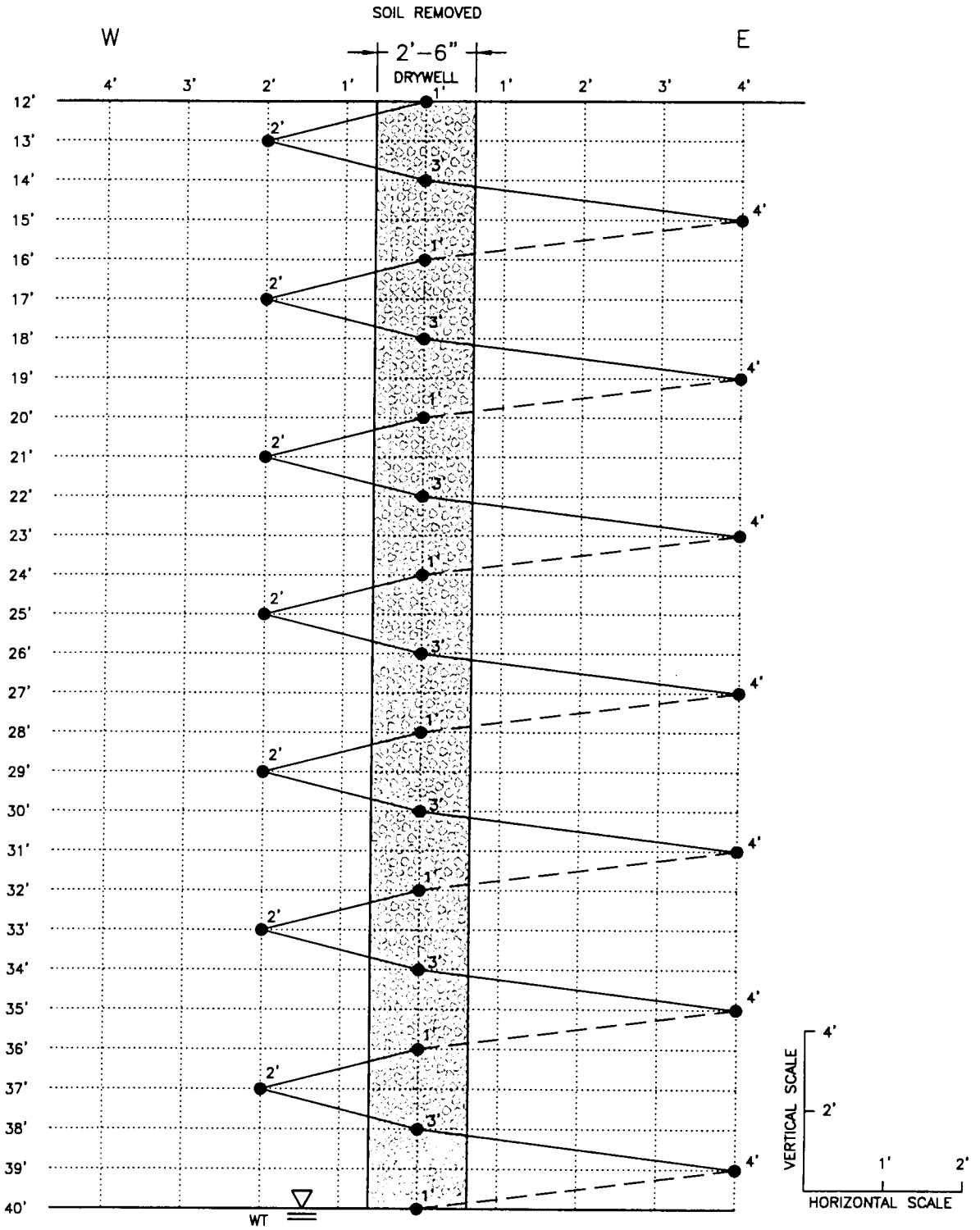

FIGURE 2-7 PLANNED DRYWELL DELINEATION SAMPLE LOCATIONS IN THE Ra/Sr TREATMENT SYSTEMS AREA

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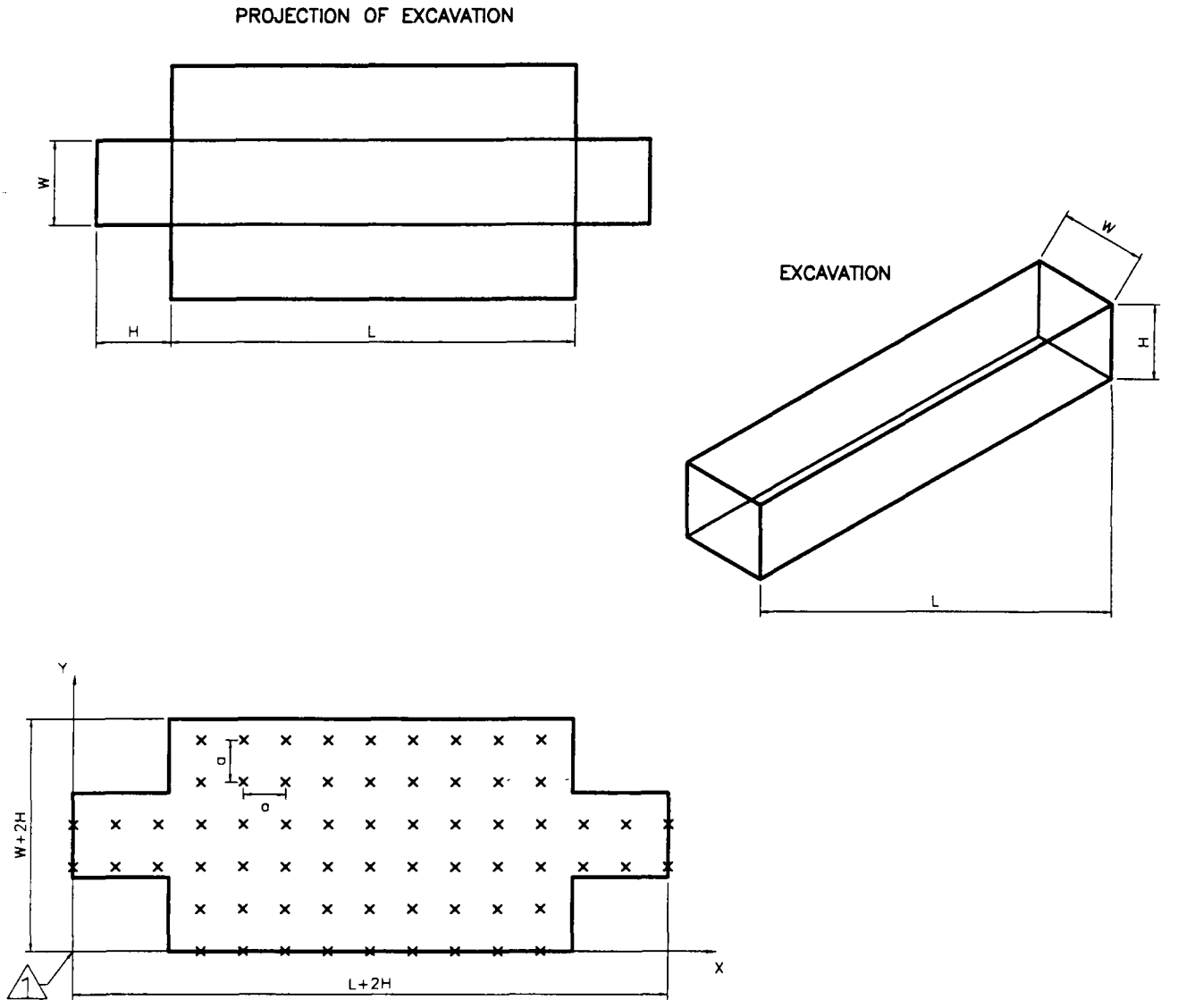

NOTES:

×	GRID SPACING, SCREENING SAMPLE LOCATION
a	DISTANCE BETWEEN GRID NODES a = 10 FT FOR EXCAVATIONS
△1	BEGIN GRID PATTERN AT THE (X,Y) COORDINATE AXIS ORIGIN (0,0)

NOT TO SCALE

Figure 2-8:
Planned Excavation Screening Sample Locations in the Ra/Sr Treatment Systems Area

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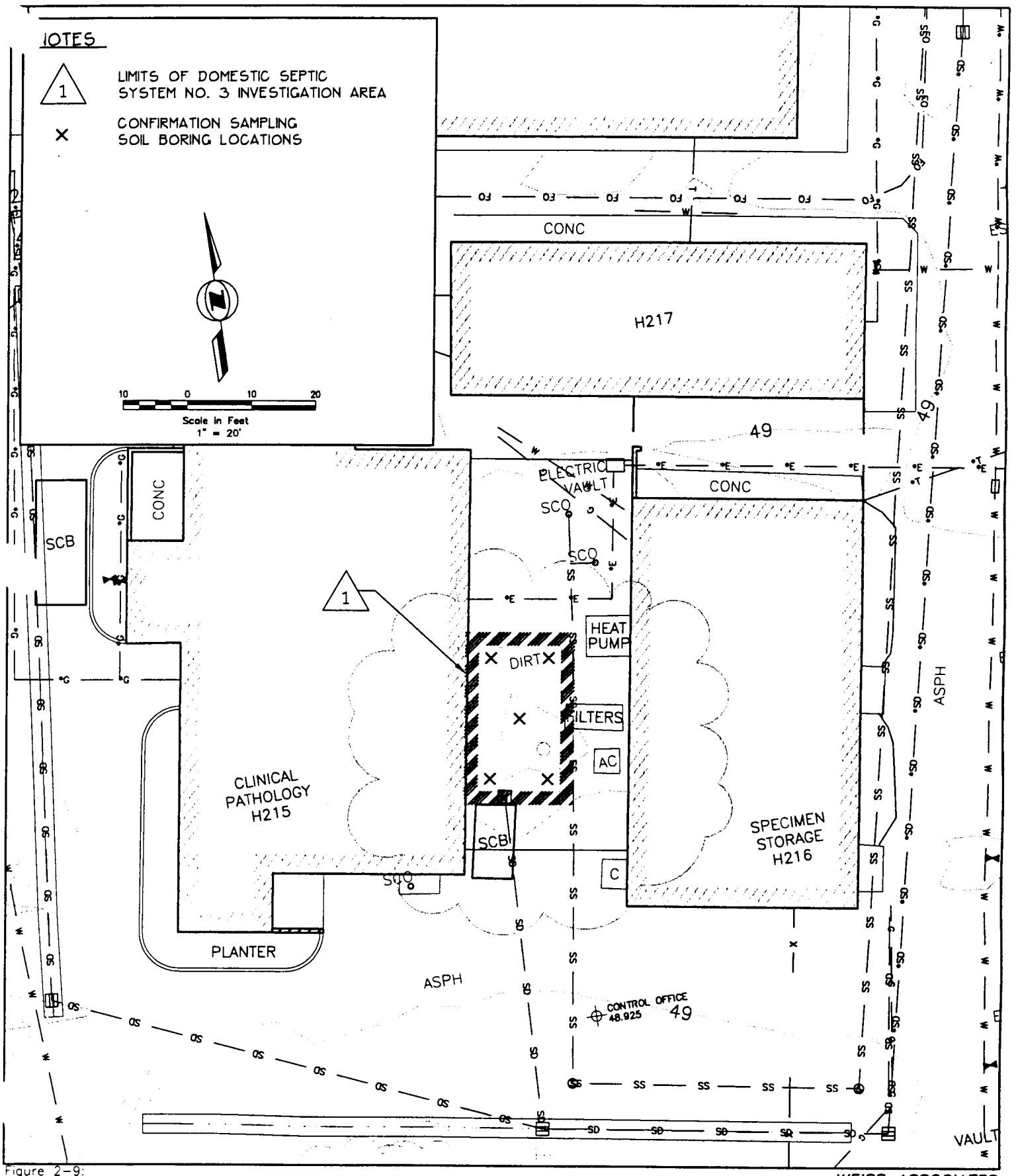

Figure 2-9:
Planned Confirmation Sample Locations in the Domestic Septic System No. 3 Area

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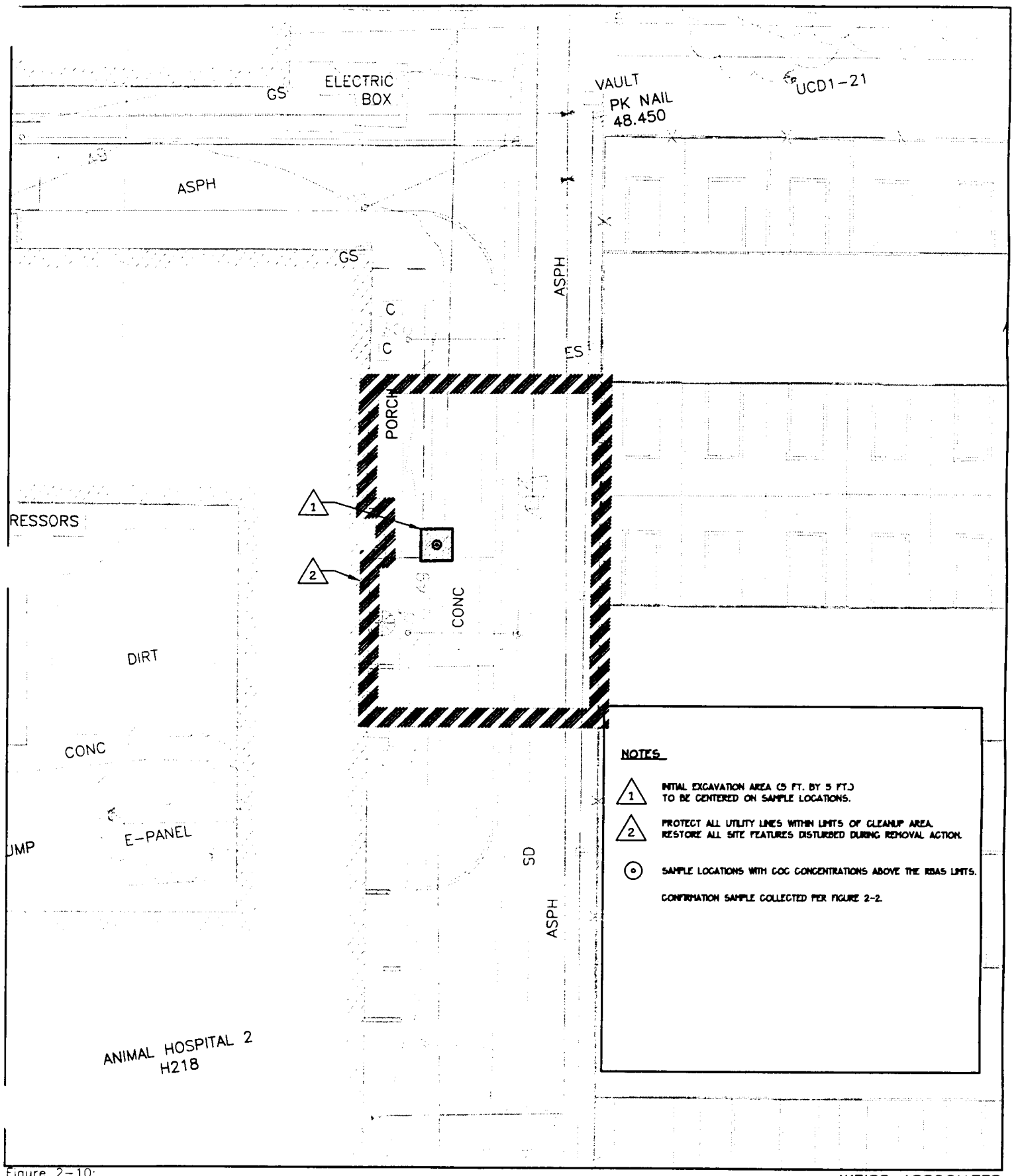

Figure 2-10:
Planned Confirmation Sample Locations in the Domestic Septic System No. 6 Area

WEISS ASSOCIATES

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3. SAMPLING AND ANALYSIS PROCEDURES

This section describes the sampling and analysis procedures that will be used during the RAs in the Southwest Trenches Area, Ra/Sr Treatment Systems Area and the Domestic Septic System Areas. Soil samples will be collected in accordance with SOP 3.1, *Surface and Shallow Subsurface Soil Sampling*, SOP 3.2, *Subsurface Sampling While Drilling*, and SOP 15.1, *Lithologic Logging*. Sample chain-of-custody records will be prepared according to SOP 1.1, *Chain of Custody*. Sample handling, packaging, and shipping will be conducted in accordance with SOP 2.1, *Sample Handling, Packaging and Shipping*. The list of Standard Operating Procedures (SOPs) to be used during this RA are presented in the Work Plan.

The sampling and analysis procedures will be conducted in accordance with the following sections from the Quality Assurance Project Plan: Section 8-Field Sampling Activities, Section 13-Inspections, Section 14-Calibration and Maintenance of Measuring and Test Equipment, Section 16-Nonconformance Control and Corrective Actions, Section 17-Change Control and Section 18-Audits and Surveillance (WA, 1998a). The Standard Quality Procedures (SQPs) associated with these sections include SQP 7.1-Quality Inspections and Inspection Records, SQP 7.2-Receipt Inspection, SQP 8.1-Calibration and Maintenance of Measuring and Test Equipment, SQP 10.1-Nonconformance Control, SQP 10.2-Corrective Actions, SQP 10.3-Stop Work Order, SQP 11.1-Field Work Variance, SQP 12.1–Quality Audits, SQP 12.2-Management Assessment, SQP 12.3-Quality Surveillance (WA, 1998b).

3.1 Sample Collection Procedures

The sampling techniques were described for each activity in Section 2. Soil samples will be collected in accordance with SOP 3.1. Soil samples will be placed in brass sleeves, glass jars, or plastic bags for field analysis and in brass sleeves for laboratory analysis. Table 3.1 summarizes the container types, volume and holding times for each analyte. The following methodology will be followed to collect the samples described in this WP.

A sample preparation area will be established adjacent to the sampling site. The sample preparation area will be set up on an elevated work surface such as a table. This work surface will be covered with poly sheeting to minimize the spread of any contamination. The following equipment will then be staged in the vicinity of the work area:

- Spill kit;
- Sample containers;
- Demineralized water;
- Sampling tools;

- Custody seals and chain-of-custody forms; and,
- Preservatives, as required.

3.2 Sample Documentation

The usability of the data obtained during this investigation will depend on its quality. A number of factors relate to data quality. Sample collection methods are as important to consider as the methods used for sample analysis. Following proper procedures for both sample collection and analysis reduces sampling and analytical error. To ensure sample integrity, samples will be handled using complete chain-of-custody documentation and preserved using proper sample preservation techniques, holding times, and shipment methods. Obtaining valid and comparable data also requires adequate QA/QC procedures and documentation.

The components of the sample documentation and custody system will include the following:

- Chain-of-custody form;
- Field logbook;
- Sample numbers;
- Sample labels; and,
- Custody seals.

3.2.1 Chain-of-Custody

Chain-of-custody forms will be completed by the sample team members to track sample custody as well as to specify the requested analyses. Chain-of-custody forms will be completed in accordance with the requirements of SOP 1.1.

3.2.2 Field Logbook

Descriptions and observations made during field and sampling activities will be documented in the field logbook. In addition, boring logs with detailed lithologic descriptions will be prepared in accordance with SOP 15.1 for any soil borings. The following will be recorded in the field logbook:

- Project name and number;
- Location of site;
- Purpose of sampling;
- Description of field activities;
- Names of sampling personnel;

- Date and time of entries;
- Sample medium description using the Unified Soil Classification System (USCS) method;
- Date and time of sample collection;
- Sample locations, identification (ID) number and methodology;
- Field observations;
- Results of field measurements; and,
- Results of field calibrations for instruments used.

3.2.3 Sample Numbers

All sample numbers will contain a unique sample identification number (i.e., sample designation) using the following format:

aabbcddd

Where,

aa = Type of sample and matrix

SS – soil sample

CW – composite waste

WS – water sample

bb = Two letter acronym designating the sample area at the site

DT – Southwest Trenches Area

RS – Radium/Strontium Treatment Systems Area

ST – Domestic Septic System Areas

c = Type of sample

F – field screening sample

C – confirmation sample

ddd = Chronological sample number (e.g., 001, 002, 003)

Example of a field screening soil sample collected from the Southwest Trenches Area

SSDTF001

The database manager will be consulted prior to commencement of field activities to confirm the above sample nomenclature.

3.2.4 Sample Labels

Sample labels will be attached to individual sample containers and will contain the following information:

- Project number;
- Sample ID number;
- Date and time collected;
- Initials of sampler; and,
- Requested analyses.

3.2.5 Custody Seals

Custody seals will be used to detect tampering and will be placed over the lid of the container and annotated with the following information:

- Project number;
- Sample ID number;
- Date and time; and,
- Initials of sampler.

3.3 Analytical Methods

Table 2-2 summarizes the analytical methods that will be performed on soil samples collected from the RA areas. The analytical methods are divided into field and laboratory methods. Field analytical methods will be used on-site to provide real-time results for screening samples. Fixed-base laboratory analytical methods will be used off-site for waste characterization, confirmation, and designated level analysis.

Field analytical methods include Ra-226 analysis using gamma spectroscopy equipped with a HPGe detector, Sr-90 analysis using the BSD detector, and chlordane analysis using the EnviroGard immunoassay-based test kits. Ra-226 and Sr-90 analyses will be performed by on-site laboratory technicians and chemists trained on the instruments. Similarly, the chlordane analysis will be performed on-site by trained technicians.

Laboratory analytical results will be validated upon receipt and transferred to the project database in accordance with procedures described in the QAPP (WA, 1998a). Sample tracking and data receipt, and storage will be performed in accordance with SOP 38.1 and SQP 4.2.

Table 3-1. Containers and Holding Times for Laboratory Analytical Methods Planned for LEHR Removal Actions

Parameter	Analytical Method	Holding Time
Radionuclides (2 x 16-oz P/G):		
Americium-241	Lab SOP	6 months
Carbon-14	Lab SOP	6 months
Gamma Emitters	EPA Method 901.1	6 months
Actinium-228		
Bismuth-212		
Bismuth-214		
Cesium-137		
Cobalt-60		
Lead-210		
Lead-212		
Lead-214		
Potassium-40		
Radium-223		
Radium-228		
Radium-226*		
Thallium-208, 234		
Thorium-228, 230, 232	Lab SOP	6 months
Gross Alpha	EPA Method 9310	6 months
Gross Beta	EPA Method 9310	6 months
Plutonium-241	Lab SOP	6 months
Strontium-90	EPA Method 905.0	6 months
Tritium	EPA Method 906.0	6 months
Uranium-233/234, 235, 238	Lab SOP	6 months
Metals/Other Inorganics (1 x 8-oz G):		
Antimony	CLP SOW ILM 02.1	6 months
Arsenic	CLP SOW ILM 02.1	6 months
Barium	CLP SOW ILM 02.1	6 months
Beryllium	CLP SOW ILM 02.1	6 months
Cadmium	CLP SOW ILM 02.1	6 months
Chromium (total)	CLP SOW ILM 02.1	6 months
Chromium (+6)	EPA Method 7196	30 days
Cobalt	CLP SOW ILM 02.1	6 months
Copper	CLP SOW ILM 02.1	6 months
Iron	CLP SOW ILM 02.1	6 months
Lead	CLP SOW ILM 02.1	6 months
Manganese	CLP SOW ILM 02.1	6 months
Mercury	CLP SOW ILM 02.1	28 days

Table 3-1. Containers and Holding Times for Laboratory Analytical Methods Planned for LEHR Removal Actions (continued)

Parameter	Analytical Method	Holding Time
Molybdenum	CLP SOW ILM 02.1	6 months
Nickel	CLP SOW ILM 02.1	6 months
Selenium	CLP SOW ILM 02.1	6 months
Silver	CLP SOW ILM 02.1	6 months
Thallium	CLP SOW ILM 02.1	6 months
Vandium	CLP SOW ILM 02.1	6 months
Zinc	CLP SOW ILM 02.1	6 months
General Chemistry		
Nitrate	EPA Method 300.0	48 hours
Nitrogen (TKN)	EPA Method 351.2	28 days
TOC	EPA Method 415.1	28 days
Ammonia	EPA Method 350.1	28 days
Organics:		
Volatile Organic Compounds	CLP SOW OLM 03.0	14 days
Semi-Volatile Organic Compounds	CLP SOW OLM 03.0	14 days to extraction, 40 days to analysis of extracts
Organochlorine Pesticides (and PCBs)	CLP SOW OLM 03.0	14 days to extraction, 40 days to analysis of extracts

Abbreviations:

CLP SOW = Contract Laboratory Program Statement of Work
OLM 03.0 = Organic Laboratory Method 03.0
ILM 02.1 = Inorganic Laboratory Method 02.1.
P = Plastic container
G = Glass container
g = grams
oz = ounces
* = 30-day ingrowth-time and 1000-minute count-time

4. DATA QUALITY OBJECTIVES

The Data Quality Objectives (DQOs) presented in this section were prepared according to Data Quality Objectives Process for Superfund, Interim Final Guidance, EPA document number EPA540-R-93-071. DQOs are decision performance criteria, presented in the form of qualitative and quantitative statements that were used to develop this SAP.

4.1 Statement of the Problem

The planning team for RAs at the Southwest Trenches Area, Ra/Sr Treatment Systems Area and Domestic Septic System Areas consists of DOE Oakland; RPMs including EPA Region IX, California Department of Toxic Substance Control (DTSC), Central Valley Regional Water Quality Control Board (RWQCB) and Department of Health Services (DHS); UC Davis; a local community group; and the DOE contracting team of WA, IT Corp., and Environmental Management Services (EMS). The primary decision-maker, DOE Oakland, will make the final decisions on all activities associated with the RA based on recommendations from the planning team.

Releases to the environment from the Southwest Trenches waste disposal pits and trenches, Ra/Sr Treatment System structures, and Domestic Septic System No. 6 pose a threat to human health and the environment.

Under National Contingency Plan (NCP) guidelines, a non-time critical RA will be conducted to minimize and reduce the threat posed by environmental contaminants at the site. Under the Memorandum of Agreement (MOA) signed between DOE and UCD, DOE will take the lead in the cleanup of soil contamination associated with LEHR-related activities. Previous investigations at the site performed by WA and other contractors have identified the vertical and lateral extent of contamination.

The RA for the Southwest Trenches Area is scheduled for Fiscal Year (FY) 1998, while the Ra/Sr Treatment System and Domestic Septic System Areas RA are scheduled for FY 1999. A contractual vehicle has been established between DOE and its RA contractors WA, IT, and EMS.

4.2 Identification of Decisions

Per the EE/CA (WA, 1998c), the specific RAOs developed from risk-based requirements, Applicable or Relevant and Appropriate Requirements (ARARs), and other pertinent factors are:

- Lower the excess cumulative cancer risk to an individual from exposure to site contaminants to within a nominal range of 10^{-4} to 10^{-6}, using 10^{-6} as the point of departure;

- Reduce the non-cancer hazard index to below 1;
- Mitigate potential future impact to ground water;
- Mitigate potential ecological risks during and after RA; and,
- Minimize impact to on-site university research.

The RA in each area will attempt to satisfy the above objectives.

4.3 Identify Inputs to Decisions

In order to satisfy the RAOs defined in Section 4.2, five sampling objectives have been developed and are presented in Section 1. The input requirements for each RA are described qualitatively below.

The environmental measurement inputs required to make assessments on the RA in the Southwest Trenches Area include:

- Review information regarding the area;
- Field observations including type of waste encountered and depth and length of the waste area;
- Sampling at appropriate locations and depths;
- Sample medium description using the USCS method:
- Field screening measurements for Ra-226, Sr-90 and chlordane;
- Laboratory analyte or radionuclide identity and concentration/activity; and,
- Laboratory data validation.

