APPENDIX A

Industrial Area Sampling and Analysis Plan Modifications

APPENDIX B

Draft Industrial Area Sampling and Analysis Plan
Example Addendum
Industrial Area Group 700-4

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ACRONYM LIST

D&D	Decontamination and Decommissioning
DQO	Data Quality Objective
IA	Industrial Area
IASAP	Industrial Area Sampling and Analysis Plan
IHSS	Individual Hazardous Substance Site
IWCP	Integrated Work Control Package
KOH	potassium hydroxide
NaOH	sodium hydroxide
OPWL	Original Process Waste Line
OU	Operable Unit
PAC	Potential Area of Concern
PCOC	potential contaminant of concern
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RWP	Radiological Work Permit
SAP	Sampling and Analysis Plan
SVOC	semivolatile organic compound
UBC	Under Building Contamination
VOC	volatile organic compound

1.0 INTRODUCTION

This Industrial Area (IA) Sampling and Analysis Plan (SAP) (IASAP) Addendum for IA Group 700-4 includes IA Group-specific information, sampling locations, and potential contaminants of concern (PCOCs) for all Individual Hazardous Substance Sites (IHSSs), Potential Areas of Concern (PACs), and Under Building Contamination (UBC) Sites in IA Group 700-4. The location of IA Group 700-4 and all IHSSs, PACs, and UBC Sites in this group are shown on Figure B1.

2.0 EXISTING INFORMATION

Existing data for the IHSSs, PACs, and UBC Sites in IA Group 700-4 are available in Appendix C to the IASAP. Additional information gathered during Decontamination and Decommissioning (D&D), and initial UBC characterization is summarized below.

2.1 Potential Contaminants of Concern

PCOCs in IA Group 700-4 are presented by IHSS, PAC, and UBC Site in Table B1.

2.2 Existing Data Maps

Existing analytical data for IA Group 700-4 are shown on Figure B2. All analytical results, greater than background plus two standard deviations for metals and radionuclides or above detection limits for organics, are shown in accordance with IASAP data quality objectives (DQOs) (Section 3.0 of the IASAP).

3.0 SAMPLING LOCATIONS

Sampling locations will be based on two characterization phases. An initial UBC characterization phase will be conducted to evaluate potential contamination and health and safety concerns. This phase of sampling will take place before the demolition of the buildings. The initial UBC characterization phase will consist of biased sampling in areas of known or suspected contaminant releases. Figure B3 illustrates the Building 771 early characterization sampling locations. Sampling locations may change based on D&D reconnaissance-level characterization and D&D sampling results.

The second phase of sampling will occur when the buildings have been demolished and will include all of IA Group 700-4. Figure B4 shows proposed biased sampling locations based on existing data, early characterization sampling locations, and IASAP approaches. Sampling locations may change based on initial UBC characterization results. The majority of sampling locations are based on an equilateral triangular grid with a 36-foot grid spacing as shown on Figure B5. In IHSSs 126.1 and 150.3, the grid alignment is biased along known OPWL leaks. Additionally, the sampling locations take into account existing data (IHSSs 150.1, 150.3, and 163.1).

4.0 PROJECT ORGANIZATION

The project organization is shown on Figure B6.

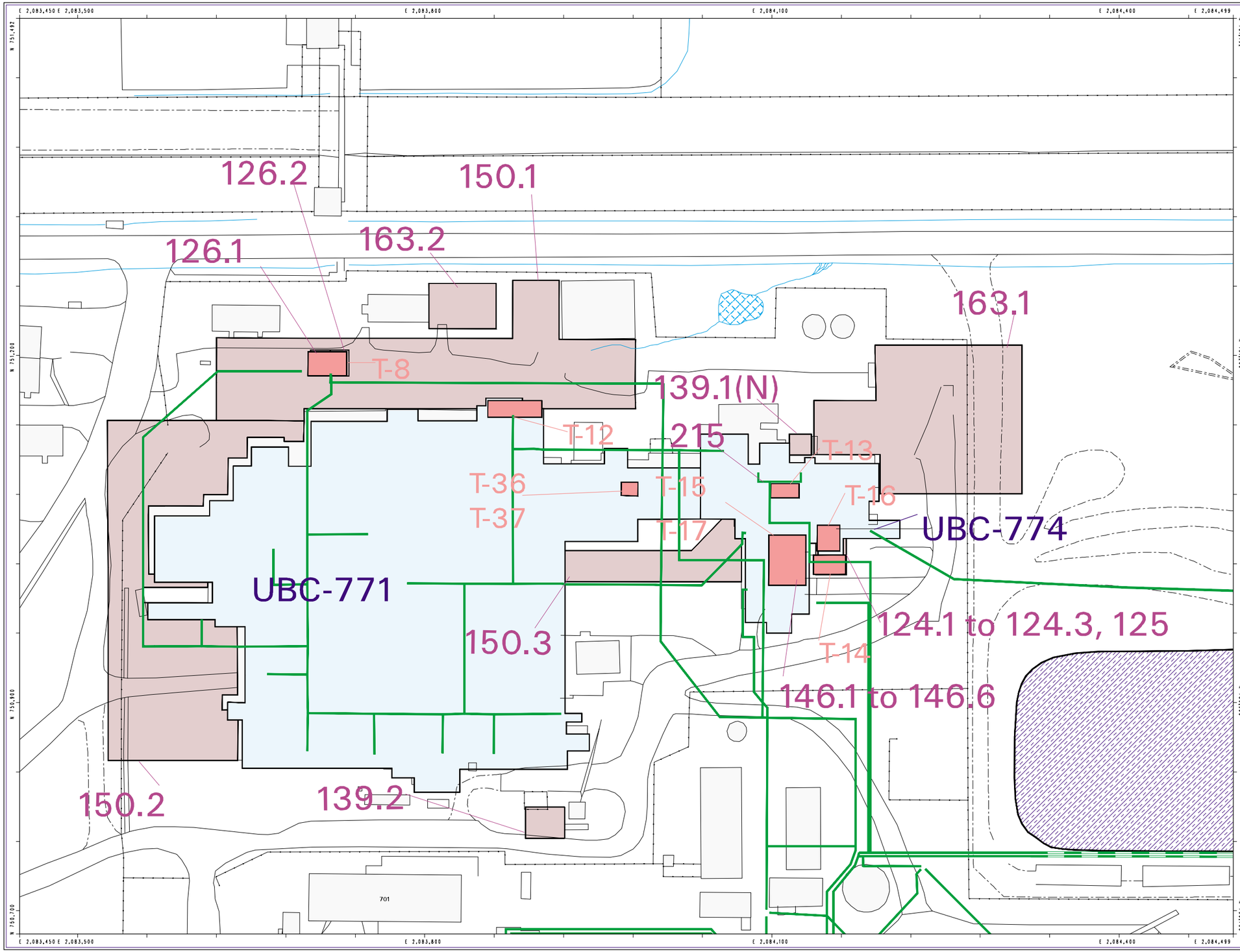

Figure B1
Location Map

EXPLANATION

700-4 IHSS

700-4 UBC

700-4 Tank

Standard Map Features

Buildings and other structures

Solar Evaporation Ponds (SEPs)

Lakes and ponds

Streams, ditches, or other drainage features

Fences and other barriers

Paved roads

Dirt roads

Industrial Area Operable Unit Boundary

Original Process Waste Lines

Location of Original Process Waste Lines that may have been removed

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs, 1/95

Data Source:
IHSS data approved by Nick Demos (RMRS) 303-966-4605.

Scale = 1 : 1020
1 inch represents 85 feet

25 0 50 100 ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

DRAFT

MAP ID: 01-0240

September 06, 2001

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Table B1
IA Group 700-4 Potential Contaminants of Concern

IHSS/PAC/UBC Site	Potential Contaminants of Concern	Data Source	Analytes	Sample Type	Sampling Location Method
UBC 771- Plutonium and Americium Recovery Operations	Trichloroethylene Americium Plutonium	Process Knowledge	Radionuclides Volatile Organic Compounds (VOCs) Semi Volatile Organic Compounds (SVOCs) Metals	Surface and subsurface soil to 6 feet	Biased toward known leaks, spills, and OPWL and Statistical Grid
UBC 774 – Liquid Process Waste Treatment	Americium Plutonium	Process Knowledge	Radionuclides VOCs SVOCs Metals	Surface and subsurface soil to 6 feet	Biased towards known leaks, spills, and OPWL and Statistical Grid
IHSS 150.2 – Radioactive Site West of Buildings 771/776	Plutonium	Process Knowledge	Radionuclides	Surface soil	Statistical Grid
IHSS 163.1 – Radioactive Site 700 North of Building 774 Wash Area	Plutonium SVOCs	Analytical Data (Operable Unit [OU] 8 RCRA Facility Investigation/ Remedial Investigation [RFI/RI]) Radionuclides VOCs SVOCs Metals	Radionuclides SVOCs	Surface soil Subsurface soil to 6 feet	Biased to not overlap with existing sampling locations Statistical Grid

IHSS/PAC/UBC Site	Potential Contaminants of Concern	Data Source	Analytes	Sample Type	Sampling Location Method
IHSS 163.2 – Radioactive Site 700 Area 3 Americium Slab	Americium Plutonium Nitrate	Process Knowledge	Radionuclides Inorganics	Surface soil and subsurface soil to 2 feet below slab	Biased around slab
IHSS 215 – Abandoned Sump Near Building 774 Unit 55.13 T-40	Silver Plutonium Uranium Nitrate	Process Knowledge	Radionuclides Metals Inorganic	Surface and subsurface soil to 6 feet	Biased around sump
IHSS 139(N)(b) – Hydroxide Tank, KOH, NaOH Condensate	Potassium Hydroxide	Process Knowledge	Inorganics	Surface soil	Biased around tank
IHSSs 124.1, 124.2, and 124.3 – Tanks	Plutonium Uranium Nitrate	Process Knowledge	Radionuclides	Surface soil and subsurface soil to 2 feet below tanks	Biased around tanks
IHSS 125 – Holding Tank	Plutonium Uranium Nitrate	Process Knowledge	Radionuclides VOCs SVOCs Metals	Surface soil and subsurface soil to 2 feet below tank	Biased around tank
IHSS 126.1 and 126.2 – Out of Service Process Waste Tanks	Plutonium Uranium Nitrate Other constituents	Process Knowledge	Radionuclides VOCs SVOCs Metals	Surface and subsurface soil to 2 feet below tanks	Biased around tanks
IHSS 121 – OPWL Tank 8, East and West Process Tanks	Plutonium Uranium Solvents Metals Oil PCBs Silver	Process Knowledge	Radionuclides VOCs SVOCs Metals	Surface and subsurface soil to 2 feet below tanks	Biased around tanks

IHSS/PAC/UBC Site	Potential Contaminants of Concern	Data Source	Analytes	Sample Type	Sampling Location Method
IHSS 121 – OPWL, Tank 12, Two Abandoned 20,000-Gallon Underground Concrete Tanks	Plutonium Uranium Nitrate	Process Knowledge	Radionuclides	Surface and subsurface soil to 2 feet below tanks	Biased around tanks
IHSS 121 – OPWL, Tank 13, Abandoned Sump – 600 Gallons	Plutonium Uranium Nitrate	Process Knowledge	Radionuclides	Surface and subsurface soil to 2 feet below tank	Biased around tank
IHSS 121 – OPWL, Tank 14, 30,000-Gallon Concrete Underground Storage Tank	Plutonium Uranium Metals Nitrate Acids Bases	Process Knowledge	Radionuclides VOCs SVOC Metals	Surface and subsurface soil to 2 feet below tank	Biased around tank
IHSS 121 – OPWL, Tank 15, Two 7,500-Gallon Process Waste Tanks	Plutonium Uranium Nitrate	Process Knowledge	Radionuclides	Surface and subsurface soil to 2 feet below tanks	Biased around tanks
IHSS 121 – OPWL, Tank 16, Two 30,000-Gallon Concrete Underground Storage Tanks	Plutonium Uranium Nitrate Metals	Process Knowledge	Radionuclides Metals	Surface and subsurface soil to 2 feet below tanks	Biased around tanks
IHSS 121 – OPWL, Tank 17, Four Concrete Process Waste Tanks	Plutonium Uranium Nitrate	Process Knowledge	Radionuclides	Surface and subsurface soil to 2 feet below tanks	Biased around tanks
IHSS 121 – OPWL, Tank 36, Steel Carbon Tetrachloride Sump	Carbon Tetrachloride	Process Knowledge	VOCs	Surface and subsurface soil to 2 feet below sump	Biased around sump

IHSS/PAC/UBC Site	Potential Contaminants of Concern	Data Source	Analytes	Sample Type	Sampling Location Method
IHSS 121 – OPWL, Tank 37, Steel-Lined Concrete Sump	Plutonium Uranium Nitrate	Process Knowledge	Radionuclides	Surface and subsurface soil to 2 feet below sump	Biased around sump
IHSS 139.2 – Caustic/Acid Spills Hydrofluoric Tank	Hydrofluoric Acid	Process Knowledge	Inorganics	Surface soil	Biased around tank
IHSS 146.1, 146.2, 146.3, 146.4, 146.5, and 146.6, Process Waste Tanks	Plutonium Uranium Acids Caustics	Process Knowledge	Radionuclides VOCs SVOCs	Surface and subsurface soil to 2 feet below tanks	Biased around tanks
IHSS 150.1 – Radioactive Site North of Building 771	Aluminum Arsenic Barium Cobalt Copper Iron Lead Manganese Nickel Silver Strontium Vanadium Zinc Anthracene Benzo(k)fluoranthene Bis(2-ethylhexyl)phthalate Fluorene	Analytical Data (OU 8 RFI/RI) Radionuclides VOCs SVOCs Metals	Radionuclides VOCs SVOCs Metals	Surface and subsurface soil to 6 feet	Biased around OPWL and to not overlap with existing sampling locations
IHSS 150.3 – Radioactive Site Between Buildings 771 and 774	Aluminum Arsenic	Analytical Data (OU 8 RFI/RI)	Radionuclides VOCs	Surface soil and subsurface	Biased around OPWL and to not

IHSS/PAC/UBC Site	Potential Contaminants of Concern	Data Source	Analytes	Sample Type	Sampling Location Method
	Barium Cobalt Copper Iron Lead Manganese Nickel Vanadium Zinc Anthracene Fluoranthene Pyrene	Radionuclides VOCs SVOCs Metals	SVOCs Metals	soil to 6 feet	overlap with existing sampling locations

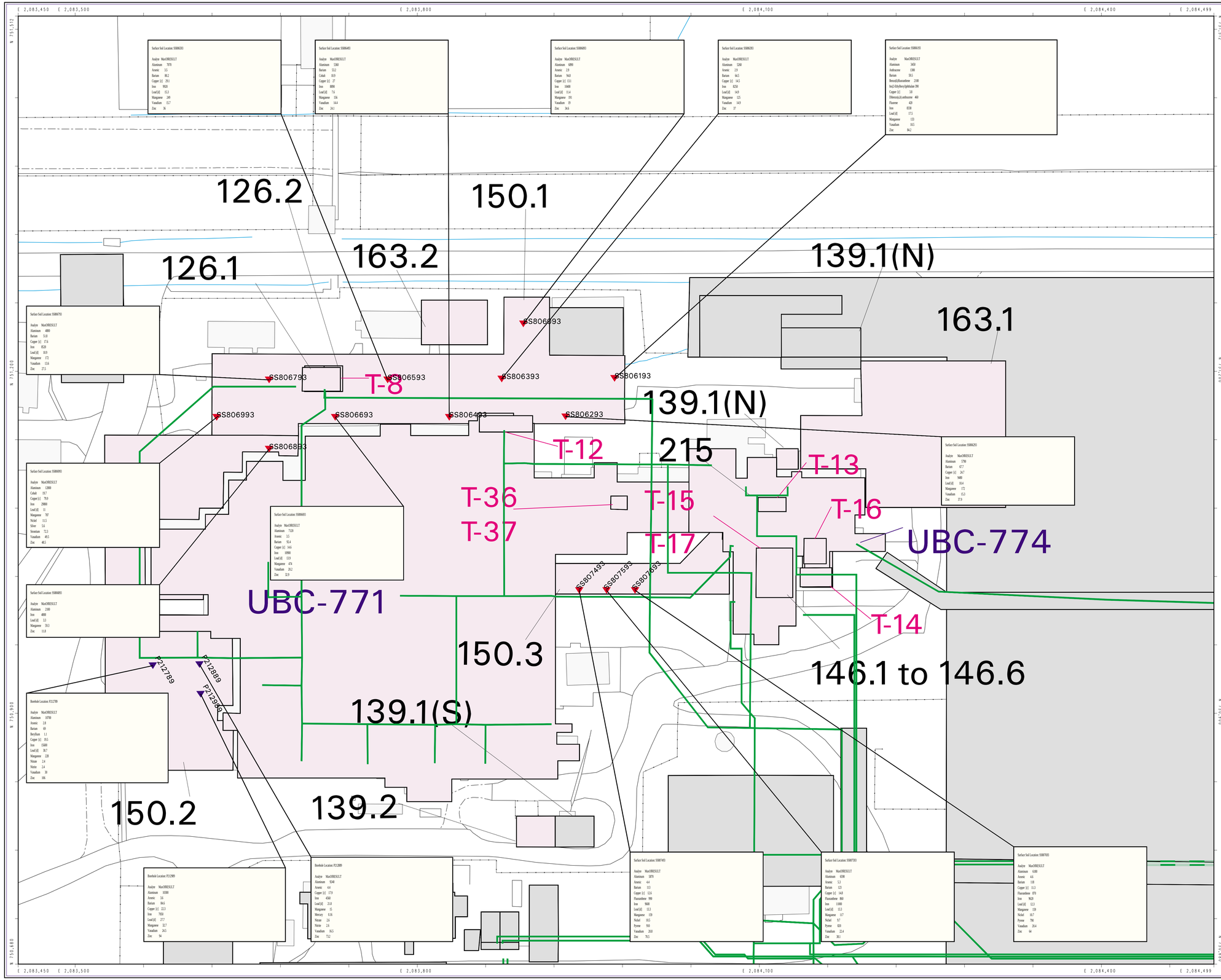

Figure B2
Draft
Existing Data

EXPLANATION

Surface Soil Sampling Location

Borehole Soil Sampling Location

IHSS Groupings

700-4

Other IA Groups

Standard Map Features

Buildings and other structures

Solar Evaporation Ponds (SEPs)

Lakes and ponds

Streams, ditches, or other drainage features

Fences and other barriers

Paved roads

Dirt roads

Industrial Area Operable Unit Boundary

Original Process Waste Lines

Location of Original Process Waste Lines that may have been removed

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95
Data Source:
IHSS data approved by Nick Demos (RMRS) 303-966-4605.

Scale = 1 : 490
1 inch represents approximately 41 feet

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by:
DynCorp
THE ART OF TECHNOLOGY

Prepared for:
KAISER•HILL COMPANY

MAP ID: 2k-0404

September 06, 2001

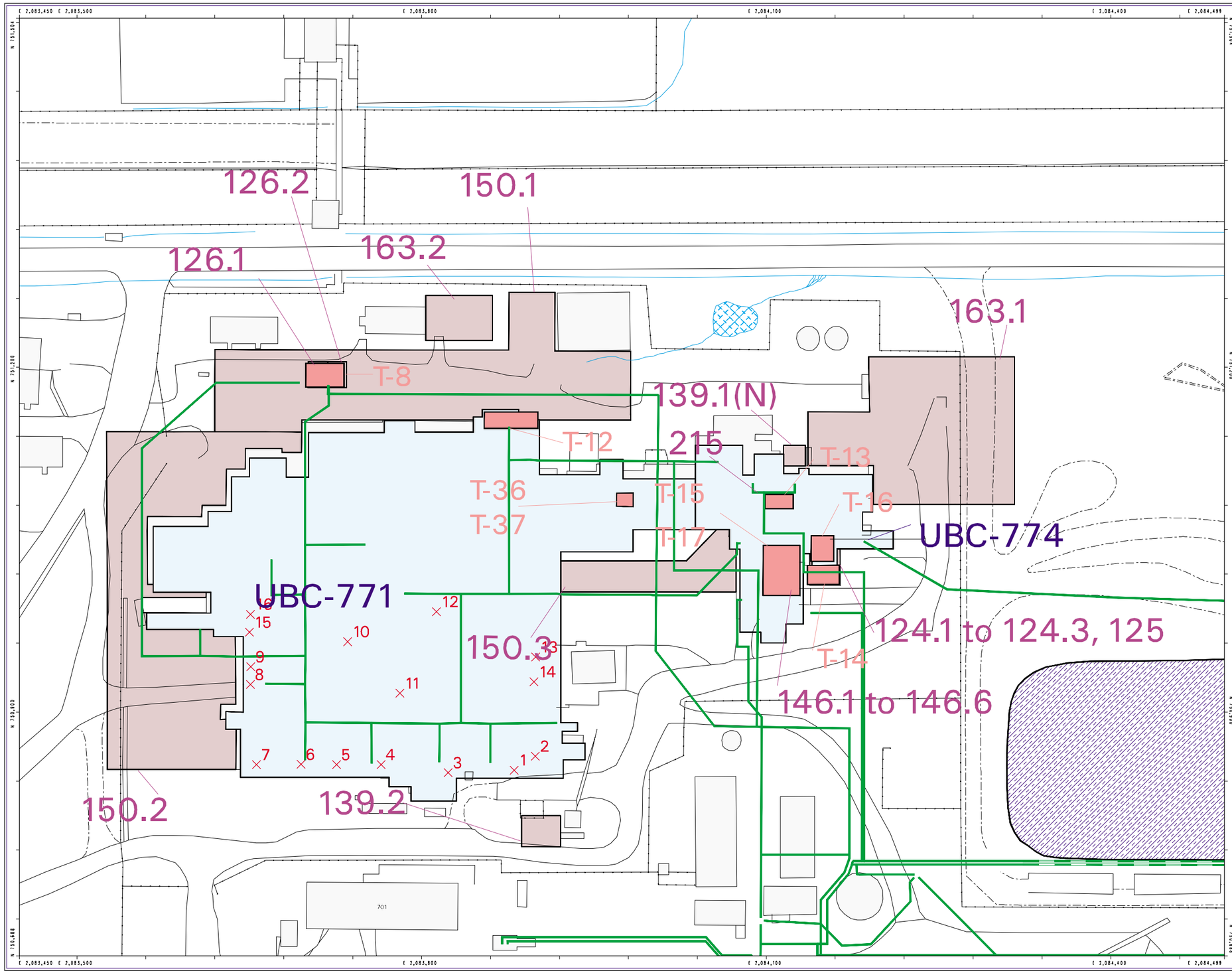

Figure B3
Building 771
Initial Sampling Locations

EXPLANATION

700-4 IHSS

700-4 UBC

700-4 Tank

Standard Map Features

Buildings and other structures

Solar Evaporation Ponds (SEPs)

Lakes and ponds

Streams, ditches, or other drainage features

Fences and other barriers

Paved roads

Dirt roads

Industrial Area Operable Unit Boundary

Original Process Waste Lines

Location of Original Process Waste Lines that may have been removed

Boring Location

Surface Soil Sampling Location

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs. 1/95
Data Source:
IHSS data approved by Nick Damos (RMRS) 303-966-4605.

Scale = 1 : 1050
1 inch represents approximately 88 feet

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

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MAP ID: 01-0240

September 06, 2001

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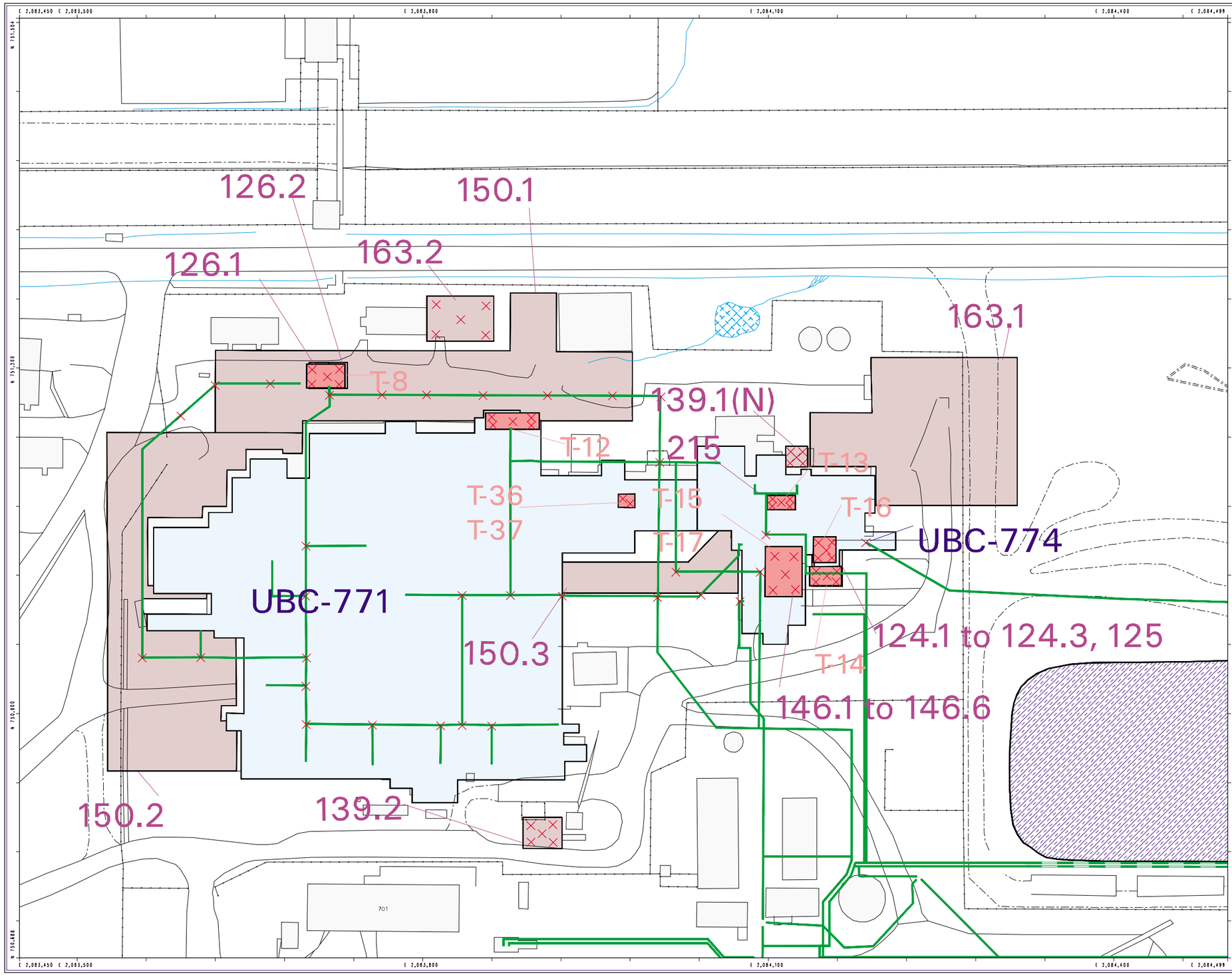

Figure B4
IA Group 700-4
Biased Sampling Locations

EXPLANATION

- 700-4 IHSS
- 700-4 UBC
- 700-4 Tank

Standard Map Features

- Buildings and other structures
- Solar Evaporation Ponds (SEPs)
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Paved roads
- Dirt roads
- Industrial Area Operable Unit Boundary
- Original Process Waste Lines
- Location of Original Process Waste Lines that may have been removed
- Boring Location
- Surface Soil Sampling Location

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs. 1/95
Data Source:
IHSS data approved by Nick Damos (RMRS) 303-966-4605.

Scale = 1 : 1050
1 inch represents approximately 88 feet

25 0 50 100ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

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MAP ID: 01-0240

September 06, 2001

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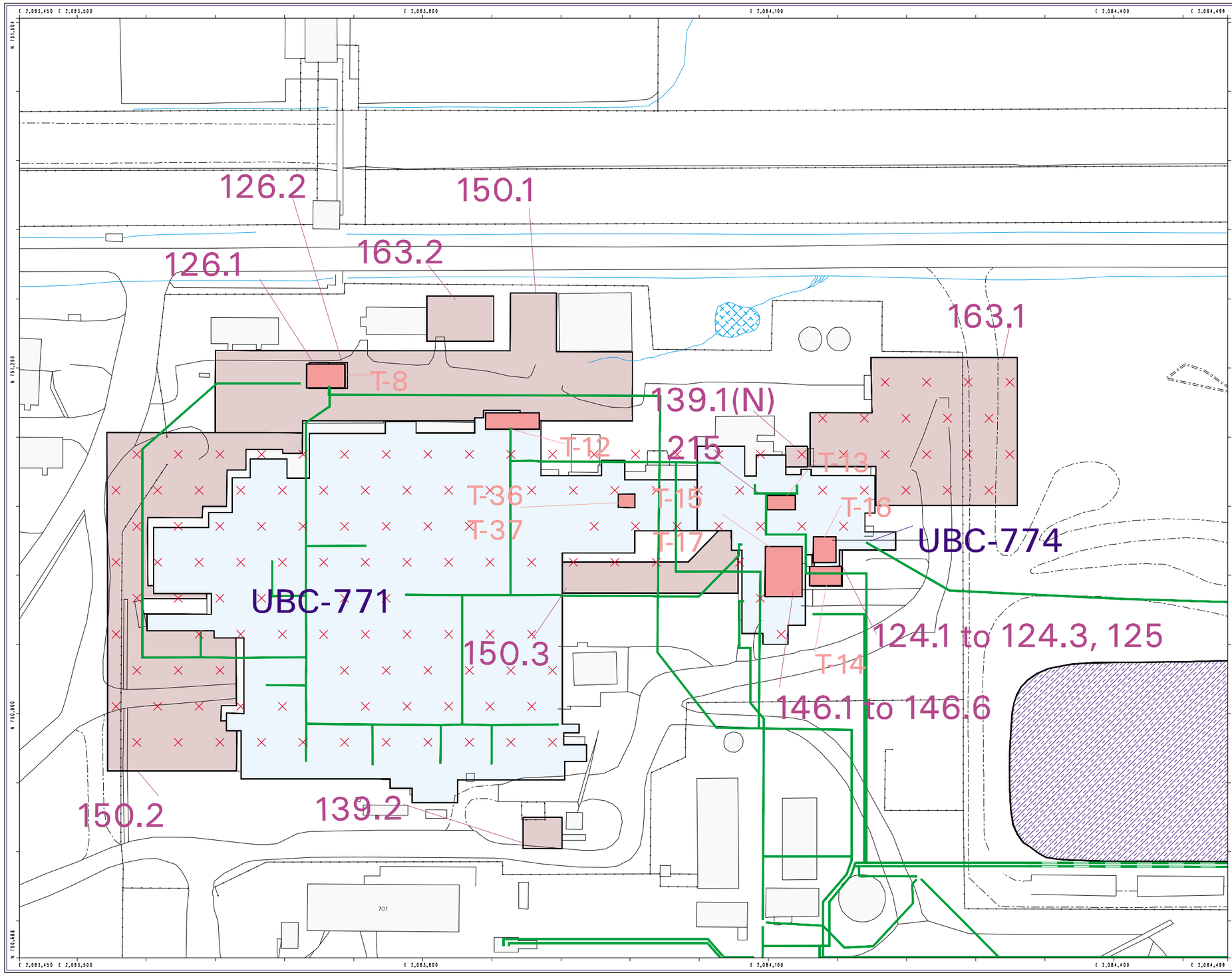

Figure B5
IA Group 700-4
Statistical Grid Sampling Locations

EXPLANATION

700-4 IHSS

700-4 UBC

700-4 Tank

Standard Map Features

Buildings and other structures

Solar Evaporation Ponds (SEPs)

Lakes and ponds

Streams, ditches, or other drainage features

Fences and other barriers

Paved roads

Dirt roads

Industrial Area Operable Unit Boundary

Original Process Waste Lines

Location of Original Process Waste Lines that may have been removed

Boring Location

Surface Soil Sampling Location

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs. 1/95
Data Source:
IHSS data approved by Nick Damos (RMRS) 303-966-4605.

Scale = 1 : 1050
1 inch represents approximately 88 feet

25 0 50 100ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

DRAFT

MAP ID: 01-0240

September 06, 2001

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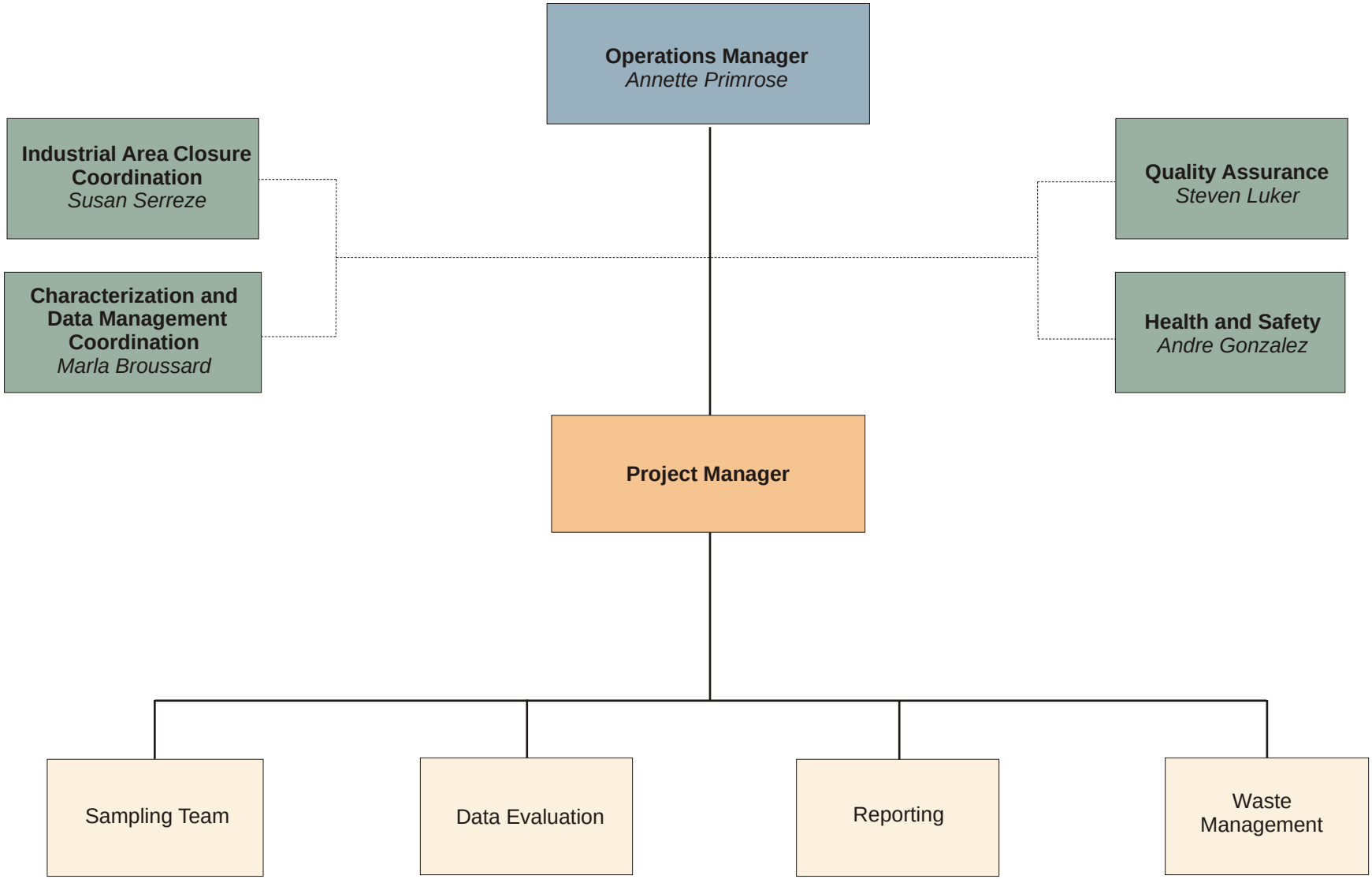
Figure B6
Industrial Area Group Characterization
Project Organization



5.0 IA GROUP 700-4 SPECIFIC DATA QUALITY OBJECTIVES

There are no IA Group 700-4-specific DQOs.

6.0 IA GROUP 700-4 SPECIFIC SAMPLING AND ANALYTICAL METHODS

The initial round of sampling at UBC Sites 771, 774, and 707 will consist of drilling through the building slabs and sampling soil directly beneath the slabs in accordance with the IASAP. These samples will be collected so that health and safety concerns can be addressed before the slabs are removed. Sampling locations will target areas of suspected contamination such as OPWL and documented spills. Figure B3 illustrates the proposed sampling locations in Building 771.

7.0 IA GROUP 700-4 SPECIFIC HEALTH AND SAFETY REQUIREMENTS

Health and safety requirements are contained in the Integrated Work Control Packages (IWCPs), as appropriate. In addition, work will be conducted under Radiological Work Permits (RWPs), as applicable. A readiness review will be conducted before the start of fieldwork for all IA Groups.

UBC Site initial characterization may result in hazards not normally encountered during routine field activities. Specific additional hazards that will be addressed include the following:

- Ventilation – Carbon monoxide emissions from combustible engines (e.g., Geoprobe rig) may result in respiratory distress. All combustible engine emissions will be diverted to an outside ventilation duct.

- Heavy Equipment Access – Maneuvering heavy equipment through building corridors will require appropriate transportation and restraining devices.

- Radiological Hazards – Radiological hazards are expected to be much higher within Buildings 771 and 774. Characterization activities will be performed in accordance with the building-specific Health and Safety Plan.

8.0 IA GROUP 700-4 SPECIFIC QUALITY ASSURANCE PROTOCOLS

There are no IA Group 700-4-specific quality assurance requirements for this project.

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Existing Data Compilation

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Acronyms

AEC	U.S. Atomic Energy Commission
AL	action level
ALF	Action Levels and Standards Framework for Surface Water, Groundwater, and Soils
Am	americium
AST	aboveground storage tank
bgs	below ground surface
BNA	base neutral acid
CDPHE	Colorado Department of Public Health and Environment
CEARP	Comprehensive Environmental Assessment and Response Program
CERCLA	Comprehensive Environment Response, Compensation, and Liability Act
cm^2	square centimeter
CPIR	Contingency Plan Implementation Report
cpm	counts per minute
CSV	Central Storage Vault
CWTS	Caustic Waste Treatment System
D&D	Decontamination and Decommissioning
DCHP	dicesium hexachloroplutonate
DOE	U.S. Department of Energy
dpm	disintegrations per minute
dpm/m^3	disintegrations per minute per cubic meter
dpm/g	disintegrations per minute per gram
dpm/k	disintegrations per minute per kilogram
dpm/L	disintegrations per minute per liter
dpm/m^2	disintegrations per minute per square meter
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
FIDLER	Field Instrument for the Detection of Low Energy Radiation
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
ft^2	square feet
ft^3	cubic feet
GC/MS	gas chromatography/mass spectrometry
g/L	grams per liter
gpm	gallons per minute
GPR	ground-penetrating radar
HAER	Historic American Engineering Record
HASP	Health and Safety Plan
HEPA	high-efficiency particulate air
HNO_3	nitric acid
HPGe	High Purity Germanium
HRR	Historical Release Report
HVAC	heating, ventilation, and air conditioning
IA	Industrial Area
IAG	Interagency Agreement

IASAP	Industrial Area Sampling and Analysis Plan
IHSS	Individual Hazardous Substance Site
IIR	Internal Investigation Report
I/O	input/output
ITPH	Interceptor Trench Pump House
ITS	Interceptor Trench System
kg	kilogram
KOH	potassium hydroxide
LLW	low-level waste
LSA	low specific activity
m^2	square meter
mCi	millicurie
MDL	method detection limit
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MPL	maximum permissible limit
mr/hr	millirems per hour
NaI	sodium iodide
NaOH	sodium hydroxide
NCR	no carbon required
NFA	no further action
NPDES	National Pollutant Discharge Elimination System
NPWL	New Process Waste Line
OPWL	Original Process Waste Line
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PA	Protected Area
PAC	Potential Area of Concern
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
pCi/g	picocuries per gram
pCi/L	picocuries per liter
pCi/m^3	picocuries per cubic meter
PCOC	potential contaminant of concern
PMJM	Preble's meadow jumping mouse
ppm	parts per million
PROVE	Plutonium recovery operations verification exercise
PSZ	Perimeter Security Zone
Pu	plutonium
PU&D	Property Utilization and Disposition
PuF_4	plutonium tetrafluoride
PVC	polyvinyl chloride
Ra	radium
RCRA	Resource Conservation and Recovery Act
RCT	radiological control technician
RFCA	Rocky Flats Cleanup Agreement

RFP	Rocky Flats Plant
RFETS	Rocky Flats Environmental Technology Site
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RLCR	Reconnaissance-Level Characterization Report
RMRS	Rocky Mountain Remediation Services, LLC
S&W	Swinerton and Walberg
SAP	Sampling and Analysis Plan
SEP	Solar Evaporation Ponds
Site	Rocky Flats Environmental Technology Site
SNM	special nuclear material
S-R	Stacker-Receiver
SS&C	sand, slag, and crucible
SVOC	semivolatile organic compound
TAL	Target Analyte List
TCA	trichloroethane
TCE	trichloroethene
TCFM	trichlorofluoromethane
TCLP	Toxicity Characteristic Leaching Procedure
Th	thorium
TRU	transuranic
U	uranium
UBC	Under Building Contamination
ugm/m^3	microgram meter per cubic meter
UST	underground storage tank
VOC	volatile organic compound
WSRIC	Waste Stream and Residue Identification and Characterization
µg/g	micrograms per gram
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
$\mu g/m^2$	micrograms per square meter
$\mu g/m^3$	micrograms per cubic meter
yd^3	cubic yards

INTRODUCTION

This existing data compilation for the Rocky Flats Environmental Technology Site (RFETS or Site) Industrial Area (IA) Sampling and Analysis Plan (SAP) (IASAP) has been derived from a number of sources. The Historical Release Report (HRR) (DOE 1992a), first released in 1992 and updated yearly, contains information on all Individual Hazardous Substance Sites (IHSSs), Potential Areas of Concern (PACs), and Under Building Contamination (UBC) Sites. Information on many of the IHSSs and all of the PACs has been gathered from the HRR (DOE 1992a). In 1994 and 1995, Resource Conservation and Recovery Act (RCRA) Facility Investigations/Remedial Investigations (RFI/RIs) were initiated at Operable Units (OUs) 8, 9, 10, 12, 13, and 14. The types of results from these RFI/RIs vary and have never been published. Information from these RFI/RIs may include detailed historical information, validated analytical data, unvalidated analytical data, and High Purity Germanium (HPGe) survey data. Data have been included when available. Associated with these OU studies are the RFI/RI work plans, which are used as appropriate. The complete set of surface and subsurface soil data for the IA are presented in the IA Data Summary Report (DOE 2000a).

Descriptions of UBC Sites were gathered from current Decontamination and Decommissioning (D&D) plans, Waste Stream and Residue Identification and Characterization (WSRIC) documents, Historic American Engineering Record (HAER) for RFETS, and other Site documents.

This data compilation is organized by IA Group. A map of the IA Groups, IHSSs, PACs, and UBC Sites is included as Figure 1 of the IASAP.

GROUP 000-1

Solar Evaporation Ponds IHSS 000-101

The Solar Evaporation Ponds (SEP) (IHSS 101) are located on the northeastern side of the Protected Area (PA) and consist of five surface impoundments: Ponds 207-A, 207-B North, 207-B Center, 207-B South, and 207-C. The major features in IHSS 101 are the SEP, Original Pond, Effluent Line IHSS 700-149.1 Interceptor Trench System (ITS), and areas in the immediate vicinity including IHSS 176 (Swinerton and Walberg [S&W] Contractor Storage Yard) (DOE 1995).

The SEP were used to store and evaporate low-level radioactive process wastes and neutralized acidic wastes containing high levels of nitrate and aluminum hydroxide. The SEP also received additional wastes, including treated sanitary effluent, aluminum scrap, alcohol wash solutions, drums of radiography solutions, leachate from the RFETS sanitary landfill, ITS groundwater, saltwater, personnel decontamination wash water, hydrochloric and nitric acids (HNO_3), hexavalent chromium, and cyanide wastes. The original pond was constructed in 1953 and used until 1956. Pond 207-A was placed in service in 1956. Ponds 207-B North, Center, and South were placed in service in 1960, and Pond 207-C was constructed in 1970 (DOE 1995).

In the 1980s, SEP use was phased out and transfer of process wastewater into the ponds ceased in 1986. Cleanup activities began in 1985 to drain and treat the liquid waste and process the pond sludges (DOE 1995). All SEP were drained and the sludge was removed in 1995.

Contamination in surface soil was investigated by conducting a gamma survey and collecting 72 soil samples in the SEP area and 38 soil samples in IHSS 176. The metal and radionuclide concentrations that exceeded background levels are located in the immediate vicinity of the ponds, primarily on the berms between ponds. In the SEP area, the maximum concentration of beryllium was 9.6 milligrams per kilogram (mg/kg), above Rocky Flats Cleanup Agreement (RFCA) Tier II action levels (ALs). Cadmium was detected at 382 mg/kg, well below the Tier II level. The highest activities of americium (Am)-241 were present on the berms of Pond 207-A, with a maximum value of 220 picocuries per gram (pCi/g), above the Tier I AL. Am-241 was present in other surface soil ranging from 0.5 to 27 pCi/g, with the majority of activities below 10 pCi/g.

The distribution of plutonium (Pu)-239/240 in surface soil was similar to Am-241. However, all activities were below the Tier II AL and ranged from 56 pCi/g on the southwestern berm of Pond 207-A to below 20 pCi/g elsewhere in the area. Uranium (U)-233/234 activities were below the Tier II AL and ranged from 1.24 to 41 pCi/g. Only 2 of 39 sample activities exceeded 8 pCi/g. U-235 activities were below the Tier II AL and ranged from 0.09 to 2.3 pCi/g. U-238 activities were below the Tier II AL and ranged from 1.27 to 27 pCi/g.

Subsurface contaminants in the SEP area that exceeded background activities include nitrate, zinc, Am-241, Pu-239/240, radium (Ra)-226, tritium, U-233/234, U-235, and U-238. Of these, only Am-241 activities were above the Tier II AL, with the activity of one sample at 44.68 pCi/g.

Six interceptor trenches and associated sumps were installed on the SEP hillside in 1971. Some of the trenches and sumps were destroyed during construction of the Perimeter Security Zone (PSZ) and the rest were abandoned in place. The ITS was installed in 1981 and consists of gravel-filled trenches approximately 1 foot wide, ranging in depth from approximately 1 to 27 feet below ground surface (bgs). Water collected in the ITS flowed by gravity to the Interceptor Trench Pump House (ITPH) located near North Walnut Creek. Until 1993, the collected water was pumped from the ITPH to Pond 207-B North. In 1993, three 750,000-gallon modular storage tanks were installed on the northern side of North Walnut Creek. At that time, the ITS water was temporarily stored in the modular storage tanks and then pumped to Building 374 for evaporation (DOE 1995).

In 1999, the SEP plume groundwater collection and treatment system was installed to intercept the nitrate- and U-contaminated groundwater derived from the SEP area. The new system collects water from the preexisting ITS and additional groundwater believed to underflow the ITS, and diverts the water to a treatment cell. The groundwater collection system extends approximately 1,100 feet in an east-west direction along the North Perimeter Road. Construction was restricted to the disturbed area around the North Perimeter Road to reduce impacts to Preble's meadow jumping mouse (PMJM) habitat.

Effluent Lines IHSSs 700-149.1 and 700-149.2

In 1972, two 1.5-inch polyvinyl chloride (PVC) pipes were installed to transfer wastes between Building 774 and the 207 SEP. These lines were abandoned in place in 1980 after the vapor compression evaporator in Building 374 was constructed.

While still in use, sometime during June or July 1973, a contractor broke the plastic line that ran from the evaporation ponds to Building 774. Repairs were made and the water continued to be drawn to the ponds.

In the late 1970s, an Original Process Waste Line (OPWL) break southeast of Building 774 resulted in a release of liquid which flowed around to the front of the building. Another, more detailed document reports that on July 21, 1980, an eight-year-old process waste line was discovered leaking southeast of Building 774. Process wastewater was observed seeping into the soil on the south side of the road southeast of Building 774. The leaking process wastewater flowed down slope, through a 30-foot culvert, along the east chain-link fence, and under the fence at the corner. From this point, the liquid flowed under the unpaved access road into a boggy area, the 771/774 Footing Drain Pond, north of Building 774 (PAC 700-1108). The vegetation in the boggy area was damaged where the spilled liquid formed a pool. It was estimated that approximately 1,000 gallons had leaked from the process waste line.

The initial response to the July 1980 incident was to stop the flow through the waste line causing the leak to stop. When the soil dried, a Field Instrument for the Detection of Low Energy Radiation (FIDLER) survey was conducted and verified that the flow did not go beyond the 771/774 Footing Drain Pond. On July 24, the broken waste line was excavated and the problem identified as a loose flange. Soil excavation began July 28, 1980; as soil was excavated, it was surveyed with radiation monitors.

Low-level radioactive wastes containing caustics and acids were released to the environment. Analysis of the spilled water from the July 1980 incident showed 2,500 picocuries per liter (pCi/L) total alpha activity, 4,000 pCi/L gross beta activity, 10,000 milligrams per liter (mg/L) nitrate, and a pH of 12. Other than repair of the pipeline in 1973, documentation was not found for any other response to the leakage from the pipeline.

Triangle Area IHSS 900-165

The Triangle Area is located east of the contractors' storage yard, which is east of the SEP (PAC 000-101) and is bounded by Spruce Avenue and the Northeast Perimeter Road. The area is referred to by many different names including SEP storage yard, Property Utilization and Disposition (PU&D) storage yard, and 779-storage yard. Several incidents of leaking storage drums were noted and are described below.

Drums were first moved into the Triangle Area during the construction of a drum storage area north of Building 883. The contents of the drums stored in the area were recoverable Pu-bearing wastes and residues. Scrap material awaiting Pu recovery was also stored in the triangle area. Examples of the types of scrap stored are graphite molds, crucibles, combustible wastes awaiting incineration, incinerator ash heels, crucible heels, and Raschig

rings. No sludges or oils were stored in the Triangle Area. Some drums contained dilute HNO_3, which contributed to the corrosion of the drums.

In 1968, more than 6,000 drums were still being stored in the open field. High winds in the unprotected area blew over as many as 150 drums at a time. Drums containing fire waste from May 1969 were stored in the Triangle Area until they could be counted at Building 771. Some fire waste was returned to the Triangle Area for storage after being counted.

In 1969, leaks and spills were detected. Specifically, drums with dilute HNO_3 were stored directly on the ground for the winter of 1966/1967. The following spring, the drums were placed on wooden pallets and were to have been double-lined with polyethylene bags with rigid poly drum liners. Drums were stored on wooden pallets until 1971 when they were stored in cargo containers. In 1973, an effort was initiated to transfer all Pu scrap to indoor storage. The drums were monitored and decontaminated according to the criteria used for spills in indoor processing areas. The leaking drums were put into cargo containers in 1973. In 1973, some of the cargo containers were noted to be leaking. Recovered radioactive soil was shipped offsite. Additional soil contamination was discovered and eight drums of soil and palliative agents were shipped offsite.

Radioactively contaminated salts from the SEP were often blown across the S&W Contractor Storage Yard (PAC 900-176) into the area and onto the drums. The integrity of drums was damaged by collected condensation and from being blown over by wind. In 1969, approximately 292 drums were discovered to be leaking. As a result, approximately 200 square feet (ft^2) of soil received high-level contamination.

In summer 1973, two drums containing incinerator ash heels leaked through the floor of the cargo container in which they were stored. After this leak the inside floors of all cargo containers were fiberglassed for added containment. Alpha surveys were performed when drums or cargo boxes were moved from the area. The surveys were limited to the area where the drum or box had been. In addition, alpha and gamma surveys of the entire area were conducted in August 1974. The first FIDLER survey was probably performed in September 1974 and surveys continued until mid-1975. Surveys were performed periodically since then and areas of soil were removed as appropriate.

In June 1973, 200 yards of Pu-contaminated soil were temporarily stored in the eastern side of the Triangle Area. The soil came from the excavation of waste storage tanks near Building 774 (PAC 700-146). In September 1973, the 200 yards of Pu-contaminated soil were removed to the Present Landfill (PAC NW-114).

S&W Contractor Yard IHSS 000-176

The S&W Contractor Storage Yard lies approximately 50 feet east of the SEP in the vicinity of Building 964. The site is approximately 290 by 390 feet in area, according to the Interagency Agreement (IAG) (DOE et al. 1991); however based on aerial photographs, the actual area used for storage appears to be considerably larger.

Since 1970, the storage yard has been used for storage of contractor materials used in various projects at the Site. Drummed storage occurred from 1970 to 1985. Containers were stored

in numerous areas at the site throughout this time. The amount of waste stored is unknown. Containers were placed directly on the ground surface or on pallets.

In 1985, materials that qualified as hazardous waste were identified in several areas. Sampling and analysis of the drummed waste determined that the components were primarily mineral spirits, water, waste oil, volatile organic compounds (VOCs), and metals. The drums were removed and disposed of as hazardous waste. Since then, most of the area has been used for storage of surplus or raw materials for construction or maintenance projects.

As part of an initial soil characterization program in 1988, soil samples were collected from 10 locations at the site. Analysis of soil samples collected from borings in the area indicated levels of methylene chloride and acetone above the detection limit, although both were also detected in the sample blanks. Inorganics detected include aluminum, arsenic, barium, beryllium, chromium, sodium, thallium, calcium, cadmium, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, vanadium, zinc, strontium, and nitrate/nitrate. Radionuclides detected include gross alpha; gross beta; tritium; Am-241; Pu-239, and -240; and U-238, -233, and -234 (DOE 1992b).

Previous groundwater sampling was conducted at several wells in the vicinity of IHSS 176, both upgradient and downgradient of the IHSS. Inorganics and radionuclides detected in the groundwater beneath IHSS 176 that were not detected in upgradient samples are cobalt, mercury, potassium, zinc, carbonate, gross alpha, and strontium-90.

Data collected at this IHSS during the OU 10 Phase I RFI/RI are included in the IA Data Summary Report (DOE 2000a). Methylene chloride, acetone, aluminum, arsenic, calcium, cadmium, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, vanadium, zinc, nitrate/nitrite, Am-241, Pu-239/240, U-238, and U-233/234 were detected in surface soil above background values.

ITS Water Spill (formerly 000-502) PAC 900-1310

A release of approximately 490 gallons of interceptor trench water was reported at 1:45 AM on November 30, 1992. Surface water runoff and potentially contaminated groundwater are collected in the ITPH system prior to being pumped from a centralized sump into the 207B North SEP. The release originated from a separation of a pipe coupling in the 3-inch transfer line on the east slope of the 207B North SEP berm and flowed onto the surrounding soil. The 3-foot section of drain hose that was connected to the end of the inlet pipe to the 207B North Pond had frozen during several days of sub-zero weather and caused back pressure in the pipe when the interceptor central sump began to pump water into the pond.

Previous analytical testing indicated that listed hazardous waste constituents were detected in the interceptor trench water. A sample of the water was collected on November 30, 1992, and preliminary results indicate that chromium, lead, mercury, silver, carbon tetrachloride, and trichloroethene were detected.

The pipe connection was repaired and the system was placed back into service. The released material was not directly recoverable because it soaked into the soil. Due to the location of the release (upgradient of the ITPH system in an area previously identified to be possibly

contaminated by past releases from the proximal SEP), no action was taken to immediately recover the material.

GROUP 000-2

Original Process Waste Line IHSS 000-121

The OPWL is a network of tanks and underground pipelines designated as IHSS 121. There are approximately 6 miles (35,000 feet) of underground pipelines that carried process waste from facilities generating waste to the Building 774 treatment facility. The OPWL was placed into service around 1952 with repairs and additions made to the system through 1975 (DOE 1992a).

Between 1975 and 1984, the OPWL was replaced by the separate, double-contained New Process Waste Lines (NPWL). Some of the tanks and pipelines from the OPWL were removed, other lines were incorporated into the NPWL, and some tanks were converted into the plenum deluge system. The OPWL that was not replaced or removed remains in place and consists of 66 pipeline segments and 5 pipeline spurs. Most of the OPWL is located in highly congested areas with other active and inactive utility lines. Approximately 13,000 feet of pipeline is beneath buildings, with another 7,000 feet beneath asphalt or concrete. There are few engineering drawings for the OPWL, and in some instances, the drawings that were found contain contradictory information (DOE 1992a).

The pipelines range from 1 to 10 inches in diameter and are constructed of a variety of materials including black iron, cast iron, plastic, polyethylene, vitrified clay, cement/asbestos, saran-lined steel, stainless steel, fiberglass, PVC, Pyrex, and Teflon. Concrete valve vaults provided access for operation and maintenance. These were included in the initial installation or added later at locations with persistent leaks such as at elbows, valves, and transitions from one pipe material to another (DOE 1992a).

The OPWL was not a continuous flowing system. Wastes were accumulated in holding tanks within the buildings, then transferred to Building 774 in batches, generally by gravity feed. The wastes transported were various aqueous process wastes containing low-level radioactive materials, nitrates, caustics, and acids. Small quantities of other liquids were also handled including medical decontamination fluids, miscellaneous laboratory wastes, and laundry effluent. These process waste streams also contained metals, VOCs, oil and grease, and cleaning compounds (DOE 1992a).

Leaks and releases are expected or confirmed at many locations within the OPWL (Figures 27 and 30A through 30F of the IASAP). However, there is little characterization information available at this time.

Valve Vault West of Building 707 IHSS 700-123.2

In December 1958, a leak occurred at an OPWL elbow in the valve vault located west of the present location of Building 707. Process waste followed the containment pipe and flowed into a ditch to the northeast of the present location of Building 707. Up to 4,050 gallons of process waste were released. Leaks occurred in the elbow connections of the OPWL due to joint expansion following the introduction of steam condensate from Building 881. The elbow was repaired and the line remained in use for another 10 years. In March 1973, this

valve vault was replaced as part of an upgrade program for this section of the OPWL system. Interviewees for the Comprehensive Environmental Assessment and Response Program (CEARP) Report (DOE 1986) indicated that this vault overflowed a number of times prior to 1973.

The liquid released contained U, solvents, oil, beryllium, nitric and hydrochloric acids, and fluoride. A soil sample collected at the valve vault west of Building 707 in 1976 indicated 54 mg/L nitrate and 0.145 disintegration per minute (dpm) Pu. No documentation was found that further details response to this occurrence or other occurrences at this location.

Building 123 Process Waste Line Break PAC 100-602

On April 13, 1989, Valve Vault 17, located on Cottonwood Avenue between Building 443 and Building 444, was found flooded with approximately 1,200 gallons of aqueous waste. Subsequent investigation showed the source of the waste was a break in the process waste line in Manhole 1, south of Building 123. Leakage from the break had migrated into bedding material surrounding the pipe and ultimately reached Valve Vault 17 through either pipe bedding materials (i.e., soil), or a PVC electrical conduit. The release also migrated into a section of the abandoned OPWL network (PAC 000-121). Discharge of Building 123 process waste into the broken line was discontinued on April 18, 1989, five days after the release to Valve Vault 17 was first detected. The potentially affected area includes the process waste line between Manhole 2 and Valve Vault 18 (immediately south of Building 123), the process waste line between Valve Vault 18 and Valve Vault 17, soil around Valve Vault 18 and Valve Vault 17, and the OPWL between Manhole 2 and Manhole 3. In July 1989, groundwater containing blue dye, used several months earlier to trace the release, was observed seeping into excavations around Valve Vault 18. According to one report, the release may also have reached the storm sewer system. Numerous detailed reports address these actions.

The release consisted of Building 123 process waste. Based on typical daily quantities of wastes discharged from Building 123, the following materials likely were released to the environment:

- 25 gallons urine;
- 12.5 gallons HNO3 (unknown concentration);
- 20 gallons hydrochloric acid (unknown concentration);
- 1.5 pounds ammonium thiocyanate;
- 1.0 pound ammonium iodide; and
- 2.5 gallons ammonium hydroxide (unknown concentration).

The above materials would have been diluted in approximately 2,000 gallons of tap water.

Minor amounts of naturally occurring U were detected in soil and water samples collected after the release. Up to 140 pCi/L alpha activity was recorded in samples of the waste from Valve Vault 17. One water sample from a manhole south of Building 123 also contained 8 percent ethylene glycol.

After process waste discharge to the broken line was discontinued, soil sampling was conducted to determine the source and extent of the release. A temporary aboveground line was installed, and a replacement underground line was planned for completion by June 1, 1989.

Because the affected areas were near existing IHSSs scheduled for investigation and remediation activities (see PAC 400-122 and PAC 100-148), no cleanup was initiated. The release was documented in RCRA Contingency Plan Implementation Report (CPIR) No. 89-003 and in Rocky Flats Plant Internal Investigation Report (IIR) No. 89-55.

Tank 29 - OPWL IHSS 000-121

Tank T-29 is located in the 700 Area northeast of Building 776 and east of the cooling tower. Tank T-29 is a 200,000-gallon carbon steel aboveground storage tank (AST). A valve vault on the north side of Tank T-29 was also sampled.

Tank T-29 was installed in 1952 and was reportedly abandoned in the mid-1980s. The tank was used to store untreated process waste from Building 774, including acids, bases, solvents, radionuclides, metals, chlorides, oils, and grease. No reported releases from this tank are known. As part of the OU 9 Phase I RFI/RI radiological surveys, soil sampling and tank sampling were conducted.

Three HPGe survey locations surrounding Tank T-29 showed elevated activities of U-238 (0.01%, 0.01% and 2.5%) and U-235 (all three at 0.01%). Thorium (Th)-232 was slightly elevated at 0.01% at one station and Am-241 was elevated at 0.01% at all three locations. Pu-239/240 was also elevated at 0.01%.

Three of the 48 sodium iodide (NaI) survey sites around Tank T-29 were above background levels. NaI activities ranged between 1,900 and 3,000 counts per minute (cpm) with background levels in the same range.

A direct radiological survey of the interior of Tank T-29 for fixed and removable beta/gamma activity revealed 45,456 dpm/100 square centimeters (cm^2) at the plane of the opened inspection port. Activity dropped to 2,841 dpm/100 cm^2 at 8 inches above the port. The valve vault on the north side of Tank T-29 shows areas of fixed and removable alpha contamination. The northeast quadrant of the manhole cover had 208 dpm/100 cm^2 fixed and removable alpha contamination and the concrete pad had 210 dpm/100 cm^2 fixed and removable alpha contamination.

Two soil samples were collected and analyzed during the OU 9 Phase I RFI/RI. Am-241, gross alpha, Pu-239/240, copper, and silver were detected above background values. Methylene chloride was the only organic detected above 1.0 microgram per liter (µg/L).

Four boreholes were drilled around Tank T-29. Am-241 and Pu-239/240 were detected above background, at a depth of 0 to 6 inches in all four boreholes. Lead was detected above background concentrations in the western, eastern, and southeastern boreholes. Methylene chloride was the only VOC detected, at a level of 1 microgram per kilogram (µg/kg). Cadmium and silver were detected above background in the eastern borehole.

A liquid sample was collected at the Tank T-29 vault. Gross beta, U-233/234, and U-235 had elevated activities and Am-241, gross alpha, Pu-239/240, and U-238 had significantly elevated activities. There were also elevated levels of metals including arsenic, barium, beryllium, cadmium, copper, silver, strontium, and vanadium. There were significantly elevated levels of iron, lead, manganese, potassium, sodium, and zinc.

Radiological samples of Tank T-29 showed results for removable alpha and beta contamination on the base of the tank ranging from 2,970 to 6,020 dpm/100 cm^2 for alpha and less than 200 to 263 dpm/100 cm^2 for beta. The sides near the base of the tank had significantly lower removable activities.

These data are available in the in the IA Data Summary Report (DOE 2000a).

Tank 31 - OPWL IHSS 000-121

There is no existing data on Tank 31.

Low-Level Radioactive Waste Leak IHSS 700-127

Persons interviewed for CEARP recalled construction activities near Building 774 and west of SEP 207C that resulted in breaking a low-level radioactive waste discharge line several times. This line carried liquids from the process waste treatment facility (Building 774) to the sanitary waste water treatment plant (Building 995).

On October 14, 1957, a line that carried process waste between Building 774 and a 200,000-gallon waste holding tank (Tank 207) leaked at a joint. It was determined that the joint had not been properly packed during construction. The joint was repaired and the excavation backfilled by November 5, 1957.

Another leak was detected in 1971 when the waste line between Building 774 and Building 5 was pressure tested. The liquid waste that flowed from Building 774 to Building 995 was high in nitrate and had small amounts of Pu. Tank 207 was used at that time to store unprocessed liquid waste for later treatment in Building 774. A soil sample collected in 1976 from a depth of 4 feet beside the leak area, north of Tank 207 and south of Building 774, was analyzed and found to contain 76 mg/L nitrate and 1.83 disintegrations per minute per gram (dpm/g) Pu.

In April 1982, the leaking section of line was replaced.

The location of IHSS 127 defined in the IAG does not correspond with the location of any process waste lines located on RFETS utility drawings. Information gathered for the HRR indicates the location of the process waste line between Building 774 and Building 995 is approximately 70 feet west of the previously identified IAG location for IHSS 127. It was

proposed that the location of IHSS 127 be redefined to coincide with the location of the process waste line discussed as PAC 700-127.

Process Waste Line Leaks IHSS 700-147.1

On September 27, 1955, a possible leak in the OPWL north of Building 881 was reported. Approximately 1 foot of process waste water was present in a manhole. In June 1959, monitoring and environmental samples showed low-level contamination along the OPWL from Building 881 to Building 774. In February 1960, the OPWL from Building 880 ruptured, releasing waste in the construction area near Building 777. On October 27, 1964, there was a break in the OPWL from Building 881 to Building 774 and process waste water was pumped into a ditch around the parking lot. In October 1964, an excavation was made in the 776 parking lot. In November 1964, contaminated liquid wastes were released into the sanitary sewer due to breaks and leaks in the process waste line from Buildings 441, 444, 881, and 883.

A May 1971 report stated that the transfer line from Building 444 and Building 881 to Building 774 had broken and leaked several times during the past 20 years. The leaks generally occurred east of Eighth Street and north of Central Avenue. The report states that nitrate migration in the soil from the leaking transfer line was traced by samples collected from shallow wells. During summer 1984, the process waste line connecting Building 881 to Building 374 cracked. The break occurred approximately 150 yards south of the Guard Gate into the Building 777 complex. Approximately 2 yards of contaminated soil were removed during the cleanup process.

Groundwater samples collected from monitoring wells located at various points east of where breaks had occurred indicated several hundred parts per million (ppm) nitrate. Typical constituents of waste discharged into the process waste system include U, Pu, beryllium, acids, and solvents.

Radioactive Site 700 Area IHSS 700-162

IHSS 162 is located along Eighth Street and extends from the southern end of Building 771 to the northern end of Building 850. Radiochemical activity was identified during groundwater monitoring activities in 1974. In response to this activity, Eighth Street was paved over to prevent mobilization of the affected material. In January 1981, an air sample collected during excavation activities at Eighth Street and Central Avenue yielded a long-lived alpha activity concentration, indicating the presence of residual activity in the area. Excavation crews were required to wet the surface soil prior to removal to reduce airborne dispersion of the soil (DOE 1992a).

No releases occurring in IHSS 162 south of the 700 Area are documented. However, there are at least 10 other IHSSs involving radioactive waste overlapping or in close proximity to this IHSS. According to the HRR, it is possible that releases in the surrounding IHSSs may have affected this IHSS. Four previously sampled polychlorinated biphenyl (PCB)/radiological sampling locations lie within IHSS 162 or in the immediate vicinity. Analyses of samples collected at the northwestern and southwestern corners of Building 776 indicated PCBs in soil. Aroclor-1260 was found with concentrations ranging from 69 to 480,000 μg/kg (EG&G 1991). A sample collected at the northwestern corner of Building 776

had an Am-241 activity of 6.8 pCi/g. Samples also indicated Pu-239/240 and Am-241 were present at levels above sitewide background activities (DOE 1992a).

HPGe survey data for locations in IHSS 162 did not indicate elevated activities in southern portions of the IHSS. HPGe survey data at northern locations indicated elevated activities for Th-232, U-238, Am-241, and Pu-239/240. Proximity to Building 569 may have influenced the measurements.

Twenty-three surface soil samples were collected in and around IHSS 162 as part of IA RFI/RIs. Organics, inorganics, and radionuclides were detected. These data are available in the IA Data Summary Report (DOE 2000a).

GROUP 000-3

Sanitary Sewer System PAC 000-500

The RFETS sanitary sewer system has been used for transport, storage, and treatment of sanitary waste since RFETS began operations in 1952. Various drains, sinks, sumps, and latrines located in RFETS buildings discharge to central collection lines which transport the waste to the sanitary sewage treatment plant (Building 995). RFETS wastes, which are incompatible with sanitary sewage treatment, are designated process wastes and are handled in a separate system from sanitary wastes (see PAC 000-121, OPWL). In each RFETS building that generates process waste, waste discharge points (drains, sinks, sumps, etc.) are designated as either sanitary waste or process waste receptacles, and are plumbed separately into the appropriate waste system. In some Plant facilities, wastes are, or have historically been, collected and temporarily stored in tanks plumbed into both systems, and transferred to the appropriate system based on analytical results. Sanitary sewer system sludges containing low levels of radionuclides were historically disposed of onsite in burial trenches.

The Rocky Flats Plant (RFP) historically discharged waste streams other than typical sanitary wastes to the sanitary sewer system. These discharges changed throughout the history of RFP in response to internal guidelines (in particular, U.S. Atomic Energy Commission [AEC] guidelines in the early history of RFP) and, increasingly during the past two decades, to state and federal regulations. Waste streams that were discharged to the sanitary sewer system include the following:

- Laboratory wastes from Building 123;
- Waste from Building 331;
- Laundry waste water from Building 442;
- Film process bath water, employee wash water, and chromic acid from Building 444;
- Chemicals from Building 559;
- Acids from Building 705;
- Laundry waste water from Building 771;

- Low-level aqueous waste from Building 779;
- Laundry waste water and other unknown water from Building 881;
- Water from employee restrooms from Building 883; and
- Acids, bases, and solvents from Building 991.

