U.S. Department of Energy

Oakland Operations Office, Oakland, California

DOMESTIC SEPTIC SYSTEMS 3 AND 6 REMOVAL ACTIONS WORK PLAN

for 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
Emeryville, California 94608-1827

May 3, 2002
Rev. 0

DOE Oakland Operations Contract DE-AC03-96SF20686

Weiss Associates
Environmental Science, Engineering and Management

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Approvals Page

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ACRONYMS

AHA	activity hazard analysis
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
CFR	Code of Federal Regulations
COC	constituent of concern
COV	coefficient of variation
CPGERP	Contingency Plan and General Emergency Response Procedures
cu yd	cubic yard
DAC	derived air concentration
dBA	decibel
DGI	Data Gaps Investigation
DI WET	waste extraction test using deionized water
DL	designated-level
DOE	Department of Energy
DP	daughter product
DQO	data quality objective
DSS	Domestic Septic System
DSSI	Domestic Septic Systems Investigation
DST	Domestic Septic Tank
DZ	decontamination zone
EDPs	Eastern Dog Pens
EMC	elevated measurement comparison
EMS	Environmental Management Services

FFA	Federal Facility Agreement
ft	foot/feet
GEL	General Engineering Laboratory
GERT	General Employee Radiological Training
H&S	health and safety
H_a	alternative hypothesis
HAZWOPER	Hazardous Waste Operations and Emergency Response
Hg	mercury
H_o	null hypothesis
HSC	Health and Safety Coordinator
HSP	health and safety procedure
HVAC	heating, ventilating and air conditioning
HW	hazardous waste
HWP	hazardous work permit
ID	identification (number)
IT Corp.	IT Corporation
K_d	adsorption coefficient
lbs.	pounds
LEHR	Laboratory for Energy-Related Health Research
LEL	lower explosive level
LLW	low-level waste
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
ml/g	milliliters per gram
MW	mixed waste
NH	non-hazardous waste
NNR	Noise Reduction Rating
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
PCB	polychlorinated biphenyl
pCi/g	picoCuries per gram

PEL	permissible exposure limit
PHSM	Project Health and Safety Manager
PHSP	Project Health and Safety Plan
PM	Project Manager
PPE	personal protective equipment
ppm	parts per million
PQAM	Project Quality Assurance Manager
PQAS	Project Quality Assurance Specialist
PRG	preliminary remediation goal
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RA	removal action
Ra-226	radium-226
RAO	Removal Action Objective
RBAS	risk-based action standard
RCT	Radiological Control Technician
RDL	reported detection limit
RfD_0	reference dose
RME	reasonable maximum exposure
RPM	Remedial Project Manager
RPP	Radiological Protection Plan
RSO	Radiological Safety Officer
SC	Site Coordinator
SHSO	Site Health and Safety Officer
SOP	standard operating procedure
SQP	standard quality procedure
Sr-90	strontium-90
SRA	Site Records Administrator
STLC	soluble threshold limit concentration
SVOC	semi-volatile organic compound

SWT	Southwest Trenches
TCLP	toxicity characteristic leaching procedure
TSM	tailgate safety meeting
TWA	time-weighted average
UC Davis	University of California, Davis
UCL	upper confidence limit
US EPA	United States Environmental Protection Agency
USCS	Unified Soil Classification System
VCP	vitrified clay pipe
VOC	volatile organic compound
WA	Weiss Associates
WAC	waste acceptance criteria
WBGT	wet bulb globe temperature
WC	Waste Coordinator
WDPs	Western Dog Pens
WET	waste extraction test
WMP	Waste Management Plan
WRS	Wilcoxon Rank Sum
WS	Waste Specialist

1. INTRODUCTION

This work plan addresses the non-time-critical removal actions (RAs) that will be conducted at Former Domestic Septic System (DSS) 3 and DSS 6 at the Laboratory for Energy-Related Health Research (LEHR or the Site) located at the University of California, Davis (UC Davis) (Figure 1-1). The RAs are being implemented in accordance with the National Contingency Plan, 40 Code of Federal Regulations (CFR) Part 300.415. Weiss Associates (WA) prepared this Work Plan under United States Department of Energy (DOE) Environmental Restoration/Waste Management Contract No. DE-AC03-96SF20686.

This section of the work plan summarizes background information for each RA area, lists the constituents of concern (COCs), and presents the removal action objectives (RAOs). A contacts list and project schedule are also provided. Section 2 describes the RA approach and supporting activities. Section 3 describes the sampling and analysis strategies and methodologies that were selected for the DSSs 3 and 6 RAs. Section 4 of this work plan describes the waste management activities, including waste stream identification, handling, packaging, and storage methodologies for the RAs. Section 5 describes the health and safety hazard analyses and hazard controls. Section 6 describes the quality assurance aspects that will be implemented during the RAs.

1.1 Site Background

The Atomic Energy Commission (now DOE) began conducting radiological studies on laboratory animals at LEHR in the early 1950s. Initial studies were carried out on the main UC Davis campus and involved irradiation of beagles. The Site began operating in its present location in 1958 when full-scale experimental use of radioactive materials began. Research at LEHR through the mid-1980s focused on the health effects from chronic exposure to radionuclides, primarily strontium-90 (Sr-90) and radium-226 (Ra-226).

Beginning in 1958, the DSSs served LEHR offices and laboratories. DSS 6 is the oldest DSS at LEHR. A plan dated December 12, 1958 shows it connected to the "Animal Holding Building." Domestic Septic Tank (DST) 3 was apparently installed during construction of Buildings H-215 and H-216 between 1962 and 1964, when the capacity of the tank serving existing Building H-217 may have become insufficient (WA, 2001e). The locations of DSSs 3 and 6 are shown on Figure 1-2.

Liquid wastes and sewage were discharged to DST 3 and 6 prior to the Site's connection to the UC Davis Wastewater Treatment Plant in 1971. At that time, DSTs 3 and 6 were reportedly backfilled with sand and the influent/effluent lines for each tank were reportedly cut and capped (IT Corp., 1996). No formal closure reports for these DSTs have been discovered (D&M, 1994).

1.2 Previous Investigations

1.2.1 Domestic Septic System 3

During the 1997 Data Gaps Investigation (DGI), 9 borings were hand-augered to 5-foot (ft) depth, and 4 borings were drilled up to a 16-ft depth near the suspected location of DSS 3 (WA, 1998b). The tank was not located, but gravelly materials were found between 4- and 8-ft deep in borings 7, 8, 14, and 15, which were considered at that time to be the DST 3 leach field. This location coincides with a former storm water drain field (Figure 1-3) that is shown connected to the storm water catchment system on 1962, 1964, and 1965 site drawings. Ra-226 at a maximum concentration of 1.45 picoCuries per gram (pCi/g) was detected in a composite sample from three borings at a depth of 15.5 ft below ground surface (bgs), beneath the former "drain field".

During the 2001 Domestic Septic Systems Investigation (DSSI), five soil borings were drilled surrounding the 1997 DGI boring locations where Ra-226 was detected at a maximum concentration of 1.45 pCi/g (Figure 1-3). Seventeen soil samples (including two field duplicates) were collected from the five borings and analyzed for gamma emitters and Ra-226. The soil samples were collected every four ft starting eight ft bgs, the termination point of the former drain field. Three samples were collected per boring: the first composite sample was collected from 8 to 12 ft bgs, the second composite sample was collected from 12 to 16 ft bgs, and the third composite sample was collected from 16 to 20 ft bgs. All of the DSS 3 sample locations are shown on Figure 1-3.

To characterize DSS 3, samples were collected from the following locations (Figure 1-3) and analyzed for radionuclides, metals, nitrate, pesticides/polychlorinated biphenyls (PCBs), semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs) and hexavalent chromium (full suite of COCs):

- The distribution box;
- Adjacent to the DST 3 tank bottom at a depth of 9 to 11 ft bgs;
- Directly below the first point of perforation on the eastern leach line at four ft bgs;
- Five ft below the first perforations in the eastern leach line;
- Directly below the approximate midpoint of the eastern leach line at four ft bgs; and,
- Below the midpoint of the eastern leach line at eight ft bgs.

To determine if residual sludge was present at the bottom of DST 3, an aluminum casing was driven to the bottom of the tank using the backhoe bucket. The tank contents were removed from the casing using a hand auger and visually inspected for signs of moisture or discoloration. There were no indications that sludge remained at the bottom of DST 3.

The analytical results from the DSS 3 samples collected during the 2001 DSSI are discussed in Section 1.3.1.

1.2.2 Domestic Septic System 6

During the 1997 DGI, 11 borings were hand-augered to a depth of five ft, and four borings were drilled up to a depth of 13 ft (Figure 1-4) in the suspected former location of DSS 6. The tank was not located, but gravel-bearing believed to be the leach field was found between 1.5 and 5 ft bgs. Mercury (Hg) was detected at 49.4 milligrams per kilogram (mg/kg) in a sample collected at a 5.5-ft depth.

During the 2001 DSSI, an approximately five-ft by five-ft area around the Hg detection was excavated and containerized for off-site disposal (Figure 1-4) in accordance with the W*ork Plan for Removal Actions in the Southwest Trenches, Ra/Sr Treatment Systems, and Domestic Septic Systems Areas* (WA, 2000c). The following samples were collected and analyzed for a full suite of COCs to characterize DSS 6:

- A two-point composite soil sample from beneath the first points of perforation on the southern leach lines;
- A two-point composite soil sample from beneath the first points of perforation on the northern leach lines;
- A two-point composite sample from beneath the effluent lines; and,
- A concrete sample from a portion of the DSS6 tank floor.

Samples were also collected from the following locations and analyzed for Hg:

- The excavation side walls and floor;
- A four-point composite sample of the leach field gravel;
- Six inches and one ft west of the southeastern leach line;
- Six inches and one foot below the gravel/soil interface on the southeastern leach line; and,
- Beneath the leach line midpoints and endpoints.

The sample locations are shown on Figure 1-4. The analytical results from the DSS 6 samples collected during the 2001 DSSI are discussed in Section 1.3.2.

1.3 Extent of Contamination

1.3.1 Domestic Septic System 3

The constituents detected in DSS 3 soil samples at concentrations that exceed the lowest risk-based action standard (RBAS), background and/or the preliminary remediation goals (PRGs) for residential soil are presented in Table 1-1. Cadmium, copper, lead, manganese, Hg, silver and Ra-226 were detected above their respective soil backgrounds at depths greater than four ft bgs (>4 ft bgs) and lowest RBAS values. Seventeen constituents were detected above their respective PRGs for residential soil.

The distribution box sediment sample and the soil sample collected beneath the first point of perforation on the leach line had the maximum reported concentrations for the majority of the detected constituents (Tables 1-1 and 1-2). The maximum reported Hg concentration, 751 mg/kg, was detected in the distribution box sediment sample. Hg concentrations in soil ranged from 0.35 mg/kg to 498 mg/kg. There were only five soil samples were collected from the DSS 3 area. Therefore, assumptions regarding the extent of Hg contamination cannot be made. The DSS 3 Hg concentrations are shown on Figure 1-3.

Ra-226 was not detected above background in any of the 17 soil samples collected from the five soil borings surrounding the 1997 DGI boring locations where Ra-226 was detected at 1.45 pCi/g. Ra-226 was detected above the soil background of 0.75 pCi/g in two of the DSS 3 investigation samples. The maximum reported concentration of Ra-226, 2.44 pCi/g, was detected in soil sample SSD3C020, collected from beneath the first point of perforation on the eastern leach line (Figure 1-3). The Ra-226 contamination appears to be limited to the distribution box sediment and immediately below the first point of perforation. The DSS 3 investigation Ra-226 concentrations are shown on Figure 1-3.

Four SVOCs were reported in sample SSD3C022 at concentrations that exceeded their respective lowest RBAS values and PRGs for residential soil (Table 1-1). Sample SSD3C022 was collected 4.5 ft bgs beneath the leach line midpoint.

1.3.2 Domestic Septic System 6

The constituents detected in DSS 6 soil samples at concentrations that exceed the lowest RBAS, background and/or the PRGs for residential soil are presented in Table 1-3. Antimony, barium, copper, lead and Hg were detected above their respective soil backgrounds (> 4 ft bgs) and lowest RBAS values. Fourteen constituents were detected above their respective PRGs for residential soil.

Hg was detected above background and the lowest RBAS in 31 of 34 samples at concentrations ranging from 0.26 to 101 mg/kg. Hg was reported at concentrations above the lowest

RBAS and residential PRGs in samples collected from beneath all four leach lines. Based on sample results, the Hg appears to be limited to the upper seven ft of the soil. The lateral extent of contamination should be limited to the areas surrounding the leach lines. Five samples were collected from the sidewalls and floor of the DSS 6 RA excavation. The Hg concentrations in these samples ranged from 0.13 to 3 mg/kg. The DSS 6 Hg concentrations are shown on Figure 1-4.

Four SVOCs were detected above their respective lowest RBAS and PRGs for residential soil in sample SSD6C001A/B (Table 1-3). This two-point composite sample was collected beneath the first points of perforation on the northern leach lines.

Since there are no established background values for concrete, the analytical results from the DST 6 concrete tank bottom sample were compared to lowest site soil backgrounds. Hexavalent chromium, at 0.13 mg/kg, was only constituent detected above the lowest site soil background in the concrete sample. However, the hexavalent chromium concentration was well below the lowest RBAS and residential PRG concentrations.

1.4 Constituents of Concern

The COCs for each RA area were identified using the data collected during the previous investigation(s). In general, compounds detected above background and the lowest RBAS or residential PRG were considered COCs. At DSS 3, formaldehyde, hexavalent chromium, cadmium, chromium, lead, manganese, Hg, molybdenum, nickel, silver, alpha-chlordane, gamma-chlordane, heptachlor epoxide, Sr-90 and Ra-226 are considered COCs. At DSS 6, hexavalent chromium, antimony, barium, copper, lead, Hg and nickel are considered COCs.

Only a few COCs were consistently detected throughout each area and are associated with past operations. The COCs detected consistently in each area that are known to have been released to the environment are considered "driver COCs". The driver COCs for the DSS 3 RA are Hg and Ra-226. The sole driver COC for the DSS 6 RA is Hg. A previous evaluation of metals and SVOC mobility and distribution indicates that Hg is a reasonable indicator of attaining cleanup in the DSS areas.

1.5 Removal Action Objectives

The objectives of these non-time critical RAs are:

- Mitigate potential excess cumulative cancer risk to an individual from exposure to site contaminants to a level within a nominal range of 10^{-4} to 10^{-6}, using 10^{-6} as the point of departure;
- Reduce potential non-cancer hazard indices to levels below 1;
- Mitigate potential future impact to ground water;

- Minimize ecological risks during and after the RAs;
- Mitigate hazardous waste; and,
- Minimize impact to site university research.

To achieve these objectives, RAs consisting of excavation and off-site disposal will be conducted at DSSs 3 and 6.

1.6 Removal Criteria

To determine successful attainment of the RAOs and completion of the DSSs 3 and 6 RAs, confirmation samples will be collected following material/waste removal activities. The confirmation sample analytical results will be compared to background soil values, RBAS, PRGs and ground water-protective designated-level (DL) soil concentrations. Section 3 presents the data quality objectives and sampling design developed to ensure attainment of the RAOs.

1.7 Removal Action Sequence

The general scope of work for the two RA areas is removal of contamination sources and associated soil, followed by confirmation sampling and analysis, backfilling and compaction of the excavation, and site restoration. All excavated waste and structures will be managed as potentially mixed waste and disposed at an appropriate facility after characterization. Waste shipment and disposal are not discussed in this work plan. A separate waste management plan will be prepared at a later date to address waste shipment and disposal. The RA sequence for each area is described in more detail below.

1. Mobilize equipment and personnel to the site;
2. Conduct site setup activities including site feature protection and establishment of storage and work areas;
3. Survey underground utilities and protect any utilities that may interfere with removal activities;
4. Remove pavement in the RA work area;
5. Remove and stockpile overburden soil;
6. Excavate and remove structures, piping, leach fields and associated soil;
7. Load waste into containers for storage (concurrent with excavation);
8. Characterize and designate waste (concurrent with waste generation);
9. Transport, weigh and store waste containers from the construction area;
10. Sample to determine whether driver COCs have been adequately removed (concurrent with excavation);

11. Conduct a preliminary evaluation (Phase I) to determine whether RAOs have been attained;
12. Present Phase I data evaluation results to DOE and regulatory agencies;
13. Perform elevated measurement comparison (EMC) test on the DSS 3 excavation (the EMC test survey plan will be issued as an addendum to this work plan).
14. Collect confirmation samples from the DSSs 3 and 6 excavation limits;
15. Survey excavation limits and confirmation sampling locations;
16. Backfill and compact the excavations;
17. Restore site features and paving;
18. Demobilize equipment and personnel from the site; and,
19. Evaluate confirmation sample analytical results, perform Phase II data evaluation and prepare the RA Confirmation Report.

1.8 Project Organization

Roles and responsibilities for the project organization are described in the LEHR Quality Assurance Project Plan (QAPP) (WA, 2000b). The RA team consists of WA, IT Corp., Environmental Management Services (EMS), and other subcontractors. WA is responsible for the overall project management, quality assurance, radiological protection, and health and safety (H&S) aspects of the project. IT Corp. is responsible for performing RA field activities safely and to appropriate quality standards. EMS provides waste management expertise and senior technical input.

1.9 Project Contacts

The following individuals are contacts for this project. The names of project deputies are shown in parentheses.

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

Project Manager – Robert Devany, R.G., C.E.G., C.H.G. (Dolores Loll)

Site Coordinator – Erik Nielsen, R.G.

Waste Coordinator – John Wolf, R.E.A., C.H.M.M.

Project Health and Safety/Radiological Control Manager – Jerry McHugh, P.E., C.I.H. (Agata Sulczynski – Health & Safety, Dawn Mitchell [EMS] – Radiological Control)

Project Quality Assurance Manager – Dolores Loll

IT Corporation (925) 288-9898

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

Task Manager – Kevin O'Leary

Radiation Safety Officer – Dave Ochs, OHST

Environmental Management Services (925) 939-0687

Senior Technical Advisor – Salem Attiga, Ph.D.

Waste Specialist – Dawn Mitchell

1.10 Project Schedule

The RA schedule is provided in Figure 1-5.

Table 1-1. Domestic Septic System 3 Investigation Sampling Analytical Results Summary

Constituent	Total Samples	Number of Samples > Background[1]	Number of Samples > RBAS[2]	Number of Samples > PRG[3]	Maximum Concentration	Sample Identification	Depth (ft)
General Chemistry					**mg/kg**		
Hexavalent Chromium	5	3	0	1	0.836	SSD3C019	9- 11.3
Nitrate	5	3	NE	NE	101	SSD3C023	8
Metals					**mg/kg**		
Arsenic	5	1	NE	5	44.1	SSD3C020	4
Barium	5	0	5	0	222	SSD3C020	4
Cadmium	**5**	**3**	**4**	**0**	**2.6**	**SSD3C020**	**4**
Chromium	5	5	0	1	249	SSD3C020	4
Copper	5	1	5	0	106	SSD3C020	4
Iron	5	0	NE	5	37,900	SSD3C023	8
Lead	**5**	**1**	**5**	**0**	**21.8**	**SSD3C020**	**4**
Manganese	**5**	**1**	**5**	**0**	**752**	**SSD3C022**	**4.5**
Mercury	**5**	**5**	**5**	**2**	**498**	**SSD3C020**	**4**
Molybdenum	5	4	NE	0	26.2	SSD3C020	4
Nickel	5	3	NE	5	285	SSD3C023	8
Selenium	5	4	0	0	10.7	SSD3C020	4
Silver	**5**	**4**	**4**	**0**	**186**	**SSD3C020**	**4**
Zinc	5	1	0	0	116	SSD3C020	4
Pesticides					**µg/kg**		
alpha-Chlordane	5	NA	1	NE	806	SSD3C020	4
gamma-Chlordane	5	NA	1	NE	1,150	SSD3C020	4
Heptachlor epoxide	5	NA	1	0	12.8	SSD3C022	4.5

Table 1-1. Domestic Septic System 3 Investigation Sampling Analytical Results Summary (continued)

Constituent	Total Samples	Number of Samples > Background[1]	Number of Samples > RBAS[2]	Number of Samples > PRG[3]	Maximum Concentration	Sample Identification	Depth (ft)
Radionuclides					**pCi/g**		
Bismuth-214	5	1	NE	NE	2.18	SSD3C020	4
Carbon-14	5	1	0	0	0.155	SSD3C023	8
Cesium-137	5	1	0	1	0.0619	SSD3C020	4
Lead-210	5	1	0	3	1.72	SSD3C020	4
Lead-214	5	1	NE	0	2.33	SSD3C020	4
Potassium-40	5	0	NE	5	11.7	SSD3C023	8
Radium-226	**5**	**1**	**5**	**1**	**2.44**	**SSD3C020**	**4**
Strontium-90	5	4	0	0	2.01	SSD3C020	4
Thorium-228	5	0	5	5	0.595	SSD3C021	8.5
Thorium-232	5	0	5	0	0.525	SSD3C020	4
Uranium-233/234	5	1	NE	0	1.1	SSD3C020	4
Uranium-238	5	1	NE	0	0.649	SSD3C020	4
SVOCs					**µg/kg**		
Benzo(a)anthracene	5	NA	1	1	6,540	SSD3C022	4.5
Benzo(a)pyrene	5	NA	1	1	1,660	SSD3C022	4.5
Benzo(b)fluoranthene	5	NA	1	1	5,600	SSD3C022	4.5
Benzo(k)fluoranthene	5	NA	0	1	3,680	SSD3C022	4.5
Dibenzo(a,h)anthracene	5	NA	1	1	1,150	SSD3C022	4.5
Indeno(1,2,3-cd)pyrene	5	NA	0	1	1,110	SSD3C022	4.5

Table 1-1. Domestic Septic System 3 Investigation Sampling Analytical Results Summary (continued)

Notes

Highlighted constituents (indicated with **bold type**) were detected above background and the lowest risk-based action standard.

[1]Site-specific background for greater than four feet below ground surface.

[2]The lowest risk-based action standard.

[3]The preliminary remediation goal for residential soil.

Abbreviations

ft	feet
mg/kg	milligrams per kilogram
NA	not applicable
NE	not established
pCi/g	picoCurie per gram
PRG	preliminary remediation goal
RBAS	risk-based action standard
SVOCs	semivolatile organic compounds
µg/kg	micrograms per kilogram

Table 1-2. Domestic Septic System 3 Distribution Box Sediment Sample Analytical Results

Constituent	Concentration	Units	RBAS [1]	Lowest Background [2]	PRG [3]
General Chemistry					
Formaldehyde	1,920	µg/kg	1,700	NA	9,200,000
Hexavalent Chromium	0.0943	mg/kg	3.8	0.054	0.2
Metals					
Antimony	1.2	mg/kg	0.3	1.4	31
Arsenic	54.4	mg/kg	NE	8.14	0.39
Barium	345	mg/kg	53	211	5,400
Beryllium	0.44	mg/kg	NE	0.564	150
Cadmium	5.1	mg/kg	0.38	0.51	9
Chromium	591	mg/kg	721.9	125	210
Copper	219	mg/kg	28	48.8	2,900
Iron	36,500	mg/kg	NE	44,000	23,000
Lead	69.6	mg/kg	0.044	9.5	400
Manganese	350	mg/kg	36	750	1,800
Mercury	751	mg/kg	0.22	0.248	23
Molybdenum	83.3	mg/kg	NE	0.26	390
Nickel	97.4	mg/kg	NE	246	150
Selenium	11.1	mg/kg	58	1.2	390
Silver	150	mg/kg	3.8	0.55	390
Vanadium	93.5	mg/kg	NE	66.8	550
Zinc	223	mg/kg	3400	72.4	23,000
Pesticides					
alpha-Chlordane	718	µg/kg	800	NA	1,600[4]
gamma-Chlordane	1,240	µg/kg	810	NA	1,600[4]
Radionuclides					
Bismuth-214	1.78	pCi/g	NE	0.54	NE
Cesium-137	0.0736	pCi/g	0.1	0.00695	0.02
Lead-210	2.29	pCi/g	9.6	1.6	0.78
Lead-214	1.94	pCi/g	NE	0.55	NE
Potassium-40	7.28	pCi/g	NE	14	0.068
Radium-226	2.31	pCi/g	0.0042	0.752	1.5
Strontium-90	0.692	pCi/g	10	0.056	14
Thorium-228	0.435	pCi/g	0.032	0.627	0.041
Thorium-232	0.414	pCi/g	0.022	0.63	24

Table 1-2. Domestic Septic System 3 Distribution Box Sediment Sample Analytical Results (continued)

Constituent	Concentration	Units	RBAS [1]	Lowest Background [2]	PRG [3]
Radionuclides (continued)					
Thorium-234	1.45	pCi/g	3.2	0.78	NE
Uranium-233/234	1.67	pCi/g	NE	0.559	18
Uranium-238	1.05	pCi/g	NE	0.565	18

Notes

[1] The lowest risk-based action standard.

[2] The lowest site-specific background value.

[3] The preliminary remediation goal for residential soil.

[4] For total chlordane.

Abbreviations

mg/kg	milligrams per kilogram
NA	not applicable
NE	not established
pCi/g	picoCuries per gram
PRG	preliminary remediation goal
RBAS	risk-based action standard
µg/kg	micrograms per kilogram

Table 1-3. Domestic Septic System 6 Investigation Sampling Analytical Results Summary

Constituent	Number of Samples	Number of Samples > Background[1]	Number of Samples > RBAS[2]	Number of Samples > PRG[3]	Maximum Concentration	Sample Identification	Depth (ft)
General Chemistry					**mg/kg**		
Hexavalent Chromium	3	2	0	0	0.198	SSD3C06A/B	3.25
Metals					**mg/kg**		
Antimony	**6**	**1**	**3**	**0**	**1.9**	**SSD3C004A/B**	**3.75**
Arsenic	6	4	0	6	9.3	LEHR-S-T603	13
Barium	**6**	**3**	**6**	**0**	**221**	**LEHR-S-T602**	**8**
Copper	**6**	**2**	**6**	**0**	**75.2**	**SSD6C001A/B**	**4**
Chromium	16	11	0	0	166	SSD6F027	3
Iron	6	0	NE	6	43,200	LEHR-S-T603	13
Lead	16	1	16	0	9.6	SSD6C004A/B	3.75
Manganese	6	0	6	0	709	LEHR-S-T603	13
Mercury	**34**	**31**	**31**	**9**	**101**	**SSD6C012**	**4**
Molybdenum	6	3	NE	0	0.41	SSD6C001A/B	4
Nickel	6	3	NE	6	274	SSD6C03A/B	3.25
Silver	6	2	0	0	1	SSD6C004A/B	3.75
Thallium	6	2	NE	0	2	SSD6C004A/B	3.75
Vanadium	6	3	NE	0	84.8	LEHR-S-T603	13
Zinc	6	5	0	0	179	SSD6C001A/B	4
Radionuclides					**pCi/g**		
Actinium-228	6	1	NE	NE	0.67	LEHR-S-T603	13
Bismuth-212	6	1	NE	NE	0.45	LEHR-S-T602	8
Bismuth-214	6	3	NE	NE	0.61	LEHR-S-T602	8
Cesium-137[4]	6	0	0	2	0.0549	SSD6C001A/B	4
Lead-210	6	1	0	2	1.75	SSD6C004A/B	3.75

Table 1-3. Domestic Septic System 6 Investigation Sampling Analytical Results Summary (continued)

Constituent	Number of Samples	Number of Samples > Background[1]	Number of Samples > RBAS[2]	Number of Samples > PRG[3]	Maximum Concentration	Sample Identification	Depth (ft)
Radionuclides (continued)					**pCi/g**		
Lead-214	6	4	NE	NE	0.75	LEHR-S-T602	8
Potassium-40	6	0	NE	6	12.8	SSD6C001A/B	4
Radium-226	6	0	6	0	0.56	LEHR-S-T603	13
Strontium-90	6	2	0	0	0.211	SSD6C001A/B	4
Thallium-208	6	2	NE	NE	0.242	LEHR-S-T602	8
Thorium-228	3	0	3	3	0.499	SSD6C002A/B	3.25
Thorium-232	3	0	3	0	0.429	SSD6C003A/B	3.25
Tritium	6	1	0	0	2.3	LEHR-S-T602	8
Uranium-233/234	3	2	NE	0	0.737	SSD6C001A/B	4
SVOCs					**µg/kg**		
Benzo(a)anthracene	6	NA	1	2	14,400	SSD6C001A/B	4
Benzo(a)pyrene	6	NA	1	1	788	SSD6C001A/B	4
Benzo(b)fluoranthene	6	NA	1	2	8,330	SSD6C001A/B	4
Benzo(k)fluoranthene	6	NA	0	1	7,000	SSD6C001A/B	4
Dibenzo(a,h)anthracene	6	NA	1	1	2,980	SSD6C001A/B	4
Indeno(1,2,3-cd)pyrene	6	NA	0	1	1,260	SSD6C001A/B	4

Notes

[1] Lowest site-specific background.

[2] The lowest risk-based action standard.

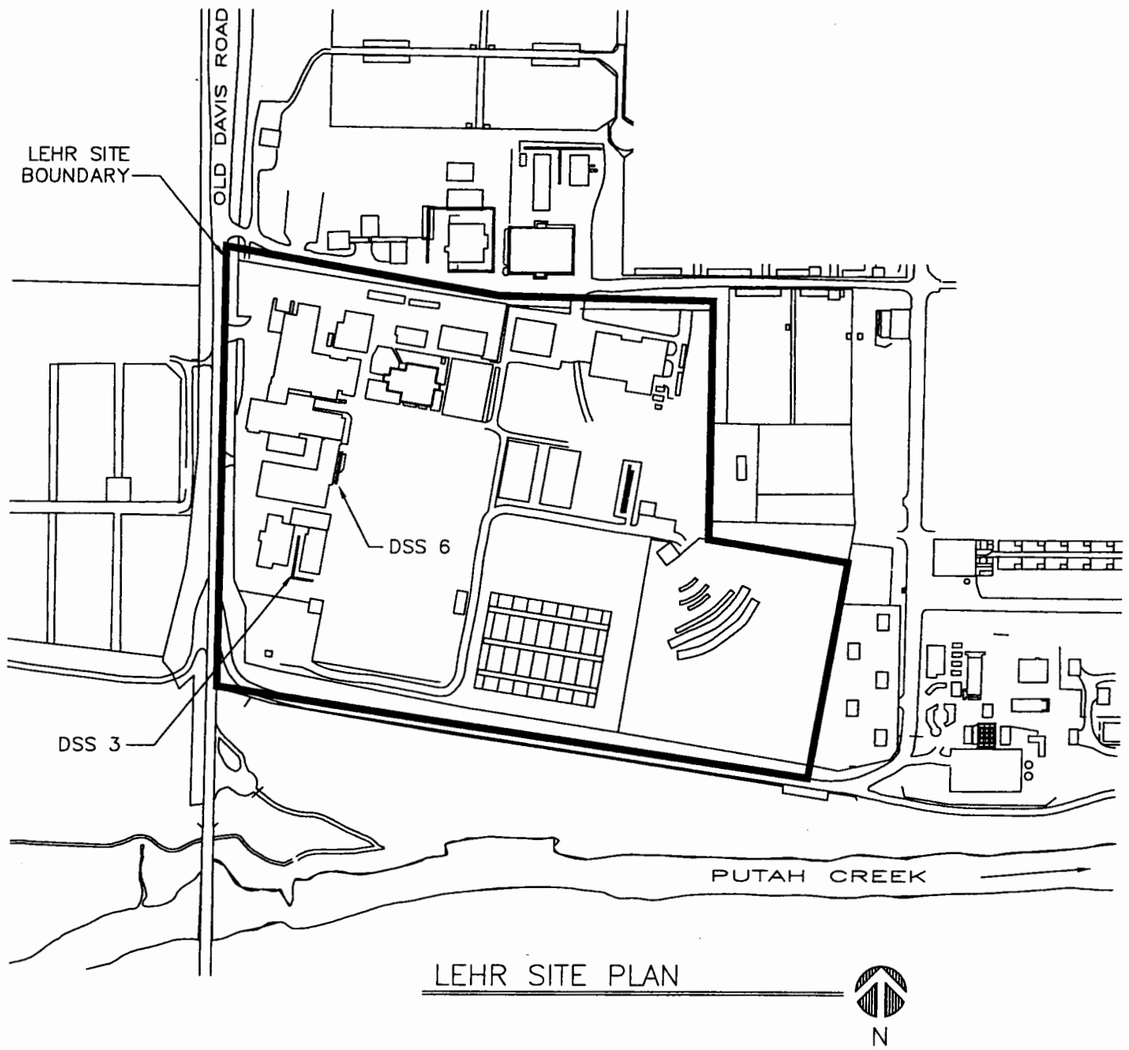
[3] The preliminary remediation goal for residential soil.

[4] Samples collected less than four feet below ground surface were compared to the zero to four feet background value.