The environmental measurement inputs required to make assessments on the RA in the Ra/Sr Treatment Systems Area will consist of:

- Field observations;
- Drilling and sampling at appropriate locations and depths;
- Sample medium description using the USCS method, and visual method for description of sludge and water:
- Field screening measurements for Ra-226 and Sr-90;
- Analyte or radionuclide identity and concentration/activity; and,
- Laboratory data validation.

The information needed to assess full characterization of the Domestic Septic System Areas will consist of:

- Field observations;
- Drilling and sampling at appropriate locations and depths;
- Sample medium description using the USCS method; and,

- Analyte or radionuclide identity and concentration/activity.

For the COCs in each area, risk-based action levels were established for three exposure scenarios including an on-site-researcher scenario and two off-site farmer scenarios. In addition, vadose zone modeling was performed to establish designated levels for residual COC concentrations in soil that would not impact ground water.

4.4 Definition of Study Boundaries

The geographical area being investigated includes the Southwest Trenches Area, Ra/Sr Treatment Systems Area, and the Domestic Septic System Areas. Figure 1-1 shows the limits of the RA in each area. Additional information on project area boundary and strata is presented in the Work Plan Drawings.

Temporal considerations for the planned field and laboratory analyses are:

- Soil samples that will be analyzed on-site for Ra-226 must be tested within 2 hours of collection.
- Soil samples that will be analyzed for hexavalent chromium must be extracted within 30 days of collection and the sample extract must be analyzed within three (3) days of extraction.
- Soil samples that will be analyzed for VOCs, SVOCs and organochlorine pesticides must be tested within 14 days of collection.
- Soil samples that will be analyzed for radionuclides and metals must be tested within six (6) months of collection.

Screening samples will be collected during excavation, and confirmation and designated level samples will be collected at the completion of the RA, when the final extent of excavation has been attained.

4.5 Development of Decision Rules

The RA will have decision rules guiding field activities. The action levels that will be used during these RAs include risk-based action standards, background concentrations, and designated levels. These cleanup criteria are presented in the WP. The mean of the data set will be used as the representative of each COC concentration, and will be compared to the cleanup criteria presented in the WP.

Conditions that may cause deviation from the planned activities include:

- Physical obstructions such as buildings and underground utilities that prevent excavation and sampling in selected locations;

- Field screening measurements indicating that the work environment, or some aspect of it, is unsafe for human or environmental health and/or welfare.

- Equipment required to perform the intended work safely is unavailable.

4.6 Specification of Limits on Decision Errors

Appendix A describes the statistical methods used to define the number of confirmation samples required in each area. Type I and II errors were established at 20% and 10%, respectively as described in Appendix A.

4.7 Sampling Process Design

The sampling and analysis strategy presented in Section 2 was developed to satisfy the DQOs described above. Sampling procedures and methodologies and the analytical requirements are presented in Section 3.

5. QUALITY ASSURANCE

The quality assurance requirements applicable to the majority of the RA activities are detailed in the Final Quality Assurance Project Plan (QAPP), for the environmental restoration activities at the LEHR site (WA, 1998a). This plan is based upon the requirements of DOE Order 5700.6c "Quality Assurance" and EPA QA/R-5 “EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations” (EPA, 1997) as they are applicable to the scope of work. Additional task-specific quality assurance requirements are detailed in the SOP prepared for each activity and will be followed as such.

6. REFERENCES

Environmental Protection Agency (EPA), 1997, EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, EPA QA/R-5, USEPA QAMS, October.

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Weiss Associates (WA), 1997a, Final Site Characterization Summary Report for the U.S. Department of Energy Areas at the LEHR, UC Davis, California, January.

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WA, 1998a, Final Quality Assurance Project Plan for Environmental Waste Management, LEHR, University of California at Davis, California, Weiss Associates, Rev 1, February.

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WA, 1998c, Draft Final Engineering Evaluation/Cost Analysis Report, LEHR, January.

APPENDIX A

REMOVAL ACTION CONFIRMATION SAMPLING DESIGN

A. REMOVAL ACTION CONFIRMATION SAMPLING DESIGN

A.1 Statistical Basis for the Removal Action Confirmation Sampling Design

Statistical methods were selected for RA confirmation sampling at the DOE areas of the LEHR site to ensure that the decision that cleanup standards have or have not been achieved is done in a scientifically valid fashion. A statistical approach cannot declare with 100% certainty that cleanup standards are achieved. However, it is reasonable to assume cleanup criteria have been met if statistical tests show that the reference-based cleanup standard was achieved with an acceptable level of certainty. The statistical approach described here was taken from Statistical Methods for Evaluating the Attainment of Cleanup Standards, Volume 3: Reference Based Standards for Soils and Solid Media (EPA, 1994), and is intended for use for those contaminants for which cleanup at or near background is desired (e.g, Ra-226).

The statistical hypothesis testing procedure begins with the statement of a null hypothesis (H_o) and alternative hypothesis (H_a). These are:

- H_o: Reference-Based Cleanup Standard Achieved; and,
- H_a: Reference-Based Cleanup Standard Not Achieved.

The above hypotheses allow some cleanup unit measurements to be larger than reference area (background data set measurements) without rejecting H_o. In addition, the statistical tests recommended in Statistical Methods for Evaluating the Attainment of Cleanup Standards (EPA, 1994) are designed to determine whether cleanup unit measurements are significantly larger, as a whole, than reference area (background) measurements.

Associated with H_o are Type I and Type II decision errors. A Type I decision error (α) is the probability of rejecting H_o when it is true. In the context of the LEHR RA, α is the probability that the statistical tests will indicate the cleanup standard was not achieved when it actually was. A Type II decision error (β) is the probability of accepting H_o when it is false. In the context of the LEHR RA, β is the probability that the statistical tests will indicate cleanup standard was achieved when it actually was not achieved. Table A-1 illustrates the relationship between α, β, actual condition of the cleanup unit, and the results of the statistical tests.

Table A-1. Decision Error Relationships

Result of Statistical Test, Based on Sample Data from Cleanup Unit	Actual Condition of Cleanup Unit	
	Standard Achieved	Standard Not Achieved
Test Indicates Standard was Achieved	Correct Test Result (Probability = $1 - \alpha$)	Incorrect Test Result Type II Error (Probability = β)
Test Indicates Standard was Not Achieved	Incorrect Test Result Type I Error (Probability = α)	Correct Test Result (Probability = $1 - \beta$)

The above table illustrates how often a statistical test may produce incorrect results. The test will be correct 100% of the time if α and β are equal to zero. However, the required number of test samples approaches infinity as α and β approach zero. Therefore, the test cannot be correct 100% of the time because an infinite number of samples cannot be collected.

To demonstrate achievement of the null hypothesis, H_o, a compromise must be made between the decision error rates α and β and the number of samples required to conduct the test. To that end, three estimates of the sample requirements were made using three pairs of values for α and β (0.2/0.1, 0.2/0.2 and 0.3/0.2, respectively). The sample number estimations using the parameter pairs are described in detail in Section A.2 below.

A.2 Estimation of the Required Number of Confirmation Samples

Ra-226 and mercury were selected as the indicator constituents of concern (COCs) for estimating the number of confirmatory samples (n) to be collected in each cleanup unit. Ra-226 and mercury were selected because they are high priority COCs from a risk-based perspective, and sample statistics for these constituents indicate they will result in the largest (most conservative) value of n. The indicator COC selection process is described in Section A.2.2. As recommended in Statistical Methods for Evaluating the Attainment of Cleanup Standards (EPA, 1994), the Wilcoxon Rank Sum (WRS) test will be the primary method to determine whether residual contaminant levels meet the cleanup criteria. The WRS test requires a minimum number of samples, n, to be statistically valid based on the decision errors α and β. Secondary and tertiary tests (Quantile Test and Hot Measurement Comparison respectively) will be used as necessary and appropriate to further confirm whether cleanup criteria have been met, but those tests do not have a minimum sample number requirement.

According to the Statistical Methods for Evaluating the Attainment of Cleanup Standards (EPA, 1994), "cleanup unit" refers to the area undergoing RA while "reference area" refers to that area off-site representing the background area. The minimum required number of confirmatory samples is determined using the following steps (discussed in more detail in Section A.2.1):

1. Determine the permissible type I error (alpha) and type II error (beta) for the statistical hypothesis. Per request of EPA Region IX, WA evaluated values for

α between 0.2 and 0.3; and values for β between 0.1 and 0.2. The recommended (EPA, 1992) values for α and β are 0.2 and 0.1 respectively.

2. Select the minimum detectable relative difference (Δ). Per request of EPA Region IX, WA evaluated Δ values between 20% and 30% of the cleanup goal or equal to the standard deviation of the background data set. Recommended values (EPA, 1992) for Δ range from 10% to 20% of the cleanup standard.
3. Calculate the standard deviation (σ) of previously collected data from the cleanup unit.
4. Calculate the relative shift (Δ/σ).
5. Determine the probability (P_r) that a measurement performed at a random location in the survey area will result in a larger value than a measurement performed at a random location in the reference (background) area. P_r is a function of the relative shift and can be found in look-up tables.
6. Determine the percentiles $Z_{1-\alpha}$ and $Z_{1-\beta}$, represented by the selected decision error levels, α and β, respectively. These values can be found in tables of the cumulative normal distribution.
7. Calculate the minimum number of data points, N. The formula and calculation procedures for N are presented in Section A.2.1.1.

$$N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{12c(1-c)(P_r - 0.5)^2(1-R)}$$

8. Calculate the minimum number of data points required in the cleanup unit and reference area using the equations n = (1 – c)N and m = cN, respectively.

Once the RA data are collected, the data set from each cleanup unit will be evaluated independently against the reference area data set using the WRS test. As stated above, the Quantile Test and the Hot Measurement Comparison will be used to further confirm whether cleanup goals have been met. The combined results of these three tests will determine whether residual contaminants in the cleanup unit exceed the target cleanup goals.

A.2.1 Sample Number Calculation

As described above, the WRS test requires a minimum number of confirmatory samples to establish whether residual contaminant levels meet the release criteria. The number of samples required varies depending on:

- The minimum detectable relative difference, Δ. Four Δ values were selected for Ra-226; 3 Δ values were selected for mercury. The Δ values for Ra-226 correspond to:
    1. 20% of the background cutoff value;
    2. 30% of the background cutoff value;

3. The mean of the background data set counting error; and,
4. The background data set standard deviation.

For mercury, Δ values were determined in the same manner except, the counting error is not applicable for mercury.

- The standard deviation of the post-RA data sets (cleanup units) and reference area data set. The "reference area" is the area from which background samples were collected. Estimates of the cleanup unit standard deviation were calculated from data collected in the Southwest Trenches Area. The procedures used to calculate post-RA standard deviations for Ra-226 and mercury are described in more detail in Section A.2.1.1.
- The selected Type I (α) and Type II (β) decision error levels. Three pairs of decision error levels were selected for this evaluation: (α_1 = 0.20, β_1 = 0.10), (α_2 = 0.20, β_2 = 0.20) and (α_3 = 0.30, β_3 = 0.20).

Per request from EPA Region IX, 12 estimates of the Ra-226 minimum sample requirement were calculated based on the four Δs and three decision error pairs. Nine estimates of the mercury minimum sample requirement were calculated based on three Δs and three decision error pairs. The approach for making these calculations is described below.

A.2.1.1 Approach

All required sample numbers N were calculated using the formula presented in Section 6.2 of EPA, 1994, which was adapted from Noether (1987):

$$N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{12c(1-c)(P_r - 0.5)^2(1-R)}$$

Where:

N is the total number of samples (OU + reference [background] area);
α is the type I error rate (assumed α_1 = 0.20, α_2 = 0.20 and α_3 = 0.30);
β is the type II error rate (assumed β_1 = 0.10, β_2 = 0.20 and β_3 = 0.20);
$Z_{1-\alpha}$ is the value that cuts off (100α)% of the upper tail of the standard normal distribution (determined from the cumulative standard normal distribution Table A-2 [Gilbert, 1987]);
$Z_{1-\beta}$ is the value that cuts off (100β)% of the upper tail of the standard normal distribution (determined from the cumulative standard normal distribution Table A-2 [Gilbert, 1987]);
c is the proportion of N that will be collected in the reference area (formula for c presented below);

P_r is the probability that a measurement performed at a random location in the cleanup unit will result in a larger value than a measurement performed at a random location in the reference area (method of calculating P_r presented below); and,

R is the expected rate of missing and/or unusable data (assumed for this analysis to be 10%).

The minimum number of samples required in the cleanup unit, n, is calculated from the formula n = (1-c)N and the number required in the reference (background) area, m, is calculated from m = cN. The value c is determined from the formula:

$$c = \frac{v^2 h^{1/2}}{v^2 h^{1/2} + 1}$$

Where: h is the number of cleanup units (2 units assumed) and v is the ratio of the standard deviation of the background data set (σbkg) divided by the standard deviation of the estimated post-RA cleanup unit data set ($\sigma_{post\text{-}RA}$). This statistical sampling and decision making approach will be used for two cleanup units, the SW Trenches and the Ra/Sr Treatment Systems.

The quantity P_r is a function of the relative shift, $\Delta/(\sigma_{post\text{-}RA})$, where the selected Δ values for Ra-226 correspond to:

1. 20% of the background cutoff value;
2. 30% of the background cutoff value;
3. The mean of the background data set counting error; and,
4. The background data set standard deviation.

The selected Δ values for mercury were:

1. 20% of the background cutoff value;
2. 30% of the background cutoff value; and,
3. The background data set standard deviation.

Estimations of the post-RA standard deviation, $\sigma_{post\text{-}RA}$, were based on histogram analysis of the Southwest Trenches Area data reported in the Site Characterization Summary Report (WA, 1997a). A histogram of Ra-226 data for the Southwest Trenches Area is shown in Figure A-1. A subset of the data was selected as representative of post-RA conditions based on inspection of the Southwest Trenches Area histogram and the background data set histogram. Inspection of the histograms indicates a significant drop in frequency at 1.5 pCi/g in the Southwest Trenches Area histogram and nothing in bins greater than 0.9 pCi/g in the background data set histogram. Therefore, RAs were assumed to eliminate most of the data in bins greater than 1.5 pCi/g. The estimated post-RA standard deviation was calculated from data in bins ranging from 0.2 pCi/g to 1.5 pCi/g.

The Southwest Trenches Area histogram for mercury is shown in Figure A-2. Mercury concentrations in the Southwest Trenches Area are assumed to be modeled by the lognormal

distribution. The lognormal assumption is based on Shapiro-Wilk W test results that indicate background data are drawn from a lognormal distribution.

The entire data set was used to calculate the post-RA standard deviation because the upper tail of the background distribution did not correlate to a significant drop in the Southwest Trenches Area histogram. However, inspection of the background histogram indicates mercury concentrations greater than 0.37 mg/kg (-1 ln(mg/kg)) are likely to be removed by remediation activities. Thus, the estimated post-RA standard deviation for mercury may result in an overly conservative prediction of the number of samples due to inclusion of the entire data set.

An example calculation of n for mercury is presented in spreadsheet form as Figure A-3.

A.2.2 Selection of Representative COCs for Sample Number Calculations

It can be shown from the equation for N and the relationship between P_r and Δ/σ that the number of samples goes to infinity as Δ/σ approaches zero. Thus, COCs with smaller relative shifts (i.e. small Δ and large σ) will control the number of samples required for the WRS test.

For the purpose of representative COC selection, the parameter Δ was estimated to be proportional to the cleanup goal. The background cutoff value was selected as the cleanup goal for all COCs in this comparison. Risk based action standards (RBASs) below the background cutoff values were not selected because they are not practically achievable. RBASs above the background cutoff value were not selected because they are likely to result in an underestimation of the number of samples required (RBAS >> σ). The parameter σ was estimated to be proportional to the standard deviation of the background data set. A summary of Δ/σ estimations for metals and radionuclides is presented in Tables A-1 and A-2.

Antimony, cadmium, hexavalent chromium, silver and thallium Δ/σ values were disregarded in this comparison because their Δ and σ values were derived from "censored" data sets. "Censored" is the term used for data sets with concentrations below the detection limit. Estimates of censored background data standard deviations were made using the Maximum Likelihood Estimator (MLE) procedure. The MLE procedure tends to make significant overestimations of the sample standard deviation which likely will result in significant overestimations of n.

The relative shift estimations presented in Table A-2 indicate that selenium and mercury have the lowest Δ/σ ratio of the remaining metals in the background database. Although selenium has the lowest Δ/σ ratio (i.e. the selenium Δ/σ ratio will predict the greatest number of samples), mercury is a more important LEHR COC. Site characterization data from the LEHR database indicate that concentrations of mercury in the Southwest Trenches Area and Former Western Dog Pens are above the background cutoff value. Selenium concentrations in all characterization samples from DOE areas of the LEHR site are below the background cutoff value. Thus, mercury was selected for sample number calculations because it is a significant LEHR COC and has a low Δ/σ ratio.

The relative shift estimations presented in Table A-3 indicate that uranium-235 and Ra-226 have the lowest Δ/σ ratio of all radionuclides in the background database. Ra-226 was selected as the indicator constituent for radionuclides because it is a COC of significantly higher priority than uranium-235 at the LEHR site. Ra-226 is known to be present in the Southwest Trenches Area and Ra/Sr Treatment System Area due to historical site activities and site characterization data. In addition, Ra-226 is a more important COC from a risk-based perspective (WA, 1997b). Concentrations of Ra-226 in soil from the Southwest Trenches Area and Radium/Stroutium Treatment Systems Area were above the risk based action standard (RBAS) for 10^{-4}, 10^{-5} and 10^{-6} risk levels. Historical data do not indicate that uranium-235 is present in the DOE areas of the LEHR site. Furthermore, concentrations of uranium-235 in soil are near or below laboratory detection limits in all of the site characterization sample results in the database.

A.2.3 Results of Sample Number Calculations

The estimated number of cleanup unit samples required for hypothesis testing using the Wilcoxon Rank Sum Test is presented in Table A-4 and Table A-5 for Ra-226 and mercury respectively. The estimated number of samples, n, for Ra-226 ranges from 11 (for α = 30%, β = 20% and Δ = mean background counting error) to 119 (for α = 20%, β = 10% and Δ = background data set standard deviation). The estimated number of cleanup unit samples for mercury ranges from 10 (for α = 30%, β = 20% and Δ = background data set standard deviation) to 51 (for α = 20%, β = 10% and Δ = 0.2 x background cutoff value). In general, n decreases as α, β and Δ increase.

The plan for placement of the calculated number of samples is presented in Section A.3, below.

A.2.4 Proposed Values for α, β and Δ

Based on the results presented above, we propose to set α at 20%, β at 10%, and Δ (relative shift) at 30%. This results in 51 required samples each in the Southwest Trenches and Ra/Sr Treatment Systems Areas.

A.3 Removal Action Confirmatory Sample Locations and Grid Spacing

Post-RA confirmatory sampling will be performed when excavation is complete to verify that residual contaminant levels in each remediated area are below the cleanup standards. Cleanup standards are defined as either background or the RBAS. The RBAS is selected as the cleanup criteria when no background data are available for a COC (as is the case for organic compounds) or when the background value is below the RBAS.

A stratified-random sampling approach will be used, focusing on sidewalls and bottom of the excavated area. Confirmatory samples from each area will be collected using a rectangular grid with

a random start in a planar (x,y) coordinate system. Each contaminated area will be excavated to resemble a rectangular box shape (or adjoining rectangular box shapes) to the extent practical with common excavation tools such as a backhoe. The dimensions of the rectangular excavation will be measured and projected into a two-dimensional plane as depicted in Figure A-4.

The random start location will be determined by setting the origin of the coordinate system as depicted in Figure A-4 and determining the x and y coordinates of the random start. The random start x coordinate will be a random number between 0 and L + 2h and the y coordinate will be a random number between 0 and W+ 2h, where L, W and h are the length, width and depth of the excavation respectively. The spacing between sampling points (a) in the rectangular grid is determined from the equation $a = (A/n_t)^{0.5}$ where A is the projected area of the excavation [A = WL + 2(hW + hL)] and n_t is the required number of samples per trench.

The required number of samples per trench is determined from an area weighted average of the total number of samples, n, to be collected from the cleanup unit where $n_{ti} = (nA_i)/(\Sigma A_i)$. The initial estimate of the number of confirmatory samples, n, for each cleanup unit was determined in the statistical analysis presented above in section A.2.

A.3.1 Application of Sampling Grid in Southwest Trenches Area

All of the excavations in the Southwest Trenches Area are anticipated to be box shaped. If trenches intersect, the common area of intersection will be removed from the corresponding wall of each box and the sample grid will be applied in the same manner as described above. Changes in trench geometry will be taken into account when calculating the box area and laying the random start coordinate system. An example of determining the box area and laying the random start coordinate system to an intersecting trench is depicted in Figure A-5.

A.3.2 Application of Sampling Grid in Radium/Strontium Treatment Systems Area

Excavation in the vicinity of the Ra/Sr Treatment Systems Area is likely to require shoring which may prevent sample collection on some of the excavation side walls. The shoring may be placed along some of the walls of the excavation to ensure safety and prevent structural damage from occurring to the surrounding buildings. The walls that cannot be accessed due to shoring will not be included in the layout of the sampling grid. Figure A-5 depicts how the box area is determined and the random start coordinate system is laid out for a trench that is missing a sidewall.

A.4 References

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Table A-2. Relative Shift Estimations for Metals, LEHR DOE Removal Actions

Compound	Standard Deviation (mg/kg)	Notes	Consolidated Data Background Cutoff Values (mg/kg)	Δ/σ
Antimony	0.77	c	1.4	1.8
Arsenic	1.4		9.6	6.7
Barium	55		260	4.8
Beryllium	0.17		0.72	4.3
Cadmium	0.15	c	0.51	3.3
Chromium	40		160	4.0
Hexavalent Chromium	0.024	c	0.054	2.2
Cobalt	5.2		31	6.0
Copper	11		60	5.3
Iron	5517		44,000	8.0
Lead	1.3		9.5	7.2
Manganese	96		750	7.8
Mercury	0.16		0.59	3.6
Molybdenum	N/A		ND < 0.26	N/A
Nickel	83		330	4.0
Selenium	0.37		1.2	3.2
Silver	0.15	c	0.55	3.6
Thallium	1.1	c	1.6	1.5
Vanadium	11		77	6.8
Zinc	16		87	5.3

Abbreviations and Symbols:

N/A = Not Applicable
Δ = Relative Shift
σ = Sample Standard Deviation
c = Censored data set. Data are not likely reliable for calculating the number of samples required. The standard deviation was estimated using the Maximum Likelihood Estimator (MLE) procedure. The MLE procedure tends to significantly overestimate the true mean of distribution.

Table A-3. Relative Shift Estimations for Radionuclides, LEHR DOE Removal Actions

Isotope	Standard Deviation (pCi/g)	Notes	Consolidated Data Background Cutoff Values (pCi/g)	Δ/σ
Actinium-228	0.0698		0.64	9.17
Americium-241	N/A		ND < 0.014	N/A
Bismuth-212	0.0479		0.43	8.98
Bismuth-214	0.0676		0.54	7.99
Carbon-14	N/A		ND < 0.13	N/A
Cesium-137	0.0436	c	0.012	0.27
Cobalt-60	N/A		ND < 0.006	N/A
Gross Alpha	1.69		8.7	5.15
Gross Beta	1.73		15	8.69
Lead-210	0.578	c	1.6	2.77
Lead-212	0.0932		0.70	7.51
Lead-214	0.0492		0.58	11.78
Potassium-40	1.21		14	11.53
Plutonium-241	N/A		ND < 0.50	N/A
Radium-226	0.143		0.75	5.24
Radium-228	0.0705		0.64	9.07
Strontium-90	0.0207	c	0.056	2.71
Thallium-208	0.0271		0.22	8.13
Thorium-228	0.119		0.74	6.19
Thorium-230	0.0605		0.79	13.06
Thorium-232	0.129		0.75	5.83
Thorium-234	0.130		0.78	5.98
Tritium	N/A		ND < 1.2	N/A
Uranium-233/234	0.0905		0.68	7.51
Uranium-235	0.0082		0.039	4.75
Uranium-238	0.0820		0.65	7.93

Abbreviations and Symbols:

N/A = Not Applicable
Δ = Relative Shift
σ = Sample Standard Deviation
c = Censored data set. Data are not likely reliable for calculating the number of samples required.

Table A-4. Estimated Number of Samples to Satisfy Cleanup Objectives Based on Wilcoxon Rank Sum Test, Radium-226, LEHR DOE Removal Actions

Type I and Type II Error	MDRD = 0.2 x Background	MDRD = 0.3 x Background	MDRD = Mean Background Counting Error	MDRD = Background Data Set Standard Deviation
α = 20%, β = 10 %	109	51	25	119
α = 20%, β = 20 %	68	32	16	75
α = 30%, β = 20 %	45	21	11	50

Definitions/notes:

MDRD = Minimum Detectable Relative Difference or relative shift of cleanup unit distribution relative to background distribution.

Assumptions:

Background = 0.75 pCi/g based on consolidated soil type samples from background data set.
Recently calculated standard deviation for Southwest Trenches Area data set, SD = 0.318 pCi/g (Bins 0 - 1.5 pCi/g)
The number of cleanup units consists of the Southwest Trenches Area and Radium Strontium Treatment Systems (i.e. h = 2)

Table A-5. Estimated Number of Samples to Satisfy Cleanup Objectives Based on Wilcoxon Rank Sum Test, Mercury, LEHR DOE Removal Actions

Type I and Type II Error	MDRD = 0.2 x Background	MDRD = 0.3 x Background	MDRD = Background Data Set Standard Deviation
α = 20%, β = 10 %	51	24	29
α = 20%, β = 20 %	32	16	19
α = 30%, β = 20 %	21	10	12

Definitions/notes:

MDRD = Minimum Detectable Relative Difference or relative shift of cleanup unit distribution relative to background distribution.

Assumptions:

Background = 0.59 mg/kg based on consolidated soil type samples from background data set.
The number of cleanup units consists of the Southwest Trenches Area and Radium Strontium Treatment Systems (i.e. h = 2)
Sample number requirement based on standard deviation of data collected from the Southwest Trenches Area.