In addition to routine or planned sanitary sewer discharges, unplanned incidental discharges have occurred as a result of equipment failure, overflow or spillage of materials, or accidental discharge of process wastes into sanitary waste receptacle.

In some cases, buildings plumbed into the sanitary system at the time of their construction have later added facilities or processes that generate process waste, and have discharged this waste into the sanitary sewer system for a period of time. Incidental or accidental sanitary sewer discharges include the following:

- Oil discharges;
- Laundry waste water;
- Foundry coolant water;
- Hexavalent chromium waste:
- Process wastes:
- Sulfuric acid:
- Silver paint;
- Demineralization waste;
- Medical waste;
- Steam plant boiler blowdown and steam condensate;
- Dye;
- Nitric acid;
- Ethylene glycol; and
- Acids.

Two major incidents involving the sanitary sewer system for which detailed documentation is available are discussed below.

An estimated 50 to 100 curies of tritium were inadvertently released from Building 779 to the sanitary sewer system in April and May 1973. The tritium originated from a shipment of

scrap Pu metal received at RFETS for reprocessing. During reprocessing activities in Building 779, the tritium was separated from the Pu and became part of the aqueous reprocessing waste. This waste was stored in accumulation tanks in Building 779 which discharged either to the sanitary sewer system or the process waste system, depending upon analytical characterization of the waste. Because tritium was not expected in these wastes, it was not targeted by the pre-discharge analyses, and tritium-contaminated wastes were released into the sanitary sewer system. One release contained an estimated 6 curies of tritium in 7,800 gallons of waste, and a second release contained an estimated 44 curies in 8,000 gallons of waste. These releases flowed to Building 995, and then were discharged as sanitary system effluent to the B-series holding ponds and eventually off the RFETS site.

In late February 1989, chromic acid stored in Building 444 for use in plating operations overflowed tanks and a containment berm and entered the building's foundation drains. The spill collected in a sump that was automatically transferred by a sump pump into the sanitary sewer system. The spilled material was observed intermittently in Building 995 over the next 2 days, but was not identified as chromic acid until 5 days later. Part of the spilled material was discharged in sanitary system effluent to the B-series ponds. As a result, an estimated 30 pounds of chromium were released to the sanitary sewer system. This incident was documented in RCRA CPIR 89-001.

A 1967 survey indicated that the sanitary sewer system total daily flow averaged 250,000 gallons, of which an average 21,000 gallons were laundry waste. A 1973 investigation of Pu releases to the sanitary sewer system indicated that 88 percent of the Pu at that time originated from laundry waste.

Photographic processing solutions were discharged to the sanitary sewer system according to the following discharge limits provided in a 1977 document: tritium, 13,000 pCi/L; Pu, 5 pCi/L; U, 10 pCi/L; and beryllium, 1.0 ppm.

Monthly estimates of total radioactivity discharged to the sanitary sewer system in Building 442 laundry wastes were summarized during the early history of RFETS in Site Survey Monthly Reports.

Storm Drains PAC 000-505

There are 239 storm drains at RFETS. The storm drains provide Site drainage from roads, parking lots, and other areas, discharging into the creeks and drainages north and south of the Site.

The storm drains were designed to convey surface water away from the Site, but unplanned accidental discharges to the system have occurred. Several incidents were reported and include the following (described in detail below):

- Potential contamination at Building 771 storm drain;
- Wash water from the degreasing of depleted U parts near Building 991;
- Release of HNO_3/nitrad waste solution from Building 460;

- Release of miscellaneous materials into the storm drain west of Building 446, PAC 400-803 (DOE 1992a);
- PCB runoff from Building 707;
- PCB runoff from Building 444 courtyard; and
- Building 776 storm drain.

Various waste liquids from laundry and decontamination facilities, the analytical laboratory, radiography sinks, and runoff from the Building 771 roof and ground areas were discharged into the Building 771 storm drain from 1953 until mid-1957. Periodic releases from laundry holding tanks occurred until 1965. Radionuclide concentrations in soil ranged from 130 to 2,000 dpm/g and in sediments from 60,000 to 200,000 dpm/g.

Cleaning operations were performed on depleted U parts in the open courtyard of Building 991 during the late 1950s and early 1960s. Parts were degreased with acetone and other organic solvents. Spills and water wash-downs were flushed into the storm drains that discharged into South Walnut Creek.

In April 1989, between 5 and 7 gallons of HNO_3/nitrad waste solution from Building 460 entered a storm drain that feeds into Pond C-2. Miscellaneous materials including silver paint and possibly oil and aluminum paint were dumped into the storm drain immediately west of Building 446 (DOE 1992a).

The Building 371 storm drains and ditches were sampled in 1987. The results of sample analysis were gross alpha at 24+/- 8 pCi/L and gross beta at 64+/-4 pCi/L in the storm drains. In September 1970, two 55-gallon drums of contaminated soil were removed from the Building 771 storm drain area and additional soil was removed in February 1971. At least 50 drums of contaminated soil were eventually removed. The remaining soil was surveyed and results ranged from 120 to 3,000 dpm/g.

Old Outfall - Building 771 IHSS 700-143

When Building 771 went into operation in 1953, some waste liquids passed through a storm drain, located north and west of the building, and into North Walnut Creek. The main source of waste liquids was outfall from the Building 771 laundry holding tanks. Other sources included the analytical laboratory and radiography sinks, personnel decontamination room, and runoff from the roof of Building 771 and the ground areas.

Waste liquid from the Building 771 laundry holding tanks were discharged to this drain if the Pu concentration was below 3,300 disintegrations per minute per liter (dpm/L). Between mid-1953 and mid-1957, 4.5 million gallons of liquid were released containing a total of 2.23 millicuries (mCi). In 1957, a waste line was completed which allowed an option of releasing these liquids to the Building 774 release below Building 995 (PAC NE-142). However, due to equipment problems, periodic releases from the laundry holding tanks to the 771 outfall continued until 1965. During this period, 430,000 gallons were released containing 0.25 mCi.

Other release sources for the 771 outfall went directly to the storm sewer system and there is no documentation of the liquid quantity or quality. These are described below.

- On April 9, 1958, it was noted that a decontamination sink was tied into a process waste drain that emptied into Walnut Creek north of Building 773.
- In May 1971, a sewer line break resulted in storage tanks overflowing through the 771 outfall.
- During the week ending August 4, 1978, a hot spot approximately 875 ft^2 was found near a culvert northwest of the Building 771 parking lot.
- Pu-contaminated waste water that also contained soaps and detergent originated from the Building 771 laundry, analytical laboratory, and radiography areas and a decontamination sink.

In addition to the water released from Building 771, a soil stabilizing solution was frequently applied during remedial activities in 1971. The stabilizer was a mixture of water, ethylene glycol, and Dowell J-197 soil stabilizer.

As early as 1953, contamination at the outfall was measured at 17,400 dpm/g in the soil. Contamination of soil at the discharge was reported in May 1956 with the highest sample activity being 130 dpm/g gross alpha.

Remediation activities at IHSS 700-143 are detailed below.

"Initial discovery" of the spot occurred in April 1970; sample results indicated Pu at levels greater than 190,000 dpm/g. The area was subsequently subject to frequent soil sampling and some monitoring with direct counting instruments. The sampling continued throughout the remediation process. Soil sample activity ranged from 28,621 to 229,290 dpm/g Pu on October 19, 1970 (prior to soil removal activities). On February 18, 1971, activities ranged from 47 to 4,437 dpm/g Pu during soil removal.

Sampling of water in April 1970 indicated gross alpha activity of 12 dpm/g draining through the effluent pipe.

In August 1970, it was reported that a 12-inch drain line used for the disposal of rain and underground water was slightly contaminated where it drained into McKay Ditch. An investigation indicated that an overflow pipe from the laundry had been accidentally piped into this line. The plumbing was corrected and contaminated soil and foliage was removed and drummed as low specific activity (LSA) waste.

In September 1970, approximately 75 cubic feet (ft^3) of contaminated soil was removed from the area. Another document states that in September, two 55-gallon drums of contaminated soil were removed.

In January 1971, the Health Physics Operations Group Technical and Construction Report stated that recent instrument surveys taken in the ditch indicated that the prior removal of two

drums of soil and vegetation was insufficient. The removal resumed in February 1971. As of February 18, 1971, there were no known open drain lines from the building to the outfall.

A letter dated February 19, 1971, requested that the drain pipe to the outfall be capped. However, because the water running out of it was not contaminated at that time and it was being checked daily by Health Physics the pipe was not capped.

As of February 26, 1971, approximately 350 ft^3 of contaminated soil from an area approximately 750 ft^2 was removed and drummed. It was believed that no contamination had been spread by the wind because the outfall was in a depression approximately 20 feet deep at the bottom of a hill, the soil was constantly moist, and the area was covered with grasses and cattails.

The Health Physics Monthly Status Report for the month of February 1971 reported that 20 soil samples collected from McKay Ditch indicated that the Pu contamination was localized and did not travel downstream.

In early March 1971, water collected from the effluent pipe at the outfall was analyzed and found to have gross activity of 9.60 pCi/L. A typical RFETS water sample activity averaged approximately 40 pCi/L at the time.

Operations during May 1971 consisted of transferring contaminated mud from 23 used drums to new drums with provisions to absorb any contaminated liquid. Digging was to be resumed as the weather improved and the mud dried. By August 31, 1971, the removal of soil was complete and 149 drums were shipped as hot waste (presumably offsite, but this was not specified in the associated documentation). Cement was added to each drum before and after filling to absorb any contained liquid. The contaminated area was approximately 800 ft^2 with contamination as deep as 3.5 feet in one small area. The maximum soil sample result was 39,000 dpm/g. Final survey of the area indicated maximum alpha counts of 250 cpm. Final soil sampling averaged 34 dpm/g with a maximum of 150 dpm/g.

Soil found in the culvert in August 1978 was cleaned up during summer 1980. The removal was complete by July 18, 1980, resulting in nine boxes of contaminated soil.

The area that formally was the outfall culvert was filled in with soil and is now a paved parking lot for Building 771. Filling and parking lot construction occurred some time after the soil removal in 1980.

Central Avenue Ditch Caustic Leak IHSS 000-190

On December 3 and 4, 1978, a bulk caustic storage tank leaked into its spill catch basin. Due to operator error, a sodium hydroxide (NaOH) solution flowed eastward down the Central Avenue Ditch and was diverted to South Walnut Creek and Pond B-1 for temporary containment. Approximately 1 to 3 gallons of concentrated caustic solution was involved.

In response to this incident, immediate steps were taken to isolate the contamination, treat the contaminated runoff, and divert drainage from adjacent areas. These steps included the following:

- Divert the 400-complex snowmelt water across the Central Avenue Ditch to the 700 Area drainage;
- Dam the upper Central Avenue Ditch above the B-Series ponds near the cattle fence;
- Divert Building 995 sewage effluent to Pond 207B-South, and retain Pond B-3 as a reserve pond;
- Rope off the upper portion of the Central Avenue Ditch;
- Pump the water from Pond B-2 to Pond A-2 and hold Pond B-2 as a last resort catch pond; and
- Neutralize Pond B-1 by adding 1,400 pounds of alum and then pump this liquid to Pond 207B-North.

Follow-up response activities to the December 1978 incident included:

- Neutralize the Central Avenue Ditch between Fifth and Tenth Streets by adding 5,000 pounds of alum;
- Complete final sampling of Pond 207B-North on approximately January 19, 1978;
- Monitor the pH of the ditch. On March 23, 1979, the ditch was no longer considered a problem and runoff from the ditch was allowed to be discharged offsite;
- Blend liquid in Pond 207B-North with sanitary water and process it through the sewage treatment plant; then transfer to Pond 207B-South for processing through the reverse osmosis building and subsequent discharge offsite;
- On approximately May 4, 1979, Pond 207B-North liquid was drained into Pond B-2; and
- On approximately June 29, 1979, the remaining liquid in Pond B-1 was declared environmentally acceptable and sprayed on the adjacent hillside.

The tank leak was identified and all repairs were completed. Furthermore, the incident was reviewed with all Stationary Operating engineers at the Central Steam Plant and they were directed to review all standard operating procedures on chemical handling and storage. An incident report was prepared.

On January 6, 1989, caustic solution was released from the same Building 443 tank involved in the December 1978 incident, into its secondary containment (spill catch basin). The outlet pipe and valve on the tank deteriorated to the extent that the pipe disconnected from the tank. Due to cold weather, the caustic froze which prevented further leakage. In response to the January 1989 incident, the tank was temporarily repiped and emptied. The removed caustic was neutralized and transferred to Building 374 for treatment as a process waste.

GROUP 000-4

New Process Waste Line PAC 000-504

The New Process Waste Line (NPWL) consist of a network of double-contained underground pipelines and tanks that transport liquid waste streams to Building 374 Waste Treatment Operations. The NPWL overlap the OPWL in many places, and for the most part, replace the OPWL infrastructure. The installation of the NPWL was completed in 1984. Some of the OPWL lines were converted to NPWL.

The NPWL transport a variety of waste streams to Building 374. These current and past waste streams include laundry water, nonradioactive/chemical laboratory waste, U and beryllium waste, PCBs, SEP water, incidental water, high nitrate waste from Building 774, and waste from Site laboratories and utilities. Potential contaminants of concern (PCOCs) include acids, bases, solvents, radionuclides, PCBs, metals, oils, and photographic laboratory chemicals.

Releases from NPWL were documented at several PACs and are summarized below:

- Nitric acid, hydrofluoric acid, and hydrochloric acid from Building 123 scrubber;
- Nitrate, radionuclides, and acids from Valve Vaults 11, 12, and 13; and
- Nitrate and radionuclides from process waste line leaks.

Spilled material from Building 123 was containerized and transferred into the Building 123 process waste system on November 7, 1989. Responses to occurrences at Valve Vaults 11, 12, and 13 have included repairing valve vaults and piping and removing contaminated soil. Contaminated soil from process waste line leaks was excavated and removed (DOE 1999).

GROUP 100-1

UBC 122 - Medical Facility

Current information on Building 122 is from WSRIC (RMRS 2000a); information on past activities is from the HAER (DOE 1998).

Building 122 houses the onsite medical facilities of the plant and the occupational health and internal dosimetry organizations. Emergency medical services, diagnosis, decontamination, first aid, x-ray, minor surgical treatment, and ambulatory activities are carried out in this building. The building also contains clinical and examination facilities to support routine employee and subcontractor physical examinations. Body counting to measure radioactive material in the body is also conducted. The facility contains three general areas: administration, internal dosimetry, and medical/health.

Building 122 went into service in 1953. One of the services performed in Building 122 was to remove metals from the blood stream of exposed employees, using a procedure called chelation therapy. This procedure used a variety of techniques, however, early success rates in removing metals such as Pu and U were limited. Several research studies, which are described below, were conducted at Building 122.

The subject of one study was the interaction of a solvent with Pu. The study determined that the solvent combined with Pu allowed toxic exposure through a dermal pathway. As a result of the study, the solvent was not approved for use, preventing what could have become a significant health risk for employees.

Cytogenetic studies performed at the plant resulted in a method to calculate Pu exposure by measuring cell damage, and identify beryllium exposure by the identification of beryllium antibodies.

Two medical studies were begun to monitor the long-term effects of exposure to beryllium and radioactive materials such as Pu, enriched U, Am, and others.

In addition to research studies and providing medical care to Site workers, personnel in Building 122 were involved in research and development of radiation detection equipment. The first patent awarded at the Plant was for a radiation wound counter to detect and quantify the presence of radioactive materials inside a wound.

Another significant item developed by medical building personnel was the body counter. This equipment was extremely sensitive, and detected minute amounts of radiation emanating from a person as a result of inhalation of radioactive particles.

Tank 1 - OPWL - Underground Stainless Steel Waste Storage Tank IHSS 000-121
The Tank T-1 source area is located in the 100 Area, along the southern side of Building 122 near the southeastern corner. Tank T-1 was an 800-gallon, stainless steel underground tank that was installed in 1955 and then removed in January 1984. It held waste streams from Building 122, the Medical Facility, including wastes such as trace radionuclides and decontamination water with constituents such as bleach, soap, blood, and hydrogen peroxide. This former tank area has been identified as a known release location (DOE 1992b).

HPGe surveys near Tank T-1 provided no evidence of anomalous activity. Groundwater samples from a borehole 7 feet northwest of Tank T-1 indicated aluminum, arsenic, manganese, vanadium, Am-241, and Pu-239/240 exceeded background concentrations.

Soil samples from a borehole on the center portion of Tank T-1 indicated that Am-241 and Pu-239/240 were elevated above background at a depth of 4.0 to 4.9 feet. Groundwater sampling at the same location indicated that aluminum, arsenic, lead, manganese, potassium, gross alpha, gross beta, Am-241, Pu-239/240, Ra-226, and U-233/234/238 exceeded background concentrations a depth of 3.0 feet.

GROUP 100-2

UBC 125 - Standards Laboratory
Information on Building 125 is from WSRIC (RMRS 2000b) and the HAER (DOE 1998). Building 125 houses the Standards Laboratory, offices for Metrology Laboratory management personnel, and the Metrology Systems Group. The Standards Laboratory, a function of Metrology, consists of several component labs, including physical, dimensional, chemical, and electrical. The Standards Laboratory provides National Institute of Standards

and Technology traceable calibration equipment and standards for the Measurements and Test Group.

The primary function of the Standards Laboratory is to ensure and implement a system of quality control for incoming materials used in manufacturing processes. The Standards Laboratory is used to prepare stock solutions for the other labs, and perform analyses on incoming radiological sources for quality assurance/quality control purposes.

GROUP 100-3

Building 111 Transformer PCB Leak PAC 100-607

A large electrical transformer is located inside the Building 111 basement. The transformer held approximately 500 gallons of cooling oil that contained PCBs. This transformer was first documented as leaking onto the underlying gravel in February 1984.

On January 30, 1986, the U.S. Environmental Protection Agency (EPA) conducted a survey of RFETS to determine compliance with federal PCB regulations. The inspection identified a number of leaking transformers, including the Building 111 transformer. Follow-up inspection by RFETS indicated that leaks originated at the transformer's tap changer and oil sample valve.

An unknown amount of PCB-bearing cooling oil leaked from the transformer between February 1984 (possibly earlier) and early to mid-1986. It is not known whether the leaks during this period were continuous or intermittent. Samples of the oil collected in early 1984 indicated 17 ppm Aroclor 1260, a commercial PCB formulation, in a paraffin-based mineral oil.

Samples collected in early 1984 indicated that PCB levels in the cooling oil were below the EPA regulatory limit of 50 ppm. No corrective actions were documented at this time.

Available documents suggest that the Building 111 transformer was cleaned and repaired in August 1986. Documentation suggested the transformer was scheduled for replacement in 1987 or 1988. Residual stain on the transformer concrete pad was noted in January 1987, and it was suggested at this time that the pad be coated with sealant.

GROUP 100-4

UBC 123 - Health Physics Laboratory

UBC 123 is located on Central Avenue between Third and Fourth Streets and consists of the Building 123 slab. The building footprint is approximately 18,444 ft^2. Building 123 went into service in 1953 and housed the Radiological Health Physics Laboratory which analyzed water, biological materials, soil, air, and filter samples for the presence of Pu, Am, U, alpha radiation, beta radiation, gamma radiation, tritium, beryllium, and organics. Additionally, personnel radiation badges were counted and repaired. Low-level liquid and chemical wastes were generated at this location and transferred to treatment systems via the process waste lines system. The process waste systems at this location consist of underground pipelines composed of steel, polyethylene, cast iron, and other materials, and sumps and pumps. PCOCs beneath the slab are U, Pu, cesium, metals, and VOCs (DOE 2000b).

The D&D of Building 123 and the surrounding area was completed in 1998. The project included the removal of Buildings 123, 123S, 113, and 114. The Building 123 floor slab was sampled to assess potentially contaminated areas. Areas of the slab that could not be decontaminated to unrestricted release were encapsulated with epoxy paint to fix any removable contamination and covered with steel plate. The building slab and process waste lines were left in place. Several source storage pits of various dimensions were used to store radioactive sources and are also present under the slab. All of the pipelines were grouted at slab level (DOE 2000b).

Waste Leaks IHSS 100-148

The eastern wing of Building 123 is encompassed by IHSS 148. Building 123 was constructed as a laboratory and was one of the first buildings at RFETS. When constructed, the building consisted of a north wing running east-west and an east wing running north-south. A west wing running north-south was added onto the western end of the north wing in the late 1960s (probably 1968) and an addition to the southern end of the east wing was added in approximately 1972.

Persons interviewed for the CEARP Phase 1 document indicated that several small spills of nitrate-bearing wastes occurred around the outside of Building 123. These wastes may have contained radionuclides. Additionally, interviewees indicated that there were potential releases of nitrate-bearing wastes from the OPWL buried beneath Building 123. This pipeline was in use from the start of operations in Building 123 until the OPWL were replaced by the NPWL. The abandonment of the OPWL beneath Building 123 occurred no later than February 1975 when engineering drawings documented the abandonment of the OPWL system.

Building 123 was serviced by a 4-inch-diameter process waste line buried beneath the north and east wings of the building. The main process waste line drained from west to east in the north wing, and from north to south the east wing. The pipe was sloped at 1percent. A number of connections were made to the main pipe, some of which consisted of headers servicing a number of process waste drains in the building. The pipe was probably constructed of a type of iron called “Duriron.” The OPWL piping from Building 123 led to an underground tank system behind Building 441 that collected wastes generated by both Buildings 123 and 441. From this tank system, the process waste materials were pumped out for treatment in the process waste system.

The OPWL drain was not double-contained, and varied in depth beneath the floor of Building 123 from approximately 0.5 to 3 ft beneath the bottom of the concrete floor of the building. The line came out from beneath the southern end of the east wing of the building, with an invert elevation of approximately 6,032.5 feet. Interviewees have stated that this line, being constructed of a type of iron, probably leaked considerable amounts of waste without personnel aware of the leak. The types of waste consisted of laboratory wastes from analysis of urine, fecal, and other bioassay samples. Nitrates and low levels of radionuclides were associated with the wastes carried in the OPWL. The NPWL that replaced the OPWL consisted of either double-contained or overhead lines (DOE 2000b).

Surface soil samples were collected and analyzed as part of the OU 13 RFI/RI. Thirty-four analytes were detected in the surface soil samples, including 26 inorganic compounds and 8

radionuclides. Eleven analytes exceeded background concentrations at a minimum of one sampling location throughout IHSS 148. Constituents that exceeded background concentrations were chromium, cobalt, copper, lead, nickel, strontium, zinc, Am-241, Pu-239/240, U-233/234, and U-238. These data are available in the IA Data Summary Report (DOE 2000a).

A soil gas survey was conducted on a 25-foot grid and samples were analyzed in the field using gas chromatography/mass spectrometry (GC/MS). Sixty-four soil gas locations were sampled and 13 samples contained VOC levels in excess of the 1 µg/L method detection limit (MDL). Benzene, toluene, ethylbenzene, xylene, and fuel constituents were detected in samples collected from the perimeter of Building 123 and within the east and west wings of the building. Trichlorofluoromethane (TCFM) was detected in nine samples distributed throughout the IHSS 148 area at levels up to 2.6 µg/L. Tetrachloroethene (PCE) was detected at 1.5 µg/L in a sample collected east of Building 123.

Unconfirmed reports of contaminant spills were indicated in interviews with building employees. In the late 1960s or early 1970s, a cesium-contaminated liquid was reportedly spilled on the concrete floor in Room 109. The floor was immediately sealed to immobilize the contamination. Room 109 also contained source storage pits. Undocumented thorium research was performed in Room 105. Scoping surveys conducted in May through July 1997 revealed elevated levels of radioactivity in both Rooms 105 and 109. In-situ gamma spectroscopic measurements performed in August 1997 indicated the presence of cesium-137 and Th-232 in Rooms 109 and 105, respectively (RMRS 1998).

Building 123 Bioassay Waste Spill PAC 100-603

An underground process waste line from Building 123 was being excavated and replaced due to a break in the line (PAC 100-602). The excavated end of the broken line was temporarily capped with a plastic bag and Building 123 process waste was rerouted to bypass the broken line. A pump used to reroute the waste failed and allowed the waste to overflow into the broken line. Part of this waste leaked around the plastic bag and into the excavation.

The release consisted of bioassay waste containing hydrochloric acid and HNO_3. The waste had a pH of approximately 1. The waste also may have contained urine, and up to a combined total of 1.5 gallons of ammonium thiocyanate, ammonium iodide, and ammonium hydroxide. The calculated maximum volume of the spill was 30 gallons. The released material mixed with rainwater in the excavation.

Potential flow from the excavation was contained with earthen berms. Approximately 100 gallons of rainwater contaminated by the spill were neutralized, pumped from the excavation, and transferred to the process waste system for treatment in Building 374. Samples were collected to evaluate the spread of contamination. The release was documented in RCRA CPIR No. 89-006.

Building 123 Scrubber Solution Spill PAC 100-611

An inoperative pump in the Building 123 process waste transfer system caused the Building 123 scrubber system to overflow, spilling scrubbing solution into a bermed area outside of the building and into three pits beneath the floor of the building. Also, approximately 5 gallons of liquid were present in and around a nearby storm water drainage ditch which

served the Building 123 parking lot. It was speculated that this liquid leaked from the berm wall interface with the underlying asphalt. However, it was later concluded that this liquid was not associated with the incident (i.e., it was in the ditch prior to the incident). All of the spilled solution was contained within secondary containment structures, and none of the solution was believed to have impacted the environment.

Under normal operating conditions, the scrubbing solution drained into the process waste system when the scrubbing process was completed. The source of the problem was waste pump switches that were in the wrong position as well as the influent valve that was blocked by glass filtering wool from Building 123.

The scrubbing solution consisted primarily of water, which was used to scrub HNO_3, hydrofluoric acid, and hydrochloric acid used in Building 123. Approximately 50 gallons were released to the bermed area, and several hundred gallons were contained in the three pits beneath the Building 123 floor. Analyses showed the solution in the bermed area had a pH of 1.6, while the solution in the three pits had a pH of 6.0.

The 5 gallons of liquid in the parking lot drainage ditch did not react when sodium bicarbonate was applied, indicating it was not acidic and therefore, was not the scrubbing solution.

Normal scrubbing solution drainage was restored when the glass wool material was cleared and the inoperative process waste pump was restarted. A submersible pump was used to transfer the scrubbing solution from the bermed area to process waste drains in Building 123. Measures were proposed to prevent subsequent buildup of glass wool in the process waste system. A RCRA CPIR (89-019) was written.

GROUP 100-5

Building 121 Security Incinerator IHSS 100-609

A security incinerator located south of Building 121 was used for incineration of classified documents. During some period in its operating history, the incinerator was used to burn no carbon required (NCR)-type paper containing PCBs. It is known that ash from the incinerator was being disposed at the Present Landfill (PAC NW-114) in December 1980. It is not known whether this was standard practice throughout the incinerator's operating history.

According to one source, “tons” of NCR paper, containing up to 10 to 20 percent PCBs, were burned in the incinerator. Dioxins and furans could potentially be generated from incineration of this paper.

In 1985, RFP proposed that two to four smear samples be collected from the incinerator and analyzed at an offsite laboratory for dioxins and furans. A second sampling phase was also proposed if warranted by the results of these samples. It is not known whether the smear samples were collected.

GROUP 300-1

Oil Burn Pit #1 IHSS 300-128

On August 18, 1956, an experiment was conducted that involved burning contaminated oil from Buildings 444 and 881in an area referred to as the garage oil-burning pit. Barrels were dumped on the south side of a pit located north of Building 331 and ignited. At one point rocks were thrown into the oil to agitate the surface to facilitate burning. Reports documenting the incident conflict as to the exact amount that was burned on that day. A Health Physics Report from 1956, which details the incident, indicates that six drums were dumped into the pit (an estimated 200 gallons). Other reports state that 10 drums of waste oil were burned.

Prior to the burning, several high-volume air samplers were started to obtain background data; however, not all the samplers were started at the same time and several were not started for approximately 1 hour after the fire had been initially ignited. The report also documents the refueling and failure of a generator that was powering many of the samplers. One sampler was placed in the path of the "black plume", which was moving at a 30 degree angle and rising to a height of 40 to 100 feet. The plume moved in the general direction of Building 123.

Filters from air samplers monitoring the experiment yielded alpha radiation readings ranging from 0.1 dpm per square meter (m^2) (dpm/m^2) to 30 dpm/m^2. The low reading was taken from the roof of Building 123 and the high reading was taken approximately 60 feet south of the burning pit directly in the smoke plume.

A direct survey was conducted of the soil and oil residue within the pit. Two spots along the south bank of the pit where the oil was dumped had meter readings of 500 and 750 cpm alpha activity. Soil samples were collected but the results are unknown.

After the burning operation, the residue was left in place and the pit backfilled. It is not known when the backfilling took place. The residues were not removed prior to further construction in the area.

One reference states that Building 225 was constructed over the area impacted by the activity; however, based on the review of aerial photographs, it appears that Sage Avenue and the Sage Avenue Ditch are now over the area.

Lithium Metal Site IHSS 300-134(N)

Reactive metal disposal was conducted in two locations north of Building 331. The first site coincides with IHSS 134; however, the boundaries were enlarged. Detailed review of aerial photographs indicates that part of the site is now covered by Sage Avenue. The second site is located in the corner formed by the L-shape of Building 331. Part of the roof and adjacent parking lot are included.

Many documents indicate that lithium was burned in this area; however, interviews with RFP Fire Department employees present during these activities contradict this. They indicated that although some small amounts of lithium may have been destroyed at this location, magnesium was the primary constituent of concern. Inspection of EPA aerial photographs reveals the presence of two pond-like structures roughly 250 feet north of Building 331. The

westernmost pond measures 30 by 40 feet and the eastern pond is 15 by 20 feet. Documents describing the operations indicate various size ponds.

The area impacted by these activities lies north of Building 335. The site was originally located in a depression adjacent to the Walnut Creek drainage north of Building 331 and west of Building 553. Aerial photographs clearly indicate construction modifications took place in this area that affected the drainage pattern of Walnut Creek. The construction of Sage Avenue began in the late 1960s and ended in 1970 when paving was completed. It now covers part of PAC 300-134.N. The drainage was also affected by construction of Building 371 in the early 1970s. Building 335 was built over the southern part of the site at approximately the same time.

Photographs taken in 1966 show a white residue coating the depression where the metal destruction took place. Other photos taken from a distance show a dense black cloud coming from this area. It is not known whether the smoke plume was the result of metal destruction or a grass fire, which was often caused by the burning activities.

In addition, it was discovered through an interview with a former RFP employee that graphite was buried nearby. The graphite was discovered during excavation at the intersection of Fourth Street and Sage Avenue. The interviewee was uncertain as to why or when the excavation took place.

Analyses of surface soil samples during the OU 13 Phase I RFI/RI indicated that Am-241 and Pu-239/240 were detected above background. These data are available in the IA Data Summary Report (DOE 2000a).

Solvent Burning Grounds IHSS 300-171

Building 335 has been used in the past, and still is to some degree, for training of fire department personnel. The original, preconstructed building was placed in an area north of Building 331 after the 1969 fire (PAC 700-150.7). Experiments took place to test heat and water effects on different types of materials (for example, filter plenums). Filter plenum tests were conducted inside the building and provided smoky, cramped, fire fighting experience. One incident of burning was on June 9, 1972, when steel beams were tested in a fire by burning diesel oil in an open pit.

Other types of training included the use of a large cross-shaped pan or a smaller square pan into which diesel fuel was placed and ignited. Most of the fuel was burned during the process although some was allowed to remain in the pan and mix with rainwater. The mixture was then dumped onto the ground. RFETS Clean Water Act Division personnel conducted an inspection on December 11, 1990. The large cross-shaped pan was found to have holes in it and oil-contaminated soil was present around the pans. The contamination was thought to have spread to a nearby catch basin (storm drain) where an oily sheen could be seen on the surface of the standing water. Running water in a nearby ditch had no visible sheen.

The area is still used today for fire fighting training. This type of training is conducted by the use of a “tree” constructed of metal that allows propane to escape from the “branches” of the

tree. A large quantity of water is used during this process that is allowed to flow into the storm drain.

At a site visit conducted on November 21, 1991, the cross-shaped pan was present but covered. The water standing in the storm drain (catch basin) still had an oily sheen on the surface. There was no evidence of soil contamination. Building 335 had a visible black residue along the top of the large, east-facing door.

When this area was first used for training purposes, magnesium chips coated with a water-soluble material were burned. Diesel fuel was the main material that was used and gasoline was used to ignite the diesel fuel. The firefighters may have also used waste solvents.

No documentation was found, and interviewees were unaware of any type of soil removal prior to construction of Building 335. No soil or air sampling was conducted to the knowledge of one RFETS Fire Department employee.

Analyses of soil samples during the OU 13 Phase I RFI/RI indicated that calcium, copper, iron, magnesium, sodium, nickel, and strontium were detected above background. These data are available in the IA Data Summary Report (DOE 2000a).

GROUP 300-2

UBC 331 - Maintenance

Information on Building 331 is from the HAER (DOE 1998). Building 331, originally constructed in 1953, was designed and used as a warehouse. When the building became too small for parts storage, a new warehouse was constructed at another Site location and Building 331 then became the Site maintenance garage. Additions to the structure, including the fire department structure, were completed in 1967.

At one time, the northeastern corner of the vehicle maintenance garage housed a technical staff and a U research and development laboratory. Rolling of enriched U foil was conducted there in 1964. This area may also have been used for the development of depleted U coating studies. After Building 865 came on-line in 1970, the area was converted for the development of remote handling techniques such as robotics and remote manipulator arms.

Lithium Metal Destruction Site IHSS 300-134(S)

Reactive metal disposal was conducted in two locations north of Building 331. The first site coincides with IHSS 134; however, the boundaries were enlarged. Detailed review of aerial photographs indicated that part of the site is now covered by Sage Avenue. The second site is located in the corner formed by the L-shape of Building 331.

IHSS 134(S) is located adjacent to the north side of Building 331 and includes a portion of the roof and adjacent parking lot. It is in the L-shaped corner of the building and the parking lot to the north RFETS where Fire Department personnel indicated lithium destruction took place. Lithium destruction may have also taken place at a location midway between Building 331 and Building 335.

Lithium was originally burned by placing it on the ground and sprinkling it with water. Sometimes magnesium chips or a flammable material such as gasoline were used as initiators. On October 13, 1966, a fireman was injured during lithium destruction activities and the use of this location for disposal of lithium was discontinued. Destruction of lithium in drums at the 331 parking lot is documented as late as 1969. On September 5, 1969, lithium was being dissolved inside a barrel when it exploded. Lithium was dispersed in the area of the 331 parking lot and onto the roof of Building 331. The building has since been re-roofed several times. The incident occurred soon after the addition was built onto the eastern end of Building 331.

Exact amounts of lithium that were destroyed in this area are not documented; however, it is known that by 1970, approximately 400 to 500 pounds of metallic lithium were destroyed and the residues buried. These amounts are thought to be a combination of lithium destruction from this site and from another site in the southeast part of the Plant (PAC 900-140). The waste lithium originated from Building 444 and Building 881 and was not radioactively contaminated.

Other reactive metals such as sodium, calcium, and magnesium, and some solvent-types of chemical compounds were also destroyed in one or both of these sites. Disposal by burning was enhanced with magnesium chips and other flammable items such as gasoline, oily rags, or paper.

An interview was conducted on December 4, 1991, with a former RFP employee. It was stated that during the excavation at the Building 335 intersection, approximately 5 to 6 yds^3 of graphite in the form of solids, molds, and fines were uncovered.

Residues resulting from metal destruction were covered. The corners may have been marked, but on a site visit conducted November 11, 1991, none were found. Building 335 was subsequently placed on or near this location, Sage Avenue was constructed over it, and the location was also disturbed by construction of Building 374.

GROUP 300-3

UBC 371 - Plutonium Recovery

Building 371 was the Plutonium Recovery Facility and is now the Interim Plutonium Storage/Repackaging Facility. Building 371 went into operation in 1981 with a mission to (1) replace Pu residue recovery and waste operations from Buildings 771 and 774; (2) recover Pu from weapons returned from the stockpile, and (3) provide storage of Pu and Pu-bearing materials. Pu recovery operations in Building 371 were terminated in 1981. Since 1989, Building 371 has been used primarily for the storage of Pu and U metals, oxides, residues, transuranic (TRU) wastes, low-level waste (LLW), and RCRA-regulated mixed waste and residues (RMRS 2000c). The remainder of this description is from the HAER (DOE 1998).

Building 371 originally had two incinerators and their afterburners located in separate concrete canyons that were designed to burn most of the combustible wastes generated by the Pu recovery operations. One incinerator was for high specific activity waste, and the other for low specific activity waste. Due to the size and shape of the incinerators, they spanned

multiple levels of Building 371. These two incinerators were stripped out approximately 10 years ago to make way for the installation of the Plutonium Recovery Operations Verification Exercise gloveboxes and Pu processing equipment.

Past operations in Building 371 focused on the recovery of Pu from Plant activities (nuclear weapons parts fabrication, component assembly, and research and development activities). Other operations included material transfer, waste incineration (radioactive wastes were never incinerated in Building 371, only simulated combustible wastes were incinerated), and laboratory support.

Pu recovery operations used two different systems to separate high-purity Pu metal from production-generated wastes. Pyrochemical processing used furnaces and molten salts to separate high-purity Pu in a dry process. Pyrochemical processing was very efficient, but could not be used with all types of Pu-bearing materials. Aqueous processing used a series of wet and dry chemical steps to separate high-purity Pu from production-generated wastes.

Materials entering the Pu recovery process were received as pieces of impure Pu metal, Pu oxide, various compounds containing Pu, and Pu-contaminated residues. The Pu content of these materials ranged from a few percent to almost pure Pu metal. The recovery processes reduced the Pu and Am content of the residues to levels below economic discard limits.

Pyrochemical plutonium recovery (or pyrochemical processing) began in 1981 and ceased in 1988. Metal Pu was processed through a pyrochemical operation in which Am was extracted from the Pu by direct contact with molten salts, yielding a Pu button low in Am. If other impurities had to be removed, the extracted metal went to an electro-refining process where the Pu was transformed by electrolysis in a molten-salt bath to an impure Pu heel, contaminated salt, and product metal of very high purity. Impure metal was burned, converting it to an oxide, and processed through the aqueous chemical recovery systems. The high-purity Pu button was transferred to the Building 707 foundry operations for casting and weapon component fabrication. Contaminated salts were transferred to Building 771 for Am separation and Pu recovery.

Dicesium hexachloroplutonate (DCHP) preparation took place for the purpose of converting Pu oxide to reagent salt DCHP. The DCHP was used as the oxidant in the pyrochemical molten salt extraction recovery process in Building 776 for the extraction of Am from site-return metal. DCHP production in Building 371 began in 1989 using nonspecification-grade Pu oxide as the source of Pu feed material, and ceased operation in 1990.

The DCHP preparation process involved two major steps: (1) oxide dissolution and (2) precipitation and drying. The oxide dissolution step involved dissolving Pu oxide in hydrochloric acid and calcium fluoride. The resulting slurry was then filtered, separating the undissolved solids from the solution. The precipitation dry step mixed the filtrate with cesium chloride in hydrochloric acid and sodium nitrate to precipitate DCHP, which was the reagent used in the Building 776 Pu recovery operations. The DCHP was removed from the solution by filtration and dried in an oven, or muffle furnace, before transfer to Building 776 for use and/or to Building 371 for storage.

The process contained a system for treatment of off-gases vented from the various reaction vessels. Oxide dissolution filtration off-gas, DCHP filtration off-gas, and muffle furnace off-gas were all initially routed into a trap flask. The off-gases were then passed into a caustic flask where potassium hydroxide was added and the gases were eventually discharged through a vacuum pump and treated in the caustic treatment process. The undissolved Pu oxide solids from the oxide dissolution step were either recycled through dissolution and/or removed from the glovebox for storage.

Aqueous Pu recovery used Pu oxide and other materials as feed material and required a series of wet and dry chemical processing steps to produce a Pu button of high purity. As a first step, the oxide and other materials were dissolved in HNO_3 in a series of cascade dissolution pots. The Pu-containing acid solutions from the dissolution processes were adjusted for normality with HNO_3 or water and ferrous sulfamate (for Pu valence adjustment) into an adjusted HNO_3 feed. This adjusted Pu nitrate feed solution was then pumped through anion exchange columns. The anion exchange resin selectively absorbed Pu ions while allowing certain other metallic ions (iron, chrome, nickel, etc.) to pass through. Am formed a weak bond with the resin, allowing selective segregation of the Am from the Pu. Solutions high in Am were segregated for further processing in Am recovery, and the remainder went through a secondary recovery process.

The loaded anion exchange resin columns were then washed with nitric to remove the metallic impurities and the product Pu nitrate solution was collected in clean product eluate tanks. The anion exchange eluate was concentrated in an evaporator. The evaporator concentrate was then fed into a line of precipitation vessels where the Pu was precipitated as Pu peroxide. The precipitate was filtered and the filtrate was recycled through anion exchange. The precipitate was transferred to calcining furnaces where the Pu peroxide was converted to Pu oxide by heating.

The dry Pu oxide was pneumatically transported to a fluidized-bed reactor, the direct fluorination process canyon. The Pu oxide was contacted with a fluorine-argon gas mixture to keep it fluidized while converting it to Pu tetrafluoride (PuF_4). When the reaction was complete, the PuF_4 was transported to a receiving vessel in the reduction canyon.

The PuF_4 reduction to Pu metal was performed in the reduction canyon. Calcium metal was measured into reduction vessels, and the PuF_4 was added. The reduction vessel was sealed in an induction furnace, evacuated, and purged with argon gas to remove the oxygen. The reduction charge was then heated to initiate a reduction reaction that yielded a pure Pu metal button and calcium fluoride slag. The Pu button was sampled, stamped, and shipped as product. The calcium fluoride slag was recycled as cascade dissolver feed.

The HNO_3 recovery process consisted of tanks, gloveboxes, an evaporator, and distillation columns that were used to purify the large quantity of HNO_3 used in the metal recovery process. The system experienced significant equipment problems. One of the problems associated with the system was that it over purified the acid above reagent grade. The pure HNO_3 interfered with proper functioning of equipment in Building 371.

There were four Pu analytical laboratories in the Building 371/374 Complex to support environmental, safeguards, and other regulatory requirements. They include the liquids

laboratory, standards laboratory, analytical laboratory, and liquid waste sampling laboratory. The liquids and analytical laboratories are out of service. Building 371 also housed Pu analytical laboratories and a chemical standards laboratory, which supported operations throughout the Site. The Pu analytical laboratories served Buildings 371 and 374 and acted as a backup for the Building 771 analytical laboratory. The majority of the work at this laboratory consisted of total alpha and beta counts along with radiochemical analyses for specific isotopes in liquid and solid samples. These analyses served as a screening process to identify highly radioactive samples which were unsuitable for detailed analyses in Building 881.

The chemical standards laboratory in Building 371 prepared both nondestructive and destructive assay standards for various user groups at the Site, and inspected standards used in the field. Most laboratory operations took place in gloveboxes. Nondestructive assay standards were prepared for Pu, Am, and U oxides and metals (including beryllium) for a wide range of instrumentation.

The Building 371 Caustic Waste Treatment System (CWTS) processed (and still does as generated) both high- and low-level Pu solutions from tank and pipe draining operations from Building 371 and Building 771. The CWTS process provides for the collection, sampling, filtration, and disposal of miscellaneous caustic and acidic Pu-contaminated solutions to waste treatment that meets the Building 374 acceptance of 4.0×10^{-3} grams/liter (g/L) Pu + U-235, and 1.0×10^{-3} g/L Am. The CWTS process provides for the treatment of RCRA-regulated hazardous waste and aqueous waste streams.

The equipment for CWTS is located in the subbasement of Building 371. Processing is performed in gloveboxes and tanks. The CWTS process uses magnesium hydroxide powder to precipitate Pu, U, Am, and other metal impurities. The CWTS process generates three products: (1) the basic filtrate solution, which meets the shipping requirements of caustic waste to Building 374; (2) a low-level dried filter sludge, which is expected to be discardable, with the required approvals; and (3) the product from high-level solutions, IDC 054H, which is high-level dried filter sludge, which requires further processing in PuSPS.

The shipping, receiving, storing, and retrieving of special nuclear material (SNM) occurred daily in Building 371 operations. The receiving and shipping of onsite and offsite waste, residue, and SNM occurred from Dock 18T of the Building 371/374 Complex Support Facility. Two additional shipping and receiving docks are in the Support Facility on the southeastern corner. Building 374 has two loading docks supporting operations. SNM is stored in vaults or vault-type rooms in Building 371. The Central Storage Vault (CSV) extends through the subbasement and basement levels of Building 371. The CSV is designed to be ventilated by a nitrogen atmosphere, and accessed by the remotely controlled Stacker-Retriever (S-R). SNM received in liquid form is stored in CWTS tanks in Building 371.

Residue and waste drum maintenance was conducted daily in Building 371. Residues and wastes are stored in many areas throughout Building 371 and the support facility. Repackaging of residues may occur in several areas.

Sand, slag, and crucible (SS&C) repack involved repacking ceramic byproduct residues from Pu metal production, which were initially stored for the recovery of residual Pu. These

residues resulted from production of Pu metal buttons and may contain PuF_4, calcium metal, magnesium oxide crucibles, and/or magnesium oxide sand. The SS&C residues will be shipped offsite for processing. After SS&C repackaging has been completed, the containers of SS&C are transferred to the nondestructive assay room. The SS&C nondestructive assay equipment is part of the repackaging process.

The CSV (and S-R) was used to store and retrieve Pu metal and solid residues. The S-R moved materials between the shipping and receiving areas, Pu storage vault, and Pu recovery processing areas. Current operations in Building 371/174 are described below.

There are four laboratories in the Building 371/374 Complex to support environmental, safeguards, and other regulatory requirements. They include the liquids laboratory, standards laboratory, analytical laboratory, and liquid waste sampling laboratory. The liquids and analytical laboratories are no longer in use. The Building 371 standards laboratory is operated daily or as chemical standards need to be made and/or verified.

Caustic waste treatment provides for the treatment of miscellaneous caustic and acidic waste solutions containing Pu. Treatment predominately consists of waste collecting, sampling, precipitating, and filtering waste solutions. The equipment for caustic waste treatment is located in the subbasement of Building 371. Processing is performed in gloveboxes and tanks within these rooms.

Various chemicals are stored and managed throughout the Building 371/374 Complex. Potassium hydroxide (KOH) (6N) is supplied from one 28,500-gallon tank and one 10,400-gallon tank located just north of B371. A 16,000-gallon storage tank in the same area supplies HNO_3 (12N). The KOH and HNO_3 storage tanks share a bermed, compartmentalized area. The chemical makeup area for the facility maintains storage of a variety of chemicals required for facility operations. In addition, the majority of bottled, compressed gases (e.g., propane and argon) are stored on Docks 18T and 5. Liquid nitrogen is stored in a tank immediately north of Dock 18T. Analytical laboratories within the facility maintain chemical inventories to support laboratory operations.

Various aspects of the maintenance, surveillance, and stabilization of SNM may be performed in Building 371. Rooms have downdraft tables for transfer of material, weighing equipment, furnaces, and access to the CSV input/output (I/O). Repackaging activities that do not require a downdraft table can be performed in Zone II rooms. Sealed pits or pressure vessels can be packaged or leaked tested in Zone II or Zone III rooms. SS&C residues are reduced for repackaging and shipment offsite.

Several documented releases of materials to the environment have occurred at Building 371 and include the following:

- Maintenance personnel discovered approximately 55 gallons of waste water on the floor of Room 2217 on August 2, 1989. This incident resulted in the filing of a RCRA CPIR.

- A RCRA inspection of a 90-day accumulation area located in Room 3811 revealed that a metal 55-gallon drum containing dilute sulfuric acid solution had ruptured on December 20, 1989. This incident resulted in the filing of a RCRA CPIR (DOE 1992a).

GROUP 300-4

UBC 374 - Waste Treatment Facility

Information on Building 374 is included in the description of Building 371. Building 374 houses the process waste treatment system and began operation in the 1970s. Several documented releases of materials to the environment have occurred:

- A solution of 40% dissolved nitrate salt overflowed Tank D-883-B in Room 3809 on June 15, 1989, and ran into the process waste floor drains.
- Process solution filled a glovebox in Room 3801, pushed out a window of the box, and approximately 50 gallons spilled onto the floor on November 23, 1989.
- Approximately 100 gallons of process waste solution leaked from a pump in Room 3810 and drained through a process floor drain on November 29, 1989.
- Approximately 500 gallons of pH 12.6 solution of hydroxide salt leaked from a tank in Room 4101; some ran through cracks in the concrete floor to a hallway beneath the room.
- Operator error led to a spill of brine concentrate in Room 3809; the spill was rinsed down the process drains.
- Due to an inoperative floor drain, 150 gallons of brine concentrate spilled onto the floor of Room 3810 (DOE 1992a).

GROUP 300-5

Inactive D-836 HW Tank IHSS 300-206

Tank D-836 was a 19,000-gallon, carbon-steel tank used for hazardous waste storage. The tank had no secondary containment and was located on compacted soil. This was a 90-day storage tank situated at the northwestern corner of Building 371 near Door 5. Specifications for Tank D-836 can be found in the RCRA 3004(u) document.

A spill of condensate water occurred on February 18, 1980, when a line from the evaporator to the tank was disconnected. The tank was used to hold off-specification Building 374 product water (i.e., water too high in conductivity). The spill in 1980 contained low concentrations of tritium.

GROUP 300-6

Pesticide Shed PAC 300-702

Building 367 was used to store pesticides and herbicides since 1952 when the first spill is assumed to have occurred. In 1988, large quantities were being stored there and the building showed signs of spills and leakage. There were no spill containment features; therefore, release of contamination to a nearby drainage ditch may have been possible.

Large quantities of pesticides and herbicides were stored and mixed in Building 367 from 1952 to 1988. Equipment and containers were cleaned and the rinsate water dumped onto the

ground outside the building. In 1988, the unused chemicals were disposed in an unknown location and the area around the building was cleaned up.

GROUP 400-1

UBC 439 - Radiological Survey

Current information on Building 439 is from WSRIC (RMRS 2000d). Building 439 was previously a maintenance building, but is currently used for PU&D operations. Building 439 is used to receive, process, and ship surplus equipment and materials released by plant custodians. Building 439 houses small portable counters that monitor alpha, beta, and gamma radiation. Sources are controlled through the Site accountability procedures. Smear samples collected throughout RFETS are brought to Building 439 for counting.

GROUP 400-2

UBC 440 - Modification Center

Information on Building 440 is from the HAER (DOE 1998) and WSRIC (RMRS 2000e). Building 440 was constructed in the late 1960s for production control and shipping final assembly products and disposal wastes. SNM and depleted U were staged and shipped out of this building by truck and railcar. For a brief period, Building 440 was used as a general warehouse and storage area for non-nuclear construction and fabrication materials.

In the early 1970s, Building 440 was used to modify and repair vehicles to meet specific U.S. Department of Energy (DOE) requirements for transport of SNM and radioactive wastes. Building 440 was expanded three times to include a railcar bay, high bay, paint booths, storage areas, and locker rooms in support of transport modification efforts. Armor, communication equipment, and comfort features were added to transport vehicles. Vehicle modification work in Building 440 continued until 1994, when the mission was transferred to another DOE facility. Most of the original equipment associated with this activity has been shipped to other DOE plants.

Production processes in Building 440 included various welding, painting, machining, pipefitting, metalworking, and electrical work used to modify transports. Modification efforts focused on developing entry deterrents. Paint booths were used to coat fabricated, non-nuclear components and the transports. The gantry and 5-ton cranes were used to move materials associated with the transport modification effort.

GROUP 400-3

UBC 444 - Fabrication Facility

Information on Building 444 is from the HAER (DOE 1998) and HRR (DOE 1992a). Originally called Plant A, Building 444 was one of the first buildings constructed at the Plant. Building 444 was the primary non-nuclear manufacturing facility at the Site. Manufacturing processes were used to fabricate weapons components and assemblies from a variety of materials, including depleted U, beryllium, stainless steel, aluminum, and vanadium.

The production equipment located in Building 444 was used to support war reserve, special orders work, and manufacturing development. Operations included casting, machining, heat treating, welding, brazing, chemical milling, plating, coating, and testing and inspection of weapons components made of depleted U, depleted U composites, beryllium, stainless steel, and ferric metals. Each material required different processing techniques.

When expansion of the Site took place in 1956 and 1957, additions were made to Building 444. The expansion was motivated by changes in trigger design and subsequent increased fabrication requirements.

The original building area contains a foundry and numerous shops and laboratories. Shops within the original portion of the building include depleted U, beryllium, and carbon (graphite) machine shops; and heat treating, coating, tool grinding, welding and brazing, and building maintenance shops. A portion of the precision shop is also housed in this building. Laboratories include pressure- and leak-testing, plating, precision measuring, and non-destructive testing laboratories. Some of the former shop areas were converted into storage areas for excess tools and materials.

A May 1960 vacuum collector fire in Building 447 and a December 1962 U/beryllium release from Building 444 have impacted much of the 400 Area.

UBC 447 - Fabrication Facility

Building 447 is part of the 444 Complex and was a depleted U fabrication facility. Ingots and semifinished and finished depleted U parts were heat treated in the induction furnace. In 1956, the chip roaster in Building 447 became operational. Depleted U chips recovered from machining areas were collected in covered 55-gallon drums, transferred to Building 447, and burned to an oxide (a more stable form) under controlled conditions in the chip roaster. The oxides were packaged and shipped offsite for disposal.

West Loading Dock Building 447 IHSS 400-116.1

The west loading dock, IHSS 116.1, is a staging and storage area associated with Building 447. The west loading dock has been in operation since 1956, and is located on the northern side of Building 447, west of Building 444. Beryllium component manufacturing operations began in approximately 1958. Major processes conducted in the building included machining, welding, and cleaning. There was also a foundry and a laboratory in which parts were etched, electroplated, and coated.

Building 447 was put into service in 1956 and housed both assembly-related processes and waste-related processes. In Building 447, metal parts from Buildings 444 and 460 were cleaned, leak-tested, welded, and heat treated. The heat treatment process was designed to relieve stress and machining damage in the parts. A chip roaster was operated at one time to convert depleted U chips from Building 444 to U oxide.

Drums containing nonradioactive solvents may have been stored on the dock. Dark stained soil from spills and leaks of oil stored in drums near Building 453 is located immediately north of the loading dock.

A radiometric survey was performed in the vicinity of the west loading dock as part of a sitewide survey in April and May 1984. Areas south and west of Building 477 and areas north of Building 453 were identified as areas that could not be surveyed for Pu because of high-level background radioactivity.

IHSS 116.1 is primarily surfaced with asphaltic concrete. Two areas of exposed soil flank the eastern and western sides of the driveway leading to the dock. The exposed soil on the western side is poorly covered with an asphalt-type substance, but this cover is not considered adequate to prevent material migration into the soil. The driveway leading to the dock is sloped toward the dock. The eastern exposed area slopes slightly toward the west, and the western exposed area slopes toward the east at approximately 45 degrees. Because of this topography, two drains provide drainage for the loading area: one on the eastern side, and one on the western side of the driveway. The IHSS boundary also includes a small area of the tarmac at the top of the west slope, directly north of Building 457. This area includes a catch basin that provides drainage for the area.

HPGe survey data collected during the OU 12 Phase I RFI/RI at the IHSS 116.1 area indicate elevated activities of U-235 and U-238. Three sediment samples were collected from IHSS 116.1. Gross beta and U-238 exceeded background levels at one location. Chromium and zinc also exceeded background. Eight soil gas locations were sampled at IHSS 116.1. Ethylbenzene and total xylenes were detected in the southeastern corner of the IHSS at concentrations of 1.050 and 5.0 µg/L, respectively. Total xylenes were detected in the southwestern corner of the IHSS, at a concentration of 4.95 µg/L. Methane was detected at three locations, with results ranging from 50 to 120 ppm. These data are available in the IA Data Summary Report (DOE 2000a).

Cooling Tower Pond West of Building 444 IHSS 400-136.1

Although reference to three cooling water ponds in the vicinity of Building 444 was made in the CEARP Phase I report (DOE 1986), documentation examined during the HRR search supported the existence of only two ponds (DOE 1992a). The pond located west and north of Building 447 (IHSS 136.1) can be seen clearly in an aerial photograph taken in 1965 (DOE 1992c). It is located north and west of the location described in the IAG as IHSS 136.3. The former pond location is now partially or completely covered by Building 460, aboveground tanks, and pavement.

IHSS 136.1 is an area where a cooling water impoundment was located. The IHSS is located east of Building 460 and west of IHSS 116.1. The entire IHSS is paved with asphaltic concrete and is partially covered by Building 460. A single catch basin is located in the southwestern corner of the IHSS.

HPGe surveys conducted during the OU 12 Phase I RFI/RI indicate elevated activities of U-238 (8.3±0.34 pCi/g) and U-235 (0.15±0.02 pCi/g). Surface soil samples collected from IHSS 136.1 indicated Ra-228, U-238, Am-241, Ra-226, and zinc above background. Four soil gas locations were sampled at IHSS 136.1. Trichloroethene (TCE) was detected at 98.0 µg/L, PCE was detected at 3.8 µg/L, and methane was detected at concentrations of 10(J) and 20 ppm.

Cooling Tower Pond East of Building 444 IHSS 400-136.2

Every document found addressing the location of cooling tower ponds in the 400 Area describes this pond as being "due east of Building 444" or "east of the Building 444 exclusion fence," which is assumed to be IHSS 136.2. The pond was reportedly used on May 25, 26, and 27, 1956, by an outside contractor (Dowell) to collect various solutions used during cleaning of the Building 444 cooling tower. Typical solutions used to clean cooling towers at the time were acidic or contained chromate. In September 1956, when the liquid had evaporated and percolated away, the pond was backfilled. On December 2, 1958, cooling water from Building 447 was reportedly pumped to a surface ditch and allowed to flow across Plant site (PAC No. 000-501). Before 1958, drainage and flushing of the cooling water was diverted to the cooling tower blowdown pond east of Building 444, not to a surface ditch, making the 1958 documentation unclear. The several references to a pond east of Building 444 may have been referring to the pond used by Dowell in 1956, or to other standing water observed in the same relative location in later photographs.

The exact location of IHSS 136.2 is unclear based on maps and text in the HRR. However, the location of standing water in later photographs best fits the description of the pond used during the Dowell operation, and it is also close to the cooling tower that is immediately east of Building 444. The probable use of this general area as a cooling tower blowdown pond is substantiated by interviews conducted during the HRR with a retired Rocky Flats employee. Another interview conducted during the HRR indicated oil sheen was visible on the surface of the pond.

This IHSS is located in the northeastern corner, and just east of the fence line of the 400 Area. The entire IHSS is unpaved. A drainage ditch for the 400 Area currently runs through the IHSS, and trends north-south. Drainage flow is to the north in this ditch. A rail spur is located east of the IHSS.

HPGe survey data collected during the OU 12 Phase I RFI/RI indicated elevated Am-241, U-238, and Pu-239 activities. Surface soil samples indicated Am-241, cesium-137, Pu-239/240, U-233/234, U-238, beryllium, chromium, copper, and zinc above background levels. Am-241, Pu-239/240, and U-238 exceeded background in sediment samples. Additionally, gross beta levels were above background levels in sediment samples. These data are available in the IA Data Summary Report (DOE 2000a).

Buildings 444/453 Drum Storage IHSS 400-182

IHSS 182 is located between Buildings 444 and 453 and covers an area of approximately 1,700 ft^2. The area is currently roped off and is generally empty, although trash, such as wood, is sometimes temporarily placed there. There are no berms around the area.

IHSS 182 was first used as a drum storage area. In May 1957, it was noted that numerous drums of depleted U oxide were being stored in the "backyard" of Building 444. Originally, 55-gallon drums were placed directly on the ground. In the mid-1970s, the top 4 inches of soil in a portion of the Drum Storage Area was removed because of potential contamination. The soil was replaced with 4 inches of asphalt. However, drums were still stored on exposed soil in the remaining portion of the Drum Storage Area. It is not known where the contaminated soil was moved or stored, or whether contaminated soil samples were collected and analyzed.

The maximum number of drums stored at one time was approximately 200. Some of these drums contained unused oil, waste hydraulic oils, and chlorinated solvents. The exact number of drums containing contaminated waste oils or solvents is unknown, although the total container storage capacity at any given time was 11,000 gallons (DOE 1992a). Beryllium and low-level U contamination were sometimes present in the waste. Other sources of contamination near IHSS 182 include Building 453, a former oil storage area, and the Building 334 cargo container (DOE 1992a).

Soil investigations in 1988 indicated the presence of acetone; 1,1,1-trichloroethane (TCA); toluene; ethylbenzene; total xylenes; naphthalene; phenanthrene; fluoranthene; and pyrene. Samples were collected from 1-foot-deep excavations below a concrete sidewalk. A 1988 FIDLER survey found readings above background on the asphalt areas and in areas along the buildings and cracks between the concrete and asphalt (DOE 1992a).

Inactive Building 444 Acid Dumpster IHSS 400-207

IHSS 207 is the former site of Building 444 acid dumpsters which were located east of Building 444. Five-hundred-gallon dumpsters receiving waste were placed in an asphalt bermed area. From 1980 through 1987, the dumpsters were used to store acidic wastes from Building 444. No previous investigations were performed at this IHSS, and no spills were reported.

Inactive Buildings 444/447 Waste Storage Site IHSS 400-208

IHSS 208 is an inactive waste storage area that was previously identified in the RCRA permit application as Unit #3. The storage area was located near Buildings 444 and 453 in the same vicinity as IHSS 182, and consisted of a 20-foot by 8-foot cargo container with a maximum waste volume of 990 gallons (DOE 1992a).

IHSS 208 was used from 1986 to 1987. Typical stored waste included a composite of HNO_3 with silver, sodium fluoride, sodium fluoride solution, plating acids (hydrochloric acid, HNO_3, and hydrofluoric acid) with concentrated chromium plating solution, concentrated cadmium cyanide solution, nickel sulfamate, and developer and fixer (DOE 1992a). The storage area had secondary containment. No leaks or spills were reported in the area.

Analyses of surface soil samples during the OU 10 Phase I RFI/RI indicated that Am-241, copper, and zinc were detected above background. These data are available in the IA Data Summary Report (DOE 2000a).

Transformer, Roof of Building 447 PAC 400-801

A transformer was located on the roof of Building 447. The pad may have had a berm around it at one time. It is believed to have leaked prior to its removal in 1987. Downspouts are located north of the transformer's former position, which would have allowed PCB-contaminated runoff to infiltrate soil adjacent to Building 447. A storm drain is situated roughly 20 feet from the building and may have also been contaminated.

Smear samples collected in 1987 from the drain valve and adjacent transformer wall revealed 120 and 194 micrograms of PCBs, respectively.

In 1976, roofing material was removed from under the transformer due to possible leaks. The transformer itself was removed in 1987.

Beryllium Fire - Building 444 PAC 400-810

In February 1977, while welding on a small inlet duct of the beryllium air plenum that serves Building 444, an S&W employee noticed a fire on the face of the prefilters. He immediately informed another S&W employee who activated a manual fire alarm. The Fire Department was already responding to the automatic filter alarm. In approximately 15 minutes, the fire was extinguished.

The exhaust fan automatically shut down when the filter fire detection equipment was activated, resulting in a negative pressure inside the building, causing smoke to back into Room 107. A worker in the area noticed the smoke and activated a third alarm.

Analytical results indicated that 14.5 grams of beryllium were released. This was the only EPA standard that was violated (the EPA limit is 10 grams). Beryllium levels in the fire water collected from the east and south impoundment were 1.6 and 4.3 mg/L, respectively. Analytical results from pond samples and the shower water impounded at Building 990 all indicated concentrations of beryllium less than 0.5 mg/L.

Air sampling stations indicated beryllium concentrations ranging from 0.009 to 0.021 microgram meter per cubic meter ($\mu gm/m^3$). At the time of this incident, the Occupational Safety and Health Administration's (OSHA's) standard for an 8-hour time-weighted average was 2.0 $\mu gm/m^3$. Samples collected along Highway 93 contained concentrations of 0.006 to 0.015 $\mu gm/m^3$, which can be compared to the EPA standard of 0.01 $\mu gm/m^3$ for continuous exposure to the general public. RFP Environmental Sciences estimated that exposure time would have been only 0.5 hour.

Stack emission was monitored for U during the fire. Total long-lived alpha was found to be 0.08 pCi/L and total U was 0.092 pCi/L. Total plant stack emissions for February 1977 were 2.3 microcuries.

Firemen responded to the fire by initially spraying the outside of the plenum where the paint had blistered. One team was able to extinguish the fire from inside the plenum. A fog nozzle was used which was thought to have “washed” any airborne particulate from the air. Other areas around Building 444 were also sprayed down to control contamination.

Fire water samples were collected from the impounded ditches south and east of Building 444. Water samples were also collected at Ponds A-3, B-3, and C-1, and from the Building 881 shower water where some employees were bussed to take showers. Air samplers were set up to establish the amount of airborne contamination. The roadway south of Building 444, where the fire water flowed, was vacuumed and monitored for beryllium. All smears were determined to have background levels.

Tank 4 - OPWL Process Waste Pits IHSS 000-121

Existing data for this site have not been located.

Tank 5 - OPWL Process Waste Tanks IHSS 000-121
Existing data for this site have not been located.

Tank 6 - OPWL Process Waste Floor Sump and Foundation Drain Floor IHSS 000-121
Existing data for this site have not been located.

South Loading Dock Building 444 IHSS 400-116.2
The south loading dock started operation in 1953 and is located on the south side of Building 444. The incidents that may have contributed to possible contamination in the south loading dock area are described in the following paragraphs (DOE 1992c).

In 1953, high winds blew the lids off drums stored in this area and potentially released U onto the dock, sidewalks, and driveways.

On August 30, 1954, the motor of a portable vacuum malfunctioned while it was being used to vacuum a centrifuge. When the chips in the vacuum receptacle ignited, the receptacle was taken to the dock (known then as Dock No. 2). To extinguish the fire, the bag's contents were transferred to a steel drum and Metal-X powder was added. The explosive nature of the burning material potentially released airborne U contamination to the outside atmosphere and covered the dock and adjacent areaway with U oxide. This areaway is the pit entrance to the basement that is used to store cyanide and graphite storage drums. After the vacuum incident, the dock was cleaned. However, there is no record that the pit inside the areaway was decontaminated.

Drums containing Perclene (a solvent containing PCE) still bottoms and HNO_3 were stored on the south dock. In October 1955, one 55-gallon drum leaked and sprayed its contents onto two workers who were in the areaway adjacent to the dock. However, the leaks were plugged and the drum was moved. The contents of the drum were transferred to a stainless-steel drum and treated with caustic. Removal of soil in this area was being considered in 1975, but it is not known if soil was removed.

Until 1970, chlorinated hydrocarbon solvents used to rinse beryllium parts were typically disposed on the ground outside Room 106, which opens to the south dock. Analytical results of soil samples collected at 2 to 4 inches bgs revealed 350 to 1,000 micrograms per gram (µg/g) of beryllium from this beryllium-contaminated solvent disposal. Beryllium concentrations are 0.01 to 2 µg/g. Personnel conducted air sampling in the area of solvent dumping from June through September 1977. The average concentration of beryllium in air was 0.0009 microgram per cubic meter ($\mu g/m^3$), which was 9 percent of the U. S. Environmental Protection Agency (EPA) air quality standard. Soil removal was not deemed necessary.

Constituents that may have contaminated surfaces around the south dock include enriched and depleted U, beryllium, and chlorinated solvents. Direct U activity read as high as 7,500 disintegration per minute per square centimeter (dpm/100 cm^2), and smear readings with a minimum of 350 dpm were detected around the south dock. Following the 1954 release, the dock and sidewalks were cleaned and the driveway was coated. Air count results during the vacuum fire-extinguishing operations were as high as 33,000 percent of the

maximum permissible limit (MPL) for airborne radioactivity. Direct counts in the dock area were as high as 1,372.

IHSS 116.2 encompasses the south loading dock for Building 444. The entire IHSS is paved with asphaltic concrete and concrete. Drainage for the area appears to be toward the southeast were material would flow into the drainage ditch that flows to the east out of the 400 Area.

Surface soil samples collected during the OU 12 Phase I RFI/RI indicated gross beta, Ra-228, U-233/234, and U-235 were above background. Benzene, ethylbenzene, methane, toluene, and total xylenes were detected in soil gas samples. These data are available in the IA Data Summary Report (DOE 2000a).

GROUP 400-4

Miscellaneous Dumping, Building 460 Storm Drain PAC 400-803
A contractor working on the roof of Building 444 was found dumping miscellaneous materials into the storm drain immediately west of Building 446. The mixture flowed along the open ditch south of Cottonwood Avenue to a point south of the fuel oil storage tanks where it passed beneath the street and ran northeast to the extent of Seventh Avenue. The dumping consisted of silver paint and possibly other materials including oil and aluminum paint.

Road North of Building 460 PAC 400-804
On June 11, 1957, a pallet box with four ingots of unknown composition fell from a truck. The road, which was north of Building 446, was damaged. After removal of the ingots, the area was dry-vacuumed but monitoring was discontinued because of rain. The day after the incident direct counts up to 500 cpm and smears up to 104 dpm were obtained from the damaged area. These hot spots were covered with asphalt patching material.

GROUP 400-5

Sump #3 Acid Site (Southeast of Building 460) IHSS 400-205
IHSS 205 is located at the southeastern corner of Building 460 at the acid solvent dumpsters. These dumpsters were operated as interim status units during 1986 and 1987 and later used as a 90-day accumulation area.