Table 1-3. Domestic Septic System 6 Investigation Sampling Analytical Results Summary (continued)

Abbreviations

ft	feet
mg/kg	milligrams per kilogram
NA	not applicable
NE	not established
pCi/g	picoCurie per gram
PRG	preliminary remediation goal
RBAS	risk-based action standard
SVOCs	semi-volatile organic compounds
µg/kg	micrograms per kilogram



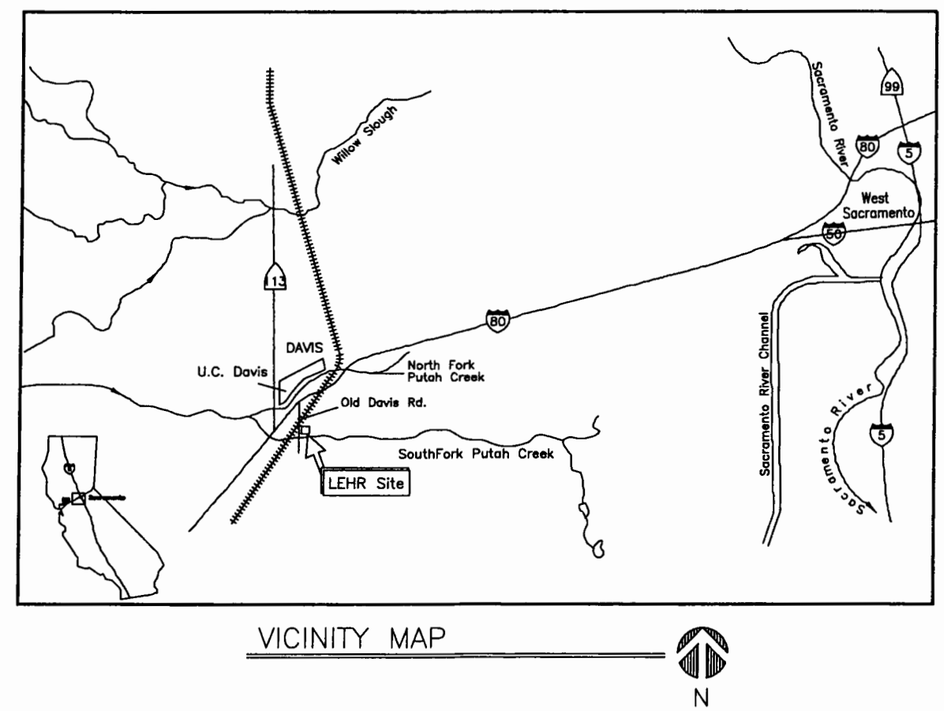


Figure 1-1. LEHR Facility Plan and Vicinity Map

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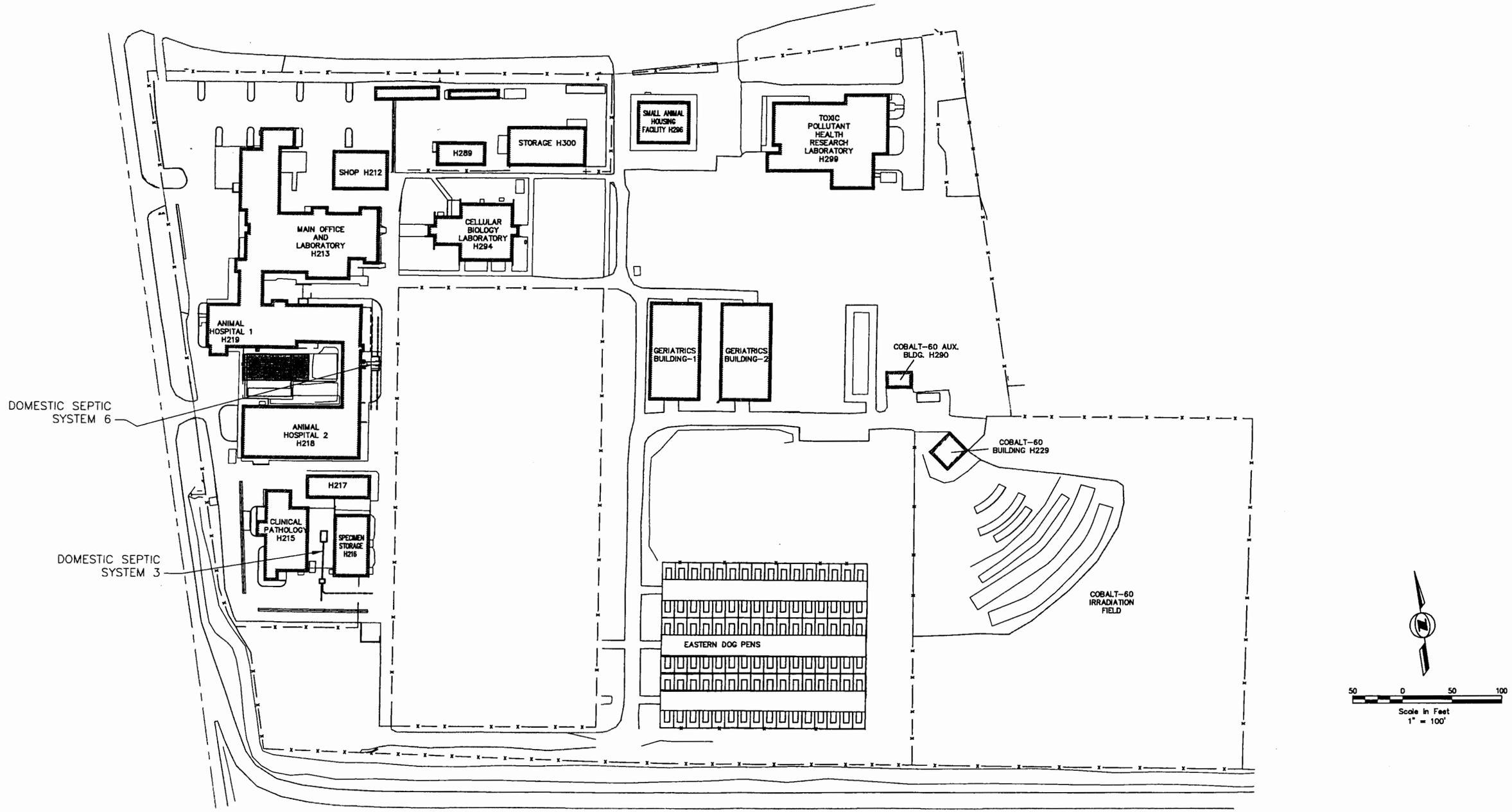

Figure 1-2. Locations of Domestic Septic Systems 3 and 6 and LEHR Facility Buildings

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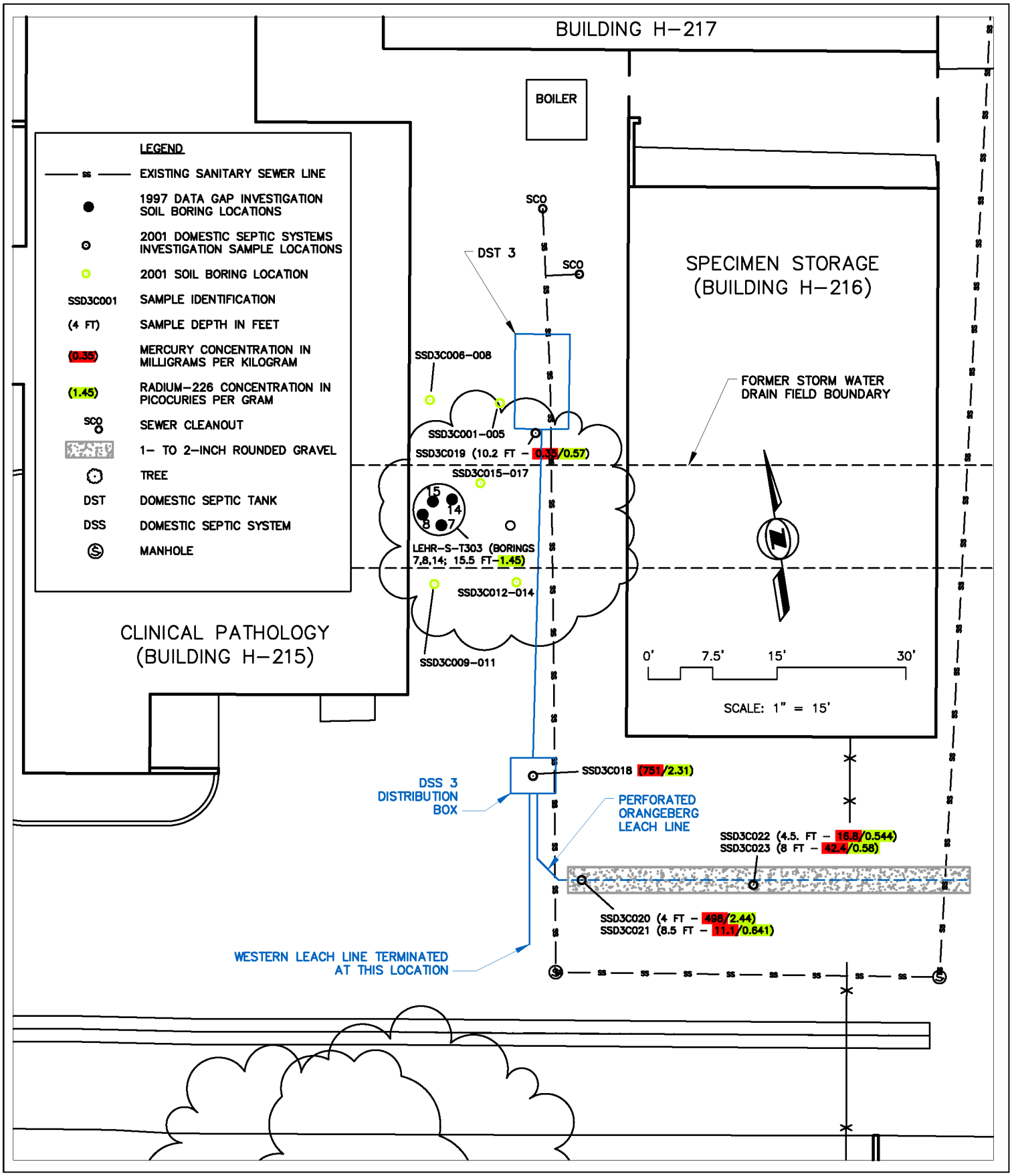

Figure 1-3. Domestic Septic System 3 Sample Locations Showing Mercury and Radium-226 Concentrations

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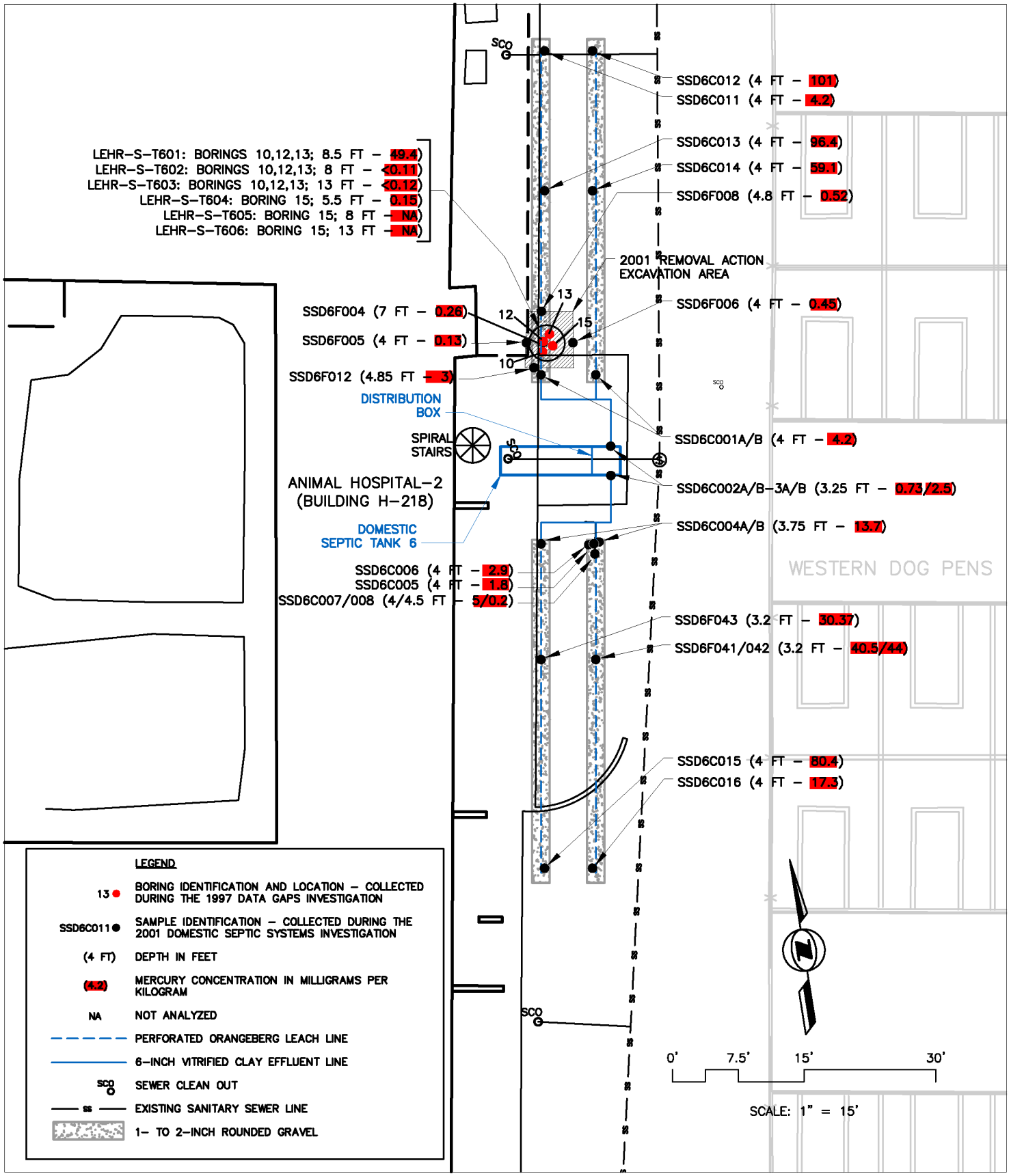

Figure 1-4. Domestic Septic System 6 Sample Locations and Mercury Concentrations

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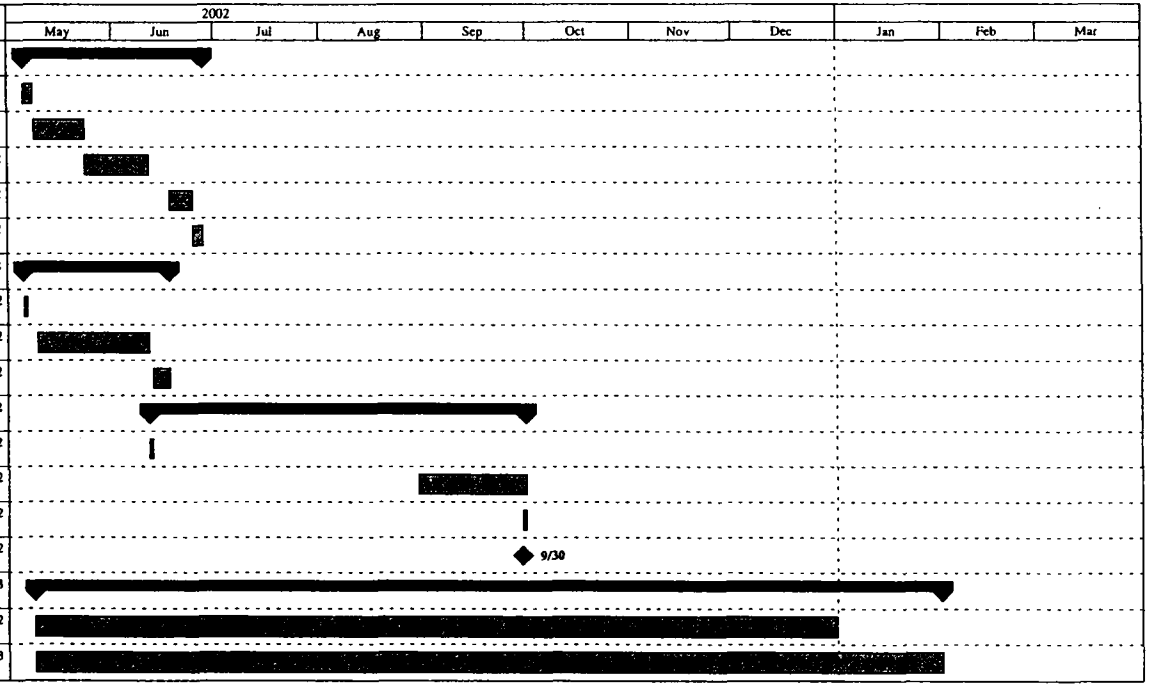
Figure 1-5. Domestic Septic Systems 3 and 6 Removal Actions Schedule

Task Name	Start	Finish
DSSs 3 and 6 Removal Actions	**Mon 5/6/02**	**Thu 6/27/02**
Mobilization/Site Setup	Mon 5/6/02	Wed 5/8/02
DSS 3 Material/Waste Removal	Thu 5/9/02	Thu 5/23/02
DSS 6 Material/Waste Removal	Fri 5/24/02	Tue 6/11/02
Backfill and Compaction	Tue 6/18/02	Mon 6/24/02
Site Restoration/Demobilization	Tue 6/25/02	Thu 6/27/02
Sampling and Analysis	**Mon 5/6/02**	**Mon 6/17/02**
Designated-Level Sampling	Mon 5/6/02	Mon 5/6/02
Excavation Screening Sampling	Fri 5/10/02	Tue 6/11/02
Confirmation Sampling	Thu 6/13/02	Mon 6/17/02
Data Evaluation and Review	**Wed 6/12/02**	**Mon 9/30/02**
Phase I Data Evaluation	Wed 6/12/02	Wed 6/12/02
Phase II Data Evaluation	Fri 8/30/02	Mon 9/30/02
Submit Draft DSSs 3 and 6 RA Confirmation Report to the RPMs	Mon 9/30/02	Mon 9/30/02
FFA Milestone for Confirmation Report Submittal	Mon 9/30/02	Mon 9/30/02
Waste Management	**Thu 5/9/02**	**Fri 1/31/03**
Waste Characterization and Designation	Thu 5/9/02	Tue 12/31/02
Material/Waste Storage	Thu 5/9/02	Fri 1/31/03



2. DOMESTIC SEPTIC SYSTEMS 3 AND 6 REMOVAL ACTION APPROACH

The following sections describe the plans for the DSSs 3 and 6 RAs and supporting activities, including pre-job planning, mobilization, site setup, material/waste removal and staging, backfill and compaction, site restoration, and demobilization. Figures 2-1 through 2-3 show the plans for various RA activities.

2.1 Pre-Job Planning

Several tasks need to be completed prior to the start of the RA to facilitate efficient field operations and to optimize field activities. These include:

- Coordinating with UC Davis facility personnel;
- Locating utilities and conducting a geophysical survey of the work area;
- Training workers; and,
- Conducting pre-construction meetings with project staff.

2.1.1 Facility Coordination

Meetings will be held with UC Davis prior to starting the RA to discuss planned field activities and any measures needed to mitigate impacts to UC Davis operations. Discussion topics will include, but are not limited to, schedule, work scope, construction area boundaries, site access, haul routes, and UC Davis facility support.

Facility coordination during the DSSs 3 and 6 RAs will consist of keeping the University of Davis Center for Health and the Environment Facility Manager informed about field operations that could affect UC Davis researchers. Removal activities will be conducted in a manner that will minimize disturbance (i.e., noise and vibration) to research activities and damage to existing site features. Building access will be provided to occupants according to UC Davis Fire Department policy.

Assistance from the UC Davis Grounds Division is not anticipated, but will be coordinated, if required, through the UC Davis Facility Engineer. The UC Davis Facility Engineer, or designee, will be on site through the duration of the RA and will be consulted regarding any decisions that affect UC Davis.

2.1.2 Geophysical Survey

A geophysical survey will be conducted prior to excavation at DSS 3 and DSS 6 to locate underground utility crossings. Underground utilities that were exposed during the previous investigations were wrapped with copper wire to strengthen the signal and help identify their location. The geophysical survey will verify utility locations and attempt to locate any other underground structures that have not been previously identified. Underground utilities located within the investigation area will be marked on the ground surface with spray paint.

As directed by WA, an independent geophysical survey contractor may use any of the following techniques to conduct the survey: electromagnetic line locating, electromagnetic terrain conductivity, ground penetrating radar and visual observations of surface structures. In addition, existing site drawings will be reviewed and Underground Services Alert will be contacted regarding underground utility locations.

When the survey is complete, the contractor will issue a report and map showing the locations of identified underground utilities and/or geophysical structures. The Site Coordinator will review the map and other applicable supporting information with RA field staff prior to commencing invasive field activities. Copies of the report and map will be kept in the project and field files.

2.1.3 Training

All workers performing RA and support activities at the Site shall have completed the following training prior to beginning work:

- Forty hours of hazardous waste (HW) operations-related training, as required by the Occupational Safety and Health Administration (OSHA), 29 CFR 1910.120;
- Eight-hour refresher course within the past 12 months if the 40-hour training was completed more than 12 months prior to the start of field activities;
- Training covering the Contingency Plan and General Emergency Response Procedures (CPGERP) (WA, 2000d);
- A minimum of three days of actual field experience under the direct supervision of a trained, experienced supervisor. The Site Coordinator (SC) shall have also completed an additional eight hours of relevant supervisory H&S training;
- Hazard communications training in accordance with Section 15 of the Project Health and Safety Plan (PHSP);
- A site hazard briefing to include instructions on emergency response procedures, location of emergency equipment, and location of the emergency notification list;
- Integrated Safety Management System training;

- RA work plan training;
- Training in accordance with the requirements specified in Standard Quality Procedure (SQP) 3.2, Indoctrination and Training (WA, 2000a), for the specific job assignments; and,
- Training on the LEHR QAPP (WA, 2000b).

Additionally, unescorted workers entering radiological control areas shall have completed:

- Radiological Worker training in accordance with the Radiological Protection Plan (RPP);
- Site-specific Radiological Worker training in accordance with the RPP; and,
- General Employee Radiological Training (GERT) will be provided for escorted workers that are not Radiological Worker trained and routinely enter controlled areas, or are likely to encounter radiological barriers and postings during the course of their work.

Employees working with hazardous and radioactive waste shall have completed the following training:

- Initial assignment as defined in Section 14 of the PHSP;
- Preparation of H&S planning documents as defined in Section 14 of the PHSP;
- Waste minimization;
- Personal protective equipment (PPE);
- Respirator fit test (if respirator usage is required);
- Medical surveillance; and,
- Preparation of hazardous materials for shipment.

All visitors entering site areas that require Level A, B, or C PPE will be required to provide evidence of completing the 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) course. Visitors entering the controlled areas will be escorted and required to complete GERT training.

Two or more people certified in First Aid, Cardiopulmonary Resuscitation and Bloodborne Pathogen Exposure Control will be on site at all times during the RA.

2.1.4 Pre-Construction Meetings

Pre-construction meetings will be held with project management personnel before beginning and during the RA to discuss work scope, review preparatory tasks and address logistical concerns. The SC will document and track any actions that are assigned during these meetings, and provide a

summary of the action items to meeting attendees. This summary will, at a minimum, include: the action items, the assignee, the assigned date, the projected completion date, and the actual completion date.

2.2 Mobilization

The personnel and equipment that are required to mobilize for the DSSs 3 and 6 RAs are listed below.

2.2.1 Personnel

The following personnel will mobilize to the Site for the duration of the DSSs 3 and 6 RA:

- SC,
- Waste Coordinator (WC),
- Sample Manager
- Sampling Technician,
- Superintendent,
- Radiological Control Technician (RCT),
- Heavy Equipment Operators, and
- Laborers.

The following personnel are already assigned to the Site:

- Radiation Safety Officer (RSO),
- Waste Specialist (WS), and
- Site Health and Safety Officer (SHSO).

The aforementioned personnel will be responsible for performing the work and ensuring that it is being conducted according to the work plan and other applicable project and program documents. Personnel roles and responsibilities can be found in program documents such as the QAPP and PHSP. During the RA, the following personnel may be mobilized to the Site on a part-time or as-needed basis:

- Project Manager (PM),
- Project Quality Assurance Manager (PQAM),
- Project Quality Assurance Specialist (PQAS),
- Senior Technical Advisor, and
- Limited Service Subcontractors.

Following mobilization and prior to commencing field activities, all personnel entering the construction area will attend daily tailgate safety meetings (TSMs), as required by Section 3.3.3 of the PHSP (WA, 2001f). During these meetings, which are held prior to the start of the work shift, the SHSO or designated representative will review health and safety information that is relevant to the

work scope. This information will be summarized on the TSM form, which will be signed by meeting attendees to document their understanding of the potential hazards and related controls. Personnel that are not able to attend the TSM, but plan on entering the construction area, must check in with the SHSO, review the information on the TSM form, and sign the TSM form to document their understanding of the information.

2.2.2 Equipment

Equipment will be mobilized to the Site on an as-needed basis during the DSSs 3 and 6 RAs. The equipment that will be mobilized includes, but is not limited to, the following:

- Backhoe with an extension arm, 24-inch bucket and breaker bit attachment;
- Loader with a 4-in-1 bucket and detachable forks;
- Pickup truck with fuel cell, for on-site transportation and fueling;
- Large (i.e., 18-ton) forklift for transporting soft-sided containers;
- Lifting frame and loading cage for soft-sided containers;
- Compactor and compaction equipment;
- Asphalt and concrete cutting saw;
- Manlift with extendable boom for trench access;
- Trench plates for scales and covering excavation areas;
- Direct-push drilling and sampling rig with limited access capabilities;
- Construction hand tools for miscellaneous activities; and,
- Air and radiological monitoring equipment for environmental and H&S monitoring.

2.3 Site Setup

Site setup for the DSSs 3 and 6 RAs will consist of installing site controls around the construction area, implementing environmental protection measures, setting up on-site laboratories for radiological and chemical analysis, and preparing the site for RA activities.

2.3.1 Site Controls

Temporary fencing will be installed around the DSSs 3 and 6 RA areas to control access (Figure 2-1). To comply with UC Davis Fire Department policy, points of building access will remain open at all times. However, access may be temporarily re-directed with the approval of the UC Davis Fire Department (Telephone Number: 530-752-1236).

The RA areas will be controlled and posted according to Chapter 7 of the PHSP (WA, 2001f) and Standard Operating Procedure (SOP) 24.1, Radiological Areas and Postings (WA, 2001d).

2.3.2 Environmental Protection Measures

Prior to the start of the RAs, environmental protection measures will be implemented to prevent impacts to the surrounding environment. These protection measures include: controlling storm water runoff and preventing airborne contaminants from impacting UC Davis heating, ventilating and air conditioning (HVAC) systems.

2.3.2.1 Storm Water/Runoff Protection

All construction activities will be performed in a manner that will mitigate the spread of contamination to surface and ground waters. Since the RAs are planned during the dry season, the threat of storm runoff is minimal. Per the California and United States Environmental Protection Agency (US EPA) storm water regulations, the dry season is defined as May to September. Storm drain covers, tarps and sand bags will be available and kept on site for use in the unlikely event of significant precipitation

If a severe storm warning is issued, precautions will be taken to protect workers, the public, the work area and any nearby property from damage. Precautions shall include, but are not limited to, covering the exposed removal area, and removing loose materials, tools and equipment from exposed locations.

2.3.2.2 Heating, Ventilating and Air Conditioning Modification

The anticipated levels of dust and contaminant concentrations are significantly lower for the DSS RAs than other RA or investigation areas, and dust suppression will be practiced continually during excavation activities. Water will be used as a dust suppressant on the haul routes and during excavation activities. For these reasons, there are currently no plans to modify the HVAC systems at any of the buildings. However, in the event that monitoring data indicate potential impacts to indoor air quality by airborne contaminants, work will be stopped and the UC Davis Facilities Services Division will be contacted to perform the necessary modifications.

2.3.3 On-Site Laboratories Setup

The on-site laboratories will be used for screening excavation samples for potential radiological and chemical impacts. The on-site laboratories will utilize a gamma spectrometer for Ra-226 analyses and an automated analyzer for Hg analyses.

On-site radiological laboratory setup will consist of cleaning and covering all surfaces with plastic sheeting, and configuring and calibrating the gamma spectrometer. Instrumentation will be calibrated and configured according to manufacturer standards. Liquid nitrogen will also be procured to maintain the gamma spectrometer cryostat at the required temperature.

The on-site chemical laboratory will consist of a Lehman Labs PS 200 automated Hg analyzer. Hg analysis will be conducted in accordance with cold-vapor atomic adsorption, US EPA

Method 7471. The analyzer will be supported with a personal computer and a printer. The work area will be located adjacent to a fume hood to vent sample digestions.

2.3.4 Site Preparation

The site will be prepared for RA activities prior to removing material/waste from the DSS areas. Site preparation will include the following tasks:

- Establishing haul routes;
- Preparing the material/waste storage area in the Western Dog Pens (WDPs) and Eastern Dog Pens (EDPs); and,
- Setting up scales for weighing soft-sided containers.

2.4 Material/Waste Removal

2.4.1 Surface Material and Overburden Removal

The surface asphalt and concrete in the DSSs 3 and 6 excavation areas will be saw-cut in place and removed with a backhoe. This material will be transported from the RA area using a loader and temporarily stockpiled in the WDPs (Figure 2-1). The aggregate road base material and soil removed from above the leach trenches will be excavated using a backhoe and placed in separate stockpiles for reuse. The overburden soil will be returned to the excavation following removal of the DSSs 3 and 6 waste. The aggregate road base will be returned to the upper foot of the excavation.

2.4.2 Domestic Septic System 3

DSS 3 consists of a septic tank with an effluent line leading to a distribution box and eventually to a leach field (Figure 2-2). DST 3 is constructed of 12-inch thick reinforced concrete, approximately 6.5 ft wide, 11 ft long and 7.7 ft deep. The effluent line from DST 3 is a single vitrified clay pipe (VCP) that extends to the distribution box located 37 feet south of the tank. The distribution box is constructed of eight-inch thick concrete and measures four feet nine inches long, four feet six inches wide and two feet four inches deep.

Two, six-inch VCP effluent lines are located on the southern end of the distribution box. The eastern effluent line runs south for 7.5 ft and then makes a 90-degree turn to the east. After making the turn eastward, the VCP is joined to a perforated orangeburg leach line that is bedded in one- to two-inch rounded gravel. The gravel trench continues east 45 ft, is approximately 3 ft wide and extends from an approximate depth of 4 to 9 ft bgs (Figure 2-2).

The western effluent line extends south for 16 ft and terminates north of a sewer manhole (Figure 2-2). It appears that the line had been removed during installation of the new sewer system. Exploratory trenching conducted in the area was unsuccessful in locating any remaining sections of the effluent line and leach trench.

As discussed in Section 1.2.1, there were no indications of sludge at the bottom of DST 3 or releases of COCs outside the tank and associated piping. Therefore, DST 3 will not be removed during excavation activities at DSS 3. Excavation will begin at the distribution box and continue south. A backhoe will direct-load the material/waste into soft-sided containers. Once the soft-sided containers are filled and sampled, a large capacity forklift will remove them from the construction area to be weighed and eventually stored in the EDPs (Figure 2-1).

Residual sediment will be removed from the distribution box prior to demolition. Depending on the state of the material, a shovel or other appropriate hand tools will be used to remove the sediment from the distribution box. If required, a hydraulic breaker bit attachment for the backhoe will be used to break up the concrete distribution box into manageable pieces. Following distribution box demolition, the concrete and six inches of underlying soil will be loaded into soft-sided containers. The distribution box excavation depth is expected to be approximately five ft bgs. All of the remaining effluent lines will be removed along with the perforated orangeburg pipe and leach trench gravels. Approximately one ft of additional soil from the trench floor and six inches from the sidewalls will be removed during excavation activities at DSS 3. The leach trench excavation depth is expected to reach approximately 10 ft bgs. The removed piping, concrete, gravels and underlying soil will be managed as potentially mixed waste.

2.4.3 Domestic Septic System 6

DSS 6 consists of a septic tank attached to a distribution box with two effluent lines leading north and south to perforated pipes set in gravel (Figure 2-3). DST 6 is constructed of six-inch thick reinforced concrete and is approximately 10 ft long, 4 ft wide and 5 ft deep. The majority of the tank's top and bottom are no longer present as it appears that they were destroyed during the installation of the existing sewer line (Figure 2-3).

Effluent from DST 6 flowed to the shallow distribution box attached to the eastern edge of the tank. Six-inch VCP effluent lines extend out of the northern and southern sides of the distribution box. The effluent lines run north and south for approximately 5 ft, make 90-degree turns westward and then make 90-degree turns northward and southward (Figure 2-3). Two perforated orangeburg pipes are attached to each effluent line which are bedded in one- to two-inch rounded gravel (Figure 2-3). The leach line gravel trenches are approximately 18 inches wide by 2 ft deep and extends to a depth of 5 ft bgs. Each of the 4 leach trenches is approximately 35 ft long.

As discussed in Section 1.3.2, the concrete sample collected from the bottom of DST 6 showed no signs of significant contamination. Therefore, DST 6 and the attached distribution box will not be removed. A backhoe and bucket will be used to excavate the material/waste. Excavation at DSS 6 will begin at the northeast corner and proceed south. Following overburden soil removal,

the leach lines will be exposed and the excavation will follow the leach lines laterally and vertically until native soil is encountered. Approximately one ft of additional soil will be removed from the trench floor and six inches will be removed from the sidewalls. The excavated material will be sampled and direct-loaded by the backhoe into soft-sided containers for storage and transport. The soft-sided containers will be removed from the construction area by a large capacity forklift, weighed and placed in storage.

Based on visual inspection and excavation screening sample results from the native soil, additional soil may be excavated and removed as necessary. The excavation is expected to be up to 11 ft wide and 7 ft deep. The DSS 6 excavation area will be roughly 90 ft long from end to end. The removed piping, gravel and underlying soil will be managed as potentially mixed waste.

2.5 Survey and Backfilling

Following completion of material/waste removal, performance of the EMC test and confirmation sampling, a land survey will be completed. The excavated area will then be backfilled to grade with clean soil and compacted to site specifications.

2.5.1 Land Survey of Removal Action Limits

Key features such as excavation boundaries, structures, and sampling locations will be surveyed following removal activities at each work location. These surveys will locate each feature both horizontally and vertically to the nearest ft and tenth of a ft, respectively, to at least three permanent benchmarks. A State of California-licensed land surveyor will perform all surveying. When complete, the land survey subcontractors will provide hard and electronic copies of survey maps and survey data for the project file.

2.5.2 Backfill

Backfill material will be free of trash, debris, organic matter, or stones larger than two inches in diameter. The material will compact thoroughly without the presence of excessive voids when compacted by mechanical means. Prior to being brought on site, imported fill will be sampled and analyzed to evaluate its physical, chemical and radiological composition. One sample will be collected for every 100 cubic yards (cu yd) of backfill for radiological and chemical parameters and one sample will be collected for every 1,000 cu yd of backfill for physical parameters as discussed below.

All samples will undergo full-suite radiological analyses, and 10% will be analyzed for metals, VOCs, SVOCs, pesticides/polychlorinated biphenyls (PCBs), nitrate, and hexavalent chromium. Analyses will include: US EPA priority pollutant metals (US EPA Method 6010/7471), VOCs (US EPA Method 8260), SVOCs (US EPA Method 8270), pesticides/PCBs (US EPA Method

8080), hexavalent chromium (US EPA Method 3060A/7196) and nitrate (US EPA Method 300.0). Backfill material must not contain any chemical or radiological constituents that are above site background concentrations or RBASs.

Samples collected for physical properties analyses will include optimum dry density and moisture content (American Society for Testing and Materials [ASTM] D 1557), and permeability and conductivity (ASTM D 5084). Satisfactory materials will be placed horizontally in eight-inch loose lifts. Prior to placement of backfill in the excavation area, geotextile liner will be placed in the excavated areas to identify boundaries. Backfill material will be broken, moisture-conditioned and thoroughly mixed to optimize compaction.

2.5.3 Compaction

Each eight-inch lift of backfill will be compacted with standard compaction equipment and techniques. Compaction equipment may include vibratory plate compactors, sheepsfoot rollers, or other acceptable methods. Each lift will be compacted to at least 90% of the optimum dry density for cohesive soils or 95% of the optimum dry density for cohesionless soils.

A qualified individual will test the in-place dry density (ASTM D 2922) and moisture content (ASTM D 3017) of the backfill using a nuclear compaction gauge. At least one test will be performed for every 5,000 square ft of surface area for each lift. Backfill and compaction activities will conform to Specification 02200, Earthwork, of the UC Davis Campus Standards and Design (UC Davis, 1994).

2.6 Restoration

After the removal area has been backfilled and compacted, it will be restored as specified below. Site restoration activities will include fence removal, paving, winterizing and housekeeping. Utility restoration and surface grading will be performed as required; however, these activities are not anticipated.

2.6.1 Paving

Asphalt and concrete paving will be conducted where the surface has been cut and where RA activities have caused significant damage to paved walkways or roadways. In these areas, the backfill will remain below grade and surface completion will conform to Specification 02500, Paving, of the UC Davis Campus Standards and Design (UC Davis, 1994).

2.6.2 Winterization and Housekeeping

The RA areas will be winterized and cleaned prior to demobilization. Stockpiles and other waste storage areas will be winterized to prevent damage or environmental releases that may be caused by high winds or storm water intrusion. Tools, equipment and unused material will be stored and secured according to site property management practices. All trash and excess debris will be disposed in an appropriate manner.