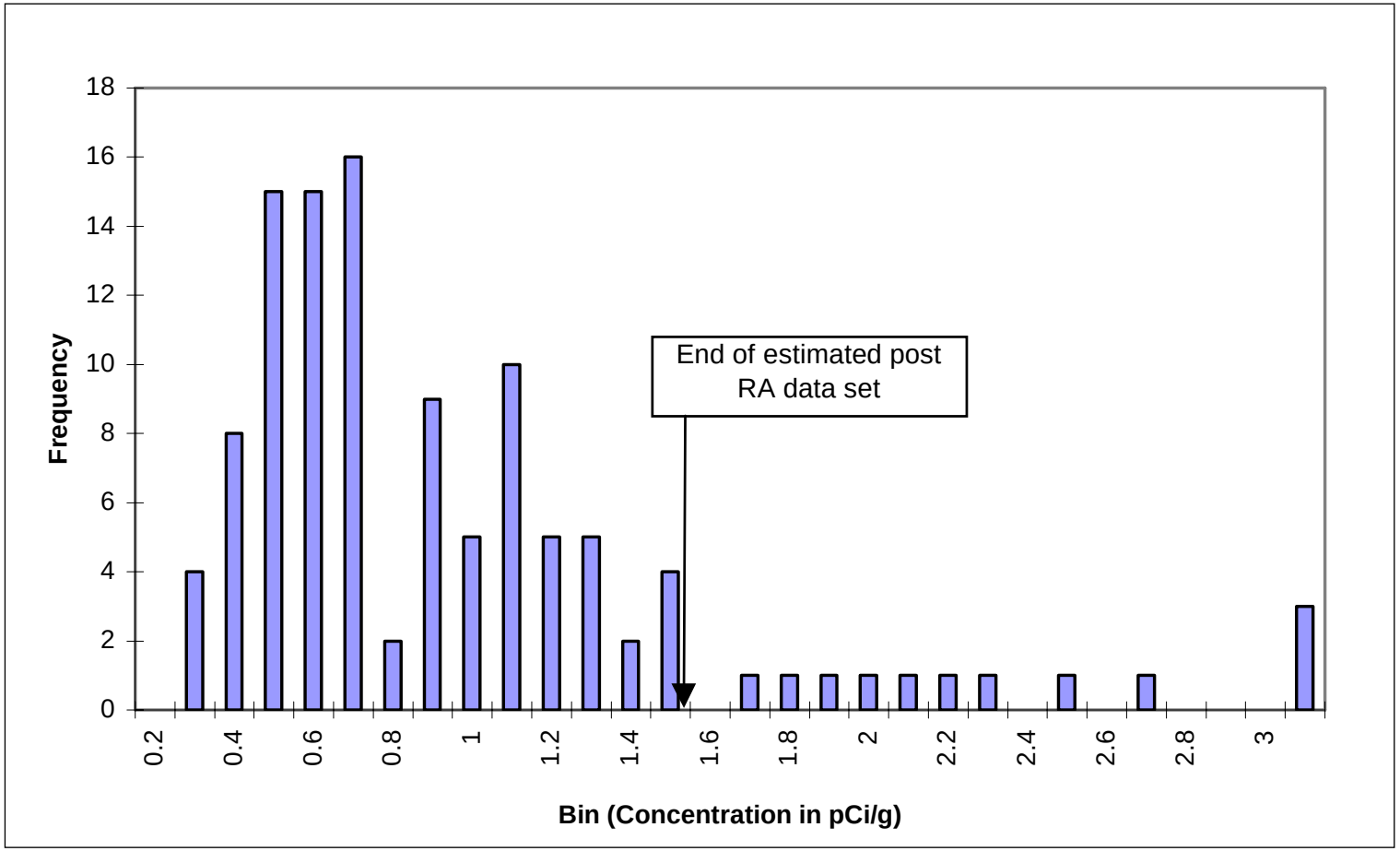

Figure A-1. Histogram of Southwest Area Trenches Data, Ra-226 (4005-031.ai)

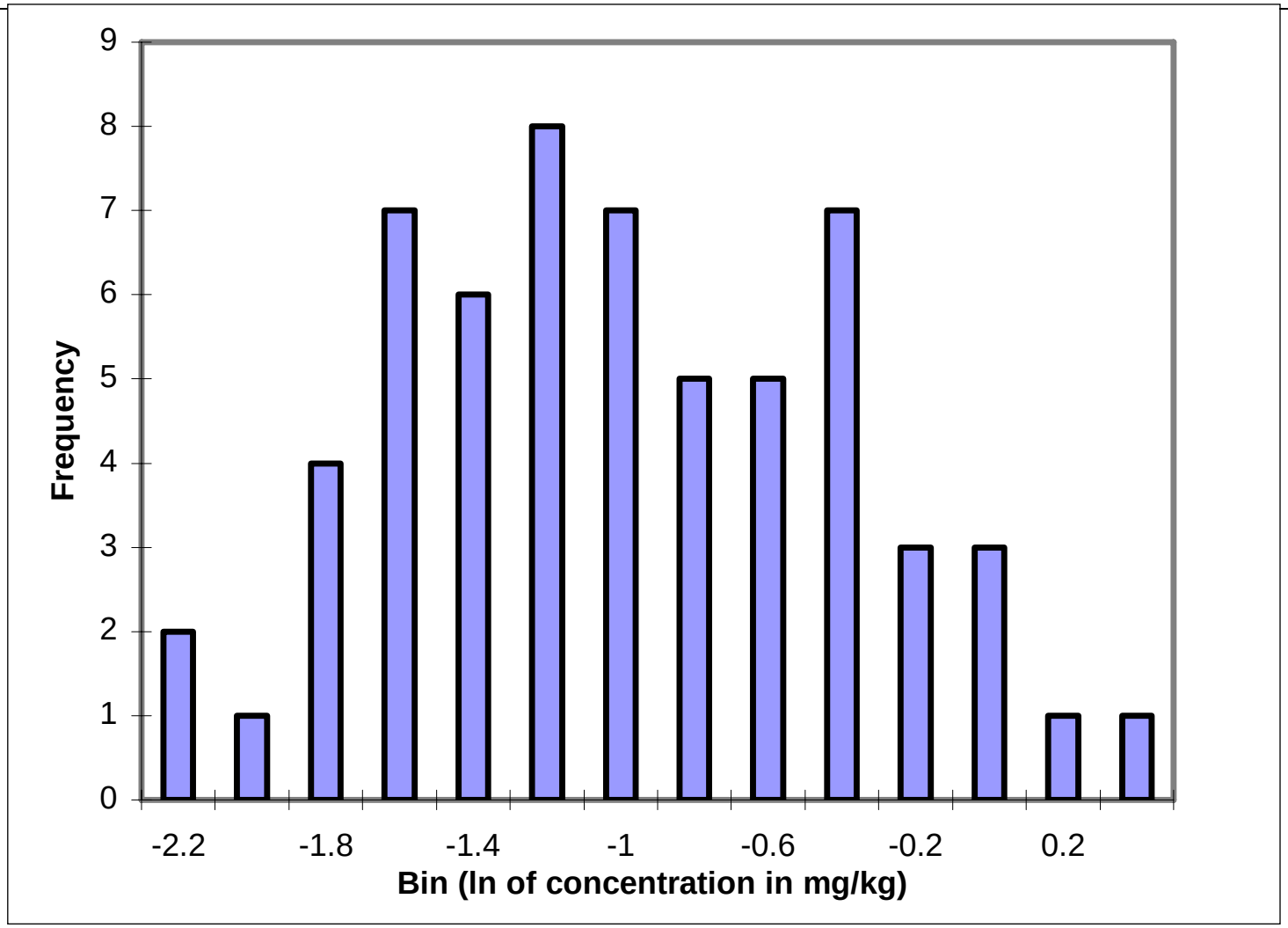

Figure A-2. Histogram of Southwest Trenches Area Data, Ln-Transformed, Mercury (4005-032.ai)

Δ = 0.2 x Background	
α =	0.2
$Z_{1-\alpha}$	0.842
β =	0.1
$Z_{1-\beta}$	1.282
Background (mg/kg)	0.59
Δ = 0.2 x Background (mg/kg)	0.118
σ_{ou1} = Standard Deviation of OU-1 Data Set (mg/kg)	0.23
σ_{bkg} = Standard Deviation of New Background Data Set (mg/kg)	0.16
v	0.70
h	2
c	0.406
Δ/σ_{ou1}	0.513
P_r	0.6426
R	0.1
N	85
m	35
n	51

Formulas:

$$N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{12c(1-c)(P_r - 0.5)^2(1-R)}$$

$$c = \frac{v^2 h^{1/2}}{v^2 h^{1/2} + 1}$$

Notes

$Z_{1-\alpha}$ and $Z_{1-\beta}$ values from Table 5.2 EPA 1997
Pr values from Table 5.1 EPA 1997
v = $\sigma_{bkg}/\sigma_{ou1}$
h = Number of cleanup units

R = 10% = Percentage of missing or unusable data
N = Total number of samples required.
m = Number of background data set samples required (m = cN).
n = Number of cleanup unit samples required (n = (1-c)N).

References

Noether, G.E. 1987. Sample Size Determination for Some Common Nonparametric Tests. Journal of the American Statistical Association 82:645-647.
USEPA 1992, Statistical Methods for Evaluating the Attainment of Cleanup Standards, Volume 3: Reference Based Standards for Soils and Solid Media.

Figure A-3. Estimated Number of Mercury Samples required for WRS Test Based on Southwest Trenches Data (4005-033.ai)

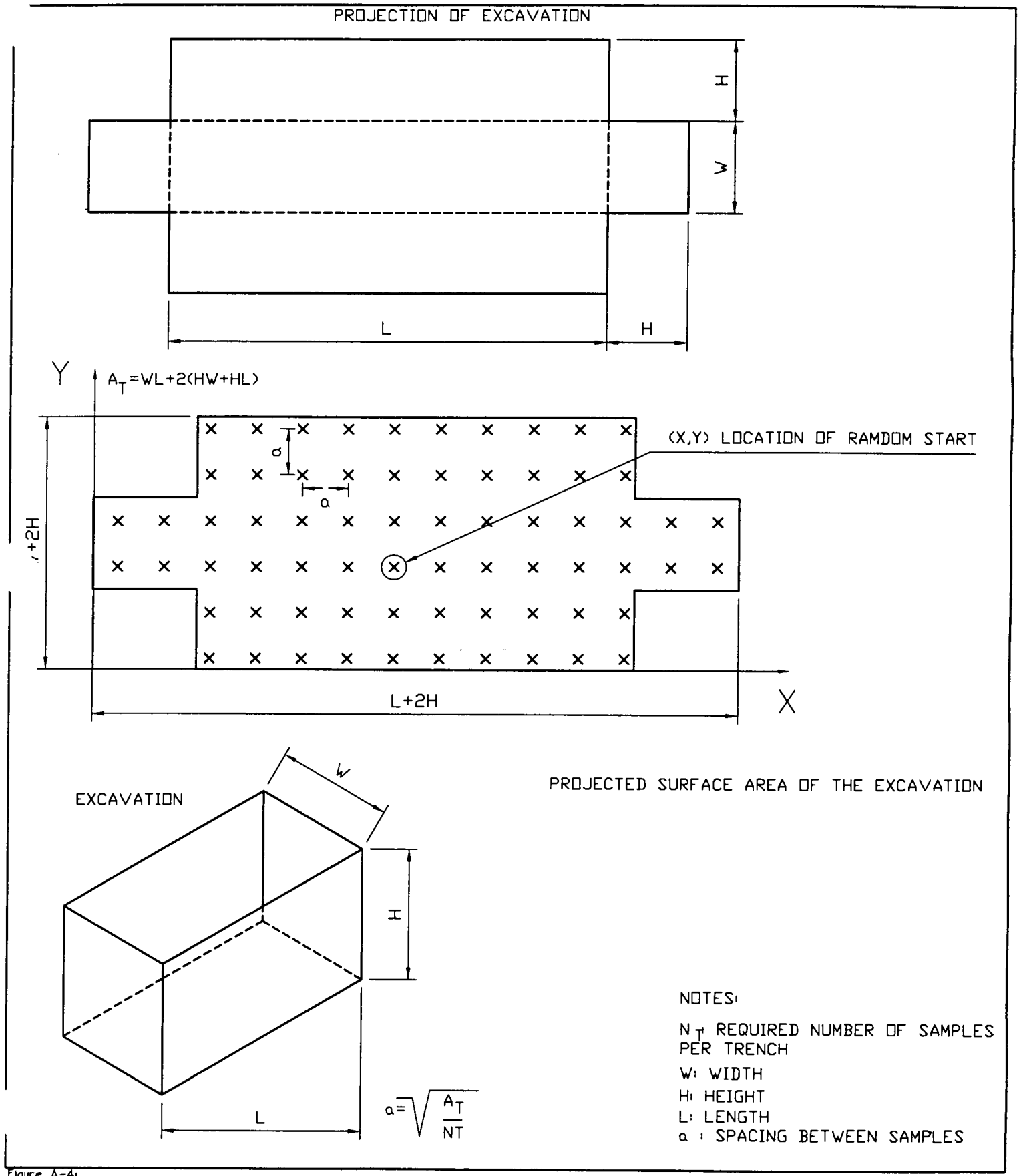

Figure A-4:
Removal Action Areas,DOE Areas of LEHR, UC Davis, California

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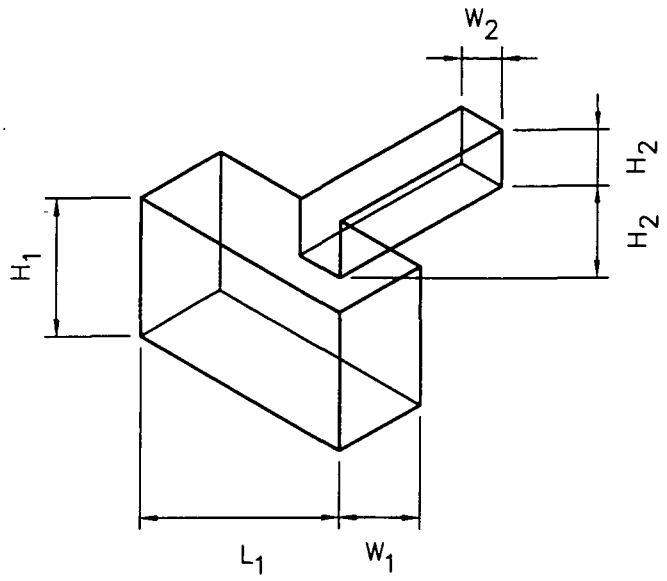

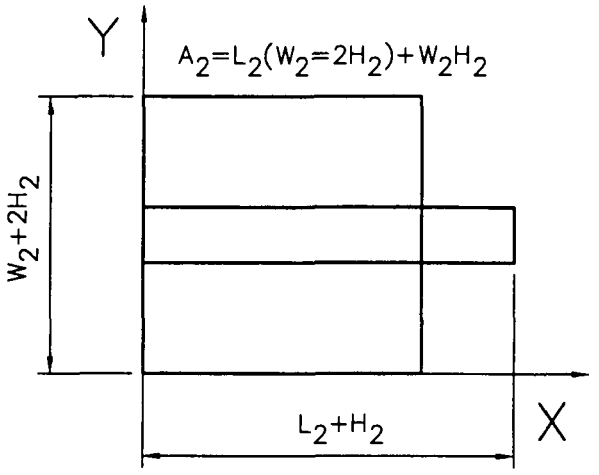

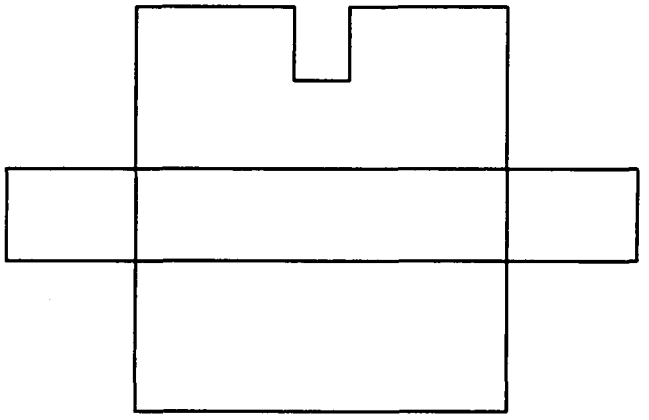

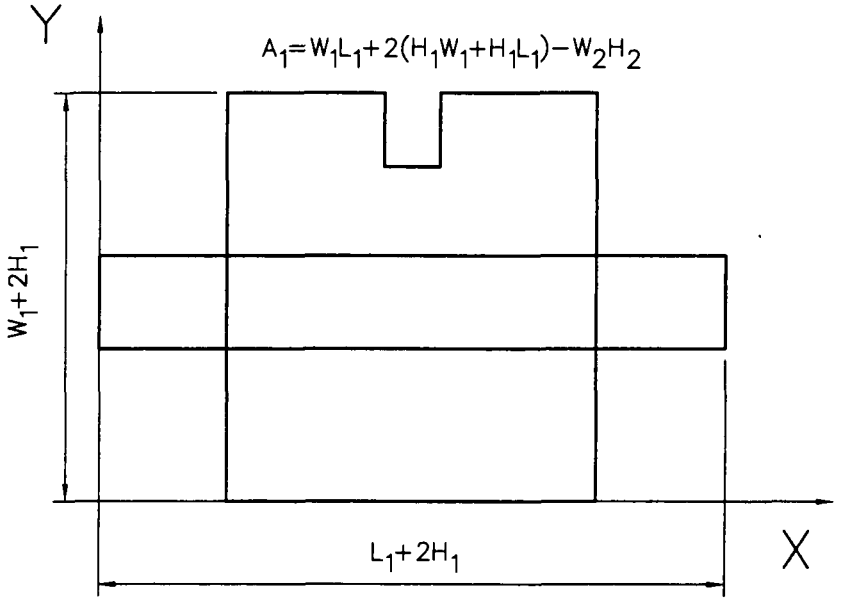

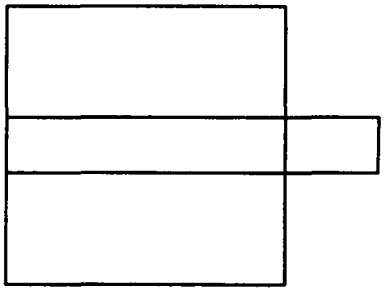

Figure A5:
Example of Box Location For Potenial Trenches, Doe Areas Of The Lehr Site, Davis, Ca.

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ATTACHMENT A

SAMPLING AND ANALYSIS PLAN ADDENDA

U.S. Department of Energy

Oakland Operations Office, Oakland, California

SAMPLING AND ANALYSIS PLAN ADDENDUM – IMPORT FILL MATERIAL

at the:

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH (LEHR)
UNIVERSITY OF CALIFORNIA AT DAVIS, CALIFORNIA

Prepared for:

United States Department of Energy
Oakland Operations Office
1301 Clay Street
Oakland, California 95612-5208

Prepared by:

Weiss Associates
5500 Shellmound Street
Emeryville, CA 94608-2411

April 9, 1999
Rev. 0

DOE Oakland Operations Contract DE-AC03-96SF20686

Weiss Associates
Environmental Science, Engineering and Management

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SAMPLING AND ANALYSIS PLAN 1

Sampling Plan 1

Analysis Plan 2

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Table 2. Import Fill Soil Analytical Parameters

SAMPLING AND ANALYSIS PLAN

This Sampling and Analysis Plan (SAP) is prepared as an addendum to the Sampling and Analysis Plan for the Removal Action (RA) at the Radium/Strontium (Ra/Sr) Treatment Systems Area I (Attachment 1 of the Work Plan). The objective of this sampling and analysis is to assess the suitability of the fill material for use as excavation backfill. In order to determine the suitability/acceptability of the fill material, representative samples will be collected and tested for specific chemical, radiochemical and physical parameters as described below.

Sampling Plan

Approximately 700 cubic yards (CYs) of soil will be required for backfilling the excavations. An offsite source of clean fill soil, preferably within 50 miles of the site, will be identified. The source is required to have a minimum of 1400 CYs of soil available for transport to the LEHR site.

A total of 7 composite samples (4-point composite samples) and 1 field duplicate will be collected from the soil source (equivalent to a minimum frequency of one composite sample per 700 CYs). Sample locations will be selected based on a grid pattern that will be laid out across the soil pile. Grid size and dimensions will be determined once the soil piles have been identified and their dimensions measured. Sample locations within the grid piles will be randomly based. Sample volumes and containers will depend on the analytical parameters and are presented in Table 1.

Sample chain-of-custody records will be prepared according to LEHR Standard Operating Procedure (SOP) 1.1, *Chain of Custody*. Sample handling, packaging, and shipping will be conducted in accordance with SOP 2.1, *Sample Handling, Packaging and Shipping*.

Following sampling, the portions of the soil stockpile sampled will be staked and marked using flagging to identify the sampled portion of the pile. The soil vendors will be informed as not to inadvertently remove the stakes.

The following information will be obtained at the site from the soil vendor:

- The original source of the soil pile including specific use of the material, volume of the soil, depth where it was removed from, and any other former use of the material;
- Physical description of the soil including soil type (silt, sand, clay), color and other visual description; and,
- The expected availability of the soil pile.

Analysis Plan

The import fill soil samples will be analyzed according to Table 2. The analytical methods that will be used are presented in Table 1. All samples (7 samples and 1 field duplicate) will be tested for radionulcides. In addition, 2 samples from each source will be tested for the full suite of constituents of concern (COCs) including metals, volatile organic compounds (VOCs), semi-VOCs, pesticides/PCBs, nitrate, hexavalent chromium. The analytical results will be compared to the background and Risk-based Action Standards (RBAS) developed for the site to determine whether the import fill can be utilized onsite as backfill material.

In addition, one soil sample per source will be tested for permeability using American Society for Testing and Materials (ASTM) Method D5084 and moisture-density relations using ASTM Method D1557. The minimum required hydraulic conductivity was specified in the RA Work Plan Revision D, dated July 22, 1998, as 10^{-4} centimeters per second (cm/sec). In addition, the Work Plan required an in-place field density of 90% of the maximum dry density.

Table 1. Laboratory Analytical Methods for Import Fill Material

Parameter	Analytical Method	Required Detection Limit (pCi/g for radionuclides, mg/kg for chemicals)	Required Sample container/ Volume
Radionuclides:			P,G / 2x16 oz.
Americium-241	Lab SOP	0.01	
Carbon-14	Lab SOP	0.1	
Gamma Emitters	EPA Method 901.1		
Actinium-228		0.1	
Bismuth-212		0.1	
Bismuth-214		0.1	
Cesium-137		0.01	
Cobalt-60		0.005	
Lead-210		0.5	
Lead-212		0.1	
Lead-214		0.1	
Potassium-40		1	
Radium-223		2	
Radium-228		0.1	
Radium-226		0.1	
Thallium-208		0.05	
Thorium-234		0.5	
Thorium-228	Lab SOP	0.1	
Thorium-230	Lab SOP	0.05	
Thorium-232	Lab SOP	0.05	
Gross Alpha	EPA Method 9310	1	
Gross Beta	EPA Method 9310	1	
Plutonium-241	Lab SOP	0.5	
Strontium-90	EPA Method 905.0	0.05	
Tritium	EPA Method 906.0	1	
Uranium-233/234	Lab SOP	0.025	
Uranium-235	Lab SOP	0.01	
Uranium-238	Lab SOP	0.025	
Metals:			
Antimony	CLP SOW ILM 02.1	0.5	G / 8 oz.
Arsenic	CLP SOW ILM 02.1	2	
Barium	CLP SOW ILM 02.1	40	
Beryllium	CLP SOW ILM 02.1	1	
Cadmium	CLP SOW ILM 02.1	0.25	
Chromium (total)	CLP SOW ILM 02.1	1	
Cobalt	CLP SOW ILM 02.1	10	
Copper	CLP SOW ILM 02.1	0.25	
Iron	CLP SOW ILM 02.1	20	
Lead	CLP SOW ILM 02.1	0.3	
Manganese	CLP SOW ILM 02.1	3	

Table 1. Laboratory Analytical Methods for Import Fill Material (continued)

Parameter	Analytical Method	Required Detection Limit (pCi/g for radionuclides, mg/kg for chemicals)	Required Sample container/ Volume
Mercury	CLP SOW ILM 02.1	0.1	
Molybdenum	CLP SOW ILM 02.1	0.1	
Nickel	CLP SOW ILM 02.1	1	
Selenium	CLP SOW ILM 02.1	1	
Silver	CLP SOW ILM 02.1	0.1	
Thallium	CLP SOW ILM 02.1	0.5	
Vanadium	CLP SOW ILM 02.1	1	
Zinc	CLP SOW ILM 02.1	4	
General Chemistry:			G / 8 oz.
Nitrate	EPA Method 300.0	1	
Hexavalent Chromium	EPA Method 3060A/7196	0.05	
Organics:			G / 8 oz.
Volatile Organic Compounds	CLP SOW OLM 03.0	Exhibit C of SOW OLM 03.0	(fill entire jar)
Semi-Volatile Organic Compounds	CLP SOW OLM 03.0	Exhibit C of SOW OLM 03.0	
Organochlorine Pesticides/PCBs	CLP SOW OLM 03.0	Exhibit C of SOW OLM 03.0	
Geotechnical			
Permeability	ASTM D5084	Not Applicable	P / 5 kg
Moisture-Density	ASTM D1557	Not Applicable	P / 5 kg

Abbreviations:

SOP = Standard Operating Procedure
CLP SOW = Contract Laboratory Program Statement of Work
OLM 03.0 = Organic Laboratory Method 03.0.
ILM 02.1 = Inorganic Laboratory Method 02.1.
P = Plastic container
G = Glass container
ASTM = American Society for Testing and Materials

Table 2. Import Fill Soil Analytical Parameters

No. of samples per source	Analytical Parameter	Method
8	Full Suite of Radionuclides	See Table 1
2	Metals, VOCs, SVOCs, Pesticides/PCBs, Nitrate, Hexavalent Chromium.	See Table 1
1	Permeability	ASTM Method D5084
	Moisture-Density	ASTM Method D1557

U.S. Department of Energy

Oakland Operations Office, Oakland, California

SAMPLING AND ANALYSIS PLAN ADDENDUM - HVAC COOLING TOWER WATER

at the:

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH (LEHR)
UNIVERSITY OF CALIFORNIA AT DAVIS, CALIFORNIA

Prepared for:

United States Department of Energy
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SAMPLING AND ANALYSIS PLAN 1

Sampling Plan 1

Analysis Plan 1

SAMPLING AND ANALYSIS PLAN

This Sampling and Analysis Plan (SAP) is prepared as an addendum to the Sampling and Analysis Plan for the Removal Action (RA) at the Radium/Strontium (Ra/Sr) Treatment Systems Area I (Attachment 1 of the Work Plan). This SAP describes the sampling and analysis for the HVAC cooling tower which is located adjacent to Animal Hospital No. 2, Laboratory for Energy-Related Health Research (LEHR) facility, University of California Davis, California. The objective of this sampling and analysis is to assess whether dust exposure generated during RA results in a contamination of the cooling tower water. In order to determine the exposure levels, representative samples will be collected and tested for Ra-226. The HVAC cooling tower has direct air to water contact, and pre-cool water-filled pipes inside AH-1, AH-2 and the accompanying rooms.

Sampling Plan

Sampling of the HVAC cooling tower will consist of collecting water samples via the water discharge outlet located on the south side of the HVAC system. To ensure that a representative sample is collected, approximately 2 to 3 liters of water will be purged from the water discharge outlet before sample collection. Samples will be collected in one-liter plastic containers. These containers will be filled to capacity, capped, sealed with tape and labeled with proper sample ID. The sample will then be prepared for offsite shipment.

Sample frequency is once per week during removal activities. In addition, two reference samples will be collected prior to the start of the RA to establish a baseline level. If a rising trend in Ra-226 concentration is noted, the field engineer may request that more frequent samples be collected.

Sample chain-of-custody records will be prepared according to LEHR Standard Operating Procedure (SOP) 1.1, *Chain of Custody*. Sample handling, packaging, and shipping will be conducted in accordance with SOP 2.1, *Sample Handling, Packaging and Shipping*. Purged water generated during sampling activities will be returned to the cooling tower for reuse.

Analysis Plan

Water samples collected will be shipped offsite to a certified lab for Ra-226 analysis by EPA Method 903.1 (Radon-222 emanation). Turnaround time for the samples will be 1 week. Field duplicate samples will be collected at a rate of 10% for quality control purposes.