The dumpsters were constructed with 3/16-inch-thick stainless steel walls and have a storage capacity of 250 gallons each. Lines ran from the waste generators to a sump or holding tank, then from the sump or holding tank through the concrete wall to the dumpsters, where they were attached by quick connect couplings. Each dumpster contained an 18-inch-diameter manhole on the top and a 1-inch-diameter drain fitted with a ball valve in the bottom. The paired dumpsters were used so that one dumpster can receive waste while the other is being emptied.

A level sensor was mounted in a 2-1/2-inch-diameter, stainless steel pipe near the end of each dumpster. An up-to-the-minute log of the volume in the tank was maintained and visually

checked with the sensor on a weekly basis to determine when dumpster changeover was necessary.

The dumpsters are contained within a concrete bermed area with a concrete divider. Each bermed area measures 4 feet, 6.5 inches wide by 8.5 feet long, and 12 inches deep. Each bermed area has a 286-gallon capacity. The containment areas cannot be drained into one another, but can be partially drained to the area outside of containment through a drain hole located 1-1/2 inches above the basin floor.

Waste materials handled by the acid dumpster were a mixture of approximately 80 percent water and 20 percent acid. The acids were primarily HNO_3 and nitrad, a combination of hydrofluoric acid and ammonium salts.

During an OU 10 Phase I RFI/RI inspection, it was observed that the tanks were disconnected, taken out of service, and triple-rinsed. Documentation of triple rinsing was found on tags attached to the tanks.

RCRA Tank Leak in Building 460 PAC 400-813

During a routine daily inspection in January 1994, approximately 2 gallons of liquid were found in the secondary containment piping associated with a RCRA-regulated process aqueous waste collection tank (RCRA Unit 40.12) in Building 460. The release originated from the gravity drain piping between a process sink and sump tank ST-2 (the ancillary equipment associated with the RCRA unit). The affected piping is located under the concrete floor in Room 151 in the approximate center of Building 460. The secondary containment system for the affected area consists of a pipe within a pipe. The released liquid was determined to contain levels of cadmium and silver that make the material a characteristic hazardous waste.

An engineering evaluation of the integrity of the secondary containment system was conducted to determine whether there was a pathway for contaminants to spread to the environment. Based on the results of the preliminary testing conducted on January 17, 1994, it was determined that there was a possibility that some of the waste was released to the environment underneath the floor of Building 460. Further evaluation on February 1 and 9, 1994, identified a breach in the secondary containment approximately 2.5 feet from the end of the pipe. The breach was approximately ¼-inch by ½-inch in area and was located in the vicinity of a sleeve that joined two sections of pipe. The released liquid contained levels of cadmium (19 ppm) and silver (13 ppm) that classify the material a characteristic hazardous waste.

The RCRA Contingency Plan was implemented and the liquid in the secondary containment was removed and placed into the process waste system on January 12, 1994. An engineering evaluation was conducted to identify the leaks in primary and secondary containment. The piping was taken out of service on January 12, and a decision was made not to repair the piping until further evaluation was completed. The pipes were temporarily capped to prevent inadvertent use of the system and alternate means of collection were used for the processes that rely on the capped lines. Waste was then collected in drums with secondary containment and the waste was transferred to the Building 460 hazardous waste collection system for disposition.

The contaminated soil beneath the building was not initially removed or sampled for several reasons including the following:

- Inaccessibility of soil removal without core drilling the floor;
- The small quantity (2 gallons) of material released to secondary containment;
- The low level of contaminants in the released hazardous waste (19 ppm cadmium and 13 ppm silver);
- The size of the breach in the secondary containment piping (1/4-inch x ½-inch);
- The location of the piping (13.7 feet above groundwater and underneath concrete); and
- No record of previous releases.

RCRA Tank Leak in Building 460 PAC 400-815

On June 29, 1994, a maintenance person discovered a release of approximately 1,800 gallons of process waste water into the secondary containment pit of Sump Tank ST-5 (RCRA Unit 40.15) located in Room 140 of Building 460. Initial surveillance indicated that the Hypalon liner in the pit leaked, filling the associated leak-detection sight tube three-quarters full of hazardous process waste water. In addition, approximately 0.5 to 0.75 inch of water was present in the surrounding bermed area. No leakage had been observed during the RCRA custodian's inspection on the previous day.

Sump Tank ST-5 collects Building 460 process waste water that is initially collected in Tank T-3 and then pumped to a roll filter table that filters the process waste water prior to its collection in Sump Tank ST-5. Sump Tank ST-5 water is then pumped to collection Tank T-1. These tanks, as well as collection Tank T-2, are all contained within a concrete bermed area. The concrete is coated with epoxy with the exception of Pit #5 surrounding Sump Tank ST-5, which is lined with a two-ply continuous 0.036-millimeter-thick Hypalon liner with glued seams. The sight tube associated with this pit is a 12-inch-diameter piece of plastic pipe. It is located in the northwestern corner of the pit and is slightly offset from the concrete floor to allow collection of any liquid beneath the liner and serve as a leak detection device for a breach of secondary containment.

Initially, the released material was believed to be nonhazardous based on process knowledge and analytical information on the cleaning processes. However, based on analytical sample results, it was later determined that the spilled material was hazardous waste. Samples of the waste water inside and outside the pit liner were collected at 5:00 p.m. on June 29, 1994. Additional samples were collected from the roll filter tank and Tank T-3 the following morning.

Preliminary sample results indicated that cadmium levels were likely present above RCRA regulatory levels for toxicity. The validated analytical data confirmed that cadmium exceeded the Toxicity Characteristic Leaching Procedure (TCLP) limit for toxicity in both the pit and the sight tube. Based on the analytical data, no other RCRA metals exceeded TCLP limits or exhibited the characteristic of corrosivity. The source of the cadmium is

believed to be from residual nondestructive testing film developer process waste, which was last placed into the process waste system on June 28, 1994. The developer waste water drains to the tank in Pit #2. Because Sump Tank ST-2 pumping is automatic, it is unknown when the solution from this tank was transferred to Tank T-3.

The maintenance person who observed the leak notified a Building 460 RCRA custodian who in turn notified the 400 Area Shift Manager. The RCRA Contingency Plan was implemented as a precautionary measure, because the possibility of a release of hazardous waste from a secondary containment to the soil beneath the building. Measurements of the pit were taken which indicated the total quantity released was approximately 1,800 gallons.

In response to the spill, cessation of all process waste activities in Building 460 occurred by 4:00 p.m. on June 29, 1994, approximately 1 hour after the leak was detected. Building 460 Maintenance personnel pumped the tank, pit, and bermed area of as much water as possible and then vacuumed the remaining waste. This water was collected in RCRA collection Tanks T-1 and T-2 in Building 460. The final removal of all liquid from under the liner was completed by noon on June 30, 1994.

On June 30, 1994, Maintenance personnel tested the Hypalon liner in the pit for leakage. Three small areas in the liner indicated leakage paths. The liner was also visually inspected and two additional small areas were found near the top of the pit where the liner had separated.

GROUP 400-6

Radioactive Site South Area IHSS 400-157.2

The Radioactive Site South Area (IHSS 157.2) includes the soil and paved area surrounding Buildings 444, 447, 440, and 439. Before 1973, soil in the vicinity was reported to contain low levels of U and chemical contamination. Buildings 439 and 440 also had possible infiltration of hydraulic oil and carbon tetrachloride originating from the U machine tool storage area. A U machine tool storage area was in the present location of Building 460. The western boundary of IHSS 157.2 was extended west (DOE 1992a) from what was presented in the IAG (DOE et al. 1991) to encompass the former U machine tool storage area, south to include the northern portions of Buildings 440 and 439, and east in an arc that follows the railroad spur. The extension of the boundaries was intended to include other activities that took place in the general area from 1953 through 1990 within this site.

Several operations associated with Building 444 may have contributed to potential contamination in the area. Probably the most significant event occurred near the south dock (IHSS 116.2) where solvents, used to rinse beryllium parts, were disposed on the ground.

Soil sampling conducted twice in 1954 indicated radioactivity levels two and three times that of background activities in a ditch south of Building 444 (DOE 1992a). Neither the sampling locations nor radioactivity results were documented in the HRR.

An ingot open storage area east of Building 444, a metal storage area south of the building, and a U machine tool storage area to the west may have contributed to low-level soil contamination. There have also been cooling tower ponds in the area, described under IHSSs

136.1 and 136.2. Numerous incidents are mentioned in documents found during the HRR search that indicated potential contaminant releases to the IHSS 157.2 area; however, most of them provide few details. The reported incidents are discussed below.

In May 1960, a vacuum collector fire in Building 447 resulted in the release of approximately 44 microcuries of depleted U. The depleted U was deposited on the roof of the building.

In December 1962, a U and beryllium release from Building 444 occurred through an unfiltered hood that vented to the exterior of the building.

In June 1966, a process waste line broke north of Building 444.

On November 11, 1974, approximately 170 ft^2 of road south of Building 444 (probably Cedar Avenue) was contaminated when a barrel containing U chips was dropped during transfer.

Low-level oblique photographs taken in 1965 indicate drum storage west of Building 555 in a location now covered by Building 460 (DOE 1992c). Similar photographs taken in 1969 indicate a drum storage area at the southeast corner of Building 444 (DOE 1992a). The contents of these drums are not known; however, drums containing cyanide and graphite were known to be stored downstairs through an areaway adjacent to the south loading dock.

Near the southeast corner of Building 444, very close to the railroad tracks, a small building can be seen in the 1969 Rocky Flats photographs. The ground around this building is covered with a white substance related to sandblasting operations (PAC 400-807). Also, just west of Building 445 in the ditch near the railroad tracks, there was a pool of water that may have been the cooling water pond identified in the HRR as IHSS 136.2 (DOE 1992c).

Rocky Flats photographs taken in 1978 show poor housekeeping in the area of Building 440. The area is littered with miscellaneous materials such as pallets, open paint cans, and machinery. There are also cargo containers located north of the building (DOE 1992c).

On February 23, 1978, a fire in the air plenum south of Building 444, which services the beryllium machining operations in Room 107, resulted in the release of an estimated 14.5 grams of beryllium. There was a large cleanup attempt after the Building 444 plenum fire. Firemen responding to the alarm began spraying the exterior of the plenum with water where the paint had started to blister and around the plenum to settle the contaminated dust. Temporary dams were established in the ditches south and east of the building, and samples were collected of the impounded fire water. Laboratory analysis revealed 1.6 mg/L beryllium in the east ditch and 4.3 mg/L in the south ditch. This water was sent to Building 774 for processing. Personnel in the building at the time of the fire were sent to Building 881 for showers. The shower water was retained until analytical results indicated that there was no beryllium present.

An incident occurred on November 4, 1985, involving pressurization of a process line in Building 447. The pressure forced liquid through a floor drain and up the vent pipe onto the roof, where it ran into the gutter and onto the ground below. The location of the vent pipe was in Room 502, although the specific area of the release on the ground was not provided in

the incident report. Documented radioactive contamination levels were as high as 10,000 cpm beta activity. The area affected by the process waste overflow was decontaminated to below 250 cpm or painted to contain the radioactivity. The drain involved was to have been relocated and have a ball check valve installed on the vent pipe.

While three drums were being transferred across the Site on November 30, 1990, one drum containing beryllium ingots was discovered to be radioactive. All areas were smeared along the path the barrels had been taken, and high smears (more than 25 cpm/ft^2) were found just outside the Building 444 beryllium machine shop at the exit/entrance door. The path of the drums is not documented in the HRR.

Little documentation has been found that specifically indicates cleanup of these incidents, except where noted. IHSS 157.2 covers the entire secured area of the 400 Area. Drainage for this IHSS is by overland flow and storm sewers located generally to the south and east.

HPGe surveys conducted during the OU 12 Phase I RFI/RI indicated Am-241 and U-238 were elevated in several locations within IHSS 157.2. Subsurface soil samples indicated that Am-241 and U-235 were elevated in the northeastern corner of the IHSS. Sediment samples indicated elevated levels of cesium-137, gross alpha, gross beta, Pu-239/240, Ra-226, U-233/234, U-238, U-235, beryllium, calcium, chromium, copper, magnesium, nickel, silver, and zinc. Total xylenes, ethylbenzene, benzene, toluene, and PCE were detected in soil gas samples at IHSS 157.2. Pesticides and VOCs were not detected at concentrations above reference levels. These data are available in the IA Data Summary Report (DOE 2000a).

GROUP 400-7

UBC 442 - Filter Test Facility

Information on Building 442 is from the HAER (DOE 1998) and HRR (DOE 1992a). Building 442 was originally used to launder U-contaminated protective clothing from Building 444. When Building 442 operations changed to filter testing, laundry operations were moved to Building 778.

The final use of the structure included a filter-testing laboratory and storage area for high-efficiency particulate air (HEPA) filters and respirator cartridges. The filter-testing laboratory performed tests on both respirator and equipment-mounted HEPA filters. Radioactive sources were used in some of the test equipment.

Both radioactive and chemical materials including U, beryllium, and enriched U from the laundry operations potentially affect the soil beneath the building. The soil in the vicinity of this building has also been affected by instances of radioactive release. In December 1963, rag-cleaning barrels leaked or spilled. Liquid drained into the ditch on the northwestern side of the building. In 1964, radioactively contaminated clothing from Building 883 infiltrated the laundry.

Radioactive Site North Area IHSS 400-157.1

Building 442 was used as a laundry facility to clean contaminated clothing from 1953 until approximately 1972 when it was converted to a filter-testing laboratory. As early as September 1953, contamination associated with the handling and steaming of contaminated

rags was observed in the soil around the building. A special survey conducted October 14, 1953, in the ditches north and west of Building 442 found maximum contamination of the soil to be 5 x 105 kilometers per meter per kilogram (km/m/kg).

On March 11, 1954, standing water in a culvert 30 feet west of the building was sampled. The water was suspected to have come from snowmelt that had drained from contaminated soil near Building 442. No documentation was found that details the results of the sample analysis.

The Site Survey Annual Report for 1954 stated that soil sampling throughout the year had disclosed contamination 10 times background in the ditches near Building 442. Building 441 and Building 442 showed consistent areas of significant contamination. No documentation was found that detailed a response to the contaminated ditch areas outside Building 442. However, it was decided that composite laundry water samples should be collected before the waste was discharged to the sewer.

In September 1959, a high count was determined on a smear sample from the Building 442 dock. The contamination was cleaned in response to the high smear on the dock in October 1959. Cleaning efforts followed the rag-cleaning barrel spill in 1963, and subsequent runoff reduced the concentrations in the area to low levels. The liquid drained east into the ditch on the northwestern side of the building. Radioactivity was detected as far as the eastern end of Building 555. In 1964, the laundry was infiltrated with enriched U impregnated in clothes from Building 883.

The laundry facility was responsible for the decontamination of clothing from manufacturing areas at RFP. Because of this, both radioactive and chemical materials including depleted U, enriched U, and beryllium may have contributed to the contamination around the building. The rag-cleaning barrel release reportedly involved solvents and radioactive metal shavings.

Prior to 1973, the ground areas around Building 442 were known to contain very low levels of U. Surface radioactivity was removed to background levels during the radiometric survey.

HPGe surveys conducted during the OU 13 Phase I RFI/RI did not indicate elevated radionuclide activities. U-235 was present in near-surface soil above background values. Copper, lead, zinc, Am-241, Pu-239/234, and U-238 exceed background values in surface soil. Benzo(a)anthracene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were also detected in surface soil. PCE and TCFM were detected in soil gas samples. These data are available in the IA Data Summary Report (DOE 2000a).

Building 443 Oil Leak IHSS 400-129

IHSS 129 is the No. 4 Fuel Oil Tank that is the southernmost of four tanks located near Building 443. The No. 3 and No. 4 tanks are no longer in use. Tanks No. 1 and No. 2 to the north are still used as “day tanks” by Building 443. The top of the No. 4 carbon-steel tank is approximately 4 feet below grade and is oriented lengthwise east to west. It is 11 feet in diameter by 27 feet in length with a total storage capacity of 19,000 gallons (DOE 1992c).

Five underground lines consisting of a steam line, return condensation line, pump line (to pump fuel oil), return line (for fuel oil), and line connected to supply tanks are connected to Tank No. 4 (DOE 1992c).

Tank No. 4 was primarily used to store #6 fuel oil from 1967 to 1984; however, #2 diesel oil was also stored in the tank during the 1970s. It was also used to store a waste mixture of compressor oil and water from 1984 to 1986 and solvent for fuel oil spills from 1967 to 1986. Tank No. 4 use was discontinued in 1986 after evidence of potential leakage was discovered. The contents of the tank were removed, although sludge may remain in the lines and the tank (DOE 1992c).

Fuel spills of #6 fuel oil associated with the four #6 fuel oil tanks were reported in 1967, 1968, and 1977, and a possible leak was reported in 1986. The Closure Plan for Tank No. 4 indicates that the tank was a potential source for leakage. The Closure Plan also indicates traces of 1,1,1-TCA and methylene chloride were detected in groundwater, however overall, Tank No. 4 leaks or spills did not impact groundwater.

During previous investigations, soil samples were collected from borings drilled to help characterize the tank area for closure. The analytes for these samples included VOCs, base neutral acids (BNAs), and metals. Results indicated the presence above detection limits of organics including 1,1,1-TCA, methylene chloride, benzene, toluene, ethylbenzene, and total xylenes. Metals detected include aluminum, arsenic, beryllium, calcium, cadmium, chromium, copper, iron, mercury, magnesium, nickel, potassium, lead, vanadium, and zinc (DOE 1992c).

HPGe survey data collected during the OU 10 Phase I RFI/RI indicated that activities for potassium-40 and Th-232 exceeded background. These data are available in the IA Data Summary Report (DOE 2000a).

Sulfuric Acid Spill Building 443 IHSS 400-187

A sulfuric acid spill (IHSS 187) occurred on September 11, 1970, from an aboveground 3,000-gallon tank located approximately 30 feet east of Building 443. Approximately 1,500 gallons of acid spilled from the tank and drained eastward, where the acid was captured in an earthen pit and neutralized with lime. IHSS 187 is located east of Building 443 and extends into an area now occupied by Building 452. Much of the area has been graded, and buildings, tanks, and sidewalks are now present at the spill location.

Building 443 was placed in service in 1953 and houses the steam generation plant. Water is softened and transferred to boilers to make steam for use in process heating and cleaning operations. The steam boilers are normally operated using natural gas, although #6 diesel fuel is used as a backup fuel. The fuel is stored in two large aboveground tanks located approximately one block east of Building 443. Aboveground tanks containing sulfuric acid and NaOH are located on the eastern side of the building. These materials are used for boiler descaling and neutralization.

The 3,000-gallon acid tank associated with IHSS 187 was salvaged from Building 881, where it had been stored an estimated 8 to 10 months after decontamination. At the time of installation, the drain line was equipped with a nonstandard valve and flange. The piping

system was hydrostatically tested on July 2, 1970. The tank was filled with water, left for 3 weeks, and determined to have no leaks. After the water was drained from the tank, the valves and gaskets were changed.

From the drain valve of the acid tank, a pipe extended to a 200-gallon mixing tank situated over a 7,000-gallon concrete, PVC-lined neutralizing tank inside Building 443. Before filling the acid tank, it was verified that the tank was empty by opening all valves and noting that no drainage occurred to the mixing tank. The tank was filled with acid on September 2, 1970. During filling, it was discovered that the level indicator was not functioning, which resulted in an overflow of approximately 0.5 gallon of sulfuric acid. Another spill occurred when the transfer hose was removed and drained. Both spills were neutralized with caustic. The tank was locked out.

On September 11, 1970, a sulfuric acid stream approximately 1/4 inch in diameter was found spraying out approximately 4 feet from the flange above the drain valve. After discovery of the leak, Fire Department personnel began spraying the tank and surrounding area with water. High winds were carrying the acid and fumes to the south and east; therefore, this procedure was curtailed. Lime was added to neutralize the sulfuric acid.

The lockout chain was cut, and the acid was allowed to drain to the mixing tank inside Building 443. The mixing tank was adapted with a flexible hose that would let the acid drain into the neutralizing tank. Approximately 9 hours after the leak was detected, the tank was completely emptied.

Because the tank was not equipped with secondary containment, the acid from the flange drained through a culvert under Fifth Street and along a ditch south of Building 442. The acid continued to flow northward along a north-south ditch east of Building 442 and west to ponds that were constructed to contain the acid. One pond measured roughly 74 feet by 25 feet, and the other was approximately 25 feet by 25 feet.

On September 12, 1970, it was discovered that the neutralization tank inside Building 443 was leaking from the drain valve into the sanitary sewer line and into the sewage treatment plant (Building 995). The acid was transferred from the neutralization tank to 25 polyethylene-lined barrels placed near earthen pits. The investigative report on this incident states that a dike surrounded the drums; however photographs taken on September 14, 1970, do not show a dike (DOE 1992a).

The drain valve on the neutralization tank had not been inspected since its installation in 1966. Dirt was found on the acid tank, which may have contributed to the inadequate closure of the neutralization tank valve.

No documentation was found that detailed the removal of contaminated soil, however, photographs indicate soil excavation immediately adjacent to the tank. The CEARP Phase I document (DOE 1986) considered that this procedure would create by-products that were benign and highly mobile; therefore, no environmental hazard should remain.

Assuming that the acid tank was filled to capacity (3,000 gallons), approximately 200 gallons of acid are unaccounted for in the description of the incident. Approximately 1,500 gallons

are reported to have leaked from the leaking flange directly to the ground. An additional 1,300 gallons were recovered from the neutralization tank. The remaining 200 gallons probably leaked from the neutralization tank into the sanitary sewer system. The Building 994 sewage treatment plant and its effluent were monitored to assess the impact of the spill. On September 12, the pH of Building 995 influent was as low as 1.8. On September 13, the effluent had a pH of 2.2 with a sulfate concentration of 1,120 ppm. It is probable that the sulfuric acid leak into the sanitary sewer system contributed to the acidic treatment plant water.

HPGe survey data collected during the OU 12 Phase I RFI/RI indicated slightly anomalous U-238 values at several locations. Surface soil sample analysis indicated that Am-241, gross beta, Pu-239/240, Ra-226, Ra-228, U-238, and U-235 were above background values. These data are available in the IA Data Summary Report (DOE 2000a).

GROUP 400-8

UBC 441 - Office Building

Building 441 is located in the northwest portion of the 400 Area and was placed into service in 1952. The building footprint is approximately 17,075 ft^2. The building was originally used as a laboratory, and in 1966, was converted into an office building. Because the footprint of the building overlaps IHSS 122, the soil beneath the building is potentially affected by nitrates, volatiles, PCBs, and radioactive contaminants. No characterization has been performed of the soil underlying the building (DOE 1992a).

Underground Concrete Tank IHSS 400-122

There are two interconnected underground tanks south of Building 441. Both tanks are concrete and each has a capacity of 3,000 gallons. The tanks were part of the OPWL system and were used to handle the waste from Building 123 and Building 441 and possibly from Building 122 and Building 444. Interviewees for the CEARP Phase I document mentioned that leaks might have occurred. At times, the tanks were known to fill with groundwater, which was pumped out and sent to waste treatment.

The tanks were originally 60 feet south of Building 441. In 1966, the Building 441 addition was constructed over approximately 7.5 feet of the existing tank system. At this time, portions of the tank walls may have been removed to accommodate the construction of Building 441.

The tank system consists of two tanks. One is constructed of concrete with a partial limestone lining and is located beneath the building. The other is a two-chambered tank that is located underground directly outside the building. The two-chambered tank received inflow from the limestone tanks and has a combined capacity of approximately 6,000 gallons. Because of the conversion of Building 441 activities, waste was no longer generated from this source; however, both tanks may have received waste from Building 123 as late as June 1966.

Documentation was found for only one release from these tanks. On June 1, 1953, the tanks overflowed by approximately 1,200 gallons. The spill consisted of process waste from Building 123. In 1953, the system was modified to allow liquid wastes to be released

directly to the sanitary system, therefore reducing the amount of waste passing through these tanks.

The tanks were known to store process waste from Buildings 441 and 123. Nitrates and radionuclides were assumed to be present. One reference describes the waste as having total dissolved solids ranging from 532 to 965 ppm and a pH that ranged from 7.15 to 5.85. Limestone was used to help control the acidic nature of the waste.

A telephone interview was conducted on November 14, 1991, with RFP Liquid Waste Operation personnel. It was stated that the limestone tank might contain groundwater seepage; however it is no longer pumped or checked.

Tank 2 - Concrete Waste Storage Tank and Tank 3 - Steel Waste Storage Tank IHSS 000-121

Tanks 2 and 3 are interconnected tanks located in the 400 Area, along the southern wall of Building 441 near its southwestern corner. Tank 3 refers to the 3,200-gallon carbon steel AST and an underlying 3,000-gallon concrete storage tank. Tank 2 is an underground concrete tank that partially underlies Building 441. The precise location of the underground tanks and the tank designation are not clear. The underground tanks could not be visually inspected because of the presence of water in the vaults and the as-built drawings do not adequately describe the tanks (DOE 1969). Tank 3 is assumed to be steel, and Tank 2 is assumed to be an underground concrete tank that has three concrete access chambers overlying the tank. The field inspection could not determine whether the tank underlying these vaults extended under Tank 3, or could the field inspection assess the condition of the underground tank(s).

Tanks 2 and 3 were installed in 1952. The underground concrete tanks and the AST were abandoned in June 1982 after reportedly being decontaminated, filled with gravel, and covered with concrete (DOE 1969). However, the reference to being filled with gravel probably refers to the part of Tank 2 that underlies the addition to Building 441, whereas the other part of Tank 2 that is outside the building probably remains intact. The as-built drawing for this tank indicates that a separate chamber to this tank lies entirely outside the building foundation (DOE 1969). Furthermore, no gravel underlying the three concrete access chambers was noted during the limited visual inspection of Tank 2. Information also indicates that a pipe directed effluent to this part of the tank so that the other parts could be filled with gravel upon construction of the structure addition to Building 441.

These tanks reportedly received waste streams from Building 122, Building 123, and Building 441. Waste streams included acids, bases, solvents, radionuclides, metals, thiocyanate, ethylene glycol, trace PCBs, bleach, soap, blood, and hydrogen peroxide. Tank 3 reportedly last stored ammonia after storing several other wastes. This site has been identified as a known release location (DOE 1992a).

HPGe surveys were conducted during the OU 9 RFI/RI and results indicated that Th-232 was slightly above background activity. NaI surveys indicated six locations above background levels. Surface soil samples were also collected and analyzed. Am-241 and Pu-239/240 were detected above background.

Subsurface soil samples indicated that Pu-239/240 was above background at a depth of 0.0 to 0.6 inches and 2.0 to 4.6 feet at a location adjacent to the northwestern corner of Tanks 2 and 3. Groundwater samples at this location indicated that all Target Analyte List (TAL) metals and radionuclides except cesium, molybdenum, beryllium, and silver exceeded background levels. Pu-239/249 and lead were detected above background at 0 to 6 inches depth adjacent to the southwestern corner of the tanks. Groundwater samples at the same location indicated that Am-241, U-233/234, U-238, aluminum, arsenic, barium, lead, manganese, potassium, sodium, and strontium exceeded background.

Soil samples from the borehole located adjacent to the south side of Building 441 indicated that Am-241, Pu-239/240, and lead exceed background at the depth of 0.0 to 6.0 inches. Pu-239/240, U-238, and lead exceeded background at a depth of 0.0 to 6.0 inches at the borehole located adjacent to the eastern side of Building 441. Groundwater samples from the same location indicated that all radionuclides were above background, and all metals except antimony, beryllium, cadmium, calcium, cesium, molybdenum, silicon, silver, and tin exceeded background.

Soil samples from the borehole adjacent to the northeastern corner of Building 441 indicated that Pu-239/240 and lead were above background at a sample depth of 0.0 to 6.0 inches. Groundwater samples indicated that all radionuclides and all metals except antimony, beryllium, cadmium, calcium, cesium, molybdenum, silicon, silver, and tin exceeded background levels. Soil data are available in the IA Data Summary Report (DOE 2000a).

Samples collected of the liquid in the Tank T-2 vault indicated that every radionuclide analyzed had positive activity, with gross alpha/beta, U-233/234, U-235, and U-238 having moderate to high activity.

GROUP 400-10

Sandblasting Area IHSS 400-807

No documentation could be found that details the dates that sandblasting began in the 400 Area. The first documented incident occurred in May 1976. References state that sandblasting of ATMX railcars took place “north of Building 664,” “inside the fence east of 44,” and “east of Building 439.”

In September 1976, Industrial Hygiene personnel initiated the substitution of alumina grit for flint sand because of its lower toxicity.

Fiberglass Area West of Building 664 IHSS 600-120.2

Building 664 became operational in 1972 and was used for storage, staging, loading, and shipping of radioactive wastes. Building 664 contained a fiberglass application operation and a real-time radiography unit.

The fiberglassing area west of Building 664 (IHSS 120.2) is fully encompassed by IHSS 161. IHSS 161 may contain low-level residual Pu and U contamination resulting from punctured or leaking drums and boxes of solid and liquid wastes.

IHSS 120.2 was used as an area for fiberglassing in conjunction with operations at Building 664 and is located on the western side of this building. The IHSS is generally paved with asphaltic concrete; however, some areas are unpaved. The unpaved areas are in the southern and western portions of the IHSS. Sediment in the eastern portion of the IHSS next to Building 664 indicated that water ponded in this IHSS.

HPGe surveys conducted during the OU 12 Phase I RFI/RI indicated that Am-241, Pu-239, and U-238 were elevated at this IHSS. Surface soil samples indicated the presence of Am-241, U-233/235, U-235, and U-238. These data are available in the IA Data Summary Report (DOE 2000a). Acetone, benzene, ethylbenzene, methane, toluene, and total xylenes were detected above background in soil gas.

Radioactive Site West of Building 664 IHSS 600-161

Persons interviewed for the CEARP Phase I report indicated that the area west of Building 664 may contain low-level residual contamination from Pu and U resulting from punctured or leaking drums and boxes of solid and liquid wastes. Building 664 was constructed in 1971 and is used to stage drummed and boxed waste prior to offsite shipment for disposal. A review of aerial photographs revealed no apparent activity in the area prior to the construction of Building 664 in 1971. No records documenting discrete releases in this area were found.

Results of an aerial radiometric survey conducted in 1977 indicated an area of elevated Am and gamma activity concentrations around the northwestern corner of Building 664. Pu- and U-contaminated liquid and solid wastes staged in Building 664 are the likely residual constituents that led to the elevated radiation readings.

In November 1988, a forklift leaked hydraulic oil outside Building 664. The cause was the rupture of a 1-inch hose on the forklift. The oil spread over the asphalt area and adjacent ground.

Soil was reportedly removed from this area in the early 1970s. No documentation was found that provides details of any soil remediation activities.

GROUP 500-1

Valve Vaults 11, 12, and 13 IHSS 300-186

Valve Vaults 11, 12, and 13 are located inline along the process waste line south of Building 374 and west of Building 552. Several incidents have occurred in one or more of the valve vaults resulting in the release of process waste to the environment. Process waste lines connect the valve vaults and containment lines surround the pipes. In addition to the double-contained lines, the process waste lines are equipped with leak-detection sensors.

The first incident related to these valve vaults for which documentation was found was on June 12, 1985. Contractors excavating a drainage ditch along the south side of the PA in the northeastern corner of the Building 371 parking lot broke the outer containment of four lines and the inner line of the low-level transfer line near Valve Vault 13. Soon after it was broken, pumping began from the process waste tanks in Building 460 to Building 374 allowing liquid to be released from the inner pipe.

In June 1986, corrosion of a 1-inch-diameter hole in a black iron flange, which was connected to a stainless steel piping system, caused a release of process waste into Valve Vault 13. The sump pump recirculated the liquid in the vault. The sensor alarm sounded but was not responded to until the next day.

Leakage of the process line between Valve Vault 12 and Valve Vault 13 was reported on October 24, 1986. The process waste lines are designed to provide a constant slope between adjacent valve vaults to allow any liquid in the containment pipe to flow into a vault and trigger an alarm. No alarm sounded when the release occurred. It was determined at the time the leakage occurred that the lines had been previously repaired and reworked in 1981 or 1982 and that they were not replaced in a manner that allowed drainage (no documentation could be found as to why the lines were repaired or replaced). Instead, a trap was created, allowing saturation of the bedding material and soil around the pipe.

On June 1, 1987, a radioactive leak was discovered near Valve Vault 13 when contamination was found in the culvert drain collection basin. The leak was found to be in the high-level transfer line between Building 374 and Valve Vault 13.

On September 13, 1988, Valve Vault 12 was flooded with 1,700 gallons of high nitrate solution during transfer between Building 774 and Building 374. A connection at a tygon tube became separated which allowed the leak to occur.

In October 1989, a significant amount of liquid was found in Valve Vault 11, Valve Vault 12, and Valve Vault 13. The alarms had sounded in the Building 231 Pump House, Pump Station #1, and Valve Vault 19, but upon inspection no problems were found at these locations. The inspection continued and resulted in the discovery of liquid in Vaults 11, 12, and 13.

Details of the spill in 1985 indicated a pH of 5 and 6 on litmus paper with a laboratory analysis of 7.2. The process waste consisted of Oakite and distilled water. It was estimated at the time that 1,700 gallons of liquid were pumped, but only approximately 4.4 gallons were spilled onto the ground.

The pipe was repaired after the 1985 incident. Investigation at that time revealed no radioactive contamination. In June 1986, the black iron flange was replaced with a stainless steel flange with no release of contamination. These repairs were thought to have contributed to the leak found in 1987, because the repairs were not compatible with the original design.

The June 1986 incident involved an acidic liquid waste that corroded the iron flange. In October 1986, the soil surrounding the pipe was saturated with a yellow liquid. Monitoring of the area disclosed alpha, beta, and U-238 contamination of up to 1.7×10^5, 5×10^4, and 9×10^2 pCi/L, respectively. Analytical results from water samples indicated the presence of U, Am, Pu, total alpha activity, and total beta activity.

After the leak had been detected in October 1986, an area 30 feet by 100 feet was excavated to locate the leak in the process waste lines. The repairs were completed on November 13, 1986. A series of small cofferdams was built to contain surface and groundwater, and the

collected fluids were eventually removed by a tank truck and placed in SEP 207A. Approximately 24 waste boxes of U-contaminated sand and gravel were shipped offsite for low-level radioactive disposal. Cleanup was completed on December 8, 1986, by reducing the radiation levels to slightly above background. The area was backfilled.

A radioactive acidic solution was released in the June 1987 incident. Analytical results from samples collected in the culvert drain collection basin showed 42,000 pCi/L gross alpha activity and 13,000 pCi/L gross beta activity.

In response to the culvert contamination in 1987, dikes were installed in the drain path to prohibit further draining. Liquids were drained from the transfer pipe and pumped to a mobile tanker. The culvert was taken out and soil was removed until both alpha and beta counts were below 250 cpm. A work order was submitted to install a leak-detection device; however it is not known whether this was complete. The high- and low-level transfer lines were replaced with fibercast piping and repaired to the original design specifications.

The liquid that leaked in 1989 was approximately 10,000 gallons of SEP water with a pH of 7.5 to 8.0. Analytical results of radioactivity levels indicated 3,122 to 7,134 pCi/L gross alpha activity.

A document written in May 1989 indicated that the backfilling of an excavation at this valve vault would have to be delayed for over a year because of legalities in dealing with the contaminated waste. This excavation may be due to the flooding incident in 1988.

The supervisor of Building 374 ordered pumping to be stopped from Building 778 and Building 774 in response to the 1989 incident. The RCRA/CERCLA office was notified. The appropriate lockout/tagouts were provided on the valves in Valve Vault 12 and in the Building 231 Pump House. The liquid was removed and repairs to the line were completed by October 22, 1989. The line flow-tested successfully. A RCRA CPIR (89-015) was prepared and submitted on this incident.

Scrap Metal Storage Site IHSS 500-197

In approximately 1958, scrap metal components, mostly from the original plant construction program, were buried in trenches west of Building 559. Some of the buried material was recovered from process areas. Another source states that the burial probably occurred in the early 1960s. The site was probably used by the Austin Company for disposal of construction debris during early building activities.

Some of the scrap metal material recovered from the process areas and buried in the trenches could have been radioactively contaminated. There is a slight possibility that transformers containing PCBs were disposed of at this site.

In 1981, excavation for the construction of the PSZ unearthed the scrap metal burial sites. RFP personnel remediated the site by complete excavation of the trenches and removal of the buried material to the sanitary landfill (PAC NW-114). Another reference states that there was a second scrap metal burial site, located west of Building 559 and northwest of the first site, which was also unearthed at the time of the PSZ construction.

North Site Chemical Storage Site IHSS 500-117.1

An area northeast of Building 551 was used as a general warehouse storage yard prior to September 1959 until the early 1970s. In September 1959, routine monitoring of the aluminum scrap pile near Building 551 showed an occasional build-up of radioactive material. In May 1963, U chips and turnings were discovered at this site in an aluminum scrap pile. A similar incident involving 40 drums of contaminated aluminum scrap occurred in 1964. In May 1964, 40 drums of contaminated aluminum scrap were dumped into the acid waste in SEP 207A (PAC 000-101).

Forty drums of aluminum scrap metal contaminated with U chips and turnings were discovered in the storage yard. In September 1959, an approximate 1 ft^2 area of the aluminum scrap pile near Building 551 showed a direct measurement of up to 20 millirems per hour (mr/hr).

The aluminum scrap pile near Building 551 was routinely monitored in September 1959 for radioactivity. In the early 1970s, material in the general warehouse storage yard was transferred to the PU&D storage yard southwest of the present landfill.

Surface soil samples collected during the OU 13 Phase I RFI/RI indicated that Pu-241, copper, mercury, lead, selenium, silver, and zinc were present above background levels. Acetone, benzene, PCE, TCE, TCFM, and toluene were detected in soil gas samples. These data are available in the IA Data Summary Report (DOE 2000a).

GROUP 500-2

Radioactive Site Building 551 IHSS 500-158

There may be residual contamination from leakage of waste boxes loaded into railroad container cars in the area north of Building 551. In September 1959, three containers measuring 6,000 to 40,000 cpm were held back from offsite shipment. On June 7, 1961, isolated spots of contamination up to 8,000 cpm were found on the dock and in the helium storage area of Building 553. Empty drums contaminated with U from offsite were received at Building 551. In October 1962, spot checks of one load of approximately 220 drums indicated they were generally contaminated up to 1,200 cpm on exteriors and up to 7,000 cpm on the interior surfaces. In July 1963 and again in 1970, RFP received equipment and drums from offsite that contained U above the acceptable level.

Spots of contamination (found in June 1961) on the dock and in the helium storage area of Building 553 were cleaned. In 1970, an entire shipment of 55-gallon drums was returned to the vendor.

Surface soil samples collected during the OU 13 Phase I RFI/RI indicated that Am-241, Pu-241, U-233/234, U-235, U-238, copper, chromium, lead, and zinc were present above background levels. These data are available in the IA Data Summary Report (DOE 2000a). Acetone, benzene, bromomethane, chloroethane, dichlorodifluoro-methane, 1,1-dichloroethene, cis,-1,2-dichloroethene, ethylbenzene, n-propylbenzene, PCE, TCE, TCFM, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, toluene, vinyl chloride, and xylenes were detected in soil gas samples.

GROUP 500-3

UBC 559 - Service Analytical Laboratory

Information on Building 559 is from the HAER (DOE 1998) and HRR (DOE 1992a). The plutonium laboratory was constructed in 1967, and first began operations in January 1968. Samples of recovered, cast, and purified materials from the Plant were analyzed in the lab. The building contained laboratory facilities for conducting spectrochemical, chemical, and mass spectrometric analyses. In 1973, the construction of Building 561 expanded the capabilities of the laboratory. Support tasks in Building 559 included primary analytical support for Building 707 production contingency, Raschig ring analysis and certification, duct remediation, analysis and characterization of low-level waste, and analysis of contaminated PCBs. Later projects included the Waste Isolation Pilot Project Bin and Alcove test program, the WSRIC program, and consolidation and stabilization of nuclear materials.

There were two analytical laboratories present in the structure. The production support and Plant support laboratories shared equipment and space. The area along the north side of the building was divided into rooms for offices, radiation monitoring, a computer room, restrooms, a locker room, storerooms, and maintenance equipment. Four large areas along the south side and eastern end of the building were used for mechanical equipment and laboratories. Specific laboratories included the spectrochemical analysis laboratory, chemistry laboratory, and mass spectroscopy laboratory. Radioactive materials processed in the laboratories were received and shipped from a loading dock on the south side of the building. A second loading dock at the western end was used to receive building supplies.

In the production support laboratory, quantitative and qualitative chemical analyses for Pu production operations were performed to ensure that raw material used in manufacturing processes were within specifications, Plant processes produced materials that met specifications, and final products conformed to requirements. Quantitative analyses included: gallium in Pu alloy, plutonium assay, carbon-hydrogen-nitrogen contents, ion analysis, tritium content, emission spectrometric analysis, atomic absorption, coulometric analysis, x-ray fluorescence spectroscopy, and identification of various isotopes. Samples consisted primarily of Pu or other metals and their alloys, oxides of Pu, U, solutions of Pu or other elements, and various gases. Materials in process were held at given stages in their sequence of operations until results of sample analyses were obtained and verified. Small samples of solids or liquids were transferred from production areas to the laboratories, where exact sample aliquots were prepared from the production samples. These samples were transferred to appropriate instruments for analysis.

The Plant support laboratory personnel performed analyses on materials from Plant support functions indirectly related to production activities (e.g., radiation monitoring and waste treatment). This group performed mass spectrometry analyses of isotopes of Pu, U, lithium, and boron (thermal ionization); organic compounds; gases; operational processes; and using spark ionization. Other analyses included infrared analysis to determine impurities, thermal characterization analysis to determine changes in phase as a function of temperature, and titrimetry to determine water content of organic solvents.

The facility was originally built with Pyrex glass waste lines in 1968. Less than a year after construction, a break was discovered. In 1972, PVC pipe was installed as a replacement. Core sections taken beneath the building confirmed some infiltration.

UBC 528 - Temporary Waste Holding Building

Information on Building 528 is from WSRIC (RMRS 2000e). Building 528 houses two storage tanks that hold process wastes from the Building 559 analytical laboratories and plenum fire water from Building 561, until the wastes are pumped to Building 374 for treatment. Wastes from Building 559 include wash water and expired reagents, such as ceric sulfate, HNO_3, and KOH; aqueous standards from the laboratory sinks; a waste solution containing solvents and acids; and waste water from the decontamination room. These wastes are accumulated in 55-gallon drums in Building 559, then transferred to Building 374 by tanks. Occasional building cleanup, maintenance, and refurbishing activities generate waste, which is transported to Building 559 for eventual disposition.

Radioactive Site Building 559 IHSS 500-159

When Building 559 began operation in March 1968, the process waste system consisted of Pyrex glass lines beneath the building and adjacent support buildings. Less than 1 year later, a break was discovered in the process waste line from the building to the pump house. In May 1972, the south half of the process waste line beneath Building 559 was discovered to be leaking. Additionally, the rupture of the process waste line from Building 559 to the process waste tank valve pit caused soil contamination with activity of 4,500 pCi/g. The contamination decreased from the pit to the concrete pad along the south side of Building 559.

In May 1977, influx of contaminated groundwater was discovered in the manhole next to the southwest corner of Building 559. The contamination was believed to be residue from the 1972 occurrence. Also in May 1977, 4,600 gallons of contaminated water leaked into a process waste collection tank in Building 528. The water leaked through a drip leg of the double-contained process waste lines and was fed by a broken 3-inch PVC process waste supply line from Building 559 to Building 561. Gross alpha in the water from the drip leg was measured at 160,000 pCi/L. It was concluded that the process water supply line, process line, and shell of the process waste line were probably broken. The primary material of concern is process waste generated at Building 559. Typically, process waste consists of an aqueous solution with radioactive constituents.

In 1968 and 1972, contaminated soil from over and around the process waste line to the process waste tank pit was removed and shipped to Idaho for disposal as radioactive waste. In 1968, the infiltrated soil removed for offsite disposal had a surface area of several hundred ft^2. In 1972, a PVC pipe bypass of the Pyrex line beneath the south half of Building 559 was installed and the remaining lines were static leak tested. In May 1972, 82 drums of contaminated soil were removed from over and around the process waste line from Building 559 to the process waste tank pit south of the building. The soil under the process waste line was not removed. In May 1977, water samples were collected at the process tank building, steam pit, Building 561, and footing drain manhole south of Building 559. Also in May 1972, the pit building was decontaminated. In addition, Building 559 terminated the generation of process waste water, and groundwater was pumped from the footing manhole

to the process waste holding tanks. No documentation was found that indicated the duration for which process waste generation was terminated.

Tank 7 - OPWL - Active Process Waste Pit IHSS 000-121
Tank 7 is located in the 500 Area within Building 528, which is referred to as the Building 559 Process Waste Pit. This tank is located approximately 30 feet southeast of Building 559. Tank 7 is consists of two 2,000-gallon, in-sump steel tanks within an underground concrete vault.

Tank 7 was reportedly installed in 1969 and received waste streams from Building 550, the Analytical Laboratory, including acids, bases, solvents, radionuclides, metals, pesticides, herbicides, and possibly PCBs. The tank was used as a 90-day TRU waste tank, according to Building 559 personnel. This tank has been identified as a known release location at its connection with Pipe P-16 (DOE 1992a).

HPGe surveys indicated elevated levels of Am-241 and Pu-239/240. These levels increased as they got closer to Building 569. Three NaI locations had activities from 1,500 to 2,500 cpm with background levels in the same range.

Soil from a borehole located adjacent to the northwestern corner of Tank T-7 had Pu-239/240 activities greater than background at a depth of 0.0 to 0.5 feet. In a groundwater sample at the same location, arsenic, barium, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, strontium, and zinc concentrations exceeded background. Gross alpha, gross beta, U-235, U-233/234, and U-238 activities were above background. In a groundwater sample at the borehole adjacent to the northeastern corner of Tank T-7, arsenic, strontium, manganese, sodium, zinc, U-233/234, and U-238 exceeded background concentrations.

Tank 33 - OPWL - Process Waste Tank IHSS 000-121
Existing data for this site have not been located.

Tank 34 - OPWL - Process Waste Tank IHSS 000-121
Existing data for this site have not been located.

Tank 35 - OPWL - Building 561 Concrete Floor Sump IHSS 000-121
Existing data for this site have not been located.

GROUP 500-4

Middle Site Chemical Storage IHSS 500-117.2
There were minor leaks and spills in the chemical storage area east of Building 551. An inspection in approximately 1971 revealed several drums that were leaking an oily substance. Constituents released included acids, oils, soaps, solvents, and beryllium scrap metal. On October 20, 1986, a 55-gallon drum of aluminum nitrate was punctured by a forklift east of Building 551. Most of the 55 gallons flowed out and across the roadway to the east.

In the early 1970s, a recommendation was made to repack leaking drums in the storage area. The chemical storage area east of Building 551 was covered with asphalt sometime during the 1970s. The October 20, 1986, incident was controlled with no environmental damage.

Surface soil samples collected during the OU 13 Phase I RFI/RI indicated that Am-241, Pu-241, Ra-226, chromium, lead, nickel, and zinc were present above background levels. These data are available in the IA Data Summary Report (DOE 2000a). Acetone, benzene, bromomethane, chloroethane, dichlorodifluoromethane, 1,1-dichloroethene, cis-1,2-dichloroethene, ethylbenzene, naphthalene, n-propylbenzene, PCE, TCE, TCFM, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, toluene, vinyl chloride, and xylenes were detected in soil gas samples.

GROUP 500-5

Transformer Leak - 558-1 PAC 500-904

Transformers 223-1 and 223-2 are located north of Building 549. These transformers leaked small amounts of oil prior to 1987. In February 1986, the valve, tap changer, and bushings of Transformer 223-1 were reported leaking. In January 1987, residual staining was noted on the concrete pad underlying Transformer 223-2.

In approximately 1985, analytical results indicated the oil in Transformer 223-1 contained over 500 ppm PCBs and the oil in Transformer 223-2 contained less than 50 ppm PCBs. In October and November 1985, it was reported that fluid in Transformers 223-1 and 223-2 contained 19,800 and 296 ppm PCBs, respectively. In November 1986, a smear sample collected from the concrete underlying the drain valve of Transformer 223-1 indicated less than 50 micrograms of PCBs. Oil containing less than 50 ppm PCBs was released from the transformers.

In February 1986, the valve, tap changer, and bushings of Transformer 223-1 were scheduled for repair. In June 1986, several actions were recommended for planning and early implementation with respect to four transformers, including Transformer 223-1. The following actions were recommended: leaking fluid be contained and properly disposed; the transformers be expeditiously repaired or replaced; and any associated contamination be satisfactorily decontaminated. Also in June 1986, Transformer 223-1 was scheduled for fluid cleansing or exchange. In January 1987, it was recommended that the concrete pad underlying Transformer 223-2 be coated with sealant. In March 1989, it was reported that Transformer 223-1 was replaced under the Environmental Hazards Elimination Project. The transformers were retrofilled with non-PCB cooling oil in 1987.

GROUP 500-6

Asphalt Surface Near Building 559 IHSS 500-906

Approximately 1 gallon of F001 waste water spilled from a hose that was used to extract excess water from a tanker. The water was from the P304 sump which collects water from the exterior of the Building 559/561 tunnel and the Building 561 basement. Normally this water is released into the surface water drainage system through pumping to a footing drain system that flows by gravity. However, the water in question was found to exceed Segment 5 stream standards for some analytes, and was thus being removed by tanker. The tanker was accidentally filled beyond the level allowed by Rocky Flats Transportation Guidelines. These guidelines require that no more than four-fifths of the capacity of the tanker be used.

After approximately 1,000 gallons of water had been off-loaded from the tanker into drums, the hose that was used leaked some water as it was transferred back to storage.

The water contained F001 hazardous waste constituents including carbon tetrachloride, TCE and 1,1-dichloroethene, based on four sampling events that occurred from July 1992 through March 1993. Chemical analytes covered by TCLP were also identified, but the concentrations were below those of a characteristic RCRA hazardous waste. Contamination levels exceeded Segment 5 stream standards for some constituents.

Oil-dry was used to absorb the water; the wet oil-dry was then managed as RCRA-regulated hazardous waste. Portions of the release were absorbed by the asphalt and evaporated into the air. Spill pans are now being used during transfer operations.

GROUP 500-7

Tanker Truck Release of Hazardous Waste from Tank 231B IHSS 500-907

At approximately 9:30 a.m. on July 13, 1994, during a RCRA tank inspection, evidence of a release was observed near Building 231. At the time of the discovery sludge was being transferred from Tank 231B to a tanker truck in an effort to lower the level of sludge in the stationary tank for a valve repair job. Approximately 0.5 pound of dried sludge was released to the soil.

At this same location on July 20, 1994, 4 gallons of liquid from the tanker were released to a secondary containment spill basin when a hose coupling was unlocked. It was estimated that more than 1 pound of liquid was sprayed onto two workers and adjacent soil both east and west of the spill basin. The workers were taken to Building 374 and decontaminated in accordance with the DOE Radiological Control Manual requirements and implementation procedures. Nasal swipes were collected from the workers and counted for radiological contamination. Subsequent internal dose calculations for one of the workers confirmed a 12 millirem exposure, which is considered a negligible dose over a 1-year time frame. The second worker showed no measurable contamination from the swipes. Radiological surveys of the surrounding soil and basin area were conducted using a Bicron and SAC-4 instrument. The highest detected level of radioactive contamination was 651 dpm. Contaminated soil was containerized and the basin area was decontaminated.

The material released from tanker truck No. 6 on July 20, 1994, was rinse water used to flush the transfer line and tanker drain hose. The sludge from the tanker contained an F-listed waste, therefore the rinse water was treated as hazardous waste under the mixture rule. EPA waste codes assigned to the waste contained in the 231 tank system include: D004, D006, D007, D008, D009, D010, D011, F001, F002, F003, F005, F006, F007, F009, and F039. No residual contamination was detected in preliminary samples.

The area was cordoned off and posted immediately due to the radiological contamination. A wet vacuum was used to remove the liquid from the spill basin, and radiological control technicians (RCTs) smeared the tanker and the basin area. Approximately 30 pounds of soil were removed on July 13, 1994, from the first release followed by an additional 40 pounds of soil from the second release on July 20 and 21, 1994. The soil was containerized in a drum and is being managed as low-level mixed hazardous waste in RCRA Unit 200.

The RCRA Contingency Implementation Plan was initiated on July 20, 1994, as a conservative measure, due to the release from containment to the environment of approximately 1 pound of hazardous waste. Samples were collected from the wet vacuum, tanker drain hose, and surrounding soil (prior to and after excavation).

GROUP 600-1

Temporary Waste Storage - Building 663 PAC 600-1001

Two temporary buildings were constructed on concrete slabs for use during the original Plant construction in the early 1950s. These buildings were located where Building 662 and Building 663 are currently located. The wooden structures were removed prior to 1954; however, the concrete slabs remained. The slabs from Buildings 662 and 663, as well as the area around them, were used for storage purposes.

In April 1954, it was proposed that the Building 663 slab be used for temporary storage of noncombustible waste awaiting disposal. It is believed from the research on the HRR (DOE 1992a) that the slab is also known as the East Slab, because it is located east of Building 334 and Building 444. Most of the waste stored at Building 663 came from these two buildings.

Storage operations began in May 1954, when 302 drums of graphite and 49 drums of liquid waste were placed on the Building 663 slab. Waste coolant drums were also stored on the slab. In November 1954, all of the drums were removed from the slab; however, storage at the area later resumed.

The area was found to be an advantageous loading area, and plans were made to convert the slab into a loading facility. On May 25, 1955, approval was requested for the conversion of the slab east of the Building 663 slab, which is the current location of Building 662, to a loading facility. The northern end of the loading facility was reinforced and refinished with concrete in October 1958.

On October 15, 1960, a waste storage building was erected on the Building 663 slab. Accumulated drums of waste from the production buildings were moved to the building upon completion of construction. In November 1962, drums and boxes of waste from Buildings 771 and 774 were moved to the western side of Building 663 for outside storage.

Documented releases occurring at these storage areas include the following.

On November 16 and 17, 1954, 59 drums of contaminated waste were moved from the concrete slab (Building 663) to the Mound for burial (PAC 900-113). At this time, many drums were found to be in poor condition. Drums of liquid wastes, which had been placed at the storage area in April 1954, had corroded and developed leaks. The south side of the concrete slab was contaminated as a result of these pinhole leaks. At the time of the discovery of the leaking drums in 1954, one drum of still bottoms was placed in a 55-gallon drum. It was stated that the southern end of the concrete slab would have to be decontaminated because of the leaks; however, no documentation was found that detailed cleanup activities.

On September 5, 1958, a drum on the East Slab containing highly contaminated coolant was punctured. As a result, the slab was contaminated with up to greater than 100,000 cpm direct reading, and up to 20,000 cpm removable contamination. Subsequently, the drum contents were pumped to another drum, and the area was cleaned "to a certain extent." Drums in the surrounding area were moved, and cleaned if contaminated. The last drum was moved on September 25, 1958. Access was restricted to the area, and it was stated that the area would be cleaned more thoroughly.

Routine smear surveys conducted at the East Slab in August 1959 indicated a maximum reading of 108 dpm, and an average reading of 16 dpm. The high reading was taken from a roped-off area of the slab. Spot checks indicated direct readings of 100,000 cpm in this area. No documentation was found that explained why the area was roped off.

Routine smear surveys conducted on the East Slab in March 1960 indicated a maximum reading of 1,734 dpm, and an average reading of 67 dpm. Fifty-nine drums at the East Slab were surveyed, resulting in a maximum beta-gamma reading of 0.4 mr/hr.

Also during March 1960, the lids of two waste drums from Building 883 came loose, resulting in contamination of approximately 2 ft^2 of slab, to 3,000 cpm, with solid material. Additionally, a waste drum from Building 881 was found to be leaking. Direct readings up to 300 cpm were found. The drums with the loosened lids were returned to Building 883 to be resealed, and the area was cleaned. The leaking drum from Building 881 was also returned, and the affected area was scrubbed and hosed off.

During May 1960, three waste drums from Building 881 were found to be leaking. The drums were returned. Acidic waste material was being released from the corroded drums and contaminating the loading facility. In response to the leaking drums in May 1960, up to 3,000 dpm was removed by scrubbing. Decontamination of the loading facility took place during May 1960; however, it is unknown whether this was due to the corroding acid waste drums, a previous incident such as the March 1960 releases, or all of these incidents.

Routine smear surveys conducted on the East Slab in June 1960 indicated a maximum reading of 126 dpm, and an average reading of 21 dpm.

During June 1960, a drum from Building 881 leaked on the East Slab. The drum was returned, and no contamination was found on the slab.

Routine smear surveys conducted on the East Slab in August 1961 indicated a maximum reading of 24 dpm, and an average reading of 6 dpm.

During August 1961, leaking drums from Building 444 and Building 776 were monitored many times. No contamination was found. The leaking drums were returned. The leaks resulted in no detectable contamination.

During loading operations on March 19, 1963, a leaking drum was discovered. The liquid was determined to be radioactive. The ground, forklift, and trailer were contaminated. The contents of the drum and the quantity released were not documented. In response to this

leaking drum, the ground was covered with gravel, and the equipment was decontaminated. The leaking drum was returned to its origin, Building 771.

On March 26, 1963, a leaking waste drum in the area outside of Building 663 resulted in the contamination of a fork lift, truck trailer, cross bar, lining in a truck trailer, the fork lift operator, a laborer, and the ground. Other documentation states that during loading operations in March 1963, three "leakers" were discovered. The trailers, two forklifts, the work area, and personal clothing were contaminated. It is unknown whether these two reports discuss the same incident or two separate incidents. No documentation regarding the contents of the drums or the extent of the ground contamination was found for either case. Following the March 26, 1963, incident, or incidents as the case may be, the contaminated drum and trailer lining were removed. The underlying floor of the trailer was "cold." The cross bar was decontaminated and the lining was replaced.

A waste drum leak on September 17, 1963, contaminated a fork truck, panel truck, and semi-trailer at Building 663. No documentation was found that detailed the contents of the drum or release to the environment.

On January 12, 1990, there was a gasoline spill on the eastern side of Building 662. The gasoline was leaking from a truck. No response, other than that the problem was "corrected," was documented following the 1990 gasoline release.

Constituents that may be present due to storage activities include oil, still bottoms, perclene, waste coolant, and solids. Gasoline was released during the January 1990 incident.

GROUP 600-2

Storage Shed South of Building 334 PAC 400-802

The storage area south of Building 334 was originally a metal or wooden structure built on a concrete slab. A July 1955 aerial photograph indicates that the building had been removed but the remaining slab was not being used for storage. The first documented usage of the storage area was reported on October 24, 1955, when 125 barrels of depleted U chips immersed in oil were stored there. The drums developed leaks that contaminated the slab. In October 1956, one or two leaking drums contaminated the slab to 537 dpm. As of November 1956, 10 to 20 drums were leaking. On November 12, 1956, a 30-gallon drum overturned and spilled contaminated oil onto the slab.

The drums were completely removed and the slab cleaned as of November 28, 1956. However, it was discovered that contamination had spread to equipment that was also stored there. The equipment was moved but results from slab smears indicated contamination up to 10,000 dpm. Additional monitoring conducted in December 1956 revealed that the contamination was spreading due to weather conditions. By January 1957, low-level radioactivity had extended to the fuel storage tank located south of Building 551 (PAC 600-152).

Cleanup was attempted in October 1956 when the drums were first found to be leaking. The "leakers" were placed in larger drums and contamination on the concrete slab was reduced from 537 dpm to 108 dpm using PCE. The activity from the overturned drum was cleaned

up and decontaminated to a "low level." The drums were moved to the "bull pen," located in part of the area covered by the 903 Pad (PAC 900-112), on November 15 and 16, 1956. The slab where the drums were stored was cleaned on November 28, 1956.

Although the slab was cleaned where the drums were stored, the area around the contaminated equipment had not been cleaned as of the end of December 1956. The equipment was moved to a production area onsite. The loose oxide was removed and the area was covered with plastic to prevent spreading of activity. Smears up to 9,936 dpm were collected prior to vacuuming. Monitoring conducted on December 20, 1956, indicated a maximum of 7,245 dpm on the slab.

No documentation was found that indicated the kinds of materials stored at the site after 1956 or whether the materials were contaminated.

GROUP 600-3

Fiberglass Area North of Building 664 IHSS 600-120.1

The fiberglassing area, IHSS 120.1, is located north of Building 664. The area is fenced with a small, irregularly shaped fiberglass panel shed (Building 668) in the center of the IHSS.

The fiberglassing area was used from 1972 to 1979 to fiberglass waste packing boxes. The fiberglassing process may have resulted in spills of polyester resin, peroxide catalyst materials, and cleaning solvents, although no documentation of spills was indicated in the HRR research.

No documentation describing discrete releases or detailed response actions in the fiberglassing area was found. Higher than background levels of gamma radiation and Am were detected by an Aerial Radiological Measurements System survey. No documentation was found that explained the origin of the elevated readings. Building 664 has been used for radioactive waste storage; however, but it is not known whether stored waste was responsible for the elevated historical readings.

During a visual inspection, the area inside the fence was not accessible. However, some dark staining was noted in the north-central part of the IHSS, and the area south of the shed appeared to be poorly paved with asphaltic concrete. At the time of the visual inspection, it was noted that a surface soil location had been sampled in the stained area.

HPGe survey data collected during the OU 12 RFI/RI indicated elevated activities of Am-241, Pu-239, U-235, and U-238. Surface soil samples indicated that Am-241, cesium-137, Pu-239/240, U-235, and U-238 exceeded background values. These data are available in the IA Data Summary Report (DOE 2000a). Ethylbenzene, methane, toluene, and total xylenes were detected in soil gas samples.

GROUP 600-4

Radioactive Site Building 444 Parking Lot IHSS 600-160

IHSS 160 consists of an area that contains the Building 444 parking lot and a section of Seventh Avenue located east of Building 444. This area was previously used as a storage

area containing punctured or leaking waste drums and boxes. Wastes resulting from the Building 776/777 fire in May 1969 were stored in this area. Aerial photographs taken in June 1965 and June 1969 show drums and boxes in the unpaved area west of Building 444.

Two retired RFP employees interviewed for the HRR stated that the area now occupied by the 444 parking lot had been used for the storage of drummed and boxed waste. In particular, waste resulting from the May 1969 fire in Building 776 and Building 777 was stored there.

On May 24, 1971, two boxes leaked an unknown contaminated liquid onto the ground at the waste box storage yard. Approximately 1,000 ft^2 of ground were contaminated from 1,000 cpm to greater than 100,000 cpm. The quantity of released liquid was not documented. Apparently the leaks were due to rain or melting snow entering the boxes. The boxes were returned to Building 777. On June 16, 1971, decontamination activities at the waste box storage yard were completed. It is likely that these activities were a result of the May 24, 1971, incident.

An alpha probe survey was conducted during February 1973 on the storage yard east of Building 444, following the removal of some boxes. No contamination was detected. U and Pu contaminants, as well as oils and coolants, were stored at the storage area in great quantity. An alpha probe survey was made of the ground surfaces in the contaminated waste storage yard east of Building 444 in February 1973. The survey was done after all boxes had been removed. No contamination was detected.

In the early 1970s, surface soil was removed from this area; however, RFP personnel interviewed for the CEARP Phase I mentioned that small amounts of Pu may have remained.

Soil samples were previously collected around a concrete pad (used to store unused or unusable transformers) located near IHSS 160 at Building 668. Aroclor-1260 was detected in the soil samples with concentrations ranging from 170 to 1,600 µg/kg (EG&G 1991). Pu-239/240 activities in these soil samples ranged from 2.3 to 9.1 pCi/g. Pu-239/240 was detected at 15.9 pCi/g from 0 to 3 feet in borehole P313489, located in the extreme northeastern corner of the IHSS. Radionuclide measurements at the other previously sampled borehole locations within the IHSS did not indicate high levels of contamination, although results did exceed background for most radionuclides. Inorganic constituents were not detected. 1,1,1-TCA was detected in each of the 2-foot interval samples collected from 0 to 10 feet. At the southeastern portion of the IHSS (P411589), PCE was detected at a concentration of 5 µg/kg in the 12- to 14-foot interval, and carbon disulfide was detected at a concentration of 9 µg/kg in the 18- to 20-foot interval (DOE 1992a).

Several organic constituents were previously detected in groundwater at downgradient monitor well 0187, including TCE, PCE, and trans-1,2-dichloroethene.

HPGe surveys conducted during the OU 14 Phase I RFI/RI indicated elevated activities of Am-241 and Pu-239 in the northwestern part of the IHSS. In the southwestern corner of the IHSS between Buildings 664 and 668, all radionuclides were elevated. NaI surveys indicated the same trends. Ninety-four surface soil samples were collected during the RFI/RI. Analytes found at concentrations above background were chromium, copper, lead,

magnesium, mercury, zinc, gross alpha, gross beta, and Pu-239/240. These data are available in the IA Data Summary Report (DOE 2000a). Organics detected in soil gas samples include acetone, benzene, PCE, and toluene.

GROUP 600-5

Central Avenue Ditch Cleaning PAC 600-1004

During a walkdown tour of several IHSSs, Site and Colorado Department of Public Health and Environment (CDPHE) representatives observed EG&G Plant Services personnel spreading excavated soil from the Central Avenue Ditch (IHSS 157.1 for OU 13 and IHSS 172 for OU 8) into areas adjacent to the two large fuel oil tanks located at the southwestern corner of Central Avenue and Seventh Street (IHSS 152).

Potentially contaminated dirt from IHSSs 157.1 and 172 was spread into the IHSS 152 area. The Central Avenue Ditch (IHSS 157.1) was surveyed with an HPGe instrument both before the disturbance and again afterward. No radiological contamination was observed above background levels.

The operation was immediately shut down due to the potential of cross contamination from one or more IHSSs to IHSS 152.

GROUP 600-6

Former Pesticide Storage Area PAC 600-1005

Building 667 was originally used to store pesticides. This site is located several hundred feet north of Building 850 in what is currently parking lot No. 881. In approximately 1982, the shed (Building 667) was moved and located west and south of Building 371. At this new location, the building was renamed Building 367, and pesticide storage in the shed resumed for an unknown time. The shed is no longer used for pesticide storage.

It is believed that pesticides were stored at the Building 667 site at least through 1978. It is possible that pesticides were spilled during loading or mixing operations. In addition, it is possible that the floor in the building was dirt, increasing the possibility of residual amounts of pesticides remaining at the site. No known rinsing of pesticide containers occurred at the shed.

Pesticides, which are regulated under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), were stored in this area. It is possible that some pesticides were released to the environment. A list of pesticides stored in Building 667 follows:

- Spectracide 600 (ant killer);
- Mouse Maze (poisoned grain for mice and pigeons);
- Bee Bopper (bee and wasp spray, includes chlordane);
- Malkill (insecticide);

- TMTD-Rhoplex (rabbit and deer repellant);
- Decon rodent poison grain;
- Ortho Liquid Iron (grass fertilizer);
- Excel (lawn fertilizer);
- DM14 (herbicide weed control);
- Hyvar X-L (Bromacil weed killer);
- Esteron 76BE (herbicide weed control);
- Tordon 22K (herbicide weed control);
- Ureabor (U.S. Borax granular weed and grass control);
- Banvel;
- Diazon;
- Poison Grain (birds);
- Malathion; and
- Diazinon (black widow spider).

GROUP 700-1

Identification of Diesel Fuel in Subsurface Soil IHSS 700-1115

On May 31, 1997, while excavating a shallow trench on the northeast corner of Building 708, workers noted a strong diesel fuel odor and oil staining adjacent to the building at approximately a 2-foot depth. The shallow trench was required to support a new diesel fuel supply line and other associated utilities as part of the Above-Ground Diesel Storage Tank project. The project was halted until environmental and safety professionals could evaluate the discovery and schedule appropriate sampling. During the pre-job safety evolution and utility locate, several diesel fuel feed and return lines were identified approximately 20 feet north of the excavation and one unknown utility (or linear object) in the immediate area of the trench.

Sampling of the suspect soil was conducted the week of June 2, 1997. Upon receipt of analytical data, the project was allowed to proceed. The source of the diesel fuel was not determined; however, ancillary piping from nearby Underground Storage Tank (UST) #16 was confirmed to be located approximately 20 feet north of the trench. Sampling of the suspect soil was conducted the week of June 2, 1997. Upon receipt of analytical data, the project was allowed to proceed.

Further research of the area confirmed that an incident involving a diesel fuel spill to the asphalt occurred in the general area on January 29, 1993, while refueling the Building 708

emergency generator. An Occurrence Report (RFFO-EGGR-PUFAB-1993-0020) states between 10 and 15 gallons of fuel were spilled onto the asphalt surface and no migration into the soil occurred. The Rocky Flats Fire Department immediately cleaned up the spill. No other documentation of past occurrences in the area could be found.

Laboratory analysis of the soil indicated that the staining was diesel fuel and radiological isotopes were comparable to background levels. There were no other contaminants associated with the findings.

Upon discovery of the diesel fuel odor and discolored soil, workers immediately stopped working and reported the finding to the project manager and shift superintendent. Environmental evaluations, safety inspections, and a thorough walkdown of Building 708 and the surrounding area were conducted on June 2, 1997. Samples were collected that day to confirm the presence of diesel fuel and/or other VOCs and specific radiological isotopes.

GROUP 700-2

UBC 707 - Plutonium Fabrication and Assembly

Information on UBC 707 is from the HAER (DOE 1998) and the Reconnaissance-Level Characterization Report (RLCR) Building 707 Cluster (DOE 2000c).

Building 707 housed the general Pu fabrication and assembly operations. Building 707 was most recently used for the stabilization of Pu and the processing and repackaging of Pu residues. Building 707 became the primary Pu fabrication building at the Plant when operations commenced on May 25, 1970. The design of Building 707 incorporated extensive control and safety features, including the first-time use of inert atmosphere in the gloveboxes, primarily in response to two earlier fires (in Buildings 771 and 776/777). The building was originally intended to house new fabrication processes associated with new Pu weapons designs; however, many of the existing foundry and fabrication operations from Building 776/777 were transferred to Building 707 as the result of a 1969 fire. The transferred operations were not changed significantly. Building 707A was built in 1971 to accommodate Pu casting and fabrication processes moved from Building 776/777 as a result of the 1969 fire.