2.7 Demobilization

All personnel and equipment that were temporarily assigned to the Site for the RAs will demobilize when site restoration is complete

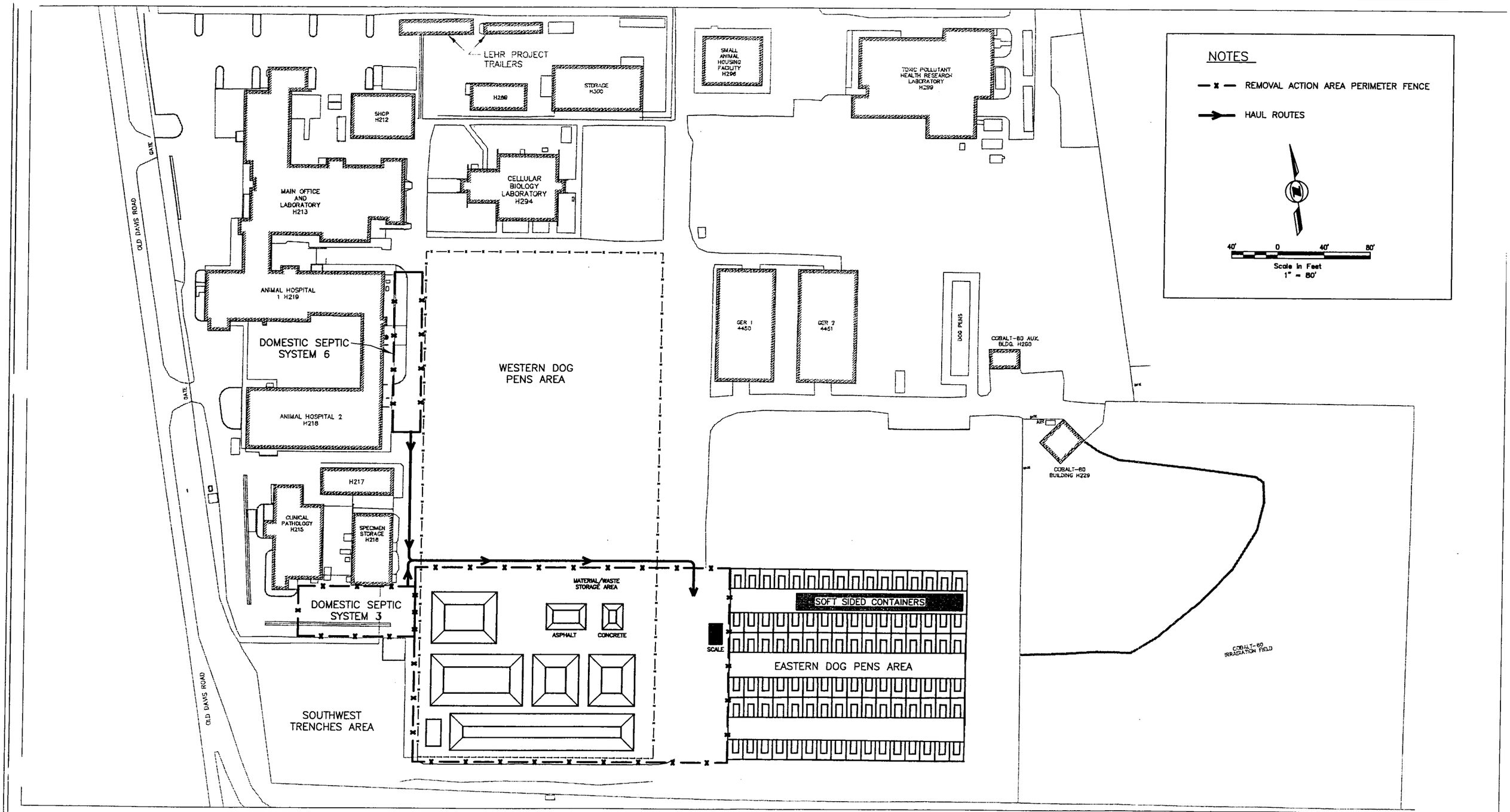


Figure 2-1. Domestic Septic Systems 3 and 6 Removal Actions Activity Locations

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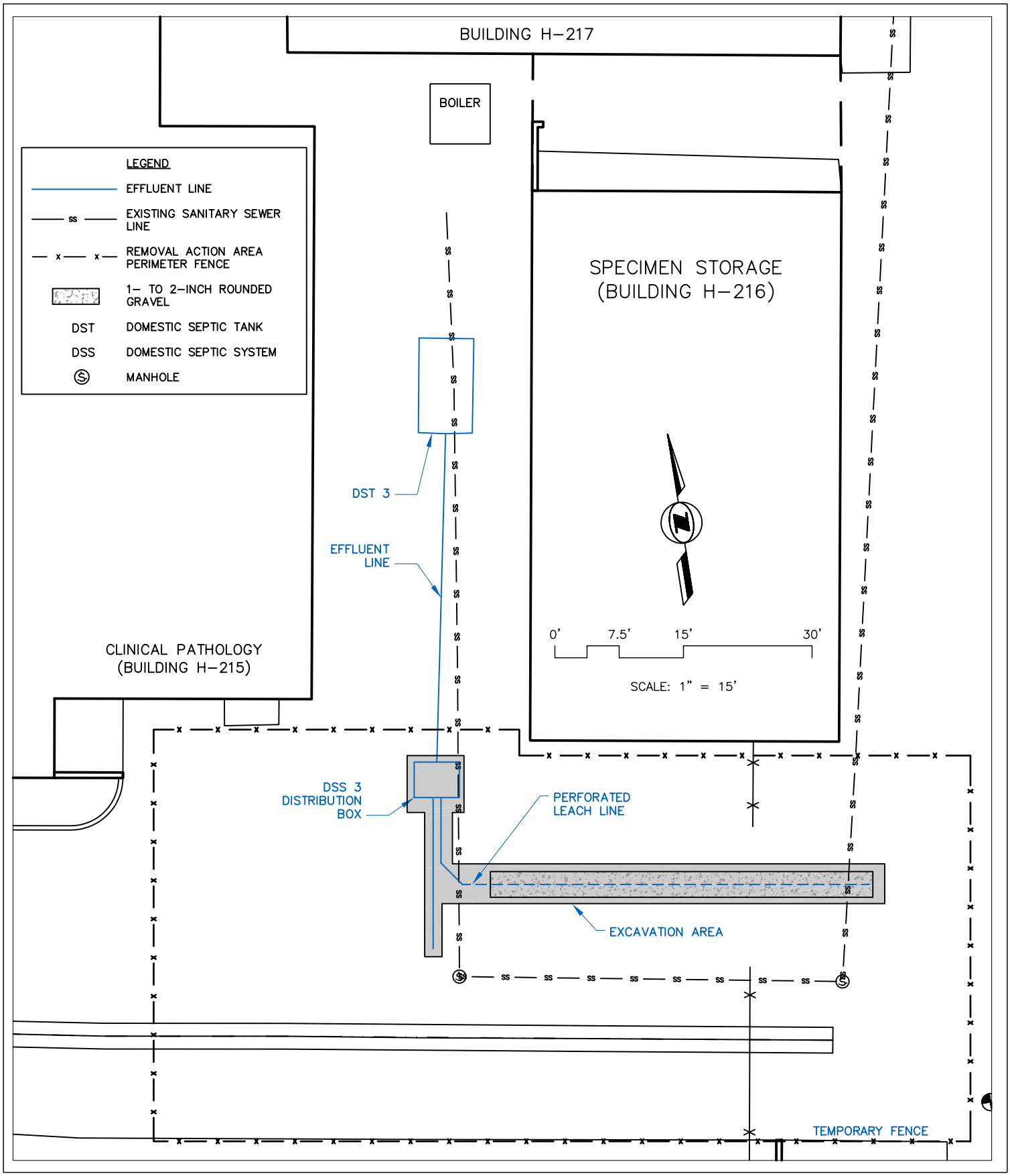

Figure 2-2. Domestic Septic System 3 Removal Action Area and Excavation Boundary

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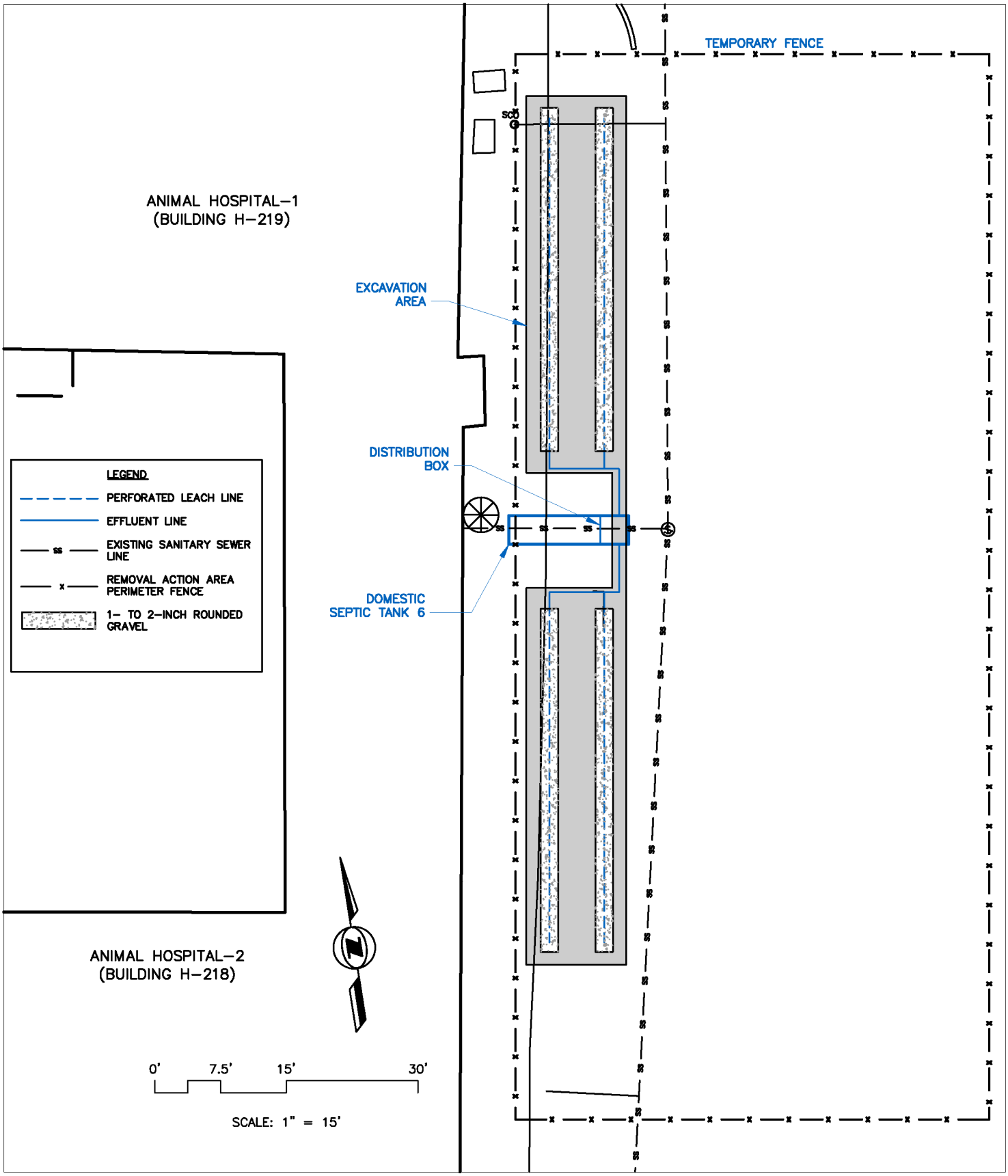

Figure 2-3. Domestic Septic System 6 Removal Action Area and Excavation Boundary

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3. SAMPLING AND ANALYSIS

This section discusses the sampling and analysis program that will be used to attain the RAOs for the DSSs 3 and 6 RAs. Sampling and analysis activities will include:

- DL sampling to determine whether residual concentrations of specific compounds in soil will potentially impact ground water;
- Screening sampling and on-site/off-site laboratory analysis to identify and delineate hot spots within the RA area and guide excavation activities; and,
- Confirmation/risk assessment sampling and off-site laboratory analysis to support the excavation confirmation/risk assessment evaluation and the DL analysis.

Waste characterization sampling and analysis are addressed in Section 4.

3.1 Sampling Approach

The driver COCs for the DSS 3 RA are Hg and Ra-226, and Hg is the sole driver COC for the DSS 6 RA. Prior to conducting the RAs, DL samples will be collected from borings at DSSs 3 and 6. During RA activities, screening samples will be analyzed for driver COCs in the on-site laboratory. Screening samples will also be analyzed by an off-site laboratory for quality assurance (QA) purposes. At the conclusion of excavation activities, confirmation samples will be collected and analyzed for the constituents listed on Table 3-1. Tables 3-2 and 3-3 present the planned field and laboratory analytical methods.

3.2 Screening Criteria

The screening criteria for the driver COCs are: 0.75 pCi for Ra-226, 6.8 mg/kg for Hg at DSS 3 and 8.3 mg/kg for Hg at DSS 6. The Ra-226 screening criteria are based on the background concentration and the Hg screening criteria are based on RBAS recalculations (Appendix C). Values specific to DSSs 3 and 6 are based on predicted post-RA contaminant distribution and lithology. Hg was assumed to remain within the first foot of soil at the base of each excavation. The planned excavation depth at DSS 3 is 10 ft bgs and the assumed post-RA contaminated depth interval is between 10 and 11 ft bgs. The planned excavation depth at DSS 6 is seven ft bgs and the assumed contamination interval is seven to eight ft bgs.

3.2.1 Designated-Level Sampling

The three-phased DL sampling approach is discussed in Section 3.6.2.2. Phase A, Preliminary DL Analysis (Appendix A), was conducted for the DSSs 3 and 6 investigation data. The preliminary DL analysis is typically conducted on the confirmation sample data. However, to meet the Federal Facility Agreement (FFA) September 30 milestone for submittal of the Draft Domestic Septic Systems 3 and 6 Removal Actions Confirmation Report, DL samples will be collected prior to RA activities. Furthermore, conducting the preliminary DL analysis on the investigation data is more conservative because the investigation samples were collected beneath the sources of contamination.

The DSS 3 preliminary DL analysis identified thirteen COCs that require additional evaluation: formaldehyde, hexavalent chromium, carbazole, arsenic, cadmium, chromium, lead, Hg, molybdenum, nitrate, selenium, silver and Ra-226. The DSS 6 preliminary DL analysis identified three COCs that require additional evaluation: hexavalent chromium, copper and Hg. The preliminary DL analysis tables are presented in Appendix A. Phase B, Data Gaps Investigation (DL sampling), will be conducted to collect additional vertical profile data for each DL COC. The objective of the DL sampling and subsequent data evaluation is to determine whether residual concentrations of specific constituents in soil will potentially impact ground water. Therefore, samples will be collected from depths that will represent post-RA residual concentrations.

One DL boring will be drilled at the first point of perforation on the eastern DSS 3 leach line. DL samples will be collected at 1-ft intervals between 10 and 15 ft bgs and analyzed for Hg. DL samples will be collected at 5-ft intervals between 10 and 40 ft bgs and analyzed for Ra-226, hexavalent chromium, SVOCs, nitrate and metals (Table 3-1).

Borings will be drilled at the first points of perforation on the southeastern and northeastern DSS 6 leach lines. At each boring, DL samples will collected at 1-ft intervals from 6 to 10-ft bgs and at 5-ft intervals from 10 to 40 ft bgs and analyzed for Hg. Samples will also be collected at 5-ft intervals from 6 to 41 ft bgs and analyzed for nitrate, total nitrogen, ammonia, copper, and hexavalent chromium.

The analytical suite for the first two soil samples collected at the five-ft interval from each boring will also include the waste extraction test using deionized water (DI WET) for metals, SVOCs and nitrate. All DL samples will be analyzed by an off-site laboratory. The samples collected between 10 and 15 ft at DSS 3 and between 6 and 10 ft at DSS 6 will also be analyzed on-site for Hg. The on-site laboratory analytical results will be used to adjust our Hg screening criteria if needed. DL sample soil borings will be drilled to the top of the seasonal water table or 40 ft, whichever is shallower. Soil samples will not be collected below the elevation of the water table. A grab ground water sample will be collected from each boring when ground water is encountered if an adequate volume of ground water is reasonably obtainable. The ground water sample will be analyzed for metals, radionuclides, SVOCs, VOCs, pesticides, nitrate and hexavalent chromium.

3.2.2 Excavation Screening Sampling

The sources of contamination at DSSs 3 and 6 are known. The excavation screening sample design is conservatively biased to identify residual contamination. The excavation screening samples will be collected at five-ft intervals from the excavation floors beneath the former locations of the leach trenches and effluent lines (Figures 3-1 and 3-2). Screening samples will also be collected at five-foot intervals along trench excavation sidewalls at depths that exceed the bottoms of the perforated leach lines.

Figures 3-1 and 3-2 present the planned DSSs 3 and 6 screening sample locations, respectively. Visual observation will also be used to select discretionary screening sample locations.

DSSs 3 and 6 screening samples will be analyzed for Hg by cold-vapor atomic absorption, US EPA SW-846 (Method 7471). DSS 3 screening samples will also be analyzed for Ra-226 according to SOP 10.4, Radium-226 Analysis by Gamma Spectrometer (WA, 2001d). Ra-226 samples will be collected, handled and documented according to SOP 10.3, Sample Collection, Handling and Data Documentation for Field Analysis Using a Gamma Spectrometer.

Screening sample analytical results will be compared against the screening criteria (Section 3.2). If results are above the screening criteria, additional screening samples will be collected to further define the extent of contamination around hot spot locations as shown in Figure 3-3. Samples will be collected 2.5 ft laterally from the hot spot location at the original sample depth and at 1-ft depth intervals until on-site analysis indicates that the sample is below the screening criteria for the driver COCs. The decision process for collecting additional screening samples and for excavation and removal of hot spots is shown in Figure 3-4. As noted in Figure 3-4, the risk/impact from the residual COC(s) may be re-evaluated based on the actual vertical and lateral extent of contamination. This could involve risk assessment, ground water impact assessment, and other methods. DOE and Remedial Project Manager (RPM) input on these evaluations will be solicited if this situation arises.

3.2.3 Confirmation Sampling

Once it is believed that the final excavation limits have been reached based on the field screening sample analyses, the data will presented to the RPMs and DOE as discussed in Section 3.7.1. After obtaining approval to proceed, confirmation samples will be collected from the DSSs 3 and 6 excavations to verify that the cleanup criteria for all COCs has been attained. Confirmation sampling COCs were designated according to the process described in Appendix E.

The DSS 3 RA confirmation suite will include formaldehyde, cadmium, chromium, copper, lead, Hg, silver, hexavalent chromium, cesium-137, lead-210, Sr-90, Ra-226, alpha and gamma chlordane, heptachlor epoxide and nitrate. The DSS 6 RA confirmation suite will include barium, copper, Hg and hexavalent chromium. Six discretionary samples and one field duplicate will be collected from each excavation area and analyzed for VOCs and SVOCs.

In addition to the excavation confirmation samples at DSS 3, a sample will be collected from beneath the effluent line leading from DST 3 to the DSS 3 DB. This sample will be collected from beneath first pipe joint encountered north of the DSS 3 DB or eight feet north of the DB, whichever is closer. Two sediment/fill samples will be collected from near the bottom of DST 3, one from the northern and one from the southern ends. An attempt will be made to collect a concrete sample from the tank floor of DST 3. All of these samples will be analyzed for a full suite of constituents including radionuclides, pesticides, SVOCs, VOCs, metals, nitrate, hexavalent chromium, and the waste extraction test (WET) and toxicity characteristic leaching procedure (TCLP) for Hg.

All of the confirmation samples collected at DSSs 3 and 6 for total mercury analysis will also be analyzed by the WET and/or TCLP analytical procedures if the total mercury concentration exceeds 10 times the soluble threshold limit concentration value or 20 times the TCLP, respectively. This procedure also applies to all residual COCs.

The confirmation sample frequency and locations were determined using the Noether Calculation (a random-start grid sampling approach) as described in Appendix B. The confirmation sampling program is summarized in Table 3-1 and the sample grid locations are shown in Figures 3-5 and 3-6.

3.3 Sample Collection Procedures

Soil samples will be collected in accordance with SOP 3.1, Surface and Shallow Subsurface Soil Sampling, and SOP 3.2, Subsurface Soil Sampling While Drilling. Soil samples will be placed in plastic containers, plastic bags or glass jars for on-site field analysis, and in glass jars, plastic containers or brass sleeves for off-site laboratory analysis. Tables 3-2 and 3-3 summarize the container type, volume and holding time for each analyte. The following methodology will be followed for sample collection.

A sample preparation area will be established adjacent to the sampling location. The work surface will be covered with plastic sheeting to minimize the potential spread of contamination. The following equipment will be staged in the sample preparation area:

- Spill kit,
- Sample containers,
- Demineralized water,
- Sampling tools,
- Custody seals,
- Chain-of-custody forms, and
- Preservatives, as required.

Samples will be collected with a hand auger and trowels will be used to transfer material into the appropriate containers. Sample handling, packaging and shipping are described in SOP 2.1, Sample Handling, Packaging and Shipping. Sampling equipment will be decontaminated according to SOP 6.1, Sampling Equipment and Well Material Decontamination, and SOP 6.2, Drilling,

Development and Heavy Equipment Decontamination, as applicable. Rinseate samples will be collected per Section 8.1 of the QAPP (WA, 2000b) if reusable sampling equipment is used for designated-level or confirmation sampling.

Duplicate samples will be collected for quality control (QC) purposes. Duplicates will be collected at a rate of 10% for all excavation screening samples, and analyzed on site for Ra-226 and/or Hg. To evaluate the performance of the on-site laboratory, duplicates will be sent to an off-site analytical laboratory for Ra-226 and/or Hg analyses. Duplicates will also be collected at a rate of 10% for confirmation samples and analyzed for the constituents listed in Table 3-1.

3.4 Sample Documentation

The usability of the data obtained during this investigation will depend on its quality. A number of factors affect data quality. 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:

- Chain-of-custody,
- Field logbook,
- Sample numbers,
- Sample labels, and
- Custody seals.

3.4.1 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, Chain-of-Custody.

3.4.2 Field Logbook

Descriptions and observations made during field 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, Lithologic Logging, for any soil borings. The following will be recorded in the field logbook:

- Project name and number;
- Site location;

- 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 for soil samples;
- Date and time of sample collection;
- Sample location, identification (ID) number and sampling methodology;
- Field observations;
- Results of field measurements; and,
- Results of field calibrations for instruments used.

3.4.3 Sample Numbers

All sample numbers will contain a unique sample ID 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 designation of the sample area at the Site

D3 – Domestic Septic System 3

D6 – Domestic Septic System 6

c = Type of sample

F – field screening sample

C – confirmation sample

ddd = Chronological sample number (e.g., 001, 002, 003)

The first field screening soil sample collected from DSS 3 will be labeled:

SSD3F001

Field and confirmation samples were collected from the DSSs 3 and 6 areas during the 2001 DSSI. Therefore, the field screening sample IDs for DSSs 3 and 6 will begin with SSD3F012 and SSD6F045, respectively. The confirmation sample identifications for DSSs 3 and 6 will begin with SSD3C024 and SSD6C017, respectively.

3.4.4 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.

3.4.5 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 collected, and
- Initials of sampler.

3.5 Sample Shipping

Shipping procedures are described in SOP 2.1, Sample Handling, Packaging and Shipping. Pre-designated containers and coolers for off-site shipment will be used for the DSSs 3 and 6 samples. Proper labeling and packaging for shipment is required along with the appropriate documentation.

3.6 Analytical Methods

Tables 3-2 and 3-3 summarize the analytical methods that will be performed on soil and water samples collected from the DSSs 3 and 6 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 for confirmation samples and QA.

Field analytical methods include Ra-226 analysis using gamma spectroscopy equipped with a high-purity germanium detector, and Hg analysis by cold-vapor atomic absorption (US EPA SW 846 Method 7471). Ra-226 and Hg analyses will be performed by on-site laboratory technicians trained to use these instruments.

Laboratory analytical results will be validated upon receipt and transferred to the project database in accordance with procedures described in the QAPP (WA, 2000b). Sample tracking, data receipt, and storage will be performed in accordance with SQP 4.2, Records Management.

3.7 Data Evaluation

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

3.7.1 Phase I Data Evaluation

The Phase I data evaluation will be conducted following material/waste removal. The excavation screening samples analytical results will be used to guide excavation activities. If analytical results indicate that driver COC concentrations are above the screening criteria (Section 3.2), then additional delineation sampling will be performed in the areas where elevated driver COCs concentrations were detected (hot spots). Excavation at the DSSs 3 and 6 areas will cease when screening data indicate that the Hg and/or Ra-226 concentrations are below the screening criteria. The Phase I data evaluation will be presented to DOE and the RPMs to reach consensus on whether cleanup goals were attained for driver COCs. Decisions will also be reached whether to proceed with collecting confirmation samples, backfilling the excavations, and restoring the Site.

3.7.2 Phase II Data Evaluation

Upon receipt of all confirmation sample analytical results, the data will be validated to ensure data usability. The confirmation sample analytical results will be validated by the WA validation chemist according to the procedures defined in SOP 21.1, Data Validation (WA, 2001d). Sample results and associated QA/QC measures will be reviewed including: holding times, field and laboratory blank results, laboratory control sample spike results, matrix spike/matrix spike duplicate results, laboratory matrix duplicate results, surrogate recoveries and internal standard performance.

All sample results will be identified as usable (no qualifier), estimated and usable (J or UJ qualifier), or rejected and unusable (R qualifier).

The Phase II data evaluation will include screening risk evaluation, refined DL analysis (Section 3.7.2.2) and RA completion analyses. 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.

3.7.2.1 Screening Risk Evaluation

Screening risk evaluation will help assess whether the first and second RAOs (Section 1) have been attained. For each COC, confirmation sampling results and, if appropriate, previous analytical results from sample locations other than those in 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 Methods for Evaluating the Attainment of Cleanup Standards, Volume 3 (US EPA, 1992) will be used to compare the 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 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. In certain cases, the actual vertical and lateral distribution of residual COCs may warrant modification of the existing RBAS. In these cases, methods will be used that are consistent with the US EPA's Risk Assessment Guidance for Superfund (US EPA, 1991) and project-specific guidelines developed for the RBASs.

Existing RBASs are the *lowest* values derived for the following three potential exposure scenarios:

- Scenario 1: On-Site Researcher—This scenario is consistent with the UC Davis long-range plan to continue research activities at the Site.
- Scenario 2: East Side Residential Farmer—This scenario assumes a residential farmer is located immediately east of the 1997 UC Davis property boundary. This scenario represents the nearest reasonable downgradient (with respect to ground water) location for a potential off-site receptor.
- Scenario 3: South Side Residential Farmer—This scenario assumes a residential farm is located immediately south of the UC Davis property boundary and Putah Creek. This location represents the nearest reasonable downwind location for an off-site receptor.

A screening-level risk evaluation will then be conducted. 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}). The sum of the ratios for carcinogenic COCs will then be computed cumulatively for the three risk scenarios. If the sum is less than one, the screening level evaluation will conclude that the first RAO has been met. A

similar ratio will be calculated for the hazard quotient for non-carcinogenic COCs to determine whether the second RAO has been attained.

3.7.2.2 Designated-Level Analysis

The third RAO is to mitigate any potential future impacts to ground water by reducing COC concentrations in soil. *The Designated Level Methodology for Waste Classification and Cleanup Level Determination* (Marshack, 1989) is a guidance document developed by the California Regional Water Quality Control Board, Central Valley Region staff for determining a soil constituent's potential to impact ground water.

The DL approach consists of three phases:

- Phase A–Preliminary DL Analysis: Evaluate investigation sampling results and identify DL COCs and hot spot areas;
- Phase B–Data Gaps Investigation: Collect additional vertical profile data if needed for each DL COC at the hot spot area; and,
- Phase C–Refined DL Analysis: Model and calculate the DL values that are protective of ground water using the vertical profile of DL COCs.

The preliminary DL analyses for investigation data were conducted prior to the RAs. The results of preliminary DL analysis are discussed in Section 3.2.1 and Appendix A. DL sampling (Phase B, Data Gaps Investigation) is discussed in Section 3.2.1. Refined DL analysis (Phase C) will be conducted following receipt and validation of the DL sampling data.

3.7.2.3 Removal Action Completion Analysis

Upon completion of the screening risk evaluation, 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, all applicable and available information, including the following items, will be compiled for an 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; and,
- Results of the screening risk evaluation.

Based on 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. The results of the Phase II data evaluation will be presented in the Draft Domestic Septic Systems 3 and 6 Removal Actions Confirmation Report, as required by the LEHR FFA. Based on these evaluations, a

determination will be made regarding the need for and scope of additional actions to achieve the RAOs.

3.8 Data Quality Objectives

The sampling and analysis program presented in Sections 3.1 through 3.6 and in Appendix B was developed using the data quality objectives (DQOs) process described in Guidance for the Data Quality Objectives Process, US EPA document number QA/G-4 (US EPA, 2000, EPA/600/R-96/055). The DQO process is a systematic planning tool for establishing criteria for DQOs and for developing data collection designs. The following sections demonstrate how the seven steps of the DQO process were used in designing the DSSs 3 and 6 RAs sampling and analysis programs.

3.8.1 Statement of the Problem

Under National Contingency Plan guidelines, non-time critical RAs will be conducted to minimize and reduce the threat posed by environmental contaminants in the DSSs 3 and 6 areas. Under the FFA signed between DOE and US EPA, DOE is the lead agency for cleanup of soil contamination associated with LEHR-related activities.

DOE-Oakland will make the final decisions on all activities associated with the RA based on recommendations from the RA planning team in accordance with the terms of the FFA, and all applicable orders, statutes and regulations. The planning team consists of DOE-Oakland; RPMs from US EPA Region IX, the California Department of Toxic Substances Control, the Central Valley Regional Water Quality Control Board, and the California Department of Health Services; UC Davis; the Davis South Campus Superfund Oversight Committee; and WA and its subcontractors, IT Corp. and EMS.

The key question to be answered by the sampling and analysis program is whether or not the RAOs for DSSs 3 and 6 (Section 1.5) have been achieved. The program described in Sections 3.1 through 3.6 and in Appendix B is designed to provide DOE Oakland and the planning team with the data needed to answer this question.

3.8.2 Identification of Decisions

The decision statements for the DSSs 3 and 6 RAs can be summarized as follows:

1. <u>Determine whether or not "hot spots" are present beneath the excavated material that require additional excavation.</u> The excavation screening sampling and data evaluation (Sections 3.2.2 and 3.7) and field excavation decision flowchart (Figure 3-4) have been designed to address this statement.

2. Determine whether or not the DSSs 3 and 6 RAs achieved the RAOs. The confirmation sampling and data evaluation (Sections 3.2.3 and 3.7) have been designed to address this statement.

3.8.3 Identify Inputs to Decisions

Existing data that will be used to resolve the decision statements include risk-based and background levels and previous DSSs 3 and 6 area COC analyses. New environmental measurement inputs will include:

- Field observations;
- Sampling at appropriate locations and depths;
- Soil sample description using the USCS;
- Field screening measurements for Ra-226 and Hg (excavation screening sampling only);
- Laboratory analyses of confirmation sampling (Table 3-1); and,
- Laboratory data validation.

3.8.4 Definition of Study Boundaries

The geographical area addressed by the sampling and analysis program consists of the DSSs 3 and 6 areas (Figures 2-2 and 2-3). The sampling and analysis program focuses on COCs potentially introduced after 1958, when DOE first began operations at the Site. The sampling and analysis program consists of two phases: screening samples collected during excavation and confirmation samples collected at the completion of the RA when the final extent of excavation has been attained.

3.8.5 Development of Decision Rules

The decision rules for the excavation screening sampling are summarized in the field excavation decision flowchart (Figure 3-4). In summary, if a sample exceeds the screening criteria (Section 3.2) the "hot spot" extent will be determined, additional excavation costs will be estimated, and/or residual risk will be evaluated. Based on the outcome of this process, additional excavation and screening analysis may be performed.

The decision rules for the confirmation sampling are described in Section 3.7.2, Phase II Data Evaluation. In summary, the confirmation sampling results and other appropriate DSSs 3 and 6 data will be compared with the appropriate RBAS for each COC. These statistical comparisons will be used in a screening-level risk evaluation to determine whether or not the RAOs have been achieved.

3.8.6 Specification of Limits on Decision Errors

Excavation screening sampling was designed to provide data for the DSS 3 distribution box, effluent line and leach trench areas, and the DSS 6 effluent line and leach trench areas.

As described in Appendix B, the confirmation sampling is designed to attain Type I and II errors of 20% and 10% or lower, respectively. The number of estimated samples was based on the background distribution of Hg. The sampling locations were determined using a random-start grid, with grid spacing based on the calculated number of samples needed. Based on previous DSSs 3 and 6 sample results, this sampling and analysis design is expected to limit Type I and Type II error to maxima of 20% and 10%, respectively, for Ra-226, Hg, chromium, copper, hexavalent chromium, nitrate, arsenic, cadmium, lead, molybdenum, silver, and vanadium.

3.8.7 Sample Design Optimization

The output from each of the first six DQO steps described in Section 3.8.1 through 3.8.6 above was used to optimize the sampling and analysis program described in Sections 3.1 through 3.6 and in Appendix B. This sampling and analysis program should provide the data needed to determine, at an appropriate level of certainty, whether or not the DSSs 3 and 6 RAOs have been achieved.

Conditions that may cause deviation from the planned sampling and analysis 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; and,
- Equipment required to perform the intended work safely is unavailable.

These conditions are considered unlikely. If one or more of these conditions occur, potential impact on achieving DQOs will be evaluated and addressed.

Table 3-1. Sampling and Analysis Summary for the Domestic Septic Systems 3 and 6 Removal Actions

Sampling Activity	Estimated Total Samples	Sampling Strategy	Assumptions	Sampling Method	Method of Analysis (1)	Analytical Parameters
DSS 3 Designated-Level Sampling	7	Discretionary	One boring at the first point of perforation on the leach line. Samples will be collected at 5-ft intervals from 10 to 40 ft bgs.	Direct-Push Drilling	Field (for Hg at 5 and 10 ft) /Laboratory	Metals, Ra-226, SVOCs, NO_3, formaldehyde, Cr^{+6}; DI WET for metals, SVOCs and NO_3 for the first two samples collected
	4	Discretionary	Additional samples will be collected at 1-ft intervals from 11 to 14 ft bgs.	Direct-Push Drilling	Field/ Laboratory	Hg
	1	Discretionary	Grab ground water at water table	Direct-Push Drilling	Laboratory	Metals, radiological, VOCs, SVOCs, pesticides, NO_3, Cr^{+6}
DSS 6 Designated-Level Sampling	16	Discretionary	Borings will be drilled at the first points of perforation on the southeastern and northeastern leach lines. Samples will be collected at 5-ft intervals from 6 to 41 ft bgs.	Direct-Push Drilling	Laboratory	Cr^{+6}, copper, NO_3, total nitrogen, ammonia, DI WET for metals, SVOCs and NO_3 for the 1st two samples collected
	22	Discretionary	Samples will be collected at 1-ft intervals from 6 to 10 ft bgs and at 5-ft intervals from 10 to 40 ft bgs and analyzed for Hg.	Direct-Push Drilling	Field (for samples collected above 10 ft)/ Laboratory	Hg

Table 3-1. Sampling and Analysis Summary for the Domestic Septic Systems 3 and 6 Removal Actions (continued)

Sampling Activity	Estimated Total Samples	Sampling Strategy	Assumptions	Sampling Method	Method of Analysis [1]	Analytical Parameters
	2	Discretionary	Grab ground water at water table	Direct-Push Drilling	Laboratory	Metals, radiological, VOCs, SVOCs, pesticides, NO_3, Cr^{+6}
Designated- Level Duplicate Samples (Laboratory QC)	5	NA	Ten percent of field and laboratory samples will be analyzed at an off-site laboratory.	Direct-Push Drilling	Laboratory	Appropriate analyses
DSS 3 Screening Sampling	35	Discretionary	Samples will be collected at 5-ft lateral intervals beneath the leach lines and excavation sidewalls.	Hand Auger	Field	Hg and Ra-226
DSS 6 Screening Sampling	82	Discretionary	Samples will be collected at 5-ft lateral intervals beneath the leach lines and excavation sidewalls.	Hand Auger	Field	Hg
Screening Hot Spot Sampling (as necessary)	20	Discretionary	Hot spots will be sampled as shown in Figure 3-3.	Hand Auger	Field	Driver COCs
Screening Duplicate Samples (Field/Laboratory QC)	14	NA	10% of field and laboratory samples analyzed at laboratory.	Hand Auger	Field/ Laboratory	Driver COCs

Table 3-1. Sampling and Analysis Summary for the Domestic Septic Systems 3 and 6 Removal Actions (continued)

Sampling Activity	Estimated Total Samples	Sampling Strategy	Assumptions	Sampling Method	Method of Analysis (1)	Analytical Parameters
DSS 3 Excavation Confirmation/Risk Assessment Sampling	25	Systematic and at hot spots	Systematic samples will be collected within the excavation area.	Hand Auger	Laboratory	Cadmium, copper, lead, Hg (2), chromium, silver, cesium-137, lead-210, Ra-226, strontium-90, formaldehyde, alpha & gamma chlordane, heptachlor epoxide, Cr^{+6}, NO_3
	4	Discretionary	One sample will be collected from beneath the effluent line leading from DST 3 to the DSS 3 DB; Two sediment samples will be collected from the bottom of DST 3; 1 concrete sample will be collected from the DST 3 tank bottom	Hand Auger	Laboratory	SVOCs, VOCs, metals (2), Cr^{+6}, NO_3, radionuclides, pesticides
	6	Discretionary	Samples will be collected at suspected hot spot locations.	Hand Auger	Laboratory	VOCs, SVOCs
DSS 6 Excavation Confirmation/Risk Assessment Sampling	22	Systematic and at hot spots	Systematic samples will be collected within the excavation area.	Hand Auger	Laboratory	Barium, copper, Hg (2), Cr^{+6}
	6	Discretionary	Samples will be collected at suspected hot spot locations.	Hand Auger	Laboratory	VOCs, SVOCs

Table 3-1. Sampling and Analysis Summary for the Domestic Septic Systems 3 and 6 Removal Actions (continued)

Sampling Activity	Estimated Total Samples	Sampling Strategy	Assumptions	Sampling Method	Method of Analysis [1]	Analytical Parameters
Confirmation/Risk Assessment Duplicate Samples (Laboratory QC)	7	NA	Ten percent of samples will be analyzed at an off-site laboratory.	Hand Auger	Laboratory	Appropriate Analysis

Notes
[1] See Table 3-1.
[2] STLC and TCLP will be requested after receiving Hg results, if total Hg concentration exceeds 10 times the STLC value or 20 times the TCLP value.

Abbreviations

bgs	below ground surface
Cr^{+6}	hexavalent chromium
DI WET	waste extraction test using deionized water
DSS	Domestic Septic System
ft	foot/feet
Hg	mercury
NA	not applicable
NO_3	nitrate
QC	quality control
Ra-226	radium-226
STLC	soluble threshold limit concentration
SVOCs	semi-volatile organic compounds
TCLP	toxicity characteristic leaching procedure

Table 3-2. Field and Laboratory Analytical Methods, Detection Limits and Holding Times for the Domestic Septic Systems 3 and 6 Removal Actions

Parameter/Container	Analytical Method	Required Detection Limit (pCi/g for radiochemicals, mg/kg for metals/general chemistry, µg/kg for organics)	Holding Time
Field Analyses			
Radium-226 (1-liter Marinelli Beaker)	Gamma Spectroscopy/HPGe	0.5	6 months
Mercury[1] (4-oz G)	EPA Method 7471	0.1	28 days
Laboratory Analyses			
Radionuclides (2 ea. 16-oz G):			
Americium-241	Lab SOP	0.01	6 months
Carbon-14	Lab SOP	0.1	6 months
Gamma Emitters	Lab SOP	—	6 months
Actinium-228	Lab SOP	0.1	6 months
Bismuth-212	Lab SOP	0.1	6 months
Bismuth-214	Lab SOP	0.1	6 months
Cesium-137	Lab SOP	0.01	6 months
Cobalt-60	Lab SOP	0.005	6 months
Lead-210	Lab SOP	0.5	6 months
Lead-212	Lab SOP	0.1	6 months
Lead-214	Lab SOP	0.1	6 months
Potassium-40	Lab SOP	1	6 months
Radium-223	Lab SOP	2	6 months
Radium-228	Lab SOP	0.1	6 months
Radium-226 (*)	Lab SOP	0.1	6 months
Thallium-208	Lab SOP	0.05	6 months
Thorium-228	Lab SOP	0.1	6 months
Thorium-230	Lab SOP	0.05	6 months
Thorium-232	Lab SOP	0.05	6 months
Thorium-234	Lab SOP	0.5	6 months
Gross Alpha	EPA Method 900.0	1	6 months
Gross Beta	EPA Method 900.0	1	6 months
Plutonium-241	Lab SOP	0.5	6 months
Strontium-90	EPA Method 905.0	0.05	6 months
Tritium	EPA Method 906.0	1	6 months
Uranium-233/234	Lab SOP	0.025	6 months
Uranium-235	Lab SOP	0.01	6 months
Uranium-238	Lab SOP	0.025	6 months

Table 3-2. Field and Laboratory Analytical Methods, Detection Limits and Holding Times for the Domestic Septic Systems 3 and 6 Removal Actions (continued)

Parameter/Container	Analytical Method	Required Detection Limit (pCi/g for radiochemicals, mg/kg for metals/general chemistry, µg/kg for organics)	Holding Time
Metals (2 ea. 4-oz G):	CLP SOW ILM 04.0		
Antimony		0.5	6 months
Arsenic		2	6 months
Barium		40	6 months
Beryllium		1	6 months
Cadmium		0.25	6 months
Chromium (total)		1	6 months
Cobalt		10	6 months
Copper		0.25	6 months
Iron		20	6 months
Lead		0.3	6 months
Manganese		3	6 months
Mercury		0.1	28 days
Molybdenum		0.1	6 months
Nickel		1	6 months
Selenium		1	6 months
Silver		0.1	6 months
Thallium		0.5	6 months
Vandium		1	6 months
Zinc		4	6 months
General Chemistry (4-oz G)			
Hexavalent Chromium	SW-846 Method 3060A/7196	0.05	24 hours
Nitrate	EPA Method 300.0	1	48 days
Formaldehyde	AOAC 931.08	0.1	14 days
Organics:			
Volatile Organic Compounds (4 ea. VOA vials [12 VOA vials for MS/MSD samples])	CLP SOW OLM 4.2/ EPA Method 5035	Exhibit C of SOW OLM 4.2	14 days Na bisulfate methanol
Semi-Volatile Organic Compounds (4-oz G)	CLP SOW OLM 4.2	Exhibit C of SOW OLM 4.2	14 days to extraction, 40 days to analysis of extract

Table 3-2. Field and Laboratory Analytical Methods, Detection Limits and Holding Times for the Domestic Septic Systems 3 and 6 Removal Actions (continued)

Parameter/Container	Analytical Method	Required Detection Limit (pCi/g for radiochemicals, mg/kg for metals/general chemistry, µg/kg for organics)	Holding Time
Pesticides/PCBs (4-oz G)	CLP SOW OLM 4.2	Exhibit C of SOW OLM 4.2	14 days to extraction, 40 days to analysis of extract

Notes

[1] Mercury is only a driver constituent of concern for the Domestic Septic Systems 6 removal action.