U.S. Department of Energy

Oakland Operations Office, Oakland, California

SAMPLING AND ANALYSIS PLAN ADDENDUM - ASPHALT STOCKPILE CHARACTERIZATION

at the:

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH (LEHR)
UNIVERSITY OF CALIFORNIA AT DAVIS, CALIFORNIA

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Table 1-3. Laboratory Analytical Methods for Asphalt Stockpile Characterization

FIGURE

Figure 1-1. Grid Sampling Locations

1. SAMPLING AND ANALYSIS PLAN

This Sampling and Analysis Plan (SAP) is prepared as an addendum to the Sampling and Analysis Plan for the Removal Action (RA) at the Radium/Strontium (Ra/Sr) Treatment Systems Area I (Attachment 1 of the Work Plan). This SAP describes the asphalt stockpile characterization for reuse on-site as backfill material.

1.1 Stockpile Volume

During the RA at Ra/Sr Treatment Systems Area I, the surface asphalt and associated base material (from surface to 0.75 ft below ground surface) was excavated and stockpiled in the Cobalt-60 Field. A total of 154 cubic yards (CY) ex-situ volume of asphalt, gravel and soil was placed in a HDPE cell and covered. One stockpile was created measuring 64 ft. in length and 19 ft. in width. Table 1-1 summarizes the dimensions and approximate volume of the stockpile.

1.2 Sampling Plan

As described in the Work Plan, soil samples will be collected to characterize the stockpile and determine an appropriate use or disposal option. The stockpile sampling summary is presented in Table 1-2 and described below.

- One composite sample will be collected per 20 CY of soil.
- Four discrete samples will be collected and combined to prepare a composite sample.
- Discrete samples will be collected using a clean trowel from a two-dimensional grid system overlying the stockpile.
- Discrete sample locations will be determined using a random number generation.
- Discrete samples will be collected from within 6 inches of the stockpile surface.
- Samples from all four locations will be placed in a stainless steel bowl and homogenized in the field.
- Each composite sample will be placed in two 8-oz glass jars, a Marinelli beaker and a plastic bag.

- Two 8-oz glass jars will be labeled and shipped to the off-site laboratory for analysis.
- The Marinelli beaker and plastic bag will be sealed and labeled for analysis on-site.

A two-dimensional grid system was designed and superimposed on the stockpile (Figure 1-1). Based on the stockpile dimensions, the grid spacing was selected as 2 feet. The stockpile was divided into sections equal or less than 20 CY. Each section contained its own grid system. Within each grid system, grid blocks were assigned consecutive numbers and a random number generator was used to select four grids for composite sample collection. Table 1-2 presents the grid system and stockpile dimensions for each section.

Sample chain-of-custody records will be prepared according to LEHR Standard Operating Procedure (SOP) 1.1, *Chain of Custody*. Sample handling, packaging, and shipping will be conducted in accordance with SOP 2.1, *Sample Handling, Packaging and Shipping*.

1.3 Analysis Plan

The analytical parameters for the asphalt stockpile sampling are presented in Table 1-3 and described below. The analyses will include nitrate and all radionuclides of concern for the Ra/Sr Treatment Systems Area I RA.

- One composite sample will be analyzed per 20 CY of soil for nitrate and full suite of radionuclides by an off-site analytical laboratory;
- One composite sample will be analyzed per 20 CY of soil for radium-226 (Ra-226), cesium-137 (Cs-137) and strontium-90 (Sr-90) by the on-site analytical laboratory;

The on-site laboratory will analyze samples for Ra-226, Cs-137, and Sr-90 using the gamma spectrometer and beta scintillation detector.

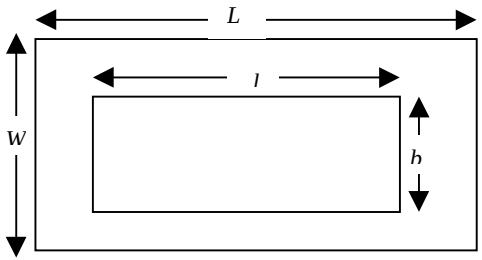
1.4 Quality Control

Field duplicate samples will be collected at a rate of 10%. One duplicate sample will be collected from the composite samples and analyzed for nitrate and full suite of radionuclides. Since reusable sampling equipment is not being used, rinseate equipment blank is not required and will not be collected.

Table 1-1. Asphalt Stockpile Area and Volume Calculation

Stockpile	Base Length, L (ft)	Base Width, W (ft)	Top Width, b (ft)	Top Length, l (ft)	Side, s (ft)	Calculated Height, h (ft)	Calculated Stockpile Volume, Vs (CY)
Asphalt	64	19	15	57	5	4	154

$$Vs = \frac{h \times 0.5 \times (W \times L \times b \times l)}{27}$$



Stockpile Plan View

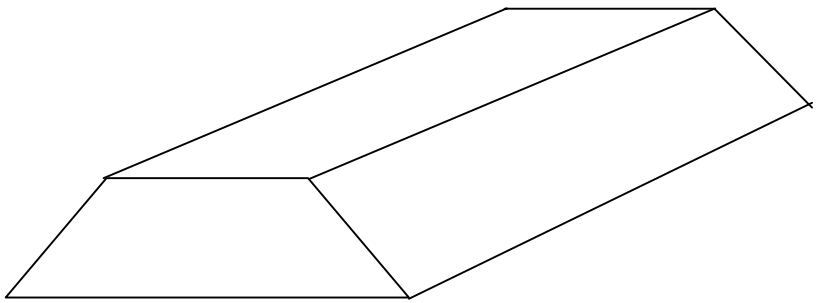


Table 1-2. Asphalt Stockpile Sampling and Analysis Plan

Stockpile Area	Calculated Volume	Composite ID	Corresponding Grid	Analysis Off-site	Analysis On-site
Area A	17 CY	CWRSC002	27, 4, 15, 9	Nitrate and Radionuclides	Ra-226, Sr-90, Cs-137
Area B	20 CY	CWRSC003	33, 8, 24, 38	Nitrate and Radionuclides	Ra-226, Sr-90, Cs-137
Area C	20 CY	CWRSC004	21, 25, 2, 13	Nitrate and Radionuclides	Ra-226, Sr-90, Cs-137
Area D	20 CY	CWRSC005	19, 23, 6, 28	Nitrate and Radionuclides	Ra-226, Sr-90, Cs-137
Area E	20 CY	CWRSC006	22, 7, 29, 31	Nitrate and Radionuclides	Ra-226, Sr-90, Cs-137
Area E (Field Duplicate)	20 CY	CWRSC007	22, 7, 29, 31	Nitrate and Radionuclides	Ra-226, Sr-90, Cs-137
Area F	20 CY	CWRSC008	11, 16, 7, 12	Nitrate and Radionuclides	Ra-226, Sr-90, Cs-137
Area G	20 CY	CWRSC009	25, 22, 14, 19	Nitrate and Radionuclides	Ra-226, Sr-90, Cs-137
Area H	17 CY	CWRSC010	28, 27, 12, 10	Nitrate and Radionuclides	Ra-226, Sr-90, Cs-137

Table 1-3. Laboratory Analytical Methods for Asphalt Stockpile Characterization

Parameter	Analytical Method	Required Detection Limit (pCi/g for radionuclides, mg/kg for chemicals)
General Chemistry:		
Nitrate-N	EPA Method 300.0	1
Radionuclides:		
Americium-241	Lab SOP	0.01
Carbon-14	Lab SOP	0.1
Gamma Emitters	EPA Method 901.1	
Actinium-228		0.1
Bismuth-212		0.1
Bismuth-214		0.1
Cesium-137		0.01
Cobalt-60		0.005
Lead-210		0.5
Lead-212		0.1
Lead-214		0.1
Potassium-40		1
Radium-223		2
Radium-228		0.1
Thallium-208		0.05
Thorium-234		0.5
Radium-226*	EPA Method 901.1	0.1
Gross Alpha	EPA Method 9310	1
Gross Beta	EPA Method 9310	1
Plutonium-241	Lab SOP	0.5
Strontium-90	EPA Method 905.0	0.05
Tritium	EPA Method 906.0	1
Thorium-228	Lab SOP	0.1
Thorium-230	Lab SOP	0.05
Thorium-232	Lab SOP	0.05
Uranium-233/234	Lab SOP	0.025
Uranium-235	Lab SOP	0.01
Uranium-238	Lab SOP	0.025

SOP = standard operating procedure

* = 30-day in-growth and 1000-minute count-time

Area A				Area B				Area C				Area D				Area E				Area F				Area G				Area H			
10	11	30	31	10	11	30	31	10	11	30	31	10	11	30	31	10	11	30	31	10	11	30	31	10	11	30	31	10	11	30	31
9	12	29	32	9	12	29	32	9	12	29	32	9	12	29	32	9	12	29	32	9	12	29	32	9	12	29	32	9	12	29	32
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4	17	24	37	4	17	24	37	4	17	24	37	4	17	24	37	4	17	24	37	4	17	24	37	4	17	24	37	4	17	24	37
3	18	23	38	3	18	23	38	3	18	23	38	3	18	23	38	3	18	23	38	3	18	23	38	3	18	23	38	3	18	23	38
2	19	22	39	2	19	22	39	2	19	22	39	2	19	22	39	2	19	22	39	2	19	22	39	2	19	22	39	2	19	22	39
1	20	21	40	1	20	21	40	1	20	21	40	1	20	21	40	1	20	21	40	1	20	21	40	1	20	21	40	1	20	21	40

Figure 1-1. Grid Sampling Locations

U.S. Department of Energy

Oakland Operations Office, Oakland, California

SAMPLING AND ANALYSIS PLAN ADDENDUM - DESIGNATED LEVEL FOR THE SOUTHWEST TRENCHES AREA

at the

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

Prepared for:

United States Department of Energy
Oakland Operations Office
1301 Clay Street
Oakland, California 95612-5208

Prepared by:

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October 18, 1999
Rev. 0

DOE Oakland Operations Contract DE-AC03-96SF20686

Weiss Associates
Environmental and Geologic Services

SAMPLING AND ANALYSIS PLAN ADDENDUM
DESIGNATED LEVEL FOR THE SOUTHWEST TRENCHES AREA

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U.S. Department of Energy
Oakland Operation Office
1301 Clay Street
Oakland, California 94612-5208

Prepared by:

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

October 18, 1999
Rev. 0

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Program Manager
Weiss Associates

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FIGURE

Figure 1. Designated Level Soil Boring Locations

TABLE

Table 1. Sampling and Analysis for Southwest Trenches Designated Level

ACRONYMS

bgs	below ground surface
C-14	carbon-14
COC	constituent of concern
Cs-137	cesium-137
DL	Designated Level
H-3	tritium
IDW	Investigation Derived Waste
LEHR	Laboratory for Energy-Related Health Research
RA	Removal Action
SWT	Southwest Trenches
UCD	University of California Davis
USCS	Unified Soil Classification System
WA	Weiss Associates

1. SAMPLING AND ANALYSIS PLAN

This Sampling and Analysis Plan (SAP) is prepared as an addendum to the Sampling and Analysis Plan for the Removal Action (RA) at the Southwest Trenches Area (Attachment 1 of the Work Plan). This document presents the approach and procedures for the Designated Level (DL) sampling and analysis in the Southwest Trenches (SWT) Area, at the Laboratory for Energy-Related Health Research (LEHR) facility, University of California Davis (UCD), California. The objective of this sampling and subsequent evaluation of the data is to estimate whether residual concentrations of specific constituents in soil will potentially impact ground water. These specific constituents were identified during the DL analysis performed as part of the SWT RA Phase II Data Evaluation. The results of the SWT RA Phase II Data Evaluation are presented in the Draft Southwest Trenches Removal Action Confirmation Report (WA, 1999a). In addition, this SAP includes descriptions and rationale for the sampling activities, procedures for fieldwork, quality assurance/quality control (QA/QC), and data management.

The DL evaluation identified five constituents of concern (COCs) that require additional evaluation: cesium-137 (Cs-137), tritium (H-3), carbon-14 (C-14), mercury and nitrate. These are subsequently referred to as DL COCs. This sampling plan is designed to delineate the vertical extent of contamination associated with Cs-137, H-3 and C-14. Nitrate contamination has been previously delineated and the results are presented in the Draft Southwest Trenches Removal Action Confirmation Report (WA, 1999a). Mercury will not be investigated at this time due to pending determination of background concentrations in stratified soils that may eliminate mercury as a DL COC.

1.1 Sampling Plan

This section describes the location and number of samples that will be collected to evaluate potential impact to ground water by the DL COCs. In general, samples will be collected at two locations for each DL COC. The locations are those with the highest and second highest activity for each COC as indicated by confirmation sample analytical data. Soil samples will be collected at each location on five-feet intervals, with the first sample collected ten feet below ground surface (bgs), and the last sample collected at 30 feet bgs. Therefore, approximately five samples will be collected from each boring. Figure 1 shows the approximate locations of the six borings along with the boring ID and target DL COC (see also Table 1). At two locations, DL-3 and DL-4, the last soil sample will be collected at 45 feet bgs and a groundwater sample will be collected. The water table in this area is estimated to be approximately forty-eight feet bgs. The borings will be advanced until groundwater is encountered, at which point, water samples will be collected and analyzed for the three DL COCs.

Each boring will be continuously cored using a direct-push sampling rig. Soil samples will be collected in a core barrel lined with a butyrate liner. The diameter of the boring will be 1-11/16 inches. The soil cores will be screened by the field geologist and radiological technician for indications of contamination. The field geologist, using the Unified Soil Classification System (USCS), will describe and document the lithology of the soil cores. The butyrate liner will be cut to provide a 6-inch long sample that will be labeled for laboratory analysis. The ends of the liner will be covered with Teflon sheets and capped with tight fitting plastic caps. The samples will be given unique ID numbers and placed in a cooler for transport to the laboratory under chain-of-custody procedures. In addition, 10% duplicate samples will be collected for quality control purposes.

All downhole drilling equipment will be steam cleaned prior to arrival on-site, and will be cleaned between each borehole using an Alconox detergent-water wash, potable water rinse, and a final de-ionized water rinse. Investigation derived waste (IDW), consisting of soil cuttings and decon water, will be placed in drums and sampled for disposal. Upon completion of the fieldwork, all borings will be grouted to the surface with a cement grout containing 3-5% bentonite by weight.

Soil sample collection will be conducted in accordance with SOP 3.1, Surface and Shallow Subsurface Soil Sampling. Sample chain-of-custody records will be prepared in accordance with SOP 1.1, Chain of Custody. Sample handling, packaging, and shipping will be conducted in accordance with SOP 2.1, Sample Handling, Packaging and Shipping.

1.2 Analytical Plan

The soil samples will be analyzed as specified in Table 1. Analyses will be performed on a standard 45-day turnaround time.

2. SAMPLING AND ANALYSIS PROCEDURES

2.1 Soil Sample Collection

All soil samples will be collected in accordance with SOP 3.1, Surface and Shallow Subsurface Soil Sampling.

2.2 Sample Documentation

The usability of the data obtained during this investigation will depend on its quality. A number of factors relate to data quality. Sample collection methods are as important to consider as the methods used for sample analysis. Following proper procedures for both sample collection and analysis reduces sampling and analytical error. To ensure sample integrity, samples will be handled using complete Chain-of-Custody documentation and preserved using proper sample preservation techniques, holding times, and proper shipment methods. Obtaining valid and comparable data also requires adequate QA/QC procedures and documentation.

The components of the sample documentation and custody system will include the following:

- Chain-of-Custody Form,
- Field Logbook/Field Activity Daily Log,
- Sample Numbers,
- Sample Labels; and,
- Custody Seals.

2.2.1 Chain-of-Custody

Chain-of-Custody forms will be completed by the sample team members to track sample custody as well as to specify the requested analyses. Chain-of-Custody forms will be completed in accordance with the requirements of SOP 1.1.

2.2.2 Field Logbook/Field Activity Daily Log

Descriptions and observations made during field and sampling activities will be documented in the field logbook and/or field activity daily log. The following will be recorded in the field logbook and/or field activity daily log:

- Project name and number;
- Location of site;
- Purpose of sampling;
- Description of field activities;
- Names of sampling personnel;
- Date and time of entries;
- Sample medium description using the Unified Soil Classification System (USCS);
- Date and time of sample collection;
- Sample locations, Identification (ID) number and methodology;
- Field observations;
- Results of field measurements; and,
- Results of field calibrations for instruments used.

2.2.3 Sample Numbers

The sample matrix will be identified by "SS" for soil sample. Since these samples will be collected from SWT Area for DL, they will be identified by the nomenclature DTDL. Samples will be numbered sequentially. Therefore, the first soil sample collected will be identified as SSDTDL01.

2.2.4 Sample Labels

Sample labels will be attached to individual sample containers and will contain the following information:

- Project number;
- Sample ID number;
- Date and time collected;
- Initials of sampler; and,
- Requested analyses.

2.2.5 Custody Seals

Custody seals will be used to detect tampering and will be placed over the lid of the shipping container and annotated with the following information:

- Date and time; and,
- Initials of sampler.

3. QUALITY ASSURANCE AND DATA MANAGEMENT

The quality assurance requirements applicable to the sampling activities at SWT Area are detailed in the QAPP for the environmental restoration activities at the LEHR site (Weiss, 1998b). This plan is based upon the requirements of DOE Order 5700.6c *Quality Assurance* and EPA QAMS-005/80 *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* as they are applicable to the scope of work. Additional task-specific quality assurance requirements are detailed in the SOPs.

The samples collected for this investigation will be analyzed by General Engineering Laboratories, Inc. (GEL) in Charleston, South Carolina. Laboratory reports (hard copies and electronic files) will be forwarded from the laboratories to the Weiss Associates Data Validation Chemist. These results will be validated and transferred to the project database by the Weiss Associates Database Manager in accordance with procedures described in the QAPP (Weiss Associates, 1998a).

4. REFERENCES

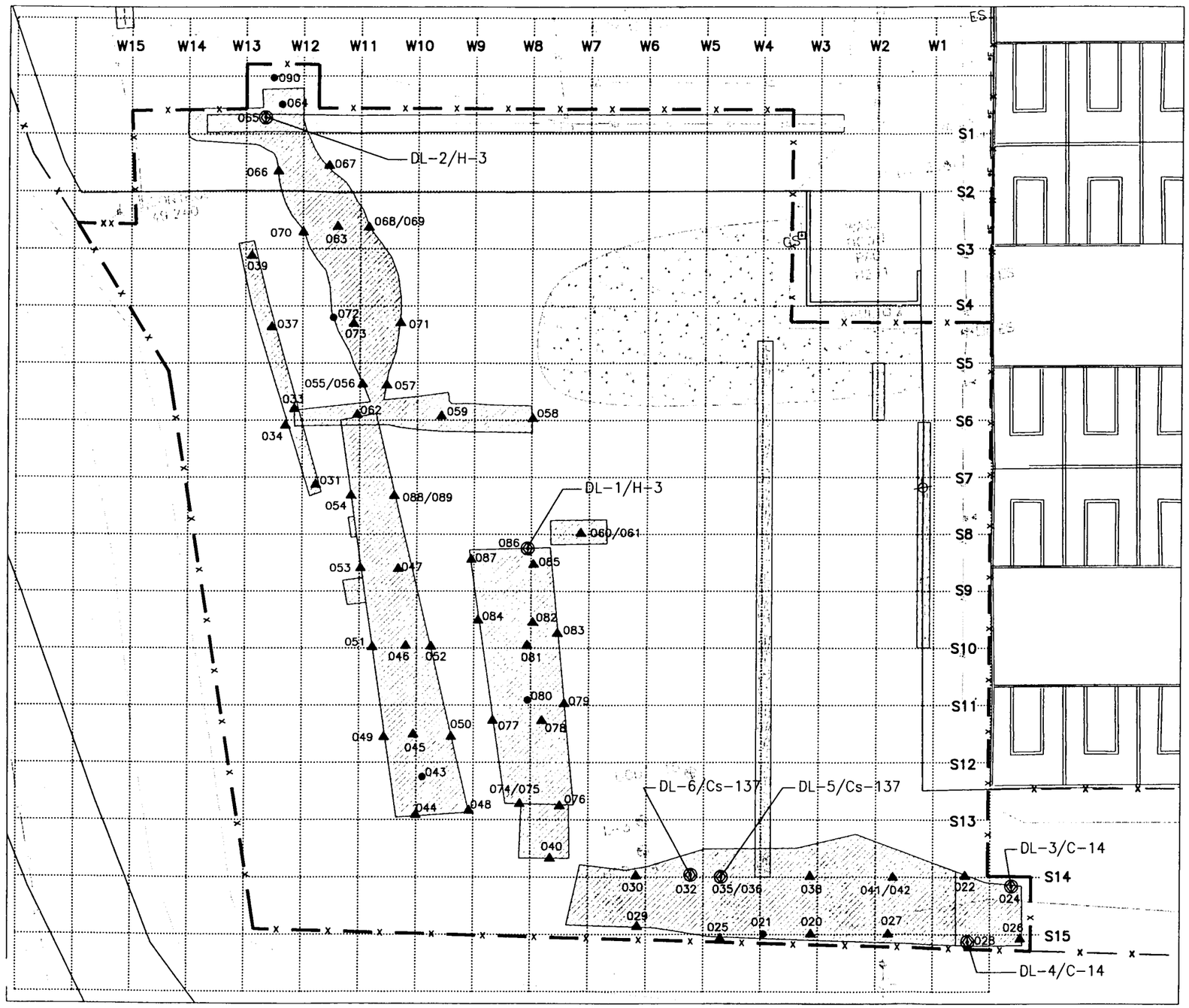
Weiss Associates (WA), 1998a, Final Quality Assurance Project Plan (QAPP) for the Laboratory for Energy-Related Health Research (LEHR), University of California at Davis, February.

WA, 1998b, Standard Operating Procedures (SOPs) for the Environmental Restoration/Waste Management, Laboratory for Energy-Related Health Research (LEHR), University of California at Davis, July.

WA, 1999a, Draft Southwest Trenches Area Removal Action Confirmation Report for the Laboratory for Energy-Related Health Research (LEHR), University of California at Davis, April.

WA, 1999b, Draft Final Work Plan for Removal Actions in the Southwest Trenches, Radium/Strontium Treatment Systems and Domestic Septic System Areas for LEHR, University of California at Davis, June.

FIGURE



LEGEND

— x — x —	LIMITS OF SOUTHWEST TRENCHES RA AREA
▲ 520	RANDOM CONFIRMATION SAMPLE LOCATION AND NUMBER
● 090	HOT SPOT CONFIRMATION SAMPLE LOCATION
060/061	CONFIRMATION SAMPLE ID/DUPLICATE SAMPLE ID
	AREA OF EXCAVATED WASTE AND SOIL
	AREA OF SHALLOW GRAVEL (APPROX. 0-1.5' BGS)
	AREA OF SHALLOW COBBLES (APPROX. 1.5-3' BGS)
DL-5/Cs-137	LOCATION ID/DESIGNATED LEVEL COC

0' 5' 10' 20' 40'

SCALE: 1" = 20'

FIGURE 1. DESIGNATED LEVEL SOIL BORING LOCATIONS

WEISS ASSOCIATES

TABLE

Table 1. Sampling and Analysis for Southwest Trenches Designated Level

Parameter	Confirmation Sample with Highest DL(1) COC(2) Activity	Boring ID(3)	Drilling Depth (ft. bgs[4])	Soil Sample	Soil Volume	Water Sample(5)	Water Volume	Analytical Method(6)	Required Detection Limit for Soil (pCi/g)	Required Detection Limit for Water (pCi/L)	TAT(8)
Tritium	SSDTC086	DL-1	30	5	6-inch tube	No	250 ml	EPA Method 906.0	1.00	700	45-day
Tritium	SSDTC065	DL-2	30	5	6-inch tube	No	250 ml	EPA Method 906.0	1.00	700	45-day
Carbon-14	SSDTC027	DL-3	45	8	6-inch tube	Yes	1 liter	Lab SOP(7)	0.10	50	45-day
Carbon-14	SSDTC028	DL-4	45	8	6-inch tube	Yes	1 liter	Lab SOP	0.10	50	45-day
Cesium-137	SSDTC035	DL-5	30	5	2 x 6-inch tube	No	2 liters (with HNO_3)	EPA Method 901.1	0.01	10	45-day
Cesium-137	SSDTC032	DL-6	30	5	2 x 6-inch tube	No	2 liters (with HNO_3)	EPA Method 901.1	0.01	10	45-day

Notes:
(1) DL = Designated Level
(2) COC = Constituent of Concern
(3) Samples will be collected in each boring from 10, 15, 20, 25, and 30 ft bgs.
(4) bgs = below ground surface
(5) Water samples will be collected from borings DL-3 and DL-4 only.
(6) Holding time is 6 months.
(7) SOP = Standard Operating Procedure
(8) TAT = Turnaround Time

ATTACHMENT II

WASTE MANAGEMENT PLAN

U.S. Department of Energy

Oakland Operations Office, Oakland, California

SAMPLING AND ANALYSIS PLAN ADDENDUM - AISLE 3 OF THE WESTERN DOG PENS

(FOLLOWING THE REMOVAL OF THE STOCKPILES GENERATED FROM THE SOUTHWEST TRENCHES REMOVAL ACTION)

at the

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH (LEHR)
UNIVERSITY OF CALIFORNIA AT DAVIS, CALIFORNIA

Prepared for:

United States Department of Energy
Oakland Operations Office
1301 Clay Street
Oakland, California 95612-5208

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July 12, 2000
Rev. 0

DOE Oakland Operations Contract DE-AC03-96SF20686

Weiss Associates
Environmental Science, Engineering and Management

SAMPLING AND ANALYSIS PLAN ADDENDUM - AISLE 3 OF THE WESTERN DOG PENS

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Project Manager
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Program Manager
Weiss Associates

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FIGURES

Figure 1-1. Location of Aisle 3 of the Western Dog Pens

Figure 2-1. Grid and Sample Locations, Aisle 3 of Western Dog Pens

TABLE

Table 2-1. Containers and Holding Times for Laboratory Analytical Methods Planned for Aisle 3 of the Western Dog Pens

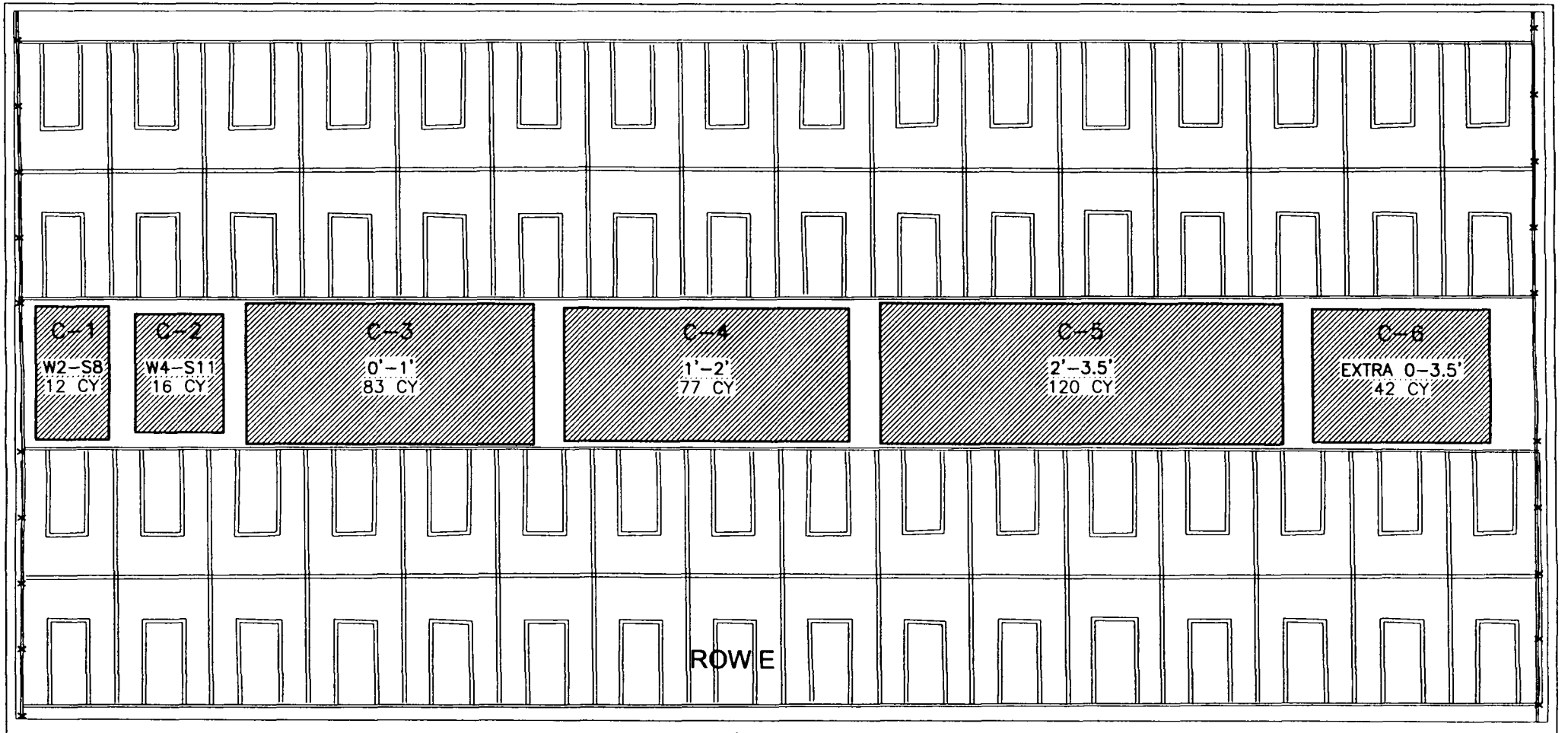
ACRONYMS

bgs	below ground surface
GEL	General Engineering Laboratories, Inc.
ID	Identification
LEHR	Laboratory for Energy-Related Health Research
mg/kg	milligrams per kilogram
pCi/g	picoCuries per gram
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
Ra-226	radium-226
SOP	Standard Operating Procedure
Sr-90	strontium-90
UC Davis	University of California at Davis

1. INTRODUCTION

This Sampling and Analysis Plan (SAP) is prepared as an addendum to the Sampling and Analysis Plan for the Removal Action (RA) at the Radium/Strontium (Ra/Sr) Treatment Systems Area I (Attachment 1 of the Work Plan). This document presents the approach and procedures for the investigation of surface soil in Aisle 3 of the Western Dog Pens at the Laboratory for Energy-Related Health Research (LEHR), University of California at Davis (UC Davis) (Figure 1-1). In addition, it includes descriptions and rationale for the sampling activities, procedures for fieldwork, quality assurance/quality control (QA/QC), and data management.