The Building 707 complex was a manufacturing facility for fabrication of Pu parts, and assembly of parts made of Pu and other materials into nuclear weapons components. The major structures of the complex include Building 707, Building 707 Annex (707A), and Building 708. Building 708 houses emergency generators and three brine chiller systems for Building 707 temperature control and dehumidification in Pu handling areas. Other structures in the complex are a cooling tower, electrical distribution station, process waste station, and outside storage tanks for inert gases, such as argon and nitrogen.

Operations in Building 707 included metallurgy, parts fabrication, inspection and testing, assembly, and storage. Pu, particularly in finely divided forms, was subject to oxidation and spontaneous combustion, and required a controlled environment for processing and storage. Control was achieved by enclosing Pu metal and associated equipment within gloveboxes and conveyors and by providing certain work areas with an inert atmosphere to control the pyrophoric nature of Pu. The general flow of work and materials was from north to south

within the building, starting with Modules A, J, and K, then sequentially from Module B to Module H.

Modules A, J, and K were used for metallurgy, primarily casting and sampling of Pu metal. These modules contained casting furnaces, gloveboxes, and casting molds made of graphite and other metals. Operations were conducted in an inert atmosphere. The primary difference between casting operations in Modules K and J were the types of molds used: graphite molds were used in Module J, and molds made of other metals were used in Module K. Ingots were sampled by breaking a small nodule off the side of the casting. Limited casting operations were conducted in Module A. Other activities in this module included sampling cast ingots for analysis of chemical purity, and removal of Pu oxides and other impurities from the casting molds.

The casting process created feed ingots and War Reserve ingots of Pu metal. Materials used for the creation of feed ingots included Pu buttons from recovery processes, briquettes, and scrap Pu metal. The first casting process created the feed ingot. The second casting process used this feed ingot recipe to create the War Reserve ingot. The War Reserve ingot was used to fabricate weapons components, the purity of which was identified by design specifications.

The casting process, conducted in a vacuum, consisted of weighing the metal, placing it in tantalum crucibles, and melting it in one of four electric induction furnaces. Molten metal was poured into graphite, tantalum, or erbium oxide-coated stainless steel molds to form ingots. Although four furnaces were present in Module K, only two were used during routine casting operations. Rejected ingots from casting in Modules A, J, and K were cut with a shear press within a glovebox and returned to the X-Y retriever for storage.

Plutonium War Reserve ingots cast in Modules A, J, and K were rolled, formed, and heat-treated in Module B under an inert atmosphere. War Reserve ingots were rolled to a specified thickness then moved to another glovebox where shapes were cut in a blanking press. Cut blanks were sent to adjacent gloveboxes for thermal treatment (annealing and homogenizing). Following thermal treatment, blanks were formed into hemi-shells (1/2 shells) in a hydroform press. After forming, the parts were annealed and measured on a density balance. Scraps left from cutting were cut into smaller pieces in the same glovebox, placed in a container, and sent to the briquetting process in Module C.

Activities in Module C were conducted in an inert atmosphere. The module was used for final machining of Pu parts and also contained equipment for the briquetting process. Gloveboxes within Module C contained lathes, mills, a drill box, a high-precision drill press, cleaning solvents, and a hydraulic press. Machining operations included jig boring, slot cutting, and threading. All tools, gauges, and fixtures remained within the gloveboxes for the useful life of the device and were removed only for disposal. When machining operations were completed, the parts were cleaned, degreased, and stored to await assembly.

The briquetting process was used to generate hockey puck-sized briquettes of Pu metal scrap. Machine turnings and scrap from the blanking press were cleaned in a solvent bath to remove cutting oils, then pressed into small briquettes. These briquettes were returned to the foundries for casting of feed ingots.

As part of the cleaning process, parts were also repeatedly wire brushed to remove oxides. Completed parts were transferred to Module E by a chain conveyor.

In Module E, Pu parts were welded with electron beam welders in gloveboxes, then inspected for leaks using nondestructive testing methods. These methods included radiography x-ray examination of Pu parts to identify structural flaws, eddy current testing on Pu parts to check the depth of weld penetration, and weld scanners and fluorescent dye penetrant processes to qualify welds and detect minute cracks and voids in parts. The washing, welding, and leak detection processes in Modules D and E were repeated several times.

Module F contained an assembly area referred to as the super-dry room, where Pu parts were assembled and tested. The super-dry room provided space for special assembly operations that required precisely controlled conditions of humidity, temperature, and airflow. As part of the assembly process, an outer metal casing was welded onto the Pu components. One area of the super-dry room was divided into two compartments, each was provided with a downdraft table. One of the downdraft tables opened into the end of a conveyor line that crossed over Module E. At this downdraft table, uncoated Pu parts and other parts from previous glovebox operations were assembled into units that could be safely transported, processed, and stored outside the protection of a glovebox.

Leak testing was conducted on stainless steel and beryllium parts. Each part was placed on 1 of 10 pump-down tables and a vacuum was exerted on the part to check for leaks and remove moisture. The encased parts were then transferred to Module G for further processing.

Activities in Module G included brazing, machining, nondestructive testing, and non-Pu parts assembly and disassembly. Pu parts encased in other metals were brazed under a vacuum. The machining process used two lathes inside B-boxes (similar to lab hoods) and a milling machine. Subassembly of nonradioactive parts occurred in a portion of the module. Rejected aluminum, stainless steel, and beryllium parts were also disassembled in Module G and either recycled or processed for disposal. Gloveboxes were not used in this module.

Assembly processes in Module H included brazing and high-pressure assembly whereby parts composed of various metals including beryllium, Pu, and U were bonded together under pressure. Final assemblies were transferred to Building 991 for eventual offsite shipment.

Individual parts, subassemblies, and assemblies were inspected and tested throughout the metallurgical machining and assembling operations to ensure that specifications were met. Inspection involved dimensional inspection (measuring). Testing processes were both nondestructive and destructive. Precision hand and electronic gauges, scales, rings, optical- and computer-assisted instruments, and laser beam instruments were used during dimensional inspections to verify that directly measurable dimensions were within specified tolerances. Parts were matched for physical and dimensional characteristics.

Nondestructive testing was used to inspect interior characteristics or properties of a part or assembly. The techniques most commonly used were radiographic x-ray examination, and ultrasonic, acoustic emission, and eddy current scanning. Other nondestructive measurement methods included weight and density determinations and leak tests. Radiography detected cracks, voids, and gaps in parts and assemblies. These testing techniques identified structural

flaws, weld depth, minute cracks, voids, and gaps. Vacuum tests were conducted on Pu, stainless steel, and beryllium parts to check for leaks and remove moisture and other impurities.

Destructive testing was used to verify the chemical content and physical integrity of a part or assembly. Parts and assemblies were subjected to gravity force analyses, and tensile strength, stress, and vibration testing. Parts were also cored and sawed for spectroscopy and chemical analyses.

Assembly included such operations as machining, cleaning, matching parts, brazing, welding, heating under vacuum for trace contaminant removal, marking, weighing, monitoring for surface contamination, and packaging for shipment. Inspection and testing processes occurred throughout the assembly process. Parts were matched for physical and dimensional characteristics, assembled, then welded or brazed into subassemblies. The subassemblies and additional parts were cleaned, physically assembled, welded, machined to the required contour, and marked. The assembled parts were subjected to final processing steps, final testing, and inspection, then stored to await shipment.

Several locations in Building 707 were used to store nuclear and non-nuclear materials. Materials stored included raw materials needed for casting, feed ingots, War Reserve ingots, parts cast within the building, and finished components.

The X-Y retriever, which began operations in 1971, was housed in Module K, and was used to sort and retrieve Pu metal for distribution to other processes in Building 707. Using the X-Y retriever, operators retrieved Pu metal from storage and conveyed it to the X-Y shuttle area where it was cut and weighed. The cut pieces were then conveyed to Modules A, J, or K for casting, or Module B for rolling and forming. Rooms 141 and 142 in Module J (the J vault) were used for storage of oxides, Pu buttons received from other DOE facilities, and to some extent, Building 771 molten salt extracts.

The metallurgical support group was responsible for administration of Pu metal used for casting, scrap Pu metal, and operation of a control system for laboratory analysis data on Pu metal.

Pu was a rare substance, and supply seldom kept up with demand. Only a fraction of the feed Pu that entered Modules A, J, or K came out of Module D as machined production parts. Every effort was made to salvage the excess material. Pu fines, chips, and scraps generated from the parts fabrication processes were collected in cans at each workstation or individual machine. These fines, never leaving the inert atmosphere system, were transferred via the chain conveyor to a workstation in Module C where the material was compressed into briquettes for later use. Residues produced by the casting operations were burned to oxide, packaged, and transferred to residue processing operations in Building 771 for Pu recovery. This thermal stabilization process was used to convert pyrophoric Pu to a nonpyrophoric Pu oxide, which could be more safely handled.

In 1992, the mission of the Plant was officially changed from weapons component production to environmental restoration and waste management. At that time, the mission of Building 707 was changed to Pu stabilization operations.

Processes and equipment contained in Modules B and C in Building 707 were dedicated to the production and assembly of Pu pits. Currently, Modules A, D, E, J, and K are being used for the stabilization of wastes, size reduction of Pu ingots and parts, and the destruction of classified shapes. If a module is not being used for stabilization or destruction processes, it is being used to store and stage waste. Utilities to the modules that the equipment in the various gloveboxes might need are: argon, instrument air, chilled water, cooling water carbon tetrachloride, 1,1,1-TCA, helium, Freon® 113, chloroform, machine oil, machine coolant, plant air, and hydraulic oil. If small amounts of liquids are needed in the glovebox, they can be added through a funnel on top of the glovebox that is valved off to prevent contamination of the room.

UBC 731 - Building 707 Process Waste

Information on Building 731 is from WSRIC (RMRS 2000f) and the HRR (DOE 1992a). Building 731 contains two process waste tanks that receive and store aqueous waste from Building 707. Process equipment includes two 1,650-gallon fiberglass tanks and two associated electric-driven transfer pumps. The aqueous waste included water, acids, and chemical solutions that are potentially contaminated with Pu and Am.

On August 28, 1991, the process waste tanks overflowed 750 gallons of process waste to secondary containment. Although this single event should not have impacted the environment, over the course of operation of Building 707, the possibility exists that the soil near Building 731 has become infiltrated.

Tanks 11 and 30 - OPWL - Building 731 IHSS 000-121

Tanks T-11 and T-30 are located on the eastern side of Building 707 in the 700 Area within Building 731, which is referred to as the Building 707 Process Waste Pit. Tank T-11 is composed of two 2,000-gallon concrete tanks within Building 731. Tank T-30 consists of a 23,111-gallon underground concrete structure and a 100-gallon concrete sump.

Tanks T-11 and T-30 were installed in 1959. In 1975, the concrete tanks were partially removed. The concrete wall separating the two tanks was removed along with part of the concrete tank surface, and new concrete was poured into the old process waste tanks and the 100-gallon sump. Currently, the area of the old process waste tanks serves as a secondary containment for the Building 707 process waste and plenum deluge tanks. Original waste streams for these tanks originated from Building 707, including solvents, radionuclides, metals, and other wastes. A 100-gallon steel tank is reportedly filled with Raschig rings and was used to contain fire deluge from Building 707 but did not reportedly receive process waste. The piping that connected with this tank was removed in 1975. Any leak from this tank would have flowed to the T-11 and T-30 tanks.

Subsurface soil samples were collected and analyzed during the OU 9 Phase I RFI/RI. Silver was detected above background at all three boreholes at a depth of 0 to 0.5 foot. Am-241 and copper were also detected above background at the boreholes located on the northern side of Building 731 and southeastern corner of Tank T-11/T-30. Thirteen NaI surveys indicated readings above background ranging between 2,064 to 3,082 cpm with activities around the tanks ranging from 1,500 to 1,900 cpm. A radiological smear collected from the northwestern side of Tank T-11 reported removable alpha contamination of 644 dpm/100 cm^2. These data are available in the IA Data Summary Report (DOE 2000a).

GROUP 700-3

UBC 776 - Original Plutonium Foundry and UBC 777 - General Pu Research and Development

Information on Building 776/777 is from the HAER (DOE 1998). Building 776/777, which went into service in 1958, was the main manufacturing facility for Pu weapons components and housed Pu foundry and fabrication operations. Following a major fire in Building 776/777 in 1969, the majority of the foundry and fabrication operations were transferred to Building 707. After the fire, the main focus of building operations was shifted to waste and residue handling, disassembly of retried weapons components, and special projects. Processes conducted in Building 776 included size reduction, advanced size reduction, pyrochemistry, coatings operations, and test runs of organic waste and combustibles in a fluidized bed incinerator.

Beginning in 1958 and continuing through 1969, Building 776/777 was the main manufacturing facility for Pu weapons components and housed foundry and fabrication operations. Building 776/777 reflected the latest design criteria and engineering technology available when it was constructed. Since the facility was first occupied in 1957, 10 major modification additions were made to update the building and/or provide increased safety.

On May 11, 1969, at 2:27 p.m., a fire was detected in Building 776/777 when an alarm in the north Pu foundry glovebox line was triggered. Spontaneous ignition of a briquette of scrap Pu alloy metal contained in a small metal can caused the fire. The fire spread through combustible materials in up to 150 connecting gloveboxes in Building 776 and the assembly line in Building 777. The fire was brought under control by 6:30 p.m. Fearing a breach in the building's outer walls, firefighters used water to control the blaze. This was the first time water was used directly on burning Pu and it did not create a nuclear criticality.

Scientists estimated an atmospheric Pu release of approximately 0.000012 gram (0.0002 curie), all of it contained onsite. There were no immediate health effects to persons offsite. The operating areas in Building 776/777 suffered extensive damage. Decontamination took 2 years to complete. The incident resulted in significant safety improvements in glovebox operations including installation of water sprinklers and firewalls to control the spread of fire, and the use of inert atmospheres for Pu operations to prevent spontaneous ignition.

After the fire, the majority of the foundry and fabrication operations were transferred to Building 707. After several months of cleanup, limited production operations resumed in Building 776/777. The main operations conducted in the building became waste and residue handling, although operations such as disassembly of Site returns (nuclear weapons shipped to the Plant from the nuclear weapons stockpile for retirement, upgrade, or reprocessing) and special projects continued in the building as well. Processes conducted in the building included size reduction of contaminated gloveboxes and miscellaneous large equipment for waste disposal, pyrochemistry, coating operations, and test runs of a fluidized bed incinerator unit.

UBC 778 - Plant Laundry Facility

Information on Building 778 is from the HAER (DOE 1998). Building 778 was constructed in 1957 as a support facility for the 700 Complex Pu production buildings. It was used to launder the white clothing and respirators worn by Plant employees. All employees, except those working in low-contamination areas such as the laboratories, were required to wear this protective clothing.

Originally, Buildings 771, 881, and 991 had their own laundries, with Building 442 laundering the clothing from Building 444. After Building 778 was constructed, laundry from these four buildings was washed there. After 1976, when Building 442 was turned over to the filter installation group, all laundry on the Site was handled in Building 778. Building 778 went out of service in 1991, with all laundry being processed through Building 566.

Laundry personnel washed, sorted, mended, folded, checked for contamination, and redistributed company-supplied clothing to locker rooms throughout the Plant. The laundry processed approximately 125,000 to 150,000 pounds of clothing each month. The laundry equipment included three 400-pound-capacity washer-extractors and six 100-pound-capacity dryers.

Decontaminated respirators were also cleaned in Building 778. Half-mask respirators were cleaned and dried in a spray-type washer with a steam-heated drying hood. Full-face masks were washed in a converted 100-pound-capacity clothes washer and dried in a 50-pound-capacity dryer with the tumbler removed.

The exhaust air from all clothes dryers and washers was exhausted through a HEPA filter plenum. The exhaust stack downstream of the filters was routinely checked by radiation monitoring personnel for any possible Pu release. Laundry water was sent to the forced evaporation operations in Building 374. Prior to Building 374 becoming operational in 1980, laundry water was sent to Building 774 second-stage aqueous waste operations and then through the evaporator located there if radioactivity in the water was above 1,667 pCi/L. If radioactivity was below this level, the wastewater was sent to Pond B-2. When the Plant first began operations, laundry wastes were discharged directly to North Walnut Creek.

UBC 701 - Waste Treatment Research and Development

Information on Building 701 is from the HAER (DOE 1998). Built in 1962, Building 701 was a research and design facility used to design, build, and evaluate bench-scale waste treatment processes. The main purpose of the research and design group located in this building was to change the form of waste materials for offsite disposal. Information from the waste treatment research and design projects was applied to waste treatment processes throughout the Site. All process evaluations conducted in Building 701 were done using nonradioactive materials; once the processes were transferred to the production and waste treatment facilities, they were applied to radioactive waste. Experimental laboratory work, primarily regarding cementing techniques, was also done in Building 701.

In the late 1970s, the use of a rotary-kiln incinerator to combust radioactive waste was investigated. This type of kiln was later installed in Building 371 for glovebox-generated solid and liquid waste from Pu processing buildings.

A model of the fluidized bed unit incinerator eventually installed in Building 776/777 was evaluated in Building 701. The fluidized bed unit model was made of glassware to allow researchers to view the process while the incinerator was operating. The fluidized bed unit was used to thermally treat low-level radioactive and mixed hazardous waste (liquid and solid). Researchers in Building 701 continued to evaluate and modify the fluidized bed unit after its installation in Building 776/777.

During the mid-1980s, the research and design group began laboratory research to establish the necessary parameters for cementing pond sludge. Cement provided a solid matrix for isolation of wastes, chemically binding water from the sludge wastes. The success of solidification with cement depended upon whether the waste adversely affects the strength and stability of the concrete product.

A thin film evaporator was tested as an upgrade for the liquid waste treatment process used in Building 774. The liquid was evaporated from the waste, leaving a solid. The solid was then cemented for disposal.

Beginning in the early 1980s and continuing into the 1990s, the research and design group investigated vitrification technologies. This technology was used to transform waste into a vitreous glass-like substance, thereby immobilizing the waste to prevent leaching of hazardous or radioactive compounds into surrounding media. Several different types of melters were investigated, including joule and induction melters. In the early 1990s, the research and design group in Building 701 developed a microwave melter to vitrify waste material.

The final use of the building was to house limited research and design activities. For example, a process was being developed to stabilize materials containing Pu and Am. These materials were once considered a waste because the concentration of Pu and Am was below the economic recovery limit. After the disposal guidelines changed, they were considered a residue. The process being developed would eventually be conducted in gloveboxes.

Solvent Spills West of Building 730 IHSS 700-118.1

A 5,000-gallon underground carbon tetrachloride storage tank was located adjacent to the western side of Building 730. In the 1970s, tank overflows occurred during filling operations. Persons interviewed for the CEARP report recalled a spill of 100 to 200 gallons of TCE north of Building 776 prior to 1970. These persons did not recall any clean-p operations. It has been postulated that this spill was carbon tetrachloride.

In March 1976, a small amount of leakage from the pipes in the tank pit was evident. At that time, Health Sciences was continuing soil gas monitoring beneath the end tank. Industrial Hygiene reported air samples were typically averaging 10 mg/L carbon tetrachloride. During the month prior to April 15, 1976, the average concentration increased to almost 2,000 mg/L. It was postulated that the tank or its associated pipes in the sump released the carbon tetrachloride into the ground.

On June 18, 1981, the tank failed, releasing carbon tetrachloride into the sump. The sump pumped some of the liquid out onto the ground surface. Temporary storage tanks were to

collect the liquid. No documentation was found that details the actual use of the temporary storage tanks.

This underground tank had its long axis running north-south, with the south head of the tank exposed in a valve pit. The north end of the tank was buried directly in soil. The base of the tank was located at an approximate elevation of 5,978 feet (approximately 9.1 feet below grade) and the base of the valve pit was at an elevation of 5,976 feet (approximately 10.25 feet below grade). The east side of the carbon tetrachloride tank valve pit was approximately 10 feet west of the exposed portion of the Building 730 pump house.

The underground carbon tetrachloride tank was used to store raw carbon tetrachloride for use in Plant operations. TCE has also been described as the constituent released to the environment in the incident prior to 1970. Other sources indicate carbon tetrachloride rather than TCE was released to the environment.

Persons interviewed for the CEARP recalled no mitigation efforts to control the spill prior to 1970. No documentation was found that detailed response to spills that occurred during filling operations in the 1970s.

In winter and spring 1976, there were efforts to stop the leakage from the pipes. Documentation was found that detailed the cleanup of spilled liquid, including that pumped onto the ground.

In February 1976, Industrial Hygiene showed interest in having the UST replaced with an aboveground tank. At this time, Health Sciences was monitoring a pipe installed below the end of the tank for airborne carbon tetrachloride and found no indications of problems with the tank itself. No documentation was found that detailed response to high concentrations of carbon tetrachloride detected during April 1976 soil gas monitoring.

The tank was removed following its failure in 1981. One Building 776 employee present at the time of the tank's removal recalled that it appeared sound with no obvious leaks or significant corrosion.

Radioactive Site 700 Area No. 1 IHSS 700-131

In June 1964, an explosion in Building 776 resulted in the release of Pu. One account claimed an approximate area of 1,500 ft^2 surrounding the Building 776 gas bottle dock was affected. Radiological surveys showed activities exceeding 300,000 dpm/100 cm^2. A later account claimed an area of approximately 40 ft^2 north of Building 776 was affected. Soil from the area with the highest counts was removed and a seal coat of oil and approximately 2 inches of gravel were put in its place (DOE 1992a).

Approximately 2,000 ft^2 on the western end of the north side of Building 776 was affected by the release of Pu as a result of fire fighting after the explosion. Radiological surveys detected Pu contamination along three northern exterior walls of Building 776. Pu was tracked out of Door 17 in Building 776 by the firefighters during the blaze. To reduce mobility of the contaminated soil, the area around Door 17 was paved twice with asphalt. In fall 1971, the asphalt was removed and placed in barrels. New asphalt was later placed in the area of Door 17.

Contamination levels in three boreholes located northeast of IHSS 131 may indicate downgradient contamination from this IHSS. However, influence from other OUs, particularly the SEP, may overshadow the potential impact from IHSS 131.

HPGe surveys conducted during the OU 14 Phase I RFI/RI did not indicate elevated activities of radionuclides. NaI surveys indicated that radionuclides exceeded background in the northwestern corner, and south-central and north-central portions of the IHSS. Surface soil samples indicated that arsenic, beryllium, chromium, copper, mercury, zinc, Am-241, Pu-239/240, and U-238 exceed background values. These data are available in the IA Data Summary Report (DOE 2000a). Benzo(a)anthracene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were detected in surface soil samples.

Radioactive Site West of Building 771/776 IHSS 700-150.2(S)

The IAG originally defined the IHSS 150.2 boundaries as a 70-foot by 250-foot area west of Building 771. Subsequent information obtained for the Final OU 8 Phase I RFI/RI Work Plan (DOE 1994) indicates that IHSS 150.2 should be divided into two separate areas. The northern portion is located adjacent to the western side of Building 771. The southern portion is located adjacent to the western side of Building 776 and extends south to the northwest corner of Building 778.

IHSS 150.2 is associated with radiological contamination that resulted from the two major industrial fires that occurred at RFETS: the September 11, 1957, fire in Building 771 and the May 11, 1969, fire in Building 776/777. There are other IHSSs that are also associated with the fires.

On September 11 and 12, 1957, a fire occurred that caused considerable damage to Building 771 and considerable radiological contamination of areas inside and outside the building. The fire started in Room 180 (some sources state Room 108), located at the southwest corner of Building 771, and spread into the main filter plenum. The breach of the plenum resulted in the release of an unknown amount of radioactivity around the building, particularly to the north. An explosion that occurred in the main exhaust duct probably contributed to the release of Pu from the stack (DOE 1994).

The western side of the building was also contaminated as a result of the fire fighting activities. Although no documentation was found that details specific activities in the area, a review of documents pertaining to the fire indicates that the western side of the building was used quite extensively during extinguishing activities. Because the fire was located in the southwestern corner of the building, the west entrance would have provided the best access for firefighters. Firefighters probably gained access to the main filter plenum through a hatchway on the western side of the building. The area was paved at the time of the fire. Currently, there is a dock located at the access door (DOE 1994).

On May 11, 1969, a major fire occurred in Building 776/777. The fire released as much as 210 microcuries Pu to the atmosphere with significant property loss (DOE 1992a). Pu was tracked outside of Building 776 by fire fighting and support personnel and was detectable on the ground around the building. One source stated that the tracking of contamination was confined to an area of 20 feet by 100 feet west of the building. Another source stated that the contaminated area extended from the south wall of Building 778 to the north wall of the

maintenance addition to Building 776 in a strip approximately 30 feet wide along the west wall of Building 776. Following the fire, rain carried the contamination into the soil. Airborne contamination from the May 1969 fire was carried predominately to the west-southwest, the average wind direction at the time. Contamination was found outside the building to a maximum of 200 feet following the fire (DOE 1994).

Oil and gravel were placed on areas of contaminated soil to stabilize the contamination. The soil, oil, and gravel were removed on July 19, 1969. An estimated 320 tons of asphalt and soil, containing 7 dpm/g, were removed and buried in a location east of Building 881, at IHSS 130. At least a portion of the sidewalk on the western side of Building 776 was also removed. A new asphalt road had been constructed on top of the affected area by the end of July 1969 (DOE 1994).

Surveys of the area just south of Door 6, in the northern half of the western side of the building, showed contamination between 100 and 300 micrograms per square meter ($\mu g/m^2$). Documentation also indicates that the steps, dock, and ramp areas on the western side of Building 776 were contaminated to 6,000 cpm. In May 1971, contaminated steps, dock, and ramp areas on the western side of Building 776 were covered with epoxy paint. Areas of contamination outside Building 776 were covered with asphalt (DOE 1994).

In January 1972, the soil at the southwest corner of Building 776 was considered contaminated. The cause of the contamination was not stated (DOE 1994).

In 1973, a survey was conducted on the asphalt road west of Building 776 to determine contamination levels prior to widening of the road. The maximum soil activity found was 70 dpm/g Pu (DOE 1994).

In June 1980, contaminated asphalt was removed from the western side of Building 776 and boxed as hot waste (DOE 1994).

The ground surface of Building 771 steps down steeply to the north, with numerous retaining walls, paved and unpaved storage pads, and loading docks. The surface west of Building 776 is relatively flat and mostly paved. The area was first paved in 1968 (DOE 1994).

The results of the Radiometric Survey, performed at Rocky Flats during the late 1970s and early 1980s with a FIDLER, indicated no extremely contaminated areas (500,000 to 1,000,000 pCi/g) around the western sides of Buildings 771 and 776 (DOE 1994).

An 8-inch foundation drain of vitrified clay pipe is located along the west wall of Building 771 (DOE 1994). A 6-inch foundation drain also of vitrified clay pipe, is located around the addition that was constructed onto the eastern side of Building 771 in 1970. There are very limited analytical data on the sampling of Building 771 foundation drains. The available data showed low levels of gross alpha, gross beta, and tritium from station FD771-4. Carbon tetrachloride and chloroform were detected at station FD771-1, which is located near the northwestern corner of the building. Foundation drains are suspected to exist at Building 776/777 because of the underground structures; however, this has not been confirmed.

Utility drawings show a storm sewer located on the western side of Building 776, with a catch basin located at the southwestern corner of the building. The outfall for the storm sewer is shown as being located on the hillside northwest of the building. As part of the OU 12 Surface Water and Sediment Sampling Program, a sediment sample was collected from site SED07595, which is located downgradient from the suspected outfall location. It is likely that the storm sewer was affected by water from the fire fighting activities and/or the rain that occurred after the 1969 fire. The results from the OU 12 sediment sampling were not available for inclusion in this report.

There are no monitoring wells or boreholes located in the immediately vicinity of IHSS 150.2. The nearest downgradient well, well 1986, is located approximately 250 feet west of the northwest corner of the IHSS. There are no wells upgradient of the IHSS. The available analytical data for well 1986 are presented in the OU 8 Phase I RFI/RI Work Plan (DOE 1994). Several VOCs were detected in groundwater samples collected from this well. Several metals, radionuclides, and inorganic constituents were detected at concentrations exceeding background.

Radioactive Site South of Building 776 IHSS 700-150.7

IHSS 150.7 consists of the areas between Buildings 776/777 and 778, and between Buildings 778 and 707. A fire that occurred in Building 776/777 on May 11, 1969, affected these areas. Pu was tracked outside of Building 776 by fire fighting and support personnel and was detectable on the ground around the building. IHSS 150.7 was originally defined as a 100-foot by 500-foot area between Buildings 776 and 707. The OU 8 Phase I RFI/RI Work Plan (DOE 1994), proposed that IHSS 150.7 be redefined to a 40 foot - by 350-foot area between Buildings 776 and 778 due to the contamination resulting from the May 1969 fire (DOE 1994). Updated information indicated the boundaries of the IHSS were approximately 40 by 330 feet, and areas affected by contamination from this incident extend to the north wall of Building 707. The areas between Building 776/777 and 778, and between Buildings 778 and 707 are very narrow, flat “courtyards” that separate Building 778 from Building 707 on the south and Building 778 from Building 776/777 on the north. Enclosed hallways, between the buildings, isolate the courtyards. The area between Building 776/777 and 778 is mostly unpaved. The area between Building 778 and 707 is paved. Much of the areas between buildings is inaccessible to vehicles and is used for light storage and by pedestrians (DOE 1994).

Following the May 1969 fire, rain carried the contamination into the soil. The spread of contamination south of Building 776/777 can also be attributed to the runoff of firewater sprayed on the building to contain the fire. Sand and gravel between Building 776/777 and Building 778 were also contaminated before the rain. Airborne contamination from the fire was carried predominantly to the west-southwest, the average wind direction at the time. Areas north, west, and south of the building were contaminated. The area north of Building 776/777 is included in OU 14 IHSS 131 and the area west of the building is included in OU 8 IHSS 150.2 (DOE 1994).

Road oil and gravel were initially placed over the contaminated soil. An asphalt roadway was completed in the area on July 22, 1969. By December 1969, asphalt in the area, contaminated soil, and presumably the road oil and gravel were removed from between the buildings and buried in a location east of Building 881 (DOE 1994).

In 1972, the soil at the southwestern corner of Building 776/777 was considered contaminated. The levels and source of this contamination are unknown, and it is not known whether it is related to the 1969 fire (DOE 1994).

A detailed study of contamination resulting from the fire was completed in May 1971. Contamination was found on the ground south of Building 776/777, as well as on the ground south of Building 778 to the north wall of Building 707. Contamination was detected in the soil approximately 200 feet from Building 776/777. The walkway area between Buildings 776/777 and 778 was contaminated to 200,000 cpm direct and 5,000 cpm removable radioactivity (DOE 1994). Surface materials were affected at this IHSS due to the 1969 fire and related fire fighting activities. The contaminant of concern is Pu.

An 18-inch, corrugated metal pipe storm drain runs through the middle of that portion of IHSS 150.7 between Buildings 778 and 707 and discharges to a manhole northeast of the northeast corner of Building 707. An 6-inch, vitrified clay pipe storm drain, which originates in the western portion of IHSS 150.7 between Buildings 776/777 and 778, ties into this 18-inch storm drain. A 6-inch foundation drain runs along the north wall of Building 707 (partially through IHSS 150.7), then turns south and runs along the west wall of Building 707.

IHSS 150.7 is also associated with spills of No. 2 diesel fuel oil from a UST (Tank 262) located north of Building 371/374. Tank 262 is a 47,500-gallon steel UST that was installed in 1980. It is overlain by a 15- by 25-foot concrete pad containing control valves and gauges. The surface around the pad is flat and unpaved.

French Drain North of Building 776/777 PAC 700-1100

A french drain, which was in use from approximately 1963 until at least 1972, leads north from Door 17T of Building 776, crosses the alleyway, then heads east where its effluent leaches into the soil. Radioactive contamination in the area of this site is the result of the June 1964 explosion incident in Building 776. The area was again contaminated at the time of the May 1969 fire in Building 776 (PAC 770-131). This drain may have provided a pathway for the migration of radioactive contamination. Another source indicated the french drain leads north from Door 14T of Building 776.

Pu contamination present in the area of this site as a result of the 1964 and 1969 incidents was possibly redistributed below the ground surface, although no surface expression was noted.

Tank 9 - OPWL - Two 22,500-Gallon Concrete Laundry Tanks IHSS 000-12; Tank 10 - OPWL - Two 4,500-Gallon Process Waste Tanks IHSS 000-121

Tanks T-9 and T-10 are located in the 700 Area within Building 730, which is referred to as the Building 776 Process Waste Pit. These tanks are approximately 50 feet north of Building 776 and approximately 30 feet east of Building 701. Tank T-9 consists of two 22,500-gallon underground concrete tanks oriented east-west and therefore will be referred to as T-9 (east) and T-9 (west). Tank T-10 consists of two 4,500-gallon concrete underground tanks oriented east-west and therefore will be referred to as T-10 (east) and T-10 (west).

The T-9 tanks were installed in 1955 and were taken out of service in October 1984, at which time both chambers were cleaned, painted, and converted to plenum deluge catch tanks. These tanks originally received laundry waste from Building 778.

The T-10 tanks were installed in 1955 and were abandoned in December 1982; however, these tanks reportedly were not cleaned when abandoned. Tank T-10 received waste streams from Building 776, Production Support, and Building 778, the Laundry.

Waste streams for both sets of tanks include radionuclides, solvents, metals, and limited amounts of machinery and lubricating oils. Documented releases from Tanks T-9 and T-10 were not found, but releases from the tanks are considered likely because of the condition of the tanks. Furthermore, numerous releases were documented from a previously removed UST adjacent to Building 730 (Tanks T-9 and T-10) that contained solvents such as carbon tetrachloride and possibly PCE. This tank was reportedly located approximately 9.0 to 10.0 feet below grade.

HPGe surveys conducted during the OU 9 Phase I RFI/RI indicated that Am-241 and Pu-239/240 activities exceeded background. One NaI location registered levels of 1,687 cpm with background of 1,595 cpm. Am-241 and Pu-239/240 were above background, at a depth of 0.0 to 6.0 inches at all borehole locations. Lead and zinc were detected above background at boreholes located northwest and southwest of the tanks. Groundwater samples from the borehole adjacent to the northwest corner of the tanks indicated gross alpha, gross beta, Am-241, U-233/234, U-235, U-238, and all TAL metals except beryllium, cadmium, cesium, selenium, silicon, silver, thallium, and tin exceeded background concentrations. Groundwater samples from the borehole adjacent to the southwestern corner of the tanks indicated U-233/234, U-235, U-238, arsenic, and selenium exceeded background. Am-241 exceeded soil background at a depth of 20.0 to 22.5 feet in the borehole located adjacent to the southeastern corner of the tanks and carbon tetrachloride was detected at a concentration of 25,000,000 μg/kg. Groundwater samples in the boreholes indicated that Am-241, Pu-239/240, Ra-226, U-233/234, U-235, U-238, aluminum, barium, copper, iron, lead, magnesium, mercury, potassium, sodium, strontium, and zinc exceeded background. Groundwater samples from the borehole located to the northeast indicated Am-241, Pu-239/240, Ra-226, U-233/234, U-235, U-238, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, mercury, nickel, potassium, sodium, strontium, and zinc exceeded background concentrations.

Sample results from liquid inside both tanks at Tank T-9 indicated positive activity for all radionuclides analyzed except Ra-226. Sample results from liquid inside Tank 10 (west) indicated positive activity of all radionuclides tested. Also, there were significant elevations of calcium, copper, lithium, manganese, nickel, potassium, sodium, strontium, and zinc. Sample results from Tank-10 (east) indicated activity for all radionuclides analyzed except Ra-226 and gross alpha. The metals lithium, potassium, sodium, and zinc appeared to be significantly elevated.

Tank 18 - OPWL - Concrete Laundry Waste Lift Sump IHSS 000-121
Existing data for this site have not been located.

Solvent Spills North of Building 707 IHSS 700-118.2

IHSS 118.2 is associated with a 5,000-gallon aboveground carbon tetrachloride tank located adjacent to the north side of Building 707, in the alleyway between Building 707 and Building 778. According to the OU 8 Phase I RFI/RI Work Plan (DOE 1994), in addition to carbon tetrachloride, the tank may have held various degreasing solvents, including petroleum distillates, benzene and dichloromethane paint thinner, 1,1,1-TCA, and methyl ethyl ketone. The OU 8 RFI/RI Work Plan defines IHSS 118.2 as an area 30 by 20 feet, adjacent to the north side of Building 707. The area is mostly flat and is fully paved.

There were numerous leaks, spills, and overflows that have occurred from the tank during routine filling operations. The most significant release occurred in June 1981 when the tank ruptured and released an unknown quantity of carbon tetrachloride to the environment. The tank and the area of the spill were subsequently cleaned up. However, no documentation has been found to support any sampling and analysis conducted to verify the complete removal of contaminated soil.

A 5,000-gallon aboveground tank containing approximately 3,500 gallons of carbon tetrachloride is currently located at the site. A concrete containment wall, approximately 4 feet high, surrounds the tank. It is not known whether this is the same tank that ruptured in 1981 or is a replacement tank. The HRR (DOE 1992a) states that the tank ruptured and leaked solvent onto the ground, "contaminating the soil." There were no foundation drains identified at Building 778; however, foundation drains were identified at Building 707. The drains are connected to a storm sewer at the southwest corner of Building 707. The storm sewer discharges at the 750 Culvert. There has been historical sampling of the 750 Culvert since the 1970s. However, samples were not analyzed for VOCs. Therefore, no conclusions can be made with regard to the foundation drains and contaminant migration from IHSS 118.2.

A soil gas survey conducted during the OU 8 RFI/RI indicated that the organic analytes exceeding 1.0 µg/L were carbon tetrachloride, PCE, toluene, TCE, chloroform, benzene, and chloromethane.

Sewer Line Overflow IHSS 700-144(N) and Sewer Line Overflow IHSS 700-144(S)

IHSS 144 (N&S) is associated with the release of radioactive laundry waste water during a transfer of the waste water from the laundry waste holding tanks, which are located beneath the Building 730 pump house, to the sanitary sewer system. The Building 730 pump house is located north of Building 776 and east of Building 701. The Building 776 laundry waste water was stored in two 22,500-gallon concrete underground tanks that are designated Tanks 776A and 776B. The tanks are colocated with two 4,500-gallon concrete process waste holding tanks that are designated Tanks 776C and 776D. The four tanks, which were constructed in 1956 or 1957, are designed so that if Tanks 776C and 776D overflowed, the excess material could drain into Tanks 776A and 776B, and vice versa. Although no documentation has been found that shows this situation ever occurred, it is possible that the release of the laundry waste water could have included constituents of the process waste tanks (DOE 1994).

All four tanks were taken out of service; however, the date they were taken out of service is unclear. The OU 8 Phase I RFI/RI Work Plan (DOE 1994) states that the tanks were taken

out of service in the 1980s and the laundry waste tanks were converted to fire water plenum deluge tanks. A 1977 engineering drawing, drawing number 25845-X065 (exact date and title illegible on copy), denotes that the four tanks were to be decontaminated and the laundry waste tanks converted to two-stage plenum firewater storage. It is not known whether the decontamination and conversion of the tanks occurred in the late 1970s or early 1980s.

According to the OU 8 Phase I RFI/RI Work Plan (DOE 1994), from approximately 1969 until 1973, laundry waste could be transferred through the sanitary sewer lines to the Building 995 sewage treatment facility. A pipe header located in the Building 703 pump house allowed for alternatives of pumping the laundry waste water to either the sanitary sewer system, the SEP, or Building 774. A drawing entitled "Piping; Process Waste Storage Tanks, Buildings 76 & 77" (RF-76-13216; As Build, August 13, 1957) shows the pipe header with the three alternatives for transferring the waste. Based on this drawing, it appears that the ability to transfer the waste to the sanitary sewer system had existed since 1957.

The discharge pipes from the laundry waste tanks exit Building 730 on the north side. The three pipes then run east, to the south side of Building 702. From there, the sanitary sewer pipe runs south, underneath the addition that was constructed on the eastern side of Building 777 in the mid-1960s. Utility drawings show that the section of the sewer that ran underneath Building 777 was abandoned, and a new PVC sewer line ties into the existing sewer at the north side of the Building 777 addition. The PVC pipe runs east along the north wall of Building 777, then turns south and runs through the alley between Buildings 777 and 779.

On approximately June 1, 1972, the Building 776 radiography vault floor drain remodel was completed. Apparently, previous transfers of laundry waste water from Tanks 776A and 776B resulted in backflow into the vault. The revision to the floor drain would allow the laundry waste to be transferred at higher pressures (DOE 1994).

On June 7 or 8, 1972, the increased pumping rate during a transfer of laundry waste water from the tanks to Building 995 caused suspension of high-level radioactive sediment in the tanks and pressurization of the sanitary waste line. The pressurization of the line caused a commode and sink in Building 701 to overflow, and a patch to rupture in the line east of the tanks. Due to the overflow of the commode and sink, the toilet, sink, and floor of Building 701, as well as the ground east of the building, were contaminated. The patch that ruptured was apparently located between Buildings 777 and 779 (DOE 1994). The HRR (DOE 1992a) states that the pressurization of the transfer line also caused sanitary waste to back up and overflow at a clean-out plug. Maintenance personnel were reportedly working at a clean-out near Building 701 at the time of the incident.

Activity levels of samples collected from the toilet bowl in Building 701 were as high as 136,000 pCi/L on June 7 and 8. The presence of black sludge was noted in the samples. A sludge sample collected from a clean-out plug in the Building 701 sanitary sewer line contained only minimal radioactivity. Analysis of the sediments from the bottom of Tanks 776A, B, and D indicated liquid-phase activities of 68,000, 9,100, and 302,000 pCi/L, respectively (DOE 1994).

Following the 1972 pressurization incident, the Building 995 outfall and other downstream points were sampled daily. There was increased radioactivity in the Building 995 effluent. The highest sample concentration of total alpha-emitting radionuclides in the effluent was 417 pCi/L, on June 11, 1972 (DOE 1994).

The location of the rupture in the sanitary sewer line is unclear. Persons interviewed for the CEARP report recalled a break in the sewer line between Buildings 777 and 779. The HRR (DOE 1992a) stated that this location is suspect because no documentation was found to support that location. Additionally, the sewer line between Buildings 777 and 779 was constructed of PVC pipe and was relatively new and installed in approximately 1968. The original sanitary sewer pipe, between Buildings 730 and 702, was constructed of vitrified clay and was installed in the late 1950s. It seems likely that the rupture would have occurred in the older section of vitrified clay pipe as opposed to the newer PVC pipe. Also, the HRR states that approximately 50 drums of contaminated soil were removed from "east of the holding tanks." A conflicting document states that 38 drums of soil were removed (DOE 1994). This information seems to support the probability that the rupture of the sewer occurred in the older vitrified clay pipe.

The contaminated soil around Building 701 was also apparently removed. As of June 8, 1972, 19 drums of soil had been removed. According to an employee logbook, no soil count was detected at that time (DOE 1994). This information seems to support the probability that the rupture of the sewer occurred in the older vitrified clay pipe.

The HRR (DOE 1992a) stated the pump line for the transfer of the laundry waste would be physically separated from the sanitary sewer line. It is not known whether this occurred. The 1977 drawing (25845xX056) does not indicate that the pipe was separated.

IHSS 144 was originally defined as a 10- by 10-foot area between Buildings 777 and 779. Based on information obtained during the development of the OU 8 Phase I RFI/RI Work Plan (DOE 1994), IHSS 144 was divided into two separate sites: IHSS 144(N) and IHSS 144(S). IHSS 144(N) has dimensions of 25- by 70-feet and is located adjacent and east of Building 730. IHSS 144(S) has dimensions of approximately 15 by 170 feet and is located in the alley between Buildings 777 and 779. The surface soil sampling grid proposed in the OU 8 RFI/RI Work Plan for IHSS 144(N) also included an area adjacent to the eastern side of Building 701. The ground surface in IHSS 144(N), and on the eastern side of Building 701, is relatively flat and unpaved. The alley between Buildings 777 and 779 (IHSS 144[S]) has been paved since 1968, and slopes to the south (DOE 1994).

Foundation drains were not identified at Building 701 or Building 776/777. However, foundation drains are suspected at Building 776/777 due to the underground structures. A foundation drain was identified on the west and north walls of the addition that was constructed on Building 779. The discharge point for this drain is located on the hillside north of the SEP. The foundation drainpipe is located adjacent to the sanitary sewer pipe in the alley between Buildings 777 and 779. If the rupture of the sewer line did occur in that area, the foundation drain probably was affected.

Historically, samples have been collected from an outfall on the hillside north of the SEP since 1977. The location code assigned to these samples was FD-779-1. Most of the

samples have indicated slightly elevated levels of gross alpha and gross beta activity. Tritium was also detected in a sample collected in March 1980. A September 15, 1989, sample indicated elevated levels of potassium, calcium, magnesium, sodium, and zinc. It appears that the outfall that has been sampled is actually a storm sewer outfall and not the foundation drain outfall. Additionally, the elevated sample results could be attributable to the SEP. Therefore, no definitive correlation can be made between the FD-779-1 sample results and the release from IHSS 144 (N&S) (DOE 1994).

The radiometric survey performed with a FIDLER in the late 1970s and early 1980s did not indicate areas above 500,000 pCi/g near the IHSS.

Soil gas and surface soil samples were collected from IHSS 144(N) and analyzed during the OU 8 Phase I RFI/RI. Carbon tetrachloride was present at a concentration of 3.2 µg/L at one soil gas location. Benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenz-(a,h)anthracene, and indeno(1,2,3-cd) pyrene were detected. Antimony, calcium, chromium, copper, lead, magnesium, silver, zinc, Am-240, and Pu-239/240 exceeded background values. Surface soil samples collected from IHSS 144(S) indicated that Pu-239/240 exceeded background values. These data are available in the IA Data Summary Report (DOE 2000a).

Transformer Leak South of Building 776 PAC 700-1116

On January 19, 1998, while conducting a surveillance audit in the 700 Building Area, it was discovered that Transformer T-776-2 was leaking small amounts of dielectric fluid from a weep hole near the bushing/seal area. Additionally, staining of the concrete transformer pad along with some of the adjacent rock/soil surrounding the pad was observed. The age of the release to the surrounding pad and adjacent soil/rock appears consistent with other transformers and stained soil that was inadvertently excluded from the Preliminary Assessment/Site Assessment of PCBs Site study (EG&G 1991).

The transformer went into service in April 1957 (RMRS 1998) and is located within IHSS 150.7. It is unclear whether the transformer underwent retrofilling in the late 1980s or at what other locations the transformer was used.

The dielectric oil in Transformer T-776-2 was sampled in July 1995 and February 1992. The results are summarized in a data report prepared for EG&G in 1992 and show Aroclor-1260 at 23 ppm (RMRS 1998). Another reference to earlier sampling of the oils was found in the Routine Maintenance Equipment Record for Transformer 776-2 (RMRS 1998) indicating PCB concentrations at 21 ppm. Neither document references the method used and there is no evidence that leaks were detected or soil was sampled.

On January 19, 1998, upon discovery of the dielectric oil escaping from the transformer and stained rock/soil, building management reported the occurrence to the spill response coordinator. The analyses noted above were evaluated to assess the nature of the release. It was determined that the staining on the rock/soil was characteristic of an old release that had occurred over many years. According to the Routine Maintenance Record, the oil leak from Transformer T-776-2 was repaired on March 30, 1998 (RMRS 1998).

Radioactive Site Northwest of Building 750 IHSS 700-150.4

IHSS 150.4 is associated with potential radiological contamination in the 750 Courtyard resulting from airborne contamination during the 1969 fire in Building 776/777 and also from decontamination activities following the fire. There were also reports of "leaking manholes" in the area. IHSS 150.4 was originally defined as a 120- by 180-foot area northeast of Building 750. Information obtained during the development of the OU 8 Phase I RFI/RI Work Plan (DOE 1994) indicated that the IHSS should only include a 20- by 20-foot area around the sump, located south of Building 778 outside Door 3, where a leaking processing waste line was discovered.

According to the HRR (DOE 1992a), the tanks and pumps that handled the decontamination fluid from cleanup operations following the 1969 fire were staged in the Building 750 courtyard, on the southeast side of Building 778. This information is suspect because no documentation has been found that confirms the staging of decontamination equipment near Building 750. Also, current and former RFETS employees did not recall the use of the area for such activities. If the area was used for decontamination activities, it is unlikely that there is any residual contamination because detailed documentation exists for the fire cleanup, and if contamination had been found, it is likely that it was recorded (DOE 1994). Additionally, Building 778 has been extended to the east since the time these activities supposedly occurred. It seems likely that if residual contamination existed in the area, it would have been discovered during the construction activities.

The HRR (DOE 1992a) also states that there were several leaks from manholes in the parking lot in 1980 and 1981. No documentation regarding "leaking" manholes was found. It is suspected that interviewees were referring to a leaking process waste line that was discovered in 1981 (DOE 1994).

During routine foundation drain and building sump sampling, elevated levels of total dissolved solids, conductivity, gross alpha, and gross beta were found in a sump located south of Building 778, just outside Door 3. These high levels were discovered during the week ending November 20, 1981. Investigation into the high levels resulted in finding a leaking process waste line located above the sump. The leak was repaired. Specific isotopic analyses indicated 900 pCi/L U and no Pu. Whether the analyses were performed on soil or water was not specified. No documentation regarding soil removal or other cleanup activities was found (DOE 1994).

The surface in the area is flat, mostly paved, and used for storage, parking, and loading/unloading for Building 750. The area has been paved since construction of Building 750 in 1969 (DOE 1994).

Foundation drains were identified at Building 707. A 6-inch-diameter foundation drain, surrounded by "graded filter material," exists around the Building 707 foundation and footings. The drains tie into the storm sewer at the southwestern corner of Building 707. The storm sewer system outfalls east of Building 707 at the 750 Culvert.

Utility drawings show that an 18-inch storm sewer runs along the north side of Building 707, parallel to the process waste line that leaked, and connects to a manhole just east of Door 3 on Building 778. From this manhole, the storm sewer runs south, through the 750 Courtyard,

along the eastern side of Building 707. The storm sewer connects to the pipe that the Building 707 foundation drains tie into and discharges at the 750 Culvert.

Historically, samples were collected, under the foundation drain and building sump monitoring program, at locations that were thought to be representative of Building 707 foundation drains. It was this sampling that led to the discovery of the leaking process waste line. In the late 1970s and 1980s, it was thought that the sump outside Door 3 on Building 778 was a discharge point for Building 707 foundation drains. This site was assigned the location code FD-707-3.

The earliest sample data available for this location were from September 1980. Elevated levels of gross beta activity were detected in every sample collected from this location between September 1980 and September 1989 (no data were available from September 1981 to April 1988). The highest measured activity was 182 pCi/L gross beta. Elevated levels of gross alpha activity were also detected in 1980 and 1981. The sample collected in September 1981 detected 7,900 pCi/L gross alpha activity. The OU 8 Phase I RFI/RI Work Plan (DOE 1994) states that the high activity levels in the sump were discovered during the week ending November 20, 1981. Analytical data were not found for location FD-707-3 for the month of November 1981. Either there was another round of sampling in November 1981, or it took until the week of November 20, 1981, for the results from the September sampling event to reach the appropriate personnel. In any event, the process waste line was apparently leaking for several months before it was repaired.

The 750 Culvert was also sampled regularly under the foundation drain and building sump monitoring program. The location code that was used until 1991 was FD-707-1. Low levels of gross beta activity were detected and several metals were detected above background concentrations in samples collected from this outfall (DOE 1994). However, because the 750 Culvert is the outfall that drains most of the 700 Area, the compounds detected cannot be attributed to IHSS 150.4.

Bedrock groundwater monitoring wells 2386 and P207389, and alluvial monitoring wells 2486 and P207489, are located downgradient of IHSS 150.4. At the location of wells 2386 and 2486, VOCs have only been detected in the bedrock well, 2386, but were detected in both the alluvial well and bedrock well at locations P207489 and P207389, respectively (DOE 1994).

Surface soil samples collected during the OU 8 RFI/RI indicated that sodium, U-235, and U-238 exceeded background values. These data are available in the IA Data Summary Report (DOE 2000a).

GROUP 700-4

UBC 771 - Plutonium and Americium Recovery Operations

Information on Building 771 is from the 771 Closure Project Decommissioning Operation Plan (DOE 2000d). Building 771 is located in the north-central section of RFETS. The original building was a two-story structure built into the side of a hill with most of the three sides covered by earth. The fourth side, facing the north, provides the main entrance to the building.

Since completion of the original building, six major additions were constructed. This series of expansion brings the total area of the building to approximately 151,000 ft^2. The first addition was Building 771A, which was constructed in 1962. This addition is separated from the process areas by a hallway and doors, and has a separate ventilation system.

Completed in 1966, the 771B office addition is a one-story building on the north side of the main building, west of 771A. The dock number 1 addition was added to the northwestern side of the main building in 1968. The maintenance shop on the western side of the main building was constructed in 1970. The waste packaging facility, Building 771C, was built in 1972, and is a one-story addition to the eastern side of Building 771, extending to the western side of Building 774.

A plenum deluge catch tank shed, built in 1974, was added on the western side of the original building adjacent to the maintenance shop addition. Inside the shed is a 4,000-gallon-capacity filter drainage catch tank and support system to collect the water used while fighting fire inside the filter plenums or incinerator.

Building 771, the primary facility for Pu operations, was one of the four major buildings to be constructed and placed in operation at RFETS. Building 771 operations included the chemical and physical operations for recovering Pu and refining Pu metal, Pu chemistry and metallurgical research, and a radiochemical analytical laboratory. The following provides a chronology of Building 771:

1951	Begin construction in November.
1952	Building 771 is occupied.
1953	First operations begin in Building 771 in May.
1957	On September 11, a glovebox fire occurs in the building, resulting in the transfer of the Pu foundry, fabrication, and assembly operations to Building 776/777.
1958	A Pu recovery incinerator begins operations.
1959	The solvent extraction process for Pu recovery is replaced with an anion exchange process.
1963/64	Building 771A is constructed to increase Pu production. Processes were expanded to include an Am recovery, Pu dissolution lines, filtrate recovery, and batching, calcination, and fluorination operations.
1967	An office expansion: 771B is added to Building 771.
1970	An addition is completed on the western side of the building to consolidate all maintenance, pipe, sheet metal, and painting activities.
1971	Building 771C, a drum-handling facility, is completed.
1979	Pu recovery operations in Building 771 are discontinued. Cleanup operations begin in Building 771.
1980	Building 771 operations are restarted due to material accountability problems in Building 371.
1989	Building 771 Pu operations are shut down in November as part of an overall Pu operations shutdown ordered by DOE.

The Building 771 stack is a reinforced concrete stack at the southeast corner of Building 771. The stack has an inside diameter of 10 feet, the base is 19 feet underground, and the stack rises 150 feet aboveground. The exhaust stack provides exhaust for the main filter plenum, which receives exhaust from the HEPA filtration system; the heating, ventilation, and air conditioning (HVAC) system; and the incinerator.

UBC 774 - Liquid Process Waste Treatment

Information on Building 774 is from the 771 Closure Project Decommissioning Operation Plan (DOE 2000d). Building 774 was designed to treat the liquid process wastes generated in Building 771. Building 774 was originally a two-story rectangular structure of poured-in-place concrete. By 1989, seven additions had been made to the building, resulting in multiple levels varying from one to four stories in height. The facility is built on a steeply sloping site. The first floor on the north side is 7.5 feet below grade, and the fourth floor on the south side is 4 feet above grade.

As RFETS expanded to accommodate increased production of nuclear weapon triggers, Building 774 began processing radioactive acidic wastes; caustics, aqueous, and organic wastes; wastes oils; and nonradioactive waste photographic solutions. Buildings 111, 112, 130, 371, T371J, 441, 444, 460, 551, 559, 664, 707, 750, 771, 776, 777, 881, and 991 generated one or more waste streams that were processed in Building 774. In 1971, the waste treatment operations in Building 774 were enclosed to provide containment of radioactive airborne particles.

The goal of the Building 774 waste treatment process was to reduce liquid radioactive wastes and convert them into a form suitable for transport offsite for storage and disposal. In general, wastes were either piped directly into Building 774, or transferred in drums, containers, or other types of packaging. The waste entered a series of interconnected tanks designed to treat acidic, caustic, and radioactive wastes, and separate relatively low-level radioactive effluent from contaminated solids or sludges. Each of the four processes used in the building was tailored to meet certain characteristics of the waste. The waste may have passed through one or more of the following processes:

- Neutralization and filtration of acidic wastes containing large quantities of metal ions or chloride ions. The main purpose of this process was to remove the large quantities of metal hydroxide solids from the waste stream, as these solids hampered the decontamination ability of the succeeding flocculation and clarification processes.

- Batch neutralization, precipitation, and filtration of acidic wastes containing only small quantities of metal ions or basic wastes containing large quantities of undissolved solids.

- Continuous radioactive decontamination of neutral and caustic wastes.

- Solidification of aqueous wastes containing complexing agents, certain radioactive isotopes, or hazardous chemicals that were undesirable in the regular waste system. These wastes were mixed with an absorbent material and Portland cement in barrels for disposal. This process was eventually replaced by the organic and sludge immobilization system. The organic and sludge immobilization system accepted waste

oils from any building at the Site that contained TRU material and converted the liquid waste into solid waste.

The second stage of the decontamination process included two separate radioactive waste decontamination processes. The benefit of segregating the wastes was better utilization of the waste storage ponds based on whether the wastes met standards for radioactive and/or chemical contamination.

The slurry from both processes was held in a slurry tank until it was processed by vacuum filtration to separate the solids from the liquid. The separated solids were mixed with a solidifying agent, and packaged for shipment and long-term storage as TRU-mixed waste.

The role of Building 774 diminished with the inauguration of the new process waste treatment facility in Building 374. Building 774 continued to process contaminated organic wastes that could not be incinerated, and the liquid process wastes generated in Building 771.

Radioactive Site West of Buildings 771/776 IHSS 700-150.2(N)

On September 11, 1957, a fire was discovered in Room 108 of Building 771. Fires in the box exhaust booster filters and main filter plenum were discovered soon after. An explosion in the main exhaust duct probably contributed to the release of Pu from the stack. The September 1957 fire in Building 771 released radioactive contamination primarily north and southwest of the building.

In September 1957, during fire fighting and decontamination activities at Building 771, access to the main filter plenum was gained through a hatchway on the western side of the building. This activity was the main cause of the spread of contamination on the western side of Building 771 at the time of the September 1957 fire.

On May 11, 1969, a fire occurred in Building 776/777. Pu was tracked outside of Building 776 by fire fighting and support personnel and was detectable on the ground around the building. The tracking of contamination was confined to an area of 20 by 100 feet adjacent and west of the building. Another source states that the contaminated area extended from the south wall of Building 778 to the north wall of the maintenance addition to Building 776 in a strip approximately 30 feet wide along the west wall of Building 776. Following the fire, rain carried the contamination into the soil. Airborne contamination from the May 1969 fire was carried predominately to the west-southwest, the average wind direction at the time. Contamination was found outside the building to a maximum of 200 feet following the fire.

Soil and asphalt removed from the western side of Building 776 contained 7 dpm/g when analyzed after the August 1969 fire; these materials were removed and buried in trenches. In December 1969, contaminated soil and asphalt were removed from behind Building 776 to fill an area east of Building 881 (PAC 900-130). In May 1971, contaminated steps, dock, and ramp areas on the western side of Building 776 were covered with epoxy paint. Areas of contamination outside Building 776 were covered with asphalt. In June 1980, contaminated asphalt was removed from the western side of Building 776 and boxed as hot waste.

Radioactive Site 700 North of Building 774 (Area 3) Wash Area IHSS 700-163.1

IHSS 163.1 was originally defined as a 6- by 150-foot area northwest of Building 774. It was reported that an area north of Building 774 was used for washing equipment and vehicles that were contaminated with radioactive materials (DOE 1992a). A former RFETS employee recalled that cleanup of trucks occurred near the dock at the northeastern corner of the building (DOE 1994). Reportedly, personnel would use HNO_3, soap, and water for cleaning and the solution would flow onto the ground. The wash water may have contained low levels of unspecified radionuclides, HNO_3, and various organic and inorganic compounds. However, Building 774 personnel did not recall this area ever being used to wash equipment or vehicles (DOE 1992a). In addition, washing down a piece of equipment or vehicles where wash water would come in contact with the asphalt or ground surface was against RFETS policy. Vehicles were decontaminated by wiping the surfaces with kimwipes and monitoring until the surface was clean (DOE 1994). There was no resulting wash water.

The western half of the IHSS is mostly flat, paved, and covered in part by Trailer T771G. The eastern half is unpaved, slopes to the north, and is crossed by an access road to the SEP.

Results of the Radiometric Survey, performed at Rocky Flats from 1977 through 1984, indicated no radioactivity above background levels northeast of Building 774 (DOE 1994). There are no wells or boreholes within, adjacent to, or downgradient of IHSS 163.1.

A foundation drain constructed of 4-inch-diameter PVC is located on the southern side of the east addition to Building 774. This foundation drain connects to a 6-inch-diameter corrugated metal pipe storm drain at the southeastern corner of the east addition to Building 771 and runs southwest to northeast through IHSS 163.1. The outfall for this storm drain is located on the hillside northeast of Building 774 at sampling station FD-774-3. This outfall has never been sampled and is usually dry. Discharge from the outfall collects in the OU 4 drain system where it is then treated.

Soil gas surveys conducted during the OU 8 RFI/RI did not detect organic chemicals at concentrations of 1.0 µg/L or greater. Benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, and dibenz(a,h)anthracene were detected in surface soil. Calcium, copper, magnesium, silver, sodium, zinc, Am-241, and Pu-239/240 exceeded background values in surface soil samples. These data are available in the IA Data Summary Report (DOE 2000a).

Radioactive Site 700 Area 3 Am Slab IHSS 700-163.2

IHSS 163.2 was originally defined as a 50- by 50-foot area north of Buildings 771 and 774, outside of the PA and southeast of Parking Area No. 71. However, more recent information indicates that this IHSS is an area approximately 60 by 40 feet near the eastern end of Trailer T771A.

Reportedly, an Am-241-contaminated concrete slab, approximately 8 feet square by 10 inches, is buried in the area near Building T771A. Between 1962 and 1968, the slab served as the foundation for a 5,000-gallon stainless steel tank located approximately 30 feet north of Building 771. The tank was part of the Filtrate Recovery Ion Exchange system that concentrated Am-241 and Pu-239/240 for recovery. The Am-241 and Pu-239/240 were concentrated on an ion exchange column and then transferred to the tank. The resulting

liquid contained in the tank was a nitrate solution high in Am-241 with some Pu-239/240 (DOE 1992a).

In approximately 1968, a leak developed in the valve/piping on the bottom of the tank and some of the contents dripped onto the concrete slab. The flanges in the area of the leak were tightened, and the valve and piping were wrapped with plastic and yellow tape. The tank was emptied through processing of the contained solution. The leakage of the radioactively contaminated liquid is not believed to be a chronic event, but rather a one-time occurrence. After the tank was emptied, it was removed from service, and taken to the size reduction facility in Building 776 (DOE 1994).

When the tank was removed, the slab was decontaminated, with respect to removable contamination, until smear samples did not detect removable radioactivity. The slab was then painted to secure the fixed radioactivity. Following this decontamination effort, the slab was reportedly moved to a ditch or low area north/northeast of the former tank location and probably buried. In the late 1970s, Building T771A was constructed in the same general area. Reportedly, there was no subsequent excavation of the slab, and the slab is believed to be underground near or beneath the eastern end of Building T771A at a depth of less than 10 feet.

The incident was not recorded as an environmental incident impacting the soil at RFETS in a 1973 environmental summary report. However, the report does note the slab on a map of the area north of Building 771, in an area farther north of where the slab is believed buried. It also states that it was later excavated and the contaminated portion cut away for offsite disposal. This is not believed to be the case, because the area shown on the map was paved several years before the slab became contaminated. Also, there is no verification that the slab was subsequently excavated (DOE 1994).

There is no mention of contaminated soil being buried with the slab. However, it is possible that a small amount of soil from beneath the slab was deposited when it was pushed into the ditch. Results of the Radiometric Survey, conducted at Rocky Flats during the late 1970s and early 1980s, indicated no extremely contaminated areas (500,000 to 1,000,000 pCi/g) north of Building 771. An aerial Radiological Survey of RFETS conducted during July 1989 did not indicate anomalous concentrations of Am-241 in the area north of Building 771. However, the survey was not structured to identify sources that occupied an area smaller than 200 meters in diameter (DOE 1994).

There are no wells or boreholes located within, adjacent to, or downgradient of IHSS 163.2 (DOE 1994). There are no foundation drains, outfalls, or sampling stations within IHSS 163.2.

Ground-Penetrating Radar (GPR) and magnetometer surveys were conducted at IHSS 163.2, during the OU 8 RFI/RI, in an attempt to identify the location of the buried concrete slab. In addition to these geophysical surveys, research of historical records and engineering drawings, interviews with personnel familiar with concrete design practices at RFETS in the 1960s, and an aerial photograph review were conducted to assist with determining the location of the concrete slab. Both the GPR and magnetometer survey were unsuccessful in

identifying the presence of a buried concrete slab in the area targeted for investigation immediately east of Trailer T771A. Conclusions from this investigation are presented below:

The concrete pad is not buried beneath Trailer T771A because the general area around the trailer does not appear, from review of aerial photographs, to consist of fill material. Large amounts of fill material should be associated with the burial area of the slab.

The slab is not buried immediately east of Trailer T771A for a distance of approximately 50 feet. If the pad existed in this area, it would have been identified by one of the geophysical survey methods. The area east of Trailer T771A consists of very shallow fill that would have been adequately penetrated by GPR for the purposes of identification of this buried slab, regardless of whether it contained steel reinforcing bars. Similarly, if the slab contained steel reinforcing bars, the magnetometer survey would have identified the buried slab. Although design and construction drawings specifically addressing construction of the concrete slab were not found, it is likely that the Am tank slab contained steel reinforcing bars. This statement is made based on typical construction methods used in the early 1960s at Rocky Flats, as verified by personnel familiar with the engineering practices at the Plant at that time.

The slab is not buried beneath Building 770 because the slab was constructed in approximately 1962 or 1963, while Building 770 was constructed in approximately 1964. The slab remained in use under the Am tank until the late 1960s.

The location of the security fence north of Building 771 and near the former location of the Am tank would have been a limiting factor in easily burying the slab. The security fence north of Building 771 had been relocated to the north during the time period of most interest for this slab. The security fence was located approximately 11 to 60 feet north of the former tank location during the time period of interest (approximately 50 to 120 feet north of the current north edge of Building 771).

The most probable location where the slab could be buried is the strip of land approximately 15 feet south of Trailer T771A. This strip of land extends from approximately the center of T771A to the west edge of Building 770. This area was low-lying land north of the Building 771 security fence during the time the Am tank was in use. This area was filled and graded in the time frame of April 25, 1970, to August 6, 1971, which is shortly after use of the tank ceased.

Filling, grading, and leveling of the land had progressed to approximately 150 feet northeast of the northeast corner of Building 770 by the time use of the tank had ceased (approximately the late 1960s). Because the slab is reported to have remained in place a few years after the tank had been removed, it seems unlikely that the slab would be present in any area closer than 150 feet northeast of the northeast corner of Building 770.

If the slab is not buried in a strip of land 15 feet south of Trailer T771A, the next most probable location for burial of the slab is approximately 150 feet northwest of the northwestern corner of Building 770. The security fence makes this possible burial location far less likely to contain the slab than the burial location described above.

It is possible that the concrete slab was not buried in any area near Building 771. Instead, the slab could have been hauled off and buried or placed in an area remote from the slab's original location.

Abandoned Sump Near Building 774 Unit 55.13 T-40 IHSS 700-215

The concrete mixed-waste storage tank adjacent to Room 103 of Building 771 was constructed in 1963. The roof of the tank serves as the floor of Room 203. The tank held sludge from second-state precipitation of liquid process waste from Building 771. Effluent from a silver recovery unit was also stored in Building 774. Use of Tank T-40 ceased when the tank was replaced in September 1989.

Hydroxide Tank, KOH, NaOH Condensate IHSS 700-139(N(b))

IHSS 139(N) consists of two separate sites located north of Building 774. One of these sites consists of an aboveground NaOH tank and is adjacent to the north wall of Building 774. The other site is located approximately 80 feet north of the NaOH tanks and consists of two large aboveground steam condensate tanks. The first site is an area approximately 20 by 20 feet around a vertical 6,500-gallon NaOH tank. The tank was built between 1955 and 1964. The tank is covered by insulation, which is in a degraded condition based on visual observations. Through holes in the insulation, it was observed that the sides of the tank are corroded, as is the base of the tank. A concrete berm approximately 18 inches high surrounds the tank and appears to be corroded (DOE 1994).

The second site consists of two 8,000-gallon steam condensate tanks (Tanks T-107 and T-108), that have riveted construction. These are located approximately 80 feet north of the NaOH tank and at a lower elevation. These tanks were built between 1971 and 1978. The two tanks are located on a concrete slab and have badly corroded bottoms (DOE 1994). Originally, the tanks held “clean” condensate from an evaporative waste concentration system formerly used in Building 774. The condensate was tested for the presence of radioactive contamination and then released (if free of contamination) to the tanks or west of the tanks depending on the valve positions (DOE 1992a). The area west of the tanks is known as Bowman’s Pond or the 774 footing drain pond. The tanks have not received condensate since approximately 1980. Since that time the western condensate tank receives overflow and precipitation runoff from the bermed area surrounding the NaOH tank. The bermed area directs flow through a pipe and into the western condensate tank. The eastern condensate tank receives overflow from the western tank. Standing water has been noted around the tanks (DOE 1994).