Abbreviations

(*)	Requires 30-day ingrowth-time and 1,000-minute count-time
CLP SOW	Contract Laboratory Program Statement of Work
COC	constituent of concern
ea.	Each
EPA	United States Environmental Protection Agency
G	glass
HPGe	high-purity germanium
ILM 4.0	Inorganic Laboratory Method 4.0
mg/kg	milligrams per kilogram
MS	matrix spike
MSD	matrix spike duplicate
Na	sodium
OLM 4.2	Organic Laboratory Method 4.2
oz	ounce
pCi/g	picoCuries per gram

Table 3-3. Laboratory Analytical Methods, Detection Limits and Holding Times for Designated-Level Grab Ground Water Samples

Parameter/Container	Analytical Method	Required Detection Limit (pCi/l for radiochemicals, mg/l for metals/general chemistry, µg/l for organics)	Holding Time
Laboratory Analyses			
Radionuclides (4 ea. 1-l Poly and 2 ea. 2-l Poly):			
Americium-241	Lab SOP	15	6 months
Carbon-14	Lab SOP	50	6 months
Gamma Emitters	Lab SOP	50	6 months
Actinium-228	Lab SOP	50	6 months
Bismuth-212	Lab SOP	50	6 months
Bismuth-214	Lab SOP	50	6 months
Cesium-137	Lab SOP	50	6 months
Cobalt-60	Lab SOP	50	6 months
Lead-210	Lab SOP	50	6 months
Lead-212	Lab SOP	50	6 months
Lead-214	Lab SOP	50	6 months
Potassium-40	Lab SOP	50	6 months
Radium-223	Lab SOP	50	6 months
Radium-228	Lab SOP	10	6 months
Radium-226 (*)	Lab SOP	10	6 months
Thallium-208	Lab SOP	50	6 months
Thorium-228	Lab SOP	50	6 months
Thorium-230	Lab SOP	50	6 months
Thorium-232	Lab SOP	50	6 months
Thorium-234	Lab SOP	50	6 months
Gross Alpha	EPA Method 900.0	3	6 months
Gross Beta	EPA Method 900.0	10	6 months
Plutonium-241	Lab SOP	50	6 months
Strontium-90	EPA Method 905.0	2	6 months
Tritium	EPA Method 906.0	4,000	6 months
Uranium-233/234	Lab SOP	4	6 months
Uranium-235	Lab SOP	4	6 months
Uranium-238	Lab SOP	4	6 months

Table 3-3. Laboratory Analytical Methods, Detection Limits and Holding Times for Designated-Level Grab Ground Water Samples (continued)

Parameter/Container	Analytical Method	Required Detection Limit (pCi/l for radiochemicals, mg/l for metals/general chemistry, µg/l for organics)	Holding Time
Metals (1-l Poly):	CLP SOW ILM 04.0		
Antimony		0.001	6 months
Arsenic		0.01	6 months
Barium		0.2	6 months
Beryllium		0.001	6 months
Cadmium		0.001	6 months
Chromium (total)	CLP SOW ILM 04.0	0.01	6 months
Cobalt		1	6 months
Copper		0.2	6 months
Iron		1	6 months
Lead		0.003	6 months
Manganese		1	6 months
Mercury		0.0004	28 days
Molybdenum		1	6 months
Nickel		0.02	6 months
Selenium		0.01	6 months
Silver		0.02	6 months
Thallium		0.0004	6 months
Vandium		1	6 months
Zinc		1	6 months
General Chemistry (1L Poly)			
Hexavalent Chromium	SW-846 Method 3060A/7196	0.1	24 hours
Nitrate	EPA Method 300.0	10	48 days
Organics:			
Volatile Organic Compounds (3 ea. VOA vials)	CLP SOW OLM 4.2	Exhibit C of SOW OLM 4.2	14 days
Semi-Volatile Organic Compounds (2 ea. 1-l Amber)	CLP SOW OLM 4.2	Exhibit C of SOW OLM 4.2	7 days to extraction, 40 days to analysis of extract
Pesticides/PCBs (2 ea. 1-l Amber)	CLP SOW OLM 4.2	Exhibit C of SOW OLM 4.2	7 days to extraction, 40 days to analysis of extract

Table 3-3. Laboratory Analytical Methods, Detection Limits and Holding Times for Designated-Level Grab Ground Water Samples (continued)

Abbreviations

(*)	Requires 30-day ingrowth-time and 1,000-minute count-time
CLP SOW	Contract Laboratory Program Statement of Work
COC	constituent of concern
ea.	each
EPA	United States Environmental Protection Agency
G	glass
HPGe	high-purity germanium
ILM 04.0	Inorganic Laboratory Method 04.0
l	liter
mg/l	milligrams per liter
OLM 04.2	Organic Laboratory Method 04.2
oz	ounce
pCi/l	picoCuries per liter
Poly	polyethylene
SOP	Standard Operating Procedure
VOA	volatile organic analysis
µg/l	micrograms per liter

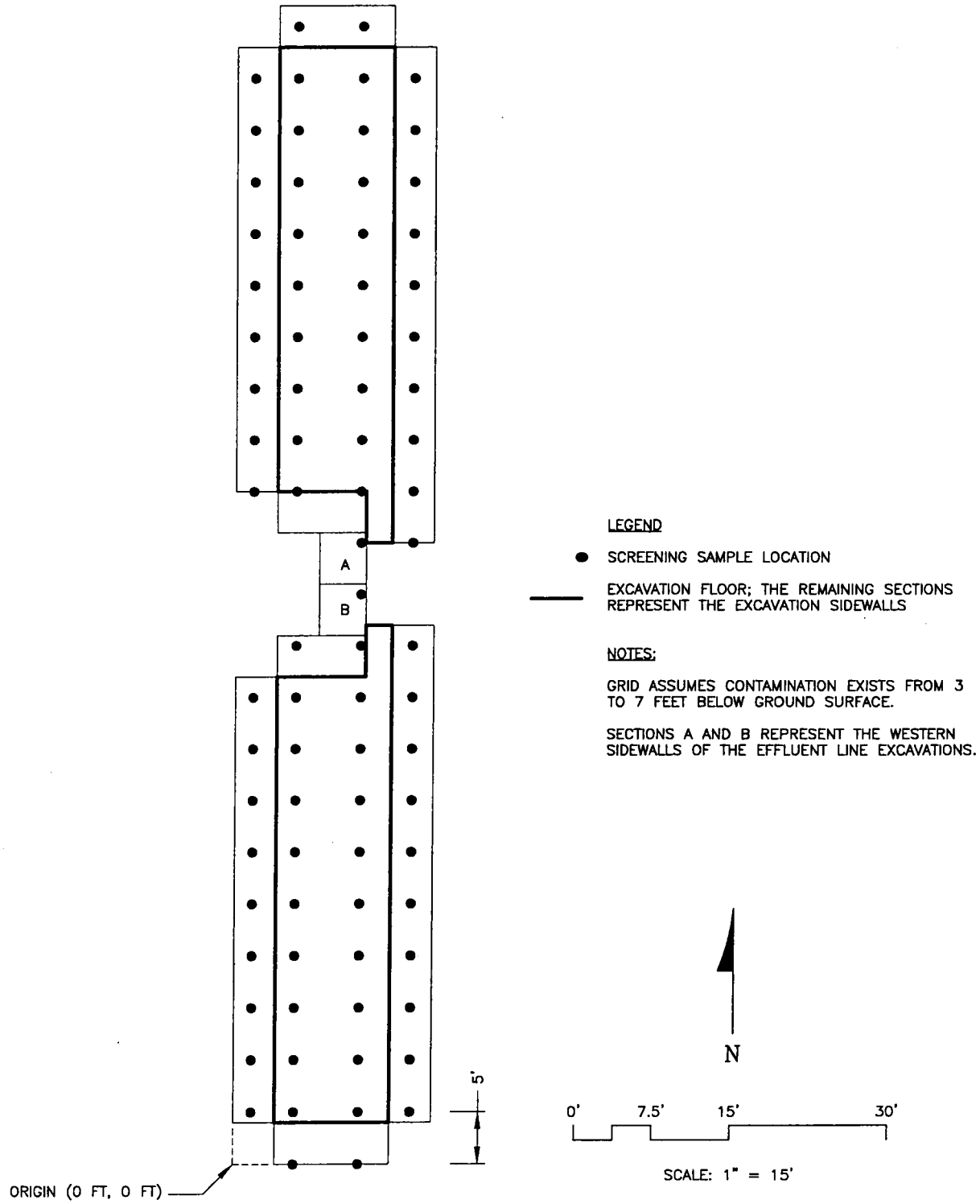

Figure 3-1. Domestic Septic System 6 Excavation Screening Sample Locations

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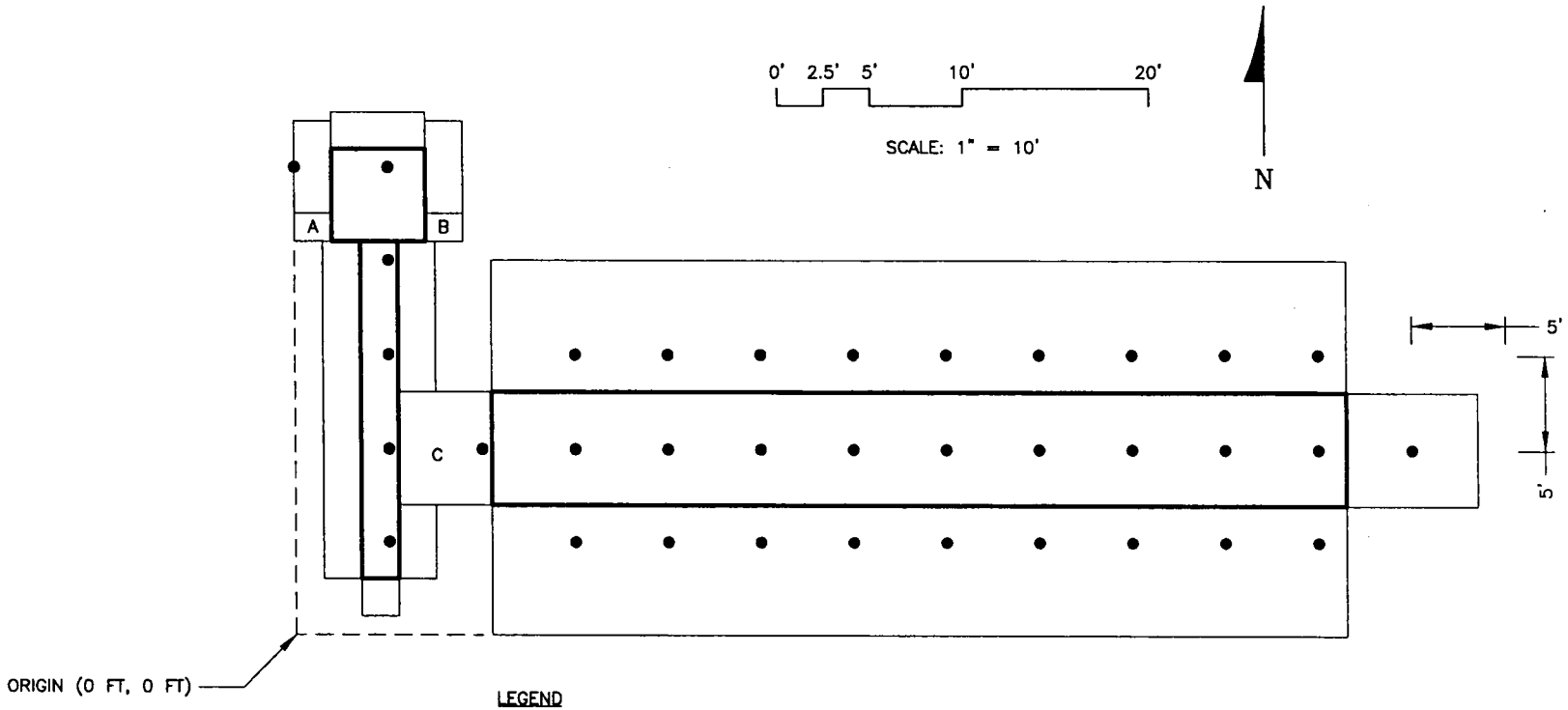

LEGEND

● SCREENING SAMPLE LOCATION

EXCAVATION FLOOR; THE REMAINING SECTIONS REPRESENT THE EXCAVATION SIDEWALLS

NOTES:

GRID ASSUMES CONTAMINATION EXISTS FROM 3 TO 10 FEET BELOW GROUND SURFACE.

SECTIONS A AND B REPRESENT THE SOUTHERN SIDEWALLS OF THE DISTRIBUTION BOX EXCAVATION.

SECTION C REPRESENTS THE SIDEWALL BETWEEN THE EFFLUENT LINE AND LEACH LINE EXCAVATIONS.

Figure 3-2. Domestic Septic System 3 Excavation Screening Sample Locations

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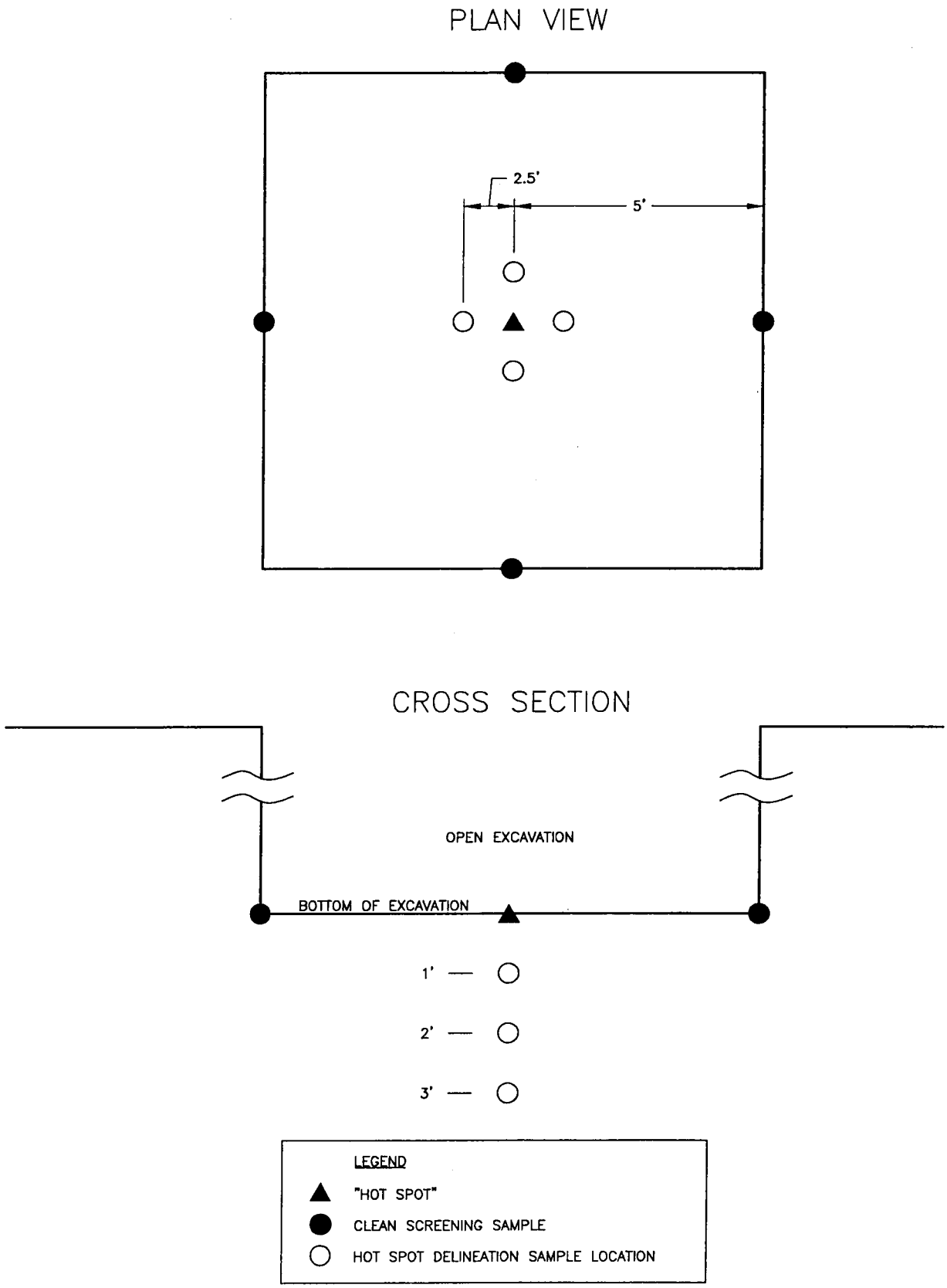

Figure 3-3. Domestic Septic Systems 3 and 6 Removal Actions Hot Spot Sample Locations

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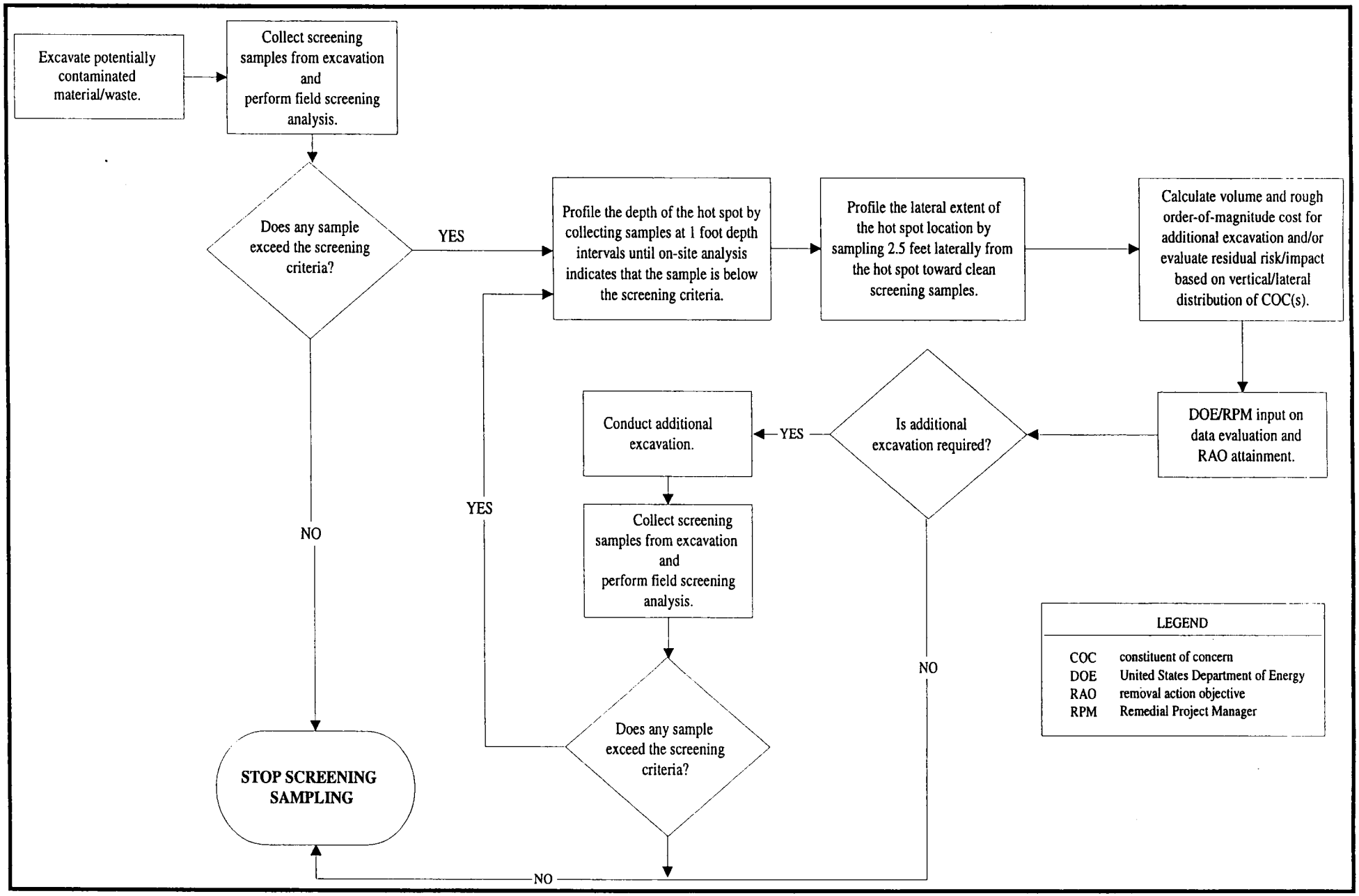

Figure 3-4. Domestic Septic Systems 3 and 6 Removal Actions Field Excavation Decision Flowchart

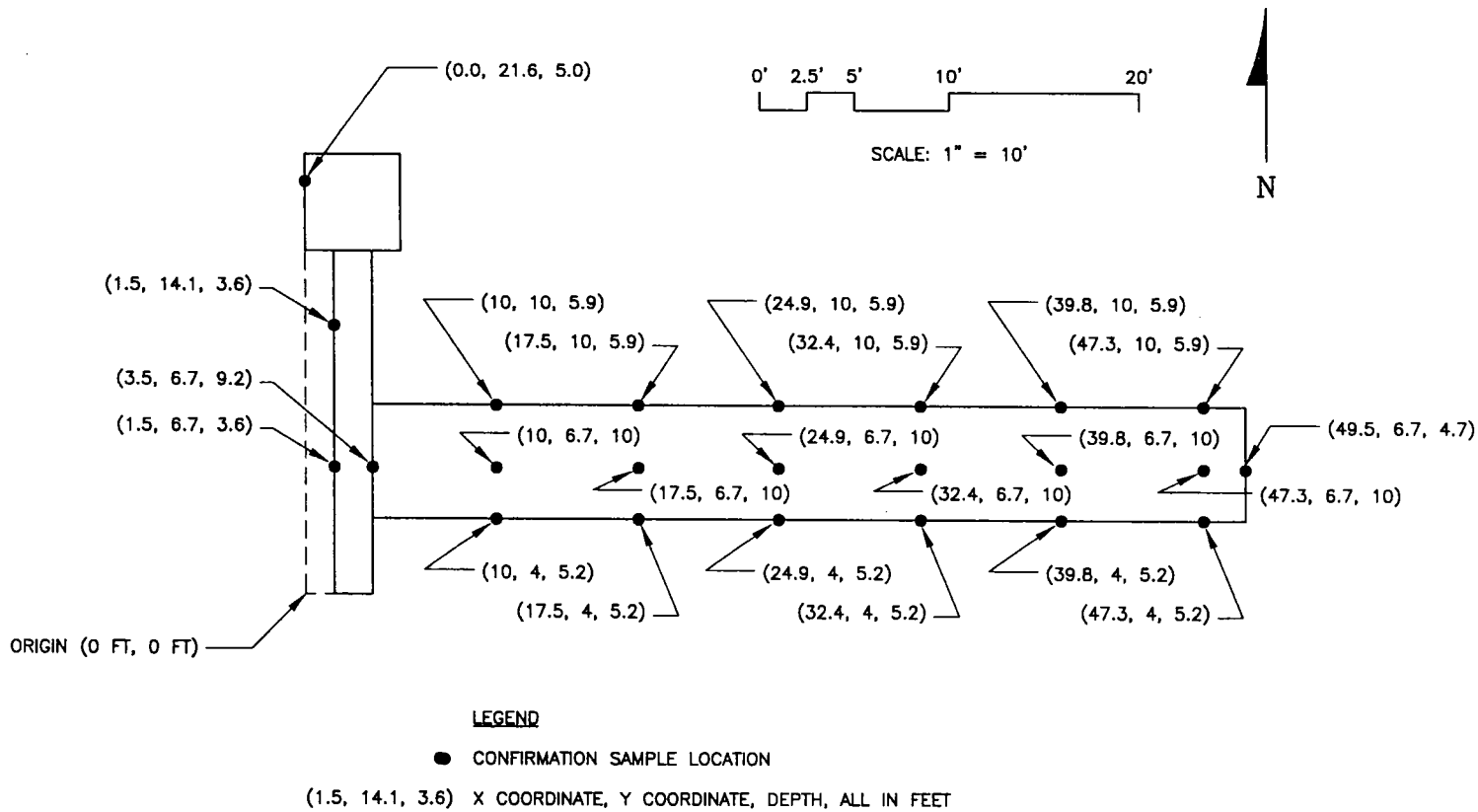

Figure 3-5. Domestic Septic System 3 Confirmation Sample Locations

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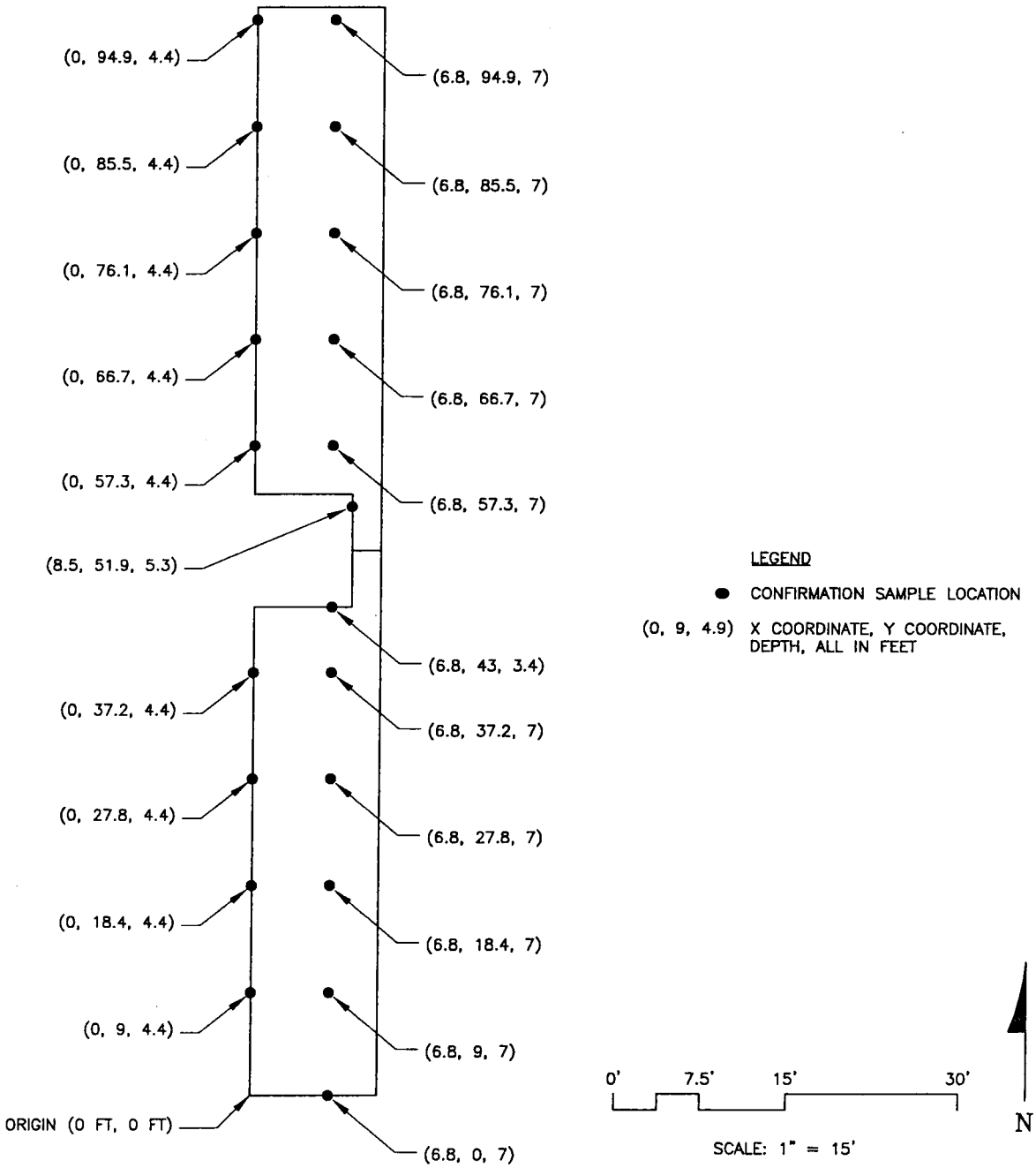

Figure 3-6. Domestic Septic System 6 Confirmation Sample Locations

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4. WASTE MANAGEMENT

This section is an activity-specific waste management plan (WMP) for waste streams and material associated with DSSs 3 and 6 RAs. This WMP references procedures developed for and specific to RA waste management activities. The LEHR waste management system is described, followed by RA-specific waste management guidance for the following activities:

- Excavation;
- Packaging and storage;
- Labeling and tracking;
- Inspection and radiological surveys;
- Characterization strategy;
- Sample collection;
- Data validation and compilation;
- Waste designation;
- Profiling; and
- Disposal.

4.1 Program Description

In general, the initial determination of waste type and management of waste/materials is dictated by process knowledge and relevant analytical data from waste of similar origin. Management practices are supported by the collection of additional analytical data. Once validated, analytical data are used to accurately characterize and designate project waste streams. Waste designation, in the form of a report submitted to the LEHR project file, determines final storage locations, physical inspection schedules and, if required, radiological survey schedules. Waste designation also initiates profile generation according to the disposal facility's 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 disposal facilities.

4.1.1 Definitions

The following terms are defined for use in this WMP:

- *Waste*—Any material, solid or liquid, generated as a result of the RA that requires disposal.
- *Material*—Any material, solid or liquid, generated as a result of the RA that may be re-used, recycled or requires off-site disposal as non-regulated waste.

- *HW*—Waste/material that meets one or more of the HW definition under the Resource Conservation and Recovery Act, 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 (LLW)*—Waste that contains radioactivity and is not classified as high-level waste, transuranic waste, or spent nuclear fuel or 11E(2) by-product material as defined by DOE Order 435.1. 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 435.1).
- *Mixed Waste (MW)*—Waste classified as both LLW and HW based on the definitions above.
- *Non-Hazardous Waste/Materials (NH)*—Waste material that does not meet the definition of applicable federal and/or state HW laws and regulations.

4.1.2 Regulatory Drivers and Standard Operating Procedures

This document references the LEHR WMP (WA, 2001c), RPP (WA, 1999) and SOPs (WA, 2001d). The SOPs used to develop this document are:

- SOP 1.1, Chain-of-Custody;
- SOP 2.1, Sample Handling, Packaging and Shipping;
- SOP 3.1, Surface and Shallow Subsurface Soil Sampling;
- 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 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 and Material Tracking System;
- SOP 35.1, Waste Certification; and,
- SOP 39.1, LEHR Site Inspection.

4.1.3 Key-Personnel Responsibilities

Proper management of LEHR RA waste streams requires contributions from various project team members. The responsible members and waste management organizational chart is presented in Section 4 of the LEHR WMP (WA, 2001c).

4.1.4 Waste Minimization

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

- Avoiding use of porous materials that cannot be decontaminated;
- Minimizing PPE waste through effective worker logistics;
- Using real-time analyses to delineate the extent of contamination and to segregate and sort material based on contamination levels;
- Optimizing waste container utilization and recycling;
- Utilizing soft-sided containers to minimize void space in waste packages;
- Using equipment decontamination solutions as dust suppressant on contaminated soil/debris excavations and stockpiles;
- Removing surface contamination from subsurface structures and pipes;
- Reusing uncontaminated soil and materials on site; and,
- Recycling uncontaminated debris and waste off site.

A detailed description of the LEHR Waste Minimization Program is located in Section 7 of the Waste Management Annual Report for Fiscal Year 1997 and WMP (WA, 1998).

4.2 Project Specific Guidance

4.2.1 Domestic Septic Systems Waste Stream Descriptions

The DSSs RAs are expected to generate waste/material including:

- Non-Hazardous waste and material:
  - Overburden soil;
  - Gravel;
  - Asphalt;
  - Concrete; and
  - Miscellaneous debris (plastic sheeting, construction debris, etc.);

- Mixed waste:
  - Soil;
  - Gravel;
  - Concrete;
  - Miscellaneous debris (clay pipe, Orangeburg pipe, etc.); and,
  - Liquid (decontamination water).

The DSSs RAs are not expected to generate HW. Because available data indicate radiological contamination above background levels but below the site RBAS, RA waste will be managed as potential MW, until on-site radiological laboratory screening data and analytical data are available for final designation. RA waste that is not covered by this work plan will be handled under separate updates.

4.2.2 Excavation, Packaging and Storage

During the DSSs 3 and 6 RAs, NH and potential MW will be excavated. Table 4-1 summarizes anticipated waste streams and authorized storage areas managed under this WMP. Expected waste generation activities, organized by waste type, are described below.

4.2.2.1 Potential Mixed-Waste

Waste from the DSS RA will be managed as potential MW because it may contain chemical and radiological contamination. Available data indicate radiological contamination above background but below the site RBAS. As a best-management practice, it is assumed that radiation has been added to this material until analytic data have been evaluated and the waste has been designated. The waste will be loaded directly into Lift Liners™ and transported to the EDPs for storage. The volume of DSS 3 DB sediment is less than one cubic foot. This sediment will be removed and packaged separately for off-site disposal. Leach field material (pipe and gravel) plus one ft of surrounding soil will be segregated from soil deeper than one ft below the base of the leach field material. Waste will be segregated into eight- to nine-cu yd lots (i.e., one Lift Liner) and the

contents of each Lift Liner will be screened for Hg using the on-site laboratory (screening data will not be used for final waste designation). Soil/debris with screening results above 20 parts per million (ppm) Hg will be managed as potentially mixed waste. Composite waste samples will be collected separately for each potentially mixed waste group(i.e., DB sediment and leach field material), and for waste containing less than 20 ppm Hg. To minimize waste disposal costs, soil will be segregated from debris when possible. For disposal purposes, the waste packages containing soil must not contain more than 10% debris (PPE, concrete, piping, etc.) by volume.

4.2.2.2 Non-Hazardous Waste

Surface soil and gravel (overburden) in the DSSs 3 and 6 RA areas are likely to be characterized as NH. Surface concrete and asphalt (sidewalks, roadways and parking lots) will also be managed as NH. Process and site operations knowledge provide sufficient data to indicate that the soil, gravel, concrete and asphalt that overlie the areas of contamination and that were removed during the 2001 DSSI contain no added-radioactivity or hazardous constituents. As such, this material will be removed and segregated from other RA wastes prior to the initiation of the RA to prevent cross-contamination.

Following completion of the RA, surface-derived concrete and asphalt will be combined with surface concrete and asphalt generated during the 2001 DSSI and will be transported to the a municipal sanitary landfill for disposition. To meet the WAC of the municipal landfill, the concrete and asphalt must be processed into pieces no larger than eight inches in any dimension.

Overburden soil will be stockpiled near the excavation and will be used as backfill once RA activities have concluded.

4.2.2.3 Miscellaneous Waste

Water used to decontaminate equipment will be stored in 55-gallon drums and will be removed from the RA area following conclusion of RA activities. Whenever possible, the water will be used as dust suppressant on the contaminated waste during the RA to minimize the volume of remaining water.

4.2.3 Constituents of Concern

The COCs for each RA area were identified using the data collected during the previous investigation(s). In general, compounds detected above background and the lowest RBAS or residential PRG were considered COCs. At DSS 3, formaldehyde, hexavalent chromium, cadmium, chromium, lead, manganese, Hg, molybdenum, nickel, silver, alpha-chlordane, gamma-chlordane, heptachlor epoxide, Sr-90 and Ra-226 are considered COCs. At DSS 6, hexavalent chromium, antimony, barium, copper, lead, Hg and nickel are considered COCs. . Nickel and chromium concentrations are regionally elevated and will be evaluated for leaching potential.