Chlordane-impacted soil generated during the Southwest Trenches Removal Action in 1998 was stockpiled and wrapped in visqueen in Aisle 3 of the Western Dog Pens (third paved aisle counting from the north [see Figure 1-1]). Subsequently, in September 1999, the soil piles were loaded in dump trucks and transported off-site for disposal. In order to confirm that soil was not displaced from the transport equipment during loading activities, samples will be collected from surface soil within Aisle 3.



SOIL PILE / WASTE LOG

NON-HAZ	NON-HAZ	RCRA HAZ	RCRA HAZ	RCRA HAZ	CAL-HAZ
C-1 W2,S8	C-2 W4,S11	C-3 0'-1'	C-4 1'-2'	C-5 2'-3.5'	C-6 EXTRA 0'-3.5'
CWDTC 001 CWDTC 021	CWDTC 002	CWDTC 005 CWDTC 006 CWDTC 007 CWDTC 008 CWDTC 022	CWDTC 009 CWDTC 010 CWDTC 011 CWDTC 012 CWDTC 013 CWDTC 023 CWDTC 024	CWDTC 014 CWDTC 015 CWDTC 016 CWDTC 017 CWDTC 018 CWDTC 019 CWDTC 020 CWDTC 025 CWDTC 026	CWDTC 003 CWDTC 004

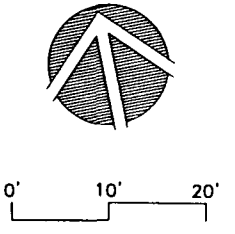


FIGURE 1-1. LOCATION OF AISLE 3 OF THE WESTERN DOG PENS

WEISS ASSOCIATES

2. SAMPLING AND ANALYSIS PLAN

This section describes the sampling and analysis plan to be used during the sampling activities in Aisle 3 of the Western Dog Pens. All work will be conducted in accordance with the Quality Assurance Project Plan (QAPP; Weiss Associates, 1998a) and the appropriate Standard Operating Procedures (SOPs; Weiss Associates, 1998b).

Soil sample collection will be conducted in accordance with SOP 3.1, Surface and Shallow Subsurface Soil Sampling. Sample chain-of-custody records will be prepared in accordance with SOP 1.1, Chain of Custody. Sample handling, packaging, and shipping will be conducted in accordance with SOP 2.1, Sample Handling, Packaging and Shipping. Samples will be collected from appropriate locations as described below.

2.1 Sampling Approach

Chlordane-impacted soil that was stored in stockpiles at Aisle 3 was properly characterized and designated for disposal. Of the six soil piles, three piles (piles C-3, C-4, and C-5) were determined to contain chlordane at levels above the Federal hazardous levels and was thus designated as RCRA hazardous waste (see Figure 2-1). These piles contained the highest detection of chlordane, and hence samples will be taken from the location of these piles. In addition, the location of former pile C-6, at the western end of the aisle, will be sampled since the loader exited the aisle through this area.

The area of Aisle 3 for sample collection is approximately 180 feet long and 20 feet wide. To determine sampling locations, the area was divided into four rows 45 ft in length and four columns 5 feet wide. Using random number generation, four sample locations were selected to represent each of the four rows and columns of the grid (see Figure 2-1). A duplicate sample will be collected at one location for QC purposes.

2.2 Analytical Plan

Four surface (0-3” bgs) soil samples will be collected and analyzed for chlordane and the full suite of radionuclide constituents. Analyses will be performed on a standard 45-day turnaround time. Table 2-1 presents the complete list of analytical parameters and methods.

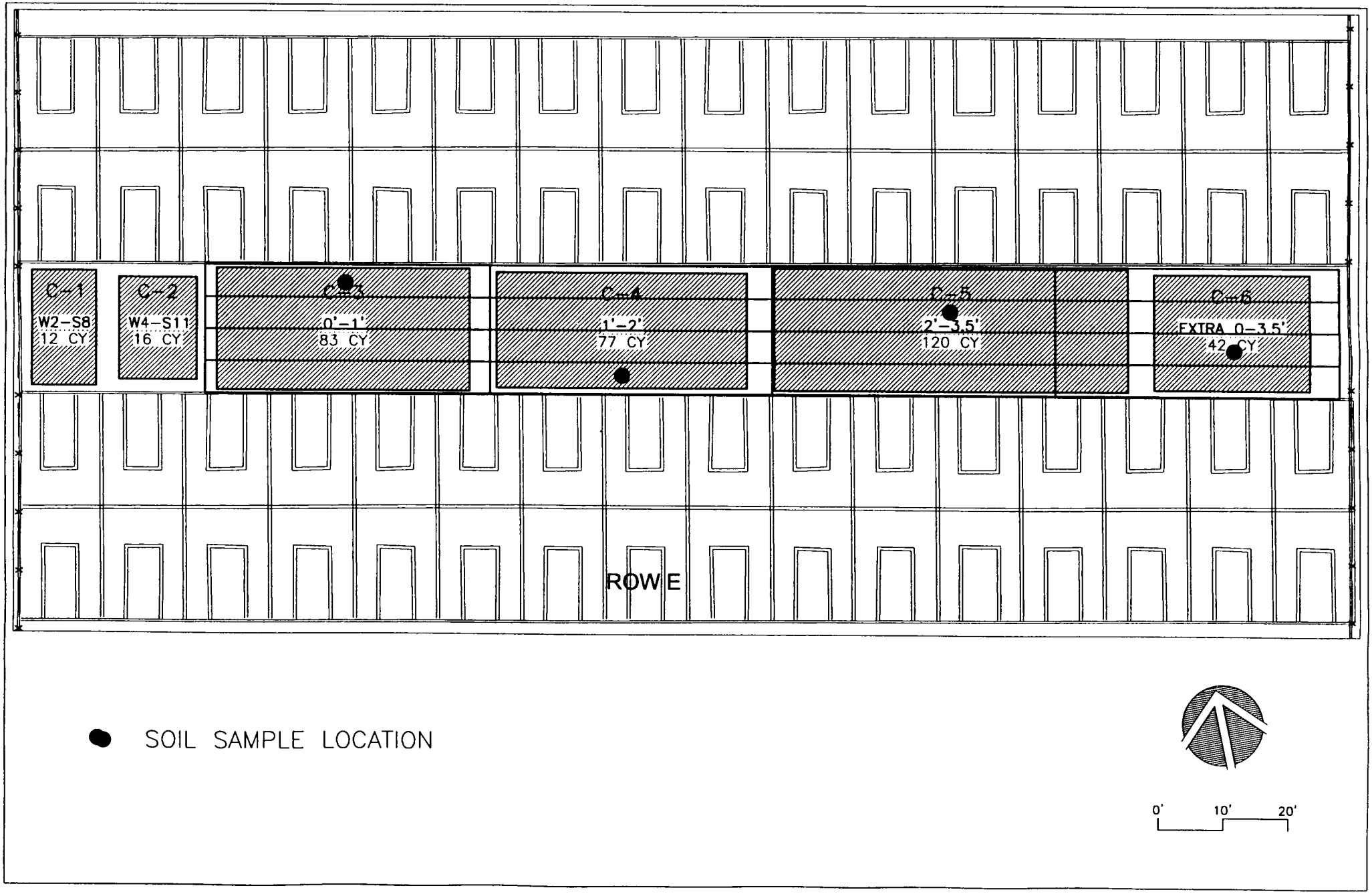


FIGURE 2-1. GRID AND SAMPLE LOCATIONS, AISLE 3 OF WESTERN DOG PENS

WEISS ASSOCIATES

Table 2-1. Containers and Holding Times for Laboratory Analytical Methods Planned for Aisle 3 of the Western Dog Pens

Parameter	Analytical Method	Holding Time
Radionuclides (2 x 16-oz P/G):		
Americium-241	Lab SOP	6 months
Carbon-14	Lab SOP	6 months
Gamma Emitters	EPA Method 901.1	6 months
Actinium-228		
Bismuth-212		
Bismuth-214		
Cesium-137		
Cobalt-60		
Lead-210		
Lead-212		
Lead-214		
Potassium-40		
Radium-223		
Radium-228		
Radium-226*		
Thallium-208, 234		
Thorium-228, 230, 232	Lab SOP	6 months
Gross Alpha	EPA Method 9310	6 months
Gross Beta	EPA Method 9310	6 months
Plutonium-241	Lab SOP	6 months
Strontium-90	EPA Method 905.0	6 months
Tritium	EPA Method 906.0	6 months
Uranium-233/234, 235, 238	Lab SOP	6 months
Organics (1 x 8-oz G):		
Chlordane	EPA Method 8080	14 days to extraction, 40 days to analysis of extracts

Abbreviations:
P = Plastic container
G = Glass container
oz = ounces
* = 30-day ingrowth-time and 1000-minute count-time

3. SAMPLING AND ANALYSIS PROCEDURES

3.1 Soil Sample Collection

All soil samples will be collected with a trowel in accordance with SOP 3.1.

3.2 Sample Documentation

The usability of the data obtained during this investigation will depend on its quality. A number of factors relate to data quality. Sample collection methods are as important to consider as the methods used for sample analysis. Following proper procedures for both sample collection and analysis reduces sampling and analytical error. To ensure sample integrity, samples will be handled using complete Chain-of-Custody documentation and preserved using proper sample preservation techniques, holding times, and proper shipment methods. Obtaining valid and comparable data also requires adequate QA/QC procedures and documentation.

The components of the sample documentation and custody system will include the following:

- Chain-of-Custody Form,
- Field Logbook/Field Activity Daily Log,
- Sample Numbers,
- Sample Labels; and,
- Custody Seals.

3.2.1 Chain-of-Custody

Chain-of-Custody forms will be completed by the sample team members to track sample custody as well as to specify the requested analyses. Chain-of-Custody forms will be completed in accordance with the requirements of SOP 1.1.

3.2.2 Field Logbook/Field Activity Daily Log

Descriptions and observations made during field and sampling activities will be documented in the field logbook and/or field activity daily log. The following will be recorded in the field logbook and/or field activity daily log:

- Project name and number;
- Location of site;
- Purpose of sampling;
- Description of field activities;
- Names of sampling personnel;
- Date and time of entries;
- Sample medium description using the Unified Soil Classification System (USCS);
- Date and time of sample collection;
- Sample locations, Identification (ID) number and methodology;
- Field observations;
- Results of field measurements; and,
- Results of field calibrations for instruments used.

3.2.3 Sample Numbers

The sample matrix will be identified by "SS" for soil sample. Since these samples will be collected from Aisle 3 of the Western Dog Pens, they will be identified by the nomenclature WDP and A. Samples will be numbered sequentially. Therefore, the first soil sample collected will be identified as SSWDPA01.

3.2.4 Sample Labels

Sample labels will be attached to individual sample containers and will contain the following information:

- Project number;
- Sample ID number;
- Date and time collected;
- Initials of sampler; and,
- Requested analyses.

3.2.5 Custody Seals

Custody seals will be used to detect tampering and will be placed over the lid of the shipping container and annotated with the following information:

- Date and time; and,
- Initials of sampler.

4. QUALITY ASSURANCE AND DATA MANAGEMENT

The quality assurance requirements applicable to the sampling activities at Aisle 3 of the Western Dog Pens are detailed in the QAPP for the environmental restoration activities at the LEHR site (Weiss, 1998b). This plan is based upon the requirements of DOE Order 5700.6c *Quality Assurance* and EPA QAMS-005/80 *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* as they are applicable to the scope of work. Additional task-specific quality assurance requirements are detailed in the SOPs.

The samples collected for this investigation will be analyzed by General Engineering Laboratories, Inc. (GEL) in Charleston, South Carolina. Laboratory reports (hard copies and electronic files) will be forwarded from the laboratories to the Weiss Associates Data Validation Chemist. These results will be validated and transferred to the project database by the Weiss Associates Database Manager in accordance with procedures described in the QAPP (Weiss Associates, 1998a).

5. REFERENCES

Final Quality Assurance Project Plan (QAPP) for the Laboratory for Energy-Related Health Research, University of California at Davis, California, Weiss Associates, 1998a.

Standard Operating Procedures (SOPs) for the Environmental Restoration/Waste Management, Laboratory for Energy-Related Health Research, University of California at Davis, California, Weiss Associates, 1998b.

U.S. Department of Energy

Oakland Operations Office, Oakland, California

SAMPLING AND ANALYSIS PLAN ADDENDUM – RA/SR AREA II TREE CHARACTERIZATION

at the:

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH (LEHR)
UNIVERSITY OF CALIFORNIA AT DAVIS, CALIFORNIA

Prepared for:

United States Department of Energy
Oakland Operations Office
1301 Clay Street
Oakland, California 95612-5208

Prepared by:

Weiss Associates
5801 Christie Ave., Suite 600
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May 31, 2000
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Weiss Associates
Environmental Science, Engineering and Management

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SAMPLING AND ANALYSIS PLAN 1

Sampling Plan 1

Analysis Plan 2

Documentation 2

SAMPLING AND ANALYSIS PLAN ADDENDUM

This Sampling and Analysis Plan (SAP) is an addendum to the Sampling and Analysis Plan for the Removal Action (RA) at the Radium/Strontium (Ra/Sr) Treatment Systems Area I (Attachment 1 of the Work Plan). This SAP Addendum describes the sampling and analysis for a tree located above the former Strontium-90 (Sr-90) Leach Field, between Animal Hospital No. 1 and Animal Hospital No. 2, at the Laboratory for Energy-related Health Research (LEHR), University of California, Davis (see Figure 1). A sample will also be collected from a tree of the same species as a background sample. The analytical results will be used to assess whether the tree contains above-background levels of Sr-90, cesium-137 (Cs-137) and/or radium-226 (Ra-226). The objective of this sampling is to characterize the Ra/Sr Area II tree for off-site disposal.

Sampling Plan

The tree samples will be collected between one and three feet above ground surface from the trunk of the tree. The bark will be removed from the sample area prior to sampling. The trunk of the tree will be drilled with a large diameter (> 1 inch) drill bit to the maximum depth that the drill bit allows. Sample locations will be determined in the field but will generally follow these guidelines: 20 locations spaced evenly around the tree and between one and three feet above ground surface. Leaves and branches will be collected randomly using hand shears or available pruning equipment. The volume of the wood shavings from the drilling (50%) and branches with leaves (50%) will be one tightly packed gallon.

If a background tree of the same species has not been cut down within the last year on campus, then branches and leaves will be removed from a live tree with the consent of UC Davis. If UC Davis does not grant consent or if a onsite tree of the same species is unavailable, then an off-site tree will be identified and sampled.

Sample chain-of-custody records will be prepared according to LEHR Standard Operating Procedure (SOP) 1.1, *Chain of Custody*. Sample handling, packaging, and shipping will be conducted in accordance with SOP 2.1, *Sample Handling, Packaging and Shipping*.

Analysis Plan

The sample IDs will be CWRST003 for the sample from the tree above the leach field, and CWRSCT004 for the background sample. The tree samples will be shipped off-site to a certified lab for Ra-226 and Cs-137 analysis by gamma spectroscopy and for Sr-90 analysis by EPA Method 905.0. The minimum detectable activities for Ra-226, Sr-90 and Cs-137 are 0.1 pCi/g, 0.05 pCi/g and 0.01 pCi/g, respectively. The turnaround time for the samples will not exceed 30 days.

Documentation

The location of the samples will be documented in the field. The tree condition, date and time and any other pertinent field observations will also be noted.

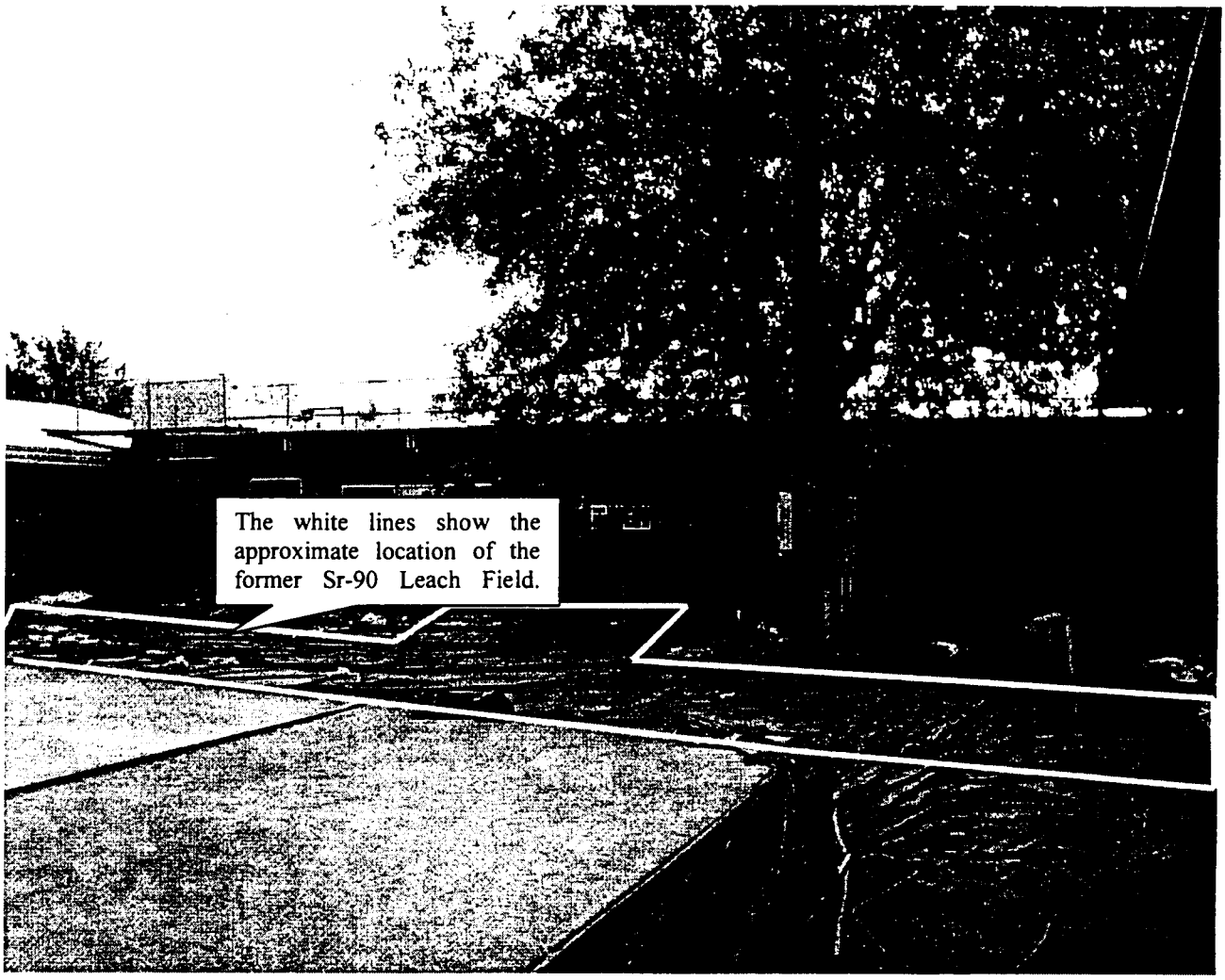

Figure 1. The location of the former Sr-90 Leach Field and tree to be sampled.

U.S. Department of Energy

Oakland Operations Office, Oakland, California

SAMPLING AND ANALYSIS PLAN ADDENDUM
IMPORT FILL MATERIAL

at the:

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UNIVERSITY OF CALIFORNIA, DAVIS

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Weiss Associates
Environmental Science, Engineering and Management

SAMPLING AND ANALYSIS PLAN ADDENDUM
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Table 1-2. Import Fill Soil Analytical Parameters

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Figure 1-2. Ten-Point Composite Sample Grid Locations (Sample SSRSB009)

Figure 1-3. Ten-Point Composite Sample Grid Locations
(Samples SSRSB010 and SSRSB011 [Field Duplicate])

ACRONYMS

ASTM	American Society for Testing Materials
LEHR	Laboratory for Energy-Related Health Research
PRG	preliminary remediation goal
Ra/Sr	Radium/Strontium
Ra-226	radium-226
RBAS	risk-based action standard
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure

1. SAMPLING AND ANALYSIS PLAN ADDENDUM

This Sampling and Analysis Plan (SAP) is prepared as an addendum to the Sampling and Analysis Plan for the Removal Action at the Radium/Strontium (Ra/Sr) Treatment Systems Area II (Attachment 1 of the *Draft Work Plan for Removal Actions in the Southwest Trenches, Ra/Sr Treatment Systems, and Domestic Septic System Areas* (Weiss, 1999a)). The objective of this sampling and analysis is to assess the suitability of the fill material for use as excavation backfill. In order to determine the suitability/acceptability of the fill material, representative samples will be collected and tested for specific chemical, radiochemical and physical parameters as described below.

1.1 Background

Approximately 1,400 cubic yards of import fill is currently stockpiled near the eastern edge of the Laboratory for Energy-Related Health Research (LEHR) Site (the Site). The fill material was obtained from Manley & Sons Trucking, Inc. of West Sacramento. The material originated from a location near the Site and was used for levee construction by the U.S. Army Corps of Engineers in the 1960s. On April 9, 1999, a total of seven (four-point) composite samples and one field duplicate were collected from the soil source. The soil currently stockpiled at the Site originated from the same stockpile in West Sacramento from which samples were collected last year. Based on a review of the analytical results from the samples collected last year, the import fill material does not contain chemicals and radionuclides at concentrations significantly above background, risk-based action standards (RBASs) or residential preliminary remediation goals (PRGs) (Weiss, 1999b).

1.2 Sampling Plan

To confirm that the import fill material discussed above is suitable for use as backfill, two additional samples will be collected. Two (ten-point) composite samples and one field duplicate will be collected from import fill that is currently stockpiled near the eastern edge of the Site. Sample locations were selected based on a grid pattern that was laid out across the soil pile. Sample locations within the grid piles were selected using a random number generator. Figures 1-1 through 1-3 show the locations for Samples SSRSB009 through SSRSB011. Discrete samples will be composited in the field. Sample volumes and containers will depend on the analytical parameters and are presented in Table 1-1.

Sample chain-of-custody records will be prepared according to LEHR Standard Operating Procedure (SOP) 1.1, Chain of Custody (Weiss, 1999c). Sample handling, packaging, and shipping

will be conducted in accordance with SOP 2.1, Sample Handling, Packaging and Shipping (Weiss, 1999c).

Following sampling, the portions of the sampled soil stockpile will be staked and marked with flagging to identify the sampled portion of the pile.

1.3 Analysis Plan

The import fill soil samples will be analyzed according to Table 1-2. The analytical methods that will be used are presented in Table 1-1. All samples (two samples and one field duplicate) will be tested for radionuclides. Sample SSRSB009 will have a 14-day ingrowth period for radium-226 (Ra-226) analysis with an accelerated turnaround time. Sample SSRSB010 and the field duplicate, Sample SSRSB011, will have a 30-day ingrowth period for Ra-226 and a normal turnaround time. In addition, the samples will be tested for metals, volatile organic compounds, semi-volatile organic compounds, pesticides/polychlorinated biphenyls, nitrate, and hexavalent chromium. The analytical results will be compared to background, RBASs and residential PRGs to determine whether the import fill can be utilized on site as backfill material.

In addition, Sample SSRSB011 will be tested for permeability using American Society for Testing Materials (ASTM) Method D-5084, and moisture-density using ASTM Method D-1557. The minimum required hydraulic conductivity is specified as 10^{-4} centimeters per second in the Draft Work Plan (Weiss, 1999a). In addition, the Draft Work Plan (Weiss, 1999a) requires an in-place density of 90% of the maximum dry density.

2. REFERENCES

Weiss Associates (Weiss), 1999a, Draft Work Plan for Removal Actions in the Southwest Trenches, Ra/Sr Treatment Systems, and Domestic Septic System Areas at the Laboratory for Energy-Related Health Research (LEHR), University of California at Davis, California, May, Rev. D.

Weiss, 1999b, Memorandum from Robert O. Devany to Susan Fields, U.S. Department of Energy, re. Ra/Sr Treatment Systems Removal Action Import Fill Soil Analytical Results, June 8.

Weiss, 1999c, Final Standard Operating Procedures for the: Environmental Restoration/Waste Management Laboratory for Energy-Related Health Research (LEHR), University of California at Davis, California, December.