In May 1978, a spill occurred during routine filling of a caustic tank near Building 771. The specific tank or the quantity spilled was not documented. The spilled caustic was contained by a berm below the tank and was not released to the environment. The HRR (DOE 1992a) states that this occurrence is believed to have involved the KOH tank south of Building 771 (IHSS 139.1[S]).

In May 1985, a small leak was found at the fitting of a thermocouple in the NaOH tank. The caustics had solidified at the fitting, and therefore had not run into the pit. The fitting was repaired (DOE 1994).

On June 22, 1987, there was an overflow of NaOH during a delivery operation to the caustic supply tank north of Building 774 because of a faulty level indicator. Approximately 100 gallons of caustic material flowed into the berm containment area of the tank and then drained to the caustic "catch" tank (T-108). Due to cracks in and deterioration of the concrete berm, caustic seeped onto the road. Tank T-108 was also found to be deteriorating, and showed signs of seepage. In response to the incident, the 1 to 2 gallons that had seeped onto the road were diluted with water and rinsed off the road. Work orders to repair the cracks in the berm and replace the deteriorating catch tank, T-108, were initiated. The liquid in T-108 was sampled and was to be subsequently pumped to the sanitary sewer system of Building 774. The level indicator on the caustic tank was repaired (DOE 1994).

In approximately 1988, the NaOH tank north of Building 774 was overfilled. It is estimated that during the 30-year history of the NaOH tank, 80 to 100 gallons of caustics were spilled (DOE 1994).

The foundation drains for Building 774, and possibly Building 771, have discharged to this area since the early 1950s. Additionally, IHSS 149.1 is associated with a release of approximately 1,400 gallons of process waste from the SEP that flowed into the area around the tanks and the pond. The vegetation in the area was damaged. Analysis of the spilled liquid from this incident detected 2,500 pCi/L alpha, 4,000 pCi/L beta, 10,000 µg/L nitrate, and a pH of 12.

On September 27, 1994, the Surface Water program collected samples for the D&D Group because D&D was to remove the steam condensate and NaOH tanks. Three surface water samples were collected and analyzed for gross alpha, gross beta, pH, and total PCBs. No PCBs were detected in any of the samples.

An unspecified diameter, corrugated metal pipe storm drain runs from an outfall in the northwestern portion of IHSS 139.1(N) west to an outfall near Bowman's Pond. A 6-inch corrugated metal pipe storm drain runs north from near the northwestern corner of the IHSS and outfalls to the surface at surface water sampling station SW-91. Additionally, a section of the OU 4 drain originates near Bowman's Pond and runs west to east through the middle of IHSS 139.1(N). It is reported that water from the pond is collected in OU 4 where it is treated. Based on observations, it appears that much of this water from the area flows overland into North Walnut Creek, and does not infiltrate to be captured by the Interceptor Trench.

Surface soil samples collected as part of the OU 8 RFI/RI were analyzed for metals. Results of these analyses indicated that silver, sodium, and zinc exceeded background values. Sediment samples were collected because the condensate receiving area was underwater. Arsenic, barium, calcium, chromium, lead, magnesium, mercury, silver, sodium, strontium, and zinc exceeded background values. These data are available in the IA Data Summary Report (DOE 2000a).

IHSS 700-124.1 30,000-Gallon Tank (68), IHSS 700-124.2 14,000-Gallon Tank (66), and IHSS 700-124.3 14,000-Gallon Tank (67)

In July 1981, Tank 66 overflowed, spilling an estimated 500 gallons of liquid waste. A second source states that during the week ending July 17, 1981, approximately 3,300 gallons

of process waste water overflowed a tank in Building 774, and approximately 50 gallons ran onto the asphalt driveway. Another source states that this spill involved between 50 to 100 gallons of liquid which contaminated the ground east of Building 774.

Tanks 66 and 67 are identical in size, construction, and age, and they share an internal wall. Tank 67 is immediately south of Tank 66, and Tank 68 is located 2 feet south of Tank 67. Tank 68 was built in 1958. The walls of all three tanks are approximately 10-inch-thick reinforced concrete, although the exact dimensions of Tanks 66 and 67 are different from Tank 68.

The released process waste water contained high concentrations of nitrate and was contaminated to approximately 40,000 dpm/L Pu. Another source states that the liquid released in the overflow incident was high in nitrate, contained Pu and U, and was measured at approximately 30,000 dpm/L. An analytical report on the process waste water released from the July 1981 Tank 66 spill indicated total alpha activity at 7.8×10^4 pCi/L, total beta activity at 4.6×10^4 pCi/L, nitrate at 5.6×10^3 mg/L, and a pH of 12.

The area east of Building 774 was paved following the overflow of Tank 66 in 1981. The contamination may not have been removed prior to paving. A sitewide radiometric survey was performed from 1977 to 1984. The purpose of the survey was to identify surface areas extremely contaminated with radioactivity (500,000 to 1,000,000 pCi/g).

In September 1989, all three tanks were taken out of service in compliance with closure regulations. No documentation was found that further details a response to the occurrence.

Holding Tank IHSS 700-125

IHSS 125 is a 14,000-gallon reinforced concrete tank at the southeastern corner of Building 774; it has a nominal capacity of 12,000 gallons. The tank was included in a 1953 engineering drawing, but it is unclear when it was first placed into service. Liquid waste was transferred to or from the tank through pipes connected with the Building 774 treatment process. A manhole is located at the top of the tank. Four 3-inch-diameter pipes enter Tank 66 from the northern end of the western wall. Two inflow pipes enter 2 feet from the roof of the tank. One passes through Tank 66 and enters Tank 67. Two outlet pipes enter approximately 6 inches from the floor of the tank and one passes through into Tank 67. The elevation of the outlet pipe above the floor of Tank 66 allows approximately 1,000 gallons of liquid to remain in the tank.

The walls of the tank are approximately 10 inches thick. The bottom elevation is at approximately 5,955 feet and the tank is approximately 8 feet high. The area occupied by the tank is 21.5 feet (east-west) by 11 feet (north-south). The floor of the tank was at the same approximate height as the second floor of Building 774 and a short pipe tunnel connects the building with the tank. Ground elevation east of the tank is approximately 5,962 feet. The western side of Tanks 66 and 67 are 4 feet from the eastern sides of the concrete storage tanks (IHSS 146). A shed was constructed over Tanks 66 and 67 with bay doors at the eastern and western sides. The roof of the tanks serves as the floor to the shed.

Westernmost and Easternmost Out-of-Service Process Waste Tanks IHSS 700-126.1 and IHSS 700-126.2

The westernmost and easternmost out-of-service process waste tanks are housed below grade in Building 728. Each tank has an operating capacity of approximately 20,000 gallons and a maximum design capacity of 25,000 gallons.

The combined exterior tank dimensions are 33 feet 6 inches (east-west) by 23 feet 5 inches (north-south) and 11 feet 8 inches high. The ceiling and wall thickness is 10 inches and the floor thickness is 1 foot. The tanks share the inner wall. The bottom elevation of the tanks' interior is at 5,931 feet. The tanks were designed with a minimum cover of 3 feet of fill except for the area overlain by the building. The original design indicated that two pipes enter each tank from the south. The invert elevations of the pipes where they entered the tanks are 5,939 and 5,938 feet. The volume of material that could remain in the tank below the level of the outlet pipe is unclear from the design drawings. The tanks had stored laundry water from the Building 771 laundry facility which ceased operations in the late 1950s. The tanks are sometimes referred to as laundry tanks.

The pump house (Building 728) is a concrete structure situated directly above the tanks with dimensions of 14 feet 10 inches (east-west) by 7 feet 10 inches (north-south) and 7 feet 6 inches high. The south wall of the pump house is above the south wall of the tanks. It contains the manholes for access into the tanks and one sump pump for each tank as well as one sampling point into each tank. The pump house is partially underground so it does not appear as large as its dimensions indicate.

Since being taken out of service in 1984, the tanks were converted to contain fire suppression deluge overflow for Building 771 plenums. The tanks leak, allowing groundwater to periodically flow into the tanks; the groundwater is then pumped into the process waste system. These tanks overflowed several times prior to 1956. Information gathered during CEARP interviews suggests the tanks may have leaked during use. Liquid process wastes that likely contained nitrate, Pu, U, and various other organic and inorganic constituents were released to the environment.

The area east of Building 774 was paved following the overflow of Tank 66 in 1981. The contamination may not have been removed prior to paving. A Sitewide radiometric survey was performed from 1977 to 1984. The purpose of the survey was to identify surface areas extremely contaminated with radioactivity (500,000 to 1,000,000 pCi/g).

Tank 8 - OPWL - East and West Process Tanks

Tank 8 is located in the 700 Area within Building 728, which is referred to as the Building 771 Process Waste Pit. It is located approximately 30 feet north of Building 771. Tank 8 consists of two 25,000-gallon underground concrete tanks. For clarity, these two tanks were designated T-8 (west) and T-8 (east).

These two tanks were installed in 1952 and were reportedly taken out of service in May 1984, cleaned, painted, and converted to plenum deluge catch tanks for fire water from Building 771. The tanks originally received waste streams from Building 771, the Pu and U Recovery Building, including radionuclides, acids, bases, solvents, metals, fuel oil, lubricating oil, PCBs, and photography laboratory wastes.

The T-8 tanks reportedly fill with groundwater periodically, and surface water reportedly runs into Building 728 during periods of high runoff.

HPGe surveys conducted during the OU 9 RFI/RI did not identify areas of elevated radionuclide activity. Radiological contamination survey results indicated that fixed and removable alpha contamination was below 100 dpm/100 cm^2 in the area around the tanks. Two boreholes were drilled around Tank 8. No radionuclides, metals, VOCs, or semivolatile organic compounds (SVOCs) were detected above background values in borehole soil samples near the northwest corner of the tank. East of Tank 8, borehole soil samples indicated that Am-241 was above background values at 14 to 15 feet in depth. These data are available in the IA Data Summary Report (DOE 2000a)

During visual inspection of the tanks, Tank 8 (east) contained 2.5 feet of clear liquid and Tank 8 (west) contained approximately 6 feet of clear liquid. No sludge was noted in either tank. These liquids were sampled and analyzed. Analytical results from the liquid in Tank 8 (east) indicated traces of aluminum, barium, calcium, copper, magnesium, mercury, molybdenum, potassium, silicon, sodium, strontium, Am-241, gross alpha and beta, Pu-239/240, Ra-226, tritium, U-233/234, U-235, and U-238. Analytical results from the liquid in Tank 8 (west) indicated traces of aluminum, barium, calcium, copper, manganese, magnesium, mercury, molybdenum, nickel, potassium, silicon, sodium, strontium, tin, zinc, Am-241, gross alpha and beta, Pu-239/240, Ra-226, tritium, U-233/234, U-235, and U-238. These data are available in the IA Data Summary Report (DOE 2000a)

Tank 12 - OPWL - Two Abandoned 20,000-Gallon Underground Concrete Tanks IHSS 000-121

Existing data for this site have not been located.

Tank 13 - OPWL - Abandoned Sump - 600 Gallons IHSS 000-121

Existing data for this site have not been located.

Tank 14 - OPWL - 30,000-Gallon Concrete Underground Storage Tank (68), Tank 16 - OPWL - Two 14,000-Gallon Concrete Underground Storage Tanks (66, 67) IHSS 000-121

Tanks T-14 and T-16 are located in the 700 Area on the eastern side of Building 774 underlying a chemical storage shed. Tank T-14, which is designated by RFETS as Tank 68, is a 30,000-gallon concrete underground tank. Tank T-16 consists of two 14,000-gallon concrete underground tanks underlying the chemical storage shed to the north of Tank T-14. The northernmost T-16 tank, which will be referred to as T-16 (north), is designated by RFETS as Tank 66 while the other T-16 tank, which will be referred to as T-16 (south), is designated by RFETS as Tank 67.

These tanks were installed in 1952 and were reportedly abandoned in November 1989. The HRR (DOE 1992a) indicates that the tanks were to be closed in compliance with RCRA closure requirements, although confirmation of this is unavailable. These tanks were reportedly removed from the list of RCRA-permitted or RCRA interim status tanks before closure was conducted and were then transferred to OU 9. The tanks received waste streams from Building 774, the Process Waste Treatment Facility, including acids, bases,

radionuclides, metals, and other wastes from RFETS processes. Releases from the tanks were documented, specifically from tank overflow in 1980 and 1981 (DOE 1992a).

HPGe surveys conducted during the OU 9 RFI/RI did not identify areas of elevated radionuclide activity. Radiological contamination survey results indicated that there was no removable contamination near the T-14 and T-16 tanks, but there was fixed alpha and beta contamination. Fixed alpha activities ranged from 118 dpm/100 cm^2 to approximately 4,500 dpm/100 cm^2. Five boreholes were drilled around Tank 16. Soil samples from the borehole located at the southeastern corner of Tank 16 indicated Am-241 and Pu-239/240 were above background from 0 to 0.5 foot. Barium, lead, Am-241, and Pu-239/240 were detected above background levels from 0 to 2.5 feet, and silver was detected from 0 to 0.5 foot in the borehole located at the southeastern corner of Tank 14. Am-241 and Pu-239/240 were also above background from 6.5 to 8.9 feet. Silver, Am-241, and Pu-239/240 were detected at levels exceeding background in the sample interval from 0 to 0.5 foot in the borehole located near the southeastern corner of Tank 14. These data are available in the IA Data Summary Report (DOE 2000a).

Sludge and liquid from Tanks 14 and 16 were sampled and analyzed. Analytical results from the liquid in Tank 14 indicated aluminum, beryllium, calcium, cesium, copper, lithium, nickel, silicon, and silver were detected at 1 ppm. Am-241, Pu-239/240, tritium, U-233/234, and U-238 were detected in quantities greater than 1,000 pCi/L and U-235 was detected at greater than 100 pCi/L. Pu-239/240 and the combination of Pu-238 plus Am-241 were detected at levels exceeding 150,000 pCi/g in the sludge sample. U-235 was detected at less than 1.82 pCi/g.

Analytical results from the liquid in Tank 14 indicated calcium, potassium, and silicon were detected at 1 ppm. Am-241, Pu-239/240, and tritium were detected in quantities greater than 1,000 pCi/L. U-233/234 was detected in quantities greater than 1,000 pCi/L and U-235 and U-238 were detected at less than 100 pCi/L. Pu-239/240 was detected at levels exceeding 325,000 pCi/g in the sludge sample. The combination of Pu-238 plus Am-241 was detected at a level exceeding 225,000 pCi/g. U-235 was detected at less than 0.3 pCi/g.

Tank 15 - OPWL - Two 7,500-Gallon Process Waste Tanks (34W, 34E) IHSS 000-121
Existing data for this site have not been located.

Tank 17 - OPWL - Four Concrete Process Waste Tanks (30, 31, 32, 33) IHSS 000-121
Existing data for this site have not been located.

Tank 36 - OPWL - Steel Carbon Tetrachloride Sump IHSS 000-121
Existing data for this site have not been located.

Tank 37 - OPWL - Steel-Lined Concrete Sump IHSS 000-121
Existing data for this site have not been located.

Caustic/Acid Spills Hydrofluoric Tank IHSS 700-139.2
IHSS 139.2 is related to two horizontal 1,300-pound hydrofluoric cylinders, each with a 1,200-pound capacity, which are located in Building 714. Building 714 is a small shed approximately 4 feet east and 29 feet south of the southeastern corner of Building 771.

Hydrofluoric acid had reportedly infiltrated the soil in the vicinity of the storage area. Numerous small spills and leaks are reported to have occurred during routine filling and transfer operations. The hydrofluoric acid was delivered in portable tanks that replaced the empty tanks, thus requiring no open transfer. These portable tanks were sealed cylinders. The acid was piped to, and used in, Building 771. The area is flat, includes both paved and unpaved surfaces, and is heavily used. A large aboveground KOH storage tank is immediately east of the site (DOE 1994).

In May 1971, a leak in a hydrofluoric connection outside Building 771 was reported. A small amount of vapor was released, but no personnel exposures occurred. No further details of this incident are available (DOE 1994).

During the week ending August 13, 1976, a hydrofluoric acid leak above Building 771 was repaired. Apparently the hoses had collected small amounts of the acid that appeared when the line was pressurized (DOE 1994).

A portable, refillable, HNO_3 dumpster is located at the southeast corner of Building 771, just north and west (approximately 25 feet) of the hydrofluoric acid storage area discussed above. This is not part of IHSS 139.2 or any other OU 8 IHSSs. However, the OU 8 Phase I RFI/RI Work Plan (DOE 1994) planned investigations for this area. These investigations included a 10-foot area around the dumpster.

According to Supervisor Investigation Report #87-7-771.1 - Acid Spill, there was a release of approximately 35 gallons of 12-normal HNO_3 at the dumpster on July 1, 1987. The cause was a leak in the supply hose. Neutralization was attempted by the use of KOH flake and sodium bicarbonate. The following day, the soil was loosened and more sodium bicarbonate was added. An asphalt layer was discovered approximately 6 inches bgs. The affected soil was removed to hazardous waste unit number 1 or IHSS 203. New road mix was to be placed on the asphalt pad (DOE 1994).

IHSS 139.2 was originally defined as a 40- by 60-foot area that encompassed the hydrofluoric shed south of Building 771. The information compiled on IHSS 139.2 for the HRR (DOE 1992a) indicated the location presented in the IAG was inaccurate. For the OU 8 RFI/RI Work Plan (DOE 1994), it was proposed that the location of IHSS 139.2 be redefined to represent the location of the hydrofluoric storage shed (Building 714). This is approximately 350 feet south and 250 feet west of the location presented in the IAG as IHSS 139.2 (DOE 1994). More recent information indicates IHSS 139.2 should be located approximately 45 feet south of the southeast corner of Building 771 and its boundaries should be reduced to approximately 25 by 35 feet.

The hydrofluoric acid release at this IHSS consisted of a vapor release. It is improbable that there is residual impact on the air from this release. Also, it is not likely that the soil, surface water, or groundwater has been impacted by this release. However, leaks and spills from the refillable HNO_3 dumpster located approximately 25 feet northwest of this site have probably impacted the surrounding ground surface (DOE 1994).

A 6-inch, tile foundation drain runs along the south wall of Building 771. This foundation drain appears to run under where the HNO_3 dumpster is located at the southeast corner of

Building 771. This foundation drain is part of the entire Building 771 foundation (and roof drain) system. This drain system eventually discharges to Manhole #3 near the northwest corner of Building 771.

Surface soil samples were collected and analyzed as part of the OU 8 RFI/RI. Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene were detected in IHSS 139.2. Additionally, cobalt, copper, mercury, potassium, silver, Am-241, and Pu-239/240 exceeded background values. These data are available in the IA Data Summary Report (DOE 2000a).

Concrete Process 7,500-Gallon Waste Tank (31) IHSS 700-146.1; Concrete Process 7,500-Gallon Waste Tank (32) IHSS 700-146.2; Concrete Process 7,500-Gallon Waste Tank (34W) IHSS 700-146.3; Concrete Process 7,500-Gallon Waste Tank (34E) IHSS 700-146.4; Concrete Process 7,500-Gallon Waste Tank (30) IHSS 700-146.5; Concrete Process 7,500-Gallon Waste Tank (33) IHSS 700-146.6

Six underground process waste holding tanks were located south of the original Building 774. Building 774, a liquid waste processing facility, has been modified several times since its construction in 1952. During the construction of a south addition in 1972, the tanks were removed. These tanks overflowed frequently.

PAC 700-146 represents a six-chambered reinforced concrete structure south of Building 774. The chambers of the structure are referred to as Tanks 30, 31, 32, 33, 34W, and 34E. Tanks 30 and 33 have a 3,000-gallon capacity. The others have a 6,000-gallon capacity. The tanks were included in a 1952 engineering drawing, but it is unclear when they were first placed into service. Liquid waste was transferred to or from the tanks through pipes connected with the OPWL. Manholes were located at the top of each chamber. The walls of the tanks were 11 feet 8 inches high. The area occupied by the tanks was 22.5 feet (east-west) by 32.5 feet (north-south). The floor of the tanks was at the same approximate height as the second floor of Building 774. Ground elevation to the south of the tanks was approximately 5,965 feet. The ground surface south of Building 774 slopes steeply to the north and levels out near the top of the tanks. RFP Drawing 1-5392-74 locates the six tanks immediately west of Tanks 66, 67, and 68, discussed as PAC 700-124 and PAC 700-125.

In October 1956, the process waste tanks at Building 774 overflowed resulting in minor environmental infiltration. In August 1957, some of the tanks leaked, resulting in minor environmental infiltration with levels up to 2,500 dpm/g that was cleaned up. One of the overflows reportedly flowed down the east road toward North Walnut Creek.

Minor leakage from the six tanks was suspected to have caused the contamination found in footing drain water north of Building 774.

The process waste stored in the tanks was an aqueous solution with Pu, U, acids, and caustics. Water from the Building 774 footing drains was as high as 500 dpm/L. Approximately 200 yds^3 of soil removed from around the tanks contained contamination levels up to 2,500 dpm/g gross alpha activity. Another 60 yds^3 of soil removed averaged approximately 250 dpm/g.

Excavation for the Building 774 addition construction began in February 1972 when contamination resulting from the overflow of the tanks was detected. At the time, the policy on waste disposal guidelines required that soil samples in excess of 34 dpm/g Pu activity be disposed as contaminated waste. Radiometric monitoring procedures included an alpha survey meter evaluation of the site to be excavated. Readings in excess of 250 cpm required that specific soil samples be collected for further analysis. Soil contamination in the excavation was identified as slightly below the 34 dpm/g limit, and by April 1972, 101 barrels of contaminated soil were reportedly shipped to Idaho Falls. It was estimated that 30 to 40 more barrels would follow.

Demolition of the concrete tanks began on May 8, 1972. A wet saw cutting method was used for the removal of the tanks. The disposition of the concrete is unknown. Approximately 200 yards of contaminated soil were removed in 1972 at the time of decommissioning of the tanks and during construction of the south addition to Building 774. The soil was piled north of Building 334 (PAC 300-156.1). The soil was then moved to the eastern end of the Triangle Area by June 1973 (PAC 900-165). Another 60 yards of soil removed from around the tanks was buried under 3 feet of fill dirt east of Building 881 (PAC 900-130). The soil averaged approximately 250 dpm/g (PAC 900-130).

Radioactive Site North of Building 771 IHSS 700-150.1

IHSS 150.1 was originally defined as a 50- by 450-foot area north of Building 771. Information from the HRR (DOE 1992a) indicated that waste storage and handling also occurred west of Building 770 and possibly north of Building 774. Due to a leaking tank incident in June 1968, it was proposed that the IHSS boundaries presented in the IAG be extended to the east approximately 120 feet. In addition, photographs show that in March 1974, more than 30 cargo containers were immediately west of Building 770. Therefore, it was proposed to extend the boundaries of IHSS 150.1 to include the area west of Building 770 (DOE 1992a). The present IHSS 150.1 is an area approximately 360 by 60 feet immediately adjacent to the north side of Building 771 (DOE 1994).

This IHSS consists of an area north of Building 771 affected by various radioactive leaks. The specific locations of these leaks were not recorded; however, the paved area north of Building 771 and west of Building 770 was used for storage probably as early as 1964. The storage area was bounded on the north by a fence that was parallel to Building 771 and extended north to enclose the west entrance of Building 770. The material was stored in drums on pallets or in cargo containers. The area encompassing this IHSS is paved, and occupied by numerous trailers, auxiliary buildings, and storage areas. A small prefabricated building used for storage is located west of Building 770 (DOE 1994).

The primary incidents of spills and leaks are described below (DOE 1994).

In September 1957, a major fire occurred in Building 771. A plenum was breached releasing an unknown amount of radioactivity around the building, particularly to the north. Between 1962 and 1968, a 5,000-gallon stainless steel tank was located approximately 30 feet north of Building 771. The tank was used in the Filtrate Recovery Ion Exchange system, which concentrated Pu and Am for recovery. In approximately 1968, a leak was discovered in the tank that dripped onto the concrete slab foundation. The tank was taken out of service and eventually disposed of offsite. The concrete slab was decontaminated, reportedly moved to a

ditch area north of the IHSS, and buried (IHSS 163.2). The location of the tank was paved before 1969.

In June 1968, during removal of drums from the 903 Storage Area, a drum leaked on the roadway as it was being transported to Building 774. The forklift carrying the leaking drum traveled across the area north of Building 771.

The paved area between Buildings 771 and 770 was used for storage of residue in drums prior to processing in Building 771. A June 1969 photograph shows more than 100 drums stored in rows on the pavement. Drums were also stored in the area south of Building 770 between the access road and building. Building 770, located north of Building 771, was used as residue and equipment storage.

In November 1970, residue leaked out of a drum of filters as it was being transported from a storage area to Building 771 for processing. The ground near the dock at Building 771, a transport truck, and a cargo container the drum came in contact with were all contaminated.

In March 1971, it was noted that there was a significant increase in the number of "hot waste" drums stored in the area north of Building 771. The drums contained residues for the Building 771 incinerator.

In June 1971, a leaking drum placed on the pavement contaminated approximately 115 ft^2 of asphalt. Soil and approximately 200 ft^2 of asphalt were removed for disposal. Shortly afterward, in July 1971, a leaking waste drum containing HNO_3 from non-line-generated waste was discovered. A rainstorm spread contamination, impacting approximately 2,500 ft^2 of asphalt and gravel with 500 to 1,000,000 cpm of Pu. It was determined that these two incidents in 1971 resulted in contamination of the area ranging from 100,000 to 300,000 dpm/100 cm^2 on the asphalt.

In August 1972, a scrap box stored inside Building 770 was punctured and contaminated 3,600 ft^2 inside and 500 ft^2 outside of the building. Levels of contamination ranged up to 200,000 dpm/cm^2. Affected asphalt and soil were removed immediately for offsite disposal.

In September 1972, a drum containing spent ion exchange resin residue leaked inside Building 770 onto the concrete floor. Contamination was tracked between Buildings 771 and 770 and covered 600 ft^2, including 50 drums and a forklift with contamination levels ranging from 5,000 to 100,000 cpm Pu.

No documentation was found that indicated any hazardous waste was associated with the Pu residue. However, decontamination activities would have focused on radioactive contamination, and it is likely that residual contaminants from hazardous constituents may have remained. The Building 771 area was used for storage until approximately 1974 when Building 776 was used for such storage. Building 770 was then used for storage of equipment and a facility for equipment assembly prior to installation in other buildings.

Surface water in this IHSS generally drains to the west. Before the mid-1960s, the area immediately north of Building 770 had a grated collection channel that directs surface water to the east into a small pond (Bowman's Pond). The soil beneath the pavement is expected to

be compacted fill material because the area had been a steep hillside sloping to the north before the area was leveled and buildings were erected.

The results of a Plantwide Radiometric Survey performed during the late 1970s and early 1980s did not identify any extremely contaminated areas (500,000 to 1,000,000 pCi/g) north of Building 771.

Samples from a piezometer (P21989), completed in 1989, in alluvium near the northeast corner of the IHSS provided the following results:

- 1,1-dichloroethane was detected at concentrations less than the MDL in several samples.
- Methylene chloride was detected in several samples; however, blank contamination was indicated for those samples.
- Arsenic, barium, copper, iron, lead, magnesium, manganese, and zinc were detected at concentrations greater than background in surficial materials. Aluminum, arsenic, barium, chromium, iron, lead, magnesium, nickel, vanadium, and zinc concentrations exceeded background in bedrock samples.
- Concentrations of Am-241, Ra-226, Ra-228, tritium, U-233/234, and U-238 in samples of surficial materials, and Ra-226, Ra-228, and tritium in bedrock samples exceeded maximum background values. None of the samples were analyzed for Pu.

HPGe surveys conducted during the OU 8 RFI/RI indicated that Am-241 and Pu-239/240 were above background values. Surface soil samples were also collected at IHSS 150.2. The results of these analyses indicate that concentrations of Am-241 and Pu-239/240 were above background. These data are available in the IA Data Summary Report (DOE 2000a).

Chemicals that exceeded the 1.0 mg/L reference concentration in soil gas samples included 1,1-dichloroethane, 1,1-dichloroethene, chloroethane, xylenes (total), trichlorofluoranthene, cis-1,2-dichloroethane, m- and p-xylenes, o-xylene, and trans-1,2-dichloroethene.

Radioactive Site Between Buildings 771 and 774 IHSS 700-150.3

This IHSS consists of an area between Buildings 771 and 774 that contains a concrete tunnel. The tunnel was originally built as an exhaust ventilation duct for Building 774 but also contains process waste lines (DOE 1994). IHSS 150.3 was originally defined as a 100- by 140-foot area east of Building 771. More recent information indicated that the boundaries of this IHSS should be changed to include an area surrounding the entire tunnel. This change makes the IHSS an approximately 155- by 25-foot area with the eastern end extending up to the southwest portion of Building 774.

The ground surface above the tunnel has been modified as a result of construction and slope stabilization activities over the years. As a result, the tunnel is now partially exposed. Currently, the ground surface slopes steeply to the north to a retaining wall approximately 10 feet high, which was constructed adjacent to the north wall of the tunnel. The area north of the retaining wall, the Building 771/774 courtyard, is flat and paved. The western portion of the hillside is covered with approximately 3 inches of spray foam, and overlain with

chicken wire. It is assumed that the foam and wire are for slope stabilization and erosion control. South of the IHSS, the area is relatively flat and mostly paved (DOE 1994).

In August 1971, liquid leaks into Building 771 at the western end of the tunnel were attributed to releases from the process waste lines where the pipes entered the building through the wall. Also in August 1971, contaminated soil was removed from beneath the tunnel. It is unknown whether the soil removal was a response to the leaks into Building 771 (DOE 1994).

In September 1971, continued construction exposed more of the tunnel and three cracks in the concrete walls were found to be contaminated. This incident reportedly released Pu into the soil. As a result, the contaminated cracks were sealed and eight drums of soil with approximately 24 dpm/g activity were removed for offsite disposal. Samples of waste water from the pipelines indicated activity of 1,000 pCi/L (the type of radiation detected was not specified). Soil samples from the area were found to be slightly contaminated (DOE 1994).

In the late 1970s or early 1980s, personnel recalled an incident when the flange on a process waste line separated, releasing an unspecified amount of aqueous process waste that reached the surface. The area was reportedly cleaned up (DOE 1992a).

A piezometer (P219189) constructed in 1989 in alluvium is located downgradient of this IHSS. The nearest wells to the south of this IHSS are P209289, an alluvial monitoring well, and P209389, a bedrock monitoring well. Based on water table maps, these wells may be upgradient of a portion of IHSS 150.3.

A storm drain, constructed of 18-inch corrugated metal pipe, runs east-west through IHSS 150.3 in the Building 771/774 courtyard. Two additional storm drains, made of similar construction, connect to the east-west drain within IHSS 150.3 and run to the north, discharging at outfalls near the southeast corner of Building 770 in IHSS 172. There are two catch basins for this storm drain system located within IHSS 150.3.

An 8-inch corrugated metal pipe foundation drain was added along the south and west walls of an addition on the south side of Building 774. As a result, the foundation drains for Building 774 may discharge to the storm drain discussed above. The outfall at sampling station FD-774-1 is the discharge pipe for this storm drain. Results of historical sampling at FD-774-1 indicated that gross alpha and/or gross beta was detected at levels exceeding background for the majority of the sampling events between June 1979 and December 1989. Tritium was detected at levels exceeding background during sampling events in March, June, and September 1980, and September 1981.

HPGe surveys conducted during the OU 8 Phase I RFI/RI indicated Am-241 and Pu-239/240 were found at concentrations above background. Radionuclide concentrations in downhole samples indicated Am-241 and U-235 activities above background levels at the 0- to 2-inch-depth interval. Surface soil samples were also collected and analyzed. The results of these analyses indicate that Am-241 and Pu-239/240 activities were above background levels. These data are available in the IA Data Summary Report (DOE 2000a). No organics were detected during the soil gas survey.

GROUP 700-5

UBC 770 - Waste Storage Facility

Building 770 is located in the north-central portion of the 400 Area. The building footprint is approximately 3,168 ft^2. Building 770 was placed into service in 1953. The building houses waste storage facilities for radioactive operations. In August 1972, a punctured scrap box and drum resulted in up to 200,000 dpm/100 cm^2 in and around the building. No characterization of subsurface soil beneath the building has been performed (DOE 1992a).

GROUP 700-6

Buildings 712/713 Cooling Tower Blowdown IHSS 700-137

IHSS 137 is associated with the cooling towers, Buildings 712 and 713, that serve Buildings 776 and 777. The cooling towers are located adjacent to each other, in the area south of Building 774 and north of Building 777. IHSS 137 was originally defined as a 50- by 150-foot area. Information obtained during the development of the OU 8 Phase I RFI/RI Work Plan (DOE 1994) indicated that the boundary should encompass the area surrounding the cooling towers. The proposed area of investigation included a zone approximately 10 feet beyond the foundation of Buildings 712 and 713 (DOE 1994).

Building 712, located west of Building 713, was constructed in 1962 to service Buildings 776 and 777. Building 713 was constructed in 1966 to provide additional cooling tower capacity. There were several laundry and process waste lines in the area where Building 713 was constructed. It is not known whether these underground pipes were removed, rerouted, or abandoned in-place. Buildings 702 and 703 serve as pump houses for Buildings 712 and 713, respectively. The cooling tower sump for Building 712 is located between the cooling tower and the 702 pump house. In the past, operation of the towers was alternated seasonally; the west tower (Building 712), which has a higher cooling capacity, operated during the summer, whereas the east tower (Building 713) operated during the winter.

In the past, utility workers have cleaned out the sump and scraped slime off the cooling tower slats. The material removed in these operations was placed on the ground immediately adjacent to the cooling towers (DOE 1992a).

Wind and rain have damaged the cooling towers and the west tower (Building 712) has been re-sided at least once. The building currently has open panel siding; while Building 713 currently has open slat siding. The slat siding allows some water to spray out of the tower onto the surrounding ground surface. The ground east of Building 713 was puddled from overspray on August 20, 1992. Building 712 was not operational on that day and has been inoperative since that time (DOE 1994).

Cooling tower water generally consists of filtered, untreated raw water from the onsite raw water reservoir. Chemicals were added to the water for the prevention of biological growth, corrosion, scaling, and other effects that can foul heat-transfer surfaces and degrade performance. Prior to 1976, chromates were added to the water as a rust inhibitor. Sodium silicate was also used in cooling tower water as a corrosion inhibitor (DOE 1994).

Water is removed from the cooling tower system from blowdown and drift. Drift water is water that is released to the atmosphere and sprayed to the ground surrounding the tower. Water is periodically blown down to maintain a specified range of total dissolved solids (DOE 1994). Prior to 1970, it was routine for the cooling towers to blow down effluent onto the soil outside the buildings. The blowdown water evaporated, infiltrated into the soil, or flowed into the storm water culverts and pipes and was directed to North Walnut Creek. Although detailed records were not found, it is believed that since 1974 the blowdown from Buildings 712 and 713 was piped to the sanitary sewers (DOE 1994).

The HRR (DOE 1992a) states that the cooling tower blowdown pipes exited the towers on the south sides. These pipes were considered the most probable source of blowdown water contamination around the cooling towers. The Pu Area Underground Piping Plan, Section & Detail (RF-14264-9; As-Built, 6/30/67) shows the blowdown pipes for Building 713 exiting the tower on the western side. As shown, these pipes connect to a 4-inch storm sewer that encircles the tower and discharges at an outfall northeast of the cooling tower, near the southeast corner of Building 774. The effluent from this storm sewer drained into North Walnut Creek. It is inconclusive as to whether the outfall was ever sampled (DOE 1994).

In September 1990, RCRA personnel checked a leaking cooling tower behind Building 777. The cooling tower was reportedly releasing approximately 20 to 40 gallons per minute (gpm). It is unclear how long the leak had occurred prior to the RCRA response to the incident. The releases were caused by leaks from corroded sides of the cooling tower (DOE 1994). No environmental cleanup occurred in response to this release. There are no records of samples being collected during the 1990 incident in the HRR or the OU 8 Phase I RFI/RI Work Plan (DOE 1994).

It is stated in the HRR (DOE 1992a) that the released water contained 50 µg/L total chromium. Witnesses speculated that the release occurred from the Building 779 cooling tower (IHSS 138) in December 1976. This seems likely because the water released in the 1976 incident was reportedly sampled and found to contain 50 ppm total chromium.

In 1979, a Sitewide project was implemented to upgrade cooling towers. The project included the collection of samples for waste classification. Buildings 712 and 713 were included in the study. Materials sampled included wood siding and soil. The results of the sampling indicated that none of the materials sampled qualified as toxic or hazardous material based on EPA guidance and extraction tests. Therefore, material removed for the upgrades was disposed in the present onsite landfill (DOE 1994).

Available analytical data from Building 774 foundation drain sampling indicates detections of chromium and sodium. However, due to the proximity of several other IHSSs, it cannot be determined whether IHSS 137 is the source of the chromium and sodium.

Surface soil samples were collected and analyzed during the OU 8 RFI/RI. Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were detected. Antimony, barium, cadmium, calcium, copper, iron, molybdenum, silver, sodium, strontium, tin, and zinc exceeded background values. U-233/234, U-235, and U-238 also exceeded background values. These data are available in the IA Data Summary Report (DOE 2000a).

Caustic/Acid Spills Hydroxide Tank Area IHSS 700-139.1(S)

IHSS 139.1(S) is associated with a 5,400-gallon aboveground KOH storage tank, which is located 55 feet south and 35 feet east of the southeast corner of Building 771. The tank was installed between 1955 and 1964. The tank is made of welded construction and appears to be in stable condition. It rests on a concrete base and is surrounded by a small earthen berm that was constructed before 1973 (DOE 1994).

The HRR (DOE 1992a) describes IHSS 139.1(S) as an "L" shaped area 25 feet wide and 140 feet long, that surrounds the KOH tank and the line that transfers the hydroxide into Building 771. Subsequent information obtained during the development of the OU 8 Phase I RFI/RI Work Plan (DOE 1994) indicated that IHSS 139.1(S) should be redefined as a 35- by 25-foot area around the tank. The IHSS is unpaved, except for the concrete pad, and is bordered by paved roads on the north, east, and south sides, and by Building 714 on the western side.

There were several spills and releases of KOH during routine filling operations. The following is a description of the reported KOH releases (DOE 1992a):

- The KOH tank overflowed before 1973. The quantity spilled is unknown. The HRR states that "As a result of this incident, it is likely that the caustic seeped through the soil and infiltrated beneath the building." This, however, is an unlikely scenario given the depth to which the KOH would have to infiltrate, properties of KOH, and nature of RFETS soil, unless the spill involved a very large quantity.

- During the week ending May 5, 1978, a spill occurred at a caustic tank near Building 771. The spill occurred during a routine filling operation but was contained by the dike surrounding the tank. This spill is believed to have involved the KOH tank.

- On November 13, 1989, the potassium tank was overfilled. Approximately 5 gallons of 12-molar KOH spilled into the earthen berm that surrounds the tank. Approximately 100 pounds of "oil dry" was used to absorb the KOH. The contaminated soil and oil dry were removed and placed into drums. The Fire Department hazardous materials team verified that the contaminated area was adequately cleaned up. The area was backfilled with new gravel.

There are no monitoring wells in the vicinity of IHSS 139.1(S) to verify whether the KOH releases had impacted groundwater beneath the Site. The engineering drawings show a foundation drain located along the south wall of Building 771 at a depth of approximately 30 feet bgs. The historical sampling of Building 771 foundation drains showed pH results ranging from 7.1 to 8.3. However, it is believed that these sampling events were not representative of the segment of the drain located along the south wall of the building (DOE 1994). Utility drawings do not show any storm sewers in the vicinity of IHSS 139.1(S).

Surface soil samples were collected and analyzed during the OU 8 RFI/RI. Benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene were detected. Calcium, chromium, silver, Am-241, and Pu-239/240 exceeded background values. These data are available in the IA Data Summary Report (DOE 2000a).

GROUP 700-7

UBC 779 – Main Plutonium Components Production Facility

Information on Building 779 is from the HAER (DOE 1998). Building 779 is the former weapons research and development laboratory. The building mission changed in 1989 to research and non-nuclear production support activities such as liquid carbon dioxide cleaning, waste minimization and characterization, stockpile reliability evaluation program, and surface analyses. In the early years of nuclear weapons production at RFP, most of the research and development functions were handled by the three laboratories associated with the Nuclear Weapons Complex: Los Alamos National Laboratory in New Mexico, Lawrence Livermore Laboratory in northern California, and Sandia National Laboratory in New Mexico and California. Any research done at RFP was incorporated into production engineering for new weapons design. When RFP became the sole producer of Pu triggers (early 1960s), research and development activities and funding increased markedly. Laboratories were established for each of the three manufacturing buildings, specializing in the material of the plant, either Pu (Building 771), enriched U (Building 881), or depleted U (Building 444). Building 779 was built in 1965 to provide additional research and development capabilities to support Pu production and recovery processes.

The specific purpose of this facility was to gain more knowledge of the chemistry and metallurgy of Pu and its interactions with other materials, which might be used in the manufacturing process. Although some of the processes in the building changed over the years, the primary purpose of the activities did not. Most of the materials used in this facility were the same as those in the Pu manufacturing buildings, and much of the work conducted involved improvement of existing processes and understanding of the materials employed.

Research, development, and support operations were divided into five areas of responsibility: process chemistry technology, physical metallurgy, machining and gauging, joining technology, and hydriding (Pu recovery) operations. The Process Chemistry Technology group supported plant production, manufacturing, and assembly operations. The process chemistry laboratories engaged in weapons process development, stockpile reliability testing, testing of various material compatibilities, Pu aging under various environmental conditions, and methods development for recovering, separating, and purifying actinides from waste streams and residues.

The Physical Metallurgy group, which included tensile testing, study of casting dynamics, electron microscopy, x-ray analyses, hardness testing, and dimensional dynamics, conducted research on various metals, alloys, and material required by Plant missions. This group also supported different research groups, design agencies, Plant production, and other metallurgy studies. The Machining and Gauging group, which involved manufacturing of special order parts and test components, had two shops and a laboratory for tool making, maintenance operations, and high-precision machining for special orders and tests. The Joining group, which involved methods such as welding and brazing, developed sophisticated joining techniques for nuclear materials.

Building 779 was also used to find new ways to recover Pu and associated actinides. The Hydriding group was involved in Pu recovery experiments. During Pu processing, significant amounts of Pu would coat on metallic and nonmetallic substrates such as

crucibles, tools, and equipment. The crucibles needed to be reused in certain operations. For many years, the sole method available for recovery of Pu from these substrates was acid dissolution, which in some cases damaged the substrate. The nonaqueous hydriding process was developed to effectively remove and recover Pu without damage to the substrates. In addition to this main advantage, the hydriding process involved relatively few process operations and generated very little waste. These features resulted in fewer material accountability problems and reduced the potential for personnel radiation exposure. It was soon discovered that Pu could also be recovered from nonvaluable or discardable substrates. A decision was made in early 1971 to design a production prototype hydriding apparatus. The apparatus was constructed in Building 779A and went on line in April 1972.

Research in Building 779 also improved the pyrochemical process for Pu purification, one of the main Pu recovery operations. Pyrochemical processing included molten salt extraction and electrorefining processes. Molten salt extraction and electrorefining were used for Pu recovery from site return materials and scraps, while other processes were used for recovery from residues and oxides. As much Pu as possible was recovered from site returns (dated weapons) and manufacturing scraps, because the material was extremely expensive, difficult to obtain, and highly controlled for national security reasons.

Building 779 Cooling Tower Blowdown IHSS 700-138

IHSS 138 is associated with the cooling towers near Building 779. The original Building 779 cooling towers were built in 1964 after construction of Building 779. The original cooling towers were relatively small structures located south of the present Building 779 cooling towers. The original cooling towers were removed when the present cooling towers, Buildings 784, 785, 786, and 787, were constructed in 1986. Building 783 is a pump house associated with the current towers and contains much of the ancillary piping (DOE 1994).

The area surrounding the towers is unpaved and relatively flat. It is heavily congested with trailers and storage containers. The area is marked by an abundance of aboveground and underground utilities and other structures (DOE 1994).

IHSS 138 is defined by two areas. The first area is a 50- by 50-foot area east of Building 779 and north of Building 727. On December 8, 1976, a leak occurred in an underground pipeline connected to the original cooling towers. This encompasses the 50- by 50-foot area. The leak discharged approximately 400 gallons of cooling tower effluent, which was released into a storm sewer east of Building 779 and northwest of Building 727. At the time, it was stated that the spilled effluent drained toward Trench No. 6. Trench No. 6 was part of the original surface water and shallow groundwater collection system north of the SEP (DOE 1994).

Utility personnel at RFETS recalled that this spill occurred when an underground cooling tower water line broke east of Building 779 and adjacent and northwest of Building 727. The ruptured line was excavated and repaired. The cooling tower water line that ruptured in the incident was removed when the original cooling towers were replaced. The cooling tower water was sampled following the incident and found to contain 50 mg/L total chromium and approximately 3,000 dpm/L alpha activity. A FIDLER survey was conducted along the course of the spill. No readings above background were observed. Additionally, soil samples were collected in the area and submitted for analysis. The results of the soil samples

are not known. Samples were also reportedly collected daily from Trench No.6; however, the sample analyses or results are not known (DOE 1994).

The second area is approximately 10 by 20 feet and east of Building 785. On December 8, 1990, an estimated 1,000 gallons of cooling tower water overflowed from the Building 785 Cooling Tower Number 2 onto the ground. The event occurred when the sump filled and water backwashed into the cooling tower and spilled out of the fan on the eastern side of the structure. The spray from the backwash extended no more than 5 to 6 feet east of the building according to Utilities personnel in Building 779. The released water was sampled and was known to contain "Nalco 2826," an inorganic phosphate rust inhibitor. An Occurrence Report prepared after the incident indicated that a sample was collected for analysis, but the type of analyses or results are not known (DOE 1994). There is no documentation to describe cleanup efforts for this spill (DOE 1992a). It is possible that surficial materials in the vicinity in the tower were impacted by such releases (DOE 1994).

IHSS 138 was originally defined as a 75- by 75-foot area northeast of Building 779 (DOE 1994). The area of the cooling tower water line break is of smaller extent and located farther east than what was presented for IHSS 138 in the IAG. It was proposed that IHSS 138 be redefined as a 50- by 50-foot area north of Building 727. It was concluded that the IHSS boundary presented in the IAG was too large and too far west of where the 1976 event occurred. The reidentification of the site in the HRR (DOE 1992a) is considered adequate for the location of the 1976 pipe leak. The effluent spilled toward Trench No. 6, presumably through the storm water drains and channels. At the time, these were monitored for radioactivity and were considered to be uncontaminated. The exact route the spill took is not known at this time and therefore cannot be mapped with accuracy.

A 6-inch, cast iron storm drain runs north from a catchment basin north of Building 782. This storm drain makes a 90-degree turn to the east and flows through the middle of the 50- by 50-foot portion of IHSS 138, to a catchment basin on the east boundary of the IHSS. From this catchment basin, a 15-inch, corrugated metal pipe storm drain flows north approximately 425 feet, where it discharges at an outfall to the hillside north of the SEP. It is believed that this is the outfall that has been sampled since the 1970s as station FD-779-1. However, some discrepancy exists concerning the exact location of sampling station FD-779-1. Approximately 150 feet north of the north boundary of IHSS 138, a foundation drain ties into this 15-inch storm drain. This foundation drain originates along the north wall of Building 779.

Both the subsurface and ground surface were potentially affected by cooling tower water. The subsurface was affected by an underground pipe failure and the surface was impacted by a release from an overflowing sump. Based on sampling conducted following the release and on process knowledge, the cooling tower water may have contained chromium, Nalco 2826, and alpha activity.

The nearest downgradient sampling points are bedrock groundwater monitoring wells 2586, P207589, and P209089, and alluvial monitoring well 2686. Groundwater samples have been collected from well 2586 on a quarterly basis since March 1987. Borehole samples have been collected from wells P207589 and P209089 during drilling, and groundwater samples were collected from these wells on a quarterly basis since 1990.

Several VOCs and radionuclides were detected at concentrations greater than background in groundwater samples from well 2586. VOCs were detected in borehole samples, and metals were detected at concentrations exceeding background in samples of surficial materials collected from well P207589. No VOCs or metals were detected at concentrations exceeding background in groundwater samples from well P207589.

The only VOCs detected in borehole samples from well P209089 were acetone and methylene chloride. Numerous metals and radionuclides were detected at concentrations exceeding their respective upper tolerance limits or background in samples of surficial materials and/or bedrock. Nitrate/nitrite was detected at relatively high concentrations in two samples of bedrock. VOCs were detected in groundwater samples from well P209089. Gross alpha, U-238, bicarbonate, and sulfate were detected at concentrations exceeding background.

Surface soil samples were collected and analyzed during the OU 8 Phase I RFI/RI. Benzo(a)pyrene and pentachlorophenol were detected at levels exceeding background. Antimony, calcium, copper, iron, lithium, magnesium, nickel, silver, sodium, strontium, and zinc exceeded background values. Am-241, Pu-239/240, and U-238 exceeded the background values. These data are available in the IA Data Summary Report (DOE 2000a).

Radioactive Site South of Building 779 IHSS 700-150.6 and Radioactive Site Northeast of Building B779 IHSS 700-150.8

IHSS 150.6 was originally defined as a 100- by 120-foot area east of Building 779. IHSS 150.8 was originally defined as an 80- by 120-foot area east of Building 779. Information obtained during the development of the OU 8 Phase I RFI/RI Work Plan (DOE 1994) indicated that the IHSS boundaries were incorrect. Also, because it was a single incident that led to the two areas being listed as IHSSs, environmental investigations at the two sites were combined (DOE 1994). Investigations for the combined IHSS 150.6/150.8 included the dock area on the eastern side of Building 779 and a 40-foot-wide area extending around the southeast corner of the building, including the south entrance.

On June 22, 1969, a drum containing residual oil contaminated with unspecified radionuclides was cut apart near a dock at Building 779. Contamination, measured at up to 50,000 dpm/100 cm^2 for gross alpha activity, was spread by pedestrian traffic across the first floor, dock, and surrounding outdoor areas south and east of Building 779 (DOE 1992a). The main dock for Building 779 is located along the northern half of the eastern side of the building. Although the exact pathway along which workers walked is unknown, it is known that the building's south entrance was also contaminated. It is unclear whether workers got from the dock to the south entrance of the building by walking inside the building, or outside and around the building (DOE 1994). Because of the uncertainty, investigations for the combined IHSS 150.6/150.8 included the roadway from the cooling towers and dock to the south entrance of the building.

No incident report for this event was found. It is likely that one was not written due to the attention demanded by the May 11, 1969, fire in Buildings 776 and 777 and subsequent cleanup activities. However, one source indicated that following a release in 1969, an unknown numbers of drums of soil were removed for offsite disposal (DOE 1992a). It is not known whether all areas affected by this incident were included in cleanup activities. It is

also not known whether the removal of soil was in response to the incident described above or a separate incident.

A foundation drain was identified along the north wall of the Building 779 addition, which was constructed in 1968. The drawings that were reviewed show that the foundation drain discharges on the hillside north of the SEP. A storm sewer was also identified east of the IHSS. Surface drainage from IHSS 150.6/150.8 collects in a catch basin, which is located in IHSS 138, and is discharged on the hillside north of the SEP. As discussed in OU 8 Technical Memorandum 1, the two outfalls on the hillside were historically sampled. However, it is believed that the outfall that has been sampled as FD-779-1 is actually the outfall for the storm sewer, and the outfall that has been sampled as SW85 (proposed location FD-779-2) is actually the foundation drain outfall. Discharges from these outfalls are probably collected in the french drain and treated in the OU 4 treatment system.

Historical sampling of location FD-779-1 detected slightly elevated concentrations of gross alpha, gross beta, and tritium. However, these results are probably attributable to the SEP and not releases from IHSS 150.6/150.8.

Review of aerial photographs and engineering drawings indicates that the areas affected by IHSSs 150.6 and 150.8 consist of both paved and unpaved areas. The eastern portion of the area outside Building 779 was paved before the 1969 incident. Portions of the IHSS that were unpaved or covered by gravel include the northernmost strip of the IHSS area, the area immediately adjacent to the north side of the building, and the southern portion of the IHSS directly adjacent to the southern side of the building. Some pavement to the south and east of the area was removed in 1979 to improve surface drainage. South 79 Drive, which runs north-south along the eastern side of the building, was repaved in 1984.

Sampling locations downgradient of IHSS 150.6/150.8 include monitoring wells 2586, P207589, and 2686. VOCs were detected in well 2586. However, VOCs were also detected in downgradient well 2586. No VOCs or metals were detected at concentrations exceeding background in samples collected from well P207589 (DOE 1994).

Surface soil samples were collected at IHSS 150.6 and analyzed as part of the OU 8 Phase I RFI/RI. Results indicated that silver, Am-241, and Pu-239/240 were above background. Surface soil samples collected at IHSS 150.8 were analyzed during the OU 8 Phase I RFI/RI. Silver, calcium, cadmium, lead, magnesium, sodium, zinc, Am-241, Pu-139/240, and U-238 exceeded background values. These data are available in the IA Data Summary Report (DOE 2000a).

Transformer Leak - 779-1/779-2 PAC 700-1105

Transformers 779-1 and 779-2 are located on the northeast side of Building 779. According to an interview with Utilities personnel, these transformers have leaked PCB-containing oil prior to 1987. In June 1986, Plant Power Engineering reported that Transformers 779-1 and 779-2 were PCB-contaminated and leaking. Oil with PCBs was released from the transformers.

In 1987, the transformers were retrofitted and then moved several feet east and north.

Tank 19 - OPWL - Two 1,000-Gallon Concrete Sumps IHSS 000-121
Existing data for this site have not been located.

Tank 20 - OPWL - Two 8,000-Gallon Concrete Sumps IHSS 000-121
Existing data for this site have not been located.

Tank 38 - OPWL - 1,000-Gallon Steel Tanks IHSS 000-121
Existing data for this site have not been located.

GROUP 700-8

750 Pad-Pondcrete/Saltcrete Storage IHSS 700-214
IHSS 214, 750 Pad Pondcrete and Saltcrete Storage, is an interim storage facility used to store low-level mixed waste resulting from the solidification of SEP sludge and sediment with Portland cement.

Unit 25, 750 Pad Pondcrete and Saltcrete Storage (IHSS 214), was initially constructed as a parking lot for Building 750 in 1969. Of the original 220,000 ft^2 surface, 104,000 ft^2 are used for storage.

The 750 Pad is used for the storage of pondcrete, a low-level mixed waste resulting from the solidification of SEP sludge or sediment with Portland cement. The material is placed in polyethylene-lined, 3/4-inch plywood boxes measuring 4 feet by 2.5 feet by 7 feet. Boxes are stacked three high on the pad. Metal boxes measuring 4 feet by 4 feet by 7 feet are also used. Saltcrete, a material similar in nature to pondcrete resulting from evaporation of liquid process waste, is treated and stored in the same fashion as pondcrete on the pad. Pondcrete and saltcrete are stored within the berm area of the 750 Pad.

The maximum waste storage inventory of the 750 Pad is 12,168 boxes of waste, accounting for approximately 183,000 ft^3 of waste (9,000 tons, assuming a density of 100 pounds/ft^3). The inventory, as of September 30 1989, consisted of 8,881 wooden boxes of pondcrete, 157 metal boxes of pondcrete, and 855 wooden boxes of saltcrete.

The 750 Pad was constructed with a 6-inch-thick aggregate overlain by a 2-inch-thick asphaltic concrete. The asphalt pad at IHSS 214 is located approximately at grade, sloped 2 percent to the east. In 1986, prior to the storage of waste, 142,000 ft^2 of the 750 Pad was overlaid with Petromat and 3 inches of asphalt. Eight-inch-high asphalt berms were constructed along the east and portions of the north and south sides. Waste storage began on November 18, 1986. Production of pondcrete ceased on May 23, 1988, in response to spills on the 904 Pad. A detailed inspection of waste stored on the 750 Pad identified approximately 5 percent (440) of pondcrete boxes were of poor quality (i.e., containing unhardened pondcrete). Severely deformed boxes of waste were transferred to metal boxes or to Building 788 to await reprocessing. Storage of pondcrete resumed in November 1986 and continues to the present.

From November 18, 1986, to September 1, 1989, two spills of pondcrete occurred. The spills, totaling approximately 0.5 ft^3, were released to the asphalt pad. Both spills consisted of unhardened SEP sludge and cement. Following each incident, the entire contents of the

failed container and spilled pondcrete were transferred to metal boxes. The spill locations were then cleaned using water and brooms to scrub the 750 Pad surface. The brooms were used to remove pondcrete from the crevices in the asphalt. Water was collected using wet vacuums. Cleaning continued until radiation levels were below detection limits for the instruments being used.

Routine inspections of the 750 Pad on November 1, 1988, and April 7, 1989, identified deformed and leaking boxes of saltcrete. All saltcrete spills have consisted of a fine, dry powder. From November 1, 1988, through July 25, 1989, a total of 64 leaking boxes were identified that had released approximately 113 pounds of saltcrete to the 750 Pad. The spill locations were cleaned by vacuuming until radiation levels were below detection limits of the instruments being used. Analytical results from samplers S-2 and S-17 located upwind from the 750 Pad identified no total long-lived alpha activity above Plant standards. No soil monitoring has been conducted at the 750 Pad to confirm whether precipitation migrated contaminants to the soil. Berms, 8 inches in height, existed on the south, north, and east sides of the pad, so surface runoff would have been minimized. The quantity of saltcrete that was retrieved is unknown.

A site visit in May 1990 observed wet, severely deformed cardboard boxes being transported into storage tents. Torn boxes with exposed plastic inner liners were also observed. There is a high probability that leakage of material will continue until all materials are removed.

Portable air monitors were moved to the 750 Pad shortly after the spill incidents. Based on these air monitors, there were no releases that exceeded the RFP Screening Guide for Pu (0.01 picocurie per cubic meter [pCi/m^3]).

Runoff from the 750 Pad is collected in seven storm water inlets between 10th Street and the 750 Pad. All runoff water storage behind the 8-inch berm occurs in the immediate vicinity of the storm water inlets. Calculated storage potential behind the berm is approximately 500 ft^3. Any precipitation event that exceeds approximately 0.03 inches will cause overlapping of the berms. The storm water inlets are directly piped to a culvert that drains to South Walnut Creek.

Radionuclide analysis of soil samples collected in the area indicate the presence of gross alpha and gross beta. Analysis of surface water samples collected in the area of IHSS 214 indicate the presence of gross alpha, gross beta, nitrate, cyanide, and cadmium.

Analysis of groundwater samples collected from upgradient well P207489 indicates detections of metals and other inorganics including calcium, magnesium, manganese, and sulfate. Radionuclides detected include Am-241, tritium, U-233, U-235, and U-236. No downgradient analytical data are available.

GROUP 700-10

Laundry Tank Overflow - Building 732 PAC 700-1101

A laundry waste water tank west of Building 778 (Building 732) overflowed into the tank pit due to malfunctioning pumps. Laundry waste water was released to the environment.

Because of the nature of building activities, it is probable that this material was a low-level waste.

GROUP 700-11

Bowman's Pond PAC 700-1108

Footing drain flows from Building 771 and Building 774 daylight in the general location of a small pond north of Building 774. Footing drains north of Building 774 carry liquid from the drain tiles around the foundation of that building. The Building 774 footing drain previously discharged to the north of Building 774 toward Walnut Creek.

Six underground process waste storage tanks, in use since the 1950s, were removed from south of Building 774 in 1972 (IHSS 700-146). Physical failure of process waste storage tanks has been one of the major contributors of chemical and radioactive contamination to the soil around Building 774. It is suspected that some minor leakage from these tanks has seeped to the building footing drain tiles.

On July 21, 1980, an 8-year-old process waste line was discovered leaking southeast of Building 774. Process waste water was observed seeping up in the soil on the south side of the road southeast of Building 774. The leaking process waste water flowed down slope and through a 30-foot culvert, along the east chain-link fence, and under the fence at the corner. From this point, the liquid flowed under the unpaved access road into a boggy area north of Building 774. The vegetation in the boggy area was damaged where the spilled liquid formed a pool. It was estimated that approximately 1,000 gallons had leaked from the process waste line.

There are two steel 8,000-gallon aboveground condensate receiving tanks located adjacent to and southeast of the Building 771/774 footing drain outfall. The two tanks are located on a concrete slab and have badly corroded bottoms. The tanks held “clean” condensate from an evaporative waste concentration system formerly used in Building 774. The condensate was tested for the absence of radioactive contamination and then released into a swampy area below the tanks. The tanks have been out of service as condensate receiving tanks since approximately 1980. The western condensate tank receives overflow and precipitation runoff from the bermed area surrounding the NaOH tank (PAC 700-139.1[N]). The bermed area directs flow through a pipe and into the western condensate receiving tank. On June 22, 1987, and again around 1988, the NaOH tank north of Building 774 was overfilled. In the June 1987 incident, approximately 100 gallons of the liquid caustic soda overflowed. The caustic that spilled inside the bermed area beneath the tank drained to the caustic catch tank (western condensate receiving tank).

A storm drain from the area on the south side of Buildings 771 and 774 daylights in the same general area as the footing drains. Any releases to the soil surface in the area serviced by the storm drain (such as transformer spills) could be found in the area of this PAC.

A March 1971 report states that water coming from the footing drains contained up to 500 dpm/L gross alpha activity. Water samples collected from the Building 774 footing drain in April 1971 contained 400 dpm/L Pu and 800 ppm nitrate.

Analysis of the spilled water from the July 1980 incident showed 2,500 pCi/L total alpha activity, 4,000 pCi/L gross beta activity, 10,000 mg/L nitrate, and a pH of 12.

The western condensate receiving tank contained NaOH from the June 1987 overflow incident in which the caustic drained from the bermed area.

Flow at the sump installed near the Building 771/774 footing drain outfall was estimated in September 1990. Measurements indicated the flow from this area was on the order of 1.2 to 1.3 gpm. Between March 1988 and June 1990, water samples collected from the 771/774 footing drain pond were analyzed and found to fall within the following ranges for the indicated analytes: 5.7 to 23.8 mg/L nitrate/nitrite, 76.7 to 105.4 mg/L nitrate, 0 to 83 pCi/L gross alpha activity, 7 to 46 pCi/L gross beta activity, 0.01 to 0.24 pCi/L Pu, 0.0 to 0.23 pCi/L Am, and 7.0 to 8.45 pH.

During the summer of 1991, PCBs were identified in the vicinity of this PAC. It is believed that these PCBs originated from PAC 700-1112.

In approximately 1975, a control structure was installed at the Building 771/774 footing drain outfall pond that consisted of a wet-well with a submersible pump. The pump would remove water from the area of the pond and pump it to SEP 207C. This wet-well was connected to the SEP ITPH system when the ITPH system was installed in 1981 (see PAC 000-101). Water from this wet-well sump now flows by gravity to the ITPH where it is pumped to SEP 207B-North.

The initial response to the July 1980 incident was to stop the flow through the waste line causing the leak to stop. When the soil dried, a FIDLER survey was conducted to determine the extent of resulting contamination. On July 24, 1980, the broken waste line was excavated and the problem identified as a loose flange.

In April 1999, an extensive characterization study was conducted at PAC 700-1108 and the adjacent steam condensate tanks (IHSS 700-139.1[N]). The purpose of the investigation was to characterize the potential nature and extent of contamination in surface soil, subsurface soil, sediment, and surface water for the pond and surrounding depositional environments adjacent to the pond. It was determined that characterization efforts were appropriate based upon the relatively high ranking priority established for the area under the RFCA (DOE 1996a) Environmental Restoration (ER) ranking process. In September 1998, PAC 700-1108 was ranked 28 due largely to the overall history of spills or releases in the area and the intended use of the pond as a capture point for footing drain and storm runoff water.

Surface soil, subsurface soil, sediment, and surface water samples were collected from PAC 700-1108 and IHSS 139.1(N) in April 1999 to characterize the potentially contaminated media and provide the basis for future remedial decisions or a no further action (NFA) determination. Prior to the initiation of fieldwork, an extensive review of all available historical data was performed and the areas and PCOCs were established. The field investigation was then conducted in accordance with an agency-approved SAP, Health and Safety Plan (HASP), and approved Site procedures. All analytical data collected underwent the appropriate verification and validation process, and were evaluated with respect to the RCFA ALs (DOE 1996a). ALs in the Action Levels and Standards Framework for Surface

Water, Ground Water, and Soils (ALF) version dated May 17, 1999, and submitted for public review and comment on July 28, 1999, were used as appropriate.

In summary, there were no compounds identified from the investigation that exceeded (or approached) RFCA Tier I ALs.

Hydroxide Tank, KOH, NaOH Condensate IHSS 700-139.1(N) (a)
IHSS 139.1(N) consists of two separate sites located north of Building 774. One of these sites consists of an aboveground NaOH tank and is adjacent to the north wall of Building 774. The other site is located approximately 80 feet north of NaOH tank and consists of two large aboveground steam condensate tanks (DOE 1994).

The first site is an area approximately 20 by 20 feet around a vertical 6,500-gallon NaOH tank. The tank was built between 1955 and 1964. The tank is covered by insulation, which is in a degraded condition based on visual observations. Through holes in the insulation, it was observed that sides of the tank are corroded, as is the base of the tank. A concrete berm approximately 18 inches high surrounds the tank and appears to be corroded (DOE 1994).

The second site consists of two 8,000-gallon steam condensate tanks (Tanks T-107 and T-108) that have riveted construction. They are located approximately 80 feet north of the NaOH tank and at a lower elevation. These tanks were built between 1971 and 1978. The two tanks are located on a concrete slab and have badly corroded bottoms (DOE 1994). Originally, the tanks held “clean” condensate from an evaporative waste concentration system formerly used in Building 774. The condensate was tested for the presence of radioactive contamination and then released (if free of contamination) to the tanks or west of the tanks depending on the valve positions (DOE 1992a). The area west of the tanks has standing water present and is known as Bowman’s Pond or the 774 footing drain pond. The tanks have not received condensate since approximately 1980. Since that time the western condensate tank receives overflow and precipitation runoff from the bermed area surrounding the NaOH tank. The bermed area directs flow through a pipe and into the western condensate tank. The eastern condensate tank receives overflow from the western tank. Standing water has been noted around the tanks (DOE 1994).

In May 1978, a spill occurred during routine filling of a caustic tank near Building 771. The specific tank or the quantity spilled was not documented. The spilled caustic was contained by a berm below the tank and was not released to the environment. The HRR (DOE 1992a) states that this occurrence is believed to have involved the KOH tank south of Building 771 (IHSS 139.1[S]).

In May 1985, a small leak was found at the fitting of a thermocouple in the NaOH tank. The caustics had solidified at the fitting, and therefore had not run into the pit. The fitting was repaired (DOE 1994).

On June 22, 1987, there was an overflow of NaOH during a delivery operation to the caustic supply tank north of Building 774 because of a faulty level indicator. Approximately 100 gallons of caustic material flowed into the berm containment area of the tank and then drained to the caustic “catch” tank (T-108). Due to cracks in and deterioration of the concrete berm, caustic seeped onto the road. Tank T-108 was also found to be deteriorating,

and showed signs of seepage. In response to the incident, the 1 to 20 gallons that had seeped onto the road were diluted with water and rinsed off the road. Work orders to repair the cracks in the berm and replace the deteriorating catch tank, T-108, were initiated. The liquid in T-108 was sampled and was to be subsequently pumped to the sanitary sewer system or Building 774. The level indicator on the caustic tank was repaired (DOE 1994).

Around 1988, the NaOH tank north of Building 774 was overfilled. No documentation was found that further detailed the event (DOE 1992a).

It is estimated that during the 30-year history of the NaOH tank, 80 to 100 gallons of caustics were spilled (DOE 1994).

It is likely that the area around the condensate receiving tanks is contaminated. The foundation drains for Building 774, and possibly Building 771, have discharged to that location since the early 1950s. Included in the OU 8 Technical Memorandum 1 appendices are memos that address sampling the water in the pond and the fate of the water depending on the activity levels. Based on the memos, the water in the pond historically contained significant activity levels. In addition, IHSS 149.1 (OU 9) is associated with a release of approximately 1,400 gallons of process waste from the SEP that flowed into the area around the tanks and the pond. The vegetation in the area was damaged. Analysis of the spilled liquid from this incident detected 2,500 pCi/L alpha, 4,000 pCi/L beta, 10,000 µg/L nitrate, and a pH of 12.

NaOH has potentially affected the ground surface due to a number of spills and probably seepage from the NaOH tank and deteriorating condensate tanks.

An unspecified-diameter corrugated metal pipe storm drain runs from an outfall in the northwest portion of IHSS 139.1(N) west to an outfall near Bowman's Pond. A 6-inch corrugated metal pipe storm drain runs north from near the northwest corner of the IHSS and outfalls to the surface at surface water sampling station SW-91. Additionally, a section of the OU 4 drain (OU 4 ITS) originates near Bowman's Pond and runs west to east through the middle of IHSS 139.1(N). It is reported that water from the pond is collected in the OU 4 ITS where it is then treated. This does not appear to be the case. Based on observations made during site visits, it appears that much of the water from the area flows overland into North Walnut Creek, with minimal or no inflow to the Interceptor Trench.

On September 27, 1994, the Surface Water program collected samples for the D&D Group because they were to remove the steam condensate and NaOH tanks at IHSS 139.1(N). Three surface water samples were collected and analyzed for gross alpha, gross beta (i.e., radiological screen), pH, and total PCBs in support of the removal action. No PCBs were detected in any of the samples.

Surface soil samples collected as part of the OU 8 Phase I RFI/RI were analyzed for metals. Results of these analyses indicated that silver, sodium, and zinc exceeded background values. Sediment samples were collected because the condensate receiving area was underwater. Arsenic, barium, calcium, chromium, lead, magnesium, mercury, silver, sodium, strontium,

and zinc exceeded background values. These data are available in the IA Data Summary Report (DOE 2000a).