4.2.4 Sampling and Characterization Strategy

Sampling and analysis will be conducted in accordance with LEHR 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 the disposal site. At least one waste characterization sample will be collected per waste type generated. A general description of sample collection activities is followed by specific sample instruction for NH, mixed and miscellaneous waste. Waste types and sample frequencies are in Table 4-1. Analysis methods and detection limits are in Table 4-2.

4.2.4.1 General

Waste characterization sampling will occur concurrently with waste/material excavation and packaging activities. Sampling staff will collect one sample in an eight-ounce glass jar from each Lift Liner™ prior to package closure and transport to the on-site laboratory for storage. Samples will be labeled and stored in the LEHR on-site laboratory for compositing for chemical and radiological analysis. Sampling staff will composite the 8-ounce jars on-site to generate samples representing 100-cu yd increments of a given waste stream. At a minimum, one sample and a field duplicate will be collected from each of the DSSs 3 and 6 RAs.

Ten percent of the waste packages will be also be sampled for VOCs analysis by EPA Method 5035. Waste packages sampled for VOC analysis will be those exhibiting odors, staining or other signs of chemical release. Lacking these characteristics, VOC samples will be collected in waste associated with highest mercury concentrations based on available data. Discrete VOC samples will be collected using plug-core samplers according to EPA Method 5035. The sample containers will be labeled and shipped to the laboratory under chain-of-custody. The off-site laboratory will composite the samples contained in the four-ounce jars prior to analyzing them for VOC constituents following US EPA Method 8260/5062. The samples collected by EPA Method 5035 will not be composited. Groups of four-ounce jars will be sent to the off-site laboratory to coincide with the 100-cubic yard increments of the other wastes that were sampled and composited on site. The VOC samples will be identified with the same sample ID number as the on-site composite. The VOC samples will be discretely marked on container lids as VOC samples to avoid confusion at the laboratory.

All samples will be analyzed for the radiological and chemical suites shown in Table 4-2, including soluble threshold limit concentration and toxicity characteristic leaching procedure for chromium, Hg and nickel. Samples collected from DSS 6 will begin with sample number CWD6C003. Samples collected from DSS 3 will begin with sample number CWD3C001.

One duplicate sample will be collected per 100 cu yd of waste to fulfill the 10% QA/QC requirement, with at least one duplicate sample collected. Sampling frequencies and parameters are in accordance with existing agreements with LEHR selected disposal facilities.

In general, samples will be collected in the following manner.

- One eight-ounce and four-ounce glass jar will be collected from each Lift Liner™;

- One composite sample will be collected per 100 cubic yards of waste;
- Samples for radiological and chemical analysis will be composited on site; and,
- Samples for VOC analysis will be sent to the laboratory for compositing and analysis.

Duplicate samples will be analyzed for the disposal suite specified in Table 4-2.

4.2.4.2 Non-Hazardous Waste

The overburden soil and gravel above the leach fields and domestic septic tanks will be designated as NH, based on process knowledge and site operations, and will be segregated and stockpiled near the excavation. At the conclusion of RA activities, the soil will be returned to the excavation and used as backfill.

NH concrete and asphalt from sidewalks, roadways and parking lots will not be sampled. Process and site operations knowledge is sufficient to indicate that this waste contains no added radioactivity or hazardous constituents.

4.2.4.3 Potential Mixed Waste

Material assumed to contain chemicals/metals and radioactive constituents will be sampled at a rate of 1 composite sample per 100 cu yd of waste (Table 4-1).

4.2.4.4 Miscellaneous Waste

Remaining decontamination water not used as dust suppression will not be sampled. This waste will be designated with the associated solid waste generated from the DSSs 3 and 6 RAs.

4.2.5 Quality Assurance/Quality Control

In all cases, duplicate samples will be collected at a rate of 10%, and equipment rinseate samples will be collected to comply with the objectives of the QAPP to evaluate whether the waste matrix is becoming contaminated during sample collection or shipment. Three trip blanks prepared by General Engineering Laboratories, Inc. (GEL) in Charleston, South Carolina will be sent with each sample cooler to ensure that VOCs are not introduced into the sample matrix during transportation and handling. Trip blanks will be assigned unique ID numbers. The trip blanks will be listed on the chain-of-custody form.

4.3 Data Validation and Compilation

GEL will analyze samples collected for laboratory analysis. Analytical 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, 2000b) and provided to the Waste Coordinator and Waste Specialist for use in waste designation.

4.4 Labeling and Tracking

All DSS RA waste and material streams will be incorporated into the LEHR Waste and Material Tracking System per SOP 34.5, Waste and Material Tracking System.

4.5 Inspection and Radiological Surveys

All waste and material packages/stockpiles will be inspected and surveyed per SOP 34.2, Low-Level Radioactive Waste Storage and 39.1, Waste Management Program Inspection.

4.6 Waste Designation

Preliminary waste designation is summarized in Table 4-1, and shall be amended by the Waste Coordinator at the time of waste generation, if required. The Waste Specialist will update this designation and will use validated analytical data and process knowledge of RA waste streams 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. The designation process is described in SOPs 34.4, Clean Waste Handling; 35.1, Waste Certification; and 35.2, Waste Characterization for Off-Site Shipment.

4.7 Profiling

The purpose of waste profiling is to verify that the selected disposal facility WAC are met. Profiling is described in SOP 35.1, Waste Certification for Off-Site Disposal.

4.8 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 SOP 34.3, Waste Shipment. Staging, loading and hauling of RA waste streams will be conducted in accordance with all applicable federal and state regulations and in accordance with SOP 34.3. Likely disposal scenarios are summarized in Table 4-1.

All DSS RA and DSSI NH (surface asphalt and concrete) will be sent to a municipal sanitary landfill for disposition.

4.9 Schedule

All DSS RA waste will be disposed by July 20, 2003. All MW shall be properly disposed within 90 days of its designation. All waste will be managed for disposal per the LEHR WMP (WA, 2001c).

Table 4-1. Domestic Septic Systems 3 and 6 Removal Actions Waste Types, Volumes and Management

Description	Ex Situ Volume (cu yd)	Number of Containers	Container Type	Authorized Storage Location	Preliminary Designation [1]	Required Samples	Required Analysis	Probable Disposition
Site Setup								
Miscellaneous Debris	12	1	roll-off bin (12 cu yd)	NR	NH	NR	NR	MLF
Asphalt	50	1	stockpile	Co-60 Field/WDP	NH	NR	NR	MLF
Concrete Sidewalks, Curbing	15	1	stockpile	Co-60 Field/WDP	NH	NR	NR	MLF
Overburden Soil [2]		1	stockpile	NR	NH	NR	NR	MLF
DSS 3 Waste Removal								
Distribution Box/ Sediment/Tank /Soil	8	1	LL	EDPs	MW	2[3]	FS	LLWDS
Gravel/Piping/Soil (Leach Field)	60	8	LL	EDP	MW	1	FS	LLWDS
Over-excavated Soil	40	5	LL	EDP	MW	1	FS	LLWDS
Decontamination of Water	0.35 (75 gal.)	1.5	55-gal. drum	Geri-1	MW	NR	NR	LLWDS
DSS 6 Waste Removal								
Gravel/Piping/Soil (Leach Field)	100	12	LL	EDP	MW	2	FS	LLWDS
Over-Excavated Soil	85	10	LL	EDP	MW	1	FS	LLWDS
Decontamination Water	0.35 (75 gal.)	1.5	55-gal. drum	Geri-1	MW	NR	NR	LLWDS

Notes

[1] Material/waste designation and the evaluation of disposition options will be provided in an addendum to this work plan.
[2] Overburden soil will be accumulated adjacent to the removal action work area and will be used for backfill.
[3] Duplicate samples will be collected from areas suspected to contain highest levels of contamination.

Table 4-1. Domestic Septic Systems 3 and 6 Removal Actions Waste Types, Volumes and Management (continued)

Abbreviations

Co-60	Former Cobalt-60 Field
cu yd	cubic yard(s)
DSS	Domestic Septic System
EDPs	Eastern Dog Pens
FS	Full Suite (see Table 4-2 for complete list of required analyses)
gal.	gallon
Geri-1	Geriatrics-1
LL	Lift Liner™
LLWDS	low-level waste disposal site
MLF	Municipal Landfill
MW	mixed waste (hazardous and radioactive)
NH	non-hazardous waste and material
NR	not required
WDP	Western Dog Pens

Table 4-2. Analytical Methods and Detection Limits for Domestic Septic Systems 3 and 6 Removal Action Waste/Material Characterization

Sample Suite	Analysis	Required Detection Limit (pCi/g for radionuclides, mg/kg for metals/general chemistry, μg/kg for organics)
Radiological	Gross Alpha/Beta (EPA 900.0)	1
	Gamma Emitters (Lab SOP)	
	Actinium-228 (Lab SOP)	0.1
	Bismuth-212 (Lab SOP)	0.1
	Bismuth-214 (Lab SOP)	0.1
	Cesium-137 (Lab SOP)	0.01
	Cobalt-60 (Lab SOP)	0.005
	Lead-210 (Lab SOP)	0.5
	Lead-212 (Lab SOP)	0.1
	Lead-214 (Lab SOP)	0.1
	Potasium-40 (Lab SOP)	1
	Radium-223 (Lab SOP)	2
	Radium-228 (Lab SOP)	0.1
	Thalium-208 (Lab SOP)	0.05
	Thorium-234 (Lab SOP)	0.5
	Radium-226 (Lab SOP)	0.1
	Strontium-90 (EPA 905.0)	0.05
	Americium-241 (Lab SOP)	0.01
	Plutonium-241 (Lab SOP)	0.5
	Uranium-233/234, 235, 238 (Lab SOP)	0.025, 0.01, 0.025, respectively
	Thorium-228, 230, 232 (Lab SOP)	0.1, 0.05, 0.05, respectively
	Tritium (EPA 906.0)	1
	Carbon-14 (Lab SOP)	0.1
Chemical	VOCs (SW-846 8260)	As specified in method
	SVOCs (SW-846 8270)	As specified in method
	Pesticides/PCBs (SW-846 8081)	As specified in method
	Title 22 Metals (SW-846 6010/7471)	
	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
	Mercury	0.1
	Molybdenum	0.1

Table 4-2. Analytical Methods and Detection Limits for Domestic Septic Systems 3 and 6 Removal Action Waste/Material Characterization (continued)

Sample Suite	Analysis	Required Detection Limit (pCi/g for radionuclides, mg/kg for metals/general chemistry, µg/kg for organics)
Chemicals (continued)	Nickel	1
	Selenium	1
	Silver	0.1
	Thallium	0.5
	Vanadium	1
	Zinc	4
	Hexavalent chromium (SW-846 3060A/7196)	0.05
	Nitrate (SW-846 300.0)	1
	Chromium, Mercury, Nickel and Zinc (SW-846 6010/1311)	10
	Chromium, Mercury and Nickel (SW-846 6010/CA STLC)	10
Disposal	Reactive Cyanide (SW-846 7.3.3.2)	0.02
	Reactive Sulfide (SW-846 7.3.4.2)	0.02
	Paint Filter Test (SW-846 9095)	Not applicable
	pH (SW-846 9045)	0.01 (pH unit)
	Herbicides (SW-846 8151)	2.0
	Ignitability (SW-846 1020A or 1010)	Not applicable

Abbreviations

CA	California
Ed.	edition
EPA	United States Environmental Protection Agency
mg/kg	milligrams per kilogram
PCBs	polychlorinated biphenyls
pCi/g	picoCuries per gram
SOP	standard operating procedure
SVOC	semi-volatile organic compound
STLC	soluble threshold limit concentration
TCLP	toxicity characteristic leaching procedure
VOC	volatile organic compound
µg/kg	micrograms per kilogram

5. HEALTH AND SAFETY

H&S considerations for the DSSs RAs incorporate the Integrated Safety Management System and are addressed by the following documents: the PHSP (WA, 2001f); Health and Safety Procedures (HSPs) (WA, 2000e); SOPs (WA, 2001d); CPGERP (WA, 2000d); As-Low-As-Reasonably-Achievable (ALARA) Program (WA, 2001a); and RPP (WA, 1999). The H&S considerations presented in this section, coupled with the foregoing documents, comprise the H&S program required by 29 CFR 1910.120, HAZWOPER and 10 CFR 835, Occupational Radiation Protection.

5.1 Hazard Analysis

Hazards associated with field activities are identified and evaluated using the Activity Hazard Analysis (AHA) process. The SC, together with the H&S and Radiation Control staff, identify potential H&S hazards, and define controls necessary for the protection of personnel. This hazard identification and evaluation is documented for each task. Some activities, such as radiological field survey and contaminated soil and waste excavation, have been evaluated in the LEHR PHSP. Those activities specific to the DSSs RA are discussed in this work plan, and the associated AHAs are included in Appendix D.

During the DSS RAs, the SC, SHSO, Radiological Control Manager, RSO, or RCT will monitor the site for any changes in conditions that would require modification of hazard controls (i.e., PPE). In the event that changes arise in radiological or industrial H&S conditions that are not addressed by this work plan or referenced documents, any new hazards will be evaluated in an AHA.

5.1.1 Underground Utilities

All available drawings, plans and diagrams will be reviewed for the existence and locations of underground utilities. UC Davis personnel will be interviewed to determine additional potential utility locations that may not be shown on existing maps. A qualified person will identify and mark the location of all underground utilities prior to commencement of any subsurface or intrusive activity described in Section 2. However, this may not completely eliminate the potential for encountering unmarked or mislocated underground utilities during the proposed activities. To minimize the dangers associated with such accidental encounters, the following precautions will be followed during removal activities:

- The main shutoff valve(s) or switch(es) for gas lines, water lines, and electric lines nearest each excavation and sampling location will be located prior to the start of work;
- Areas of potential concern will be identified prior to the start of work; and,
- Samples will be collected using a hand auger in the first five ft of each boring after utilities are cleared. Hand augering is one of the least intrusive and safest sampling methods that can be employed to sample soil in areas containing utilities.

5.1.2 Heavy Equipment Operation

A large part of the DSSs RAs work includes removal of waste and material from the DSSs areas using heavy machinery, such as an excavator, a loader, a backhoe with a jackhammer attachment, and a forklift. Various hazards associated with the operation of such equipment include:

- Collisions with buildings, other vehicles or pedestrians;
- Spotters or pedestrians caught in the pinch points of the bucket arms or the pivot areas of articulated machines;
- Load drops and spills on workers;
- Machine malfunction;
- Falls when mounting or dismounting or performing maintenance on the equipment; and,
- Falling objects.

General safety precautions should be observed when operating heavy equipment. Equipment should be operated slowly and with care, especially when traveling downgrade, when empty, or when traveling on uneven terrain. Accidents occur most frequently when reversing equipment; therefore, additional caution should be exercised when reversing. The operator should be aware of the surroundings, use properly adjusted rear view mirrors and, when lighting is poor, and use both front and rear lights or spotlights placed in the work area (see Table 5-5 of the PHSP for required work area illumination). A spotter should be utilized whenever the operator's visibility is impaired. The drive train should never be put into reverse gear without looking behind the equipment. Back-up alarms and horns should be inspected daily and be functional. Work should be stopped and the horn used if anyone is observed in the equipment's danger zone.

The operator should always use the three-point contact rule when climbing onto or off of heavy equipment: both feet and one hand, or one foot and both hands, should be in contact with the ladder access at all times. No one other than the operator should ride in or on the equipment, unless the equipment is designed to carry a passenger. The equipment cage is designed to protect the operator in the event of rollover as long as the operator is inside the cage with the seat belt fastened.

Extreme caution should be used when operating articulated extensions to prevent an injury in a pinch point at the pivot. Operators should always check both sides of the machine before moving it to make sure no one is in this danger area. The heavy equipment work area should be demarcated using barricade tape or traffic cones and only spotters should be allowed in the area. The spotter should exercise caution, especially when there is a raised attachment (e.g., bucket). The spotter should never walk under any raised attachment.

5.1.2.1 Communication

Good communication between the operator and a spotter is essential for safe operation of construction equipment. Two-way radios should be used when feasible to ensure clear communication. If use of radios is impractical, a standardized set of hand signals must be used. All ground-based workers in the vicinity of heavy equipment should wear high visibility vests to help the operator locate them quickly. The equipment should have a back-up warning alarm that can be heard by all nearby workers.

5.1.2.2 Training and Inspections

Equipment operators must be properly trained in the use of heavy equipment and must inspect the equipment daily as defined in HSP 1.1, Health and Safety Forms. Additional safety information specific to equipment safety is available in Section 5 of the PHSP.

5.1.3 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 trench wall stability, undermining of buildings, confined space entry, slips, trips, falls and impaired 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.

HSP 4.1, Trenching and Excavation, will be followed for the DSSs 3 and 6 RAs. If for any reason personnel need to enter a trench or excavation, the required permits and clearances must be approved prior to entry into the trench or excavation, and the excavations will be shored, sloped or benched as required by 29 CFR 1926.

5.1.4 Overhead Electrical Lines

There are no overhead electrical lines in the vicinity of DSSs 3 and 6 areas. However, there are energized 1.2 kilovolt overhead lines approximately 30 ft above ground near the entrance to the former Co-60 Field storage area and adjacent to the import fill stockpile. Equipment traveling in these areas will avoid travel under the electrical lines to the extent feasible. When equipment is

required to travel under the electrical lines, all parts of the equipment will be positioned to maintain a 10-ft minimum vertical clearance. A notice of the 10-ft minimum vertical clearance will be provided to the equipment operator and posted in the cab of the equipment.

5.1.5 Equipment Fueling Operations

The discharge of static electricity while dispensing fuel is a serious hazard that can potentially result in a catastrophic fire or explosion. All piping, tanks, valves and dispensing equipment must be bonded continuously so that all non-current-carrying metal parts have the same potential to ground. This is especially important at the dispensing hose and nozzle because fuel passing through a hose creates static electricity. The risk of static electricity discharge is greatest when the nozzle is being removed from the tank being filled.

All dispensing equipment including pumps, hoses and nozzles must be Underwriters Laboratories-listed for the intended usage. Pumping fuel from a truck requires that a bonding wire be attached anytime flammable liquids are discharged into a top fill tank. Trucks are insulated from ground by rubber tires, so when a bonding wire is attached to the tank being filled, a continuous path to ground is provided. Because the length of time required for static electricity to dissipate varies, removing the bonding wire before static electricity is dissipated can create a spark. Grounding the truck in addition to bonding to the tank being filled addresses this issue, is required by OSHA and is prescribed in National Fire Protection Association guidelines. Allowing a few minutes to elapse before removing nozzles when the pumping is complete helps to ensure that static electricity has dissipated.

Diesel fuel is exempt from bonding requirements. However, when diesel fuel is pumped into a container that has previously held a higher-grade product, bonding and grounding are necessary.

5.1.6 Transfer to Waste Containers

RA activities in the DSSs 3 and 6 areas will generate waste that will require transfer to a storage location pending characterization and disposal. This operation will involve moving soft-sided containers using a forklift and a specialized lifting frame. The tasks associated with this activity and the required hazard controls are detailed in Appendix D.

5.1.7 Concrete Demolition

Breaking, cutting, and crushing of underground concrete DSS structures are likely to generate airborne dust. A light water mist will be maintained during these processes to reduce the potential for fugitive dust and potential worker exposure, while maintaining the material/waste at an acceptable moisture content (i.e., no free liquids) for storage and disposal. Dust exposure will be controlled by the use of water spray or other wetting methods. Continuous monitoring of the dust

levels will be performed to ensure that action levels and OSHA permissible exposure limits (PELs) listed in Table 5-1 are not exceeded. If dust exposure cannot be kept below the action levels presented in Table 5-1, respiratory protection will be used.

5.1.8 Trips and Falls

The DSSs 3 and 6 areas contain uneven surfaces, with many holes, sharp pieces of metal grating, nails, broken concrete curbs and shrubbery. While most of the removal work in the area will be performed with heavy equipment, there may be tasks that require workers to be on the ground. In such cases, the potential for injury due to trips and falls can be high. Prior to any on-the-ground activity, workers will be instructed to exercise extreme caution when working in the area. They will be periodically reminded of the hazards. When possible, the potential trip hazards will be cleared from the immediate work area to provide a more stable ground surface for work activities, such as manual shoveling or spotting the equipment operation.

5.1.9 Material Handling

Some of the activities associated with the DSS RAs require handling of heavy materials, including tools, plywood sheeting and concrete pieces. When loading or unloading materials or tools, care should be taken to avoid bending, twisting or carrying loads for long distances. HSP 10.1, Manual Lifting, provides additional detail on safe lifting practices.

5.1.10 Repetitive Motion Hazards

Installation, repair and maintenance of the perimeter fencing and manual sample collection involve the use of hand tools such as screwdrivers, hammers and augers. Steady and prolonged use of hand tools can involve a constant twisting of the wrist. Activities that require repetitive hand or wrist motion will be alternated with other tasks to the extent practical. Battery-operated screw guns and other mechanized tools will be considered when the use of manual tools is expected to be continuous. For prolonged activities requiring a hammer, hammers with wooden handles will be provided as they tend to transmit less vibration than steel and fiberglass hammer handles. When using vibrating tools, special gloves that "dampen" vibration will be provided.

For activities involving the use of a shovel, such as clearing gravel from areas inaccessible to heavy equipment, the workers will be instructed to alternate the left hand and right hand forward to reduce the repetitive stress by allowing muscles on both sides of the body to share the work.

5.1.11 Puncture Hazards

Due to the potential presence of sharp metal objects, steel-toed safety shoes conforming to American National Standards Institute (ANSI) Z41.1/75 are required for work in the DSSs areas. Gloves are required when manually handling material presenting a puncture hazard.

5.1.12 Biological Hazards

The DSSs 3 and 6 areas may house brown recluse spiders, black widow spiders, rabid animals (e.g., mice, rats, etc.), rattlesnakes, deer ticks carrying lyme disease, ticks carrying rocky mountain spotted fever, and scorpions. Boots are required for work in the DSSs areas. Gloves will be worn if workers are required to place their hands in areas of potential biological hazard (e.g., brush, bushes, or under concrete). Additional measures for protection against biological agents described in Section 5.4.5.1 of the PHSP will be implemented as necessary when required by the SHSO.

5.1.13 Radiological Exposure

The material/waste removed from the DSSs areas may contain low levels of radioactivity. Based on previous investigations and RAs, the radionuclides of concern from an H&S perspective appear to be limited to Ra-226 and Sr-90, and are significantly below regulatory exposure limits applicable to the LEHR Site.

Removal, stockpiling, sorting, packaging and sampling activities may result in exposure to radioactive materials through contact, ingestion and inhalation. Exposure to radionuclides will be monitored and controlled by the RCTs in accordance with the LEHR RPP. Gross alpha, beta, and gamma radioactivity readings will be collected by RCTs using field instruments to identify the presence of radionuclides above background levels that may pose an occupational hazard. Ingestion of radionuclides will be minimized by use of proper PPE (gloves) and personal hygiene (washing of hands and face). Area air monitoring will be conducted to determine a baseline potential exposure to airborne radioactivity (Section 5.2.9 of this work plan and Section 11 of the PHSP). The PPE level described in Section 5.2.3 may be modified based on monitoring results.

Dose 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. The use of administrative procedures for the control of occupational radiological worker exposures is not anticipated for this

project. Applicable ALARA principles and procedures are presented in the ALARA Program (WA, 2001a) and will be discussed with the workers during on-the-job training.

Based on prior occupational radiological exposure monitoring data, potential exposure above the regulatory limits is not likely for the proposed RA tasks. Radiological field surveys and area air monitoring will be performed during RA activities to ensure that these assumptions remain valid and to confirm that occupational exposure monitoring is not required for occupational compliance purposes.

5.1.14 Chemical Exposure

Concrete demolition, waste removal, stockpiling, sorting, packaging and sampling activities may present an inhalation exposure to nuisance dust. Real-time nuisance dust (total) air monitoring will be performed using field instruments and the data will be evaluated for any potential occupational hazard. Engineering controls, such as water spray, will be used to reduce the potential exposure to nuisance dust. If nuisance dust levels cannot be maintained below the action levels with engineering controls, respiratory protection will be required.

Low levels of Hg are present in the DSS 3 area. The airborne Hg concentrations were obtained during the previous RAs and indicate that the exposure levels are significantly below OSHA PELs. Workers will be instructed in proper PPE use and personal hygiene (handwashing) to prevent any exposure.

5.1.15 Heat Stress

The DSSs 3 and 6 RAs are scheduled to be performed between May and June when wearing PPE may put workers at risk of heat stress. All workers will have medical clearance prior to working on site and will be required to undergo an acclimation period. Heat stress prevention will include the following mitigation measures:

- Proper rest prior to work,
- Scheduled breaks,
- Appropriate water intake,
- Shaded work/rest areas when feasible, and
- Rotation of heavy work tasks.

A work/rest regime established in accordance with Section 5 of the PHSP will be implemented to prevent heat-related injuries. A Wet Bulb Globe Temperature (WBGT) instrument will be used to monitor weather conditions. Estimated employee work loads for each anticipated RA activity (expressed in calories expended per hour) are provided in Table 5-2 and will be used in conjunction with the WBGT readings to adjust the work/rest cycle as required by the PHSP and HSP 3.1, Working in Hot Environments. Integrated heat stress monitoring will be performed daily and may require modification of this regimen. Body temperature, heart rate and the physical

appearance of workers will be monitored as discussed in Section 5 of the PHSP and detailed in HSP 3.1, Working in Hot Environments.

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. During the TSMs, the SHSO will communicate to the workers the signs and symptoms of heat stress, appropriate engineering controls, and the need to replenish body fluids. The buddy system will be used to help monitor heat stress symptoms.

5.1.16 Noise Exposure

High noise levels from equipment, such as jackhammers and percussion hammers used to demolish the concrete sidewalk at the eastern perimeter of DSSs, can create noise in excess of maximum permissible time-weighted average (TWA) levels of 85 decibels (dBA). Long term exposure to excessive noise may cause permanent hearing loss. Hearing protection will be required and provided when noise levels exceed a TWA of 85 dBA in accordance with Section 5.4.3.3 of the PHSP.

5.2 Hazard Controls

The following control measures will be implemented during the DSSs RA to supplement the requirements of the PHSP and the QAPP.

5.2.1 Hazardous Work Permit

Hazardous work permits (HWPs) will be used to control work in areas where hazardous conditions may exist. An HWP will be issued in accordance with the procedures specified in the PHSP (WA, 2000f) and in accordance with HSP 17.1, Hazardous Work Permits. The following information will be described or referenced in the HWP.

5.2.2 Boundaries

The work areas will be enclosed by temporary fencing. Additional boundary ropes or tape supported with stanchions may be used to delineate internal work area boundaries as determined necessary by the RSO and/or the SHSO. The boundaries will be set up in a manner that facilitates personnel and equipment access to the work area. Appropriate signs will be posted in accordance with the PHSP and the RPP.

5.2.3 Personal Protective Equipment

Workers in the contamination area (CA) will wear the modified Level D PPE identified below, unless otherwise specified in an HWP.

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

- Steel-toed boots;
- Boots or boot covers (chemical-resistant or Tyvek®)
- Gloves (chemical-resistant or Tyvek®);
- Leather work gloves, as necessary; and,
- ANSI-approved hardhat if potential overhead hazards or head impact hazards are present.

5.2.4 Decontamination Procedures

A decontamination zone (DZ) for equipment and personnel will be established adjacent to the CA when workers are handling hazardous or mixed waste. The zone will be delineated with traffic cones and/or radiological barrier tape. The DZ will be posted with an appropriate warning sign. Personnel, equipment and PPE will be decontaminated in accordance with Section 10 of the PHSP and applicable SOPs.

Workers will survey themselves with radiological field instruments to ensure that they are free of radiological contamination before exiting the CA or DZ, as appropriate. If contamination is found, an RCT will be notified to determine the extent of contamination and direct/supervise radiological decontamination.

Equipment will be cleaned and surveyed for radiological contamination by an RCT prior to its removal from the CA/DZ, in accordance with SOP 6.2, Drilling, Development and Heavy Equipment Decontamination, and Section 10 of the PHSP.

5.2.5 Training

All workers performing RA and support activities on site shall have completed the training required by Section 2.1.3 of this work plan in addition to training required by the PHSP, RPP and the QAPP. Additional training may be provided at the daily TSMs, which are required by the PHSP.

5.2.6 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 there is a potential for worker contamination or injury.

The buddy system is a method of organizing workers into groups and is designed to provide those workers with assistance when needed. Each worker in a 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 CA;
- 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 SHSO if emergency help is needed.

5.2.7 Safety Equipment

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.

5.2.8 Spill Containment

A spill and discharge control plan has been prepared to address potential spills and discharges from handling and movement of potentially hazardous materials or waste during field activities. This spill and discharge control plan is in the PHSP and the CPGERP (WA, 2000d).

5.2.9 Air Monitoring

Baseline air monitoring will be conducted in accordance with HSP 6.1, Air Monitoring; HSP 14.1, Airborne Radioactivity Monitoring; Section 11 of the PHSP; and the RPP. This monitoring will be performed in locations having the highest potential for generating airborne radioactive contaminants.

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

If determined to be required by the Project Health and Safety Manager (PHSM) or RSO, selective personal air monitoring of high-risk workers (i.e., those who are closest to the source of contamination) will be conducted. All personal air monitoring samples and direct reading instrumentation readings taken for the purpose of determining appropriate H&S controls will be collected in the approximate "breathing zone" of site personnel and integrated over an appropriate time interval.

Real-time continuous monitoring during RA activities will consist of visual observations, radiological surveys, and respirable dust readings. Nuisance respirable dust and nuisance total dust TWA (8-hour OSHA) monitoring will be conducted if the field instruments indicate that action levels in Table 5-1 are exceeded.

All air 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.

Table 5-1. Domestic Septic Systems 3 and 6 Removal Actions Airborne Radiological and Respirable Dust Action Levels

Compound	Action Level (8-hr TWA)	OSHA PEL (8-hr TWA)	Action if Action Level is Exceeded
Radionuclides	10% DAC	—	Actions to include the following progressive steps for all compounds: • 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	5.0 mg/m^3	

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
RSO	Radiation Safety Officer
SHSO	Site Health and Safety Officer
TWA	time-weighted average

Table 5-2. Estimated Employee Workload per Activity for the Domestic Septic Systems 3 and 6 Removal Actions

Activity	Workload (kcal/hr)
Hand tool operation (e.g., screwdriver)	120
Heavy equipment operation (e.g., excavator)	168
Manual debris Removal	246
Sample collection – manual sifting	246
Sample collection with hand auger	306
Shoveling/digging	516
Spotter – standing and spraying water	120
Spotter – walking	210
Waste container surveying	186

Abbreviation
kcal/hr kilocalories per hour

6. QUALITY ASSURANCE

This section describes how quality is integrated into project activities by providing guidance to project personnel in implementing the QAPP (WA, 2000b) and associated SQPs, as they are applicable to RA activities at DSSs 3 and 6.

6.1 Roles and Responsibilities

The roles and responsibilities of key project personnel are described in Section 2.1 of the QAPP. Additional H&S responsibilities are also provided in Section 3 of the PHSP (WA, 2000f).

Project personnel may delegate the execution of, but not the responsibility for, their quality-affecting tasks to other qualified project personnel at any time. However, key project personnel may also delegate a substantial subset of their functions to a qualified deputy, who will assume full responsibility for the delegated duties. In either case, delegated duties and responsibilities shall be clearly defined, documented in writing, and provided to the PM and the PQAM.

6.2 Personnel Training and Qualification

Prior to the start of the RA, personnel training and qualification will be conducted and evaluated in accordance with Section 5 of the QAPP and SQP 3.2, Indoctrination and Training. Personnel training and qualification review will be required for all management and staff positions. The need for any training or qualification review that is required beyond H&S training for temporary subcontractor services will be determined by the PM and the PQAM.

The Program Manager, PM and PHSM will review and approve project management and staff qualifications against the requirements listed in the project job descriptions. Following their review, documentation of staff qualifications (i.e., academic credentials, personal resumes, certifications and/or training records) will be attached to the approved job descriptions and filed in the project record.

Following the qualification review and prior to the start of field activities, job-specific required reading matrices (similar to Attachment 6.1 of SQP 3.2, Indoctrination and Training) (WA, 2000a) will be distributed to project personnel. These matrices will list all of the project documents and procedures that pertain to the RA, each of which will be marked with an "X" or an "O," depending on whether the reading material is required ("X") or recommended ("O") for a specific position. Project personnel will document their review of each document or procedure by initialing and dating the matrix. When the matrix is complete, it will be submitted to the PQAM for

review and approval. Once approved, the required reading matrices will be filed in the project record.

6.3 Field Documentation and Records Management

All quality-affecting records generated during the RA will be managed in accordance with Sections 4 and 8.2 of the QAPP, SQP 4.1, Document Control, and SQP 4.2, Records Management. Quality-affecting documents include, but are not limited to, personal field logs, calibration records, monitoring data, inspection checklists, sampling documentation, and procurement records.

Records will be completed as required by applicable project documents. Personal field logs will be submitted on a daily basis by the SC, the WC, the Sample Manager, and the SHSO when working on site.

All records generated by project personnel must be complete, legible and written in ink. Corrections must be made with a single line, and documented with the initials of the person making the correction and the date the correction was made.

Field documentation will be collected and compiled on a daily basis by the SC or designee. Completed packages will be submitted to the Site Records Administrator (SRA) within three working days for quality review, copying and filing. If a package is deemed unacceptable by the SRA during the quality review, it will be returned to the SC (or designee) for prompt correction prior to copying and filing. After records have been copied and filed in the project record, the originals will be forwarded to the Project Records Administrator for inclusion in the project file.

6.4 Test Control

Analytical and geotechnical testing will be performed and documented in accordance with Section 15 of the QAPP. The PQAS will verify that the tests have been ordered, performed and documented correctly.

6.5 Design Control

Project design calculations and drawings will be developed, reviewed, documented and filed in accordance with Section 10 of the QAPP. The PM will be primarily responsible for the implementation of design control requirements.

6.6 Calibration and Maintenance of Measuring and Test Equipment

Measuring and test equipment will be calibrated and maintained in accordance with Section 14 of the QAPP and SQP 8.1, Calibration and Maintenance of Measuring and Test Equipment. Measuring and test equipment includes, but is not limited to, H&S monitoring equipment, radiological detection instruments and compaction testing gauges.

Measuring and test equipment shall be calibrated, source-checked and maintained according to manufacturer specifications, or as specified by project documents, procedures or guidelines. Calibration and/or source check data shall be recorded each day calibrations and/or source checks are performed. Data for multiple instruments may be recorded on a single form or on forms specific to the instrument.

Measuring and test equipment will not be used in the field if results of calibrations/source checks are not within the tolerances specified by the manufacturer or by project documents, procedures or guidelines. Failed calibration results should be reported immediately to the PQAM.

6.7 Field Sampling

Field sampling will be conducted according to Section 4 of this work plan, and conform to the requirements of Section 8 of the QAPP and all applicable SOPs. The Sampling Manager will coordinate sampling activities in the field, report to the SC, and interface with the Project Chemist on a regular basis.

6.8 Procurement

All material, equipment and subcontractor services will be procured and received according to the requirements of the Federal Acquisition Regulations, the Department of Energy Acquisition Regulations, Section 7 of the QAPP and SQP 7.2, Receipt Inspection. The SC or designated Field Procurement Agent will initiate procurement actions through the Contracts Manager and document the receipt of all procurements in the field. Copies of all procurement documents that are generated in the field will be kept in the project contract files, the field office procurement file, and the daily field package for the day the document was generated.

6.9 Change Control

Changes to scope, schedule and cost will be documented in field work variances, as specified in Section 17 of the QAPP and SQP 11.1, Field Work Variance. Field work variances will be documented and tracked by the SC, and reviewed and approved by the PM. The PHSM and/or the PQAM will be consulted regarding any changes that have the potential to affect H&S and/or quality.

6.10 Inspections, Audits and Surveillances

Inspections, audits and surveillances will be conducted according to Sections 13 and 18 of the QAPP and SQP 3.3, Readiness Review Inspection, SQP 7.1, Quality Inspections and Inspection Records, SQP 12.1, Quality Audits, SQP 12.2, Management Assessment, and SQP 12.3, Quality Surveillances.

A readiness review will be conducted with DOE and project staff prior to the start of the RAs, prior to major activities that were not covered during the initial readiness review or prior to resuming work after any significant work stoppages. All other activities will be addressed with preparatory phase inspections at the discretion of the PM and the PQAM.

Periodic inspections and section audits will be conducted by the PQAS or trained quality assurance personnel. These inspections and audits will include observation of field activities and/or review of project documentation. All observations, findings and supporting documentation resulting from the inspections and audits will be summarized in the appropriate report format and submitted to the project file.

Third-party reviewers will also participate in audits and surveillances to maintain the integrity of the Quality Assurance Program and promote continuous improvement within the project. During the RA, periodic assessments will be performed by the Program and Project Managers. Project staff will also be assigned to conduct surveillances of tasks for which they are familiar, but not directly involved.

6.11 Nonconformance Control and Corrective Action

Nonconformances and corrective actions will be addressed according to Section 16 of the QAPP and SQP 10.1, Nonconformance Control, SQP 10.2, Corrective Action, and SQP 10.3, Stop Work Order. The PQAM will be notified immediately of potentially nonconforming conditions, so that the appropriate course of action can be determined (e.g., nonconformance report, stop work order, etc.). Nonconformances will be reviewed with project staff once the root cause, corrective action, and preventative measures have been identified and documented. Corrective actions will be submitted to the corrective action database for tracking pending verification of completion.