TABLES

Table 1-1. Laboratory Analytical Methods for Import Fill Material

Parameter	Analytical Method	Required Detection Limit (pCi/g for Radionuclides, mg/kg for Metals/General Chemistry)	Required Sample Container/ Volume
Radionuclides:			P/1x2-L
Americium-241	Lab SOP	0.01	
Carbon-14	Lab SOP	0.1	
Gamma Emitters	EPA Method 901.1		
Actinium-228		0.1	
Bismuth-212		0.1	
Bismuth-214		0.1	
Cesium-137		0.01	
Cobalt-60		0.005	
Lead-210		0.5	
Lead-212		0.1	
Lead-214		0.1	
Potassium-40		1	
Radium-223		2	
Radium-228		0.1	
Thallium-208		0.05	
Thorium-234		0.5	
Radium-226 (*)	EPA Method 901.1	0.1	
Thorium-228	Lab SOP	0.1	
Thorium-230	Lab SOP	0.05	
Thorium-232	Lab SOP	0.05	
Gross Alpha	EPA Method 9310	1	
Gross Beta	EPA Method 9310	1	
Plutonium-241	Lab SOP	0.5	
Strontium-90	EPA Method 905.0	0.05	
Tritium	EPA Method 906.0	1	
Uranium-233/234	Lab SOP	0.025	
Uranium-235	Lab SOP	0.01	
Uranium-238	Lab SOP	0.025	
Metals:	CLP SOW ILM 03.0		G/8 oz.
Antimony		0.5	
Arsenic		2	
Barium		40	
Beryllium		1	
Cadmium		0.25	
Chromium (total)		1	
Cobalt		10	
Copper		0.25	
Iron		20	
Lead		0.3	
Manganese		3	

Table 1-1. Laboratory Analytical Methods for Import Fill Material (continued)

Parameter	Analytical Method	Required Detection Limit (pCi/g for Radionuclides, mg/kg for Metals/General Chemistry)	Required Sample Container/ Volume
Mercury		0.1	
Molybdenum		0.1	
Nickel		1	
Selenium		1	
Silver		0.1	
Thallium		0.5	
Vanadium		1	
Zinc		4	
General Chemistry:			G/8 oz.
Nitrate	EPA Method 300.0	1	
Hexavalent Chromium	EPA Method 3060A/7196	0.05	
Organics:			G/8 oz.
Volatile Organic Compounds	CLP SOW OLM 03.1	Exhibit C of SOW OLM 03.1	(fill entire jar)
Semi-Volatile Organic Compounds	CLP SOW OLM 03.1	Exhibit C of SOW OLM 03.1	
Organochlorine Pesticides/PCBs	CLP SOW OLM 03.0	Exhibit C of SOW OLM 03.0	
Geotechnical			
Permeability	ASTM D5084	Not Applicable	P/5 kg
Moisture-Density	ASTM D1557	Not Applicable	P/5 kg

Abbreviations:

(*)	=	14-day/30-day ingrowth time and 1,000-minute count time are required.
ASTM	=	American Society for Testing Materials
CLP SOW	=	Contract Laboratory Program Statement of Work
EPA	=	U.S. Environmental Protection Agency
G	=	glass container
ILM 03.0	=	Inorganic Laboratory Method 03.0
kg	=	kilogram
mg/kg	=	milligram per kilogram
OLM 03.0	=	Organic Laboratory Method 03.0
oz.	=	ounce(s)
P	=	plastic container
PCBs	=	Polychlorinated biphenyls
pCi/g	=	picoCuries per gram
SOP	=	Standard Operating Procedure

Table 1-2. Import Fill Soil Analytical Parameters

Number of Samples	Analytical Parameter	Method
3	Full Suite of Radionuclides, Metals, VOCs, SVOCs, Pesticides/PCBs, Nitrate, and Hexavalent Chromium	See Table 1-1

Abbreviations:

VOCs = Volatile organic compounds
SVOCs = Semi-volatile organic compounds
PCBs = Polychlorinated biphenyls

FIGURES

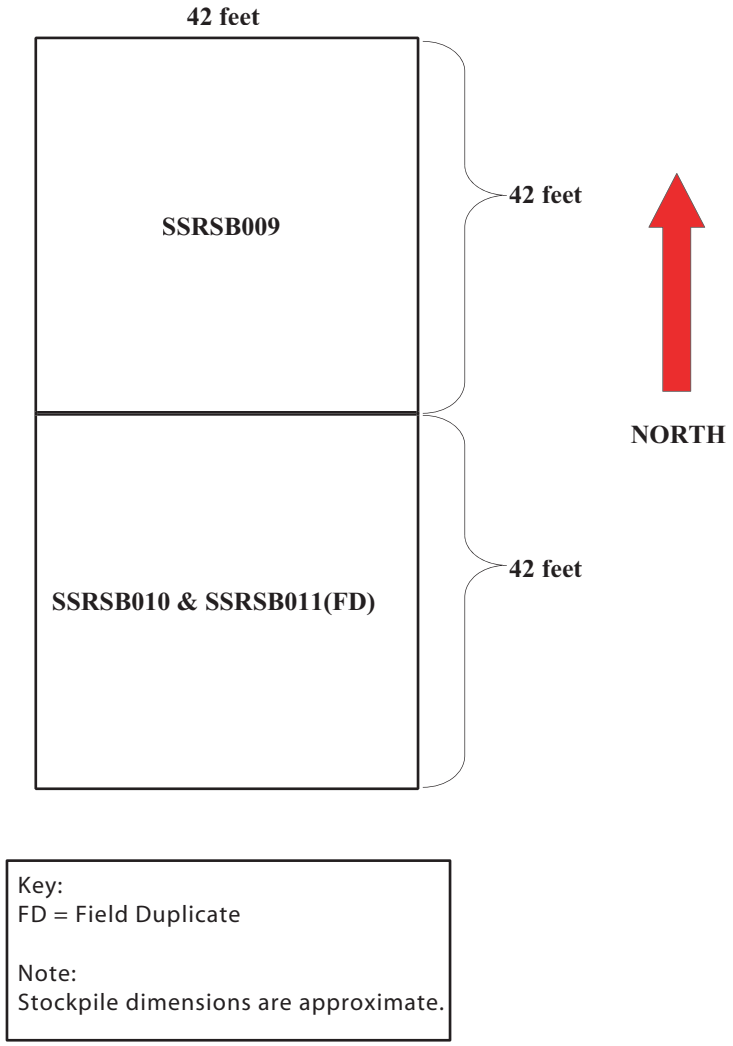

Figure 1-1. Import Fill Stockpile Sampling Locations

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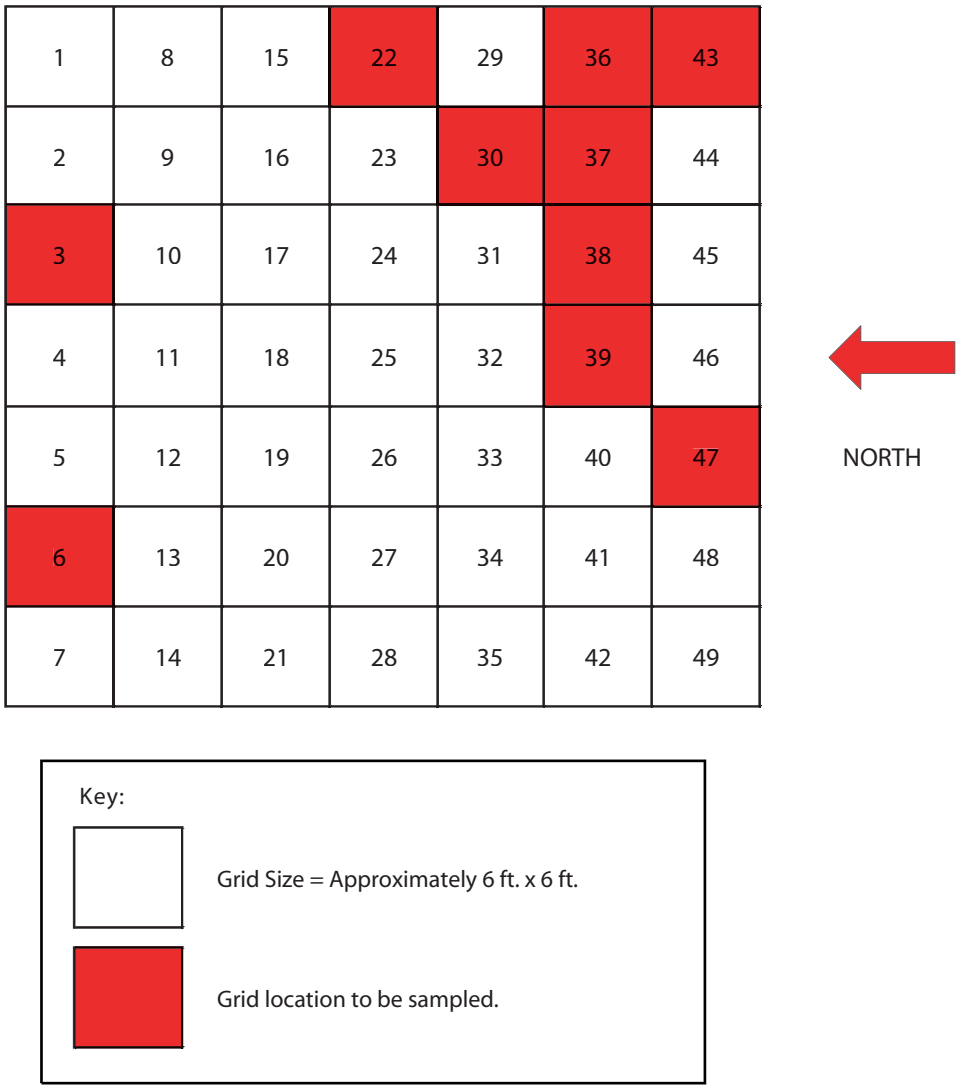

Figure 1-2. Ten-Point Composite Sample Grid Locations (Sample SSRSB009)

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1	8	15	22	29	36	43
2	9	16	23	30	37	44
3	10	17	24	31	38	45
4	11	18	25	32	39	46
5	12	19	26	33	40	47
6	13	20	27	34	41	48
7	14	21	28	35	42	49

NORTH

Key:

Grid Size = Approximately 6 ft. x 6 ft.

Grid location to be sampled.

Note:
Grid Location 30 will be sampled twice.

Figure 1-3. Ten-Point Composite Sample Grid Locations
(Samples SSRSB010 and SSRSB011 [Field Duplicate])

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Oakland Operations Office, Oakland, California

WASTE MANAGEMENT PLAN FOR REMOVAL ACTIONS IN THE SOUTHWEST TRENCHES, RA/SR TREATMENT SYSTEMS, AND DOMESTIC SEPTIC SYSTEM AREAS

at the

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH
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Environmental Science, Engineering and Management

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at the

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Figure 1-2 Waste Management Organizational Chart

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ACRONYMS

AH-1	Animal Hospital No. 1
COC	constituent of concern
cu yd	cubic yard
D&D	decontamination and decommissioning
DA	Database Administrator
DECON	decontamination (water)
DOE	United States Department of Energy
DSS	Domestic Septic System
EPA	Environmental Protection Agency
FPI	Field Personnel of Interest
ft bgs	feet below ground surface
FWC	Field Waste Coordinator
FY	Fiscal Year
gal.	gallon(s)
GEL	General Engineering Laboratories, Inc.
Ger-I	Geriatrics Building No. 1
H-3	tritium
HDPE	high density polyethylene
HW	hazardous waste

IDW	investigation-derived waste
LEHR	Laboratory for Energy-Related Health Research
LLW	low-level radioactive waste
MW	mixed waste
NH	non-hazardous waste
pCi/g	picoCuries per gram
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan for Environmental Restoration/Waste Management
RA	removal action
Ra/Sr	Radium/Strontium
RCRA	Resource Conservation and Recovery Act
RCTs	Radiation Control Technicians
RMMA	Radioactive Materials Management Area
RPP	Radiological Protection Plan
RSO	Radiation Safety Officer
SCC	Southern Cargo Container
SOP	Standard Operating Procedure
Sr-89/90	strontium-89/90
SVOC	semi-volatile organic compound
SWT	Southwest Trenches
TGD for WM	Technical Guidance Document for Waste Management
TRU	transuranic
UDM	Unique Domains Method

VOC	volatile organic compound
WAC	waste acceptance criteria
WB	Waste Broker
WC	Waste Coordinator
WDP	Western Dog Pens
WMP	Waste Management Plan
WP	work plan
WPO	Waste Packaging Observer
WS	Waste Specialist
WTS	Waste Tracking System
WTSC	Waste Tracking System Coordinator
µg/kg	microgram per kilogram

1. INTRODUCTION

This Waste Management Plan (WMP) provides information on the excavation, characterization, handling, containment, storage and disposal of waste streams associated with the Southwest Trenches (SWT), Radium/Strontium (Ra/Sr) Treatment Systems and Domestic Septic System (DSS) Areas Removal Actions (RAs) (Figure 1-1) at the Laboratory for Energy-Related Health Research (LEHR). This WMP supports the Work Plan (2000c) and details procedures developed for and specific to RA waste management activities.

1.1 Waste Stream Descriptions

The scope of this WMP is to describe the management practices for existing and anticipated waste streams associated with the SWT, Ra/Sr, and DSS RAs. The anticipated and/or potential waste stream types include:

- Non-Hazardous Waste and Material (NH)
  - Soil
  - Miscellaneous debris (asphalt, concrete, wood, etc.)
- Low-Level Radioactive Waste (LLW)
  - Soil and gravel
  - Liquid and sludge
  - Miscellaneous debris (asphalt, concrete, wood, etc.)
- Hazardous Waste (HW)
  - Soil
  - Liquid and sludge
  - Miscellaneous debris (asphalt, concrete, wood, etc.)
- Mixed Waste (MW)
  - Liquid and sludge
  - Miscellaneous debris (asphalt, concrete, wood, etc.)

Waste streams that are not covered by the project WMP or this WMP will be handled under separate waste management plan updates that will be developed as the need arises.

1.2 Constituents of Concern and Analytic Methods

Based on the Final Site Characterization Report (WA, 1997) and the Draft Final Engineering Evaluation/Costs Analysis (WA, 1998b) three sets of constituents of concern (COCs) were established for the three scheduled RAs. COCs for the SWT and Ra/Sr RAs are listed below in Tables 1-1 and 1-2, respectively. The COCs for the DSS RA are radium-226 (Ra-226) and mercury only. Field and analytical methods for the RA waste characterization are presented in Table 1-3.

1.3 Schedule

All SWT RA waste streams, with the exception of nitrate-impacted soils, will be disposed by December 31, 2000. The nitrate-impacted soil is discussed further in Section 2.3.1 of this WMP. All Ra/Sr and DSS waste streams will be disposed by December 31, 2002. The waste stream disposal schedule is presented in Table 1-4.

1.4 Regulatory Drivers and Standard Operating Procedures

This document references the Technical Guidance Document for Waste Management at LEHR (TGD for WM) (IT Corp, 1999), the LEHR Radiological Protection Plan (RPP) (1998c) and LEHR Standard Operating Procedures (SOPs) (WA, 1998d). Detailed descriptions of regulations governing waste classification, containment, storage, labeling, management and inspection are provided in Tables 1 and 2 of the TGD for WM. The SOPs used to develop this document are summarized below:

- SOP 1.1, Chain-of-Custody
- SOP 2.1, Sample Handling, Packaging and Shipping
- SOP 6.1, Sampling Equipment and Well Material Decontamination
- SOP 12.1, Soil Stockpiling
- SOP 17.1, Sample Labeling
- SOP 17.2, Sample Numbering
- SOP 18.1, Field QC Sampling
- SOP 19.1, On-Site Sample Storage
- SOP 20.1, Sample Containers, Preservation and Holding Times
- SOP 21.1, Data Validation
- SOP 24.1, Radiological Areas and Postings
- SOP 25.1, Radiological Surveys and Instrumentation

- SOP 31.1, Lead Characterization, Packaging and Shipping
- SOP 32.1, Contamination Control
- SOP 34.1, Waste Processing and Packaging
- SOP 34.2, Low-Level Radioactive Waste Storage
- SOP 34.3, Waste Shipment
- SOP 34.4, Clean Waste Handling
- SOP 34.5, Waste Tracking System
- SOP 35.1, Waste Certification
- SOP 39.1, Waste Management Program Inspection
- SOP 42.2, Building Survey Procedures

1.5 Definitions

The following terms are defined for use in this WMP.

Waste: Any material, solid or liquid, generated as a result of the RAs that requires disposal.

Hazardous Waste: Waste Material that meets the HW definition under Federal Environmental Protection Agency (EPA) Resource Conservation and Recovery Act (RCRA), 40 CFR Part 261; California Hazardous Waste Regulations in Title 22 of the California Code of Regulations; and DOE orders.

Low-Level Radioactive Waste, also referred to as *Low-Level Waste:* Waste that contains radioactivity and is not classified as high-level waste, transuranic (TRU) waste, or spent nuclear fuel or 11E(2) by-product material as defined by DOE Order 5820.2A. A test specimen of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as LLW provided the concentration of transuranic materials is less than 100 nanoCuries per gram. (DOE Order 5820.2A).

Mixed Waste: Waste classified as both LLW and HW (Federal and State) based on the definitions above.

Non-Hazardous Waste: Waste material that does not meet the definition of applicable federal and/or state HW laws and regulations.

1.6 Key-Personnel Responsibilities

Proper management of LEHR RA waste streams requires contributions from various LEHR project team members. The responsibilities of selected team members are described below. A waste management organizational chart is presented as Figure 1-2.

1.6.1 Waste Coordinator

The Waste Coordinator's (WC) primary function is to ensure that the WMP is executed as designed, that all waste is packaged, stored, labeled, inspected and surveyed in accordance to applicable federal and state regulations and according to LEHR management practices as prescribed in the project SOPs, the LEHR RPP and the TGD for WM. In addition, the WC or designee signs all waste manifests.

1.6.2 Field Waste Coordinator

The Field Waste Coordinator (FWC) is responsible for the day-to-day implementation of the WMP at the LEHR site and reports to the WC and the LEHR Project Manager. The FWCs primary responsibilities include waste identification, segregation and packaging, identification of required waste containers, review of packaging logs, preparation of disposal documents, authorization of container closure and transfer to the waste storage/staging facility; supervision of the WPOs and ensuring that waste characterization samples are collected. At the time of waste generation, the FWC or designee, initiates a Waste Tracking Sheet. The FWC has the overall responsibility of ensuring that the Waste Tracking Sheets are completed properly prior to submission to the Waste Program Database Administrator (DA) prior to entry into the Waste Tracking System (WTS) database.

1.6.3 Waste Tracking System Coordinator

The Waste Tracking System Coordinator's (WTSC) primary responsibilities include reviewing waste tracking sheets for completeness and ensuring that this information is properly input into the WTS database by reconciling WTSs with electronic database file printouts.

1.6.4 Waste Program Database Administrator

The Primary responsibilities of the DA include maintenance of the WST database, including transcription of Waste Tracking Sheets into electronic files. The DA will update the database as soon as possible after he/she receives changes recorded on Waste Tracking Sheet updates. Following the electronic update, the DA will provide the WTSC with a copy of the electronic file and Waste Tracking Sheets to compare with the field waste tracking forms.

1.6.5 Field Personnel of Interest

The Field Personnel of Interest (FPI) are responsible for performing all sampling of the waste and are qualified to initiate and complete Waste Tracking Sheets or may provide the WPO, or FWC with required information so they can complete the Waste Tracking Sheet.

1.6.6 Waste Specialist

The Waste Specialist (WS) is responsible for evaluating analytical data, designating project waste streams, completing waste profiles and coordinating with waste disposal facilities.

1.6.7 Waste Packaging Observer

The WPO is a trained individual, preferably, but not limited to, an RCT that observes the excavation and loading of all waste materials into storage containers. The WPO is responsible for directing waste segregation, documenting waste package contents, completing container logs and submitting them to the FWC or designee for daily review.

1.6.8 Waste Broker/Agent

The Waste Broker (WB) is responsible for the safe and proper shipment of waste materials as assigned by the WC.

Table 1-1. Constituents of Concern in the Southwest Trenches Area

Analyte	Maximum Activity/ Concentration	Sample No.	Sample Matrix	Location of Maximum Detection	Depth (ft bgs)	Sample Date
Radionuclides (pCi/g)						
Cesium-137	23.0	S-350	Soil	Grid 7-9	5	Jul-96
Strontium-90	16,700	S-340	Sludge	T-2, T-6	6.5	Jul-96
Radium-226	7.06	S-338	Gravel	T-2	6.5	Jul-96
Gross alpha	16.7	S-357	Soil	T-6, Pit No. 2	14.5	Jul-96
Gross beta	34,700	S-340	Sludge	T-2, T-6	6.5	Jul-96
Tritium (pCi/L)	91.1	S-347	Gravel	T-5	1.5	Jul-96
Lead-214	4.3	S-342	Plastic Bag	T-2	3.5	Jul-96
Uranium-235	2.6	S-362	Wood	T-6, Pit No. 1	12	Jul-96
Actinium-228	5.5	S-342	Plastic Bag	T-2	3.5	Jul-96
Carbon-14	117.0	S-339	Bone	T-2	6	Jul-96
Thallium-208	0.6	S-340	Sludge	T-2, T-6	6.5	Jul-96
Potassium-40	16.7	S-473	Soil	SB-7	21	Aug-96
Bismuth-214	1.68	S-356	Soil	T-6	1	Jul-96
Cobalt-60	0.04	S-340	Sludge	T-2, T-6	6.5	Jul-96
Thorium-234	39.5	S-362	Wood	T-6, Pit No. 1	12	Jul-96
Metals (mg/kg)						
Arsenic	9.7	S-481	Soil	SB-8	30	Aug-96
Barium	270	S-336	Soil	T-2	3.5	Jul-96
Beryllium	4.80	---	Soil	SB-20	0.0	Mar-90
Chromium VI	1.2	---	Soil	SB-19	0.0	Mar-90
Total Chromium	250	S-349	Soil	T-5	4	Jul-96
Cobalt	35.00	---	Soil	SB-21	10.0	Mar-96
Copper	890	S-340	Sludge	T-2	6.5	Jul-96
Iron	46,000	S-352	Soil	Grid 7-9	3.5	Jul-96
Lead	49	S-340	Sludge	T-2	6.5	Jul-96
Manganese	1,000	S-357	Soil	T-6	14.4	Jul-96
Mercury	5.2	S-483	Soil	SW Corner of Site	3	Aug-96
Nickel	420	S-495	Soil	Washdown Pad	3-4.5	Aug-96
Selenium	1.5	S-340	Sludge	T-2	6.5	Jul-96
Vanadium	82	S-481	Soil	SB-8	30	Aug-96
Zinc	730	S-340	Sludge	T-2	6.5	Jul-96

Table 1-1. Constituents of Concern in the Southwest Trenches Area (continued)

Analyte	Maximum Activity/ Concentration	Sample No.	Sample Matrix	Location of Maximum Detection	Depth (ft bgs)	Sample Date
VOCs (mg/kg)						
Benzene	0.001	S-359	Gravel	7-6, Pit No. 1	12	Jul-96
Carbon tetrachloride	0.044	S-352	Soil	Grid 7-9	3.5	Jul-96
Ethylene benzene	1.2	S-362	Wood	T-6, Pit No. 1	12	Jul-96
2-Hexanone	0.075	S-362	Wood	T-6, Pit No. 1	12	Jul-96
Methylene chloride	0.03760	---	Soil	UCD1-15	N/A	Mar-96
Toluene	0.49	S-362	Wood	T-6, Pit No. 1	12	Jul-96
Styrene	0.80	S-362	Wood	T-6, Pit No. 1	12	Jul-96
Xylenes	6.2	S-362	Wood	T-6, Pit No. 1	12	Jul-96
SVOCs (mg/kg)	30,947	S-362	Wood	T-6, Pit No. 1	12	Jul-96
Pesticides (mg/kg)						
Chlordane	2,000	---	Soil	T-06	N/A	1988
1,1-dichloro-2, 2-bis (p-chlorophenyl)ethane	0.26	S-484	Soil	Shallow soil	3.5	Aug-96
1,1-dichloro-2, 2-bis (p-chlorophenyl)ethylene	0.014	S-378	Soil	T-3	2.5	Aug-96
1,1,1-trichloro-2, 2-bis-(p-chlorophenyl)ethane	0.0037	S-490	Soil	Shallow soil	4	Aug-96
Dieldrin	0.07	S-484	Soil	Shallow soil	3	Aug-96
Heptachlor	0.10	S-486	Soil	Shallow soil	3	Aug-96
Endosulfan I	0.011	S-485	Soil	Shallow soil	3	Aug-96
Endosulfan sulfate	0.011	S-485	Soil	Shallow soil	3	Aug-96
Heptachlor epoxide	0.0013	S-490	Soil	Shallow soil	4	Aug-96
Methoxychlor	0.0011	S-490	Soil	Shallow soil	4	Aug-96
PCB Arochlor-260	1.0	S-340	Sludge	T-2	6.5	Jul-96
Pyrene	0.033	S-333	Soil	T-1	6	Jul-96
Others (mg/kg)						
Chloride	470	S-331	Soil	T-1	2	Jul-96
Formaldehyde	530.0	---	Soil	SSL00001	0.4	Jun-95
Hexanol	660.00	---	Soil	SSL00003	0.5	Jun-95
Nitrate (as Nitrogen)	390.0	S-357	Soil	T-6, Pit No. 2	14.4	Jul-96
Nonanol	340.0	---	Soil	SSL00002	0.4	Jun-95
Sulfate	5,700	S-340	Sludge	T-2, T-6	6.5	Jul-96

Abbreviations:

---	Sample number unknown
ft bgs	feet below ground surface
mg/kg	milligram per kilogram
N/A	Not Applicable (Background Concentration) or Not Available (Depth)
pCi/g	picoCuries per gram
pCi/L	picoCuries per liter

Table 1-1. Constituents of Concern in the Southwest Trenches Area (continued)

Notes:
Reference Draft Final Engineering Evaluation/Cost Analysis Report (WA, 1998b) for sample locations.

Table 1-2. Constituents of Concern in the Ra/Sr Treatment Systems Area[1]

Analyte	Maximum Activity/ Concentration	Location of Maximum Detection	Depth (ft bgs)	Sample Date
Radionuclides (pCi/g):				
Actinium-228	0.93	SB-4	25-27	Aug-96
Bismuth-214	6.52	SB-1	18-20	Aug-96
Cesium-137	6.2	SB-13	N/A	Oct-87
Carbon-14	16	SB-5	6.5-8	Aug-96
Gross alpha	185	Distribution Box	9.5	Aug-96
Gross beta	156	Distribution Box	9.5	Aug-96
Lead-212	0.94	SB-5	19-20	Aug-96
Lead-214	7.73	SB-1	18-20	Aug-96
Potassium-40	17.24	SB-28	10.0	Mar-90
Radium-226	106.2	Distribution Box	9.5	Aug-96
Strontium-90	37.6	SB-2	15-17	Aug-96
Thallium-208	0.25	SB-5	19-20	Aug-96
Thorium-228	2.1	Beneath Radium Tank B	N/A	Mar-92
Thorium-232	1.66	Beneath Radium Tank B	N/A	Mar-92
Thorium-234	1.41	SB-5	19.20	Aug-96
Tritium (pCi/L)	230	Distribution Box	9.5	Aug-96
Uranium-235	0.15	SB-2	15-17	Aug-96
Metals (mg/kg):				
Beryllium	2.40	SB-26	10.0	Mar-90
Chromium VI	7.00	SB-24	1.0	Mar-90
Cobalt	38.4	SB-28	6.5	Mar-90
Copper	160	SB-5	23-25	Aug-96
Lead	19.3	UCD1-22	5.0	Oct-90
Manganese	870	SB-4	29-31	Aug-96
Vanadium	75	SB-5	13-15/28.5-30	Aug-96
Zinc	165	SB-25	5	Mar-90
VOCs (mg/kg):				
Methylene chloride	0.044	SB-28	10	Mar-90
SVOCs (mg/kg)	243	SB-3	7-10	Aug-96
Pesticides (mg/kg)	0.0021	SB-5	23-25	Aug-96
Others (mg/kg):				
Nitrate (as Nitrogen)	736.00	SB-28	15.0	Mar-90

Abbreviations:

ft bgs	feet below ground surface	pCi/L	picoCuries per liter
mg/kg	milligram per kilogram	SVOCs	semi-volatile organic compounds
N/A	Not Available (Depth)	VOCs	volatile organic compounds
pCi/g	picoCuries per gram		

Notes:

Reference Draft Final Engineering Evaluation/Cost Analysis Report (WA, 1998b) for sample locations.