GROUP 700-12

Process Waste Spill - Portal 1 PAC 700-1106

Approximately 10 gallons of process waste water spilled from a tank truck at the entrance to Portal 1. The truck was enroute from the Valve Vault 12 leak area to SEP 207 A. The tank was overfilled and the liquid splashed out of the top manhole while the truck was driven around a corner. Process waste water from the Valve Vault 12 leak was released onto the street. Analysis of water samples collected from Valve Vault 12 and a related process waste line leak indicated total alpha was 170,000 pCi/L and U-238 was 120,000 pCi/L. It was determined at the time of the spill that there was no radioactivity on the street.

GROUP 800-1

UBC 865 - Materials Process Building

Information on Building 865 is from the HAER (DOE 1998). Building 865, built in 1970, was part of the Plant research and development program. The building housed metalworking equipment for the study of non-Pu metals and the development of alloys and prototype hardware. The building serviced not only Plant requests, but also handled developmental work for other DOE facilities such as Los Alamos Laboratory in New Mexico and Lawrence Livermore National Laboratory in California. Alloys and prototype hardware developed at the request of the Plant were used to evaluate new or proposed Plant processes. Alloys and prototype hardware developed for other DOE facilities were used to aid in the development of new process or weapon designs for the DOE Complex.

The building is used for fabricating prototype hardware and developing metal alloys and processes. Operations include metalworking, machining, and metallurgical laboratory operations.

The most common metals processed were depleted U, steel, and aluminum. Other metals worked in the building included copper, molybdenum, beryllium, titanium, silver, niobium, tantalum, gold, iridium, platinum, vanadium, and tungsten, and alloys of these metals.

All metalworking operations were conducted in the high-bay area. Metalworking processes included arc and vacuum induction melting, hammer forging, press forming, hydrospinning, swaging, extruding, drawing, rolling, diffusion bonding, furnace heat treating, salt bath and glovebox operations, and cutting and shearing.

Metals were melted using one of two methods: arc melting and vacuum furnace melting. In arc melting, the furnace is evacuated of air. With the power turned on, an arc is struck between the electrode and a starting block placed in the mold. Heat from the arc progressively melts the end of the electrode; the molten metal is transferred across the arc and deposited on top of an ingot situated in the mold. Materials melted with this process included stainless steel alloys, depleted U, depleted U alloys, and beryllium. In vacuum melting, an electrical current is induced into the metal by an induction coil connected to a power supply. The metal charge acts as a secondary circuit for the current. The melted

metal (including beryllium, depleted U, copper, aluminum, lead, and steel) is then cast into molds.

There were several processes used to create forms or shapes for parts. Hammer forging was used to force heated metal to conform to the shape of a metal die by hammer blows. The press forming process pressed hot or cold beryllium, U, steel, and other ferrous and nonferrous metals into the desired shape. Hydrospinning formed hot or cold metals into desired shapes using rollers while the metal was rotated at a high speed. Swaging subjected stock (bar or tube) to a series of blows from two or four dies that rotated around the stock so that the piece was hammered from all sides.

Other methods were used to produce specific types of shapes. Extrusion was used to produce cylindrical bars, hollow tubes, and shapes with irregular cross-sections by forcing preheated metal through a die orifice under high pressure. Drawing was used to change the cross-section of metal wire, rods, or tubing by pulling the metal through a die. The rolling process, used to reduce cross-section, shaped metals by passing them between two rollers revolving at the same speed in opposite directions.

Metal parts were joined in a bonding process where thin layers of bonding material were plated on the surfaces of materials being joined. Pressure was applied to the joined surfaces (under an inert atmosphere or a vacuum) to create the bond.

Formed metal parts were furnace heat-treated in an argon or air atmosphere, or under a vacuum using electric resistance-type furnaces. Salt baths were used to heat metal pieces to a high temperature in preparation for forging, rolling, or some other type of working.

Operations involving beryllium powder were conducted inside gloveboxes. High-purity beryllium was produced, and canned (sealed in a can) in gloveboxes. Beryllium chips from lathe operations were processed in two types of mills (ball mill and fluid energy mill) to form a powder. The powder was then sealed into stainless steel containers in preparation for further processing.

A large abrasive wheel was used to reduce large billets and bar stock to a useable size for further fabrication. Sheet metal was cut to the desired shape and size using a shear press.

Machining operations included milling, grinding, drilling, and cutting operations. The machine shop was equipped with standard equipment including surface grinders, drill presses, and saws. Other equipment in the machine shop was specialized; lathes and milling machines in the shop were equipped with tracers.

A metallurgy laboratory, located in the northeastern corner of the building, conducted mechanical testing of metals and prepared metal samples for examination. Mechanical tests determined the tensile properties of the metals at room, elevated, and very low temperatures. Other tests measured hardness of the metals and alloys using various methods (Brinell, Rockwell, Knoop, and diamond pyramid). These test methods used the depth of indentation of a steel ball, or a diamond pyramid under pressure, to measure hardness.

Samples were prepared for macroscopic and microscopic examination by sawing, cutting, mounting, grinding, polishing, and etching operations. After preparation, the samples were visually examined at various magnifications and optical conditions to identify structural details, including the crystalline structure of alloys.

The final use of the building was to conduct metallography laboratory work and decontamination activities for the product research and development group.

Building 866 Spills PAC 800-1204

Building 886 holds five process waste tanks that service Building 865 and Building 889. The following contaminant releases originating from the filling of the tanks were documented:

- January 1978 - Vent Pipe Overflow. A faulty vacuum breaker for a process waste line vent pipe between Building 864 and Building 881 allowed liquid to be released to the environment. Apparently, gravel caused the vent line to stick open and approximately 2 gallons spilled onto the ground. Approximately 16 ft^2 were affected near the 865 Guard Post.

- In 1978, laboratory analysis of the released liquid indicated 410,000 dpm/L alpha activity. It consisted of predominately depleted U activity. FIDLER surveys did not indicate activities above background levels. Samples of the released liquid were collected and radiation surveys were conducted. A portable air sampler was utilized. The day following the incident 3 inches of moist gravel were removed.

- 1984 - Tank Overflow. A valve was left open while pumping decontamination water to a fill tank in Building 889. When the tank overfilled, the water drained to the sump pump and was then pumped to the process waste tanks in Building 865. These tanks also overflowed through the vent to the roof where they drained to the ground via the downspouts. A similar incident occurred in 1983, but apparently the water drained into Building 886 instead of on the ground. Water samples collected from the north and south ditches measured 2.2×10^3 µg/L for total U and maximum activities of 7.9×10^2 pCi/L and 5.8×10^2 pCi/L for total beta activity and tritium, respectively. The drainage ditch west of Building 866 was dammed with gravel to contain the released liquid. Mention is made of decontamination of the interior of Building 866 and Building 889, but radiation monitoring indicated no contamination. Surface gravel from the area of the overflow was reportedly removed and shipped as waste. Forty to 45 gallons of liquid were vacuumed and taken to Buildings 889 waste drains.

- 1986 - Tank Overflow. The filling of the process waste tanks in Building 866 resulted in an overflow of process waste through the roof vent and out the downspout, releasing approximately 20 gallons to the ground. No contamination was found on the ground or in the building. Liquid level alarms were installed for each tank.

Building 866 Sump Spill PAC 800-1212

During a walkthrough of Building 866 on April 8, 1992, a plant engineer identified a lack of epoxy coating on the concrete sump pit within the secondary containment system for the waste collection tanks (RCRA Unit Nos. 40.17, 40.18, 40.19, 40.32, and 40.33). Upon further investigation, it was determined that the pit also contained approximately 6 inches of

liquid and sludge, which had possibly accumulated over several years. The RCRA Contingency Plan was implemented because the waste liquid was not removed from secondary containment within 24 hours due to operating limits of the sump pump. After removal and sampling of the liquid and sludge, which showed gross alpha and beryllium contamination, it was concluded that the liquid originated from the waste tanks in the building. Approximately 35 gallons of liquid waste and sludge were retrieved from the pit. After visual inspection of the sump, Civil Engineering and Environmental Design Engineering noted that it appeared groundwater was seeping into the sump along the northwest wall and seepage was especially evident in the northwest corner. It was concluded that the sump had a visible pathway for waste to enter the environment. Based on noted groundwater seepage into the sump, the possibility also exists that the material in the sump may be remnant contamination from past spills documented in PAC 800-1204.

The analytical results for the liquid indicated that it contained beryllium (4 to 5 ppm) and radioactive contamination (800 pCi/L gross alpha and 500 pCi/L gross beta). Additional laboratory analyses also indicated a residue of lubricating oil. As a result of the general consensus that the waste had originated from the waste tanks, the waste was characterized as containing all of the hazardous constituents the tanks were approved to store including EPA codes D001, D004, D005, D006, D007, D008, D011, and F003.

Responses to the occurrence included the following:

- The generating processes in Buildings 865 and 889 were shut down.
- The tanks in Building 866 were emptied with the exception of a very small amount of steam condensate.
- The sump in Building 866 was emptied, the sludge removed, and the sump cleaned.
- The liquid pumped from the sump was transferred to a polyliner, and Liquid Waste Operations, Building 374, picked up the liquid waste. The sludge was transferred on May 25, 1992, into poly bottles which were placed into a rigid liner and then into a 55-gallon drum. The sludge was placed into two drums and transferred to the 90-day accumulation area in Building 865. The sludge was to be treated in the bottle box in Building 774.

As of October 28, 1993, Building 889 operations had ceased, and Building 865 was undergoing transition, generating excess chemical waste. Secondary containment for the tanks in Building 866 were provided for by adequate epoxy sealing of the 2-foot curb surrounding the tanks as well as the floor and walls of the building. The sump was sealed off from the activities of the building with a steel plate that has a glass window in place to monitor water levels in the sump pit.

Tank 23 - OPWL IHSS 000-121

Existing data for this site have not been located.

GROUP 800-2

UBC 881 - Laboratory and Office

Information on Building 881 is from the HAER (DOE 1998). Initially known as Plant B, Building 881 was one of the four original manufacturing buildings that composed the Plant in the early 1950s and was the fourth building to come on-line. Beginning in 1953, this structure housed the Plant's only enriched U component manufacturing and recovery operations. The original purpose of Building 881 was the processing and machining of enriched U (oralloy) into finished weapons components. The oralloy process included chemical recovery operations and foundry equipment. A large part of the early work at the Plant took place in this building, because the triggers required a large amount of enriched U.

Enriched U recovery processes used at the Plant were based upon those developed at the Los Alamos Scientific Laboratory and Oak Ridge Reservation during and after World War II. The processes were refined at the Oak Ridge Reservation Y-12 Plant in the several years preceding the construction of RFP.

Plant personnel contributed many unique improvements to enriched U recovery processes. Improvements were made to the continuous dissolution processes of the following materials: sand and slag from foundry operations, and skull oxide (material recovered from foundry crucibles). Improvements were made in the other continuous processes for: (1) peroxide precipitation, (2) calcination of U peroxide, and (3) leaching of powdered solids. Site personnel developed improved processes for graphite incineration, and oralloy parts decontamination, and achieved a 15-kilogram (kg) scale reduction of U tetrafluoride to metal.

Equipment improvements included safe-dimension troughs for continuous leaching or dissolution, safe-dimension rotary drum vacuum filters, and a continuous rotary calciner. Pyrex glass Raschig rings were used extensively as the primary criticality control of large process vessels.

In 1964, enriched U operations in the building began to be phased out with the advent of the AEC's single mission policy for each facility within the nuclear weapons complex. This policy was instituted to eliminate redundancy of activities within the complex. Production of oralloy components ceased at the Plant in 1964, when the Y-12 Plant at the Oak Ridge Reservation assumed sole responsibility.

Associated with this single mission policy was the transfer of stainless steel manufacturing from the American Car and Foundry Company of Albuquerque, New Mexico, to the Plant, Building 881. Stainless steel manufacturing, referred to as the J-line, began in 1966. These operations occupied the space that enriched U processes formerly occupied. Fabrication and testing of stainless steel parts was conducted in Building 881 until 1984, when Building 460 was constructed. Building 881 operations can be divided into three categories representing three distinct periods: (1) enriched U manufacturing and recovery and special projects (1952-1966); (2) stainless steel operations (1966-1984); and (3) recent activities (post-1984).

Enriched U component manufacturing and recovery processes were housed in Building 881 from 1952 until 1964. Manufacturing and recovery operations were phased out at the Plant between 1964 and 1966. Limited enriched U recovery operations for site returns (weapons returned to the Plant for upgrade, reprocessing, or retirement) continued at the Plant until the

mid-1970s. After 1966, prefabricated enriched U components were shipped to the Plant from other DOE facilities to be incorporated into the final trigger assembly.

Enriched U component manufacturing included a foundry for casting shapes and ingots and machining and inspection of enriched U components. Initially, hockey puck-sized buttons of pure enriched U were received at the Plant from the Oak Ridge Reservation in Tennessee. These buttons went directly to the machining operations to be shaped. A few months after Building 881 became operational, enriched U buttons were produced for the foundry when recovery operations in the building were brought on-line.

The original foundry processes cast enriched U into spherical shapes that were sent directly to machining operations. When the hollow core weapon design replaced the first trigger design, enriched U was cast into ingots from which components were fabricated (rolled, formed, and machined).

Casting operations began with two furnaces and as production increased, four additional furnaces were added. In the casting process, U metal was placed in a crucible, heated in bottom-pouring induction furnaces, and then poured into graphite molds to form spherical shapes (1952-1957) or slabs and ingots (1957-1964). Crucibles in the casting process were originally made of magnesium oxide and, after 1958, they were made of graphite.

Between 1952 and 1957, cast spherical shapes went directly for final machining. Milling machines and lathes were used to form the final shape of the first trigger design. The new hollow core trigger design was more complex and required additional manufacturing steps. Enriched U was cast into slabs or ingots in Building 881, and was sent to Side B of Building 883 for rolling and forming, then returned to Building 881 for final machining. By 1957, computer tape-controlled turning machines used in the final machining process provided additional precision needed for hollow component designs.

Completed parts were sent for inspection and testing in the northeastern corner of the building and in Building 883. Nondestructive testing used radiography to detect internal flaws in fabricated parts. Fabricated enriched U components were sent to Buildings 991, 777, or 707 (depending on the time frame) for final trigger assembly.

Enriched U recovery operations, conducted in Building 881 from 1952 through 1964, were initiated shortly after fabrication operations began. Several different recovery operations were used, depending on the type of initial material. Enriched U recovery processed relatively pure materials and solutions and solid residues with relatively low U content.

U recovery involved both slow and fast processes. The slow process involved placing relatively impure materials with low concentrations of U into HNO_3 for leaching and solvent extraction. Impure materials such as slag, sand, crucibles from foundry operations, and residues from the incinerator were reduced via the slow process. The materials were crushed into pea-sized feed in a rod mill and placed in dissolving tanks containing HNO_3. Solutions from the dissolution filters were concentrated in tall (three-story-high) solvent extraction columns that originated in a pit in the basement. The solution was then pumped into various evaporators for further processing.

The fast process handled materials that were relatively pure, including uranyl nitrate, and used conversion and reduction steps to produce a pure U button (conversion steps changed the physical or chemical nature of the compound; reduction steps changed the compound from a higher to a lower oxidation state). Materials such as chips from machining operations, and black skull oxide from the foundry operations, contained fairly high percentages of enriched U that were easy to convert into pure U buttons. Chips and skull oxides were burned to form U oxide and then transferred for dissolution in small batches of concentrated HNO_3. The dissolution room housed three rows of controlled hoods known as B-boxes (similar to lab hoods). These boxes operated with high air velocities at their openings to ensure the vapors were contained within the hood.

The dissolution process yielded a uranyl nitrate solution from which a U peroxide was precipitated. Once filtered, the precipitate formed a yellow, cake-like substance that was heated (calcined) to produce an orange U oxide. The dissolution, precipitation, and calcination processes were originally performed as batch processes. By the late 1950s to early 1960s, the processes became one continuous operation. The orange oxides were converted to U tetrafluoride, a green salt. The conversion was conducted by placing the orange oxides into monel (copper-nickel alloy) containers, heating to reduce the compound, and adding anhydrous hydrogen fluoride. The green salts were transferred to a sealed metal reactor for final reduction to U metal.

Other recovery operations included incineration of combustible residues, reprocessing enriched U from site returns (weapons returned to the Plant for upgrade, reprocessing, or retirement), briquetting of relatively pure enriched U scraps, and recovery of enriched U fines from oil coolant systems.

U-contaminated combustible materials such as wipes, cheesecloth used to clean up minor drips, wood, cardboard, and air filters were incinerated. White ash generated by the incinerator was sent to the slow recovery process side to recover enriched U.

Beginning after 1960 and continuing until 1977, Building 881 housed the chemical recovery operations for site returns and rejected enriched U weapon components. The first step was to remove surface Pu contamination by bathing the returned parts in HNO_3. The used acid solution was collected, concentrated by evaporation, calcined to a dry oxide, and sent to Building 771 for recovery of Pu. The cleaned parts were crushed in a press, processed, and used as feed material for the foundry.

The briquetting process was used to recover scraps of relatively pure enriched U from machining operations. The scraps were cleaned in a solvent bath, then pressed into small briquettes to be used as foundry feed material.

Accumulated U fines were cleaned out of the machining operations' oil coolant system on a semiannual basis. After the coolant lines were drained, accumulated fines were flushed from the system using an acid solution. The acid/U fine solution was sent through the slow process for recovery of the U. U trapped on the oil coolant filters was recovered by incineration.

A number of special projects ranging from ongoing research and development to one-time operations were conducted in Building 881 between 1953 and 1966. These projects included tracer components (processing of neptunium, curium, and cerium), U-233 processing, lithium fabrication, recovery of fuel rods, distillation, and cadmium plating of U parts.

Stainless steel work at the Plant consisted primarily of fabrication of the reservoirs, tubes, and fasteners associated with the trigger delivery system, and the sealing of beryllium ingots into stainless steel containers as part of the beryllium wrought process. Stainless steel work was transferred from Building 881 to Building 460 between 1983 and 1985.

Feed material for stainless steel operations was received at the Plant as bar stock purchased from an offsite vendor. Stainless steel casting, forging, or recovery operations were not conducted on a production scale at the Plant.

Production operations included machining, cleaning, assembling, inspection and testing, and support. Depending on technical requirements, methods, and/or equipment needed, the sequence of operations was altered to meet specific project needs.

Conventional tools, such as lathes, mills, borers, and presses, were used in stainless steel machining operations. After machining, fabricated parts were cleaned using solvents, acids, and aqueous detergents. Equipment associated with the cleaning process included two vapor degreasers, and an ultrasonic cleaning unit. After machining and cleaning, the parts were inspected and tested.

Inspection and testing operations included dimensional inspection (precise measurements), nondestructive testing, and destructive testing of representative samples. As part of non-destructive testing, parts were visually inspected for flaws and x-rayed to identify internal structural flaws.

Assembly operations were conducted in Building 881, although final assembly of some components was conducted in Building 707. Assembly operations included matching, brazing, and welding. The parts were physically matched together, then assembled and joined by brazing or welding (tungsten-inert gas, electron-beam, or resistance). Welding machines were maintained in vacuum chambers. Other assembly operations consisted of clinching pressure fittings, tube bending, wire winding, solid film applications, fixture assembly, vacuum bakeout, resin molding, and adhesive assembly.

Stainless steel operations in Building 881 were incorporated into the beryllium wrought process in October 1967. Beryllium ingots (cast in Building 444) were transferred to Building 881 to be enclosed in stainless steel. This was done to aid in subsequent beryllium rolling and forming processes that occurred in Building 883.

After stainless steel manufacturing was moved out of Building 881, the building became a multipurpose facility for research and development, computer support, analytical support, and administrative functions. Building 881 housed the Plant's central computing facilities and general chemistry laboratory. The laboratory provided general analytical and standards calibration, as well as development operations including waste technology development and testing of mechanical systems for weapons systems.

After the Plant's mission changed to environmental remediation in 1989, a reduced amount of research and development continued in Building 881. The laboratories are intact, but idle.

The final use of the building was to house approximately 40 organizations. These included production, production support, research, and administrative functions. Administrative operations involved operation of the computer center, development of computer systems, and management and storage of Plant records.

Building 881, East Dock PAC 800-1205
Building 881's east dock may be an area of potential concern due to the production activities that took place in the building until 1964. The CEARP Phase I Draft indicated that the dock was contaminated in February 1960, but there is no mention of what caused the contamination.

The only documented incident occurred on January 7, 1990. Fire department personnel found a large puddle on the dock. The Stationary Operating Engineer found the source to be overflow from a condensate pan. U and Pu may have contaminated the east dock in the 1960s. It is documented that condensate was also spilled in the area. There is no mention of cleanup in 1960 or 1990.

Tank 24 - Seven 2,700-Gallon Steel Process Waste Tanks; Tank 32 – 131, 160-Gallon Underground Concrete Secondary Containment Sump IHSS 000-121

Tanks T-24 and T-32 are located in the 800 Area in Building 887 and the Building 881 Process Waste Pit, respectively. Tank T-32 is a 131,160-gallon concrete vault underlying Building 887 and it serves as secondary containment for the seven 2,700-gallon aboveground tanks (T-24 is one of the seven ASTs). Tanks T-24 and T-32 were installed in 1952 and received waste streams from Building 881, including radionuclides, solvents, metals, acids, bases, oils, and PCBs. No reported releases from these tanks are known.

Soil samples from a borehole at the southwestern corner of the tanks indicated that U-233/234 was greater than background at this location. Zinc exceeded background at a depth of 16 to 18 feet in a borehole located at the southeastern corner of the tanks. These data are available in the IA Data Summary Report (DOE 2000a).

Tank 39 - OPWL - Four 250-Gallon Steel Process Waste Tanks IHSS 000-121
Existing data for this site have not been located.

GROUP 800-3

UBC 883 - Roll and Form Building
Information on Building 883 is from the HAER (DOE 1998). Building 883 was a non-reactor nuclear facility. It was constructed in 1956 to accommodate fabrication of enriched and depleted U parts used in weapons. The sealed, hollow shape of the weapon components required a significant amount of rolling and forming of both types of U. Because space in Buildings 881 and 444 (enriched U and depleted U parts manufacturing) was inadequate, Building 883 was constructed to handle some of the U rolling and forming operations.

Additions to Building 883 began in 1958 with the construction of storage and U component manufacturing spaces. In 1972, a valve room was added. From 1983 to 1985, additions were constructed to support the manufacturing of armor plates for M1A1 tanks.

Enriched U was processed in Building 883 from 1957 to 1964. These operations were moved from the building to the Oak Ridge Reservation between 1964 and 1966. After 1967, metalworking operations in the building primarily involved depleted U and binary metal (U-238 alloyed). Some stainless steel and aluminum work also occurred in the building on a fairly routine basis. Beryllium, copper, and other metals and alloys were occasionally worked on in the building. Projects included rolling, pressing, and spinning classified blanks for trigger contingency and special order work; bending tubes for weapon body parts; and swaging reservoir stems.

Historical operations within Building 883 included manufacturing of parts from U and beryllium, and a series of special projects involving various metalworking operations. Manufacturing processes included rolling and forming enriched U, depleted U, U-niobium alloys (binary metal), and beryllium into parts for weapons production. Actual manufacturing processes depended on the type of metal used and the desired final form.

Operations included rolling, shearing, forging, pressing, roller leveling, grinding, punching, bending, welding, heating, annealing, and cleaning. Metal was annealed in salt baths or in furnaces with argon atmospheres. Vapor degreasing, grit blasting, water washing, and HNO_3 etching were used during the cleaning process. Other processes conducted in Building 883 included inspection, nondestructive testing, weighing, shipping of fabricated parts, and receipt of raw materials used to fabricate, inspect, and clean the parts.

The flow of materials into, within, and from Building 883 varied according to the type of material. Enriched U was cast in Building 881, sent to Side B of Building 883 for rolling and forming, and returned to Building 881 for machining and inspection. Depleted U was cast in ingots in Building 444, sent to Side A of Building 883 for rolling and forming, and returned to Building 444 for machining and inspection. Depleted U products manufactured in Building 883 were shipped to Building 444 for subsequent machining operations.

Building 883 received depleted U (U-238) that consisted of either virgin stock from offsite vendors or recycled scrap generated from site processes. The U-238 ingots or billets were hot rolled and formed into various weapons parts or electrode strips, or combined with niobium to form binary metal which was subsequently formed into weapon components. Virgin U-238 ingots were weighed, immersed in a salt bath, rolled into a sheet, then sheared to length. The sheets were annealed in a second salt bath, cooled, and cleaned in water. These flat plates were either shaped into weapon components or sheared a second time and trimmed to form electrode and electrode filler strips. The electrode strips were bent, cleaned in acid, and welded in a box configuration. The electrode filler strips were rolled, punched for bolt holes, and cleaned in acid. The electrode and electrode filler strips were then transferred to Building 444.

Recycled U-238 ingots were weighed, cropped, reweighed, and heated in a salt bath. The ingots were rolled into sheets and sheared to length; the sheets were annealed, cooled, and cleaned in water. They were then sheared, cut into discs, heated, and formed into parts. A

second forming, called a re-strike, was done to ensure proper size. These parts were vapor degreased (cleaned using a hot solvent vapor process to remove contaminants) and sent to Building 444.

Manufacture of weapon parts from enriched U occurred in Building 883 from 1957 to 1964, at which time enriched U part manufacturing operations were transferred from the Plant to the Oak Ridge Reservation in Tennessee. Enriched U was cast in Building 881, then sent to Side B of Building 883 for rolling and forming. The formed enriched U parts were then transferred back to Building 881 for machining into final shape.

Binary metals, depleted U alloys, were delivered to Building 883 as recycled ingots and non-recycled rolling pucks (slices off a cylindrical ingot). The binary ingots were heated in an argon atmosphere, and rolled into sheets. The sheets were either formed into shapes to make weapon components, or cut into electrode filler strips. The electrode filler strips were stamped with batch identification marks and bolt holes were punched in one end. The strips were then annealed in an argon atmosphere and quenched in water. The strips were strengthened in the roller leveler, cut to final length, and transferred to Building 444. The binary pucks were also heated in an argon atmosphere, rolled into sheets, annealed, and water quenched. The sheets were then straightened in a roller leveler and cut into discs for forming into parts. After inspection, the parts were sent to Building 444.

Beryllium-forming operations, which took place in Side A from 1962 to the mid-1980s, required the development of special techniques to compensate for the brittle nature of beryllium. Beryllium ingots were cast in Building 444 and encased in stainless steel in Building 881. The stainless steel and beryllium sandwich was heated and rolled into sheets; stainless steel forms were cut away after the beryllium was rolled to the specified thickness. The beryllium sheets were heat-treated and pressed into the desired shapes in Building 883, then returned to Building 444 for further machining.

Starting in 1989, Building 883 operations began to diminish. By 1993, Building 883 operations focused on rolling and pressing of classified blanks for trigger contingency (war reserve) and special order work, bending tubes for weapon body parts, and swaging reservoir stems to meet production requirements.

In 1994, Building 883 operations ceased and the building was closed.

Valve Vault 2 PAC 800-1200

During a routine inspection of Valve Vault 2 on April 25, 1989, liquid was discovered in the leak detection collection bottle. The bottle was also leaking; therefore, the alarm was not sounded. The leak was coming from the south process transfer line that consists of a 3-inch PVC Schedule 80 pipe inside a 6-inch polyethylene chase pipe (containment pipe). A pH check of the liquid indicated that the inner pipe, which originates from waste tanks in Building 883, was leaking. Three discharges had occurred through this line since the vault was last inspected (March 14, 1989), at which time no leakage was apparent.

Building 883 generates a process waste that is HNO_3 and/or rinsate water contaminated with depleted U. A pH check of the liquid showed a pH of 1 to 2. The waste is partially

neutralized with roughly equal amounts of a KOH solution before it is discharged to Building 374 via Valve Vault 2. Total alpha activity measured 39,000,000 pCi/L.

Upon detection of the leak, discharge valves from the waste tanks in Building 883 were closed and locked out. Plumbing changes took place within 2 days after the leak was detected to ensure that no more transfers were made through the line. Hydrostatic testing of the inner line began on May 8, 1989, and continued through the month. Removal of the inner line began on May 29 and continued through June 2. Salt encrustations were found at the elbow where the process waste line exits the nitrad pickling operation room.

During the week of June 5 to 9, 1989, the secondary chase pipe was hydrostatically tested. When it was found to be leaking, the line was inspected by electronic visual imaging on June 15, 1989, to locate the leak. Soil sampling had not begun as of July 31, 1989.

Because the release amounts exceeded the reportable quantity, the event was reported to the National Response Center on June 15, 1989. A RCRA CPIR (Implementation Report No. 89-007) was submitted.

Tank 25 - OPWL - 750-Gallon Steel Tanks (18, 19) IHSS 000-121
Existing data for this site have not been located.

Tank 26 - OPWL - 750-Gallon Steel Tanks (24, 25, 26) IHSS 000-121
Existing data for this site have not been located.

Radioactive Site South of Building 883 PAC 800-1201
Contamination in the area between Building 883 and Building 881 is documented as early as 1958. After the Pu fire in 1957, studies were initiated to determine the spread of contamination. This study was extended to research the impact of RFP operations on the environment. One particular spot in the 800 Area with significant Pu contamination was located 500 feet east of the 881 Building road and 500 feet north of Building 881 (prior to construction of Building 883).

In 1978, while conducting field surveys during excavation for a telephone line, readings above background were found approximately 30 feet south of Building 883. Radiometric soil surveys found two other spots; one at the northwest corner of Building 889; and the other at the southeast corner of Building 865.

In 1958, soil samples were collected at the northwest corner of Building 881 and 20 feet west of the building. Analysis indicated total activity of 4.5×10^4 disintegrations per minute per kilogram (dpm/kg) and 1.5×10^5 d/m/kg, respectively, with some Pu. During the excavation in 1978, soil samples were found to contain U-235.

No documentation of cleanup activities was found in response to the 1958 incident. Removal of contaminated soil in two small areas near Building 883 was completed in April 1981.

GROUP 800-4

UBC 886 - Critical Mass Laboratory

Information on Building 886 is from the HAER (DOE 1998). The continued presence of large quantities of fissile material in numerous forms at RFP made it necessary to maintain an active criticality safety program. A Nuclear Safety Group was formed in 1953 to perform the criticality experiments. At that time, the group did not have its own facility. In those early years, the group performed subcritical experiments in the areas in which the materials were handled, using the actual materials that went into production of the product. The experimenter would set up the production materials in various arrays to perform multiplication-type experiments ("in situ" experiments, which were always subcritical) and measure critical nuclear conditions with respect to safe geometries for various kinds of production vessels, spacing parameters, shipping containers, and other items. Once Building 886 was commissioned, the Nuclear Safety Group conducted its work there. Since that time, the Nuclear Safety Group has conducted approximately 1,700 critical mass experiments using U and Pu in solutions (900 tests), compacted powder (300), and metallic forms (500).

Nuclear criticality safety can be defined as anything associated with avoiding an accidental nuclear criticality event. A criticality is an instantaneous nuclear fission chain reaction caused when too much fissile material is placed within too small an area. A criticality event would not result in a nuclear explosion, but could liberate a large amount of energy and high levels of radiation. While criticality events can vary widely in power level, the amount of radiation that could be generated in a criticality could be fatal to nearby personnel. Since the beginning of the nuclear industry to 1967, there have been a few dozen nuclear criticality accidents nationwide. These extensively studied incidents, none of which occurred at RFP, caused eight deaths and, in some cases, resulted in property damage.

The primary mission of the Critical Mass Laboratory was to perform criticality measurements on a variety of fissile material configurations in support of plant activities. The criticality experiments and measurements were performed to establish criticality limits and ensure the safe handling and processing of fissile materials. A simplified sequence of events in performing a typical critical mass measurement involved removing the fissile material from storage, placing it in one of the Reactivity Addition Devices, operating the device remotely until criticality was achieved, measuring the slightly supercritical parameters, reversing the operation of the device to slightly subcritical and measuring these parameters, completing the reversal to well below subcritical, and returning the fissile material to storage. This effort supported the Plant's activities and assisted the Nuclear Regulatory Commission in setting industry safety standards. The measurements were essential to validate computer models that were, in turn, used to establish nuclear criticality safety limits now called Criticality Safety Operating Limits.

The experiments were conducted in a manner to control the approach to criticality. Only rarely were the radiation levels such that it was not possible to directly touch the fissile material and testing apparatus immediately after the experiments. The experiments conducted in the Critical Mass Laboratory generally involved generated power levels of no more than 10 milliwatts for no more than 1 hour. Approximately one-half of the experiments conducted in Building 886 actually achieved criticality.

Highly enriched U was introduced into the building in summer 1965 and the first experiments were performed in September 1965. Since then, the building was used to perform experiments on enriched U metal and solution, Pu metal, low enriched U oxide, and several special applications. After 1983, experiments were conducted primarily with uranyl nitrate solutions, and did not involve solid materials.

Experiments to validate the safety parameters for the storage of fissionable solutions in Raschig ring tanks resulted in the design of two substitute storage tank configurations: the Annular tank and the Poison Tube tank. These designs allowed for more economical solution testing with no decrease in safety. The Poison Tube tanks were not used at the Plant due to the change in the overall Site mission; however, they were used at other DOE facilities. Experiments were also conducted to validate the cross-sections and usefulness of materials (i.e., concrete and polyvinyl chloride) used at the Plant. Data generated from decades of experiments at the Plant are still being used to set new safety standards and validate computer models.

Tank 21 - OPWL - 250-Gallon Concrete Sump IHSS 000-121; Tank 22 - OPWL - Two 250-Gallon Steel Tanks IHSS 000-121; Tank 27 - OPWL - 500-Gallon Portable Steel Tank IHSS 000-121

Tanks T-21, T-22, and T-27 are located in the 800 Area within Building 828, the Building 886 Process Waste Pit. Tank T-21 is a 250-gallon floor sump in the southeast corner of the 886 Waste Pit vault. Tank T-22 is a 250-gallon stainless steel aboveground tank filled with Raschig rings within the 886 Waste Pit vault that was used for waste storage. Another identical tank was located within the vault to the north of Tank T-22 that stored product, but this tank was outside the scope of this investigation. Tank T-27 was a 500-gallon portable tank that was located on a concrete pad to the north of the 886 Process Waste Pit; Tank T-27 was previously removed.

Tank T-22 and the T-21 sump were installed in 1963 and then abandoned in 1978. Tank T-22 held waste from the laboratories in Building 886, including radionuclides, laboratory soaps, janitorial cleaning fluids, and possible nitrates. Tank T-21 captured overflow from Tanks T-22 and the other tank. Historical reports of the 886 Criticality Laboratory indicate Tanks T-21, T-22, and T-27 may have been associated with cesium-137 handling. No known releases at this location were identified.

It is unknown when Tank T-27 was installed. This tank was decontaminated, removed, and sent to the size reduction building for disposal in July 1989 after a state employee noted a wet area, approximately 4.0 to 5.0 inches in diameter, under the bottom drain valve of the tank. This tank was used to store and transfer Building 886 process waste from Tanks T-21 and T-22 to the waste treatment facility.

HPGe surveys conducted during the OU 9 Phase I RFI/RI indicated Ra-226, Th-232, U-235, and U-238 were above background. Two NaI surveys indicated that radionuclide activity was above background directly west of the tanks on the concrete driveway and at the northeast corner of the process waste pit. Activities ranged from 1,600 to 2,200 cpm.

Radioactive Site #2 800 Area, Building 886 Spill IHSS 800-164.2

Since the occupancy of Building 886 in 1965, the area has been a source of concern for possible soil infiltration. The summary of events indicates a contamination release on June 9, 1969. No details are given. On September 26, 1989, a 500-gallon stainless steel portable tank was found leaking a colorless liquid from its drain valve onto the concrete, creating a wet spot approximately 5 inches in diameter.

A radiation monitoring survey resulted in direct counts of 650 cpm and 12 to 24 dpm on a smear. This was considered low-level contamination. The valves were tightened, decontaminated, bagged, and readied for shipment to Size Reduction Operations in Building 776. The concrete was sealed with acrylic paint. Soil samples indicated contamination from U. Contamination was removed from the concrete.

GROUP 800-5

UBC 887 - Process and Sanitary Waste Tanks

Building 887 is located in the far southern portion of the 800 Area. The building footprint is approximately 336 ft^2. Building 887 was placed into service in 1953. The building houses the process and sanitary waste holding tanks. On October 27, 1989, a utility worker discovered that the process waste tanks had overflowed on to the floor with excess process water from the acid scrubbers. This incident resulted in the filing of a RCRA CPIR. No characterization has been performed of the soil underlying the building (DOE 1992a).

Building 885 Drum Storage IHSS 800-177

The Building 885 drum storage area consists of the eastern and western sections of Building 885. A roof covers each of the two drum storage areas. The eastern portion is enclosed on two sides and the western portion is enclosed on three sides. The floors are constructed of concrete and each floor is approximately 10 by 20 feet.

The drum storage areas have been used since 1953. Since 1986, the areas were used as a 90-day accumulation area and a satellite collection station. The western section of Building 885 was used to store unused paint and waste oils. The eastern section stored unused paint, waste paint, and paint solvents. Waste material also contained low-level radioactive wastes. A maximum of ten to twenty 55-gallon drums were stored on pallets on the concrete floors in each area. There are no berms around the storage areas. Only one drum in each section was used for waste storage; the remaining drums contained unused oils and solvents. The total container storage capacity was 1,100 gallons. There were no documented spills or leaks in this area (DOE 1992a).

As part of an initial soil characterization program, four soil samples were collected from 1-foot-deep test pits below a 6-inch asphalt layer; these samples were analyzed in 1988. Analysis of soil samples collected from locations surrounding IHSS 177 indicated detections of organics including acetone, 2-butanone, and trans-1,2-dichloroethene. Metals and inorganics detected include aluminum, arsenic, beryllium, chromium, strontium, manganese, barium, calcium, cadmium, copper, lead, iron, magnesium, mercury, vanadium, zinc, potassium, and nitrate/nitrite. Radionuclides detected include gross alpha, gross beta, tritium, U-238, U-233 and –234, Pu-239 and –240, and Am-241.

Analysis of groundwater samples collected from an upgradient well (Well 527) indicated detections of metals and other inorganics including aluminum, calcium, copper, magnesium, manganese, nickel, sodium, zinc, and sulfate. Radionuclides detected at the well include Am-241, gross alpha, Pu 239, U-234 and –238, and tritium. Downgradient data (Well 537) indicated detections of calcium, copper, magnesium, nickel, sodium, zinc, and sulfate. The radionuclides detected include U-233 and U-234. Detailed information on the analyses and sampled locations can be found in the OU 10 Phase I RFI/RI Work Plan (DOE 1992b).

Surface soil samples were collected and analyzed during the OU 10 Phase I RFI/RI. Benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene were detected in surface soil. Calcium, chromium, copper, lead, strontium, and zinc were detected above background values. These data are available in the IA Data Summary Report (DOE 2000a). Acetone, cis-1,2-dichloroethene, methane, PCE, and 1,1,1-TCE were detected above 1.0 mg/L in soil gas samples.

GROUP 800-6

UBC 889 - Decontamination and Waste Reduction

Building 889 was placed into service in 1966. Building 889 houses decontamination and waste reduction operations for wastes originating outside the PA. Wastes entering Building 889 include surplus equipment that may be decontaminated by steam cleaning for reuse on site or sale offsite. HEPA filters, combustible wastes, and nonreusable equipment are compacted, placed in crates, and shipped offsite for disposal.

Radioactive Site 800 Area Site #2 Building 889 Storage Pad IHSS 800-164.3

Building 889 is a decontamination facility that was first occupied in 1969. A storage pad north of the building was used to store U-contaminated equipment and contaminated drums prior to decontamination. An area to the west was used for the same purpose. A radioactive survey supports the fact that there was contamination at this western location.

Two incidents occurred at Building 889 that involve contaminated drums. On June 16, 1982, a waste drum spontaneously ignited, and on July 20, 1984, a chip fire started in an improperly packed drum. Another incident occurred in September 1983, when nine machine tools were stored outside waiting for decontamination. The plastic sheeting that was covering the equipment had blown off, possibly allowing contamination to spread.

Building 884 was constructed in 1958 as a storage facility for Building 883. It is currently used as a mixed waste storage building. In September 1966, drums were reported to be leaking in the drum storage area outside of this building. Approximately 700 ft^2 of soil and rocks were contaminated. It is thought that this information refers to a storage area east of Building 884 that was used prior to the construction of Building 889.

Some drums that contained hazardous or nonhazardous environmentally safe waste were sent to Building 889 for decontamination and reuse. The drum incidents in 1982 and 1984 involved U chip fires.

No contamination was reported released when the drum caught fire in 1982. No documentation was found that detailed responses related to the incidents in 1983 or 1984.

Tank 28 - Two 1,000-Gallon Concrete Sumps IHSS 000-121
Existing data for this site have not been located.

Tank 40 - Two 400-Gallon Underground Concrete Tanks IHSS 000-121
Tank T-40 is located in the 800 Area west of Building 889. Tank T-40 was reportedly installed in the mid-1950s and was abandoned in 1981 or 1982. The tank consists of two 400-gallon underground concrete tanks underlying a concrete vault approximately 7 feet deep.

HPGe surveys conducted during the OU 9 RFI/RI indicated that U-235 and U-238 were above background. Additionally, one NaI site on the southeastern side of the tank indicated activity above background. U-233/234 exceeded background at a depth of 0 to 0.5 foot. Groundwater samples collected from boreholes near the tank indicate barium, calcium, magnesium, manganese, mercury, sodium, and strontium exceeded background. These data are available in the IA Data Summary Report (DOE 2000a).

GROUP 900-1

UBC 991 - Weapons Assembly and R&D
Information on Building 991 is from the HAER (DOE 1998). Building 991, constructed between 1951 and 1952, was the first major building to be completed. Building 991 was designed for shipping and receiving and final assembly of weapon components. Pu, enriched U, and depleted U components fabricated onsite, along with components manufactured from the Hanford Site and the Oak Ridge Reservation, were assembled into final products, inspected, tested, and placed back in storage prior to offsite shipment in Building 991. Administrative services for the Plant were also carried out in Building 991 until Building 111 was completed in 1953.

Initially, radioactive components were coated in nickel or encased in plastic allowing assembly of the early concept design products in open rooms, not in enclosed gloveboxes or B-boxes (similar to a lab hood). In 1957, production began on a new weapon design, requiring changes in the amount of materials used in the trigger, amount of machining and handling required, and need for tighter controls. Because of the new design, final trigger assembly took place in the newly constructed Building 777. Assembly of older U-based weapons continued in Building 991 until the 1960s. A limited number of Pu-based triggers may have been assembled in Building 991 during the early 1960s.

After 1957, the mission of Building 991 focused on shipping, receiving, and storage. Materials handled included special nuclear, nonradioactive raw, and classified materials, other metal components, partially finished products, purchase order items, special order items, samples, instruments, and documents. All radioactive materials received and stored in Building 991 were in U.S. Department of Transportation, DOE, or intraplant-approved shipping containers. For a brief period of time, between 1975 and 1976, shipping was moved to Buildings 439 and 440. Due to security concerns, shipping was moved back to Building 991 after 1976.

In addition to material shipping, receiving, and storage, a number of research and development projects were conducted in Building 991 from the 1960s to the mid-1970s. These projects included radiation studies, beryllium coating processes, and an explosives-

forming project. Most special projects and research and development operations were moved out of the building by 1976.

Building 991 was used to test the quality of non-nuclear raw material and non-nuclear non-classified parts fabricated by offsite vendors. A metallography laboratory was used for the testing. In the mid-1970s, Building 991 took over storage and inventory functions from Building 881 for these non-nuclear raw materials and non-nuclear, nonclassified parts. In the late 1980s, handling of nonclassified materials parts was moved to Buildings 130 and 460. Materials and parts ready for assembly were moved directly to Building 460.

Until the mid-1980s, materials were shipped and received from the eastern dock areas (Room 166). The west dock was added in the mid-1980s to provide a covered shipping area specifically designed for the safe secure transports used to ship production materials.

Until 1994, when a special loading dock was added to Building 371, Building 991 had the only shipping/receiving dock at the Plant capable of handling offsite shipments of special nuclear and classified materials. The building also housed nondestructive testing operations and other support operations. Radioactive and nonradioactive raw materials, special order items, packaging items, components, and samples were stored in the Building 991 vaults. All non-nuclear and nuclear materials sent to Building 991 were handled in Rooms 170 (shipping dock) and 134. Primary materials handled include 55-gallon and 30-gallon drums of U and Pu parts from offsite and onsite parts.

The final activity in Building 991 was waste storage.

Radioactive Site Building 991 IHSS 900-173

IHSS 173 originally encompassed Building 991 and associated underground storage vaults/tunnels 996, 997, 998, and 999. However, based on a proposal made in the HRR (DOE 1992a) and accepted by the regulatory agencies, the IHSS was reduced to include only the dock area of Building 991 (DOE 1994). Building 991 was the first active building at RFP and was used for storage and loading/unloading of finished products. IHSS 173 is located at the southwestern corner of the building and encompasses the south dock. The south dock is a loading facility for the vaults/tunnels. The surface around Building 991 is paved and enclosed by a security fence. The area receives moderate to heavy traffic and has been paved for more than 20 years. The pavement has been disrupted at times by construction and was extended to encompass Building 984 in the 1980s (DOE 1994).

Final products containing Pu and U were shipped from the dock. Final and raw products were not considered radioactive because they were plated with nickel. Acetone, PCE, and TCA solvents were used within the building. Reportedly, small parts and equipment were washed in the dock area along the north wall of the asphalt-covered courtyard. Acetone and other solvents were used for cleaning the parts and the spent solutions were stored in drums and removed for disposal. In the late 1950s and early 1960s, cleaning of depleted U parts was conducted in the courtyard of Building 991, which is located on the western side of the building near the dock. According to records, the dock and courtyard were often washed down with water that could have seeped into cracks and the edge of the asphalt. Spills and water could also have drained into the storm drains (DOE 1994). No documentation has

been found detailing releases to the environment or responses to occurrences in the dock area.

Results of a radiometric survey performed at RFETS during the late 1970s and early 1980s indicated no extremely contaminated areas (500,000 to 1,000,000 pCi/g) around the south dock of Building 991 (DOE 1994). However, an August 1981 aerial radiological survey (it is unknown whether this is the same as the radiometric survey) detected 8,000 to 16,000 cpm of gross "man-made" radioactivity and 1,000 to 2,000 cpm of Am activity centered on Building 991 (EG&G 1990a).

One alluvial monitoring well (2187) and one bedrock monitoring well (2287) are located approximately 450 feet downgradient of IHSS 173. There are no wells located immediately upgradient of the IHSS. Groundwater samples were collected from these wells quarterly since March 1988. In well 2187, detectable concentrations of acetone and PCE were observed. In addition, calcium, copper, magnesium, nickel, sodium, zinc, U-233/235, U-235, bicarbonate, chloride, and sulfate were detected above background values. In well 2287, detectable concentrations of PCE were observed, as well as calcium, Am-241, cesium-137, strontium-89/90, U-235, and sulfate concentrations above background values. These groundwater data indicate that groundwater downgradient of IHSS 173 has been impacted by RFETS operations. However, these wells are also downgradient of IHSS 184 (as well as several other IA IHSSs) that may have contributed to the levels of contaminants detected.

One 15-inch-diameter cast iron storm drain originates at the dock in IHSS 173 and flows south through IHSSs 173 and 184. It connects with an east-flowing 30-inch-diameter corrugated metal pipe storm drain approximately 40 feet south of IHSS 184. There are no sampling stations associated with this storm drain.

Foundation drains exist for Building 991 and its associated vaults/tunnels. One of these foundation drains appears to run north-south along the west wall of Building 991, but its presence has not been confirmed. However, none of these foundation drains appear to impact IHSS 173.

Surface soil samples were collected and analyzed as part of the OU 8 Phase I RFI/RI. Silver exceeded background values. These data are available in the IA Data Summary Report (DOE 2000a). Acetone, benzene, PCE, TCE, and cis-1,2-dichloroethene were detected above 1.0 μg/L in soil gas samples.

Radioactive Site 991 Steam Cleaning Area IHSS 900-184

IHSS 184 was originally defined as a 50- by 50-foot area near Building 992, southwest of Building 991 (DOE 1994). More recent information indicate that the boundaries of this IHSS are approximately 55 by 77 feet, but no documentation exists that defines the location of washing activities. However, the paved area between the south dock of Building 991 and Building 992 may have been used for steam cleaning. The OU 8 Phase I RFI/RI Work Plan (DOE 1994) proposed extending the IHSS boundaries to include the paved area. The primary source of contamination at IHSS 184 is considered to be steam cleaning that was done in an area within the southwest corner of Building 991.

The HRR (DOE 1992a) states that an area southwest of Building 991, near Building 992, was used between 1953 and 1978 to steam clean radioactively contaminated equipment and drums. The rinse water was collected in a sump for treatment in the RFETS process waste system. Building 991 personnel indicated that steam cleaning was done in an area within the southwest corner of the Building 991, not beside the guard shack or elsewhere outside the building. This was discontinued around 1969 when new cleaning facilities became available. The area was used to clean stainless steel containers needed to ship materials to other DOE facilities. These containers were returned empty to Building 991 by the other facilities and were steam cleaned before reuse. Reportedly, some of the equipment may have been radioactively contaminated. The cleaning was done on a concrete floor that is still in place. Wash water ran into an outside drain that flowed south and east beneath the pavement before emptying into an unlined ditch just southeast of the building (DOE 1994).

Reports indicate that there was a small contaminated spot on the ground that was cleaned up. Approximately 3 feet of soil were excavated during cleanup and disposed of in Idaho. It was stated that this occurred on the north side of Central Avenue, southwest of Building 991; however, the exact location was not stated. Many spots of contamination had been detected in the past in soil along Central Avenue in this area due to the presence of the Mound, Trench No. 1, and Oil Burn Pit No. 2. It is unlikely that the 3 feet of contaminated soil were associated with the steam cleaning activities (DOE 1994).

The IAG indicates that spillage from IHSS 184 is visible on August 6, 1971, aerial photographs of the site. Originals of these photographs are relatively sharp but of small scale (approximately 1 inch equals 2,200 feet), and spillage emanating from the steam cleaning area was not identified under 10x stereoscope magnification. Small discolored areas are evident on the ground east of Building 991, but do not appear to originate at the steam cleaning area. Building 991 personnel indicated that steam cleaning was discontinued before the aerial photograph date (DOE 1994).

There is serious doubt that the steam cleaning incident actually occurred in the IHSS 184 area. Based on numerous other interviews during the course of the HRR, no one has been able to provide information on steam cleaning in this area. The original description contains some language that makes it inherently inaccurate. Specifically, there was no sump in the paved area north of Building 992 and there are no process waste lines associated with Building 991/992 (DOE 1992a).

Results of the Radiometric Survey, conducted during the late 1970s and early 1980s, indicated relatively low contaminated areas (500,000 to 1,000,000 pCi/g) at this site (DOE 1994).

The nearest downgradient wells to IHSS 184 are wells 2187 and 2287. Acetone, PCE, several metals, and several radionuclides were detected at concentrations exceeding background in these wells. According to the OU 8 Phase I RFI/RI Work Plan, the levels of radionuclides detected in groundwater samples from these wells may be attributable, in part, to releases from this IHSS (DOE 1994). However, it should be noted that groundwater in the area of this IHSS is downgradient of a significant portion of the IA.

An attempt was made to better locate the concrete floor, sump, and outfall associated with IHSS 184 during the OU 8 RFI/RI. Based on this work, the sump is not believed to exist in the area. Based on a review of engineering drawings, it is possible that this "sump" could be a french drain in the paved area north of Building 992. The only real sump known to exist in the area is in the southeast corner of the basement of Building 991, which is not the described location of the steam cleaning activities.

One 15-inch-diameter cast iron storm drain originates at the dock in IHSS 173 and flows south through IHSSs 173 and 184. It connects with an east-flowing, 30-inch-diameter corrugated metal pipe storm drain approximately 40 feet south of IHSS 184. There are no sampling stations associated with this storm drain.

Foundation drains exist for Building 991 and its associated vaults/tunnels. One of these foundation drains appears to run north-south along the west wall of Building 991, but its presence has not been confirmed. However, none of these foundation drains appear to impact IHSS 184.

Building 991 Enclosed Area PAC 900-1301

An enclosed area believed to be approximately 50 feet wide along the south side of Building 991 was used for storage of various radioactively contaminated waste and materials. The earliest document found regarding this area indicated that in November 1953, 79 drums of concreted waste were stored. Monthly reports from the Waste Disposal Co-Ordination Group document that no drums were added to the area or taken away until January 1961, when the drums were moved to the Mound. It is believed that these drums were only stored at the Mound, as opposed to buried there. No documentation was found that detailed a release to the environment from these drums.

Other materials were in storage in the same general area. These materials included storage of shipping crates and carrying cases for assembled weapon components that may have been contaminated. No documentation was found which detailed a release to the environment due to stored materials.

The 79 drums stored from 1953 to 1961 contained concreted wastes from Building 991. These wastes were contaminated with enriched and depleted U.

GROUP 900-3

904 Pad Pondcrete Storage IHSS 900-213

IHSS 213, 904 Pad Pondcrete Storage, is an interim storage facility used to store low-level mixed waste resulting from the solidification of SEP sludge and sediment with Portland cement. IHSS 213 is an active waste storage unit, and therefore is a potential source of contamination.

Unit 15, 904 Pad Pondcrete Storage, is located in the southeastern portion of the RFP production area and occupies a 129,505-ft^2 rectangular area, measuring 439 feet north-south and 295 feet east-west.

The 904 Pad is used for the storage of pondcrete, a low-level mixed waste resulting from the solidification of SEP sludge or sediment with Portland cement. The material is placed in polyethylene-lined 3/4-inch plywood boxes measuring 4 by 2.5 by 7 feet. Metal boxes measuring 4 by 4 by 7 ft are also used. Boxes are stacked three high on the 904 Pad. Saltcrete, a material similar in nature to pondcrete, is treated and stored in the same fashion as pondcrete. Saltcrete results from evaporation of liquid process water. Pondcrete and saltcrete are stored within the bermed area of the 904 Pad.

The maximum pondcrete and saltcrete storage capacity of the 904 Pad is 6,136 wooden and 102 metal boxes of waste, accounting for approximately 103,464 ft^3 of waste (5,000 tons, assuming a density of 100 pounds per ft^3). The 904 Pad is currently at maximum capacity.

The 904 Pad was constructed in August 1987 of 3-inch-thick hot bituminous pavement placed over 6 inches of Class 6 coarse aggregate. The aggregate was placed on regraded native soil. The 904 Pad was located adjacent to the 903 Pad, a documented source of Pu release to the environment at RFP. Prior to construction, soil samples collected at a depth of approximately 2 inches were analyzed. Pu-239 activities were generally above background levels, indicating some Pu contamination was present at the 904 Pad location prior to construction. The area was resampled when the top 6 to 12 inches of soil were removed after grading for the 904 Pad construction. Pu-239 activities were found to be more than one order of magnitude higher than the previous shallow samples.

The sampling results indicated that relatively clean soil material has been laid down over previously contaminated soil material in the area of the 904 Pad. Covering Pu-contaminated soil with clean soil was a practice at RFP during the late 1960s and early 1970s. Excavated contaminated material was stockpiled along the west border of the 904 Pad, covered with clean soil, and vegetated to prevent wind dispersal.

The 904 Pad began receiving waste during October 1987. The initial pad was not constructed with a containment berm. Pondcrete accumulation was temporarily halted in May 1988 as the result of a spill. On June 6, 1988, a 6-inch-high asphalt berm was constructed around the west, north, and east perimeter of the 904 Pad in an attempt to collect surface water runoff samples. Spills and leakage of both pondcrete and saltcrete were a recurrent problem at the 904 Pad. A number of incidents are related to the incomplete solidification of the waste material that results in a failure of the container and releases to the pad surface. Spills of pondcrete are cleaned using water and brooms to scrub the pad surface. The brooms are used to remove contaminants from the crevices in the asphalt. Water is collected using a wet vacuum cleaner. The cleaning process is continued until radiation levels are below the detection limit for the monitoring instrument. Saltcrete spills are generally composed of dry material that is cleaned by vacuuming the surface until radiation levels are below the detection limit for the monitoring instrument. Portable air monitors are moved to the pad shortly after a spill incident. Based on these monitors, there were no releases that exceeded the RFP Screening Guide for Pu in air of 0.01 pCi/m^3.

Soil sampling, prior to and during grading activities associated with the 904 Pad construction, have documented pre-existing radioactive contamination. Samples of runoff water from the 904 Pad collected after spills have indicated gross alpha and beta activities above drinking water standards. RFETS employees reported seepage of runoff water below

the asphalt berm. Analysis of runoff data indicates 41 percent of all runoff samples equal or exceed the gross alpha drinking water standard of 15 pCi/L and 37 percent of all runoff samples equal or exceed the gross beta drinking water standard of 50 pCi/L. The surface water background value for gross alpha is 177 pCi/L and for gross beta is 163 pCi/L. Analysis of existing data indicates that runoff from the 904 Pad may be contributing to the elevated analyte concentrations in the South Walnut Creek water. South Walnut Creek is diverted into Pond B-4 that intermittently discharges to Pond B-5, the last control point on the South Walnut Creek drainage. Pond B-5 discharges must meet the RFP National Pollutant Discharge Elimination System (NPDES) permit.

A memo dated January 26, 1989, entitled 89-RF-0332, addressed the possible impact of runoff from the 904 Pad and 750 Pad. The runoff may result in chronic low levels of contaminants being released into Pond B-5 that discharge from the pond and would violate the NPDES permit. Therefore, the potential for contamination exists along the path from the 904 Pad to Pond B-5.

Analysis of soil samples collected from borings in the area indicate the presence of gross alpha, gross beta, total Pu, total U, U-234, U-238, Am-241, and Pu-239. In addition, analysis of surface water samples collected in the area of IHSS 213 indicate the presence of gross alpha, gross beta, nitrate, cyanide, and cadmium.

GROUP 900-4&5

S&W Building 980 Contractor Storage Facility IHSS 900-175

IHSS 175 is a 25- by 25-foot area in the eastern one-third of the storage yard located south of Building 980. The site was used from approximately 1980 to 1986 for storage of drummed waste from vehicle maintenance and painting activities at the S&W contractor's maintenance and fabrication shops. No more than 10 drums were stored at the site at any time. The drums were placed directly on the ground surface, and a berm was reportedly located on the west, south, and east sides of the overall storage yard. Documentation of spills or leaks is not available, although ground stains are visible.

In 1985, drum sampling found the wastes typically contained paraffinic-based mineral oil, a mixture of paraffinic- and naphthionic-based mineral oil, xylenes, freon, trichlorofluoroethane, glycol ether/borate-based brake fluid, aluminum, barium, beryllium, calcium, sodium, lead, silicon, and zinc. In 1988, soil samples were collected as part of an initial soil characterization program. Organics detected were methylene chloride and acetone, although these were also detected in sample blanks. Metals and other inorganics detected included arsenic, barium, beryllium, chromium, iron, manganese, nickel, strontium, vanadium, calcium, copper, mercury, lead, magnesium, potassium, zinc, and nitrate/nitrites. Radiochemistry analyses were performed for gross alpha, gross beta, tritium, U-233, -234, -238, Pu-239 and –240, and Am-241. No upgradient or downgradient analytical groundwater data were reportedly collected.

Surface soil samples were collected as part of the OU 10 RFI/RI. Benzo(a)pyrene, benzo(g,h,i)perylene, benzoic acid, chrysene, 2-methylnaphthalene, phenanthrene, and phthalates were detected at this IHSS. Calcium, chromium, copper, mercury, nickel, and zinc were detected above background values. These data are available in the IA Data

Summary Report (DOE 2000a). Methane was the only organic detected above 1.0 µg/L in soil gas samples.

Gasoline Spill Outside of Building 980 PAC 900-1308

In 1996, a service attendant was refueling Wackenhut Security, Inc. (WSI) vehicles at the southeast corner of Building 980 when a gasoline spill occurred. Central Fleet Management fuel trucks refuel WSI vehicles inside the PA from a truck that contains three fuel tanks carrying 50 gallons of gasoline, 80 gallons of gasoline, and 80 gallons of diesel fuel. The attendant had placed the 80-gallon tank hose in the 50-gallon tank to refill the 50-gallon tank, while the 50-gallon tank hose was lying in the truck bed ready to refuel the vehicle. When the tank pump was turned on, the 50-gallon hose released approximately 0.7 gallon of gasoline to the truck bed and the ground because the hose nozzle had been inadvertently left on. Seven-tenths of 1 gallon of gasoline were released to the environment.

The contaminated soil was excavated and placed in a black and white drum that was taken to Building 331. Meetings were held with J.A. Jones personnel on December 2 and with WSI personnel on December 3 to discuss spill reduction in remote refueling operations. The goals of the meetings were to minimize the number of refueling locations and locate these over paved surfaces instead of dirt, away from IHSS areas. As a result of these meetings, the number of refueling locations within the PA was reduced to two, which are located off of the roadway west of Portal 1 and west of the Cooling Tower 3, near Building 561. On weekends, the 750 courtyard is also used as a refueling location. In addition, three alternative locations have also been approved. On December 2, the manual catches on the garage portable refueling nozzles were removed to ensure that nozzles could not be accidentally left open.

GROUP SW-2

Original Landfill IHSS SW115

The Original Landfill (IHSS 115) is located on the steep, south-facing hillside immediately south of the West Access Road and north of Woman Creek. The Original Landfill is unlined, and was operated from 1952 to 1968 to dispose of general Site wastes.

An estimated 2 million ft^3 of miscellaneous Site wastes are buried at this location. The waste may include solvents, paints, paint thinners, oil, pesticides, cleaners, construction debris, waste metal, and glass (Rockwell 1988). Beryllium and/or U wastes and used graphite were also disposed at this location. It was reported that ash containing an estimated 20 kg of depleted U was also buried in the landfill (DOE 1996b). The nature and extent of contamination in IHSS 115 is documented in the Phase I RFI/RI Report for the Woman Creek Priority Drainage, OU 5 (DOE 1996b).

Because the Original Landfill is located on a steep slope, erosion is occurring and debris is exposed at the surface. The area is periodically monitored to ensure that corrective actions are taken as necessary to mitigate issues caused by erosion.

Water Treatment Plant Backwash IHSS SW196

The water treatment plant backwash pond, known as Pond 6, was located south of the water treatment plant (Building 124). A July 1955 aerial photograph shows a pond on the north

slope of the Woman Creek drainage approximately 800 feet south of Building 124. The water treatment plant backwash discharge pipeline is also apparent on this aerial photograph which suggests that this pond south of the access road was the backwash pond for the water treatment plant.

An October 1954 reference indicates that discarded backwash water from the water treatment plant flowed through the western side of the "plant burning pit" (PAC SW-115) and continued down to Woman Creek. It is possible that the Pond 6 location was the plant burning pit prior to this time. The plant burning pit was used for dumping, burning, and discharging of miscellaneous waste.

No documentation was found that specifically identifies Pond 6 as the location of a release. However, Pond 6 was in the vicinity of the water treatment plant backwash discharge pipeline. An indirect reference states that the pond was used for backflushing sand filters from the "old waste water treatment plant," which is inferred to be Building 124 even though it treated raw water and not waste water. It is therefore likely that Pond 6 received water treatment plant backwash water. The backwash water would have contained flocculants (aluminum sulfate or lime), residual chlorine, and suspended solids. It is possible that the Pond 6 location was used prior to pond construction as the "plant burning pit" for dumping, burning, and discharging of miscellaneous waste.

In 1953, the effluent from the water treatment plant in 1953 was discontinuous and made up of filter backwash, filter prewash, sludge blowdown, and other waste water from the treatment of raw water. It contained all of the silt, mud, and filterable solids removed from the raw water. The characteristics of raw water were seasonally variable and therefore the characteristics of the backwash effluent was also variable. Chemical analysis of the water was conducted from November 1952 through June 1953.

No documentation was found that detailed a response to this occurrence.

REFERENCES

DOE, 1969, Engineering Drawing 21641-39 Building 441 Addition and Renovation Process Waste Pit Modification.

DOE, 1986, Comprehensive Environmental Assessment and Response Program Report Phase I Installation Assessment Rocky Flats Plan, Washington, D.C.

DOE, 1992a, Historical Release Report for the Rocky Flats Plant, Golden, Colorado, June.

DOE, 1992b, Phase I RFI/RI Work Plan Rocky Flats Plant Other Outside Closures, Operable Unit 10, Rocky Flats Plant, Golden, Colorado, May.

DOE, 1994, Phase I RFI/RI Work Plan for Operable Unit 8, 700 Area, 21100-WP-OU-8.01, Rocky Flats Plant, Golden, Colorado, October.

DOE, 1995, Operable Unit 4 Solar Evaporation Pond Interim Measure/Interim Remedial Action – Environmental Assessment Decision Document, Rocky Flats Environmental Technology Site, Golden, Colorado, February.

DOE, U.S. Environmental Protection Agency, and Colorado Department of Public Health and the Environment, 1996a, Rocky Flats Cleanup Agreement.

DOE, 1996b, Final Phase I RFI/RI Report, Woman Creek Priority Drainage Operable Unit No. 5, Rocky Flats Environmental Technology Site, Golden, Colorado, April.

DOE, 1998, Historic American Engineering Record, Rocky Flats Environmental Technology Site.

DOE, 2000a, Rocky Flats Environmental Technology Site Industrial Area Data Summary Report, Golden, Colorado, September.

DOE, 2000b, Final Sampling and Analysis Plan for the Characterization of Under Building Contamination for UBC 123 and Building 886 Implementing Horizontal Directional Drilling and Environmental Measurement While Drilling, Rocky Flats Environmental Technology Site, Golden, Colorado, May.

DOE, 2000c, Reconnaissance-Level Characterization Report (RLCR) Building 707 Cluster, Rocky Flats Environmental Technology Site, Golden, Colorado, August.

DOE, 2000d, Draft 771 Closure Project Decommissioning Operations Plan, Rocky Flats Environmental Technology Site, Golden, Colorado, August.

DOE, U.S. Environmental Protection Agency, Colorado Department of Public Health and Environment, 1991, Rocky Flats Interagency Agreement.

EG&G, 1991, Preliminary Assessment/Site Assessment of Polychlorinated Biphenyls (PCBs) Site, Rocky Flats Plant, Golden, Colorado.

RMRS, 1998, Final Close-Out Report, Building 123 Decommissioning Project RF/RMRS-98-253.UN, Rev 0, Rocky Flats Environmental Technology Site, Golden, Colorado September.

RMRS, 2000a, Rocky Flats Environmental Technology Site Waste Stream and Residue Identification and Characterization, Building 122, May.

RMRS, 2000b, Rocky Flats Environmental Technology Site Waste Stream and Residue Identification and Characterization Building 125, May.

RMRS, 2000c, Rocky Flats Environmental Technology Site Waste Stream and Residue Identification and Characterization, Building 371, May.

RMRS, 2000d, Rocky Flats Environmental Technology Site Waste Stream and Residue Identification and Characterization, Building 439, May.

RMRS, 2000e, Rocky Flats Environmental Technology Site Waste Stream and Residue Identification and Characterization, Building 440, May.

RMRS, 2000f, Rocky Flats Environmental Technology Site Waste Stream and Residue Identification and Characterization, Building 731, May.

Rockwell, 1988, Closure Plan Container Storage Facilities, Rocky Flats Plant, Golden, Colorado.

APPENDIX D

Comprehensive Risk Assessment Methodology

The Final Comprehensive Risk Assessment Methodology will be included when it is approved by the regulatory agencies.

APPENDIX E

Industrial Area Potential Contaminants of Concern, Contaminants of Concern, and Method Detection Limits

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ACRONYM LIST

%R	percent recovery
AOC	area of concern
AL	action level
ALF	Action Levels and Standards Framework for Surface Water, Ground Water, and Soils
ASTM	American Society for Testing and Materials
BHC	lindane
CAS No.	Chemical Abstract Society Number
COC	contaminant of concern
DCA	dichloroethane
DCB	dichlorobenzene
DCE	dichloroethene
DNT	dinitrotoluene
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
IA	Industrial Area
IASAP	Industrial Area Sampling and Analysis Plan
ICP-MS	Inductively Coupled Plasma-Mass Spectroscopy
IHSS	Individual Hazardous Substance Site
LCS	laboratory control sample
LIBS	laser-induced breakdown spectroscopy
m	metastable
MDL	method detection limit
mg/kg	milligrams per kilogram
mm	millimeter
MS	matrix spike
MSD	matrix-spike duplicate
PCB	polychlorinated biphenyl
PCOC	potential contaminant of concern
ppm	parts per million
QC	quality control
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RPD	relative percent difference
s	standard deviation
S^2	variance
SAP	Sampling and Analysis Plan
SOW	Statement of Work
SVOC	semivolatile organic compound
TCA	trichloroethane
U	undetected
UWQ4	usable with qualification, result no longer representative, source area remediated
UWQ5	usable with qualification, QC data; do not use for statistics or contaminant characterization
VOC	volatile organic compound
XRF	x-ray fluorescence

1.0 ANALYTICAL METHODS

Analytical methods, method detection limits (MDLs), and contaminants of concern (COCs) for the Industrial Area (IA) Sampling and Analysis Plan (SAP) (IASAP) are shown in Tables E1 through E12. The tables present the minimum required analytes within each respective suite, as well as the required sensitivity for each analyte. Sensitivities are expressed as MDLs, and are specific to the measurement systems used for IA samples. The action levels (ALs) provided represent the lowest values stipulated in the Rocky Flats Cleanup Agreement (RFCA), based on the various exposure scenarios. These (conservative) values are provided to ensure that method sensitivities, for each and every COC, are adequate for making project decisions that depend on sampling and analytical data.

General accuracy and precision tolerances for the methods are also given at the bottom of each table. Actual upper and lower control limits will be evaluated on a laboratory-by-laboratory basis. All MDLs will be less than or equal to RFCA ALs, where possible. The MDLs listed in the following tables represent values generally attainable by commercial laboratories and field mobile laboratories. The laboratory MDLs will be established using the following three steps.