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APPENDIX A

PRELIMINARY DESIGNATED-LEVEL DATA ANALYSIS

A. PRELIMINARY DESIGNATED-LEVEL DATA ANALYSIS

A.1 Preliminary Designated-Level Data Analysis

The preliminary designated-level (DL) analysis was done to evaluate DSS 3 and 6 data to identify DL constituents of concern (COCs). After the DL COCs are identified, additional vertical profile data will be collected (Section 3.2.1). This data will be used to determine if residual concentrations of specific constituents in soil will potentially impact ground water.

A.1.1 Data Management

All of the analytical data from the 1997 Data Gaps Investigation and 2001 Domestic Septic Systems Investigation were compiled in electronic form and entered into the LEHR Microsoft Access database. The complete suite of analyses consisted of 173 analytes and was individually tabulated for the Domestic Septic Systems (DSSs) 3 and 6 data sets using the database. The compiled data set was then processed through a screening and evaluation step described in the following section.

A.1.2 Preliminary Designated-Level Data Analysis

The preliminary DL analysis consists of four steps described in detail below. Figure A-1 is a decision flow diagram to evaluate and screen data for preliminary DL analysis.

A.1.2.1 Step 1—Detected versus Non-Detected Analytes

After data validation, a table listing all analytes that had been detected in at least one sample was generated. Of the 173 analytes, 115 and 116, respectively, were not detected in any DSS 3 and DSS 6 samples. The majority of these analytes were semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), and pesticides. Analytes not detected in any sample were removed from further DL evaluation. The detected analytes are shown in Tables A-1 and A-2 by their analytical group and include metals, pesticides, radionuclides, SVOCs, VOCs, and nitrate.

A.1.2.2 Step 2—Background Comparison

The DSS 3 investigation samples were collected at or greater than four feet (ft) below ground surface (bgs), and were compared to the background data collected greater than four ft bgs. The DSS 6 samples were collected above and below four ft bgs. Therefore, the DSS 6 samples were compared

to the lowest background values. As shown in Tables A-1 and A-2, many analytes were detected in a limited number of samples at levels that were close to or slightly above background.

Step 2 of the preliminary DL data analysis consisted of comparing the magnitude (maximum concentration) of the detected analytes to site background levels. Maximum concentrations of detected analytes were compared to 1.5 times background. This value was selected based on a review of acceptable error margin in analytical measurements which concluded that detection of 1.5 times background is not significantly above background. For organic compounds such as pesticides, SVOCs, and VOCs, where no background data were available, the reported detection limits (RDLs) were used for the comparisons.

The decision to use a factor of 1.5 times the background value when screening maximum concentrations is based on contributions from two forms of error. The first form of error is the acceptable margin of quantitative error allowed in laboratory sample preparation and analysis. The acceptable quantitative error in preparation and analysis of soil samples is ±30% for non-radiological analytes and ±25% for radiological analytes. These error limits are the laboratory control sample recovery limits, which track the combined sample preparation and analysis errors. Analytical errors typically exceed these limits, especially for results reported near the method detection limits, and many of the LEHR-specific background levels are near the method detection limits. The analytical error is taken into account in the screening process, because the maximum concentration is a single laboratory analysis result rather than a value with a high level of statistical confidence.

The second form of error is based on the probability of falsely concluding that a maximum value is representative of contamination. The background value is the 80 % lower confidence limit on the 95th percentile. Because 5% of uncontaminated soil has concentrations above the background value, the maximum concentration will likely be above the background value whether or not the soil is contaminated. The 1.5 factor provides reasonable assurance that carrying naturally occurring maximum values (background concentrations that are above the background value) forward in the screening process occurs with a frequency of less than 20%.

At the Step 2, 31 analytes for DSS 3 and 21 analytes for DSS 6 remained for further evaluation in Step 3 (Table A-1 and A-2).

A.1.2.3 Step 3—Chemical and Physical Properties

Step 3 of the preliminary DL data analysis consisted of comparing the chemical and physical properties that would determine the fate and transport mechanisms of the analytes in the environment and predict their potential impact to the ground water. Specifically, the soil adsorption coefficient (K_d) and the decay half-life of each analyte were used as indicators of the fate and transport in the vadose zone. Tables A-1 and A-2 present the K_d and half-life values for the analytes retained for Step 3. K_d values were used to evaluate potential impacts of metals, pesticides, and VOCs; half-lives were utilized for radionuclides.

K_d values, which represent the relative capacity for a compound to sorb to the surface of a soil particle versus water, were based on data presented in the following references:

- The United States Environmental Protection Agency (US EPA) database entitled "Superfund Chemical Data Matrix" from the US EPA internet website (http://www.epa.gov); and,
- "Soil Screening Guidance for Radionuclides: Technical Background Document," US EPA, EPA/540-R-00-006, October 2000.

The smaller the K_d value, the less sorptive (more mobile) the analyte. In this analysis, the lowest reported K_d value from the literature was selected to be conservative.

During previous site-specific vadose zone Non-Isothermal Unsaturated Flow and Transport modeling, K_d values for specific organic compounds were correlated to the time for the peak concentration to occur at the water table (time-to-peak). A significant correlation was observed during the site-specific modeling, and thus the K_d was selected based on an acceptable time-to-peak for organic compounds. For example, a K_d of 10 milliliters per gram (ml/g) would be equivalent to 2,000 years for the analyte to reach the water table at the peak concentration. A K_d of 1,000 ml/g, corresponds to a time-to-peak of about 100,000 years.

The K_d values for pesticides, SVOCs, and VOCs were compared to a K_d of 10 ml/g. The K_d values for inorganics, such as metals and radionuclides, were compared to a K_d of 1,000 ml/g. The fundamental basis for this screening step is that organic compounds degrade while most inorganic compounds do not. Site vadose zone modeling indicates that a constituent with a K_d of 10 ml/g will reach the ground water table after about 2,000 years. Hence, the screening step eliminates organic compounds with a K_d greater than 10 under the assumption that they will have degraded during the 2,000 year travel time. The K_d screening level for inorganic compounds is set at 1,000 which corresponds to a vadose zone travel time of 100,000 years.

The majority of the analytes evaluated in Step 3 had K_d values less than the screening limits and were potentially less sorptive (more mobile). Detected organics have K_d values in the range of 0.36 to 7,500 ml/g. Thirteen and 11 organic analytes were screened out of the DSSs 3 and 6 analyses, respectively. Detected inorganics and radionuclides have K_d values in the range of 0 to 1,000 ml/g. Three radionuclides were screened out of the DSS 3 analysis.

The decay half-lives for the radionuclides detected at the site were selected from the following sources:

- The Handbook of Environmental Degradation Rates (Howard, 1991);
- US EPA database titled "Superfund Chemical Data Matrix" from the US EPA internet web site; and ,
- "Soil Screening Guidance for Radionuclides: Technical Background Document" (US EPA, 2000).

A screening criterion of less than one year was chosen for half-life comparison based on the LEHR Site waste disposal history. Since land disposal activity at the site ceased at least 20 years ago, and given that the maximum activities of radionuclides at LEHR were on the order of milliCuries, radionuclides with half-lives of one year or less should not significantly impact the ground water.

Half-life values for several radionuclides detected at the site are much less than one year and were therefore eliminated from further evaluation. These radionuclides are typically daughter products (DPs) of other radionuclides and have half-lives on the order of minutes or days. For example, lead-214 and bismuth-214 are DPs of radium, have a 20-minute half-life, and therefore do not pose a risk to the ground water. Tables A-1 and A-2 list the radionuclides that fail the half-life screening test and were retained for evaluation in Step 4.

A.1.2.4 Step 4—Wilcoxon Rank Sum/Designated-Level/Biodegradability Test

Following Steps 1 through 3, 17 and 9 analytes, respectively, were retained for Step 4 analyses for DSS 3 and 6 (Tables A-1 and A-2). Hexavalent chromium, nitrate, arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, selenium, silver, zinc, radium-226 (Ra-226), strontium-90 (Sr-90), uranium-233/234, carbazole, and toluene remained for Step 4 of the DSS 3 analysis. Hexavalent chromium, copper, mercury, molybdenum, silver, zinc, Sr-90, tritium, and toluene remained for Step 4 of the DSS 6 analysis. For the Step 4 analyses, the Wilcoxon Rank Sum (WRS) test was performed on the analytes when applicable. In addition, the biodegradability of specific VOCs and the magnitude or frequency of metals and radionuclides were also further scrutinized.

During the preliminary DL analysis, site-specific DLs were not available for the analytes since modeling had not been completed based on area-specific lithology to determine if the analyte would pose a potential risk to the ground water. DL values from the DL modeling for the Southwest Trenches (SWT) removal action (RA) were compared to the DSSs 3 and 6 investigation data for two of the analytes, hexavalent chromium and Sr-90. Based on this comparison, hexavalent chromium was above its corresponding SWT DL value while Sr-90 was below its corresponding SWT DL value for both the DSSs 3 and 6 analytes.

The results of the WRS test are summarized in Tables A-1 and A-2. The WRS test statistically measures the relative similarity between the background data set and the environmental sample population, and is used to indicate whether the confirmation data can be represented by the background distribution. To perform this test, at least 40% of the data set should be above the detection limit (US EPA, 1994).

There were a limited number of samples collected at DSSs 3 and 6. Therefore, all of the WRS tests were qualified due to insufficient data. For the DSS 6 data, silver had a qualified pass and for the DSS 3 data, arsenic, copper and zinc had qualified passes. The background data sets for molybdenum and tritium were at or below the detection limits; therefore, a WRS test was not feasible for these analytes.

A.1.2.5 Domestic Septic System 3 Analytes Removed After Step 4

Five of the 17 DSS 3 analytes were removed from consideration as potential DL COCs after Step 4, as discussed below.

- Copper and zinc—These COCs were both detected in only one sample above background. Copper and zinc both passed (qualified) the WRS test for background data greater than four ft bgs. Copper and zinc do not have primary maximum contaminant levels (MCLs) and do not appear to pose a potential threat to ground water. Therefore, they were not retained as a DL COCs.
- Sr-90—Modeling for the SWT RA identified that a DL soil value of 17 picoCuries per gram (pCi/g) would protect ground water. Since lithologies are generally similar in the SWT and DSS 3 areas, the maximum value of 2.01 pCi/g in the DSS 3 area is an order of magnitude below the SWT DL value for Sr-90. Therefore, Sr-90 was not retained as a DL COC
- Uranium-233/234—This COC was only detected above background in one sample and passed (qualified) the WRS test. The maximum concentration is less than two times the background value. Therefore, uranium-233/234 was not retained as a DL COC.
- Toluene—Toluene does not have a background value. Therefore, the RDLs was used for the background comparisons and a WRS test was not feasible. This organic has a K_d valueless than 10 ml/g. However, toluene was detected at a relatively low concentrations and is readily biodegradable in the environment. Toluene does not appear to pose a potential threat to ground water. Therefore, toluene was not retained as a DL COC.

A.1.2.6 Domestic Septic System 3 Analytes Retained After Step 4

Twelve of the 17 DSS 4 analytes were retained as potential DL COCs after Step 4, as discussed below.

- Hexavalent chromium—This COC was detected in three of five samples above the background value of 0.054 milligrams per kilogram (mg/kg) in concentrations ranging from 0.105 to 0.84 mg/kg.
- Nitrate—This COC was detected in three of five samples above the background value of 36.0 mg/kg in concentrations ranging from 57.2 to 101 mg/kg.
- Arsenic—This COC was detected above background in one of five samples at 44.1 mg/kg, over four times the background concentration of 10.9 mg/kg.
- Cadmium—This COC was detected above background in three of five samples at concentrations ranging from 0.58 to 2.6 mg/kg.
- Carbazole—This COC was detected in one sample at 1,540 mg/kg, over 1.5 times the detection limit.

- Chromium—This COC was detected above background in all five samples at concentrations ranging from 128 to 249 mg/kg.
- Lead—This COC was detected above background in one of five samples at a concentration of 21.8 mg/kg, over twice the background concentration of 9.5 mg/kg.
- Mercury—This COC was detected above background in all five samples at concentrations ranging from 0.35 to 498 mg/kg.
- Molybdenum—This COC was detected above background in four of five samples at concentrations ranging from 1.6 to 26.2 mg/kg.
- Selenium—This COC was detected above background in four of five samples at concentrations ranging from 1.3 to 10.7 mg/kg.
- Silver—This COC was detected above background in four of five samples at concentrations ranging from 4.5 to 186 mg/kg.
- Ra-226—This COC was detected above background in one of five samples at 2.44 pCi/g, over three times the background concentration of 0.75 pCi/g.

A.1.2.7 Domestic Septic System 6 Analytes Removed After Step 4

Six of the nine analytes were removed from consideration as potential DL COCs after Step 4, as discussed below.

- Molybdenum, silver and zinc—These COCs were removed after Step 4. Silver passed (qualified) the WRS test. The maximum silver and copper concentrations were less than two times background. The maximum zinc concentration was less than 2.5 times background. There are also no primary or secondary MCLs for zinc, silver, and molybdenum. The low concentrations should not impact ground water. Therefore, molybdenum, silver and zinc were not retained as DL COCs.
- Sr-90—Modeling from the SWT RA identified that a DL soil value of 17 pCi/g would protect ground water. Since lithologies are generally similar in the SWT and DSS 6 areas, the maximum value of 0.211 pCi/g in the DSS 3 Area is two orders of magnitude below the SWT DL value for Sr-90. Therefore, Sr-90 was not retained as a DL COC.
- Tritium—This COC was detected in only one sample, less than two times background. The laboratory error for this sample was 33%. Therefore, tritium was not retained as a DL COC.
- Toluene—This COC does not have a background value. Therefore, the RDL was used for background comparison and a WRS test was not feasible. This organic compound has a K_d value less than 10 ml/g. However, it was detected at a relatively low concentration and is readily biodegradable in the environment.

Therefore, toluene does not appear to pose a potential threat to ground water and it was not retained as a DL COC.

A.1.2.8 Domestic Septic System 6 Analytes Retained After Step 4

The remaining three analytes were retained as potential DL COCs after Step 4, as discussed below.

- Copper—This COC was detected above background in one of six samples at a concentration of 75.2 mg/kg.
- Hexavalent chromium—This COC was detected above background in two of three samples at concentrations ranging from 0.0966 to 0.198 mg/kg.
- Mercury—This COC was detected above background in 26 of 34 samples at concentrations ranging from 0.26 to 101 mg/kg.

A.2 References

United States Environmental Protection Agency (US EPA), 1994, Superfund Removal Procedures, Removal Response Reporting: POLREPS and OSC Reports, USEPA Publication 9360.3-03, June.

US EPA, 2000, "Soil Screening Guidance for Radionuclides: Technical Background Document," US EPA, EPA/540-R-00-006, October.

US EPA database entitled "Superfund Chemical Data Matrix" from the US EPA internet website (http://www.epa.gov).

Howard, P., et al. (Howard), 1991, "Handbook of Environmental Degradation Rates," Lewis Publishers Inc., Chelsea, MI.

Table A-1. LEHR Domestic Septic System 3 Investigation Sampling Analytical Results Summary

Analyte	Step 1		Step 2				Step 3			Step 4			Conclusion	
	Sample Count	Number of Detections	Units	Background > 4 ft or Det Limit[1]	Maximum Concentration	Is Max > 1.5 x BKG or Det Limit	Partioning Coefficient (K_d) (ml/g)	Radiological Half-Life (years)	Is Kd < Limit[2] and Half-Life > 1 yr	Is WRS test applicable?	WRS Test Result	Is analyte biologically recalcitrant?	Is Analyte a DL COC?	Explanation
General Chemistry														
Hexavalent Chromium	5	4	mg/kg	0.054	0.836	Yes	19	NA	Yes	Yes	Fail [3]	Yes	**Yes**	**Requires additional evaluation/sampling.**
Nitrate	5	5	mg/kg	36	101	Yes	0	NA	Yes	Yes	Fail [3]	Yes	**Yes**	**Requires additional evaluation/sampling.**
Metals														
Arsenic	5	5	mg/kg	10.9	44.1	Yes	200	NA	Yes	Yes	Pass [3]	Yes	**Yes**	**Requires additional evaluation/sampling.**
Barium	5	5	mg/kg	294	222	No	---	---	---	---	---	---	No	
Beryllium	5	5	mg/kg	0.924	0.53	No	---	---	---	---	---	---	No	
Cadmium	5	5	mg/kg	0.51	2.6	Yes	75	NA	Yes	Yes	Fail [3]	Yes	**Yes**	**Requires additional evaluation/sampling.**
Chromium	5	5	mg/kg	125	249	Yes	19	NA	Yes	Yes	Fail [3]	Yes	**Yes**	**Requires additional evaluation/sampling.**
Cobalt	5	5	mg/kg	31	24.5	No	---	---	---	---	---	---	No	
Copper	5	5	mg/kg	61.8	106	Yes	420	NA	Yes	Yes	Pass [3]	Yes	No	Only one sample is greater than background; passes WRS test; maximum concentration is less than two times background.
Iron	5	5	mg/kg	44000	37900	No	---	---	---	---	---	---	No	
Lead	5	5	mg/kg	9.5	21.8	Yes	900	---	Yes	Yes	Fail [3]	Yes	**Yes**	**Requires additional evaluation/sampling.**
Manganese	5	5	mg/kg	750	752	No	---	---	---	---	---	---	No	
Mercury	5	5	mg/kg	0.248	498	Yes	52	NA	Yes	Yes	Fail [3]	Yes	**Yes**	**Requires additional evaluation/sampling.**
Molybdenum	5	4	mg/kg	0.26	26.2	Yes	20	NA	Yes	No	NA	Yes	**Yes**	**Requires additional evaluation/sampling.**
Nickel	5	5	mg/kg	246	285	No	---	---	---	---	---	---	No	
Selenium	5	4	mg/kg	1.2	10.7	Yes	300	NA	Yes	Yes	Fail [3]	Yes	**Yes**	**Requires additional evaluation/sampling.**
Silver	5	4	mg/kg	0.55	186	Yes	8.3	NA	Yes	Yes	Fail [3]	Yes	**Yes**	**Requires additional evaluation/sampling.**
Vanadium	5	5	mg/kg	80.3	76.7	No	---	---	---	---	---	---	No	
Zinc	5	5	mg/kg	93.1	116	No	62	NA	Yes	Yes	Pass [3]	Yes	No	Only one sample is greater than background; passes WRS test; maximum concentration is less than two times background.

Table A-1. LEHR Domestic Septic System 3 Investigation Sampling Analytical Results Summary (continued)

Analyte	Step 1		Step 2				Step 3			Step 4			Conclusion	
	Sample Count	Number of Detections	Units	Background > 4 ft or Det Limit[1]	Maximum Concentration	Is Max > 1.5 x BKG or Det Limit	Partioning Coefficient (K_d) (ml/g)	Radiological Half-Life (years)	Is Kd < Limit[2] and Half-Life > 1 yr	Is WRS test applicable?	WRS Test Result	Is analyte biologically recalcitrant?	Is Analyte a DL COC?	Explanation
Pesticides														
alpha-Chlordane	5	4	µg/kg	98.4	806	Yes	140	NA	No	---	---	---	No	
gamma-Chlordane	5	4	µg/kg	98.4	1150	Yes	280	NA	No	---	---	---	No	
Heptachlor epoxide	5	1	µg/kg	9.4	12.8	No	160	NA	No	---	---	---	No	
Radiological														
Actinium-228	5	5	pCi/g	0.642	0.55	No	---	---	---	---	---	---	No	
Americium-241	5	1	pCi/g	0.014	0.0054	No	---	---	---	---	---	---	No	
Bismuth-212	5	5	pCi/g	0.434	0.378	No	---	---	---	---	---	---	No	
Bismuth-214	5	5	pCi/g	0.54	2.18	Yes	NA	3.7861E-05	No	---	---	---	No	
Carbon-14	5	1	pCi/g	0.13	0.155	No	---	---	---	---	---	---	No	
Cesium-137	5	3	pCi/g	0.00695	0.0619	Yes	1000	30.2	No	---	---	---	No	
Lead-210	5	3	pCi/g	1.6	1.72	No	---	---	---	---	---	---	No	
Lead-212	5	5	pCi/g	0.684	0.611	No	---	---	---	---	---	---	No	
Lead-214	5	5	pCi/g	0.581	2.33	Yes	NA	5.0989E-05	No	---	---	---	No	
Plutonium-241	5	1	pCi/g	0.5	0.47	No	---	---	---	---	---	---	No	
Potassium-40	5	5	pCi/g	14	11.7	No	---	---	---	---	---	---	No	
Radium-226	5	5	pCi/g	0.752	2.44	Yes	450	1600	Yes	Yes	Fail [3]	Yes	**Yes**	**Requires additional evaluation/sampling.**
Radium-228	5	5	pCi/g	0.655	0.55	No	---	---	---	---	---	---	No	
Strontium-90	5	4	pCi/g	0.056	2.01	Yes	35	29.1	Yes	Yes	Fail [3]	Yes	No	DL modeling from the SWT RA identified a DL soil value of 17 pCi/g would protect ground water. Assuming similar lithology, the maximum value of 2.01 pCi/g in the DSS 3 Area is well below the SWT RA DL value for Sr-90.
Thallium-208	5	5	pCi/g	0.223	0.185	No	---	---	---	---	---	---	No	
Thorium-228	5	5	pCi/g	0.771	0.595	No	---	---	---	---	---	---	No	
Thorium-230	5	5	pCi/g	1.04	0.606	No	---	---	---	---	---	---	No	
Thorium-232	5	5	pCi/g	0.8	0.525	No	---	---	---	---	---	---	No	
Thorium-234	5	5	pCi/g	0.78	0.641	No	---	---	---	---	---	---	No	

Table A-1. LEHR Domestic Septic System 3 Investigation Sampling Analytical Results Summary (continued)

Analyte	Step 1		Step 2				Step 3			Step 4			Conclusion	
	Sample Count	Number of Detections	Units	Background > 4 ft or Det Limit[1]	Maximum Concentration	Is Max > 1.5 x BKG or Det Limit	Partioning Coefficient (K_d) (ml/g)	Radiological Half-Life (years)	Is Kd < Limit[2] and Half-Life > 1 yr	Is WRS test applicable?	WRS Test Result	Is analyte biologically recalcitrant?	Is Analyte a DL COC?	Explanation
Uranium-233/234	5	5	pCi/g	0.706	1.1	Yes	450	159,200/ 244,500	Yes	Yes	Pass [3]	Yes	No	Passes WRS test and maximum concentration is less than two times background
Uranium-238	5	5	pCi/g	0.645	0.649	No	---	---	---	---	---	---	No	
SVOCs														
Anthracene	5	1	µg/kg	748	1990	Yes	59	NA	No	---	---	---	No	
Benzo(a)anthracene	5	1	µg/kg	748	6540	Yes	800	NA	No	---	---	---	No	
Benzo(a)pyrene	5	1	µg/kg	748	1660	Yes	2000	NA	No	---	---	---	No	
Benzo(b)fluoranthene	5	1	µg/kg	748	5600	Yes	2500	NA	No	---	---	---	No	
Benzo(k)fluoranthene	5	1	µg/kg	748	3680	Yes	2500	NA	No	---	---	---	No	
bis(2-Ethylhexyl)phthalate	5	1	µg/kg	788	976	No	---	---	---	---	---	---	No	
Carbazole	5	1	µg/kg	748	1540	Yes	6.8	NA	Yes	No	---	No	**Yes**	**Requires additional evaluation/sampling.**
Chrysene	5	1	µg/kg	748	6060	Yes	800	NA	No	---	---	---	No	
Dibenzo(a,h)anthracene	5	1	µg/kg	748	1150	Yes	7500	NA	No	---	---	---	No	
Fluoranthene	5	1	µg/kg	748	8770	Yes	220	NA	No	---	---	---	No	
Fluorene	5	1	µg/kg	748	765	No	---	---	---	---	---	---	No	
Indeno(1,2,3-cd)pyrene	5	1	µg/kg	748	1110	No	---	---	---	---	---	---	No	
Phenanthrene	5	1	µg/kg	748	5810	Yes	59	NA	No	---	---	---	No	
Pyrene	5	1	µg/kg	748	5480	Yes	210	NA	No	---	---	---	No	
VOCs														
Toluene	5	3	µg/kg	11.8	133	Yes	0.36	NA	Yes	No	---	No	No	Low concentration and biodegradable.

Table A-1. LEHR Domestic Septic System 3 Investigation Sampling Analytical Results Summary (continued)

Notes

[1] Established background value for naturally occurring analyte in soil located at depths below 4 feet below ground surface. Detection limit used for pesticides, VOCs and SVOCs.
[2] K_d limit is 1,000 ml/g for inorganic compounds and 10 ml/g for organic compounds.
[3] Insufficient data were available to demonstrate allowable decision error in WRS test results.

Abbreviations

> Greater than
< Less than

---	The results of previous screening steps indicated that the analyte was not a DL COC
BKG	Established background value (80% lower confidence limit on the 95th percentile based on background sample results)
COC	constituent of concern
Det Limit	analyte detection limit
DL	designated-level
K_d	Soil/water partitioning coefficient for analyte
Max	maximum concentration in confirmation samples
MCL	maximum contaminant level for drinking water (United States Environmental Protection Agency)
mg/kg	milligrams per kilogram
ml/g	milliliters per gram
pCi/g	picoCuries per gram
SVOCs	semi-volatile organic compounds
VOCs	volatile organic compounds
WRS Test	Wilcoxon Rank Sum test for non-parametric comparisons of two sample populations
yr	year
µg/kg	micrograms per kilogram

Table A-2. LEHR Domestic Septic System 6 Investigation Sampling Analytical Results Summary

Analyte	Step 1		Step 2				Step 3			Step 4			Conclusion	Explanation
	Sample Count	Number of Detections	Units	Background > 4 ft or Det Limit[1]	Maximum Concentration	Is Max > 1.5 x BKG or Det Limit	Partioning Coefficient (K_d) (ml/g)	Radiological Half-Life (years)	Is Kd < Limit[2] and Half-Life > 1 yr	Is WRS test applicable?	WRS Test Result	Is analyte biologically recalcitrant?	Is Analyte a DL COC?	
General Chemistry														
Hexavalent Chromium	3	2	mg/kg	0.054	0.198	Yes	19	N/A	Yes	Yes	Fail [3]	Yes	**Yes**	**Requires additional evaluation/sampling.**
Metals														
Antimony	6	3	mg/kg	1.4	1.9	No	---	---	---	---	---	---	No	
Arsenic	6	6	mg/kg	8.14	9.3	No	---	---	---	---	---	---	No	
Barium	6	6	mg/kg	211	221	No	---	---	---	---	---	---	No	
Beryllium	6	3	mg/kg	0.564	0.4	No	---	---	---	---	---	---	No	
Cadmium	6	1	mg/kg	0.51	0.27	No	---	---	---	---	---	---	No	
Chromium	15	15	mg/kg	125	166	No	---	---	---	---	---	---	No	
Cobalt	6	6	mg/kg	31	25.9	No	---	---	---	---	---	---	No	
Copper	6	6	mg/kg	48.8	75.2	Yes	420	N/A	Yes	Yes	Fail [3]	Yes	**Yes**	**Requires additional evaluation/sampling.**
Iron	6	6	mg/kg	44000	43200	No	---	---	---	---	---	---	No	
Lead	16	16	mg/kg	9.5	9.6	No	---	---	---	---	---	---	No	
Manganese	6	6	mg/kg	750	709	No	---	---	---	---	---	---	No	
Mercury	34	32	mg/kg	0.248	101	Yes	52	N/A	Yes	Yes	Fail [3]	Yes	**Yes**	**Requires additional evaluation/sampling.**
Molybdenum	3	3	mg/kg	0.26	0.41	Yes	20	N/A	Yes	No	NA	Yes	No	No primary or secondary MCLs. Maximum concentration is less than two times background.
Nickel	6	6	mg/kg	246	274	No	---	---	---	---	---	---	No	
Selenium	6	3	mg/kg	1.2	1	No	---	---	---	---	---	---	No	
Silver	6	2	mg/kg	0.55	1	Yes	8.3	N/A	Yes	Yes	Pass [3]	Yes	No	Passes WRS test; maximum concentration is less than two times background.
Thallium	6	3	mg/kg	1.6	2	No	---	---	---	---	---	---	No	
Vanadium	6	6	mg/kg	66.8	84.8	No	---	---	---	---	---	---	No	
Zinc	6	6	mg/kg	72.4	179	Yes	62	N/A	Yes	Yes	Fail [3]	Yes	No	No primary or secondary MCL; maximum is less than 2.5 times background.

Table A-2. LEHR Domestic Septic System 6 Investigation Sampling Analytical Results Summary (continued)

Analyte	Step 1		Step 2				Step 3			Step 4			Conclusion	Explanation
	Sample Count	Number of Detections	Units	Background > 4 ft or Det Limit[1]	Maximum Concentration	Is Max > 1.5 x BKG or Det Limit	Partioning Coefficient (K_d) (ml/g)	Radiological Half-Life (years)	Is Kd < Limit[2] and Half-Life > 1 yr	Is WRS test applicable?	WRS Test Result	Is analyte biologically recalcitrant?	Is Analyte a DL COC?	
Radiological														
Actinium-228	6	6	pCi/g	0.633	0.67	No	---	---	---	---	---	---	No	
Americium-241	3	1	pCi/g	0.014	0.0042	No	---	---	---	---	---	---	No	
Bismuth-212	6	5	pCi/g	0.388	0.45	No	---	---	---	---	---	---	No	
Bismuth-214	6	6	pCi/g	0.54	0.61	No	---	---	---	---	---	---	No	
Cesium-137	6	3	pCi/g	0.00695	0.0549	Yes	---	---	---	---	---	---	No	
Gross Alpha	6	6	pCi/g	7.42	8.3	No	---	---	---	---	---	---	No	
Gross Beta	6	6	pCi/g	15	16.4	No	---	---	---	---	---	---	No	
Lead-210	6	3	pCi/g	1.6	1.75	No	---	---	---	---	---	---	No	
Lead-212	6	6	pCi/g	0.684	0.672	No	---	---	---	---	---	---	No	
Lead-214	6	6	pCi/g	0.55	0.75	No	---	---	---	---	---	---	No	
Potassium-40	6	6	pCi/g	14	12.8	No	---	---	---	---	---	---	No	
Radium-226	9	6	pCi/g	0.752	0.89	No	---	---	---	---	---	---	No	
Radium-228	3	3	pCi/g	0.63	0.49	No	---	---	---	---	---	---	No	
Strontium-90	3	3	pCi/g	0.056	0.211	Yes	35	29.1	Yes	Yes	Fail [3]	Yes	No	DL modeling from the SWT RA identified a DL soil value of 17 pCi/g would protect ground water. Assuming similar lithology, the maximum value of 0.211 pCi/g in the DSS 6 Area is well below the SWT RA DL value for Sr-90.
Thallium-208	6	6	pCi/g	0.204	0.242	No	---	---	---	---	---	---	No	
Thorium-228	3	3	pCi/g	0.627	0.499	No	---	---	---	---	---	---	No	
Thorium-230	3	3	pCi/g	1.04	0.484	No	---	---	---	---	---	---	No	
Thorium-232	3	3	pCi/g	0.63	0.429	No	---	---	---	---	---	---	No	
Thorium-234	6	3	pCi/g	0.78	0.504	No	---	---	---	---	---	---	No	
Tritium	6	1	pCi/g	1.2	2.3	Yes	0	12.3	Yes	No	NA	Yes	No	Only one tritium sample was above the detection limit
Uranium-233/234	3	3	pCi/g	0.559	0.737	No	---	---	---	---		---	No	
Uranium-238	3	3	pCi/g	0.565	0.553	No	---	---	---	---		---	No	

Table A-2. LEHR Domestic Septic System 6 Investigation Sampling Analytical Results Summary (continued)

Analyte	Step 1		Step 2				Step 3			Step 4			Conclusion	Explanation
	Sample Count	Number of Detections	Units	Background > 4 ft or Det Limit[1]	Maximum Concentration	Is Max > 1.5 x BKG or Det Limit	Partioning Coefficient (K_d) (ml/g)	Radiological Half-Life (years)	Is Kd < Limit[2] and Half-Life > 1 yr	Is WRS test applicable?	WRS Test Result	Is analyte biologically recalcitrant?	Is Analyte a DL COC?	
SVOCs														
Acenaphthene	6	1	µg/kg	720	818	No	---	---	---	---	---	---	No	
Anthracene	6	1	µg/kg	720	2940	Yes	59	---	No	---	---	---	No	
Benzo(a)anthracene	6	2	µg/kg	3600	14400	Yes	800	---	No	---	---	---	No	
Benzo(a)pyrene	6	1	µg/kg	720	788	No	---	---	---	---	---	---	No	
Benzo(b)fluoranthene	6	2	µg/kg	720	8330	Yes	2500	---	No	---	---	---	No	
Benzo(k)fluoranthene	6	1	µg/kg	720	7000	Yes	2500	---	No	---	---	---	No	
Carbazole	6	1	µg/kg	720	1080	No	---	---	---	---	---	---	No	
Chrysene	6	3	µg/kg	3600	10800	Yes	800	---	No	---	---	---	No	
Dibenzo(a,h)anthracene	6	1	µg/kg	720	2980	Yes	7500	---	No	---	---	---	No	
Fluoranthene	6	3	µg/kg	3600	20000	Yes	220	---	No	---	---	---	No	
Fluorene	6	1	µg/kg	720	1120	Yes	28	---	No	---	---	---	No	
Indeno(1,2,3-cd)pyrene	6	1	µg/kg	720	1260	Yes	6900	---	No	---	---	---	No	
Phenanthrene	6	1	µg/kg	720	8310	Yes	59	---	No	---	---	---	No	
Pyrene	6	3	µg/kg	720	4730	Yes	210	---	No	---	---	---	No	
VOCs														
Toluene	6	2	µg/kg	11.4	204	Yes	0.36	---	Yes	No	NA	No	No	Low concentration and biodegradeable.

Table A-2. LEHR Domestic Septic System 6 Investigation Sampling Analytical Results Summary (continued)

Notes

[1] Established background value for naturally occurring analyte in soil located at depths below four feet below ground surface. Detection limit used for pesticides, VOCs and SVOCs.
[2] K_d limit is 1,000 ml/g for inorganic compounds and 10 ml/g for organic compounds.
[3] Insufficient data were available to demonstrate allowable decision error in WRS test results.

Abbreviations

> Greater than
< Less than

---	The results of previous screening steps indicated that the analyte was not a DL COC
BKG	Established background value (80% lower confidence limit on the 95th percentile based on background sample results)
COC	constituent of concern
Det Limit	analyte detection limit
DL	designated-level
K_d	soil/water partitioning coefficient for analyte
Max	maximum concentration in confirmation samples
MCL	maximum contaminant level for drinking water (United States Environmental Protection Agency)
mg/kg	milligrams per kilogram
ml/g	milliliters per gram
pCi/g	picoCuries per gram
SVOCs	semi-volatile organic compounds
VOCs	volatile organic compounds
WRS Test	Wilcoxon Rank Sum test for non-parametric comparisons of two sample populations
yr	year
µg/kg	micrograms per kilogram

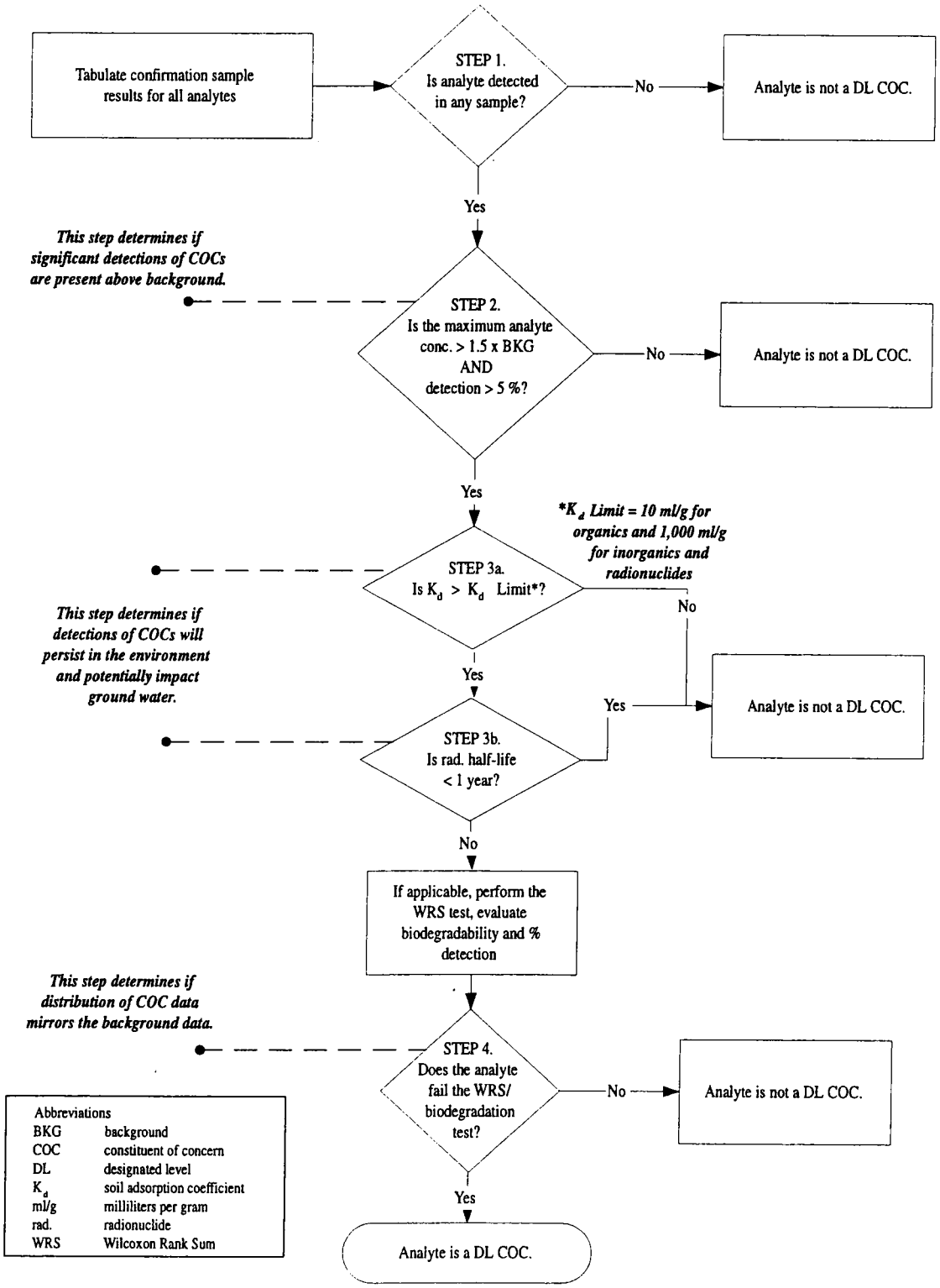

Figure A-1. Preliminary Designated-Level Analysis Flow Chart

Weiss Associates

APPENDIX B

CONFIRMATION SAMPLING DESIGN

B. CONFIRMATION SAMPLING DESIGN

This appendix describes the confirmation sampling design used to determine the sample frequency and locations.