[1] Excluding sludge/wood data. This data is summarized in Section 2.3.2.2.

Table 1-3. Field and Laboratory Analytical Methods Planned for LEHR Waste Characterization

Parameter	Analytical Method	Required Detection Limit (pCi/g for radionuclides, mg/kg for Metals/General Chemistry, µg/kg for Organics)
Driver COCs	**Field**	
Radium-226	Gamma Spectroscopy/HPGe Screening	1
Strontium-90	Proprietary Beta Scint, Inc. Scintillation	10
Chlordane	Immuno-assay, EPA Method 4041	0.7
Full Suite of COCs	**Laboratory**	
Radionuclides:		
Americium-241	Lab SOP	0.01
Carbon-14	Lab SOP	0.1
Gamma Emitters	EPA Method 901.1	
Actinium-228	EPA Method 901.1	0.1
Bismuth-212	EPA Method 901.1	0.1
Bismuth-214	EPA Method 901.1	0.1
Cesium-137	EPA Method 901.1	0.01
Cobalt-60	EPA Method 901.1	0.005
Lead-210	EPA Method 901.1	0.5
Lead-212	EPA Method 901.1	0.1
Lead-214	EPA Method 901.1	0.1
Potassium-40	EPA Method 901.1	1
Radium-223	EPA Method 901.1	2
Radium-228	EPA Method 901.1	0.1
Radium-226	EPA Method 901.1	0.1
Thallium-208	EPA Method 901.1	0.05
Thorium-234	EPA Method 901.1	0.5
Gross Alpha	EPA Method 9310	1
Gross Beta	EPA Method 9310	1
Plutonium-241	Lab SOP	0.5
Strontium-90	EPA Method 905.0	0.05
Thorium-228	Lab SOP	0.1
Thorium-230	Lab SOP	0.05
Thorium-232	Lab SOP	0.05
Tritium	EPA Method 906.0	1
Uranium-233/234	Lab SOP	0.025
Uranium-235	Lab SOP	0.01
Uranium-238	Lab SOP	0.025
Metals:		
Antimony	EPA Method 6010	0.5
Arsenic	EPA Method 6010	2
Barium	EPA Method 6010	40
Beryllium	EPA Method 6010	1
Cadmium	EPA Method 6010	0.25
Chromium (total)	EPA Method 6010	1

Table 1-3. Field and Laboratory Analytical Methods Planned for LEHR Waste Characterization (continued)

Parameter	Analytical Method	Required Detection Limit (pCi/g for radionuclides, mg/kg for Metals/General Chemistry, µg/kg for Organics)
Cobalt	EPA Method 6010	10
Copper	EPA Method 6010	0.25
Iron	EPA Method 6010	20
Lead	EPA Method 6010	0.3
Manganese	EPA Method 6010	3
Mercury	EPA Method 7471	0.1
Molybdenum	EPA Method 6010	0.1
Nickel	EPA Method 6010	1
Selenium	EPA Method 6010	1
Silver	EPA Method 6010	0.1
Thallium	EPA Method 6010	0.5
Vandium	EPA Method 6010	1
Zinc	EPA Method 6010	4
General Chemistry:		
Chromium VI	EPA Method 3060A/7196	0.05
Nitrate (as Nitrogen)	EPA Method 300.0	1
Total Organic Carbon	EPA Method 415.1	100
Ammonia	EPA Method 350.1	1
Total Kjeldahl Nitrogen	EPA Method 351.2	2
Formaldehyde	Modified NIOSH 3500/AOAC 20.062	0.2
pH	SW-846 Method 9045	0.01 (pH unit)
Reactivity with Cyanide	SW-846 Chapter 7	0.02
Reactivity with Sulfide	SW-846 Chapter 7	0.02
Ignitability	SW-846 Modified 1020A or 1010 (210°C)	Not Applicable
Paint Filter Test	SW-846 Method 9095	Not Applicable
Total Plate Count	Standard Method, 17th Ed., 9215	Not Applicable
Organics:		
Volatile Organic Compounds	EPA Method 8260	As specified in method
Semi-Volatile Organic Compounds	EPA Method 8270	As specified in method
Organochlorine Pesticides/PCBs	EPA Method 8080	As specified in method
Herbicides	EPA Method 8151	As specified in method

Abbreviations:

COCs constituents of concern
EPA United States Environmental Protection Agency
HPGe high-purity germanium
mg/kg milligrams per kilogram
NIOSH National Institute of Occupational Safety and Health
pCi/g picoCuries per gram
µg/kg micrograms per kilogram

Table 1-4. Waste Stream Disposal Completion Schedule

Removal Action Area	Completion Date
Southwest Trenches [1]	December 31, 2000
Radium/Strontium Treatment Systems	December 31, 2002
Domestic Septic Systems	December 31, 2002

Note:
[1] Excludes potential nitrate-impacted soils.

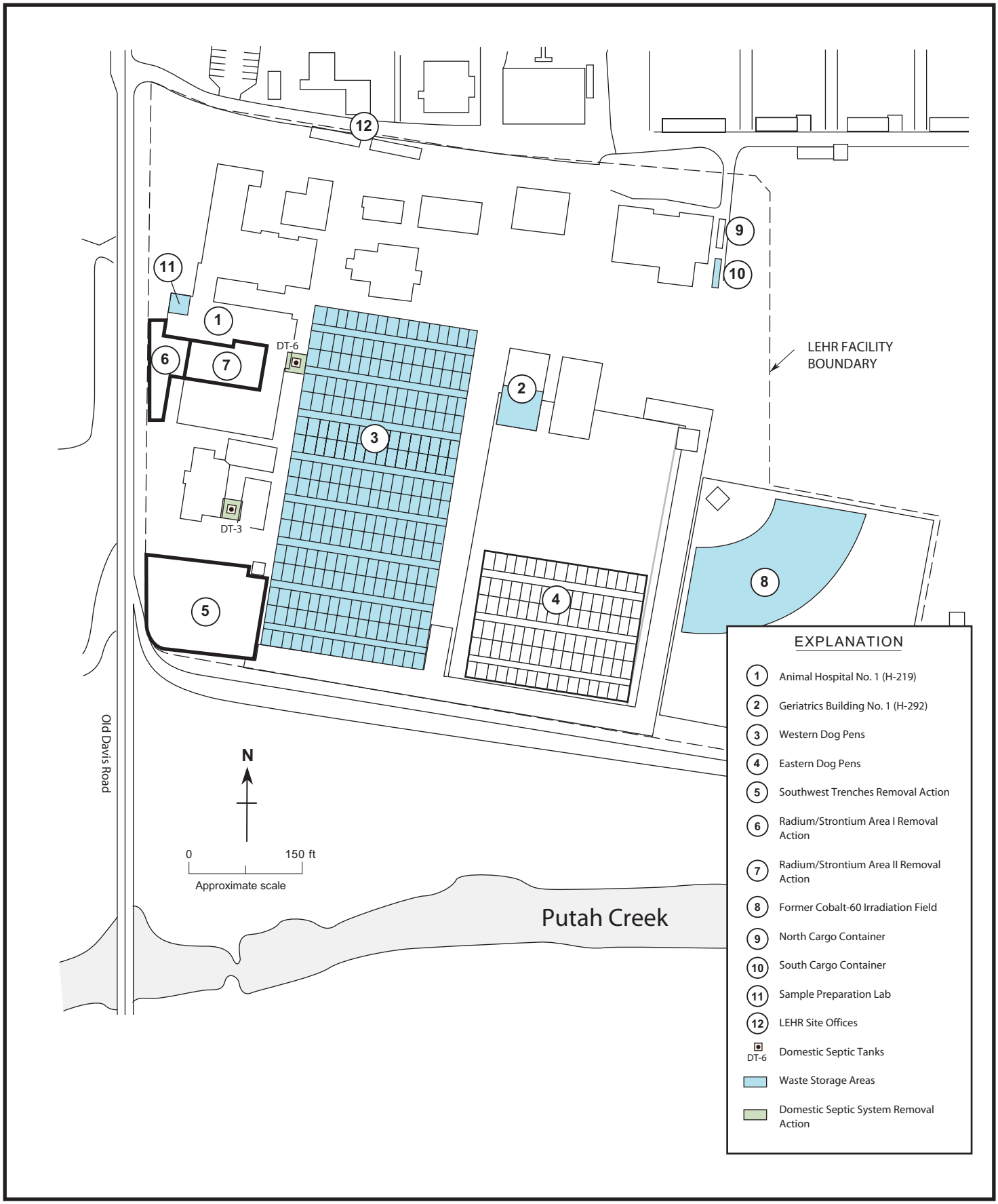

Figure 1-1. Waste Storage Areas and Removal Action Locations—LEHR Facility, Davis, California

Weiss Associates

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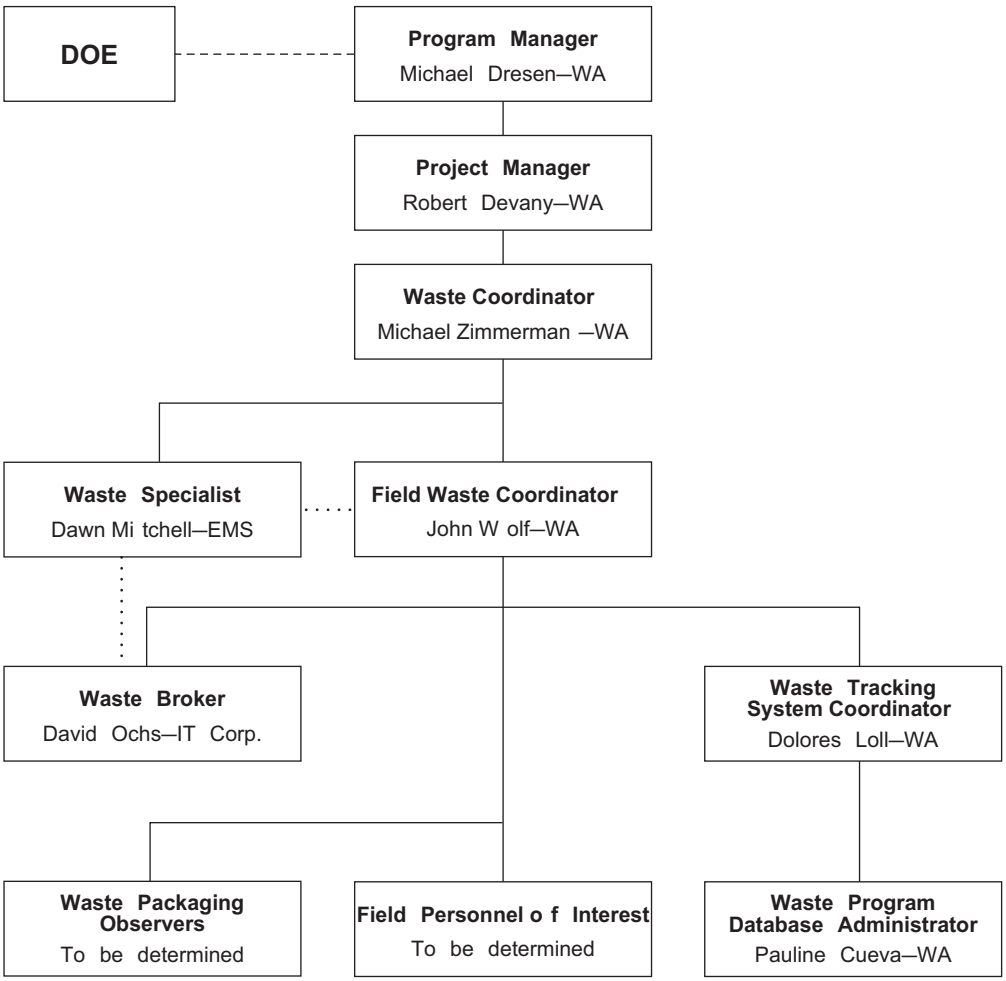

Abbreviations:

DOE	United States Department of Energy
EMS	Environmental Mana gement Services
IT Corp.	IT Corporation
WA	Weiss A ssociates

Notes:

(1) An organizational char t depicting the en tire LEHR RA Structure, incl uding Health an d Safety, Project Mana gement an d Quality A ssurance/Quality Control can be found in the Workplan for Removal Act ions in t he Southwest Trenches, Ra/Sr Treatment Systems, and Domestic Septic System A reas (WA, 2000)

Figure 1-2. Waste Management Organizational Chart - LEHR Facility, Davis, California

Weiss Assoc iates

2. WASTE MANAGEMENT

This section describes the excavation, sampling, characterization, designation, profiling, staging, packaging, storing, and inventory requirements for actual and anticipated RA waste streams. A general description of the LEHR waste management system is provided and followed by RA-specific waste management guidance that is structured to provide specific practices for each waste stream. Each RA section (Sections 2.3.1, 2.3.2 and 2.3.3) is divided into sub-sections, as appropriate:

- Excavation;
- Sampling and Characterization;
- Data Validation and Compilation;
- Waste Designation;
- Profiling;
- Sorting, Packaging and Storage;
- Labeling and Tracking;
- Inspection and Radiological Surveys; and,
- Disposal.

2.1 Program Description

In general, the initial determination of waste type and management of waste materials is dictated by process knowledge and relevant and related analytical data from waste streams of similar origin. Management practices are supported by the collection of additional analytic data. Once validated, analytical data are used to accurately characterize and designate project waste streams (Figure 2-1). Waste designation, in the form of a report submitted to the LEHR project file, determines storage locations, physical inspection schedules and if required, radiological survey schedules. Waste designation also initiates profile generation according to the disposal facility waste acceptance criteria (WAC). This waste stream profile distills process knowledge and analytical data into a concise format that is used by project staff to gain acceptance of RA waste streams to selected facilities.

2.2 Waste Minimization

The LEHR Waste Management Program is committed to minimizing waste volumes at the LEHR Site by giving preference to source reduction, material substitution, decontamination, and recycling. Applicable waste minimization activities include:

- Avoiding porous materials that cannot be decontaminated;
- Minimizing personal protective equipment waste through effective worker logistics;
- Using real-time analyses to delineate extent of contamination;
- Optimizing waste container utilization and recycling;
- Using equipment decontamination solutions as dust suppressant on contaminated soil/debris excavations and stockpiles;
- Removing surface contamination from subsurface structures and pipes; and,
- Re-using uncontaminated soil and materials on site.

A detailed description of the LEHR Waste Minimization Program is located in Section 7 of the Waste Management Annual Report for Fiscal Year (FY) 1997 and Waste Management Plan (WA, 1998f).

2.3 Removal Action Waste Streams

This section is divided into three sub-sections based on ongoing and planned RAs at the LEHR site:

- Southwest Trenches Area (SWT);
- Radium/Strontium (Ra/Sr) Treatment System Area ; and
- Domestic Septic Systems Areas (DSS).

Actual and anticipated waste streams associated with these RAs will be individually discussed within the following sub-sections. These RA-specific sub-sections are designed to provide all information relating to the proper management of specific waste streams from generation to disposal.

2.3.1 Southwest Trenches Removal Action

During the RA of 1998, NH, HW, LLW and MW were excavated. The majority of the waste was shipped off-site for disposal as LLW and HW in 1999. However, buried laboratory waste and

potentially mixed waste were segregated for additional evaluation. In addition, investigation-derived waste, in the form of decontamination solution and borehole drill cuttings, were also generated.

The Work Plan for Bulking and Sampling Segregated Southwest Trenches Removal Action Waste (WA, 2000a) will be implemented in Calendar Year 2000. This plan contains detailed description and waste volumes. It is assumed that when the plan is being implemented, remaining waste will be incorporated into existing waste profiles for disposal purposes.

2.3.2 Radium/Strontium Treatment System, Areas I and II

2.3.2.1 Excavation

During the planned Ra/Sr RA, it is assumed that NH, LLW and MW will be excavated. The Ra/Sr RA will be divided into two sections, Area I and Area II (Figure 1-1). Table 2-1 summarizes anticipated waste streams managed under this WMP and is followed by a written description of waste generation organized by waste type. Additional descriptions of RA waste excavations are located in Section 3 of the Work Plan for Removal Actions in the Southwest Trenches, Radium/Strontium Treatment System, Domestic Tanks (WA, 2000).

- Low-Level Waste—Excavation of LLW is anticipated during the RAs at the Ra/Sr areas. Contaminated soil, cobble and gravel will be excavated from the areas around the Ra/Sr Area tanks, the strontium leachfields, buried influent piping, the three drywells and associated seepage trench. These soils, cobbles and gravel will be placed in B-25 boxes and soft-sided containers (1 cubic yard [cu yd] and 10 cu yd) as excavation proceeds. Contaminated concrete will be excavated during demolition of the Ra/Sr Area tanks and drywells. The concrete manways that sit atop each drywell and the tank walls will be crushed and placed in B-25 boxes and potentially soft-sided containers depending on the outcome of performance testing. In addition, wood waste will be generated during demolition of the strontium tank cover. The wood will be cut/broken into small pieces and loaded into B-25 boxes and soft-sided containers. In order to minimize waste disposal costs, soil will be segregated from debris. For disposal purposes, the soil waste stream must not contain more than 10% by volume.
- Hazardous Waste—No HW is anticipated in the Ra/Sr Area. All potential hazardous waste will be managed as potential MW because it was removed from a Radioactive Materials Management Area (RMMA). Materials from these areas may contain added radioactivity based on the operational history of the area. As a best-management practice, we assume that radiation has been added to these materials until analytic data have been evaluated and the waste has been designated.

- Mixed Waste—Sludge from the Area II Ra/Sr tanks has the possibility of being a MW and is the subject of a pre-removal characterization plan *Addendum No. 2 to the Final Visual Inspection and Sampling Plan for the Underground Radium and Strontium Treatment Tanks* (WA, 2000b). If the sludge is identified as being MW, it will be segregated from other RA waste streams for disposal purposes. In addition, if the sludge is MW, the wood and concrete in contact with it will also likely be MW and will have to be segregated from the LLW waste stream. The concrete and wood will be processed for optimal packaging and will be placed in either B-25 boxes or soft-sided containers, as appropriate.
- Lead solder joints from the Ra/Sr Treatment System conveyance pipelines are anticipated to be MW. During decontamination and decommissioning (D&D) of the above-ground structures in the Ra/Sr Treatment Systems Area, conveyance pipelines inside the buildings were found to have lead joints. The lead joints were characterized as a MW based on the level of radioactive contamination and the lead leaching potential. During this RA, the conveyance pipelines outside the buildings will be removed. After these pipelines are removed from the ground, the lead joints will be removed, placed in 55-gallon drums and stored for disposal according to SOP 31.1. The remaining piping, which will then be free of lead joints, will be considered LLW and managed according to SOP 34.2.
- Non-Hazardous Waste—Surface soils in the Ra/Sr Area are likely to be characterized as NH. Overburden soils will be delineated with the use of an on-site laboratory, excavated and stockpiled in high density polyethylene (HDPE) cells in the Western Dog Pens (WDP) in the former Co-60 Field, pending off-site laboratory analysis. In addition, some concrete, asphalt and decontamination (DECON) water will also be excavated and/or accumulated, that will likely be considered NH. Concrete will be stockpiled in the former Co-60 Field and will be managed with other RA-generated concrete waste streams. Asphalt will be pulverized, removed from the area and stored in an HDPE-covered stockpile in the former Co-60 Field pending analysis with the intention of re-using it on site as base material. DECON water will be stored in 55-gallon drums and will be removed from the RA area following conclusion of RA activities. In addition, water has accumulated in Ra/Sr Area tanks. This water is assumed to be NH and will be pumped from the tanks into portable, 2,500-gallon holding tanks and sampled for disposal purposes. In addition, several trees will be removed from Areas I and II. This material is assumed NH. Samples will be collected to confirm this assumption. The material will be staged in the WDP or former Co-60 Field pending analysis.

2.3.2.2 Sampling and Characterization

All project waste streams will be sampled for waste characterization purposes concurrent with waste excavation and packaging. Samples will be collected prior to waste storage container

sealing and before they are removed from the Contamination Area. Sampling and analysis will be conducted in accordance with SOPs 1.1, 2.1, 6.1, 17.1, 17.2, 18.1, 19.1, 20.1, with the intent of obtaining the required data necessary to meet the WAC of Envirocare of Utah (Envirocare). Sampling frequencies and parameters are in accordance with existing agreements with the facility.

Previous site investigations have yielded analytical data that will be used in the characterization and designation sequence. Process knowledge and the collection of additional samples will supplement this data set and provide the sufficient data to characterize, designate and profile the waste.

Using process knowledge, previous investigation findings, and RA observations, waste characterization sampling will be based on the Unique Domains Method (UDM). The UDM objective is to collect at least one sample for each continuous domain identified (e.g., a continuous disposal trench, leach field, distribution box) and for each media found within that domain (e.g., soil, concrete, wood, etc.). These samples are intentionally biased towards the most contaminated portion of the media. Process knowledge and field observations, including radiation surveys and photoionization dosimeter readings, are used to determine the sample locations. Table 2-2 and 2-9 provide the domains and media expected in the Ra/Sr Treatment Area and in Domestic Septic Systems No. 3 and No. 6 Areas, respectively. Because UDM relies on real-time field observations, specific sample location decisions will be the responsibility of the Waste Coordinator or his designee, and shall be documented in the WTS. At the discretion of the Waste Coordinator, statistical or other technically valid sampling strategies may be employed in lieu of UDM. These deviations shall be documented in writing including the techniques used, the sample locations and the rationale for not using UDM. It is necessary that all waste sampling meet the acceptance requirements of the disposal facility

Although Ra/Sr Area sludge was characterized previously, a data gap was identified and a subsequent sampling event is scheduled and detailed in the *Addendum No. 2 to the Final Visual Inspection and Sampling Plan for the Underground Radium and Strontium Treatment Tanks* (WA, 2000b). Sludge and wood data are summarized below.

Three tank sludge samples (LEHR-SL-001, -002, -003) were collected from Tank A on September 24 and 25, 1997. Two wood samples were collected from the tank on September 25, 1997. One wood sample (LEHR-W-001) was collected from below the sludge, and a second wood sample (LEHR-W-002) was collected from above the sludge.

Compounds detected in the sludge samples are summarized below:

- Gross beta and strontium-89/90 (Sr-89/90) were detected in all sludge samples at maximum concentrations of 13,040 picoCuries per gram (pCi/g) and 18,600 pCi/g respectively. Ra-226 (3.88 pCi/g), tritium (H-3) (3.8 pCi/g), bismuth-214 (1.11 pCi/g), cesium-137 (0.71 pCi/g), and americium-241 (Am-241) (0.037 pCi/g) were also detected. No other radionuclides were detected at activity levels above the minimum detectable activity (MDA).

- Semi-volatile organic compounds (SVOCs) were detected at up to 5.1 mg/kg (napthalene).
- Volatile organic compounds (VOCs) were detected in all three samples at up to 22 µg/kg (2-butanone).
- Antimony, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc were detected in all three samples.
- The only pesticide detected was 4,4-DDE, which was detected at up to 21 µg/kg. PCB-1260 was detected at up to 1,100 µg/kg.

Compounds detected in the wood samples are summarized below.

- Gross beta and Sr-89/90 were detected in both wood samples at maximum concentrations of 3,650 pCi/g and 998 pCi/g, respectively. H-3 (1.85 pCi/g), lead-214 (0.72 pCi/g), and Am-241 (0.018 pCi/g) were also detected. No other radionuclides were detected at activity levels above the MDA.
- SVOCs were detected at up to 2,200 mg/kg (fluoranthene).
- VOCs were detected in both samples at up to 33 µg/kg (styrene).
- Antimony, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc were detected in both samples.
- No pesticides or PCBs were detected.

Material assumed to be clean through process knowledge and the use of the on-site lab, and intended to be re-used on site shall be sampled at a rate of one 10-point composite sample per 50 cu yds of soil. Stockpile sampling will be performed as defined in the addendum to the Sampling and Analysis Plan for Chlordane Stockpile Characterization (WA, 1998a). In general, samples will be collected in the following manner:

- One 10-point composite per 50 cu yds for soil scheduled for on-site re-use;
- Discrete samples will be collected using a trowel from a two-dimensional grid system overlying the stockpile;
- Discrete sample locations will be determined using a random number generator;
- Discrete samples will be collected from within 6 inches of the pile surface; and,
- Samples from all 10 locations will be combined into a single sample.

Composite samples will be collected from remaining RA DECON water and the Ra/Sr tank water not used for dust suppression in an effort to meet the WAC of the UC Davis Wastewater Treatment Facility. In all cases, duplicate samples will be collected at a frequency of 10%, and

equipment rinseate samples will be collected to comply with the objectives of the LEHR Quality Assurance Project Plan for Environmental Restoration/Waste Management (QAPP).

The Waste Characterization Sampling and Analysis Plan is summarized in Table 2-2.

2.3.2.3 Data Validation and Compilation

Samples collected for laboratory analysis will be analyzed by General Engineering Laboratories, Inc. (GEL) in Charleston, South Carolina. Laboratory reports (hard copies and electronic files) will be forwarded from GEL to WA. Hard copies of analytical reports and electronic data files are typically delivered from GEL to WA within 45 days. The 45-day turnaround time is required to allow for the 30-day in-growth of Ra-226 daughter products used in gamma spectrometry. These results will be validated by the Project Chemist and/or his designee in accordance with SOP 21.1, Data Validation. Once validated, the data will be transferred to the project database in accordance with procedures described in the QAPP (WA, 1998e) and provided to the Waste Coordinator and Waste Specialist for use in waste designation.

2.3.2.4 Waste Designation

Validated analytical data and process knowledge of RA waste streams will be used to certify and designate waste as NH, HW, LLW or MW. This designation process determines the practices required to properly manage RA waste streams in accordance with LEHR SOPs and applicable Federal and State requirements.

One designation report will be prepared for each of the Ra/Sr RA Areas, addressing all waste stream types.

Waste designation reports are submitted to the WC for review and approval. The approved designation reports initiate and form the basis of the waste profile. As a best-management practice, waste streams of similar origin and composition are consolidated into large designation reports for efficient review and reduced costs associated with report preparation.

2.3.2.5 Profiling

The purpose of the waste profiling process is to verify that the selected disposal facility (Envirocare) WAC are met. The WS will compile all analytic data, radiological survey data, waste tracking information including WTSs (see section 2.3.1.7) in order to complete the waste profile.

Three waste profiles are planned for Ra/Sr RA Areas I and II waste streams. It is assumed that lead generated will be incorporated into a profile for all site lead to be prepared at a future time. Table 2-3 shows Ra/Sr RA Areas I and II waste streams and associated profiles.

Waste profiles are submitted to the WC for review and approval. As a best-management practice, waste streams of similar origins are grouped into larger profiles, saving costs associated with report preparation and review cycles.

2.3.2.6 Sorting, Packaging and Storage

The majority of the waste removed from the Ra/Sr Areas are assumed to be NH or LLW. Sampling and analysis will be used to determine if the subject waste stream is LLW, HW, MW or NH (as described in Section 2.3.2.2). The waste will be segregated during the RA as described in Section 3 of the RA Work Plan and in accordance with SOPs 31.1, 34.1 and 34.4. Table 2-4 shows assumed waste types, packaging and storage locations. In general, waste is stored in three locations at the LEHR site, the former Cobalt-60 Field, the Geriatrics Building No. 1 (Ger-I) and the Western Dog Pens (WDP) (Figure 1-1). In addition, archived samples and some analytical test spoils are stored in Animal Hospital 1 (AH-1) and the Southern Cargo Container (SCC) (Figure 1-1). The Eastern Dog Pens are available for storage as required but are not a primary storage area. Each area is secured and posted in accordance with the TGD for WM, the RPP and SOPs 34.2 and 34.4. Each waste category, NH, HW, LLW and MW, will be segregated and stored in discrete areas dependent on classification and compatibility.