1. Seven Replicates
   Prepare (extract, digest, etc.) and analyze seven samples of a matrix spike (MS) (American Society for Testing and Materials [ASTM] Type II water for aqueous methods, Ottawa sand for soil methods, and glass beads of 1-millimeter [mm] diameter or smaller for metals) containing the analyte of interest at a concentration three to five times the estimated MDL.

2. Variance and Standard Deviation

   Determine the variance (S^2) for each analyte as follows:

$$S^2 = \frac{1}{n-1}\left[\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2\right]$$

   where x_i = the ith measurement of the variable x and $\bar{x}$ = the average value of x

$$\bar{X} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

   Determine the standard deviation (s) for each analyte as follows:

$$s = (S^2)^{1/2}$$

3. MDL

Determine the MDL for each analyte as follows:

$$MDL = 3.14(s)$$

(Note: 3.14 is the one-sided t-statistic at the 99 percent confidence level appropriate for determining the MDL using seven samples.)

MDLs are greater than the existing RFCA Tier I and Tier II ALs for some organics, as shown in Tables E1 and E2.

Table E1
Method Detection Limits Greater Than Tier I and Tier II Action Levels

Analyte (Base-Neutral Extractables)	Soil (mg/kg) Mobile Lab (SW8270C)	Action Levels (mg/kg)	
		RFCA Tier I	RFCA Tier II
2,4-DNT	6.60E-01	5.01E-02	5.01E-04
2,6-DNT	6.60E-01	3.88E-02	3.88E-04
Bis(2-chlorethyl)ether	6.60E-01	9.73E-03	9.73E-05
n-Nitrosodi-n-propylamine	7E-01	1.89E-03	1.89E-05

Table E2
Method Detection Limits Greater Than Tier II Action Levels

Analyte	Soil (mg/kg) Mobile Lab	Action Levels (mg/kg)	
		RFCA Tier I	RFCA Tier II
VOCs			
1,1,2-2-Tetrachloroethane	5E-03	1.68E-01	1.68E-03
Trans-1,3-Dichloropropene	5E-03	1.20E-01	1.20E-03
Vinyl chloride	5E-03	3.46E-01	3.46E-03
SVOCs			
Nitrobenzene	7E-01	5.39E+00	5.39E-02
Isophorone	6.60E-01	2.09E+01	2.09E-01
2,4,6-Trichlorophenol	6.60E-01	1.07E+01	1.07E-01
2,4-Dichlorophenol	6.60E-01	6.35E+01	6.35E-01
Pentachlorophenol	3.30E+00	2.11E+00	2.11E-02
Pesticides			
α-BHC	2E-02	5.80E-02	5.80E-04
β-BHC	4E-02	2.08E-01	2.08E-03
γ-BHC	2.7E-02	7.50E-01	7.50E-03
Dieldrin	1.4E-02	3.92E-01	3.92E-03

Table E3 presents the analytical procedures for the IASAP. Tables E4 through E11 present the method detection limits for various analytes.

Table E3
Analytical Procedures

Analytical Method	Parameter	Preparatory Methods
8081A	Organochlorine pesticides (water and soil)	3510C, 3520C, 3540C, 3541, 3545, 3550B
8082	PCBs (water and soil)	3510C, 3520C, 3540C, 3541
8260B	Volatile organics (water and soil)	3585, 5021, 5030B, 5031, 5032, 5035
8270C	Semivolatile organics (water and soil)	3510C, 3520C, 3540C, 3541, 3545, 3550B
6020 6200/LIBS	Trace metals by ICP-MS (water and soil)	3005A, 3010A, 3015, 3050B, 3051 NA
7471A	Mercury (soil)	1311
9056	Common anions	NA
KH Module RC01 (alpha spec); Gamma Spectroscopy RC03-A.1[A] In situ[B]	Radionuclides (RFETS standard suite of five isotopes)	NA

[A] Containerized samples for field-laboratory analysis
[B] In situ measurements; see Appendix H for measurement specifications
NA not applicable

Table E4
Method Detection Limits for Metals

	Soil (mg/kg)		Action Levels (mg/kg)		Background Levels (ppm)	
Analyte	**Fixed Lab (SW6010B)**	**Portable/ Field Lab (LIBS/XRF)** [B]	**RFCA Tier I**	**RFCA Tier II**	**Surface Mean Plus 2 σ**	**Subsurface Mean Plus 2 σ**
Aluminum	3.E+00	TBD	>1.E+06	>1.E+06	1.69E+04	3.54E+04
Antimony[A]	4E+0	5E+02	7.68E+02	7.68E+-2	NA	1.70E+01
Arsenic[A]	6E+01	2E+02	2.99E+02	2.99E+00	NA	1.31E+01
Barium	2.E+01	3.E+02	1.33E+05	1.33E+05	1.41E+02	2.89E+03
Beryllium	2.E-01	<1	1.04E+02	1.04E+00	9.66E-01	1.42E+01
Cadmium	1.E-01	3.E+01	1.92E+03	1.92E+03	1.612E+00	1.7E+00
Calcium[C]	NA	NA	NA	NA	4.47E+03	NA
Chromium	≥2E+00	2E+00	8.72E+03	1.02E+03	1.7E+01	6.83E+01
Cobalt	1.E+01	1.3E+02	1.15E+05	1.15E+05	1.1E+01	2.90E+01
Copper	6.E-01	3.E+00	7.11E+04	7.11E+04	1.8E+01	3.82E+01
Iron[C]	NA	NA	NA	NA	1.8E+04	4.10E+04
Lead	4.E-01	3.E+01	1.00E+03	1.00E+03	5.5E+01	2.5E+01
Lithium	2.E+01	2.E+02	3.84E+04	3.84E+04	1.2E+01	3.47E+01
Manganese	3.E+00	1.3E+02	6.68E+04	8.36E+04	3.65E+02	9.02E+02
Mercury	2.E-01	6.E+00	5.76E+02	5.76E+02	1.34E-01	1.52E+00
Molybdenum[A]	8E+00	1E+01	9.61E+03	9.61E+03	NA	2.56E+01
Nickel	5.E+00	.9E+02	3.84E+04	3.84E+04	1.5E+01	6.22E+01
Selenium	3.E+00	1.5E+02	9.61E+03	9.61E+03	1.2E+00	4.8E+00
Silver[A]	7E+00	1.3E+01	9.61E+03	9.61E+03	NA	2.45E+01
Sodium[C]	NA	NA	NA	NA	9.2+01	NA
Strontium	4.E+01	1.3E+02	>1E+6	>1E+6	4.9E+01	2.11E+02
Vanadium	8.E+00	1.3E+02	1.34E+04	1.34E+04	4.6E+01	8.85E+01
Zinc	4.E+00	2.E+01	5.76E+05	5.76E+05	7.4E+01	1.39E+02
ACCURACY	±20% recovery (of reference standards) SOW reqs	±20% calibration standard; acceptable regression w/ lab results				
PRECISION	±25% RPD (MSD)	±35% RPD				

[A] Subsurface soil only

[B] Laser-induced breakdown spectroscopy (LIBS)/x-ray fluorescence (XRF). Measurements may require extended analysis times to meet MDL (e.g., 2 minutes vs. 1 minute).

[C] Constituents may be eliminated for the risk assessment if they are essential human nutrients (EPA 1989). Commonly detected chemicals considered an essential part of a daily human diet (EPA 1994) include calcium, iron, magnesium, potassium, and sodium.

TBD to be determined

NA not applicable

Table E5
Method Detection Limits for Volatile Organic Compounds

Analyte	Soil (mg/kg) Mobile Lab (SW8260B)	Action Levels (mg/kg)	
		RFCA Tier I	RFCA Tier II
1,1,1-TCA	5E-03	9.48E+01	9.48E-01
1,1,2,2-Tetrachloroethane	5E-03	1.68E-01	1.68E-03
1,1,2-TCA	5E-03	1.23E+00	1.23E-02
1,1-DCA	5E-03	6.89E+02	6.89E+00
1,1-DCE	5E-03	2.19E+00	2.19E-02
1,2-DCA	5E-03	6.68E-01	6.68E-03
1,2-DCB	2E-03	1.32E+03	1.32E+01
1,2-Dibromo-3-chloropropane	5E-03	1.40E+01	1.40E-01
1,2-Dichloropropane	5E-03	1.13E+00	1.13E-02
1,4-DCB	6.60E-01	1.65E+02	1.65E+00
2-Butanone	1.0E-01	NV	1E+06
Acetone	1.0E-01	2.72E+04	2.72E+02
Benzene	5E-03	1.41E+00	1.41E-02
Bromodichloromethane	5E-03	2.64E+01	2.64E-01
Bromoform	5E-03	3.72E+01	3.72E-01
Bromomethane	5E-03	5.98E+00	5.98E-02
Carbon tetrachloride	5E-03	3.56E+00	3.56E-02
Chlorobenzene	5E-03	8.30E+01	8.30E-01
Chloroethane	5E-03	1.55E+05	1.55E+03
Chloroform	5E-03	2.14E+01	2.14E-01
Chloromethane	5E-03	3.45E+04	3.45E+02
Cis-1,3-Dichloropropene	5E-03	1.20E-01	1.20E-03
Dibromochloromethane	5E-03	5.34E+03	5.34E+01
Ethylbenzene	5E-03	9.32E+02	9.32E+00
Methylene chloride	5E-03	5.78E-01	5.78E-03
Styrene	5E-03	2.74E+02	2.74E+00
TCE	5E-03	3.28E+00	3.25E-02
Tetrachloroethene	5E-03	3.15E-02	7.07E+00
Toluene	5E-03	7.07E+00	4.07E+00
Trans-1,3-Dichloropropene	5E-03	1.20E-01	1.20E-03
Vinyl acetate		3.33E+03	3.33E+01
Vinyl chloride	5E-03	3.46E-01	3.46E-03
Xylenes (total)	5E-03	9.74E+03	9.74E+01
ACCURACY	±30% R for LCS; lab-specific for MS (per analyte) SOW reqs		
PRECISION	RPD ≤30% (MSD)		

NV No value

Table E6
Method Detection Limits for Semivolatile Organic Compounds

Analyte (Base-Neutral Extractables)	Soil (mg/kg)	Action Levels (mg/kg)	
	Mobile Lab (SW8270C)	RFCA Tier I	RFCA Tier II
1,2,4-Trichlorobenzene	6.60E-01	4.33E+02	4.33E+00
1,2-DCB	6.60E-01	1.32E+03	1.32E+01
1,4-DCB	6.60E-01	1.65E+02	1.65E+00
2,4-DNT	6.60E-01	5.01E-02	5.01E-04
2,6-DNT	6.60E-01	3.88E-02	3.88E-04
2-Chloronaphthalene	6.60E-01	1.54E+05	1.54E+05
2-Methylnaphthalene	6.60E-01	7.68E+04	7.68E+04
2-Nitroaniline	3.30E+00	1.15E+02	1.15E+02
3,3'-Dichlorobenzidine	1.30E+00	9.96E+02	4.84E-03
4-Chloroaniline	1.30E+00	7.68E+03	4.37E-01
Acenapthene	6.60E-01	5.34E+04	5.34E+02
Anthracene	6.60E-01	5.76E+05	1.12E+04
Benzo(a)anthracene	6.60E-01	1.60E+02	1.60E+00
Benzo(a)pyrene	6.60E-01	1.60E+02	6.14E+00
Benzo(b)fluoranthene	6.60E-01	4.95E+02	4.95E+00
Benzyl alcohol	1.30E+00	5.76E+05	5.76E+05
Bis(2-chlorethyl)ether	6.60E-01	9.73E-03	9.73E-05
Bis(2-chloroisopropyl)ether	6.60E-01	6.40E+03	6.40E+01
Bis(2-ethylhexyl)phthalate	6.60E-01	3.20E+04	3.20E+02
Butyl benzylphthalate	6.60E-01	3.84E+05	1.44E+04
Chrysene	6.60E-01	1.60E+04	1.6E+02
Di-n-octylphthalate	6.60E-01	>1E+06	3.84E+04
Dibenz(a,h)anthracene	6.60E-01	6.14E+01	6.14E-01
Dibenzofuran	6.60E-01	7.68E+03	7.68E+03
Diethyl phthalate	6.60E-01	3.10E+04	3.10E+02
Dimethly phthalate	6.60E-01	>1E+06	>1E+06
Fluoranthene	6.60E-01	7.68E+04	5.37E+03
Fluorene	6.60E-01	6.94E+04	6.94E+02
Hexachlorobenzene	6.60E-01	1.89E+02	1.89E+00
Hexachlorobutadiene	6.60E-01	2.01E+02	2.01E+00
Hexachlorocyclopentadiene	6.60E-01	1.33E+04	3.44E+02
Hexachloroethane	6.60E-01	3.77E+01	3.77E-01
Indeno(1,2,3-cd)pyrene	6.60E-01	6.14E+02	6.14E+00
n-Nitrosodiphenylamine	7.E-01	7.84E+01	7.84E-01
n-Nitrosodi-n-propylamine	7.E-01	1.89E-03	1.89E-05
Naphthalene	6.60E-01	1.01E+04	1.01E+02
Nitrobenzene	7.E-01	5.39E+00	5.39E-02
Pyrene	6.60E-01	5.76E+04	3.97E+03
Isophorone	6.60E-01	2.09E+01	2.09E-01

Table E6 (continued)
Method Detection Limits for Semivolatile Organic Compounds

Analyte (Acid Extractables)	Soil (mg/kg)	Action Levels (mg/kg)	
	Mobile Lab (SW8270C)	RFCA Tier I	RFCA Tier II
2,4,5-Trichlorophenol	6.60E-01	2.79E+02	2.79E+00
2,4,6-Trichlorophenol	6.60E-01	1.07E+01	1.07E-01
2,4-Dichlorophenol	6.60E-01	6.35E+01	6.35E-01
2,4-Dimethylphenol	6.60E-01	5.77E+02	5.77E+00
2,4-Dinitrophenol	3.30E+00	5.29E+00	5.29E-02
2-Chlorophenol	6.60E-01	2.57E+02	2.57E+00
2-Methylphenol	6.60E-01	7.06E+02	7.06E+00
4,6-Dinitro-2-methylphenol	3.30E+00	1.92E+02	1.92E+02
4-Methylphenol	6.60E-01	9.61E+03	9.61E+03
4-Nitrophenol	3.30E+00	1.54E+04	1.54E+04
Benzoic acid	3.30E+00	1.09E+04	1.09E+02
Pentachlorophenol	3.30E+00	2.11E+00	2.11E-02
Phenol	6.60E-01	3.25E+03	3.75+01
ACCURACY	±30% Recovery (R) for LCS; lab-specific for MS (per analyte) SOW reqs		
PRECISION	RPD ≤30% (MSD)		

Table E7
Method Detection Limits for Pesticides

Analyte	Soil (mg/kg)	Action Levels (mg/kg)	
	Mobile Lab (SW8081A)	RFCA Tier I	RFCA Tier II
α-BHC	2.E-02	5.80E-02	5.80E-04
β-BHC	4.E-02	2.08E-01	2.08E-03
α-Chlordane	1E+00	8.25E+02	8.25E+00
β-Chlordane	1E+00	8.25E+02	8.25E+00
γ-Chlordane	1E+00	8.25E+02	8.25E+00
Aldrin	2.7E-02	2.64E+01	2.64E-01
Dieldrin	1.4E-02	3.92E-01	3.92E-03
Heptachlor	2.E-02	9.96E+01	9.96E-01
Heptachlor Epoxide	5.4E-02	4.93E+01	4.92E-01
Methoxychlor	1.2E+00	9.61E+03	1.34E+02
Toxaphene	1.7E+00	4.07E+02	4.07E+00
ACCURACY	±30% R for LCS; lab-specific for MS (per analyte) SOW reqs		
PRECISION	RPD ≤ 50% (MSD)		

Table E8
Method Detection Limits for PCBs

Analyte	Soil (mg/kg) Mobile Lab (SW8082)	Action Levels (mg/kg)	
		RFCA Tier I	RFCA Tier II
PCB-1016	3.50E-01	2.24E+02	2.24E+00
PCB-1221	3.50E-01	2.24E+02	2.24E+00
PCB-1232	3.50E-01	2.24E+02	2.24E+00
PCB-1242	3.50E-01	2.24E+02	2.24E+00
PCB-1248	3.50E-01	2.24E+02	2.24E+00
PCB-1254	3.50E-01	2.24E+02	2.24E+00
PCB-1260	3.50E-01	2.24E+02	2.24E+00
ACCURACY	±30% R for LCS; lab-specific for MS (per analyte) SOW reqs		
PRECISION	RPD ≤50% (MSD)		

Table E9
Minimum Detectable Activities for Radionuclides

Analyte	Soil (pCi/g)		Action Levels (pCi/g)	
	Onsite Gamma Spec	Offsite Alpha Spec (Module GR01)	RFCA Tier I	RFCA Tier II
Americium-241	1.0	0.3	209	38
Plutonium-239/240	8[A]	0.3	1088	252
Uranium-233/234	EST	1.0	1627	307
Uranium-235	0.5	1.0	113	24
Uranium-238	5.0[B]	1.0	506	103
ACCURACY	±20% recovery (of reference standards) SOW reqs.			
PRECISION	±40% RPD (duplicates)			

[A] Plutonium-239/240 is estimated based on site-specific decay ratios between americium-241 and plutonium-239/240.

[B] Uranium-238 is estimated based on equilibrium with thorium-234 and protactinium-234.

Table E10
Method Detection Limits for Method SW9056 Analytes

Analyte	Soil (mg/kg)	RFCA Action Levels (mg/kg)	
		Tier I	Tier II
Nitrate	1.0	>1E+6	>1E+6
Nitrite	1.0	1.92E+05	1.92E+05
ACCURACY	±30% R for LCS; lab-specific for MS (per analyte) SOW reqs		
PRECISION	RPD ≤50% (MSD)		

Table E11
Method Detection Limits for Method SW9010B Analytes

Analyte	Soil (mg/kg)	RFCA Action Levels (mg/kg)	
		Tier I	Tier II
Total cyanide	0.25	3.84E+04	3.84E+04
ACCURACY	±30% R for LCS; lab-specific for MS (per analyte) SOW reqs		
PRECISION	RPD ≤50% (MSD)		

2.0 CONTAMINANTS DISQUALIFIED FROM FURTHER CONSIDERATION

The contaminants disqualified from further sampling and analysis in the IA are based on the (data) filter criteria listed below. All data related to these contaminants were passed through the prerequisite "Data Quality Filter" as referenced in Section 3.1 of the IASAP.

The data comparisons described below were performed for two separate subsets of data, specifically the two matrix types of interest: surface soil and subsurface soil.

2.1 DETECTION LIMIT/BACKGROUND COMPARISON

Results are disqualified from further consideration based on the following criteria:

1. The analyte was not detected (specifically, the result was flagged with laboratory qualifier "U"), not remediated after detection ("UWQ4"), or was not a laboratory quality control (QC) sample ("UWQ5");

2. The analyte does not exceed published background values (Appendix F) plus two standard deviations;

3. The analyte exists as a tentatively identified compound only;

4. The analyte was rejected through formal data validation process ("R"); or

5. The analyte did not have a published Tier I or Tier II AL (RFCA Attachment 5), as noted in Table E12.

Note that background values are not established for most organic analytical suites of interest (especially volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, and polychlorinated biphenyls (PCBs).

Potential contaminants of concern (PCOCs) will be re-evaluated on an IHSS, PAC, or UBC site basis during the IASAP Addendum development process to ensure that potential contaminants are not overlooked during sampling and analysis.

2.2 COMPARISON WITH RFCA ACTION LEVELS

If a RFCA AL is not published for the analyte of interest (RFCA Attachment 5), the analyte is disqualified from further consideration as a potential contaminant, consistent with the RFCA Action Levels and Standards Framework for Surface Water, Ground Water, and Soils (ALF).

Those analytes exceeding detection limits, but without associated RFCA ALs, will be addressed on an individual hazardous substance site (IHSS)-by-IHSS basis.

Table E12
Disqualified Analytes

Analyte	CAS_No[A]	Number of Samples[B]	MaxRESULT[C]	MaxDL[D]
1,1,1,2-TETRACHLOROETHANE	630-20-6	149	129	20
1,1,2-TRICHLOROTRIFLUOROETHANE	76-13-1	122	150000	11
1,1-DICHLOROPROPENE	563-58-6	149	88	20
1,2 DICHLOROETHANE -D4	17060-07-0	620	121	10
1,2,3-TRICHLOROBENZENE	87-61-6	149	135	20
1,2,3-TRICHLOROPROPANE	96-18-4	149	154	20
1,2-DIBROMOETHANE	106-93-4	149	144	20
1,2-DICHLOROBENZENE-D4	2199-69-1	35	128	0.5
1,2-DICHLOROETHENE (TOTAL)	540-59-0	1833	13000000	13000000
1,2-DICHLOROETHENE(TOTAL)	544-59-2	11	620	620
1,3-DICHLOROBENZENE	541-73-1	1465	38000	12000
1,3-DICHLOROPROPANE	142-28-9	149	146	20
2,2-DICHLOROPROPANE	594-20-7	149	86	20
2,2-DICHLOROPROPANOIC ACID	75-99-0	4	100	200
2,4,5-TRICHLOROPHENOXYACETIC ACID	93-76-5	4	100	200
2,4,6-TRIBROMOPHENOL	118-79-6	714	106	10
2,4-DB	94-82-6	4	100	200
2,4-DICHLOROPHENOXYACETIC ACID, SALTS AND ESTERS	94-75-7	42	112	200
2-CHLOROETHYL VINYL ETHER	110-75-8	33	50	26
2-FLUOROBIPHENYL	321-60-8	702	131	10
2-HEXANONE	591-78-6	2011	13000000	13000000
2-NITROPHENOL	88-75-5	1269	38000	12000
3-NITROANILINE	99-09-2	1314	190000	31000
4,4-DDD	72-54-8	863	990	990
4,4-DDE	72-55-9	863	920	990
4,4-DDT	50-29-3	898	990	990
4-CHLORO-3-METHYLPHENOL	59-50-7	1323	38000	12000
4-CHLOROPHENYL PHENYL ETHER	7005-72-3	1314	38000	12000
4-ISOPROPYLTOLUENE	99-87-6	149	116	20
4-NITROANILINE	100-01-6	1314	190000	31000
ACENAPHTHYLENE	208-96-8	1315	38000	12000
ACETIC ACID, DICHLORO-	79-43-6	4	95	1
ALKALINITY AS CACO3	10-09-3	1	513.9	10
AMMONIUM	7664-41-7	22	78	0.3
BENZENAMINE	62-53-3	6	1800	1800
BENZENE, 1,2,4-TRIMETHYL	95-63-6	149	129	20
BENZENE, 1,3,5-TRIMETHYL-	108-67-8	149	124	20
BENZIDINE	92-87-5	28	1800	1800
BENZO(ghi)PERYLENE	191-24-2	1315	28000	12000
BICARBONATE AS CACO3	71-52-3	26	624	10
BIS(2-CHLOROETHOXY)METHANE	111-91-1	1314	38000	12000
BIS(2-CHLOROISOPROPYL) ether	39638-32-9	80	2100	2100
BROMOBENZENE	108-86-1	149	141	20
BROMOCHLOROMETHANE	74-97-5	149	88	20
BROMOFLUOROBENZENE	460-00-4	1126	161	10
CALCIUM	7440-70-2	2221	3490000	5000
CARBAZOLE	86-74-8	336	12000	12000
CARBONATE AS CACO3	3812-32-6	93	101	52.2
CESIUM	7440-46-2	2099	5170	1900
CESIUM-134	13967-70-9	498	1.119	3.09
CESIUM-137	10045-97-3	626	10	29.4
CHEMICAL OXYGEN DEMAND	C-004	23	121.8	20
CHLORDANE	57-74-9	17	20	20
CHLORIDE	16887-00-6	53	996	250
cis-1,2-DICHLOROETHENE	156-59-2	162	630	630
CORROSIVITY FOR LIQUID WASTE	261.22-A-1	2	7.1	0.01
CURIUM-244	13981-15-2	42	0.4618	0.0671
delta-BHC	319-86-8	863	500	500
DIBROMOMETHANE	74-95-3	149	132	20
DI-BUTYLCHLORENDATE	1770-80-5	282	510	16

Analyte	CAS_No[A]	Number of Samples[B]	MaxRESULT[C]	MaxDL[D]
DICAMBA	1918-00-9	4	150	200
DICHLORODIFLUOROMETHANE	75-71-8	149	104	20
DICHLORPROP	120-36-5	4	107	200
DIESEL FUEL	68334-30-5	20	194	25
DI-n-BUTYL PHTHALATE	84-74-2	1314	38000	12000
ENDOSULFAN I [c]	959-98-8	863	500	500
ENDOSULFAN II [c]	33213-65-9	863	920	990
ENDOSULFAN SULFATE [c]	1031-07-8	863	990	990
ENDRIN	72-20-8	900	920	990
ENDRIN ALDEHYDE	7421-93-4	151	990	990
ENDRIN KETONE	53494-70-5	806	920	190
FLUORIDE	16984-48-8	55	119.9	2.5
GAMMA-BHC [Lindane]	58-89-9	898	500	500
GASOLINE	8006-61-9	27	560	100
GROSS ALPHA	10-78-6	2	320	14
GROSS ALPHA	12587-46-1	2372	6300	897
GROSS BETA	12587-47-2	2376	6053	560
ISOPROPYLBENZENE	98-82-8	149	120	20
m,p-XYLENE	000-00-0	20	28.813	6
m+pCRESOL	65794-96-9	1	10	10
m+p XYLENE	136777-61-2	14	140	0.3
MAGNESIUM	7439-95-4	2235	353000	5000
MCPA	94-74-6	2	100000	100000
MCPP	93-65-2	2	100000	100000
n-BUTYLBENZENE	104-51-8	149	107	20
NEPTUNIUM-237	13994-20-2	31	0.05457	0.199
NITROBENZENE-D5	4165-60-0	744	128	10
N-NITROSODIMETHYLAMINE	62-75-9	6	730	730
n-PROPYLBENZENE	103-65-1	150	120	20
o-CHLOROTOLUENE	95-49-8	149	119	20
o-FLUOROPHENOL	367-12-4	707	1200	10
OIL AND GREASE	10-30-0	1	0.163	0.05
ORTHOPHOSPHATE	14265-44-2	16	98	0.05
o-XYLENE	95-47-6	46	133	13
p-BROMODIPHENYL ETHER	101-55-3	1314	38000	12000
p-CHLOROTOLUENE	106-43-4	149	145	20
PETROLEUM HYDROCARBONS, TOTAL RECOVERABLE	10-90-2	33	91	30
PH	10-29-7	359	10.5	0.1
PHENANTHRENE	85-01-8	1314	220000	12000
PHENOL, 2-(1-METHYLPROPYL)-4,6-DINITRO-	88-85-7	4	100	200
PHENOL-D5	4165-62-2	714	131	10
PLUTONIUM-238	13981-16-3	213	0.3131	0.727
PLUTONIUM-242	13982-10-0	42	0.0848	0.2547
POTASSIUM	7440-09-7	2221	12000000	121000
PROPANE, 1,2-DIBROMO-3-CHLORO-	96-12-8	407	387	20
PROPANOIC ACID, 2-(2,4,5-TRICHLOROPHENOXY)-	93-72-1	42	111	200
RADIUM-226	13982-63-3	534	150	8
RADIUM-228	15262-20-1	479	28	38
sec-BUTYLBENZENE	135-98-8	149	111	20
SILICON	7440-21-3	574	288000	500
SODIUM	7440-23-5	2221	30800000	140000
SPECIFIC CONDUCTIVITY	10-34-4	114	15900	10
STRONTIUM-89	14158-27-1	30	0.5	0.7
STRONTIUM-89,90	11-10-9	796	68.9	6.1785
STRONTIUM-90	10098-97-2	33	13	0.65
SULFATE	14808-79-8	60	1800	250
SULFIDE	18496-25-8	344	203	10.7
TANTALUM	7440-25-7	84	89.3	500
TERPHENYL-D14	1718-51-0	715	232	10
tert-BUTYLBENZENE	98-06-6	149	117	20
THALLIUM	7440-28-0	2343	157	15
TNT	118-96-7	3	0.23	0.23
TOLUENE - D8	2037-26-5	1099	143	10
TOTAL DISSOLVED SOLIDS	10-33-3	27	15631.03	50

Analyte	CAS_No[A]	Number of Samples[B]	MaxRESULT[C]	MaxDL[D]
TOTAL ORGANIC CARBON	10-35-5	259	24700	50
TOTAL RADIOCESIUM	13-00-0	68	136	200
TOTAL SUSPENDED SOLIDS	10-32-2	27	1218	6.8
trans-1,2-DICHLOROETHENE	156-60-5	193	630	630
TRIBUTYL PHOSPHATE	126-73-8	50	440	440
TRICHLOROFLUOROMETHANE	75-69-4	149	93	20
TRITIUM	10028-17-8	953	329000	4490
URANIUM-232	14158-29-3	42	0.0562	0.0644
URANIUM-233,-234	11-08-5	2508	3400	70
URANIUM-235	15117-96-1	2311	670	30
URANIUM-238	7440-61-1	2522	38000	70

[A] Chemical Abstract Society Identification Number
[B] Total number of samples collected in the IA
[C] Maximum result in mg/kg (pCi/g for radionuclides
[D] Maximum detection limit

3.0 REFERENCES

EPA, 1989, Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A), EPA 154011-89002, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1994, Evaluating and Identifying Contaminants of Concern for Human Health, No. RA-03: Contaminants of Concern, Region 8 Technical Guidance, U.S. Environmental Protection Agency, Washington, D.C., September.

APPENDIX F

Background Levels for Inorganic and Radionuclide Potential Contaminants of Concern

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ACRONYMS

BSCP	Background Soils Characterization Plan
DOE	U.S. Department of Energy
g/cm^3	grams per cubic centimeter
IDL	instrument detection limit
mg/kg	milligrams per kilogram
n	number of samples
NC	not calculated
nd	non-detect
pCi/g	picocuries per gram
RFETS	Rocky Flats Environmental Technology Site
U	undetected
UTL	upper tolerance limit

Background levels for inorganic and radionuclide potential contaminants of concern in soil at the Industrial Area are listed in Tables F1, F2, F3, F4, and F5.

Table F1
Summary Statistics for BSCP Metals (mg/kg) and Naturally-Occurring Radionuclides (pCi/g)

Analyte	Distribution	Count (n)	% Non-detection	Minimum mg/kg	Maximum mg/kg	Mean	Standard Deviation	M+2SD
ALUMINUM	Normal	20	0	4050	17100	10244	3329	16902
ANTIMONY	X	20	96	.19U	0.6255	X	X	X
ARSENIC	Normal	20	0	2.3	9.6	6.09	2	10.09
BARIUM	Normal	20	0	45.7	134	102.4	19.43	141.26
BERYLLIUM	Normal	20	0	0.24	0.9	0.66	0.153	0.966
CADMIUM	Non-parametric	20	39	.295U	2.3	0.714	0.449	1.612
CALCIUM	Normal	20	0	1450	4550	2969	749	4467
CESIUM	X	20	100	6.05U	7U	X	X	X
CHROMIUM	Normal	20	0	5.5	16.9	11.29	2.85	16.99
COBALT	Normal	20	0	3.4	11.2	7.29	1.81	10.91
COPPER	Non-parametric	20	0	5.2	15.68	12.94	2.56	18.06
IRON	Normal	20	0	7390	17503	12549	2744	18037
LEAD	Normal	20	0	8.6	53.3	33.6	10.51	54.62
LITHIUM	Lognormal	20	0	4.8	11.6	7.69	1.93	11.55
MAGNESIUM	Lognormal	20	0	1310	2806	1913.1	468.1	2849.3
MANGANESE	Normal	20	0	129	357	237.3	63.89	365.08
MERCURY	Lognormal	20	65	.04U	0.12	0.072	0.031	0.134
MOLYBDENUM	X	20	91	.29U	0.9515	X	X	X
NICKEL	Normal	20	0	3.8	14	9.63	2.64	14.91
POTASSIUM	Normal	20	0	1110	2830	2061.2	453	2967.2
SELENIUM	Non-parametric	20	39	.29U	1.4	0.634	0.295	1.224
SILICON	Normal	20	0	934	1650	1383.5	179	1741.5
SILVER	X	20	100	.19U	.22U	X	X	X
SODIUM	Lognormal	20	0	43.8	105	62.16	14.84	91.84
STRONTIUM	Lognormal	20	0	9.6	45.2	28.44	10.25	48.94
THALLIUM	X	15*	100	.385U	.445U	X	X	X
TIN	X	20	91	1.35U	4.85	X	X	X
VANADIUM	Normal	20	0	10.8	45.8	27.85	8.87	45.59
ZINC	Normal	20	0	21.1	75.9	49.56	12.1	73.76
RADIUM-226	Lognormal	20	0	0.1	0.805	0.619	0.153	0.925
RADIUM-228	Normal	20	0	0.2	2.3	1.35	0.48	2.31
URANIUM-233,-234	Lognormal	20	0	0.6	3.1	1.097	0.578	2.253
URANIUM-235	Lognormal	20	0	0.033	0.11	0.0539	0.02	0.0939
URANIUM-238	Lognormal	20	0	0.74	2.6	1.09	0.455	2

X = not applicable because > 80% of data were non-detects
% Non-detects (nds) are calculated from all accepted valid data except equipment rinsates
Min and Max values: highest/lowest detected value or, if no detected values, 1/2 IDL (notated with "U")
IDL = instrument detection limit
Uranium-238 had 2 outliers removed for calculation of upper tolerance limit (UTL); outliers retained for summary statistics

Normal* : Distribution assumed to be normal for summary statistics of supporting data
NC = Not calculated

DOE, 1995. Geochemical Characterization of Background Surface Soils: Background Soils Characterization Program, Table E-1, RFETS, May 1995.

Table F2
Summary Statistics for BSCP Fallout Radionuclides and Supporting Data

Analyte	Distribution	Count (n)	% Non-detection	Minimum	Maximum	Mean	Standard Deviation	Units
AMERICIUM-241	Nonparam	50	0	0.001	0.025	0.0107	0.006	pCi/g
CESIUM-134	Nonparam	50	0	0.05	0.3	0.2	0.056	pCi/g
CESIUM-137	Lognormal	50	0	0.3	1.7	0.941	0.372	pCi/g
PLUTONIUM-239/240	Lognormal	50	0	0.017	0.072	0.038	0.014	pCi/g
STRONTIUM-89,-90	Lognormal	50	0	0.065	0.64	0.254	0.128	pCi/g
% Clay	Normal*	50	0	1	34	11.58	6.37	%
% Sand	Normal*	50	0	24	78	53.29	11.97	%
% Silt	Normal*	50	0	20	51	35.21	7.49	%
Soil density	Normal*	50	0	0.8	1.2	0.944	0.78	g/cm^3
Tot. Org. Carbon	Normal*	50	0	1.4	6.05	3.66	1.24	%

Normal*: Distribution assumed normal for summary statistics of supporting data

DOE, 1995. Geochemical Characterization of Background Surface Soils: Background Soils Characterization Program, Table E-3, RFETS, May 1995.

Table F3
Summary Statistics for Inorganics (mg/kg)

Analyte	Distribution	Count (n)	% Non-detection	Minimum mg/kg	Maximum mg/kg	Mean	Standard Deviation	M+2SD
AMMONIA	Normal*	20	39	0.5U	7	2.033333333	1.897674785	5.8
CARBONATE	Normal*	20	100	5U	5.5U	X	X	X
NITRATE/NITRITE	Normal*	20	0	2	7	4	1.685854461	7.4
OIL&GREASE	Normal*	20	0	52	130	94.575	19.32497362	133.2
pH	Normal*	20	0	6	6.8	6.3575	0.242397564	6.8
SPECIFIC COND.	Normal*	20	0	0.1	0.53	0.20825	0.089593747	0.4
T.O.C.	Normal*	20	0	4920	17600	16132.66667	2696.900452	21526.5
% CLAY	Normal*	20	0	7	36	20.45	8.62	37.7
% SAND	Normal*	20	0	22	76	43.93	15.27	74.5
% SILT	Normal*	20	0	18	45.5	35.76	7.52	50.8
SOIL DENSITY	Normal*	20	0	0.9	1.2	0.923	0.07	1.1

Normal* : Distribution assumed to be normal for summary statistics of supporting data
NC = Not calculated

DOE, 1995. Geochemical Characterization of Background Surface Soils: Background Soils Characterization Program, Table E-2, RFETS, May 1995.

Table F4
Subsurface Background Soils - Inorganics

Analyte	Flow System	Sample Size (n)	Percent Detects	Mean	Standard Deviation	Units
ALUMINUM	UPPER	98	100	12,752.03	11,310.57	mg/kg
ANTIMONY	UPPER	66	3	4.71	6.13	mg/kg
ARSENIC	UPPER	99	75	3.88	4.63	mg/kg
BARIUM	UPPER	99	89	96.46	96.46	mg/kg
BERYLLIUM	UPPER	99	91	4.78	4.71	mg/kg
CADMIUM	UPPER	81	48	0.82	0.44	mg/kg
CALCIUM	UPPER	99	86	6,951.09	16,215.59	mg/kg
CESIUM	UPPER	95	78	230.46	273.51	mg/kg
CHROMIUM	UPPER	99	100	19.61	24.33	mg/kg
COBALT	UPPER	99	30	7.5	10.77	mg/kg
COPPER	UPPER	99	91	12.57	12.82	mg/kg
IRON	UPPER	99	100	14,531.98	13,257.27	mg/kg
LEAD	UPPER	99	100	10.87	7.05	mg/kg
LITHIUM	UPPER	99	45	11.76	11.45	mg/kg
MAGNESIUM	UPPER	99	64	2,584.42	3,365.51	mg/kg
MANGANESE	UPPER	99	100	217.64	341.99	mg/kg
MERCURY	UPPER	86	34	0.24	0.64	mg/kg
MOLYBDENUM	UPPER	99	14	8.93	8.34	mg/kg
NICKEL	UPPER	96	91	20.73	20.74	mg/kg
POTASSIUM	UPPER	98	29	1,311.57	2,442.62	mg/kg
SELENIUM	UPPER	82	26	1.22	1.79	mg/kg
SILVER	UPPER	83	41	5.62	9.46	mg/kg
SODIUM	UPPER	99	9	300.66	475.29	mg/kg
STRONTIUM	UPPER	99	43	65.62	72.88	mg/kg
THALLIUM	UPPER	75	3	0.52	0.66	mg/kg
TIN	UPPER	92	23	61.75	112.28	mg/kg
VANADIUM	UPPER	99	98	31.49	28.50	mg/kg
ZINC	UPPER	98	96	36.86	51.12	mg/kg

DOE, 1993. Background Geochemical Report, Table D-16, RFETS, September, 1993.

Table F5
Subsurface Background Soils - Radionuclides

Analyte	Flow System	Sample Size N	Percent Detects	Mean	Standard Deviation	Units
AMERICIUM	UPPER	28	100	0.00	0.01	pCi/g
CESIUM-137	UPPER	99	100	0.01	0.04	pCi/g
GROSS ALPHA	UPPER	99	100	24.91	9.28	pCi/g
GROSS BETA	UPPER	99	100	24.72	6.06	pCi/g
PLUTONIUM-239,240	UPPER	83	100	0.00	0.01	pCi/g
RADIUM-226	UPPER	83	100	0.75	0.23	pCi/g
RADIUM-228	UPPER	99	100	1.40	0.32	pCi/g
STRONTIUM-89,90	UPPER	99	100	0.03	0.36	pCi/g
TRITIUM	UPPER	99	100	141.72	126.75	pCi/g
URANIUM TOTAL	UPPER	99	100	1.46	0.79	pCi/g
URANIUM-244,234	UPPER	99	100	0.78	0.93	pCi/g
URANIUM-235	UPPER	99	100	0.02	0.05	pCi/g
URANIUM-238	UPPER	99	100	0.73	0.38	pCi/g

DOE, 1993. Background Geochemical Report, Table D-17, RFETS, September, 1993.

APPENDIX G

Elevated Measurement Comparison

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Table G1 Hot Spot Equation Analysis Single Sample Exceedance of Tier I Action Level Pentachlorophenol Soil Data 3
Table G2 Hot Spot Equation Analysis Single Sample Exceedance of Tier II Action Level HCB Soil Data 6

ACRONYM LIST

AOC	area of concern
AL	Action Level
COC	contaminant of concern
EMC	Elevated Measurement Comparison
ft^2	square feet
HS	hot spot
HCB	hexachlorobenzene
IA	Industrial Area
IASAP	Industrial Area Sampling and Analysis Plan
IHSS	Individual Hazardous Substance Site
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
mg/kg	milligrams per kilogram
MYAPC	Maine Yankee Atomic Power Company
PAC	Potential Area of Concern
RESRAD	Residual Radioactivity Computer Code
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
SAP	Sampling and Analysis Plan
UBC	Under Building Contamination
UCL	upper confidence limit

The Elevated Measurement Comparison (EMC) is discussed in Section 5.3 of the Industrial Area (IA) Sampling and Analysis Plan (SAP) (IASAP). The EMC (MYAPC 1999) defines significantly high measurements relative to the size of a hot spot, magnitude of an action level (AL), and mean of the surrounding measurements. The comparison includes an equation that depends on several variables: AL, measured value, size of the hot spot, and size of the area of concern (AOC). The EMC is applicable to all sample results or hot spots that are above the Rocky Flats Cleanup Agreement (RFCA) Tier I or Tier II ALs. In AOCs where all sample results are less than ALs, the EMC is not required.

Because the EMC includes an area-weighting component, results for very small hot spots may indicate action is not necessary for very high contaminant concentrations. To reduce this effect, when the concentration of the contaminant at a hot spot is three times the Tier I AL, action is indicated.

The first term (i) of Equation G1 will be applied to each contaminant of concern (COC) separately. The first term will be used for all observations less than Tier I or Tier II ALs within the AOC. As shown in Equation G1, the first term is defined as the ratio of the 95% upper confidence limit (UCL) of the mean to the RFCA Tier I or Tier II AL for the AOC. Observations greater than the ALs will be excluded from the 95% UCL calculations because this type of censorship will ensure that the data set will comply with normality assumptions required for calculating the 95% UCL.

The second term (j) of the equation will be applied to each sample result that exceeds the RFCA Tier I or Tier II AL separately, so that these results can be evaluated as a function of the hot spot size relative to the AOC and magnitude of the AL. Because human health risks are based on an individual's exposure across an area, the incremental risk due to a small, elevated COC sample result (hot spot) needs to be determined. The second term of Equation G1 is defined as the difference between the 95% UCL of the mean concentration and the sample result divided by the RFCA Tier I or Tier II AL for the given COC. The AL is area-weighted, which is appropriate because the weighted exposure to contamination is random across an area.

The area-weighted AL will be applied to nonradionuclides as shown in Equation G1.

Equation G1

$$\text{If}: \sum_{i=1}^{n}\left[\frac{95\%\text{UCL}_{\text{AOC}}}{\text{AL}}\right]_i + \sum_{j=1}^{n}\left[\frac{\left(\text{SampleResult}_{\text{hs}} - 95\%\text{UCL}_{\text{AOC}}\right)}{\left(\frac{\text{AL} * \text{Area}_{\text{AOC}}}{\text{Area}_{\text{hs}}}\right)}\right]_j \geq 1$$

Then: Action is Indicated

Where:

$(95\%\text{UCL})_{\text{AOC}}$ = 95% UCL of the mean concentration in IHSS, PAC, or UBC Site
AL = Tier I or Tier II soil action level
$(\text{Sample Result})_{\text{hs}}$ = hot spot sample result
$(\text{Area})_{\text{AOC}}$ = IHSS, PAC, or UBC Site

$(Area)_{hs}$ = hot spot site (based on the area surrounding the elevated sample result)
i = number of COCs
j = number of hot spots for a particular COC

For radionuclides, an area factor consistent with Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (1997) guidance is applied to the AL as shown in Equation G2. Radionuclide-specific area factors are based on exposure pathway models, which can be estimated from Residual Radioactivity Computer Code (RESRAD) simulations.

Equation G2

$$\text{If}: \sum_{i=1}^{n}\left[\frac{95\%UCL_{AOC}}{AL}\right]_i + \sum_{j=1}^{n}\left[\frac{\left(SampleResult_{hs} - 95\%UCL_{AOC}\right)}{\left(AL * AF\right)}\right]_j \geq 1$$

Then: Action is Indicated

Where:

$(95\%UCL)_{AOC}$ = 95% UCL of the mean concentration in IHSS, PAC, or UBC Site
AL = Tier I or Tier II soil action level
$(Sample\ Result)_{hs}$ = hot spot sample result
AF = area factor (for radionuclides)
i = number of COCs
j = number of hot spots for a particular COC

Examples 1, 2, and 3 use the data listed in Table G1 to illustrate how the equation works for different hot spot sizes and hot spot concentrations. These data were fabricated and are not representative of any area at the Rocky Flats Environmental Technology Site (RFETS).

Example 1:

$$\sum_{i=1}^{n}\left[\frac{1393.9}{4770.0}\right]_i + \sum_{j=1}^{n}\left[\frac{\left(5000_{hs} - 1393.9_{AOC}\right)}{\left(\frac{4770 * 16}{1}\right)}\right]_j = .34$$

This value is less than 1, therefore this hot spot does not need to be remediated. This value is low because of the following:

1) The concentration of the hot spot is close to the Tier I AL.

2) The size of the hot spot is small.

Table G1
Hot Spot Equation Analysis
Single Sample Exceedance of Tier I Action Level Pentachlorophenol Soil Data

Sampling Location	Pentachlorophenol Soil Concentration (mg/kg)	Pentachlorophenol Hot Spot Concentration (mg/kg)	Part 2 Hot Spot Equation Ratio *	Part 1 + Part 2 Hot Spot Equation Total Ratio **
1	50	5000	0.05	0.34
2	100	6000	0.06	0.35
3	150	7000	0.07	0.37
4	200	8000	0.09	0.38
5	250	9000	0.10	0.39
6	500	10000	0.11	0.40
7	600	20000	0.24	0.54
8	700	30000	0.37	0.67
9	600	40000	0.51	0.80
10	800	50000	0.64	0.93
11	1000	60000	0.77	1.06
12	1500	70000	0.90	1.19
13	2000	80000	1.03	1.32
14	2500	90000	1.16	1.45
15	3000	100000	1.29	1.58
Number of Sample Results	15			
Mean Concentration	930.0			
Standard Deviation	916.7			
95% Confidence Interval	463.9			
95% UCL of Mean	1,393.9			
Tier I Office Worker Soil Action Level	4,770.0			
Tier I Ratio (Part I - Hot Spot Equation ($[95\%UCL]_{AOC}$/AL)	0.2922			

* - ([{Sample result}hs - $\{95\%UCL\}_{AOC}$]/[((AL)$(Area)_{AOC}$)/{Area}hs])
** - Assumes that only one hot spot is present and is 1/16 of the total sample area.

Example 2:

If the size of the hot spot was larger, remediation might be necessary. For this example, remediation will occur when the hot spot size equals the AOC size. Remediation of a hot spot of the same size as in Example 1 would occur when the concentration of the hot spot is 55,413 milligrams per kilogram (mg/kg).

$$\sum_{i=1}^{n}\left[\frac{1393.9}{4770.0}\right]_i + \sum_{j=1}^{n}\left[\frac{\left(55413_{hs} - 1393.9_{AOC}\right)}{\left(\frac{4770*16}{1}\right)}\right]_j = 1$$

Example 3:

The EMC calculation indicates that action is not required for this hot spot, however, as stated in Section 5.3 that action will be taken at three times the AL. For example, action is warranted at this hot spot when the measurement is ≥14,310 mg/kg (4770 mg/kg [AL] x 3).

$$\sum_{i=1}^{n}\left[\frac{1393.9}{4770.0}\right]_i + \sum_{j=1}^{n}\left[\frac{\left(15000_{hs} - 1393.9_{AOC}\right)}{\left(\frac{4770*16}{36}\right)}\right]_j = .47$$

Example 4:

For an assumed 36- square feet (ft^2) hot spot in an 6,000 ft^2 Individual Hazardous Substance Site (IHSS) with pentachlorophenol, and a hot spot concentration of 10,000 mg/kg:

$$\sum_{i=1}^{n}\left[\frac{1393.9}{4770.0}\right]_i + \sum_{j=1}^{n}\left[\frac{\left(10000_{hs} - 1393.9_{AOC}\right)}{\left(\frac{4770*6000}{36}\right)}\right]_j = .303$$

Example 5:

Example 5 is being used because the AL is lower than the AL for pentachlorophenol. Example 5 is an assumed 36-ft^2 hot spot in a 6,000-ft^2 IHSS with hexachlorobenzene (HCB) as the COC using the data in Table G2. Table G2 is a hot spot analysis for HCB

in soil assuming a hot spot size 1/16 the size of the AOC. The data listed in Table G2 are not based on actual information or data from RFETS.

$$\sum_{i=1}^{n}\left[\frac{2.7}{2.8}\right]_i + \sum_{j=1}^{n}\left[\frac{\left(7.5_{hs} - 2.7_{AOC}\right)}{\left(\frac{2.8 * 6000}{36}\right)}\right]_j = .98$$

Table G2
Hot Spot Equation Analysis
Single Sample Exceedance of Tier II Action Level
HCB Soil Data

Sampling Location	HCB Soil Concentration (mg/kg)	HCB Hot Spot Concentration (mg/kg)	Part 2 Hot Spot Equation Ratio *	Part 1 + Part 2 Hot Spot Equation Total Ratio *
1	0.1	3.9	0.00	0.97
2	0.5	5.0	0.00	0.98
3	0.9	6.3	0.01	0.98
4	1.2	7.5	0.01	0.98
5	1.4	9.8	0.02	0.99
6	1.7	10.5	0.02	0.99
7	2.0	12.0	0.02	0.99
8	2.2	15.0	0.03	1.00
9	2.5	16.0	0.03	1.00
10	2.8	21.0	0.04	1.01
11	3.0	25.0	0.05	1.02
12	3.6	88.0	0.18	1.15
13	3.5	104.0	0.22	1.19
14	3.7	200.0	0.42	1.39
15	3.0	251.0	0.53	1.50
Number of Sample Results	15			
Mean Concentration	2.1			
Standard Deviation	1.2			
95% Confidence Interval	0.6			
95% UCL of Mean	2.72			
Tier II Office Worker Soil Action Level	2.80			
Tier II Ratio (Part I - Hot Spot Equation ([95%UCL)$_{AOC}$/AL])	0.9.715			

* - [[{Sample result}$_{hs}$ – {95%UCL}$_{AOC}$]/[{(AL)(Area)$_{AOC}$}/{Area}$_{hs}$)]

APPENDIX H

Industrial Area Sampling and Analysis Plan
Quality Assurance Project Plan

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ACRONYM LIST

%D	percent difference
%R	percent recovery
%RSD	relative standard deviation
AL	action level
AR	Administrative Record
ASD	Analytical Services Division
ASQC	American Society of Quality Control
CAS	Chemical Abstract Service
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
CRDL	Contract Required Detection Limit
DER	duplicate error ratio
DMP	Decision Management Plan
DOE	U.S. Department of Energy
DQA	Data Quality Assessment
DQO	data quality objective
DRC	Data Review Checklist
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
GC	gas chromatography
GC/MS	gas chromatography/mass spectrometry
GIS	Geographic Information System
GPS	global positioning system
H&S	Health and Safety
HASP	Health and Safety Plan
IA	Industrial Area
IASAP	Industrial Area Sampling and Analysis Plan
ICP	interference check sample
IMP	Integrated Monitoring Plan
IWCP	Integrated Work Control Package
K-H	Kaiser Hill Company, LLC
LCS	Laboratory control sample
LIBS	laser-induced breakdown spectroscopy
M&TE	measurement and test equipment
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDA	minimum detectable activity

MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
n	number of observations
NIST	National Institute of Standards Technology
PARCC	precision, accuracy, representativeness, completeness, and comparability
PATS	plant action tracking system
PE	performance evaluation
QA	quality assurance
QAPjP	Quality Assurance Project Plan
QC	quality control
RDL	required detection limit
RFCA	Rocky Flats Cleanup Agreement
RFEDS	Rocky Flats Environmental Database System
RFETS	Rocky Flats Environmental Technology Site
RPD	relative percent difference
RSP	Radiological Safety Practices
RWP	Radiological Work Permit
SAP	Sampling and Analysis Plan
SDP	standard data package
SOP	standard operating procedure
SOW	Statement of Work
STD	standard
SWD	Soil/Water Database
TBD	to be decided
TCLP	Toxicity Characteristic Leaching Procedure
TIC	tentatively identified compound
TPU	total propagated uncertainty
TSR	Training, Scheduling, and Records
UWQ1	usable with qualification, unable to associate with validated Laboratory batch
UWQ2	usable with qualification, potential low bias may exist per validation qualifier
UWQ3	usable with qualification, samples taken without controlling documents
UWQ4	usable with qualification, source material has been remediated
UWQ5	usable with qualification, QC data
V&V	verification and validation
XRF	x-ray fluorescence

1.0 QUALITY ASSURANCE CRITERIA

Quality assurance (QA) criteria presented in this Quality Assurance Project Plan (QAPjP) are consistent with quality requirements as defined by both the U.S. Department of Energy (DOE) (Order 414.1A, *Quality Assurance*) and the U.S. Environmental Protection Agency (EPA) (QA/R-5, *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations*, 1997a). Table H1 provides a "crosswalk" between these requirements, illustrating the overlap between them. The application and implementation of these criteria into items and services will be consistent with the graded approach.

The graded approach is a "process of basing the level of application of managerial controls applied to an item or work according to the intended use of the results and the degree of confidence needed in the quality of the results" (E-4, ANSI/ASQC, 1994). The graded approach is also a function of safety (risk) and security required to accomplish program objectives (10 CFR 830.3). In practical terms, the graded approach requires selective application of QA requirements and control to items and services commensurate with their impact on risks posed to workers, the public, and the environment. EPA states that "Environmental data operations encompass diverse and complex activities, and they represent efforts pertaining to rulemaking, compliance with regulations, and research. Consequently, any plan that is developed to represent how QA/quality control (QC) should be applied to environmental activities must contain considerable flexibility…" (EPA 1994a). The content and level of detail in this QAPjP is tailored to the nature of the work and associated risk with the Industrial Area (IA) Project.

Hazardous and radiological risks to project personnel are addressed in the project's Health and Safety Plan (HASP). 10 Code of Federal Regulations (CFR) 830.120 (QA) does not apply to activities controlled by the IA Sampling and Analysis Plan (SAP) (IASAP), unless inventories of materials, under direct control of the project, become nuclear facilities as defined in DOE Standard 1027-92.

References cited in this appendix are provided in Section 1.6, References, whereas Rocky Flats Environmental Technology Site (RFETS) internal documents are referenced throughout this QAPjP by control numbers maintained at RFETS by Kaiser-Hill Company, L.L.C. (K-H).

QA will also be consistent with the following guidance and regulatory documents:

- ANSI/ASQC E4-1944, American National Standard, Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs;
- DOE Order 414.1, Quality Assurance;
- DOE Order 5400.1, General Environmental Protection Program;
- EPA, 1994a, Guidance for the Data Quality Objectives Process; QA/G-4;

Table H1
Crosswalk Between EPA QA/R-5 and DOE Order 414.1A

			DOE Order 414.1A Requirements								
	Program	Personnel Training & Qualification	Quality Improvement	Documents & Records	Work Processes	Design	Procurement	Inspection/Acceptance Testing	Management Assessment	Independent Assessment	
EPA QA/R-5 Elements											
A1 Title and Approval Sheet				■							
A2 Table of Contents				■							
A3 Distribution List				■							
A4 Project/Task Organization	■					■					
A5 Problem Definition & Background	■										
A6 Project/Task Description	■										
A7 Quality Objectives & Criteria for Measurement Data					■	■					
A8 Special Training Requirements		■									
A9 Documentation & Records	■			■							
B1 Sampling Process and Design					■	■					
B2 Sampling Methods Requirements					■	■					
B3 Sample Handling and Custody Requirements					■	■					
B4 Analytical Methods Requirements					■	■					
B5 Quality Control Requirements					■	■		■			
B6 Instrument/Equipment Testing, Inspect. & Maintenance Reqs.					■	■		■			
B7 Instrument Calibration & Frequency					■	■		■			
B8 Inspection/Acceptance Requirements - Supplies/Consumables					■	■	■	■			
B9 Data Acquisition Requirements					■	■					
B10 Data Management					■	■					
C1 Assessments & Response Actions			■						■	■	
C2 Reports to Management			■						■	■	
D1 Data Review, Validation, & Verification Requirements								■			
D2 Validation & Verification Methods								■			
D3 Reconciliation w/ User Requirements					■			■			

- EPA, 1994b, USEPA Contract Laboratory Program National Function Guidelines for Inorganic Data Review;
- EPA, 1997b, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575, EPA 402-R-97-016, December;
- EPA, 1998, Guidance for the Data Quality Assessment Process: Practical Methods for Data Analysis; QA/G-9; and
- EPA, 1999, Guidance on Environmental Data Verification and Validation, QA/G-8.

2.0 MANAGEMENT

2.1 PROGRAM

The IA quality program implements requirements set forth in Order 414.1A, which is "flowed-down" through the RFETS-specific quality documents of K-H (K-H-QAPD-001**,** *Quality Assurance Program Description*). Key personnel and organizations for project management are provided in the project's organization charts (Figures 35 and 36). The organization charts illustrate the infrastructure, functional responsibilities, levels of authority, and organizational interfaces necessary to accomplish the projects goals and K-H's contractual commitments to DOE.

The documents listed in Section 1.0 and the QA Implementation Matrix (Table H2) provide a general perspective of the documents establishing the engineering and administrative controls in place for the IA Project. Specific document and record control numbers may be obtained through review of the IA Project Files, K-H Records Center, or K-H Document Control.

2.2 PERSONNEL TRAINING AND QUALIFICATION

Personnel will be qualified to perform their respective tasks based on a combination of education, training, and experience. Education and professional experience will constitute the primary means of qualification for activities that emphasize management and problem-solving strategies. Training will be the primary means of qualification where:

- Consistency and team coordination constitutes a major component of the overall quality (or safety) of the process or item; and
- The process is well established, proven, and perfunctory.

In addition, a project-specific QA briefing will be given during the pre-evolution briefing before project start-up in the field. New personnel will also receive a QA briefing prior to their participation on the project. The QA briefing will cover the requirements stated in this QAPjP and will be documented via an attendance roster.

Table H2
QA/QC Implementation Matrix for the IASAP

DOE Quality Requirement		Implementing Documents and Quality Records
Management	Program	*Rocky Flats Cleanup Agreement* (RFCA) *K-H Team Quality Assurance Program* IA QAPjP (this section of the IASAP) *Stop Work Action* (1-V10-ADM-15.02)
	Training/Qualification	Health & Safety Plan (HASP) K-H Human Resources (Personnel Files) Subcontractor (various) Human Resources (Personnel Files) Readiness Review (verifies personnel training) SOWs/Contracts (for subcontractors)
	Quality Improvement	Plant Action Tracking System (PATS) *Corrective Actions Process* (3-X31-CAP-001) K-H Assessment Reports (Independent & Management)
	Controlling Documents	*Document Control Program Manual* (MAN-063-DC) *Site Documents Requirements Manual* (MAN-001-SDRM) *Records Management Guidance for Records Sources* (1-V41-RM-001) *CERCLA Administrative Record Program* (1-F78-ER-ARP.001) SOWs
	Records	Various maps (esp. from GIS/SmartSampling applications) K-H QA Assessment Reports Analytical/radiochemistry data packages, incl. EDDs IA Final Reports/Technical Memoranda H&S Quality Records, per HASP Radiological Quality Records, incl. routine monitoring Administrative Record (AR) Daily Shift Reports Field Logbooks (controlled) ER GIS Database (ARC/INFO; land surveys/GPS)
Performance	Work Processes	*Control of Processes* (1-C20-QAP-09.01) *Industrial Area Sampling & Analysis Plan* (IASAP) *Integrated Work Control Manual* (MAN-071-IWCP) IWCPs (Integrated Work Control Packages) - TBD *(RFETS Radiological Control Manual* (Radcon Manual) *Radiological Safety Practices* (RSPs) *Site Design Control Manual* (1-W56-COEM-AMN-101) *Conduct of Operations Manual* (MAN-066-COOP) Subcontractor Statements of Work (incl. Gamma Spec) Gamma Spectroscopy Kaiser-Hill Analytical Services Field Laboratory – Organics *RFETS Integrated Monitoring Plan* (IMP) Radiological Work Permits (RWPs) SOPs
	Design	IWCPs (listed above) Industrial Area Sampling & Analysis Plan (IASAP) IASAP Addenda Data Management Plans (TBD)
	Procurement	*Procurement Quality Assurance Requirements* (PRO-572-PQR-001)
	Inspection and Acceptance Testing	Calibration/maintenance records for M&TE *Identification and Control of Items* (1-A67-QAP-08.01) *Inspection and Acceptance Test Program* (1-PRO-072-001)
Assessments	Management	*K-H Mgmt Assessment Program* (3-W24-MA-002)
	Independent	Site Integrated Oversight Manual (MAN-013-SIOM)

Fundamental education and experience are captured by transcripts and resumes, which are maintained by K-H Human Resources or K-H subcontractors, as applicable. Site-specific and project-specific training records are managed within the IA Project File and the K-H Training, Scheduling, and Records (TSR) database. Qualification requirements and records may also be maintained through the project manager, individual staff, procurement (within contractual agreements), and/or the centralized training group within K-H.

2.3 QUALITY IMPROVEMENT

Quality improvement will be realized through use of a systematic means of identifying, tracking, and correcting problems (deficiencies, nonconformances, issues, etc.). Problems may be identified by any project personnel, at any time, through formal documentation of issues as stated in 3-X31-CAP-001, *Corrective Actions Process*. Management and independent assessments will also be used to identify, track, and correct issues (see subsections below). The extent of causal analysis and corrective action will be commensurate with the significance (potential risk) of the failure or problem. "Lessons learned" will be communicated to staff by management where appropriate.

2.4 DOCUMENTS AND RECORDS

Work-controlling documents, such as work plans (including Integrated Work Control Packages [IWCPs]), standard operating procedures (SOPs), HASPs, etc., will be controlled, where "control" is constituted by the following criteria:

- The documents are uniquely identified for reference purposes.
- The required reviews and approvals are accomplished.
- The personnel who need the documents to perform work use the latest approved versions of the document(s).

The document control process is described in MAN-063-DC-06.01, *Document Control Program Manual*, and MAN-001-SDRM, *Site Document Requirements Manual*. Essential policies, plans, procedures, decisions, data, and transactions of the project will be documented to an appropriate level of detail. The objective will be to maximize the utility of records and data for accomplishment of performance objectives while minimizing the cost of information management and paperwork for the project (K-H) and its subcontractors. The documents controlling this project are summarized in Table H2.

All documents that constitute contractual deliverables to DOE, such as work plans or final reports, will undergo a minimum of three reviews to ensure that minimum quality requirements are met:

- Management review (level of management higher than originating author[s]);
- Technical/peer review (subject matter experts as determined by management); and
- QA review.

The project manager may assign other technical reviewers, as applicable, to cover the technical disciplines represented within the document.

Quality records, including digital data stored on computerized media, will be managed to ensure that information is retained, retrievable, and legible. Active records will be maintained by project personnel, including K-H subcontractors, in an organized and retrievable fashion, until such time that the records have served their purpose and become inactive. Quality records are considered active until the final peer reviews are conducted and are not subject to the 30-day limit on turnover to the Records Center until final peer reviews are conducted. Peer reviews of records must be conducted on records completed by the originator within 2weeks of completion. Records at the job site will be stored and protected in standard filing cabinets, consistent with 1-V41-RM-001**,** *Records Management Guidance for Records Sources*, and ultimately with 1-F18-ER-ARP.001, *Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Administrative Record Program*. Quality records managed by subcontractors will be consistent with K-H requirements.

Quality records resulting from direct measurements or technical sampling activities will be authenticated by the originator and subsequently authenticated by a peer reviewer ("QC checked"). For data uploaded to computer from the quality records described above, final data entry (as portrayed on hardcopy output or electronic file) must be reviewed by someone other than the data entry person. Errors and changes on completed quality records will be maintained as follows:

- Hardcopy - By striking through the original entry with a line, and incorporation of the correct data and authentication adjacent to the strikeout; and
- Electronic files - By incorporating configuration/change control in each applicable document, where all changes and additions (e.g., QC checks) are dated with electronic signatures.

K-H Analytical Services Division (ASD) is responsible for archiving all original hardcopy records produced by offsite laboratories. The K-H Soil/Water Database (SWD) will archive the complete electronic data deliverables (EDDs) provided by the laboratories via K-H ASD. The IA Project will manage, in real time, all data critical for decisionmaking in the field, and will be responsible for summarizing the data into usable formats for reporting purposes. Reporting purposes include primarily, decisions relative to contaminant characterization, remediation, and comprehensive risk assessment. A data flow/data management diagram will be appended to the IASAP prior to fieldwork.

3.0 PERFORMANCE

3.1 WORK PROCESSES

3.1.1 Workforce

Management will hire and maintain a workforce capable of performing the project objectives as set forth in the IASAP. Establishment and maintenance of the workforce for this project will be within budgetary constraints as defined by K-H.

Individual workers are responsible for the quality of their work. Management will provide the workforce with the tools, materials, and resources (including training) necessary for successful accomplishment of their assigned tasks. Performance criteria for personnel are established and

clearly communicated to project personnel through the SAP, associated procedures, and briefings, including "pre-evolution" meetings, readiness reviews, and daily "tool-box" meetings.

3.1.2 Sampling and Analysis

All sampling events will be controlled through documented procedures. These procedures, specific to the type of sampling implemented, are referenced throughout the IASAP, within the context of sampling discussions, as applicable.

Field methods for metals will be correlated (regressed) with SW-846 methodology, specifically SW6010 and/or 6020. As sampling and analysis in the field progresses, approximately 5 to 10 percent of the samples will be analyzed in a separate laboratory for correlation of results. Such a correlation will provide a basis for overall accuracy and precision.

Inorganic chemical analysis will be correlated to (onsite analysis) or consistent with (offsite analysis) SW-846 methodologies as follows:

- General metals suite -- SW6010/6020;
- Beryllium -- SW7090/7091;
- Mercury -- SW7471A; and
- Inorganic metals -- K-H Module SS05.

Quality controls required for all chemical and radiological services will be further specified in contractual requirements with the applicable vendors (i.e., within Statements of Work [SOW], in progress).

Verification samples will be taken on a systematic basis during field measurements to ensure adequate quality control of the field-based sampling and analysis process. Verification samples are necessary to ensure systematic control of quantitative field-based measurements (e.g., those samples analyzed by x-ray fluorescence [XRF] or laser-induced breakdown spectroscopy [LIBS]) and progression of the characterization/remediation process as a whole. Verification sampling cannot be relegated to only latter stages of the project because of two basic potential liabilities:

1. Problems discovered with repeatability of field measurements (only at the end of the project) would cast ambiguity on the entire field measurement effort (in contrast to correlation of problems with specific segments of field sampling, and thus specific, smaller data sets).
2. Field measurements unassociated with remediation would have no process control, as only the confirmation samples would be analyzed by routine SW-846 methods.

A combination of sampling strategies is planned for the IA. Both statistical (EPA 1994a, QA/G-4, and EPA 1998, QA/G-9) and geostatistical methods will be adopted. Use of these two general approaches is consistent with use of the EPA data quality objective (DQO) process, which determines the types, quality, and quantity of data needed for environmental decisionmaking, while optimizing time and cost considerations.

3.1.3 Radiological Surveys

Radiological surveys and monitoring will be routinely performed, primarily for purposes of ensuring contamination control and general Health and Safety (H&S) purposes. All surveys for

removable and fixed contamination, as well as monitoring for airborne contamination, will be performed and reported consistent with RFETS Radiological Safety Practices (RSPs). Those RSPs planned for implementation in the IA Project are listed and controlled on the RFETS intranet.

3.1.4 Radiochemistry

Gamma spectroscopy is the primary means by which the type and quantity of radionuclides will be determined. In general, gamma spectroscopy will be used in lieu of alpha spectroscopy, because gamma spectroscopy provides data of comparable quality and sensitivity. Limited alpha spectroscopy analyses may be performed for verification/validation of the gamma spectroscopy methods, consistent with the fielding of this technology in other major projects at RFETS (e.g., Trench-1 and 903 Pad). Alpha spectrometry methods are defined in the following controlling documents:

- K-H Module RC01, *Isotopic Determinations by Alpha Spectrometry*; and
- K-H Module GR01, *General Laboratoryy Requirements*.

Gamma spectroscopy methods for the project may be used in at least two configurations: in situ and field laboratories. In situ methods are measurements acquired in the field for two-dimensional measurements (areal), or three-dimensional measurements with limited thickness. field laboratory methods will count containerized samples with distinct 3D configurations. An initial draft of QC specifications for the in situ techniques is given in Attachment H1. Field laboratory specifications are addressed in K-H Module RC03, *Determination of Radionuclides by Gamma Spectrometry*. These controls will be contractually required of the gamma spectroscopy vendor. The attachment will be revised before requests for proposals are released to vendors.

3.1.5 Analytical Chemistry

Analytical chemistry generally consists of two types: organic and inorganic, both of which are addressed separately with respect to QC.

Variances to the referenced protocols are summarized below, which allow for mobile methods that will be faster and less expensive than traditional methods, while concurrently providing sufficient quality in the data for making project decisions (including risk assessment). More specific variances will be provided in the final SOW for the vendor ultimately providing analytical services. Generally, the variances reside in the following areas:

- Abbreviated analytical suites, based on IA contaminants of concern (COCs) only;
- Generalized accuracy specifications, especially percent recoveries;
- Sensitivity specifications, as detailed below; and
- Reporting requirements for abbreviated data packages, with emphasis on EDD specifications designed for use in the field.

Organic chemical analysis will be accomplished through use of a mobile gas chromatography (GC) or gas chromatography/mass spectrometry (GC/MS), preceded by the appropriate extraction/digestion method. Preparation and analytical methods will consist of SW-846

methodology, and will generally be consistent with existing K-H ASD contractual requirements, as referenced below:

- K-H Module SS01, *Volatile Organics*;
- K-H Module SS02, *Semivolatile Organics*; and
- K-H Module SS03, *PCB/Pesticides*.