B.1 Statistical Basis for the Removal Action Confirmation Sampling Design

Statistical methods were used for the Domestic Septic Systems (DSSs) 3 and 6 confirmation sampling designs to ensure that decisions regarding attainment of cleanup standards are scientifically valid. 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 standards were achieved with an acceptable level of certainty. The statistical approach described in this appendix is based on the Multi-Agency Radiation Survey and Site Investigation Manual (US EPA, 1997) and the Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys (NRC, 1997) and is intended for use for those contaminants for which cleanup at or near background is desired (e.g., radium-226 [Ra-226]).

The statistical hypothesis testing procedure begins with the statement of a null hypothesis (H_o) and an alternative hypothesis (H_a). These are:

- H_o: The median concentration of residual radioactivity in the survey unit is indistinguishable from the median background concentration; and,,
- H_a: The median concentration of residual radioactivity in the survey unit is greater than the median background concentration.

Based on the power curve for this hypothesis, the lower bound on the gray region is zero and the upper bound on the gray region is one-third of the background value. The background value is defined as the 80% lower confidence limit on the 95th quantile determined from uncontaminated background samples.

These 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 the United States Environmental Protection Agency (US EPA) statistical methods (US EPA, 1997; NRC, 1997) 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 DSSs 3 and 6 RAs, 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 DSSs 3 and 6 RAs, β is the probability that the statistical tests will indicate cleanup standard was achieved when it actually was not achieved. Table B-1 illustrates the relationship between α, β, the actual condition of the cleanup unit, and the results of the statistical tests.

Table B-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 = $1 - \beta$)

Table B-1 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 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 of α and β and the number of samples required to conduct the test. Decision error rates of α=0.2 and β=0.1 were previously agreed upon by the LEHR Remedial Project Managers. Estimates of the required number of samples based on these allowable decision errors are described in detail in Section B.2.

B.2 Estimation of the Required Number of Confirmation Samples

A minimum number of confirmation samples is required to maintain decision errors below the established limits for α and β when applying a statistical test to compare the distribution of cleanup unit concentrations with the distribution of reference unit concentrations. The required number of cleanup unit and reference unit samples is different for each constituent of concern (COC) and is a function of the coefficient of variation (COV) which is the standard deviation divided by mean). The required number of confirmation samples is not determined for individual COCs because the sample grid design would be different for each COC, which makes the sample collection effort too costly. Thus, indicator COCs are selected to determine the number of confirmation samples to use in the sample design. The indicator COC is that with the highest COV. Mercury (Hg) was selected as the indicator COC for estimating the number of confirmation samples (n) to be collected at both DSSs 3 and 6.

As recommended by the US EPA (US EPA, 1997), the Wilcoxon Rank Sum (WRS) test, a non-parametric statistical comparison of two data distributions to determine whether there is a difference in the mean, will be the primary method to determine whether COC levels are below background. The WRS test requires a minimum number of samples, n, to be statistically valid based on the decision errors α and β. A secondary hot measurement comparison that compares data suspected to be "hot" to determine if the data agree with hot measurement standards, will be used as necessary and appropriate to further confirm whether cleanup criteria have been met. However, that comparison does not have a minimum sample number requirement.

The term "cleanup unit" refers to the area undergoing cleanup while "reference area" refers to an off-site area representing the background. The minimum required number of confirmatory samples is determined using the following steps:

1. Determine the permissible Type I error (α) and Type II error (β) for the statistical hypothesis. Values of α = 0.2 and β = 0.1 were established for confirmation sampling in previously completed removal action (RA) areas at the site (WA, 2000).
2. Establish the shift (Δ) A shift (Δ) equal to 30% of the background value was established (WA, 2000) for previously completed RAs at the site.
3. Calculate the standard deviation (σ) of previously collected representative data.
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.
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 total number of data points (N) for the cleanup unit (n) and reference area (m), where N = n + m. The formula for calculating N is:

$$N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{12c(1-c)(P_r - 0.5)^2(1-R)}$$

where parameter values independent of the constituent are:

$Z_{1-\alpha} = 0.8418$

$Z_{1-\beta} = 1.282$ and,

$R = 0$.

Hg-specific values used to predict N are:

$c = 0.5$; and,

$Pr = 0.6903$.

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 confirmation data sets are collected, the data sets from DSSs 3 and 6 will be evaluated independently for each COC against the reference area data set using the WRS test. The Quantile test will be run when a constituent passes the WRS test. As stated above, the hot measurement comparison will be used to further confirm whether cleanup goals have been met. The combined results of the WRS test and hot measurement comparison will determine whether residual contaminants in the cleanup unit exceed the target cleanup goals.

B.2.1 Sample Number Calculation

The Noether calculation, which determines the number of samples required in the background and cleanup units based on constituent concentration statistical parameters, was run for Hg. Deep (>four feet below ground surface [bgs]) Hg background data were selected for the large n prediction because Hg is stratified with depth and other LEHR data do not likely match the depth range or Hg distribution at the DSSs 3 and 6 areas.

The results of the Noether calculations indicated that at least 21 samples are required for Hg. The recommended sample count was increased to 25 for DSS 3 and 23 for DSS 6 to provide additional assurance that sufficient samples would be collected.

B.3 Removal Action Confirmation Sample Locations and Grid Spacing

Post-RA confirmation sampling will be performed to verify that residual contaminant levels in the DSSs 3 and 6 areas are below the cleanup standards, defined as either background or the risk-based action standards (RBAS). The RBAS is selected as the cleanup criterion when background is zero for a COC (as is the case for most organic compounds), or when the background value is below the RBAS.

A random-start sampling approach was used to select the sample locations. Confirmation samples will be collected from the DSSs 3 and 6 excavations on rectangular grids with random starts in planar (x, y) coordinate systems. The estimated excavation dimensions were determined and mapped. The excavation side walls were unfolded onto the same two dimensional plane as the excavation. After all of the grid locations were located on the two-dimensional plane map, the side walls were folded back up. The sample depths were determined by calculating the distance from the ground surface to the (x, y) location.

The random start was determined by placing the origin of the coordinate system at the lower left corner of the grid area and using a random number generator to produce the start coordinates. The random start coordinate X'_1 (2.1 ft for DSS 3 and 10.8 ft for DSS 6) was determined by multiplying the planar layout width (W') by a random number between 0 and 1. Similarly, the random start coordinate Y'_1 (32 ft for DSS 3 and 9.39 ft for DSS 6) was the product of a random number and the length (L') of the grid layout. The spacing between sampling points (a) in the rectangular grid was determined from the equation $a = (A/n)^{0.5}$ where A is total grid area and n (determined in Section B.2.1) is the required number of samples. Hot spots do not drive the grid spacing. A separate procedure (Section 3.2.2) was designed to address hot spots. The calculated grid spacing for the confirmation sampling is 7.45 ft for DSS 3 and 9.39 ft for DSS 6. The confirmation grid calculations and 3-dimensional sample locations are presented in Tables B-2 through B-5.

The planned locations of the DSSs 3 and 6 confirmation samples are shown in Figures 3-5 and 3-6.

B.4 References

United States Environmental Protection Agency (US EPA), 1997, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575, EPA 402-R-97-016.

Nuclear Regulatory Commission (NRC), 1997, A Proposed Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys, NUREG-1505.

Weiss Associates (WA), 2000, Sampling and Analysis Plan for Removal Actions in the Southwest Trenches, Ra/Sr Treatment Systems, and Domestic Septic Systems Areas for the Laboratory for Energy-Related Health Research, University of California, Davis, Rev. 0, July.

Table B-2. Confirmation Grid Calculation, Domestic Septic System 3

Excavation Dimensions
See Figure 3-5

A (ft^2)	n	a (ft)	Grid Type
1165	21	7.45	Limited suite grid

Definitions:
A = Area of 2-D Domestic Septic System 3 layout
n = approximate number of samples to be collected
a = side dimension of squares in grid
Formulas:
A = length x width + 2 x length x height + 2 x width x height
a = (A/n)^.5

Random Number	W' (ft)	X'_1 (ft)
0.0755943	28	2.1

Random Number	L' (ft)	Y'_1 (ft)
0.504196295	63.5	32.0

Definitions:
Random Number = Number between 0 and 1 generated by Excel random number generator
W' = Width of 2-D Domestic Septic System 3 layout
L' = Length of 2-D Domestic Septic System 3 layout
X'_1 = Grid point of random start on X' axis
Y'_1 = Grid point of random start on Y' axis
ft=feet

Limited Suite Grid Points

X' (ft)	Y' (ft)
2.1	9.7
2.1	17.1
2.1	24.6
9.6	9.7
17.0	2.2
17.0	9.7
17.0	17.1
24.5	2.2
24.5	9.7
24.5	17.1
31.9	2.2
31.9	9.7
31.9	17.1
39.4	2.2
39.4	9.7
39.4	17.1
46.8	2.2
46.8	9.7
46.8	17.1
54.3	2.2
54.3	9.7
54.3	17.1
61.8	9.7

Table B-3. Domestic Septic System 3 Sampling Locations

x (feet)	y (feet)	Depth (feet)
1.5	6.7	3.6
1.5	14.1	3.6
0.0	21.6	5.0
3.5	6.7	9.2
10.0	4.0	5.2
10.0	6.7	10.0
10.0	10.0	5.9
17.5	4.0	5.2
17.5	6.7	10.0
17.5	10.0	5.9
24.9	4.0	5.2
24.9	6.7	10.0
24.9	10.0	5.9
32.4	4.0	5.2
32.4	6.7	10.0
32.4	10.0	5.9
39.8	4.0	5.2
39.8	6.7	10.0
39.8	10.0	5.9
47.3	4.0	5.2
47.3	6.7	10.0
47.3	10.0	5.9
49.5	6.7	4.7

Table B-4. Confirmation Grid Calculation, Domestic Septic System 6

Northern and Southern Leach Field Excavation Dimensions	
length (ft)	86
width (ft)	11
height (ft)	4

A (ft^2)	n	a (ft)	Grid Type
1851	21	9.39	Limited suite grid

Effluent Pipe Excavation Dimensions	
length (ft)	10
width (ft)	2.5
height (ft)	4

Note: The northern and southern sidewalls of the pipe excavations were not included because the soil will be removed to the distribution box walls.

Definitions:
A = Area of 2-D Domestic Septic System 6 Layout
n = approximate number of samples to be collected
a = side dimension of squares in grid
Formulas:
A = length x width + 2 x length x height + 2 x width x height
a = (A/n)^.5

Random Number	W' (ft)	X'_1 (ft)
0.5693533	19	10.8

Random Number	L' (ft)	Y'_1 (ft)
0.702871792	112	78.7

Definitions:
Random Number = Number between 0 and 1 generated by Excel random number generator
W' = Width of 2-D Domestic Septic System 6 layout
L' = Length of 2-D Domestic Septic System 6 layout
X'_1 = Grid point of random start on X' axis
Y'_1 = Grid Point of random start on Y' axis
ft=feet

Limited Suite Grid Points

X' (ft)	Y' (ft)
1.4	13.0
1.4	22.4
1.4	31.8
1.4	41.2
1.4	69.3
1.4	78.7
1.4	88.1
1.4	97.5
1.4	106.9
10.8	3.6
10.8	13.0
10.8	22.4
10.8	31.8
10.8	41.2
10.8	50.6
10.8	59.9
10.8	69.3
10.8	78.7
10.8	88.1
10.8	97.5
10.8	106.9

Table B-5. Domestic Septic System 6 Sampling Locations

x (feet)	y (feet)	Depth (feet)
0.0	9.0	4.4
0.0	18.4	4.4
0.0	27.8	4.4
0.0	37.2	4.4
0.0	57.3	4.4
0.0	66.7	4.4
0.0	76.1	4.4
0.0	85.5	4.4
0.0	94.9	4.4
6.8	0.0	6.4
6.8	9.0	7
6.8	18.4	7
6.8	27.8	7
6.8	37.2	7
6.8	43.0	3.4
8.5	51.9	5.3
6.8	57.3	7
6.8	66.7	7
6.8	76.1	7
6.8	85.5	7
6.8	94.9	7

APPENDIX C

RISK-BASED ACTION STANDARD RECALCULATION FOR MERCURY

C. RISK-BASED ACTION STANDARD RECALCULATION FOR MERCURY

The general site-wide risk-based action standard (RBAS) value for mercury was calculated in the Draft Determination for Risk-Based Action Standards for DOE Areas (WA, 1997). The site-wide RBAS value was based on two assumptions that will not apply to post-removal action (RA) mercury contamination at DSSs 3 and 6. The two assumptions were:

- Contamination is present in surface soil; and,
- Contamination is present between 0 and 15 feet (ft) below ground surface (bgs).

These two assumptions will not apply after the RA because excavation activities will remove all mercury contamination down to 10 ft bgs at DSS 3 and 7 ft bgs at DSS 6, and clean fill will be installed up to ground surface. Thus, more realistic site-specific assumptions about the location of mercury contamination should be made and RBAS values re-calculated for DSSs 3 and 6.

C.1 Approach

Risk Based Action Standards (RBAS) were recalculated for mercury for use during the DSSs 3 and 6 RAs. The RBAS values will be used to guide the decision process during RA activities.

The DSSs 3 and 6 RBAS values were recalculated using the same approach used in Draft Determination for Risk-Based Action Standards for DOE Areas (WA, 1997). The calculations were performed for the non-carcinogenic effects related to mercury under Risk Scenario 2 (East Residential Farmer). Calculations were not performed for Risk Scenarios 1 (On-Site Researcher) and 3 (South Residential Farmer) because all contaminant migration pathways under these scenarios will be closed upon RA completion at DSSs 3 and 6. Migration to ground water will be the only possible pathway because any remaining post-RA contamination will be covered with clean fill and located at least 10 ft bgs at DSS 3 and 7 ft bgs at DSS 6. Migration to ground water is a closed pathway under Scenarios 1 and 3 as explained in the Draft Determination for Risk-Based Action Standards for DOE Areas (WA, 1997). The remaining pathways, which are direct contact, atmospheric dispersion, and surface water runoff, will be closed for all three Scenarios due to the clean fill that will overly any residual contamination. The exposure pathway analysis is shown in Table C-1.

The soil profile used for the recalculations is the same as that used to determine designated-level (DL) residual soil concentrations in the Radium/Strontium Treatment Systems area as shown in Appendix D of the Final Ra/Sr Treatment Systems Area Removal Action Confirmation Report (WA, 2001). The Radium/Strontium Treatment Systems area soil profile was used because it closely

resembles the lithology in borings in the DSSs 3 and 6 vicinities. The soil profile will be updated and RBAS values recalculated if DL borings indicate the Radium/Strontium Treatment Systems area soil profile is not representative of lithologic conditions at DSSs 3 and 6.

Mercury was assumed to remain within the first foot of soil at the base of each excavation. The planned excavation depth at DSS 3 is 10 ft bgs and the assumed post RA contaminated depth interval is between 10 and 11 ft bgs. The planned excavation depth at DSS 6 is 7 ft bgs and the assumed contamination interval was 7 to 8 feet bgs. The contaminated interval assumptions were based on previously collected site characterization samples at DSS 6, which indicate mercury attenuates rapidly (sorbs strongly) with depth upon entering the native soil. For example, DSS 6 sample LEHR-S-T601 contained 49.4 mg/kg of mercury 5.5 ft bgs and sample SSD6F004 contained only 0.26 mg/kg of mercury at 7 ft bgs. DL sampling will be conducted prior to the RAs and the contaminated interval assumptions and RBAS values will be updated if mercury is found more than one foot below the planned excavations. The physical parameters used to model mercury migration from the vadose zone to ground water are shown in Table C-2.

The RBAS values were recalculated using chemical properties and toxicity information from the US EPA Superfund Chemical Data Matrix (US EPA, 1996) and Integrated Risk Information System, respectively. Mercury was assumed to exist as mercuric chloride. The mercury RBAS calculations for DSSs 3 and 6 are shown in Tables C-4 and C-5, respectively. The calculation results are shown below in Table C-6. The vadose zone modeling results are shown in Tables C-7 and C-8.

Table C-6. Risk-Based Action Standard Recalculation Results

Area	Risk-Based Action Standard (mg/kg)
Domestic Septic System 3	6.8
Domestic Septic System 6	8.3

Abbreviation
mg/kg milligrams per kilogram

Table C-1. Risk Scenario 2—Residential Farmer

Source	Transport Mechanism	Exposure Route	Pathway Complete?	Rationale
DSS 3 and 6 Post RA Soil Contamination	Direct contact	Dermal exposure	No	No direct access to on-site soil assumed.
		Direct ingestion	No	Resident assumed not to cross LEHR Site boundary and ingest source soil directly.
	Migration in saturated/unsaturated zone via diffusion, advection, etc.	Ground water ingestion	Yes	Ground water ingestion from residential well assumed. Receptor is assumed downgradient of contamination source.
	Subsurface diffusion/volatilization	Inhalation	No	Mercury is in a non-volatile form
	Dispersion and deposition of particulates in air	Inhalation of particulates	No	No contact between subsurface soil and atmosphere for dispersion.
		Deposition with dermal exposure/Direct ingestion	No	
		Deposition with impacted food ingestion	No	
	Precipitation and surface water runoff	Incidental ingestion of surface water	No	No contact between subsurface soil and surface water.
		Dermal exposure to surface water	No	
		Aquatic food ingestion	No	
	Direct exposure	External radiation	No	Mercury is not a radiological constituent

Table C-2. One-Dimensional Vadose Zone Modeling Physical Parameters

Soil Type Parameter	Unit	Clayey Sandy Silt
Solid density (ρs)	kg/m^3	2,570
Bulk density (ρB)	kg/m^3	1,700
Vertical hydraulic conductivity (Kz)	cm/sec	7.08E-05
Intrinsic permeability	m^2	7.22E-14
Porosity (f)	%	0.354

Abbreviations

%	percent
cm/sec	centimeter per second
kg/m^3	kilogram per cubic meter
m^2	square meter

Table C-3. Mercury Chemical-Specific and Toxicological Parameters

Parameter	Unit	
MCL	mg/l	0.002
Mol. Wt.	g/mole	232.68
RfDo	mg/kg-day	0.0003
RfDi	mg/kg-day	none
Sfo	1/(mg/kg-day)	none
Sfi	1/(mg/kg-day)	none
K_d	ml/g	52

Abbreviations

K_d adsorption coefficient
MCL maximum contaminant level
Mol. molecular
RfD_0 reference dose
RfDi reference dose inhalation
Sfi slope factor inhalation
Sfo slope factor oral
Wt. weight

References

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Thibault, D.H., Sheppard, M.I., and Smith, P.A., 1990, A Critical Compilation and Review of Default Soil Solid/Liquid Partition Coefficients, Kd, for use in Environmental Assessments, March 1990.

US Department of Energy, 1996 RESRAD-BASELINE for Windows, Version 2.20, Radiological Health Risk Section, Environmental Assessments Division, Argone National Laboratory.

US Environmental Protection Agency (EPA), 2000, Region 9 Preliminary Remediation Goal (PRG) Table, November 2000.

US EPA , 1998, Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Vol. 2, EPA-530-D-98-001B.

US EPA , 1998, Superfund Chemical Data Matrix

Weiss Associates, 1997, Draft Final One-Dimensional Vadose Zone Modeling for the Laboratory for Energy-Related Health Research (LEHR), University of California at Davis, California, April 1997.

Table C-4. Domestic Septic System 3 Mercury Risk-Based Action Standard Calculation

Scenario 2, RBAS value and Hazard Quotients for mercury, 10-11 ft deep contaminated interval, Domestic Septic System 3

Target HQ 1.00E+00

Analyte	Soil Conc. (mg/kg)	Ground Water Ingestion HQ	Swimming Ingestion HQ	Dermal Swimming HQ	Dermal Showering HQ	Soil Ingestion HQ	Dermal Soil HQ	Inhalation HQ	Fish Ingestion HQ	Plant Ingestion HQ	Meat Ingestion HQ	Milk Ingestion HQ	HQ Across Pathways
mercury (hg)	6.77	9.95E-01	0.00E+00	0.00E+00	4.86E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.000E+00

Ground Water Ingestion Pathway

Scenario 2, HQ Back Calculation - Non-Carcinogens, Ground Water Concentration Conversion Factors

Analyte	Soil Concentration (10-11 ft bgs) (mg/kg)	Vadose Zone Modeling Result[1] Ground Water/Soil Ratio (mg/L)/(mg/kg)	Ground Water Concentration (mg/L)
mercury (hg)	6.77	4.83E-04	3.27E-03

WDP Soil Profile

[1] Vadose zone modeling result is the ground water concentration at the receptor divided by the concentration in soil at the source.

Summary Table

Scenario 2, HQ Back Calculation - Ingestion of chemicals in drinking water.

Chemical	CW (mg/L)	Child IR (L/d)	Adult IR (L/d)	EF (d/yr)	Child ED (yr)	Adult ED (yr)	Child BW (Kg)	Adult BW (Kg)	Child AT (days)	Adult AT (days)	I (mg/kg-day)	RfDo (mg/kg-day)	HQ (unitless)
mercury (hg)	3.27E-03	1.0	2	350	6	24	15	70	2190	8760	2.99E-04	0.0003	9.95E-01

CW = Chemical Concentration in Water (mg/L)
IR = Ingestion Rate (L/d)
EF = Exposure Frequency (d/yr)
ED = Exposure Duration (yr)
BW = Body Weight (Kg)
AT = Averaging Time (days)
I = Intake (mg/kg-day) = $CW \times IR_{child} \times EF \times ED_{child} / BW_{child} / AT_{child} + CW \times IR_{adult} \times EF \times ED_{adult} / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = I / RfDo

Showering - Dermal Pathway

Scenario 2, HQ Back Calculation - Dermal Contact With Chemicals in Water While Showering.

From GW Ingestion

Summary Table

Chemical	CW (mg/L)	SA (cm^2)	PC (cm/hr)	ET (hr/d)	EF (d/yr)	Child ED (yr)	Adult ED (yr)	CF ($1L/1000cm^3$)	Child BW (Kg)	Adult BW (Kg)	Child AT (days)	Adult AT (days)	AD (mg/kg-day)	RfDo (mg/kg-day)	HQ (unitless)
mercury (hg)	3.27E-03	23,000	0.001	0.25	350	6	24	0.001	15	70	2190	8760	1.46E-06	0.0003	4.86E-03

CW = Chemical Concentration in Water (mg/L)
SA = Skin Surface Area Available for Contact (cm^2)
PC = Dermal Permeability Constant (cm/hr) - chemical specific. Values from Table I-1.
ET = Exposure Time (hr/d)
EF = Exposure Frequency (d/yr)
ED = Exposure Duration (yr)
CF = Volumetric Conversion Factor for Water ($1L/1000cm^3$)
BW = Body Weight (Kg)
AT = Averaging Time (days)
AD = Absorbed Dose (mg/kg-day) = $CW \times SA \times PC \times ET \times EF \times ED_{child} \times CF / BW_{child} / AT_{child} + CW \times SA \times PC \times ET \times EF \times ED_{adult} \times CF / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = AD / RfDo

End of Calculations

Table C-5. Domestic Septic System 6 Mercury Risk-Based Action Standard Calculation

Scenario 2, RBAS value and Hazard Quotients for mercury, 7-8 ft deep contaminated interval, Domestic Septic System 6

Target HQ 1.00E+00

Analyte	Soil Conc. (mg/kg)	Ground Water Ingestion HQ	Swimming Ingestion HQ	Dermal Swimming HQ	Dermal Showering HQ	Soil Ingestion HQ	Dermal Soil HQ	Inhalation HQ	Fish Ingestion HQ	Plant Ingestion HQ	Meat Ingestion HQ	Milk Ingestion HQ	HQ Across Pathways
mercury (hg)	8.29	9.95E-01	0.00E+00	0.00E+00	4.86E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.000E+00

Ground Water Ingestion Pathway

Scenario 2, HQ Back Calculation - Non-Carcinogens, Ground Water Concentration Conversion Factors, .

Analyte	Soil Concentration (7-8 ft bgs) (mg/kg)	Vadose Zone Modeling Result[1] Ground Water/Soil Ratio (mg/L)/(mg/kg)	Ground Water Concentration (mg/L)
mercury (hg)	8.29	3.94E-04	3.27E-03

WDP Soil Profile

[1] Vadose zone modeling result is the ground water concentration at the receptor divided by the concentration in soil at the source.

Summary Table

Scenario 2, HQ Back Calculation - Ingestion of chemicals in drinking water.

Chemical	CW (mg/L)	Child IR (L/d)	Adult IR (L/d)	EF (d/yr)	Child ED (yr)	Adult ED (yr)	Child BW (Kg)	Adult BW (Kg)	Child AT (days)	Adult AT (days)	I (mg/kg-day)	RfDo (mg/kg-day)	HQ (unitless)
mercury (hg)	3.27E-03	1.0	2	350	6	24	15	70	2190	8760	2.99E-04	0.0003	9.95E-01

CW = Chemical Concentration in Water (mg/L)
IR = Ingestion Rate (L/d)
EF = Exposure Frequency (d/yr)
ED = Exposure Duration (yr)
BW = Body Weight (Kg)
AT = Averaging Time (days)
I = Intake (mg/kg-day) = $CW \times IR_{child} \times EF \times ED_{child} / BW_{child} / AT_{child} + CW \times IR_{adult} \times EF \times ED_{adult} / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = I / RfDo

Showering - Dermal Pathway

Scenario 2, HQ Back Calculation - Dermal Contact With Chemicals in Water While Showering.

From GW Ingestion

Summary Table

Chemical	CW (mg/L)	SA (cm^2)	PC (cm/hr)	ET (hr/d)	EF (d/yr)	Child ED (yr)	Adult ED (yr)	CF ($1L/1000cm^3$)	Child BW (Kg)	Adult BW (Kg)	Child AT (days)	Adult AT (days)	AD (mg/kg-day)	RfDo (mg/kg-day)	HQ (unitless)
mercury (hg)	3.27E-03	23,000	0.001	0.25	350	6	24	0.001	15	70	2190	8760	1.46E-06	0.0003	4.86E-03

CW = Chemical Concentration in Water (mg/L)
SA = Skin Surface Area Available for Contact (cm^2)
PC = Dermal Permeability Constant (cm/hr) - chemical specific. Values from Table 1-1.
ET = Exposure Time (hr/d)
EF = Exposure Frequency (d/yr)
ED = Exposure Duration (yr)
CF = Volumetric Conversion Factor for Water ($1L/1000cm^3$)
BW = Body Weight (Kg)
AT = Averaging Time (days)
AD = Absorbed Dose (mg/kg-day) = $CW \times SA \times PC \times ET \times EF \times ED_{child} \times CF / BW_{child} / AT_{child} + CW \times SA \times PC \times ET \times EF \times ED_{adult} \times CF / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = AD / RfDo

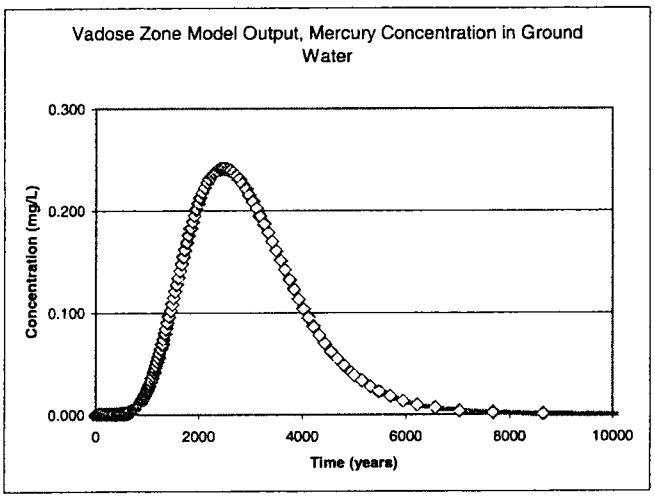
End of Calculations

Table C-7. Non-Isothermal, Unsaturated Flow and Transport Results, Mercury Risk-Based Action Standards, 10- to 11-Foot Depth

Time (years)	Concentration (mg/L)
0.00000	0.00E+00
3.17E-08	2.10E-99
1.03E-07	5.57E-96
2.64E-07	1.03E-92
6.25E-07	1.66E-89
0.0000014	2.55E-86
0.0000033	3.82E-83
0.0000074	5.66E-80
0.000017	8.27E-77
0.000037	1.19E-73
0.000084	1.75E-70
0.000188	2.57E-67
0.000424	3.79E-64
0.000953	5.55E-61
0.002140	8.04E-58
0.002740	1.61E-57
0.005397	1.47E-54
0.01130	1.69E-51
0.02425	1.90E-48
0.05178	1.73E-45
0.1070	9.90E-43
0.2090	2.95E-40
0.2740	7.83E-40
0.4604	1.13E-37
0.802	2.18E-35
1.001	5.08E-35
1.585	4.46E-33
2.00	1.38E-32
3.02	1.23E-28
4.26	1.88E-22
5.00	8.30E-22
5.9	7.82E-21
6.9	4.11E-20
7.9	2.04E-19
9.0	8.16E-19
10.0	2.12E-18
11.1	6.10E-18
12.3	1.57E-17
13.5	3.65E-17
14.7	7.89E-17
15.0	9.31E-17
16.2	1.87E-16
17.4	3.55E-16
18.6	6.47E-16
19.8	1.14E-15
20.0	1.22E-15
21.2	2.06E-15
22.5	3.38E-15
23.7	5.42E-15
24.9	8.49E-15
26.2	1.30E-14
27.5	1.97E-14
28.7	2.92E-14
30.0	4.26E-14
30.0	4.29E-14
31.3	6.17E-14
32.6	8.76E-14
33.9	1.23E-13
35.2	1.71E-13
36.5	2.35E-13

Peak Concentration in Ground Water (mg/L)
0.2416

Soil to Offsite Ground Water Conversion Factor		
Arbitrary initial concentration in soil	100	mg/kg
Peak ground water concentration	0.2416	mg/L
Vadose zone factor	0.002416	(mg/L)/(mg/kg)
Lateral ground water factor	0.2	(mg/L)/(mg/L)
Total conversion factor	**0.000483**	(mg/L)/(mg/kg)



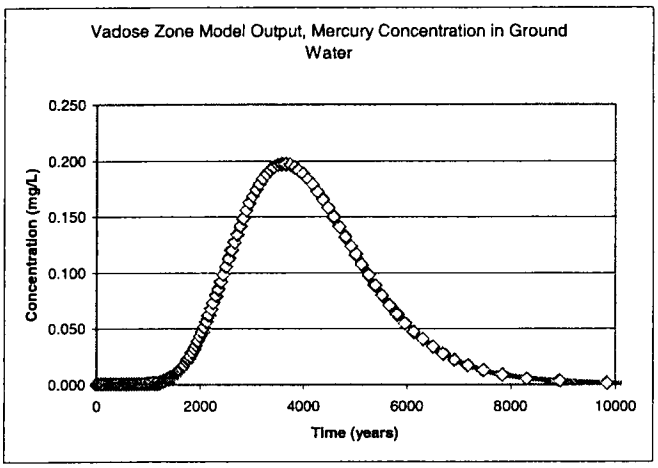
Abbreviations
mg/kg milligrams per kilogram
mg/L milligrams per liter

Table C-8. Non-Isothermal, Unsaturated Flow and Transport Results, Mercury Risk-Based Action Standards, 7- to 8-Foot Depth

Time (years)	Concentration (mg/L)
0.00000	0.00E+00
3.17E-08	1.94E-146
1.03E-07	1.32E-141
2.64E-07	6.23E-137
6.25E-07	2.58E-132
0.0000014	1.02E-127
0.0000033	3.90E-123
0.0000074	1.47E-118
0.000017	5.48E-114
0.000037	1.98E-109
0.000084	7.48E-105
0.000188	2.83E-100
0.000424	1.06E-95
0.000953	3.98E-91
0.002140	1.46E-86
0.002740	2.95E-86
0.005397	6.69E-82
0.01130	1.89E-77
0.02425	4.88E-73
0.05178	9.08E-69
0.1070	8.41E-65
0.2090	2.94E-61
0.2740	8.03E-61
0.4604	1.25E-57
0.802	2.72E-54
1.001	6.50E-54
1.585	5.37E-51
2.00	1.92E-50
3.02	7.54E-40
4.01	3.14E-33
5.00	3.82E-31
6.0	6.42E-30
7.1	7.41E-29
8.2	5.25E-28
9.4	2.66E-27
10.0	4.52E-27
11.2	1.74E-26
12.4	5.74E-26
13.6	1.69E-25
14.8	4.52E-25
15.0	5.08E-25
16.2	1.25E-24
17.5	2.91E-24
18.7	6.39E-24
19.9	1.34E-23
20.0	1.39E-23
21.3	2.80E-23
22.5	5.44E-23
23.8	1.03E-22
25.0	1.88E-22
26.3	3.35E-22
27.6	5.83E-22
28.9	9.94E-22
30.0	1.53E-21
31.3	2.52E-21
32.6	4.08E-21
34.0	6.50E-21
35.3	1.02E-20
36.6	1.59E-20
38.0	2.43E-20

Peak Concentration in Ground Water (mg/L)
0.1972

Soil to Offsite Ground Water Conversion Factor		
Arbitrary initial concentration in soil	100	mg/kg
Peak ground water concentration	0.1972	mg/L
Vadose zone factor	0.001972	(mg/L)/(mg/kg)
Lateral ground water factor	0.2	(mg/L)/(mg/L)
Total conversion factor	**0.000394**	(mg/L)/(mg/kg)



Abbreviations
mg/kg milligrams per kilogram
mg/L milligrams per liter

APPENDIX D

ACTIVITY HAZARD ANALYSES

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Domestic Septic Systems 3 and 6 Removal Actions - All Activities

ANALYZED BY/DATE: Agata Sulczynski/ February 7, 2002

REVIEWED BY/DATE:

PRINCIPLE STEPS	POTENTIAL HAZARDS	RECOMMENDED CONTROLS
All removal action activities	Heat stress.	Workers will be properly trained to identify signs and symptoms of heat stress. Drinking water will be available. Work shift duration will be designed appropriately for environmental conditions.
	Contact with contamination.	Personnel who may be exposed to ionizing radiation will, at a minimum, have completed the appropriate level of Radiological Worker training. All activities will be performed in accordance with the provisions of the hazardous work permit (HWP).
	Biological agents.	Workers will be instructed to recognize potential biological agents (e.g., spiders, mice, etc.). Gloves will be worn if there is a need to place hands in areas where spiders, mice and other biological agents may be present.

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
personal protective equipment (PPE)	Verify integrity prior to use.	Occupational Safety and Health Administration (OSHA) 40-hour, OSHA 8-hour refresher, and OSHA 8-hour supervisor training (as appropriate).
Water, cooling vests, other heat reducing equipment.	Verify potability of water. Use cooling vests according to manufacturer's recommendations.	Not applicable (NA).

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Domestic Septic Systems 3 and 6 Removal Actions – Container Loading and Transport

ANALYZED BY/DATE: Agata Sulczynski/ February 7, 2002

REVIEWED BY/DATE:

PRINCIPLE STEPS	POTENTIAL HAZARDS	RECOMMENDED CONTROLS
Soft-sided-container loading	Impact due to loading frame failure.	All personnel will stay at least one foot away from lifting the frame during loading.
Soft-sided container transport	Heavy equipment operations.	Operators must be trained and experienced in the use of heavy equipment. Loading area will be clear of unnecessary personnel. Emergency equipment will include portable radio, first aid kit, and fire extinguisher. Equipment must have seat and seat belts for all riders.
	Traffic accidents.	All vehicle movements shall be monitored for location of obstacles. Trees will be trimmed as necessary (a separate activity hazard analysis [AHA] will be used for this operation). Back-up alarms will be operational. Traffic control will be implemented, as appropriate, using cones and/or road signs. Ground personnel in high traffic areas will wear high-visibility traffic safety vests.
Soft-sided container unloading (by forklift)	Pinch points.	Personnel will ensure that feet and hands are clear of all pinch points between the soft-sided container and the loading frame when the container is being removed from the frame. Workers will ensure the container is properly hooked to the lifting frame prior to lifting the container. If opening the loading frame, keep a safe distance from the moving wall of the frame (at least one foot).
	Injury with hand tools.	Safety glasses and work gloves will be used by workers using a hammer to open the loading frame. The hammer will be inspected daily prior to use for integrity.
Soft-sided container storage	Slips, trips and falls.	Workers will be instructed to pay close attention to uneven surfaces, grade changes or other slip, trip and fall hazards. Plywood platforms will be placed over uneven surfaces, when practical, to minimize the hazards.