- Non-Hazardous Waste—Surface or overburden soils in Ra/Sr areas are likely to be characterized as non-hazardous. Overburden soils will be stockpiled in HDPE cells in the WDP or stored in soft-sided containers in the former Co-60 Field pending analysis. Tree material will be staged in the WDP or former Co-60 Field pending analysis. Concrete will be stockpiled in the former Co-60 Field. Asphalt will be stored in HDPE covered stockpiles pending analysis.
- LLW—Solid LLW will be packaged in B-25 boxes and soft-sided containers, and stored in the WDP and Co-60 Field. The loaded, sealed and labeled boxes will be arranged in rows, no more than one box high. Loaded boxes will not be stacked. Soft-sided containers (1 cu yd and 10 cu yd) will be covered with HDPE cells to minimize exposure to sunlight.
- Hazardous Waste—No Hazardous waste is expected in the Ra/Sr RA.
- Mixed Waste—Mixed waste will be stored in an area designated for mixed waste either in the Western Dog Pens, Geriatrics I, or in another area designated for mixed waste storage. Lead joints will be removed from piping. After the lead joints are removed, they are to be consolidated directly into a 5-gallon bucket inside the controlled environment. Once the 5-gallon bucket is at capacity, it is to be sealed and stored in the mixed waste storage area of Geriatrics I or another approved area. The remaining, lead-free piping will be handled as LLW and be deposited into B-25 Boxes or soft-sided containers. Sludge will be removed from the Ra/Sr tanks as described in the WP. The material will be placed in drums or tanks prior to sampling and will be stored in Ger-I.
- DECON—DECON will be stored in 55-gallon drums or other suitable containers, sampled, sealed, labeled, and inventoried into the LEHR WTS. DECON water will be staged in Ger-I on spill containment pallets until disposal options are identified.

- Investigative Derived Waste (IDW)—All IDW will be drummed and analyzed for disposal purposes. Upon review of the analytical results, the IDW soil and liquid will be designated HW, LLW, MW or Non-HW. The designation will determine the management practice to be used.

2.3.2.7 Labeling and Tracking

All RA waste streams are or will be incorporated into the LEHR Waste Tracking System, an electronic inventory database. The following section provides a summary of the Waste Tracking System; a detailed description of the system is provided in SOP 34.5.

Every project waste package is assigned a unique waste tracking number and all pertinent information for the subject waste package is incorporated into the Waste Tracking System database. Waste is tracked from generation to disposal and the Waste Tracking System is updated when any changes occur to the waste stream, including but not limited to, a change in storage location, review of analytic data, and final transport and disposal.

Each container is given a unique 8-digit code number to be tracked in the field and by the office database. The Waste Tracking Label, in the form of a weather resistant decal, is permanently affixed to the waste package. In addition, packaged waste will be labeled and marked as required by the disposal facility as described in SOP 34.5. In order to keep the Waste Tracking System current, a field form called the Waste Tracking Sheet (WTS) (Form SOP 34.5.) is completed to document the packaging of project waste streams. At a minimum, the following information shall be included in each WTS:

- New or Update box Checked
- Package Number
- Package Type
- DOT Container Type
- Waste Description
- Maximum Dose Rate
- Hot Spot
- Radiological Survey Number
- Date Waste Was Generated
- Site Area
- Storage Location
- Storage Start Date
- External Package Volume

- Internal Package Volume
- Previous Package Number

2.3.2.8 Inspection and Radiological Surveys

An inventory of the RA wastes will be conducted weekly during the storage inspections, and new containers will be inventoried the day they are sealed and placed in storage. Inspection forms will be completed by the FWC or designee and submitted to the WC and to the LEHR project files in accordance with SOP 39.1.

Radiological surveys will be conducted by appropriately trained personnel under supervision of the RSO and in accordance with the LEHR RPP. Inspection and radiological survey schedules for both Areas are listed in Table 2-5.

2.3.2.9 Disposal

All waste disposal documents, including but not limited to waste manifests, bills of lading, waste profiles and DOE commercial facility exemption packages, will be completed in accordance with LEHR SOP 34.3. Staging, loading and hauling of RA waste streams will be conducted in accordance with all applicable Federal and State regulations and in accordance with LEHR SOP 34.3.

Clean overburden will be used as backfill material or for final grading if possible. LLW will likely be disposed at Envirocare and mixed waste will be treated and disposed at Envirocare or another authorized treatment storage and disposal facility. Prior to off-site treatment and/or disposal of mixed waste, DOE will be requested to supply a variance for disposal of DOE radioactive waste at a commercial facility. A variance has already been granted to the LEHR Site by DOE for the commercial disposal of low level waste (EMS/WA, 1998). Prior to disposal of hazardous waste removed from a Radioactive Materials Management Area (e.g., the Southwest Trenches Area and the Ra/Sr Treatment Area), a DOE Hazardous Waste Disposal Moratorium Release Package must be prepared and approved by DOE. The purpose of the DOE Hazardous Waste Disposal Moratorium is to insure that hazardous waste containing added radioactive constituents is not inadvertently disposed of as hazardous waste. The Moratorium Release Package compares the radiological constituents to established background concentrations. If radiological concentrations exceed background and the waste is a RCRA hazardous waste, the material must be managed and disposed as mixed low level waste. Following any waste disposition, the LEHR Waste Tracking System will be updated.

IDW DECON water not used for dust suppression and determined to be non-hazardous is to be stored in drums or tanks, appropriately labeled, and will be discharged to the sanitary sewer under a temporary discharge permit. Following disposal, the Waste Tracking System will be updated to reflect any changes.

Likely disposal scenarios for Ra/Sr specific waste streams are listed in Tables 2-6 and 2-7.

2.3.3 Domestic Septic Systems

2.3.3.1 Excavation

Previous investigations have been conducted in seven Domestic Septic System Areas at the LEHR site. Based on these investigations and as described in EE/CA (WA, 1998b), only DSS 3 and 6 require restorative measures. This section addresses the management of waste streams excavated during the RA planned for Domestic Septic Systems No. 3 and No. 6. Estimated waste types and volumes are listed in Table 2-8. These volumes are preliminary and are subject to change.

- Non-Hazardous—Surface soils in the DSS area are likely to be characterized as non-hazardous. Overburden soils will be stockpiled in HDPE cells in the WPD or the former Co-60 Field. Concrete will be stored on pallets in the former Co-60 Field and will be managed with other RA-generated concrete waste streams. Asphalt will be rubbleized and stored in a stockpile within the former Co-60 Field.
- Hazardous—Metals-impacted soils from the DSS No. 6 area may be considered hazardous waste. Waste will be handled in accordance with SOP 43.1.
- Low-Level—Ra-226 impacted IDW may be excavated during the sampling event. Following completion of the RA, this liquid waste will be drummed and stored on spill containment pallets in Geri-1.
- Mixed—No MW is expected to be generated as part of this RA.

2.3.3.2 Sampling and Characterization

A description of the sampling and characterization strategies and SOPs is provided in Section 2.3.1.2 of this WMP. The waste characterization SAP for the DSS is summarized in Table 2-9.

2.3.3.3 Data Validation and Compilation

A description of Data Validation and Compilation is provided in Section 2.3.1.3 of this WMP.

2.3.3.4 Waste Designation

One designation report will be produced for the DSS RA waste streams. This designation report will address all waste generated during conduct of this RA and will be submitted to the project files.

2.3.3.5 Profiling

Up to two profiles will be prepared for DSS waste streams, one for LLW and one for HW. Because of the extremely low volume of the waste streams, it is likely that existing waste profiles for LEHR waste steams will be amended. Table 2-10 lists required profiles.

2.3.3.6 Sorting, Packaging and Storage

The DSS RA waste streams will be segregated during the RA as described in the RA Work Plan, Sections 3.3 to 3.8 and in accordance with SOPs 31.1, 34.1 and 34.4. Table 2-11 shows assumed waste types, packaging and storage locations. See Section 2.2.1.8 for further description of the waste storage areas.

2.3.3.7 Labeling and Tracking

All project waste streams will be incorporated into the LEHR Waste Tracking System. A detailed description of labeling requirements and of the Waste Tracking System is provided in Section 2.2.1.7 of this WMP.

2.3.3.8 Inspections and Radiological Surveys

A detailed description of waste inspections and radiological surveying is located in Section 2.2.1.9 of this WMP. Inspection and radiological survey schedules for the DSS RA are shown in Table 2-12.

2.3.3.9 Disposal

See Section 2.2.1.9 for a description of LEHR waste disposal strategies. Likely disposal scenarios for DSS waste streams are listed in Table 2-13.

Table 2-1. Ra/Sr Areas I and II Removal Action Waste/Material Stream Descriptions

Preliminary Designation [1]	Description	Area I Waste Volumes [2]	Area II Assumed Waste Volumes [2]	Matrix
Hazardous	N/A	N/A	N/A	N/A
Low-Level	Concrete	10 cu yds	325 cu yds	Debris
	Soil	643 cu yds	974 cu yds	Soil
	Cobble/Gravel	134 cu yds	96 cu yds	Debris
	Piping-Iron	100 LF	336 LF	Debris
	Piping—PVC	N/A	200 LF	Debris
	Wood	0.25 cu yd	12 cu yds	Debris
	PPE	N/A	N/A	Filler
Potentially Mixed [3]	Pipe Joints (lead)	1 55-Gallon drum	84 Joints	Debris
	Sludge—Tank A	N/A	250 Gal	Solid
	Wood	N/A	0.5 cu yd	Debris
Non-Hazardous	Soil—Overburden	450 cu yds	507 cu yds	Soil
	Concrete	25 cu yds	35 cu yds	Debris
	Asphalt	40 cu yds	N/A	Debris
	DECON Water	250 Gallon	750 Gal	Liquid
	Tank Water [4]	N/A	4200 Gal	Liquid

[1] Preliminary designation based on operational history and limited field screening.
[2] Estimate subject to change. Actual waste volumes will be provided in the Removal Action Summary Report when complete.
[3] All wastes from radiological contamination areas assumed to contain added radiation until designation is complete.
[4] Volume based on a 6-inch water level in Ra/Sr Area tanks.

Abbreviations:

DECON	=	Decontamination Water
Gal.	=	gallon
LF	=	linear feet
N/A	=	not applicable
PPE	=	Personal Protective Equipment
PVC	=	polyvinyl chloride

Table 2-2. Summary of Waste Characterization Sampling and Analysis Plan in the Ra/Sr Treatment Systems Area Removal Action

Sampling Activity	Sampling Strategy	Assumptions	Sampling Method	Method of Analysis(1)	Analytical Parameters
Overburden	Random grid sampling	One 10-point composite sample/ 50 cu yds of soil.	Hand auger/trowel/composite on-site	Lab	Full Suite of COCs, TCLP/STLC
Contaminated soil	Domain-Specific	One sample each leach trench/field.	Scoop/Trowel	Lab	Full Suite of COCs, and 20% WAC analysis, TCLP/ STLC
Tree material	Composite of wood cores	Background tree of same species required.	Branches, leaf and trunk core using hand drill or equivalent	Lab	Radium/Strontium(2)
Demolition debris (gravel, concrete, steel re-enforcement, and wood)	Previously characterized	Contaminated with radioactive material.	N/A	N/A	Full Suite of COCs, and 20% WAC analysis, TCLP/ STLC
Steel re-enforcement	None	Survey and evaluate for release.	N/A	N/A	N/A
Tank A sludge	Composite	Contaminated with radioactive material.	N/A	N/A	Full Suite of COCs, and 20% WAC analysis, TCLP/ STLC
Piping	Previously characterized	Contaminated with radioactive material.	Process knowledge	N/A	N/A
IDW/Liquid Disposal	Composite	One composite per source. Majority of this liquid to be used on-site as dust suppressant in contaminated areas	Grab	Lab	UC Davis Wastewater Disposal Criteria
Duplicate samples (Laboratory QC)	As Necessary	10% of field and lab samples analyzed at lab	Trowel	Lab	Full Suite of COCs, TCLP/STLC

Notes:

Full Suite of COCs = Radionuclides, metals, VOCs, SVOCs, pesticides, chromium (VI) and nitrate; Driver COCs = Ra-226, Sr-90 and nitrate.
WAC analysis = The anticipated disposal facility requires the following additional analysis: Reactive Sulfide/Cyanide, Paint Filter, pH, Formaldehyde, Herbicides, Ignitability, and Total Plate Count.
UC Davis Wastewater Disposal Criteria = Ra-226, Sr-90, Tritium, Carbon-14, VOCs, Nitrate, Pesticides (for SWT only), and Hexavalent Chromium.
(1) = See Table 1-3.
(2) = Based on the location, the selected analytical parameters will be either Radium or Strontium or both.

Abbreviations:

COCs	=	Constituents of Concern
IDW	=	Investigation-Derived Waste
N/A	=	not applicable
QC	=	Quality control
STLC	=	Soluble threshold limit concentration
TCLP	=	Toxicity characteristic leaching procedure
WAC	=	Waste Acceptance Criteria

Table 2-3. Ra/Sr Areas I and II Removal Action Required Waste Profiles

Preliminary Designation [1]	Description	Area I Required Profiles	Area II Required Profiles
Hazardous	N/A	N/A	N/A
Low-Level	Concrete	Incorporate into soil/debris profile	Incorporate into soil/debris profile
	Soil	1	1
	Cobble/Gravel	Incorporate into soil/debris profile	Incorporate into soil/debris profile
	Piping-Iron	Incorporate into soil/debris profile	Incorporate into soil/debris profile
	Piping—PVC	Incorporate into soil/debris profile	Incorporate into soil/debris profile
	Wood	Incorporate into soil/debris profile	Incorporate into soil/debris profile
	PPE	Incorporate into soil/debris profile	Incorporate into soil /debris profile
Potentially Mixed [2]	Pipe Joints (lead)	Incorporated into planned profile	Incorporated into planned profile
	Sludge	N/A	1
	Wood/Concrete	N/A	Incorporate into sludge profile
Non-Hazardous	Soil—Overburden	N/A	N/A
	Concrete	N/A	N/A
	Asphalt	40 cu yds	N/A
	DECON Water	N/A	N/A
	Water	N/A	N/A

[1] Preliminary designation based on operational history and limited field screening.
[2] All wastes from radiological contamination areas assumed to contain added radiation until designation is complete.

Abbreviations:
DECON = Decontamination Water
N/A = not applicable
PPE = Personal Protective Equipment
PVC = polyvinyl chloride

Table 2-4. Ra/Sr Areas I and II Removal Action Waste Packaging and Assumed Storage Locations

Preliminary Designation [1]	Description	Package	Assumed Storage Locations
Hazardous	N/A	N/A	N/A
Low-Level	Concrete	B-25 Box/Soft-sided Container	WDP
	Soil	B-25 Box/Soft-sided Container	WDP
	Cobble/Gravel	B-25 Box/Soft-sided Container	WDP
	Piping-Iron	B-25 Box/Soft-sided Container	WDP
	Piping—PVC	B-25 Box/Soft-sided Container	WDP
	Wood	B-25 Box/Soft-sided Container	WDP
	PPE	B-25 Box/Soft-sided Container	WDP
Potentially Mixed [2]	Pipe Joints (lead)	Poly-buckets/55-gallon Drum	Ger-I
	Sludge	B-25 Box	Ger-I
	Wood/Concrete	B-25 Box/Soft-Sided Container	Ger-I
Non-Hazardous	Soil—Overburden	Stockpile	WPD/Co-60 Field
	Concrete—Overburden	Stockpile	Co-60 Field
	Asphalt	Stockpile	Co-60 Field
	DECON Water	55-gallon drum	Ger-I
	Water—Tanks	55-gallon drum	Co-60 Field
	Tree Material	Stockpile	WDP/Co-60 Field

[1] Preliminary designation based on operational history and limited field screening.
[2] All wastes from radiological contamination areas assumed to contain added radiation until designation is complete.

Abbreviations:

Co-60	=	Cobalt-60
DECON	=	Decontamination Water
Ger-I	=	Geriatrics Building No. 1
N/A	=	not applicable
PPE	=	Personal Protective Equipment
PVC	=	polyvinyl chloride
TBD	=	to be determined
WDP	=	Western Dog Pens

Table 2-5. Ra/Sr Areas I and II Removal Action Waste Inspection and Radiological Survey Schedule

Preliminary Designation [1]	Description	Inspection Frequency	Radiological Survey Frequency	Assumed Location
Hazardous	N/A	N/A	N/A	N/A
Low-Level	Concrete	Weekly	Weekly	WDP
	Soil	Weekly	See RPP	WDP
	Cobble/Gravel	Weekly	See RPP	WDP
	Piping-Iron	Weekly	See RPP	WDP
	Piping—PVC	Weekly	See RPP	WDP
	Wood	Weekly	See RPP	WDP
	PPE	Weekly	See RPP	WDP
Potentially Mixed [2]	Pipe Joints (lead)	Weekly	See RPP	Ger-I
	Sludge	Weekly	See RPP	Ger-I
	Wood/Concrete	Weekly	See RPP	Ger-I
Non-Hazardous	Soil—Overburden	N/A	N/A	WPD/Co-60 Field
	Concrete—Overburden	N/A	N/A	Co-60 Field
	Asphalt	N/A	N/A	Co-60 Field
	DECON Water	N/A	N/A	Ger-I
	Water—Tanks	N/A	N/A	Co-60 Field
	Tree Material	N/A	N/A	WDP/Co-60 Field

[1] Preliminary designation based on operational history and limited field screening.
[2] All wastes from radiological contamination areas assumed to contain added radiation until designation is complete.

Abbreviations:

Co-60	=	Cobalt-60
DECON	=	Decontamination Water
Ger-I	=	Geriatrics Building No. 1
N/A	=	not applicable
PPE	=	Personal Protective Equipment
PVC	=	polyvinyl chloride
WDP	=	Western Dog Pens

Table 2-6. Ra/Sr Area I Removal Action Waste Disposal Scenarios

Preliminary Designation [1]	Description	Assumed Waste Volume [2]	Matrix	Assumed Disposal Scenario
Hazardous	N/A	N/A	N/A	N/A
Low-Level	Concrete	10 cu yds	Debris	Envirocare
	Soil	643 cu yds	Soil	Envirocare
	Cobble/Gravel	134 cu yds	Debris	Envirocare
	Pipe—Cast Iron	100 LF	Debris	Envirocare
	Wood	0.25 cu yd	Debris	Envirocare
	PPE	N/A	Filler	Envirocare
Potentially Mixed [3]	Pipe Joints (lead)	25 Joints	Debris	TBD
Non-Hazardous	Water—DECON	500 Gal	Liquid	Sanitary Sewer/On-Site Re-use
	Tree Material	40 cu yds	Debris	On-Site Re-Use
	Asphalt	40 cu yds	Debris	On-Site Re-Use

[1] Preliminary Designation based on operational history and limited field screening.
[2] Saturated volume subject to change.
[3] All wastes from radiological contamination areas assumed to contain added radiation until designation is complete.

Abbreviations:
cu yds = cubic yards
DECON = Decontamination Water
LF = linear feet
N/A = not applicable
PPE = Personal Protective Equipment
TBD = to be determined

Table 2-7. Ra/Sr Area II Removal Action Waste Disposal Scenarios

Preliminary Designation [1]	Description	Assumed Waste Volume [2]	Matrix	Assumed Disposal Scenario
Hazardous	N/A	N/A	N/A	N/A
Low-Level	Concrete	325 cu yds	Debris	Envirocare
	Soil	974 cu yds	Soil	Envirocare
	Cobble/Gravel	96 cu yds	Debris	Envirocare
	Piping-Iron	336 LF	Debris	Envirocare
	Piping—PVC	200 LF	Debris	Envirocare
	Wood	12 cu yds	Debris	Envirocare
	PPE	N/A	Filler	Envirocare
Potentially Mixed [3]	Pipe Joints (lead)	84 Joints	Debris	Envirocare
	Sludge	250 Gal	Liquid	Envirocare
	Wood	0.5 cu yd	Debris	Envirocare
Non-Hazardous	Soil—Overburden	507 cu yds	Soil	On-site Re-use
	Concrete—Overburden	35 cu yds	Debris	RCRA Disposal Facility
	Asphalt	40 cu yds	Debris	On-Site Re-use
	DECON Water	750 Gal	Liquid	Sanitary Sewer/ On-site Re-use.
	Water [4]	4,200 Gal	Liquid	Sanitary Sewer/ On-site Re-use.

[1] Preliminary designation based in operational history and limited field screening. Designation Incomplete.
[2] Estimated volume, subject to change.
[3] All wastes from radiological contamination areas assumed to contain added radiation until designation is complete.
[4] Volume based on 6-inch water level in Ra/Sr area tanks.

Abbreviations:

cu. yd(s).	=	cubic yard(s)
DECON	=	Decontamination Water
Gal.	=	gallon(s)
LF	=	linear feet
N/A	=	not applicable
PPE	=	Personal Protective Equipment
PVC	=	polyvinyl chloride
TBD	=	to be determined

Table 2-8. Domestic Septic System Area Removal Action Waste Stream Descriptions

Preliminary Designation [1]	Description	Estimated Waste Volume (2)	Matrix
Hazardous	Soil—Metals Impacted	5 cu yds	Soil
Low-Level	IDW	1 cu yd	Soil
Potentially Mixed	N/A	N/A	N/A
Non-Hazardous	Water—DECON	25 Gal	Liquid
	Soil	5 cu yds	Soil
	Concrete	2 cu yds	Debris
	Asphalt	2 cu yds	Debris

[1] Preliminary designation based on operational history and limited field screening.
[2] Estimated volume, subject to change.

Abbreviations:

cu. yd(s).	=	cubic yard(s)
DECON	=	Decontamination Water
Gal.	=	gallon(s)
IDW	=	Investigation-Derived Waste
N/A	=	not applicable

Table 2-9. Summary of Waste Characterization Sampling and Analysis Plan in the Domestic Septic System No.3 and No.6 Areas

Sampling Activity	Sampling Strategy	Assumptions	Sampling Method	Method of Analysis[1]	Analytical Parameters
Overburden soil stockpile sampling	Random grid sampling	One 10-point composite sample/ 50 cu yds of soil	Hand auger	Lab	Full Suite of COCs, TCLP/STLC
Contaminated soil sampling	Domain-Specific	For each system: − one sample soil − one sample leachfield fill − one sample concrete	Scoop/Trowel	Lab	Full Suite of COCs, and 20% WAC, TCLP/STLC
IDW/Liquid Disposal	Composite	One composite per source	Grab	Lab	UC Davis Wastewater Disposal Criteria
Duplicate samples (Laboratory QC)	As Necessary	10% of field and lab samples analyzed at lab	Scoop/Trowel	Lab	Full Suite of COCs, TCLP/STLC

Abbreviations:

NA not applicable
TCLP Toxicity characteristic leaching procedure
STLC Soluble threshold limit concentration
WAC Waste Acceptance Criteria

Notes:

Full Suite of COCs = Radionuclides, metals, VOCs, SVOCs, pesticides, chromium (VI) and nitrate; Driver COCs = Ra-226, Sr-90 and nitrate
WAC analysis = The disposal facility requires the following additional analysis: Reactive Sulfide/Cyanide, Paint Filter, pH, Formaldehyde, Herbicides and Ignitability.
Wastewater Disposal Criteria = Ra-226, Sr-90, Tritium, Carbon-14, VOCs, Nitrate, Pesticides (for SWT only) and Hexavalent Chromium.
[1] = See Table 1-3.

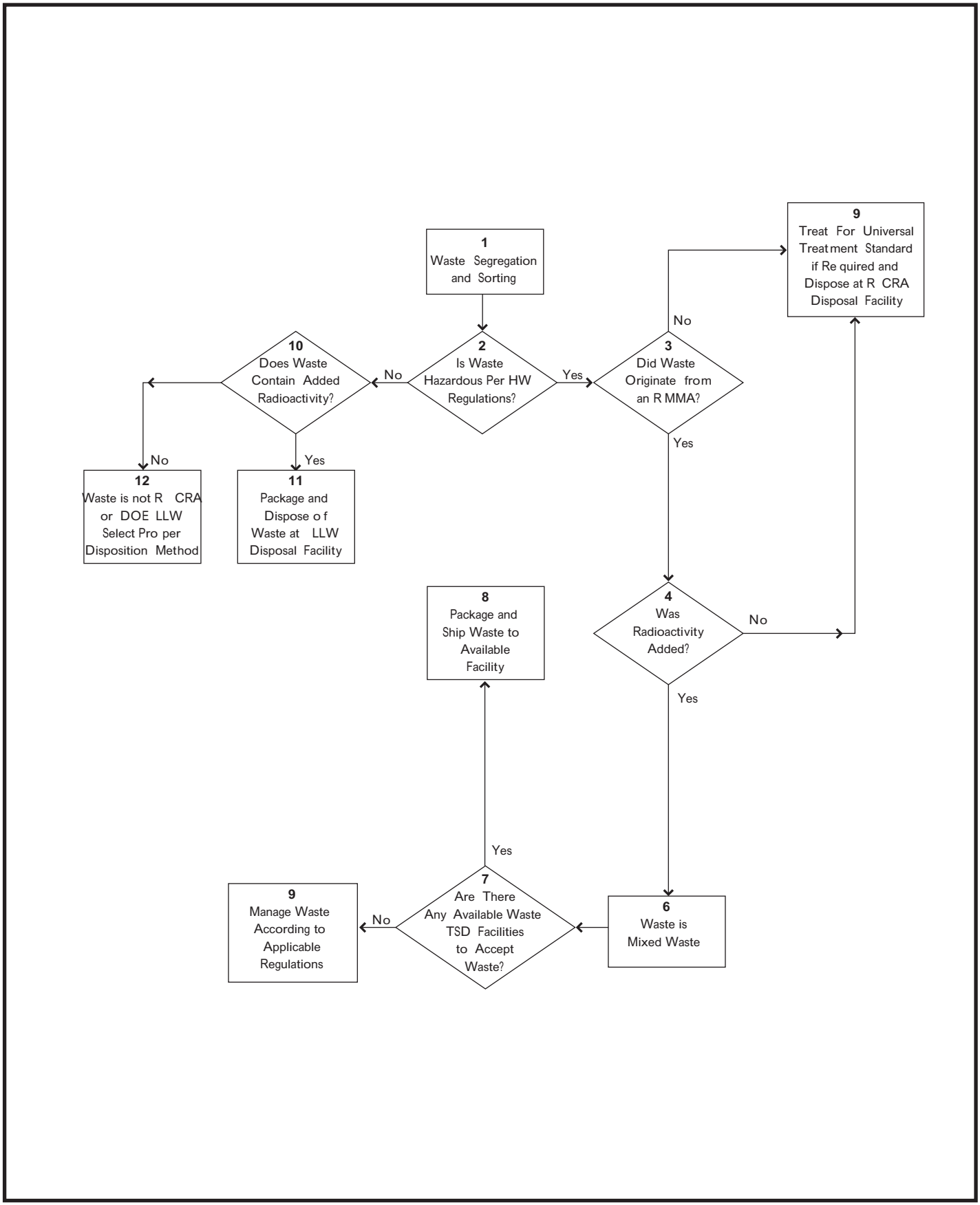

Figure 2-1. Waste Classification and Disposition Process—LEHR Facility, Davis, California

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