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Domestic Septic Systems 3 and 6 Removal Actions – Waste Transport to Cobalt –60 Field or Other Storage Area

ANALYZED BY/DATE: Agata Sulczynski / December 8, 2000

REVIEWED BY/DATE:

PRINCIPLE STEPS	POTENTIAL HAZARDS	RECOMMENDED CONTROLS
Soft-sided container storage (continued)	Falls from ladder.	Ladders will be placed on even, sturdy surfaces. Workers will be trained in, and will observe, ladder safety. Ladders will be inspected on a periodic basis.
	Crushing.	Containers will be placed to allow safe access for unhooking them from the loading frame. Workers will visually inspect each container after it has been placed to ensure that it is securely stacked prior to unhooking the loading frame.
B-25 box loading and transport	Heavy equipment operations – forklift.	Operators must be trained and experienced in the use of heavy equipment. The loading area will be clear of unnecessary personnel. Emergency equipment will include portable radio, first aid kit, and fire extinguisher. Forklifts must have seats and seat belts for all riders.
	Traffic.	All vehicle movements shall be monitored for location of obstacles. Trees will be trimmed as necessary (a separate AHA will be used for this operation). Back-up alarms will be operational. Traffic control will be implemented, as appropriate, using cones and/or road signs. Ground personnel in high traffic areas will wear high-visibility traffic safety vests.
	Vehicle use and traffic.	All vehicle movements shall be monitored for location of obstacles. Trees will be trimmed as necessary (a separate AHA will be used for this operation). Field vehicles emergency equipment will include portable radio, first aid kit, and fire extinguisher. Daily vehicle safety inspections are required prior to use. Vehicles will have seats and seat belts for all riders. Back-up alarms will be operational. Initiate traffic control by using cones and/or road signs, as appropriate, and by wearing high-visibility safety vests.

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Domestic Septic Systems 3 and 6 Removal Actions – Waste Transport to Cobalt –60 Field or Other Storage Area

ANALYZED BY/DATE: Agata Sulczynski / December 8, 2000

REVIEWED BY/DATE:

PRINCIPLE STEPS	POTENTIAL HAZARDS	RECOMMENDED CONTROLS
B-25 box placement in storage	Slips, trips and falls.	Workers will be instructed to pay close attention to uneven surfaces, grade changes or other slip, trip and fall hazards. Plywood platforms will be placed over uneven surfaces when practical, to minimize the hazards.

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Loader/forklift	Daily vehicle safety inspections. Daily visual lifting equipment inspections. Visual inspection of area prior to work. Daily inspection of field vehicle emergency equipment.	Contractor will be trained on work routes. Only appropriately qualified personnel will be permitted to operate loader/forklift.
Hand tools	Daily visual inspection of hand and power tools.	Workers will be trained in the proper operation of hand and power tools.
PPE	Inspection of PPE for integrity prior to donning.	Workers will be trained in the proper use of PPE.

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Domestic Septic Systems 3 and 6 Removal Actions – Utility Protection/ Relocation

ANALYZED BY/DATE: Agata Sulczynski/ December 8, 2000

REVIEWED BY/DATE:

PRINCIPLE STEPS	POTENTIAL HAZARDS	RECOMMENDED CONTROLS
Utility line protection or relocation	Hazards associated with breach of potential natural gas lines, water supply lines, and electrical lines.	Utility lines will be identified and marked before removal work begins. If utilities are present, workers will manually excavate in several areas to expose the lines and verify the location of the utilities. Shut-off valves will be located, if feasible, for any utilities expected. Utilities will be shut off before work begins in conformance with lock-out and tag-out procedures when possible and practical. The excavator bucket will keep at least one foot of horizontal distance from any identified line. If work around natural gas lines is necessary, a lower explosive level (LEL) monitor will be used to ensure that no natural gas build-up exists. If the LEL monitor shows >10% LEL, work will be stopped and procedures evaluated.

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Line location equipment	Manufacturer's inspection requirements will be applied.	Line location equipment will be used by qualified contractor/personnel.

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Domestic Septic Systems 3 and 6 Removal Actions – Fence Installation

ANALYZED BY/DATE: Agata Sulczynski/ February 7, 2002

REVIEWED BY/DATE:

PRINCIPLE STEPS	POTENTIAL HAZARDS	RECOMMENDED CONTROLS
Installation of perimeter fence	Back strain due to improper lifting of heavy objects (e.g., fence sections).	Workers will be trained in proper lifting techniques. Two or more people required for objects weighing more than 60 pounds (lbs). Proper lifting equipment will be used by trained personnel as instructed by the Site Health and Safety Officer (SHSO). Inspect lifting equipment daily at a minimum.
	Slips, trips and falls.	Workers will be instructed to pay close attention to uneven surfaces, grade changes or other slip, trip and fall hazards.
	Injuries due to hand and power tools (e.g., puncture hazard from nails and screws).	Safety glasses will be worn when working with hand and power tools. Work gloves will be used as necessary to prevent blisters and cuts. Caution will be exercised when removing nails and screws.
	Cuts with sharp ends of fencing material.	Work gloves will be worn to prevent cuts.
	Loud noise/communication when using power tools.	When noise levels exceed 85 decibels (dBA) (or wherever voices must be raised in order to be understood at arms' length), hearing protection must be worn. A Noise Reduction Rating (NRR) of at least 25 shall be used in the selection of hearing protection devices.

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Hand tools, power tools	Visual inspection of area prior to work. Daily visual inspection of hand and power tools.	Workers will be trained in operation of hand and power tools and appropriate PPE.

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Domestic Septic Systems 3 and 6 Removal Actions – Asphalt Removal

ANALYZED BY/DATE: Agata Sulczynski/ December 7, 2000

REVIEWED BY/DATE:

PRINCIPLE STEPS	POTENTIAL HAZARDS	RECOMMENDED CONTROLS
Asphalt removal	Loader operation.	Operators must be trained and experienced in the operation of heavy equipment. The loading area will be clear of unnecessary personnel. Emergency equipment will include portable radio, first aid kit, and fire extinguisher. Equipment must have seats and seat belts for all riders.
	Traffic.	All vehicle movements shall be monitored for location of obstacles. Trees will be trimmed as necessary (a separate AHA will be used for this operation). Back-up alarms will be operational. Traffic control will be implemented, as appropriate, using cones and/or road signs. Ground personnel in high traffic areas will wear high-visibility traffic safety vests.
Spotting	Slips, trips and falls.	Workers will be instructed to pay close attention to uneven surfaces, grade changes or other slip, trip and fall hazards.

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Heavy equipment – loader	Daily vehicle safety inspections. Daily visual equipment inspections. Visual inspection of area prior to work. Daily inspection of field vehicle emergency equipment.	Only qualified operators may operate the equipment.

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Domestic Septic Systems 3 and 6 Removal Actions – Waste/Soil Excavation

ANALYZED BY/DATE: Agata Sulczynski/ February 7, 2002

REVIEWED BY/DATE:

PRINCIPLE STEPS	POTENTIAL HAZARDS	RECOMMENDED CONTROLS
Contaminated soil and waste excavation	Lifting heavy objects.	Workers will be trained in proper lifting techniques. Two or more people required for lifting objects weighing greater than 60 lbs. Proper lifting equipment will be used by trained personnel as instructed by the SHSO. Inspect lifting equipment daily at a minimum.
	Heavy equipment operations.	Operators must be trained and experienced in the use of heavy equipment. Equipment must be inspected daily at a minimum prior to use. All other applicable requirements must be met prior to use.
	Vehicle use and traffic.	All vehicle movements shall be monitored for location of obstacles. Field vehicles emergency equipment will include portable radio, first aid kit, and fire extinguisher. Daily vehicle safety inspections are required prior to use. Vehicles will have seat and seat belts for all riders. Back-up alarms will be operational. Initiate traffic control by using cones and/or road signs as appropriate, and by wearing high-visibility safety vests.
	Open Trenches.	Personnel must be trained in excavation operations and safety. Protective systems must be designed and installed for excavations of five feet or more in depth. Guardrails or fall protection will be used for all personnel who need to work near the any excavation presenting a fall hazard.

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Domestic Septic Systems 3 and 6 Removal Actions – Consolidation and Sifting of Gravel

ANALYZED BY/DATE: Agata Sulczynski/ December 8, 2000

REVIEWED BY/DATE:

PRINCIPLE STEPS	POTENTIAL HAZARDS	RECOMMENDED CONTROLS
Demolition of domestic tank structures	Injury with jackhammer attachment.	Equipment will be inspected prior to use. Personnel will be trained on the proper use of equipment. Safety glasses will be worn.
	Loud noise.	When noise levels exceed 85 dBA (or wherever voices must be raised in order to be understood at arms' length), hearing protection must be worn. An NRR of at least 25 shall be used in the selection of hearing protection devices. Wherever possible, the use of barriers is encouraged.
	Injury from projectiles.	The demolition area will be maintained clear of personnel. The equipment operator will close all equipment cab windows/doors. Face shields and hard hats will be worn by spotters if they are in the area of a potential projectile pathway.

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Hand tools, power tools	Visual inspection of area prior to work. Daily visual inspection of hand and power tools.	Workers will be trained in the operation of hand and power tools, the use of appropriate PPE, and lockout/tagout procedures.
Heavy equipment operation	Daily vehicle safety inspections. Daily visual lifting equipment inspections. Visual inspection of area prior to work. Daily inspection of field vehicle emergency equipment.	Only qualified operators may operate the equipment.

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Domestic Septic Systems 3 and 6 Removal Actions – Stockpiling

ANALYZED BY/DATE: Agata Sulczynski/ February 7, 2002

REVIEWED BY/DATE:

PRINCIPLE STEPS	POTENTIAL HAZARDS	RECOMMENDED CONTROLS
Stockpiling	Loader	Work area is will be clear of unnecessary personnel. Emergency equipment will include a portable radio, first aid kit, and fire extinguisher. Equipment must have seats and seat belts for all riders

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Heavy equipment	Daily vehicle safety inspections. Daily visual lifting equipment inspections. Visual inspection of area prior to work. Daily inspection of field vehicle emergency equipment.	Only qualified operators may operate the equipment.

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Domestic Septic Systems 3 and 6 Removal Actions – Removal of Piping

ANALYZED BY/DATE: Agata Sulczynski/ February 7, 2002

REVIEWED BY/DATE:

PRINCIPLE STEPS	POTENTIAL HAZARDS	RECOMMENDED CONTROLS
Piping removal	Injury during backhoe operation.	Depth of excavation will not exceed three feet. Work area will be clear of unnecessary personnel. Emergency equipment will include a portable radio, first aid kit, and fire extinguisher. Equipment (backhoe) must have seats and seat belts for all riders
	Injury from improper use of shovels and other hand tools.	Work area will be clear of unnecessary objects. Work gloves will be worn to prevent blisters and cuts. Eye protection will be worn when projectile hazards are present (e.g., hammer operation). Workers will be instructed in proper body position to avoid repetitive stress injury.
Packaging	Back strain due to improper lifting of heavy objects.	Workers will be trained in proper lifting techniques. Two or more people are required to lift objects weighing more than 60 lbs. Proper lifting equipment will be used by trained personnel as instructed by the SHSO. Inspect lifting equipment daily at a minimum.

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Heavy equipment	Daily vehicle safety inspections. Daily visual lifting equipment inspections. Visual inspection of area prior to work. Daily inspection of field vehicle emergency equipment.	Only qualified operators may operate the equipment.
Hand tools	Visual inspection of area prior to work. Daily visual inspection of hand tools.	Workers will be trained in operation of hand and power tools, the use of appropriate PPE, and lockout/tagout procedures.

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Domestic Septic Systems 3 and 6 Removal Actions – Sampling

ANALYZED BY/DATE: Agata Sulczynski/ February 7, 2002

REVIEWED BY/DATE:

PRINCIPLE STEPS	POTENTIAL HAZARDS	RECOMMENDED CONTROLS
Sampling	Slips, trips and falls.	Workers will be instructed to pay close attention to uneven surfaces, grade changes, or other slip, trip and fall hazards.
	Biological agents.	Workers will be instructed to recognize potential biological agents (e.g., spiders, mice, etc.). Gloves will be worn if there is a need to place hands in areas where spiders, mice and other biological agents may be present.

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
NA	NA	NA

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Domestic Septic Systems 3 and 6 Removal Actions – Backfill and Compaction

ANALYZED BY/DATE: Agata Sulczynski/ February 7, 2002

REVIEWED BY/DATE:

PRINCIPLE STEPS	POTENTIAL HAZARDS	RECOMMENDED CONTROLS
Backfill	Loader.	Work area will be clear of unnecessary personnel. Emergency equipment must include a portable radio, first aid kit, and fire extinguisher. Equipment must have seats and seat belts for all riders
	Traffic.	All vehicle movements shall be monitored for location of obstacles. Trees will be trimmed as necessary (a separate AHA will be used for this operation). Back-up alarms will be operational. Traffic control will be implemented, as appropriate, using cones and/or road signs. Ground personnel in high traffic areas will wear high-visibility traffic safety vests.
Compaction	Excavator operation.	Work area will be clear of unnecessary personnel. Emergency equipment will include portable radio, first aid kit, and fire extinguisher. Equipment must have seat and seat belts for all riders.
Compaction testing	Radiation exposure from nuclear gauge.	Only a certified operator may use the compaction gauge. Areas will be clear of unnecessary personnel.
	Injury with slide hammer.	Work gloves will be worn and care will be taken when hammering.
	Loud noise during slide hammer operation.	When noise levels exceed 85 dBA (or wherever voices must be raised in order to be understood at arms' length), hearing protection must be worn. An NRR of at least 25 shall be used in the selection of hearing protection devices. Wherever possible, use of barriers is encouraged.

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Hand tools, power tools	Visual inspection of area prior to work. Daily visual inspection of hand and power tools.	Workers will be trained in operation of hand and power tools, the use of appropriate PPE, and lockout/tagout procedures.

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Domestic Septic Systems 3 and 6 Removal Actions – Backfill and Compaction

ANALYZED BY/DATE: Agata Sulczynski/ February 7, 2002

REVIEWED BY/DATE:

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Nuclear compaction gauge	To be inspected per manufacturer's instructions.	Only a certified operator may operate the equipment.

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Domestic Septic Systems 3 and 6 Removal Actions – Site Restoration

ANALYZED BY/DATE: Agata Sulczynski/ February 7, 2002

REVIEWED BY/DATE:

PRINCIPLE STEPS	POTENTIAL HAZARDS	RECOMMENDED CONTROLS
Grading	Loader/road grader operation.	Work area will be clear of unnecessary personnel. Emergency equipment will include a portable radio, first aid kit, and fire extinguisher. Equipment must have seats and seat belts for all riders.
	Traffic.	All vehicle movements shall be monitored for location of obstacles. Trees will be trimmed as necessary (a separate AHA will be used for this operation). Back-up alarms will be operational. Traffic control will be implemented, as appropriate, using cones and/or road signs. Ground personnel in high traffic areas will wear high-visibility traffic safety vests.

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Heavy equipment	Daily vehicle safety inspections. Daily visual lifting equipment inspections. Visual inspection of area prior to work. Daily inspection of field vehicle emergency equipment.	Only qualified operators may operate the equipment.

ACTIVITY HAZARD ANALYSIS

ACTIVITY: Domestic Septic Systems 3 and 6 Removal Actions - Miscellaneous

ANALYZED BY/DATE: Agata Sulczynski/ February 7, 2002

REVIEWED BY/DATE:

PRINCIPLE STEPS	POTENTIAL HAZARDS	RECOMMENDED CONTROLS
Moving tools and equipment	Slips, trips and falls.	Workers will be instructed to pay close attention to uneven surfaces, grade changes or other slip, trip and fall hazards.
	Back strain due to improper lifting of heavy objects.	Workers will be trained in proper lifting techniques. Two or more people are required to lift objects weighing more than 60 lbs. Proper lifting equipment will be used by trained personnel as instructed by the SHSO. Inspect lifting equipment daily at a minimum.

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
NA	NA	NA

APPENDIX E

DETERMINATION OF CONSTITUENTS OF CONCERN FOR DOMESTIC SEPTIC SYSTEMS 3 AND 6

E. DETERMINATION OF CONSTITUENTS OF CONCERN FOR DOMESTIC SEPTIC SYSTEMS 3 AND 6

Analytical data from all samples collected during the 1997 Data Gaps Investigation and 2001 Domestic Septic Systems (DSSs) Investigation were queried from the LEHR electronic database and used to determine constituents of concern (COCs) specific to DSSs 3 and 6. Not all of the 72 analytes that were identified as LEHR site COCs in the Draft Determination of Risk-Based Action Standards (RBAS) (WA, 1997) are COCs specific to DSSs 3 and 6. A COC screening process was developed to determine which of the 72 potential COCs are specific to DSSs 3 and 6.

E.1 Constituent of Concern Screening Process

The screening process began by separating potential COCs into two groups based on their presence in natural background. The two groups are:

1. Constituents whose lowest RBAS value was greater than or equal to the background value; and,
2. Constituents whose lowest RBAS value was less than the background value.

Lowest RBAS values correspond to a risk of 10^{-6} for carcinogens and a hazard quotient of 1.0 for non-carcinogens. The lowest RBAS is also the lowest value among all three risk analysis scenarios (on-site researcher, east residential farmer, and south residential farmer) developed for the LEHR site (WA, 1997). The background value is the 80% lower confidence limit on the 95th percentile determined from background sample results.

The potential COCs were separated into two groups because their bases for comparison are different. Most of the DSS data were compared to the RBAS value and United States Environmental Protection Agency Region 9 Preliminary Remediation Goal (PRG) for residential soil. However, some constituents at the LEHR site have background concentrations in excess of the RBAS and/or PRG values. The basis for comparison for these potential COCs cannot be the RBAS or PRG because cleanup below background is not required. These COCs must be compared to background in a separate screening process. The details and results of each screening process are described below.

E.1.1 Screening Comparison to Risk-Based Action Standards and Preliminary Remediation Goals

DSSs 3 and 6 characterization results were used to determine reasonable maximum exposure (RME) concentrations for comparison with RBAS and PRG values. The RME was the maximum concentration in the DSS if the potential COC was detected in ten or less samples. If a non-radiological constituent was detected in more than ten samples, the 95% upper confidence limit (UCL) on the mean was determined and used as the RME. The 95% UCL was used as the RME for some radiological constituents with more than ten samples, but ten or less detected concentrations, because radiological results are statistically valid below the detection limit. Comparisons between these values and the maximum detected concentrations are shown in Tables E-1 and E-3 for DSSs 3 and 6, respectively.

Constituents that were not detected in any of the samples were not carried forward into the comparison with PRG and RBAS values because method detection limits were verified to be below these screening criteria.

Based on the screening comparison shown in Tables E-1 and E-3, the COCs with concentrations above RBAS and PRG values were:

- **DSS 3**—Formaldehyde, hexavalent chromium, chromium, silver, cesium-137, lead-210, alpha-chlordane, gamma-chlordane, heptachlor epoxide, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. Strontium-90 was included as a COC because it is a radiological constituent with activities significantly above background.
- **DSS 6**—Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and dibenzo(a,h)anthracene.

E.1.2 Screening Comparison to Background

The first step in the background screening process was to compare the maximum detected concentrations to background values. Constituents whose maximum value was below the background value were eliminated from further consideration as a COC. This comparison is shown in Tables E-2 and E-4 for DSSs 3 and 6, respectively.

If the maximum concentration was greater than the background value, the data were compared to background using the Wilcoxon Rank Sum (WRS) test. The WRS test results are summarized in Tables E-2 and E-4. "Fail" was listed in the table for test results indicating the DSS data were above background. All constituents that failed the WRS test were identified as COCs. The additional COCs based on background comparison were:

- **DSS 3**—Cadmium, copper, lead, mercury, and radium-226; and,
- **DSS 6**—Barium and mercury.

COCs identified in the comparisons to RBAS, PRG, and background are considered COCs specific to DSSs 3 and 6.

E.2 References

Weiss Associates (WA), 1997, Draft Final Determination of Risk-Based Action Standards for DOE Areas for the Laboratory for Energy-Related Health Research at University of California, Davis, August, Rev. C.

Table E-1. Determination of Domestic Septic System 3 Constituents of Concern—Risk-Based Action Standard Greater than or Equal to Background

Potential COC	Number of Samples	Number of Detections	Units	Maximum Detected Concentration	95% UCL	RME	Lowest RBAS	Residential Soil PRG	COC Determination
General Chemistry									
Formaldehyde	4	1	µg/kg	1,920	N/A	1,920	1,700	9,200,000	COC
Hexavalent Chromium	6	5	mg/kg	0.836	N/A	0.836	3.8	0.2	COC
Metals									
Chromium	9	9	mg/kg	591	N/A	591	722	210	COC
Selenium	9	5	mg/kg	11.1	N/A	11.1	58	390	----
Silver	9	5	mg/kg	186	N/A	186	3.8	390	COC
Zinc	9	9	mg/kg	258	N/A	258	3,400	23,000	----
Pesticides/PCBs									
4,4'-DDD	9	0	µg/kg	ND	N/A	ND	7,948	2,400	----
4,4'-DDE	9	3	µg/kg	107	N/A	107	5,611	1,700	----
4,4'-DDT	9	0	µg/kg	ND	N/A	ND	5,611	1,700	----
Aroclor-1260	9	0	µg/kg	ND	N/A	ND	248	90	----
Alpha-BHC	9	0	µg/kg	ND	N/A	ND	7.50	1,600	----
alpha-Chlordane	9	5	µg/kg	806	N/A	806	800	220	COC
delta-BHC	9	0	µg/kg	ND	N/A	ND	13	320	----
Dieldrin	9	0	µg/kg	ND	N/A	ND	15.3	30	----
Endosulfan I	9	0	µg/kg	ND	N/A	ND	29,000	370,000	----
Endosulfan Sulfate	9	0	µg/kg	ND	N/A	ND	26,000	None	----
gamma-BHC (Lindane)	9	0	µg/kg	ND	N/A	ND	30.4	440	----
gamma-Chlordane	9	5	µg/kg	1,240	N/A	1,240	810	1,600	COC
Heptachlor	9	0	µg/kg	ND	N/A	ND	170	110	----
Heptachlor Epoxide	9	1	µg/kg	12.8	N/A	12.8	0.567	53	COC
Methoxychlor	9	0	µg/kg	ND	N/A	ND	100,000	310,000	----

Table E-1. Determination of Domestic Septic System 3 Constituents of Concern—Risk-Based Action Standard Greater than or Equal to Background (continued)

Potential COC	Number of Samples	Number of Detections	Units	Maximum Detected Concentration	95% UCL	RME	Lowest RBAS	Residential Soil PRG	COC Determination
Radionuclides									
Americium-241	6	1	pCi/g	0.0054	N/A	0.0054	0.092	1.9	----
Carbon-14	9	0	pCi/g	ND	N/A	ND	4,200	770	----
Cesium-137	24	5	pCi/g	0.126	0.0219	0.0219	0.1	0.02	COC
Cobalt-60	24	0	pCi/g	ND	0.00285	ND	0.022	0.0043	----
Lead-210	24	13	pCi/g	4.4	1.45	1.45	9.6	0.78	COC
Plutonium-241	6	1	pCi/g	0.47	N/A	0.47	3.2	150	----
Strontium-90	9	5	pCi/g	2.01	N/A	2.01	10	14	COC[1]
Thorium-234	24	21	pCi/g	4.11	1.13	1.13	3.2	None	----
Tritium	9	0	pCi/g	ND	N/A	ND	5.4	11,000	----
Uranium-235/236	9	6	pCi/g	0.0903	N/A	0.0903	0.15	0.16	----
SVOCs									
Acenaphthene	9	2	µg/kg	576	N/A	576	250,000	3,700,000	----
Anthracene	9	3	µg/kg	1,990	N/A	1,990	1,400,000	22,000,000	----
Benzo(a)anthracene	9	3	µg/kg	6,540	N/A	6,540	1,199	620	COC
Benzo(a)pyrene	9	3	µg/kg	1,660	N/A	1,660	237	62	COC
Benzo(b)fluoranthene	9	3	µg/kg	5,600	N/A	5,600	2,613	620	COC
Benzo(g,h,i)perylene	9	0	µg/kg	ND	N/A	ND	9,100,000	None	----
Benzo(k)fluoranthene	9	3	µg/kg	3,680	N/A	3,680	26,132	610	COC
bis(2-Ethylhexyl)phthalate	9	9	µg/kg	1,220	N/A	1,220	7,700	35,000	----
Carbazole	9	1	µg/kg	1,540	N/A	1540	2,226	24,000	----
Chrysene	9	3	µg/kg	6,060	N/A	6,060	20,269	6,100	----
Di-n-butylphthalate	9	1	µg/kg	41.4	N/A	41.4	890,000	6,100,000	----
Di-n-octylphthalate	9	0	µg/kg	ND	N/A	ND	4,900,000	1,200,000	----
Dibenzo(a,h)anthracene	9	1	µg/kg	1150	N/A	1,150	261	62	COC
Dibenzofuran	9	1	µg/kg	409	N/A	409	14,000	290,000	----
Diethyl Phthalate	9	0	µg/kg	ND	N/A	ND	220,000	49,000,000	----

Table E-1. Determination of Domestic Septic System 3 Constituents of Concern—Risk-Based Action Standard Greater than or Equal to Background (continued)

Potential COC	Number of Samples	Number of Detections	Units	Maximum Detected Concentration	95% UCL	RME	Lowest RBAS	Residential Soil PRG	COC Determination
SVOCs cont'd									
Fluoranthene	9	3	µg/kg	8,770	N/A	8,770	1,800,000	2,300,000	----
Fluorene	9	1	µg/kg	765	N/A	765	170,000	2,600,000	----
Indeno(1,2,3-cd)pyrene	9	3	µg/kg	1,110	N/A	1,110	2,613	620	COC
Naphthalene	9	1	µg/kg	380	N/A	380	39,000	56,000	----
Pentachlorophenol	9	0	µg/kg	ND	N/A	ND	13,351	3,000	----
Phenanthrene	9	3	µg/kg	5,810	N/A	5,810	1,200,000	None	----
Pyrene	9	4	µg/kg	5,480	N/A	5,480	490,000	2,300,000	----
VOCs									
2-Butanone	9	1	µg/kg	4	N/A	4	12,000	7,300,000	----
Acetone	9	7	µg/kg	31.6	N/A	31.6	1,700	1,600,000	----
Benzene	9	1	µg/kg	1.58	N/A	1.58	14.7	650	----
Carbon tetrachloride	9	0	µg/kg	ND	N/A	ND	55.3	240	----
Ethylbenzene	9	3	µg/kg	3.45	N/A	3.45	10,000	230,000	----
Methylene Chloride	9	6	µg/kg	24	N/A	24	132	8,900	----
Styrene	9	2	µg/kg	2.01	N/A	2.01	76,000	1,700,000	----
Toluene	9	6	µg/kg	298	N/A	298	19,000	520,000	----
Xylenes (Total)	9	6	µg/kg	19.8	N/A	19.8	700,000	210,000	----

Note

[1] Strontium-90 will be included as a COC because it is a radiological constituent with activities significantly above background.
[2] Lead-210 background value is 1.6 pCi/g.

Table E-1. Determination of Domestic Septic System 3 Constituents of Concern—Risk-Based Action Standard Greater than or Equal to Background (continued)

Abbreviations

BHC	hexachlorobutadiene
COC	constituent of concern
DDD	dichlordiphenyl dichlor
DDE	dichlordiphenyl dichloroethylene
DDT	dichlordiphenyl trichlor
mg/kg	milligrams per kilogram
N/A	not applicable
ND	not detected
PCBs	polychlorinated biphenyl
PRG	United States Environmental Protection Agency Region 9 Preliminary Remediation Goal
RBAS	risk-based action standard
RME	reasonable maximum exposure concentration
SVOCs	semi-volatile organic compounds
UCL	upper confidence limit
VOCs	volatile organic compounds
µg/kg	micrograms per kilogram

Table E-2. Determination of Domestic Septic System 3 Constituents of Concern—Risk-Based Action Standard Less Than Background

Potential COC	Number of Samples	Number of Detections	Units	Maximum Detected Concentration	Background Value [1] (> 4 ft bgs)	Is Maximum Concentration Greater than Background ?	WRS Test Result	COC Determination
Metals								
Antimony	9	1	mg/kg	1.2	1.4	No	N/A	----
Barium	9	9	mg/kg	345	294	Yes	Pass	----
Cadmium	9	6	mg/kg	5.1	0.51	Yes	Fail	COC
Copper	9	9	mg/kg	219	61.8	Yes	Fail	COC
Lead	9	9	mg/kg	69.6	9.5	Yes	Fail	COC
Manganese	9	9	mg/kg	808	750	Yes	Pass	----
Mercury	9	7	mg/kg	751	0.248	Yes	Fail	COC
Radionuclides								
Radium-226	24	24	pCi/g	2.44	0.752	Yes	Fail	COC
Thorium-228	6	6	pCi/g	0.595	0.771	No	N/A	----
Thorium-232	6	6	pCi/g	0.525	0.8	No	N/A	----

Notes

[1] Background value is the 80% lower confidence limit on the 95th quantile determined from background sample results.
> 4 ft bgs = Data represent native soil deeper than four ft below ground surface for analytes that show stratification with depth.

Abbreviations

bgs	below ground surface
COC	constituent of concern
ft	feet
mg/kg	milligrams per kilogram
N/A	not applicable
pCi/g	picoCuries per gram
WRS Test	Wilcoxon Rank Sum test

Table E-3. Determination of Domestic Septic System 6 Constituents of Concern—Risk-Based Action Standard Greater than or Equal to Background

Potential COC	Number of Samples	Number of Detections	Units	Max. Detected Concentration/RME	Lowest RBAS	Residential Soil PRG	COC Determination
General Chemistry							
Formaldehyde	3	0	mg/kg	ND	1,700	9,200,000	----
Hexavalent Chromium	6	5	mg/kg	0.198	3.8	0.2	----
Metals							
Chromium	16	16	mg/kg	166	722	210	----
Selenium	6	3	mg/kg	1	58	390	----
Silver	6	2	mg/kg	1	3.8	390	----
Zinc	6	6	mg/kg	179	3,400	23,000	----
Pesticides/PCBs							
4,4'-DDD	6	0	µg/kg	ND	7,948	2,400	----
4,4'-DDE	6	0	µg/kg	ND	5,611	1,700	----
4,4'-DDT	6	0	µg/kg	ND	5,611	1,700	----
alpha-BHC	6	0	µg/kg	ND	7.5	90	----
alpha-Chlordane	6	2	µg/kg	2.8	800	1,600	----
Aroclor-1260	6	0	µg/kg	ND	248	220	----
Delta-BHC	6	0	µg/kg	ND	13	320	----
Dieldrin	6	0	µg/kg	ND	15.3	30	----
Endosulfan I	6	0	µg/kg	ND	29,000	370,000	----
Endosulfan sulfate	6	0	µg/kg	ND	26,000	None	----
gamma-BHC (Lindane)	6	0	µg/kg	ND	30.4	440	----
gamma-Chlordane	6	2	µg/kg	2.6	810	1,600	----
Heptachlor	6	0	µg/kg	ND	170	110	----
Heptachlor epoxide	6	0	µg/kg	ND	0.567	53	----
Methoxychlor	6	0	µg/kg	ND	100,000	310,000	----
Radionuclides							
Americium-241	3	1	pCi/g	0.00422	0.092	1.9	----
Carbon-14	6	1	pCi/g	ND	4,200	770	----
Cesium-137	6	6	pCi/g	0.0549	0.1	0.02	----
Cobalt-60	6	3	pCi/g	0.013	0.022	0.0043	----
Lead-210	6	6	pCi/g	1.75	9.6	0.78	----
Plutonium-241	3	0	pCi/g	ND	3.2	150	----
Strontium-90	3	3	pCi/g	0.211	10	14	----
Thorium-234	6	6	pCi/g	0.65	3.2	None	----
Tritium	3	0	pCi/g	ND	5.4	11,000	----
Uranium-235/236	3	3	pCi/g	0.0439	0.15	0.16	----
SVOCs							
Acenaphthene	6	3	µg/kg	818	250,000	3,700,000	----
Anthracene	6	3	µg/kg	2,940	1,400,000	22,000,000	----
Benzo(a)anthracene	6	3	µg/kg	14,400	1,199	620	COC
Benzo(a)pyrene	6	2	µg/kg	788	237	62	COC
Benzo(b)fluoranthene	6	3	µg/kg	8,330	2,613	620	COC
Benzo(g,h,I)perylene	6	1	µg/kg	28.7	9,100,000	None	----
Benzo(k)fluoranthene	6	3	µg/kg	7,000	26,132	610	COC
bis(2-Ethylhexyl)phthalate	6	6	µg/kg	387	7,700	35,000	----

Table E-3. Determination of Domestic Septic System 6 Constituents of Concern—Risk-Based Action Standard Greater than or Equal to Background (continued)

Potential COC	Number of Samples	Number of Detections	Units	Max. Detected Concentration/RME	Lowest RBAS	Residential Soil PRG	COC Determination
SVOCs cont'd							
Carbazole	6	3	µg/kg	1,080	2,226	2,400	COC
Chrysene	6	3	µg/kg	10,800	20,269	6,100	----
Di-n-butylphthalate	6	0	µg/kg	ND	890,000	6,100,00	----
Di-n-octylphthalate	6	0	µg/kg	ND	4,900,000	1,200,000	----
Dibenzo(a,h)anthracene	6	3	µg/kg	2,980	261	62	COC
Dibenzofuran	6	2	µg/kg	561	14,000	290,000	----
Diethyl phthalate	6	0	µg/kg	ND	22,0000	49,000,000	----
Fluoranthene	6	3	µg/kg	20,000	1,800,000	2,300,00	----
Fluorene	6	2	µg/kg	1,120	170,000	2,600,000	----
Indeno(1,2,3-cd)pyrene	6	3	µg/kg	1,260	2,613	620	COC
Naphthalene	6	1	µg/kg	274	39,000	56,000	----
Pentachlorophenol	6	0	µg/kg	ND	13,351	3,000	----
Phenanthrene	6	3	µg/kg	8,310	1,200,000	None	----
Pyrene	6	3	µg/kg	4,730	490,000	2,300,000	----
VOCs							
2-Butanone	6	0	µg/kg	ND	12,000	7,300,000	----
Acetone	6	4	µg/kg	13	1,700	1,600,000	----
Benzene	6	0	µg/kg	ND	14.7	650	----
Carbon Tetrachloride	6	0	µg/kg	ND	55.3	240	----
Ethylbenzene	6	1	µg/kg	0.682	10,000	230,000	----
Methylene Chloride	6	3	µg/kg	4.82	132	8,900	----
Styrene	6	0	µg/kg	ND	76,000	1,700,000	----
Toluene	6	2	µg/kg	204	19,000	520,000	----
Xylenes (total)	6	2	µg/kg	4.51	700,000	210,000	----

Abbreviations

BHC	hexachlorobutadiene
COC	constituent of concern
DDD	dichlordiphenyl dichlor
DDE	dichlordiphenyl dichloroethylene
DDT	dichlordiphenyl trichlor
Max.	maximum
mg/kg	milligrams per kilogram
ND	not detected
PCBs	polychlorinated biphenyls
pCi/g	picoCuries per gram
PRG	preliminary remediation goal
RBAS	risk-based action standard
RME	reasonable maximum exposure concentration
SVOCs	semivolatile organic compounds
VOCs	volatile organic compounds
µg/kg	micrograms per kilogram

Table E-4. Determination of Domestic Septic System 6 Constituents of Concern—Risk-Based Actions Standard Less than Background

Potential COC	Number of Samples	Number of Detections	Units	Maximum Detected Concentration	Background Value [1]	Is Maximum Concentration Greater than Background ?	WRS Test Result	COC Determination
Metals								
Antimony	6	6	mg/kg	1.9	1.4	Yes	Pass [2]	----
Barium	6	6	mg/kg	221	211	Yes	Fail	COC
Cadmium	6	6	mg/kg	0.27	0.51	No	N/A	----
Copper	6	6	mg/kg	75.2	48.8	Yes	Fail	COC
Lead	16	16	mg/kg	9.6	9.5	Yes	Pass	----
Manganese	6	6	mg/kg	709	750	No	N/A	----
Mercury	31	29	mg/kg	101	0.248	Yes	Fail	COC
Radionuclides								
Radium-226	6	6	pCi/g	0.89	0.752	Yes	Pass	----
Thorium-228	3	3	pCi/g	0.499	0.627	No	N/A	----
Thorium-232	3	3	pCi/g	0.429	0.63	No	N/A	----

Notes

[1] Background value is the 80% lower confidence limit on the 95th quantile determined from background sample results.
[2] Noether calculation indicates the number of samples may not be sufficient for WRS test.
> 4 ft bgs = Data represent native soil deeper than four feet below ground surface for analytes that show stratification with depth.

Abbreviations

COC	constituent of concern
mg/kg	milligrams per kilogram
N/A	not applicable
pCi/g	picoCuries per gram
WRS Test	Wilcoxon Rank Sum test