Inorganic chemistry, primarily metals, will be accomplished through use of both field and laboratory methods. Field methods will implement EPA Method 6200, *Field Portable XRF Spectrometry*, and manufacturer's instructions for a LIBS system. The required analytical suites, sensitivities, and general QC requirements are given in Appendix E of the IASAP.

The minimum quality requirements specific to use of field/portable metals analysis are summarized below:

1. SOPs - The manufacturer's operating instructions will be used. Any deviations or modifications to the instructions provided with the instrumentation will be documented and dispositioned by both the manufacturer/vendor and the project. Use of SOPs will also include full-range calibrations, periodic performance checks, and maintenance of equipment.

2. Sample Preparation/Measurements - Bulk samples will be composited and homogenized for the purpose of optimizing sample precision. A procedure for sample preparation to homogenize samples before analysis will be produced and controlled as a prerequisite to field analysis, consistent with EPA guidance (EPA 1995). Specific sampling geometries may also be considered, such as compositing samples about a point via a symmetrical, triangular pattern.

3.2 DESIGN

Sound engineering/scientific principles and appropriate technical standards will be incorporated into designs to ensure that they perform as intended, including use of the RFETS Conduct of Engineering Manual.

Final designs, as documents, quality records, or computerized data, will undergo validation through peer review. Peer reviews will be commensurate with the scale, cost, specialty, and hazards of the item or activity in question. Management approval, in addition to peer and quality reviews of designs, will be obtained prior to procurement, manufacture, construction, or field implementation. Peer and quality reviews are corroborated through authentication of the design reviews.

3.2.1 Data Quality Objectives

DQOs are addressed, in detail, in IASAP Section 3.0.

3.2.2 Computerized Systems (Software/Hardware)

Design control of computerized systems will be commensurate with the hazards associated with the process for which the computer system controls. Systems controlling critical H&S processes will be verified and validated as prescribed in either the HASP or the RSPs, and must simulate

working conditions prior to usage in real settings. Such systems will also be tested periodically to ensure functionality as defined in the RFETS *Radiation Control Manual* or the HASP.

Computerized systems used for data reduction and analysis will be controlled to:

- Ensure traceability of changes made to original data; and
- Allow independent peer reviewers to relate inputs to outputs.

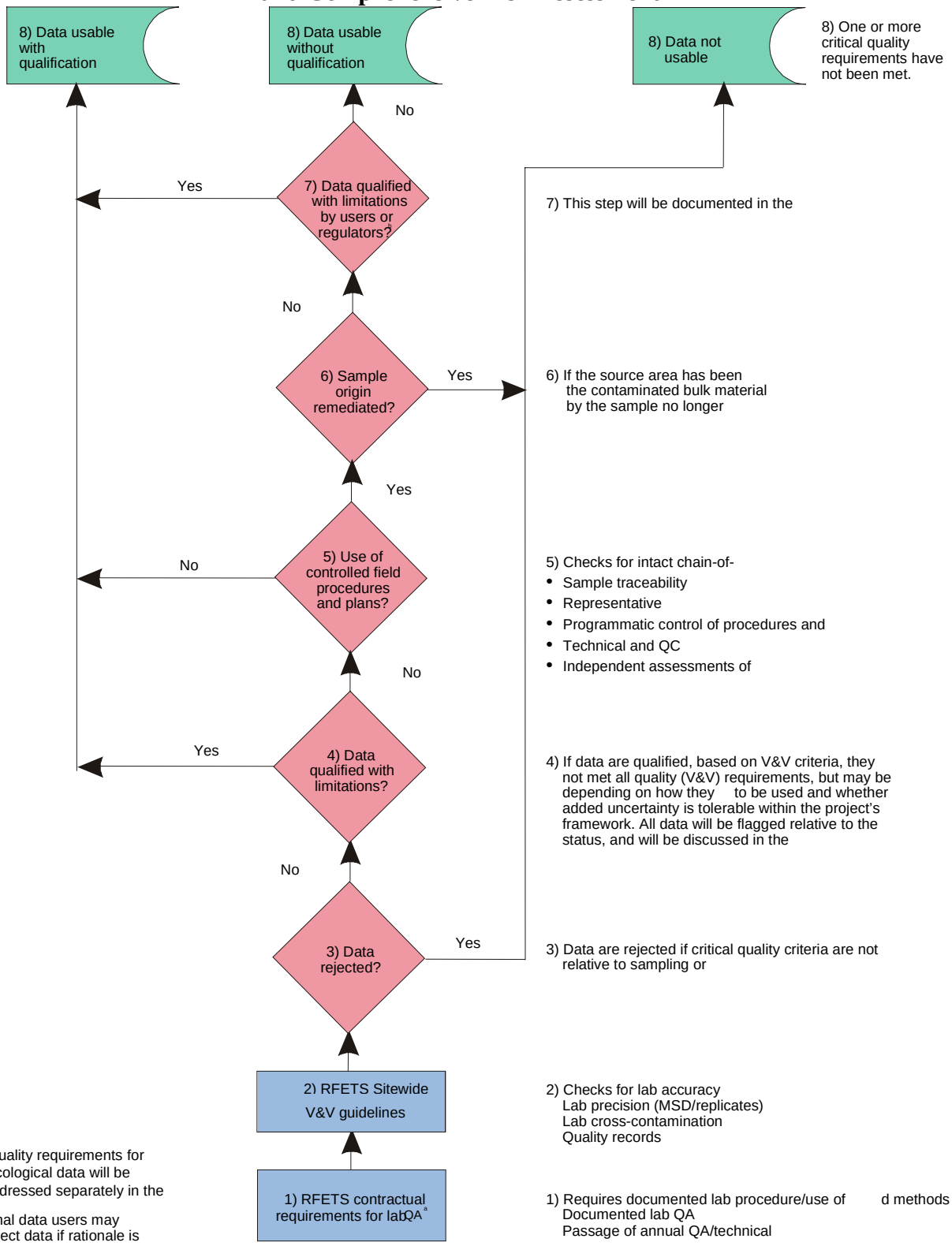
Computerized systems used for measurements will be calibrated via "system calibrations" (i.e., while integrated with all relevant software/hardware configurations, as they are to be operated during routine use). Management of digital data through computerized systems is described in the IASAP, Section 6.0.

Figures H1, H2, and H3 illustrate the minimum quality criteria required of the data prior to its use in the IA Project. Tables H3 through H7 provide further database filter criteria, illustrated on the flowcharts, relative to qualification of data required for characterization and/or risk assessment. Duplicate records from legacy data (i.e., historical analytical data digitally archived within the RFETS SWD were removed from the IA data set to improve efficiency and integrity. Criteria for defining duplicate records were as follows:

- Location code;
- Sample collection date;
- Test method;
- Laboratory analysis date;
- Chemical Abstract Service (CAS) number;
- Result type code;
- Result; and
- Dilution factor.

A separate Environmental Restoration (ER) Decision Management Plan (DMP) (in progress) will document all specifications and detailed maintenance and quality requirements for data produced, archived, and reported for the project. These data will be produced from various activities under control of the project, including characterization, remediation, and risk assessment.

Figure H1
Data Quality Filter for the Industrial Area Sampling and Analysis Plan and Comprehensive Risk Assessment



[a] Quality requirements for ecological data will be addressed separately in the

[b] Final data users may reject data if rationale is

Figure H2
Industrial Area Data Quality Filter –Subsurface Soil

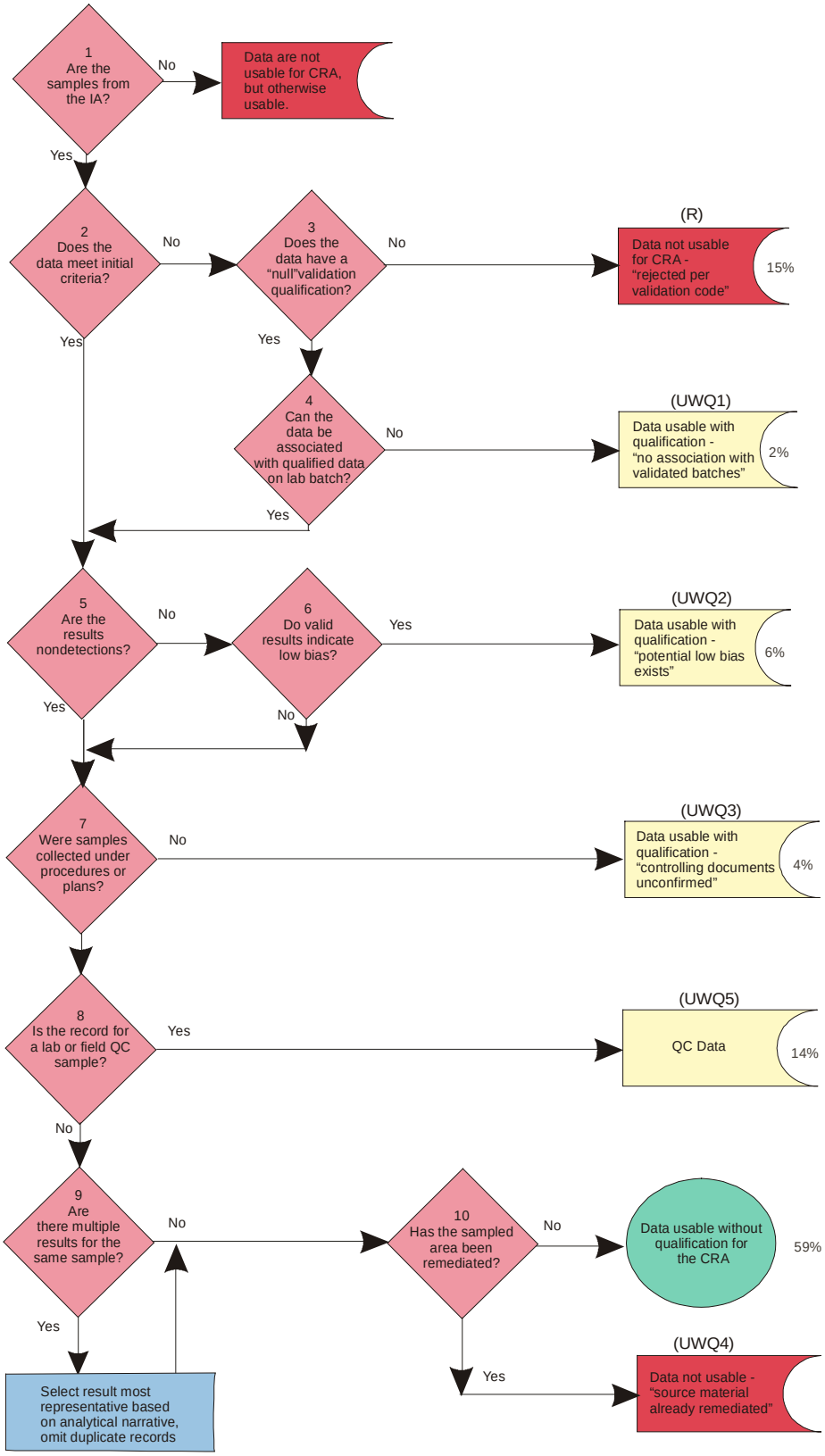


Figure H3
Industrial Area Data Quality Filter – Surface Soil

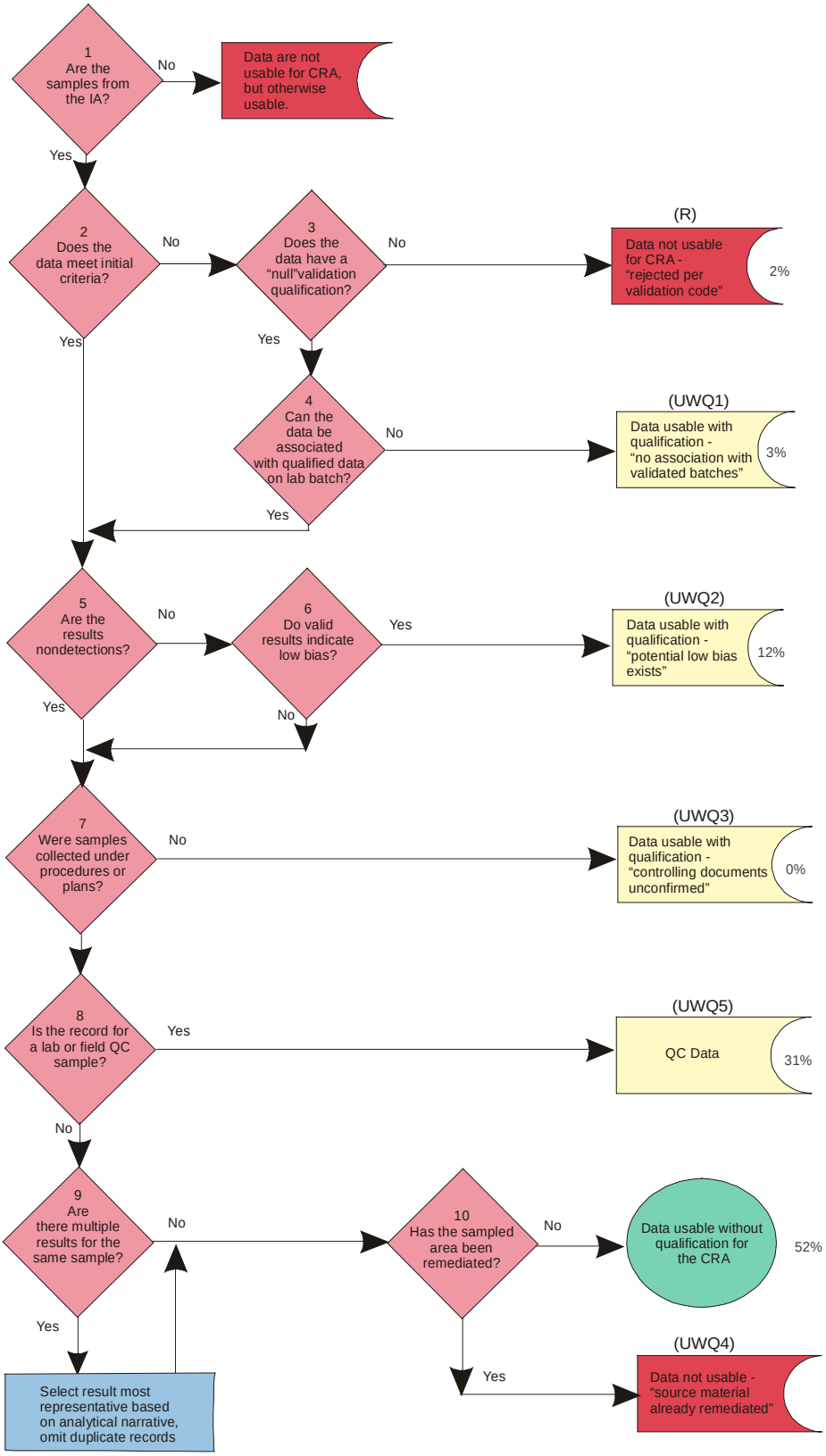


Table H3
Validation Qualifier Codes

Validation Qualifier Code	SWD Definition (sic)	How the Code Was Used in the Filter	Rationale for Inclusion in the Data Quality Filter
1	QC DATA; PACKAGE VERIFICATION (PARTIAL OR COMPLETE)	NA	NA
A	DATA ARE ACCEPTABLE, WITH QUALIFICATIONS	NA	NA
A1	DATA ARE ACCEPTED W/ QUALIF.; BY ONSITE VALIDATORS	NA	NA
B	INDICATES COMPOUND WAS FOUND IN BLK AND SAMPLE	NA	NA
C	CALIBRATION	NA	NA
E	ASSOC VAL EXCEEDS CALIB RANGE DILUTE AND REANALYZE	NA	NA
J	Estimated quantity - Validation	NA	NA
J1	Estimated quantity - Verification	NA	NA
J2	Estimated quantity - Examination	NA	NA
N	HISTORICAL--VALIDATORS ASKED NOT TO VALIDATE THIS	NA	NA
P	SYSTEMATIC ERROR	NA	NA
R	Data are unusable - Validation	NA	NA
R1	Data are unusable - Verification	Fig 1, Diamond 3, Figs 2 & 3, Diamonds 2 & 3, R (rejected)	QC deficiency results in unquantifiable uncertainty of contaminant concentration
R2	Data are unusable - Examination	Fig 1, Diamond 3, Figs 2 & 3, Diamonds 2 & 3, R (rejected)	QC deficiency results in unquantifiable uncertainty of contaminant concentration
S	MATRIX SPIKE	NA	NA
U	ANALYZED, NOT DETECT AT/ABOVE METHOD DETECT LIMIT	NA	NA
U1	ANALYZED, NOT DETECT AT/ABOVE METH DET LIMIT, VERIFICATION	NA	NA
V	No problems with the data - Validation	NA	NA
V1	No problems with the data - Verification	NA	NA
V2	No problems with the data - Examination	NA	NA
Y	ANALYTICAL RESULTS IN VALIDATION PROCESS	NA	NA
Z	VALIDATION WAS NOT REQUESTED OR PERFORMED	NA	NA
JA	Estimated, acceptable	NA	NA
JB	ORGANIC METHOD BLANK CONTAMINATION - VALIDATION	NA	NA
JB1	ORGANIC METHOD BLANK CONTAMINATION - VERIFICATION	NA	NA
JB2	ORGANIC METHOD BLANK CONTAMINATION - EXAMINATION	NA	NA
NJ	Associated value is presumptively estimated	NA	NA
NJ1	Value presumptively estimated - Verification	NA	NA
NJ2	Value presumptively estimated - Examination	NA	NA
R1	DATA ARE UNUSABLE - VERIFICATION	NA	NA
UJ	Associated value is considered estimated at an elevated detection	NA	NA
UJ1	Estimated at elevated level - Verification	NA	NA
UJ2	Estimated at elevated level - Examination	NA	NA
VA	Data are valid, acceptable with qualifications	NA	NA

NA This validation qualifier code was not used in the data quality filter.
NOTE: dbIAFilterTotalrev2.mdb must be revised so as not to reject subsets of data covered by these qualifiers.

Table H4
Validation Reason Codes

Validation Reason Code	Definition	How the Code Was Used in the Filter	Rationale for Inclusion in the Data Quality Filter
***	Unknown code from RFEDS	NA	NA
1	Holding times were exceeded	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
10	LCS recovery criteria were not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
101	Holding times were exceeded (attributed to laboratory problem)	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
102	Holding times were grossly exceeded (attributed to laboratory problem)	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
103	Calibration correlation coefficient does not meet requirement	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
104	Calibration verification recovery criteria were not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
105	Low-level check sample recovery criteria were not met	NA	NA
106	Calibration did not contain minimum number of STDS	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
107	Analyte detected but < RDL in calibration blank verification	NA	NA
109	Interference indicated in the ICP (interf chk smpl)	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
11	Duplicate sample precision criteria were not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
110	LCS recovery criteria were not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
111	Laboratory duplicate sample precision criteria were not met	NA	NA
112	Predigestion matrix spike (MS) criteria were not met (+/- 25%)	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
113	Predigestion MS recovery is <30%	NA	NA
114	Postdigestion MS criteria were not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
117	Serial dilution percent criteria not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
12	Predigestion MS criteria were not met (+/- 25%)	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
128	Improper aliquot size	NA	NA
129	Verification criteria for frequency or sequence were not met	NA	NA

Validation Reason Code	Definition	How the Code Was Used in the Filter	Rationale for Inclusion in the Data Quality Filter
13	Predigestion MS criteria were not met (<30%)	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
136	MDA exceeded the RDL		
139	Tune criteria were not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
14	Postdigestion MS recovery criteria were not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
140	Requirements for independent calibration verification were not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
141	Continuing calibration verification criteria were not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
142	Surrogates were outside criteria	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
143	Internal standards were outside criteria	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
145	Results were not confirmed	NA	NA
147	Percent breakdown exceeded 20 percent	NA	NA
148	Linear range of measurement system was exceeded	NA	NA
149	Method, preparation, or reagent blank contamination > RDL	NA	NA
15	MS/matrix spike duplicate (MSD) was required but not performed	NA	NA
152	Reported data do not agree with raw data	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
153	Calculation error	NA	NA
155	Original result exceeded range of calibration, result report	NA	NA
159	Magnitude of calibration verification blank result exceeded	NA	NA
16	MS/MSD calibration correlation coefficient <0.995	NA	NA
168	QC sample frequency does not meet requirements	NA	NA
17	Serial dilution criteria were not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
175	Blank data not submitted	NA	NA
18	Documentation was not provided	NA	NA
19	Calibration verification criteria not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
199	See hardcopy for further explanation	NA	NA
2	Holding times were grossly exceeded	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration

Validation Reason Code	Definition	How the Code Was Used in the Filter	Rationale for Inclusion in the Data Quality Filter
20	AA duplicate injection precision criteria were not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
201	Preservation requirements were not met by the laboratory	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
205	Unobtainable omissions or errors on SDP deliverables (requirement)	NA	NA
206	Analyses were not requested according to SOW.	NA	NA
207	Sample pretreatment or sample preparation method is incorrect	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
21	Reagent blanks exceeded MDA	NA	NA
213	Instrument detection limit is greater than the associated rd	NA	NA
214	IDL is older than 3 months from date of analysis	NA	NA
216	Post digestion spike recoveries were outside of 85 -115% criteria	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
219	Standards have expired or are not valid	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
22	Tracer contamination	NA	NA
229	Element not analyzed in ICP interference check sample	NA	NA
23	Improper aliquot size	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
230	QC sample/analyte (e.g. spike, duplicate, LCS) was not analyzed	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
231	MS/MSD criteria were not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
232	Control limits were not assigned correctly	NA	NA
234	QC sample does not meet method requirement	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
235	Duplicate sample control limits do no pass	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
236	LCS control limits do not pass	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
237	Prep blank control limits do not pass	NA	NA
238	Blank correction was not performed	NA	NA
24	Sample aliquot not taken quantitatively	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
242	Tracer requirements were not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
243	Std values were not calculated correctly (LCS, tracer, standards)	NA	NA

Validation Reason Code	Definition	How the Code Was Used in the Filter	Rationale for Inclusion in the Data Quality Filter
246	Background calibration criteria were not met	NA	NA
249	Result qualified due to blank contamination	NA	NA
25	Primary standard had exceeded expiration date	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
250	Incorrect analysis sequence	NA	NA
251	Miss identified target compounds	NA	NA
26	No raw data submitted by the Laboratory	NA	NA
27	Recovery criteria were not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
28	Duplicate analysis was not performed	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
29	Verification criteria were not met	NA	NA
3	Initial calibration correlation coefficient <0.995	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
30	Replicate precision criteria were not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
31	Replicate analysis was not performed	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
32	LCSs >+/- 3 sigma	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
33	LCSs >+/- 2 sigma and <+/- 3 sigma	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
36	MDA exceeded the RDL	NA	NA
37	Sample exceeded efficiency curve weight limit	NA	NA
38	Excessive solids on planchet	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
39	Tune criteria were not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
4	Calibration verification criteria were not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
40	Organics initial calibration criteria were not met	NA	NA
41	Organics cont. Calibration criteria were not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
42	Surrogates were outside criteria	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
43	Internal standards were outside criteria	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration

Validation Reason Code	Definition	How the Code Was Used in the Filter	Rationale for Inclusion in the Data Quality Filter
44	No mass spectra were provided	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
45	Results were not confirmed	NA	NA
47	Percent breakdown exceeded 20 percent	NA	NA
48	Linear range of instrument was exceeded	NA	NA
49	Method blank contamination	NA	NA
5	CRDL check sample recovery criteria were not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
51	Nonverifiable Laboratory results and/or unsubmitted data	NA	NA
52	Transcription error	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
53	Calculation error	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
54	Incorrect reported activity or MDA	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
55	Result exceeds linear range, serial dilution validation reported	NA	NA
56	IDL changed due to significant figure discrepancy	NA	NA
57	Percent solids < 30 percent	NA	NA
58	Percent solids < 10 percent	NA	NA
59	Blank activity exceeded RDL	NA	NA
6	Incorrect calibration of instrument	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
60	Blank recovery criteria were not met	NA	NA
61	Replicate recovery criteria were not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
62	LCS relative percent error criteria were not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
63	LCS expected value was not submitted/verifiable	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
64	Nontraceable/noncertified standard was used	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
67	Sample results were not submitted/verifiable	NA	NA
68	Frequency of quality control samples was not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
69	Samples were not distilled	NA	NA
7	Analyte values > IDL were found in the blanks	NA	NA
70	Resolution criteria were not met	NA	NA

Validation Reason Code	Definition	How the Code Was Used in the Filter	Rationale for Inclusion in the Data Quality Filter
701	Holding times were exceeded (not attributed to Laboratory)	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
702	Holding times were grossly exceeded (not attributed to Laboratory)	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
703	Samples were not preserved properly in the field (not attrib)	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
71	Unit conversion of results	NA	NA
72	Calibration counting statistics were not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
74	LCS data were not submitted	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
75	Blank data was not submitted	NA	NA
76	Instrument gain and/or efficiency not submitted	NA	NA
77	Detector efficiency criteria were not met	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
78	MDAs were calculated by reviewer	NA	NA
79	Result obtained through dilution	NA	NA
8	Negative bias was indicated in the blanks	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
80	Spurious counts of unknown origin	NA	NA
801	Missing deliverables (required for data assessment)	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
802	Missing deliverables (not required for data assessment)	NA	NA
803	Omissions or errors on SDP deliverables (required for data A	NA	NA
804	Omissions or errors on SDP deliverables (not required for da	NA	NA
805	Information missing from narrative	NA	NA
806	Site samples were not used for sample matrix QC	NA	NA
807	Original documentation was not provided	NA	NA
808	Incorrect or incomplete Data Review Checklist (DRC)	NA	NA
81	Repeat count outside of 3 sigma counting error	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
810	EDD does not match hardcopy; may be resubmitted	NA	NA
82	Sample results were not corrected for decay	NA	NA
83	Sample results were not included on data sum. Table	NA	NA
84	Key fields wrong	NA	NA
85	Record added by validation	NA	NA

Validation Reason Code	Definition	How the Code Was Used in the Filter	Rationale for Inclusion in the Data Quality Filter
86	Results considered. Qualitative not quantitative	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
87	Laboratory did not perform analysis for this record	NA	NA
88	Blank corrected results	NA	NA
89	Sample analysis was not requested	NA	NA
9	Interference indicated in the ICP interference check sample	Fig 1, Diamond 4, Figs 2 & 3, Diamonds 5 & 6, UWQ2	QC deficiency results in possible underestimation of analyte concentration
90	Sample result was not validated due to reanalysis	NA	NA
91	Unit conversion, QC sample activity/uncertainty/MDA	NA	NA
99	See hardcopy for further explanation	NA	NA

NA This validation reason code was not used in the data quality filter.

Indicates that query must be modified to include these criteria to yield a UWQ2 qualification.

Table H5
Result Type Codes

Result Type Code	Definition	How the Code Was Used in the Filter	Rationale for Inclusion in the Data Quality Filter
BL1	Reagent blank - 1st try (rads only)	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
BL2	Reagent blank - 2nd try (rads only)	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
BL3	Reagent blank - 3rd try (rads only)	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
BL4	Reagent blank - 4th try (rads only)	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
BLK	Blank	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
BS	Blank spike	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
BS1	Blank spike	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
BS2	Blank spike	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
BS3	Blank spike	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
BS4	Blank spike	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
BSD	Blank spike duplicate	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
D	Laboratory duplicates	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
DIL	Dilution	NA	NA
DL	Normal 1st run dilution	NA	NA
DL1	Dilution	NA	NA
DL2	2nd analysis run dilution	NA	NA
DL3	Dilution	NA	NA
DL4	4th analysis run dilution	NA	NA
DL5	5th analysis run dilution	NA	NA
DL6	6th analysis run dilution	NA	NA
DL7	7th analysis run dilution	NA	NA
DL8	8th analysis run dilution	NA	NA
DL9	9th analysis run dilution	NA	NA
DP1	Laboratory duplicate - 1st retry	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
DP2	Laboratory duplicate - 2nd retry	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
DP3	Laboratory duplicate - 3rd retry	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
DUP	Laboratory duplicate	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
FIX	Laboratory incorrectly used tic or	NA	NA

Result Type Code	Definition	How the Code Was Used in the Filter	Rationale for Inclusion in the Data Quality Filter
	surrogate, Quantalex will fix		
LC1	Laboratory control sample - 1st try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LC10	Laboratory control sample - 10th try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LC11	Laboratory control sample - 11th try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LC12	Laboratory control sample - 12th try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LC1B	Laboratory control blank	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LC2	Laboratory control sample - 2nd try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LC3	Laboratory control sample - 3rd try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LC4	Laboratory control sample - 4th try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LC5	Laboratory control sample - 5th try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LC6	Laboratory control sample - 6th try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LC7	Laboratory control sample - 7th try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LC8	Laboratory control sample - 8th try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LC9	Laboratory control sample - 9th try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LCS	Laboratory control sample	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LD	Laboratory duplicate	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LD1	1st Laboratory duplicate	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LD1B	Laboratory control duplicate	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LD2	2nd Laboratory duplicate	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LD3	3rd Laboratory duplicate	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LD4	4th Laboratory duplicate	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LD5	5th Laboratory duplicate	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LD6	6th Laboratory duplicate	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LD7	7th Laboratory duplicate	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LD8	8th Laboratory duplicate	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are

Result Type Code	Definition	How the Code Was Used in the Filter	Rationale for Inclusion in the Data Quality Filter
			aggregated for characterization, risk assessment, or statistics.
LD9	9th Laboratory duplicate	Figures 2 & 3, Diamond 10, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
LFB	Laboratory field blank	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MB	Method blank	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MB1	Method blank - 1st try (non-rad only)	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MB2	Method blank - 2nd try (non-rad only)	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MB3	Method blank - 3rd try (non-rad only)	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MB4	Method blank - 4th try (non-rad only)	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MB5	Method blank - 5th try (non-rad only)	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MB6	Method blank - 6th try (non-rad only)	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MB7	Method blank - 7th try (non-rad only)	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MB8	Method blank - 8th try (non-rad only)	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MB9	Method blank - 9th try (non-rad only)	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MD1	Matrix spike duplicate - 1st try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MD2	Matrix spike duplicate - 2nd try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MD3	Matrix spike duplicate - 3rd try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MD4	Matrix spike duplicate - 4th try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MD5	Matrix spike duplicate - 5th try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MD6	Matrix spike duplicate - 6th try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MD7	Matrix spike duplicate - 7th try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MD8	Matrix spike duplicate - 8th try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MD9	Matrix spike duplicate - 9th try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MS	Matrix blank	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MS1	Matrix spike - 1st try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MS2	Matrix spike - 2nd try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are

Result Type Code	Definition	How the Code Was Used in the Filter	Rationale for Inclusion in the Data Quality Filter
			aggregated for characterization, risk assessment, or statistics.
MS3	Matrix spike - 3rd try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MS4	Matrix spike - 4th try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MS5	Matrix spike - 5th try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MS6	Matrix spike - 6th try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MS7	Matrix spike - 7th try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MS8	Matrix spike - 8th try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MS9	Matrix spike - 9th try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
MSD	Matrix blank duplicate	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
PB	Prep blank	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
PB1	Preparation blank - 1st try (tritium only)	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
PB2	Preparation blank - 2nd try (tritium only)	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
PB3	Preparation blank - 3rd try (tritium only)	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
PB4	Preparation blank - 4th try (tritium only)	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
R	Reanalysis	NA	NA
RA1	Reanalysis 1st try	NA	NA
RA2	Reanalysis 2nd try	NA	NA
RA3	Reanalysis 3rd try	NA	NA
RB	Reagent blank	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
RB1	Reagent blank - 1st analysis	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
RB2	Reagent blank - 2nd analysis	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
RE	Re-extraction	NA	NA
REA	Reanalysis	NA	NA
REP	Replicate	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
REX	Re-extraction	NA	NA
RP1	Replicate - 1st try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
RP2	Replicate - 2nd try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
RP3	Replicate - 3rd try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are

Result Type Code	Definition	How the Code Was Used in the Filter	Rationale for Inclusion in the Data Quality Filter
			aggregated for characterization, risk assessment, or statistics.
RP4	Replicate - 4th try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
RS	Historical value - unknown meaning	NA	NA
RX1	Re-extraction 1st try	NA	NA
RX2	Re-extraction 2nd try	NA	NA
RX3	Re-extraction 3rd try	NA	NA
RX4	Re-extraction 4th try	NA	NA
RX5	Re-extraction 5th try	NA	NA
RX6	Re-extraction 6th try	NA	NA
RX7	Re-extraction 7th try	NA	NA
RX8	Re-extraction 8th try	NA	NA
RX9	Re-extraction 9th try	NA	NA
S	Spike	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
S1	Spike 1st try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
S2	Spike 2nd try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
S3	Spike 3rd try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
SD	Spike duplicate	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
SP	Spike 3rd try	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
SPK	Spike	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
SUR	Surrogate	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
TB	Trip blank	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
TB1	Trip blank - 1st analysis	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
TB2	Trip blank - 2nd analysis	Figures 2 & 3, Diamond 8, UWQ5	QC results must not be confused w/ "real" results when data are aggregated for characterization, risk assessment, or statistics.
TIC	Tentatively identified compound	NA	NA
TR1	Target analysis 1st try	NA	NA
TR2	Target analysis 2nd try	NA	NA
TR3	Target analysis 3rd try	NA	NA
TR4	Target analysis 4th try	NA	NA
TR5	Target analysis 5th try	NA	NA
TR6	Target analysis 6th try	NA	NA
TR7	Target analysis 7th try	NA	NA
TR8	Target analysis 8th try	NA	NA
TR9	Target analysis 9th try	NA	NA
TRG	Target	NA	NA
UNK	Historical value - unknown meaning	NA	NA

Result Type Code	Definition	How the Code Was Used in the Filter	Rationale for Inclusion in the Data Quality Filter
NA	This result type code was not used in the data quality filter.		

Table H6
Validation Reason Codes

Reason Code	Reason Description
101	Holding times were exceeded (attributed to Laboratory problem)
102	Holding times were grossly exceeded (attributed to Laboratory problem)
103	Calibration correlation coefficient does not met requirements
104	Calibration verification recovery criteria were not met
105	Low-level check sample recovery criteria were not met
106	Calibration did not contain minimum number of Standards
107	Analyte detected but < RDL in calibration blank verification
109	Interference indicated in the ICP Interference Check Sample
110	LCS recovery criteria were not met
111	Laboratory duplicate sample precision criteria were not met
112	Predigestion MS criteria were not met (+/- 25%)
113	Predigestion MS recovery is <30%
114	Postdigestion MS criteria were not met
115	MS/MSD was required but not performed
116	MS/MSD calibration correlation coefficient <0.995
117	Serial dilution percent D criteria were not met
123	Improper aliquot size
128	Laboratory duplicate was not analyzed
129	Verification criteria for frequency or sequence were not met
130	Replicate precision criteria were not met
131	confirmation % difference criteria not met
132	Laboratory control samples >+/- 3 sigma
136	MDA exceeded the RDL
139	Tune criteria were not met
140	Requirements for independent calibration verification were not met
141	Continuing calibration verification criteria were not met
142	Surrogates were outside criteria
143	Internal standards were outside criteria
145	Results were not confirmed
147	Percent breakdown exceeded 20 percent
148	Linear range of measurement system was exceeded
149	Method, preparation, or reagent blank contamination > RDL
150	Unknown carrier volume
152	Reported data do not agree with raw data
153	Calculation error
155	Result exceeds linear range, serial dilution value reported
159	Magnitude of calibration verification blank result exceeded the RDL
164	Standard traceability or certification requirements not met
166	Carrier aliquot nonverifiable
168	QC sample frequency does not meet requirements
170	Resolution criteria were not met
172	Calibration counting statistics were not met
174	LCS data were not submitted
175	Blank data were not submitted

Reason Code	Reason Description
177	Detector efficiency criteria were not met
188	Blank corrected results
199	See hardcopy for further explanation
201	Preservation requirements were not met by the Laboratory
205	Unobtainable omissions or errors on SDP deliverables (required for data assessment)
206	Analyses were not requested according to SOW
207	Sample pretreatment or sample preparation method is incorrect
211	Poor cleanup recovery
212	Instrument detection limit was not provided
213	Instrument detection limit is greater than the associated RDL
214	IDL is older than 3 months from date of analysis
215	Blank results were not reported to the IDL/MDL
216	Post digestion spike recoveries were outside of 85 –115% criteria
217	Post digestion spike recoveries were less than 10%
218	Sample COC was not verifiable (attributed to laboratory)
219	Standards have expired or are not valid
220	Toxicity Characteristic Leaching Procedure (TCLP) sample percent solids are less than 0.5%
222	TCLP particle size was not performed
224	Incomplete TCLP extraction data
225	Insufficient TCLP extraction time
226	Tentatively identified compound (TIC) misidentification
227	No documentation regarding deviations from methods or SOW
228	Calibration requirements affecting data quality have not been met
229	Element not analyzed in ICP Interference Check Sample
230	QC sample/analyte (e.g. Spike, Duplicate, LCS) not analyzed
231	MS/MSD criteria were not met
232	Control limits not assigned correctly
233	Sample matrix QC does not represent samples analyzed
234	QC sample does not meet method requirement
235	Duplicate sample control limits do not pass
236	LCS control limits do not pass
237	Prep blank control limits do not pass
238	Blank correction was not performed
239	Winsorized mean and std deviation of the same were not calculated or calculated incorrectly
240	Sample prep for soil, sludge, or sediments have not been homogenized or aliquotted properly
241	No micro ppt. or electroplating data available
242	Tracer requirements were not met
243	Standard values were not calculated correctly (LCS, tracer or standards)
244	Standard or tracer is not National Institute of Standards Technology (NIST) traceable
245	Energy calibration criteria was not met
246	Background calibration criteria was not met
247	Sample or control analytes not chemically separated from each other
248	Single combined TCLP result was not repeated for sample with both miscible and nonmiscible liquids
249	Result qualified due to blank contamination
250	Incorrect analysis sequence
251	Mis-identified target compounds
252	Result is suspect due to level of dilution

Reason Code	Reason Description
701	Holding times were exceeded (not attributed to laboratory)
702	Holding times were grossly exceeded (not attributed to laboratory)
703	Samples were not preserved properly in the field (not attributed to laboratory)
704	Sample COC was not verifiable (not attributed to laboratory)
801	Missing deliverables (required for data assessment)
802	Missing deliverables (not required for data Assessment)
803	Omissions or errors on SDP deliverables (required for data assessment)
804	Omissions or errors on SDP deliverables (not required for data assessment)
805	Information missing from narrative
806	Site samples not used for sample matrix QC
807	Original documentation not provided
808	Incorrect or incomplete DRC
809	Non-Site samples reported with Site samples
COMMENTS	
131	Added 8/10/99 per TechLaw request
252	Added 11/3/00 per letter 01EAB003

Table H7
Validation Qualifiers

Qualifier	Description
V	No problems with the data were observed at the indicated review level.
J	The associated value is an estimated quantity.
JB	Result was qualified due to blank contamination for results below the RDL.
U	The associated value is considered undetected at an elevated level of detection.
NJ	The associated value is presumptively estimated.
UJ	The associated value is considered estimated at an elevated level of detection.
R	The data are unusable. (Note: Analyte may or may not be present.)

3.2.3 Data Quality Assessment

Data Quality Assessment (DQA) is the scientific and statistical evaluation of data to determine whether data are adequate to support project decisions and quantify uncertainties. DQA consists of two basic processes: verification and validation, with application of statistical tests as necessary. Verification and validation ensure that data used to design and conclude the project are usable and defensible.

Verification and Validation

All data (100%) collected during ER characterization and remediation sampling will be verified and validated relative to the ER DMP (in progress) and QA requirements. Verification will consist of ensuring that all data received from the vendor(s) are complete and correctly formatted. Validation will consist of a systematic comparison of all QC requirements with QC results reported by the vendor (e.g., relative to laboratory control samples [LCS], matrix spikes [MS], matrix spike duplicates [MSD], blanks). The verification and validation (V&V) module

(process) will establish ultimate usability of the data by determining, reporting, and archiving the following criteria relative to each measurement set or batch:

- Precision;
- Accuracy;
- Bias;
- Sensitivity; and,
- Completeness.

Representative portions of hardcopy data will be formally validated. Formal validation is currently performed on a Sitewide basis at approximately 25percent frequency of all RFETS subcontracted laboratories managed by K-H ASD. Satisfactory validation at this frequency indicates that the subcontracted laboratories are operating competently on an industry-wide basis. More specifically, analytical procedures are implemented under adequate quality controls. Sitewide data validation coupled with annual laboratory audits also provides the inference that all analytical and radiochemical results that are not specifically validated are under adequate control as well.

PARCC Parameters

Data will be evaluated relative to the precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters as described in the following subsections. Data aggregation and statistical tests are described in the appropriate sections throughout the IASAP.

Precision

Precision is a measure of the reproducibility of results, and is measured through the following sample types:

- Laboratory replicates (radionuclides);
- MSD; and
- Field duplicates.

Through use of these samples, precision is evaluated from two perspectives:

1. Analytical standpoint (reproducibility within the laboratory that reflects analytical precision inherent to the method); and
2. Overall project standpoint, which combines both analytical precision and reproducibility of the field sampling method specific to the matrix type.

Precision may be expressed quantitatively by at least two functions. The most typical measure for nonradiological analyses is the relative percent difference (RPD) term, whereas, because of the stochastic nature of radioactivity, a statistical measure is better suited for evaluating radiological reproducibility - the duplicate error ratio (DER).

Chemical

$$\text{RPD} = \frac{C_1 - C_2}{(C_1 + C_2)/2} * 100$$

Where:

C_1 = first sample
C_2 = duplicate sample

The RPD targets are 35 percent for solids and 20 percent for liquids. If QC results exceed these tolerances, the data must be qualified and/or additional samples may be required.

Radiological

$$\text{DER} = \frac{C_1 - C_2}{\sqrt{(TPU^2 + TPU^2)}}$$

Where:

TPU = total propagated uncertainty

(Note: The counting error, also known as the 2-sigma error, may be used in lieu of the TPU as a conservative measure. If precision exceeds the critical value of 1.96, TPU should be used in the equation prior to qualifying precision of the measurements in question.)

The DER must be less than 1.96 as defined in Evaluation of Radiochemical Data Usability (Lockheed Martin 1997). If DER values exceed the test statistic, associated data must be qualified and additional samples may be necessary. Alternatively, an RPD may also be evaluated to put the statistical exceedance in perspective (i.e., the RPD value may be used as a benchmark value). Commentary will be provided as to how qualifications in precision affect overall uncertainty in the sample results.

Ongoing precision of the radiological survey instrumentation will be evaluated based on logging periodic (daily) source check measurements. Any measurement that exceeds defined tolerance limits ($\pm$20percent) will result in corrective action (e.g., instrument repair or replacement) before measurement of real samples. Further tolerance specifications may be found in the applicable RSPs.

Accuracy

Accuracy is a measure of how closely a measurement corresponds to a standard reference (or the "true") value.

Accuracy will be based on the following criteria:

- Calibrations, with reference standards, periodic full-range and 1-point "performance checks" (all equipment);
- LCS/spikes;
- Laboratory MS;
- Relative standard deviation (%RSD);

- Laboratory blanks (method and equipment);
- Chemical yield (radionuclides);
- Counting time (radionuclides; XRF); and
- Sensor efficiency (radionuclides).

In general, accuracy of instrumentation will be based on annual calibrations of instrumentation and daily source checks that perform within specified tolerances (e.g., ±20percent) as specified in the RSPs (radionuclides) or manufacturer's specifications (nonradiological field instrumentation). Novel or prototypical instrumentation also requires satisfactory passage of blind performance evaluation (PE) samples (within 20 percent of standard value), where existing validation and verification documentation does not cover the equipment (configuration), geometry, or matrix of interest.

Accuracy relative to a standard reference value is typically evaluated relative to percent recovery (%R) or, stated differently, a percent difference (%D), expressed as

$$\%D = \frac{X_1 - X_2}{X_1} * 100$$

Where:

x = observation (concentration or activity)
n = number of observations

Bias will also be considered as a component affecting accuracy, as it indicates the tendency of a measurement system to be consistently higher or lower than the true value. Bias will be discussed relative to its impact on final project decisions.

Representativeness

Representativeness will be achieved through use of the IASAP, together with the use of standard field, sampling, and analytical procedures. All work-controlling documents undergo required reviews and approvals to ensure representativeness of the sampling and analysis effort. Compliance with controlling documents coupled with implementation of other quality controls contributes to corroboration of representative sampling. If the representativeness of any sample set is ambiguous, the data will be qualified and/or additional samples may be required.

Completeness

Completeness is a quantitative measure of data quality expressed as the percentage of valid or acceptable data obtained from the project relative to each medium and analytical suite of interest. The completeness goal for each discrete IA sampling effort is 90 percent. If completeness of any sample set is not achieved, additional data will be required or the data set (and decisions) qualified.

Completeness will be established based on a comparison (ratio, expressed as a percentage) of actual sample results reported versus the number of samples planned.

The formula for calculating completeness is presented below:

$$\% \text{ completeness} = \frac{\text{number of valid results}}{\text{number of planned results}}$$

A summary table, such as the one outlined below, will be used to summarize the data subsets; specific analytes will be broken-out as necessary.

Hazard Type	Planned Number of Samples	Actual Number of Samples	Completeness	Comments
Chemical				
Radiochemical				
Radiological Survey unit				
Other				

Comparability

All results will be comparable with characterization analyses (methods and media) on a national- and DOE Complex-wide basis. This comparability will be based on nationally recognized methods (especially EPA-approved methods), systematic quality controls, use of standardized units of measure, and thorough documentation of the planning, sampling, and analysis process.

Sample collection methods and analyses in accordance with the protocols specified in the IASAP provide comparability with other similar media types and COCs across the DOE Complex and the commercial sector.

Sensitivity

All measurements must have adequate sensitivity, or resolution, to confidently compare results with action levels (ALs). For chemical constituents, MDLs will be provided based on formal MDL studies as stated in Appendix E. For radiochemical constituents, MDLs must also be less than half the associated action level. Derivations of radiological MDLs will be provided for all measurement equipment used, and will follow guidance provided in §6.7.1 of MARSSIM (EPA 1997b).

3.3 PROCUREMENT

Quality requirements will be specified in procurement and subcontract documents. All contracts (subcontracts) that have the potential to affect quality of IA Project services or deliverables will be reviewed for QA requirements to ensure that adequate quality controls are established and implemented. Quality control of procurements will be implemented as described in PRO-572-PQR-001, *Procurement Quality Assurance Requirements*.

3.4 INSPECTION AND ACCEPTANCE TESTING

Items or activities that require inspections and/or acceptance testing will be specified in work-controlling documentation (e.g., work plans, SOPs, and data management plans). Acceptance criteria and any hold points will be clearly defined, and will be based on manufacturer's specification unless otherwise stated. Measurement and test equipment (M&TE) will be accepted or rejected based on calibration information and pre-established tolerances, including unique identification, traceability, accuracy, resolution, measurement ranges, and acceptance/rejection criteria. Materials and equipment that affect quality (of items or services) or H&S will be controlled (i.e., identified, maintained, and traceable) according to their intended purpose. Measurement, monitoring, and data collection equipment will be of the accuracy and resolution needed for their intended purposes based on calibrations. Calibrations will be traceable to nationally recognized or industry standards. Essential policies, plans, procedures, decisions, data, and transactions of the project will be documented to an appropriate level of detail.

4.0 ASSESSMENTS

4.1 MANAGEMENT ASSESSMENT

At least once during the fielding of the project, management will evaluate the organization to determine the effectiveness of the QAPjP and overall K-H organization performance. Management assessments will be documented in formal reports, and will be implemented in accordance 3-W24-MA-002, *K-H Management Assessment Program.*

4.2 INDEPENDENT ASSESSMENT

Independent assessments, in contrast to management assessments, will be performed by personnel who are not directly responsible for the work being performed. Independent assessments will be performed according to MAN-013-SIOM, *Site Integrated Oversight Manual.*

5.0 REFERENCES

10 CFR 830.120, Quality Assurance.

ANSI/ASQC E4-1994, *American National Standard, Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs.*

DOE 1999, DOE Order 414.1A.

EPA, 1994a, Guidance for the Data Quality Objectives Process, EPA QA/G-4.

EPA, 1994b, USEPA Contract Laboratory Program National Function Guidelines for Inorganic Data Review.

EPA, 1995, Superfund Innovative Technology Evaluation Program, Final Demonstration Plan for the Evaluation of Field Portable X-Ray Fluorescence Technologies, EPA Contract No. 68-CO-0047.

EPA, 1997a, EPA Requirements for Quality Assurance Project Plans, QA/R-5.

EPA, 1997b, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575, EPA 402-R-97-016, December.

EPA, 1998, Guidance for the Data Quality Assessment Process: Practical Methods for Data Analysis; QA/G-9.

EPA, 1999, Guidance on Environmental Data Verification and Validation, QA/G-8.

ERDMP, Industrial Area Project Data Management Plan (Environmental Restoration).

Lockheed Martin, 1997, Evaluation of Radiochemical Data Usability, ES/ER/MS-5, Lockheed Martin Environmental Restoration Program, April.

ATTACHMENT H1

In Situ Gamma Spectroscopy Quality Requirements

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ACRONYM LIST

ADC	analog-to-digital converter
ANSI	American National Standards Institute
CA	control area
CTR	Contract Technical Representative
DQO	data quality objective
EDD	electronic data deliverable
F/E	equivalency ratio
FOV	field of view
FWHM	full-width half maximum
FWTM	full-width tenth maximum
GPS	Global Positioning System
HPGe	high-purity germanium
IASAP	Industrial Area Sampling and Analysis Plan
ICD	interference check sample
J	estimated value < MDA
K-H	Kaiser-Hill Company, L.L.C.
keV	kiloelectron volts
LCS	laboratory control sample
M	replicate instrument readings not within control limits
M&TE	measurement and test equipment
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCA	multi-channel analyzer
MDA	minimum detectable activity
NIST	National Institute of Standards Technology
pCi/g	picocuries per gram
QA	quality assurance
QAPjP	Quality Assurance Project Plan
QC	quality control
RDL	required detection limit
REAL	target isotope
RFETS	Rocky Flats Environmental Technology Site
ROI	region of interest
RP	replicate area
SC	source check
SME	subject matter expert
SOP	Standard Operating Procedure
SRM	standard reference material
TBD	to be decided
TPU	total propagated uncertainty
U	undetected, analyzed for, but not detected

1.0 REPORTING AND DELIVERABLE REQUIREMENTS

1.1 QUALITY ASSURANCE PROJECT PLAN

The subcontractor will be responsible for maintaining a Quality Assurance (QA) Project Plan (QAPjP) that outlines their plan for implementing quality control on the project. The QAPjP will describe the policy, organization, functional responsibilities, and QA requirements and methods (Standard Operating Procedures [SOPs]) necessary to ensure that the quality of data meets the objectives dictated by its intended use. The SOPs detail the techniques to be utilized during the investigation and provide guidance for the performance of all fieldwork. The QAPjP will be provided to Kaiser-Hill Company, L.L.C. (K-H) within 2 weeks of notification of award.

1.2 ANSI STANDARDS AND STANDARD OPERATING PROCEDURES

The subcontractor will be responsible for identifying required activities that require the use of SOPs. The subcontractor will also be responsible for identifying any and all American National Standards Institute (ANSI) standards that are determined to be applicable to work activities. These standards are to include, but not be limited to, the development, documentation, and control of computer software.

A list of SOPs and applicable ANSI standards will be provided to the project, or referenced if already established at the Rocky Flats Environmental Technology Site (RFETS). The subcontractor will provide K-H with copies of all applicable SOPs, as referenced in their QAPjP for review and approval. The subcontractor will provide K-H with copies of applicable ANSI standards upon request

1.3 DATA PACKAGE REQUIREMENTS

The general data package deliverable requirements for this project are provided in Table H1-1. All deliverables consisting of final hardcopy data will be transmitted to K-H. The electronic data deliverable (EDD) (Table H1-2) is required within 24 hours of completion of the measurement set.

Table H1-1
Data Package Deliverables

Deliverable Section Number	Deliverable Section Title
1	Cover Page
2	Narrative
3	Sample Summary
4	Data Review Checklist
5	Analysis Reports
6	Attachments EDD and raw data files

Table H1-2
Gamma Spectroscopy Electronic Digital Data Format

Space	Field	Format	Comment
1-10	File Name	Character (10)	Provide file name as identified on the EDD
11-20	Project Identification	Character (10)	Identification number as defined by the project manager
21-30	File Date	Character (10)	(MM/DD/YYYY) - Date of EDD creation
31-50	Measurement Set Identification Number	Character (10)	Unique number associated w/ $\leq$20 in situ measurements and required QC measures
51-60	Measurement Location - Northing	Numerical (10)	Measurement-specific area location, as specified using the GPS
61-70	Measurement Location - Easting	Numerical (10)	Measurement-specific area location, as specified using the GPS
71-80	Measurement Date	Date (10)	(MM/DD/YYYY) - Date the measurement was collected
81-90	Result Identifier	Character (5)	Code that differentiates between analytical results, replicates, reals, and QC items
91-100	Associated Sample	Character (10)	Provides the real-sample file name to correlate duplicate samples with real samples
101-130	Isotope	Character (30)	Descriptive name of the isotope
131-140	Result (measured value)	Number (10)	Analytical result associated with the analysis for this isotope (pCi/g)
141-150	Result Units	Character (10)	pCi/g, %, keV, etc.
151-155	Result Qualifier	Character (5)	See Table H1-3 for acceptable values
156-165	Counting Error	Number (10)	Reported value of measurement uncertainty due to counting error (typically 2σ)
166-175	MDA	Number (10)	Minimum detectable activity (pCi/g)
176-185	Equivalency ration (F/E)	Number (10)	Precision measure used for comparison with a test statistic
186-190	Control Area Yield	Number (5)	Percentage of the established control area value
191-210	CAS Number	Character (20)	See Table H1-3
211-220	Total Propagated Error	Number (10)	(TBD by SME; to be used in evaluating precision control)
221-245	Test Method	Character (25)	A referenceable method type, e.g., the procedure title, revision number, and date used by the subcontractor
246-255	Source Check	Number (10)	Value in energy units (keV)
256-260	Count Time	Number (5)	Count time of measurement, in minutes
261-265	Efficiency	Number (5)	Efficiency of the detector system, in percent
266-280	Instrumentation/ System Identification Number	Character (15)	Identification of the measurement system
Note: All parameter fields are left justified and padded to the right with blanks. The File Name field may be omitted if all records are provided as one file.			

1.3.1 Data Package Cover Page Requirements

All data packages, which correspond to data sets as established in the EDD, will be provided as a measurement set not to include more than 20 real measurements. The Cover Page will include the following: site location, title, subcontractor name, subcontract number, report date, author's name and authentication, and peer reviewer's name and authentication.

1.3.2 Data Package Narrative

Data Package Narratives will be included in the data package and will include a description of all problems, unusual circumstances, and weather conditions encountered during the measurement process. At a minimum this will include: descriptions of interferences, an explanation of any quality control (QC) deficiencies, reasons for re-shooting a location, SOP title and revision, an explanation of any deviations from SOPs or protocols, and any other information that might affect the data quality. Additionally, the spectral acquisition and processing software and version used to acquire and process data will be provided. The narrative will also include all Site-specific input parameters used in the model including, but not limited to, moisture content, radionuclide depth distribution, soil bulk density, air temperature, and barometric pressure.

1.3.3 Summary of Results

All measurement results will be arranged by Site location or sample identification number. All QC measurements will be identified as QC measurements and identify the batch of real measurements the QC measurement is associated with. The Site will retain all original data generated during the course of this project, including:

- Radioactive source calibration certificates for any source used during the project;
- Certificates of calibration for all balances and other measuring equipment;
- Electronic and hardcopies of spectral libraries, if any;
- Copies of the original spectral acquisition before any additional processing;
- Copies of the spectra after additional processing has been performed; and
- A hardcopy printout of the report produced for each
  - Sample,
  - QC sample,
  - Energy calibration,
  - Efficiency calibration, and
  - Source check.

For each shot or sample, the results will include the following:

- Isotope(s), see Table H1-3;
- Isotope(s) activity; minimum detectable activity (MDA) is reported as the result if the measurement is below the MDA;
- Activity units;

- Overall measurement uncertainty at 3-sigma;
- MDA (same units as the reported activity);
- Method or formula by which spectral processing software calculates the MDA;
- System identification (and/or detector identification);
- Location identification;
- Geometry; and
- Any comments associated with the measurement that may affect the results.

The QC sample type will be designated as follows:

- Replicate is the corresponding location identification + "D";
- Standard reference control area is designated as "CA"; and
- Background locations will be designated as "BG."

Table H1-3
CAS Numbers

CAS No.	Isotope	RDL	Units
14596-10-2	Am^{241}	1.0	pCi/g
15117-96-1	U^{235}	0.5	pCi/g
7440-61-1	U^{238}	5.0	pCi/g

The QC sample results will include the following:

- QC type and unique identification;
- Isotope(s);
- Isotope activity;
- Activity units;
- MDA (same units as the reported activity);
- Total propagated uncertainty (TPU) (same units as the reported activity);
- Location identification;
- Geometry; and
- Any comments associated with the measurement that may affect the results.

For replicates, the following additional information will be reported:

- MDA (same units as the reported activity);
- Location identification;
- Comparative isotope results; and
- Associated real sample.

For the CA, the following additional information will be reported:

- CA standard value;
- CA standard value uncertainty at 3-sigma; and
- CA % recovery.

For the background measurement, the following additional information will be reported:

- MDA (same units as the reported activity) will also be reported for each radionuclide detected at the location; and
- Location of background measurement.

The target isotope activities, QC results, measurement uncertainties, and MDAs will be reported to a number of significant digits commensurate with associated measurement accuracy and precision (typically three significant figures).

The Instrument Calibration Summary is a summary of the energy calibration, backgrounds and efficiency determinations for all High-Purity Germanium (HPGe) detectors used to analyze Site locations and the associated QC areas. The following information will be reported for the energy calibration:

- Instrument and detector identification;
- Date of the energy calibration;
- Calibration source identification;
- Energy span and geometry used;
- Linear response of system over range of energy spectrum; and
- Gain expressed as kiloelectron volts (keV)/channel.

The following information will be reported for the background shot or sample:

- Instrument and detector identification;
- Date of the background shot or sample;
- Respective "Start" and "End" region of interest (ROI) in channels or energy for the determination of the specific radionuclides requested; and
- Respective ROI background for the determination of the specific radionuclides requested.

The following information will be reported for the detector efficiency determinations:

- Instrument and detector identification;
- Date of the efficiency analysis;
- Calibration source identification;
- Matrix;
- Geometry;
- Detector characterization data; and

- Characterization verification data.

The gamma spectroscopy instrumentation, analysis, and preparation SOP(s) will be identified and listed.

Data Package Review Checklist

The Data Package Review Checklist documents the completeness and the quality control status of the Sample Data Package. Table H1-4 depicts the required minimum information to complete this check for in situ analysis. A completed Data Review Checklist form will be submitted with each Sample Data Package and will conform to the formatting and content of the form provided in Table H1-4.

Table H1-4
Data Package Review Checklist

	Checklist Item	Caveat?	Compliance?	
1.	**COVER PAGE**		***√Yes***	***XNo***
	All components are present in accordance with requirements.			
2.	**NARRATIVE**			
	All components are present, including all results & controls out of tolerance.			
3A.	**SAMPLE RESULTS SUMMARY**			
a)	For each shot or sample, the results will include the following: isotopes, activity, units, uncertainty at 3-sigma (TPU), MDA, method for calculating MDA, system identification, location identification, geometry, and any comments.			
b)	All results reported for each requested radionuclide			
c)	Appropriate use of significant figures			
d)	Electronic and/or hardcopy of spectral library (one-time submittal)			
e)	Electronic and/or hardcopy of final spectra from measured areas/sources			
f)	Results from measured areas correlated to location, measurement set identification, and any related QC measurements (i.e., energy calibrations, efficiency calibrations, replicates, blanks [background], and control area)			
3B.	**QC SAMPLE RESULTS SUMMARY**			
a)	Calibration certificates for radioactive sources (one-time submittal)			
b)	Source check results within tolerance			
c)	Blank (background) measurements are reported, including location and MDA			
d)	For locations that required reanalysis, all measurement set information is included with the results.			
e)	For each QC sample type (replicate, control area, and background), the QC type and QC location identification is provided.			
f)	For each QC sample, the results will include the following: QC type and identification, isotopes, activity, units, uncertainty at 3-sigma, MDA, location identification, geometry, and any comments.			
g)	All QC deficiencies are detailed above in the Narrative.			
h)	The following information is required for each replicate sample: MDA, location identification, and the comparative isotope results.			
i)	The following information is required for the CA Results: CA standard value, CA standard uncertainty at 3-sigma, and CA % recovery.			

	Checklist Item	Caveat?	Compliance?	
3B.	**QC SAMPLE RESULTS SUMMARY (cont.)**			
j)	The preparation blank activity meets the requirements specified in RC03, Exhibit E, if applicable			
k)	Detector characterization specifications, for each detector, including peak shapes (one-time submittal)			
l)	MDA determination at 95% confidence w/ $\geq$ 5 replicate measurements (one-time submittal)			
4.	**INSTRUMENT CALIBRATION SUMMARY**			
a)	The energy calibration parameters are within established tolerances, and are reported as specified including: instrument and detector identification, date, source identification, energy span and geometry used, linear response of system, and gain.			
b)	The background shot or sample information includes the following: instrument and detector identification, date, "Start" and "End" ROI.			
c)	Detector efficiency information will include the following: instrument and detector identification, date of the efficiency analysis, calibration source identification, matrix, geometry, detector characterization data, and characterization verification data.			
5.	**COUNTING RAW DATA SUMMARY**			
	At a minimum, the raw data summary will consist of the following: analysis date and time, instrument identification, SOP identifier, location identification, QC locations and identifications, and the analyst's initials.			
6.	**ELECTRONIC DATA DELIVERABLE (EDD)**			
a)	The EDD is in compliance with Site requirements			
b)	Completeness of data $\geq$ 95% (' 6.5).			

Respond to each checklist item in the "Caveat?" column with a footnote as applicable and provide the caveat in the Footnotes section below.

FOOTNOTES:

I certify that all responses to this checklist accurately reflect the completeness and quality aspects of this sample data package as outlined in the associated Statement of Work. Furthermore, I understand that inaccuracies in the completion of this checklist will be considered a nonconformance to subcontract requirements as evidenced by the following signature of the laboratory manager or designee.

Printed/Typed Name: _____ Title: _____

Signature: _____ Date: _____

Analysis Report
The subcontractor will include analysis output records in this section to include the gamma spectrum analysis output, peak analysis output, nuclide identification report, interference corrected reports, and nuclide MDA reports. All output and reports will provide a unique identification number to easily correlate to the associated measurement location.

Raw Data
The raw data for all measurements will be provided for each reported value. The raw data will also include shot or samples performed but not used for reporting. This data will include, at a minimum, the following: data analysis date and time collected, instrument identifications, SOP identifier, location identifications, QC location identifications, and the analyst's initials. The raw data will be in a format that is compatible for uploading into Canberra's software packages (e.g., Gennie 2000 Ver. 1.2, ProCount Ver. 1.1, and ISCOS software Ver. 1.1) for reprocessing the data (version updates must be documented as appropriate).

1.4 ELECTRONIC DATA DELIVERABLE FORMAT REQUIREMENTS

This section describes the required format for the gamma spectroscopy EDD requirements. Files will be in fixed-width format that is readily convertible for use with MS ACCESS or EXCEL software. Format may vary from the template displayed below. However, the key requirement is that unique and individual records are produced with the minimum parameters specified, and the data are readable by the commercial software cited.

1.4.1 Spectral Acquisition, Processing, and QA/QC Software

The Site is aware that several commercial and custom spectral acquisition and processing software packages exist. The subcontractor will declare which software package(s) will be used to analyze Site measurements and will provide documentation of assumptions, calculations, and unique terms incorporated into, or used by, the software. The subcontractor will supply evidence of software verification and validation that will be approved by K-H prior to first use. Any changes to the software package(s) must be approved by K-H prior to analysis of Site measurements.

The subcontractor will maintain a program that addresses measures taken to ensure computer programs used to generate data are validated, verified, and documented for both vendor-supplied and in-house software packages. This program will incorporate the "Computer Hardware and Software" requirements from ANSI/ANQC E4-1994. This program will include the following minimum requirements:

- Software validation will occur before initial use, and following subsequent revisions;
- A correlation between the validation documentation and the software will be established;
- A historical file of software revisions and associated validation documentation will be maintained. The historical file will be maintained in chronological order; and
- Computer program and analytical data on electronic media will be handled, stored, safeguarded, and controlled to prevent damage and deterioration.

1.4.2 Spectral Libraries

The Site is aware that some commercial spectral analysis software requires that a spectral library be established and searched to identify peaks present in a sample spectrum. The isotopes, gamma energies, and search order of such libraries will be reviewed by K-H prior to use by the subcontractor. Any changes to the content, gamma energies, or search order of an approved library must be approved, in writing, by K-H prior to use on samples.

Result Identifiers

QC Item Types

BG - Background Area
CA- Control Area
SC- Source Check
RP- Replicate Area
REAL- Target Isotope

Units of Measure

pCi/g - picocuries per gram
% - percent recovery or efficiency
keV- kiloelectron-volts

Result Qualifiers

E - Activity exceeds calibration range of instrument
J - Estimated value < the MDA
M - Replicate instrument readings not within control limits
U - Undetected (analyzed for, but not detected)

1.5 MEASUREMENT SET CONTROLS

QC measurements for each individual HPGe system used will be implemented at systematic and regularly defined frequencies or time intervals. Although physical samples are not acquired for these analyses, the idea of controlling quality based on sample batching is analogous and applicable to controlling quality (in the field) relative to a minimum number of measurements, or "shots" by the HPGe system. Twenty real (excluding QA/QC) measurements per individual detector will be designated as a measurement set.

All instrument/system settings used in measurements (calibrations and real measurements) will be logged, (e.g., multi-channel analyzer [MCA] energy range, analog-to-digital converter [ADC] gain and zero, and Lower Level Discriminator).

All measurements will be traceable to specific 3-dimensional point-locations based on concurrent use of a Global Positioning System (GPS).

The frequency and types of QC samples described below will be based on control of the measurement sets (or batches, when containerized samples are measured), except where time is defined as the frequency basis of choice.

1.5.1 Measurement Identification

All measurements will be assigned unique identifiers that are traceable to both sample type (QC type or real measurement) and location. EDD requirements are delineated in Table H1-2.

1.5.2 QC Traceability to Primary SRM Certificate

Source checks and calibration standards will be current and traceable to a primary standard reference material (SRM) certificate or appropriate interlaboratory control sample program identity. The subcontractor may use secondary standards, in an appropriate matrix, which was purchased from a reputable supplier as a laboratory control sample (LCS). Previous inter-laboratory comparison samples and secondary standards may be used as standards provided that they are current and traceable.

1.5.3 Daily Source Checks

At least three sources spanning the energy range 5 to 3,000 keV will be counted at the beginning of each day to demonstrate that the energy calibration of the instrument has not changed. Americium-241 at 59.4 keV will be used as one of these sources. The results of the source check will be recorded and submitted as described in Table H1-2. For each source check, error tolerance is acceptable if less than 3σ (using the standard deviation value provided by the source manufacturer). For any actual value that exceeds the associated source's error tolerance, corrective action will be implemented before any further real (in situ) measurements are performed.

1.5.4 Energy Calibration/Detector Characterization Requirements

The peak shape, as defined by the full-width half maximum (FWHM) and full-width tenth maximum (FWTM) specification of the detector, will be supplied. The resolution of the detector will not exceed 10 percent of the manufacturer's original specification. Any geometric arrangements of sources or treatments within software reduction will be documented.

The energy calibration for each detector will be performed. A linear curve will be fit for Energy (Y-axis) versus Channel (X-axis) of the curve, and the constants for the equation will be documented. The correlation coefficient (r) will be provided. The slope of the equation will approximate 0.375 keV/Channel for a 8192 channel analyzer.

The effective area for each detector will be documented as a function of gamma energy and angle of incidence.

1.5.5 Efficiency Determination Requirements

The efficiency determinations will be performed on each detector using matrix- and geometry-specific National Institute of Standards Technology (NIST)-traceable calibration source(s). After consultation with the K-H and project personnel, problems with difficult matrices will be resolved and documented. Americium-241 will be included in the efficiency calibration source.

It is expected that the certified value for each isotope in the efficiency standard has been determined at a specific energy, therefore the efficiency determination will also use that specific energy.

The subcontractor will document the reason that any of the peaks present in the original efficiency calibration source are not used to determine the efficiency curves above or below the knee. The efficiency error and confidence level will be documented.

1.5.6 Background Measurements

At least one background measurement will be performed for every measurement set. The background is constituted by measuring a fixed area as defined by the K-H project personnel onsite. The location of the background measurement will be determined. Background measurements will be measured in the same manner as all other standard in situ measurements.

1.5.7 Replicate Measurements

At least one replicate measurement will be performed for every measurement set. The replicate is constituted by remeasuring an in situ measurement within the measurement set of interest. Error tolerance must comply with the statistically based comparison (equivalence test) given below:

$$F = |S - R| \qquad \text{(Equation H-2)}$$

$$F/E < 1.96 \qquad \text{(Equation H-3)}$$

Where

F = Delta between real and replicate
S = Original in situ activity
R = Replicate in situ activity
ER = TPU of replicate
ES = TPU of original measure

1.5.8 Corrective Actions

Corrective actions will be implemented following any exceedance of tolerances by a QC sample (source checks, blanks, calibrations, replicates, or CAs), including the possibility of rejecting the entire measurement (data) set. Should questionable anomalies occur during in situ measurements (based on the operator's or oversight professional's judgment), K-H project personnel will be contacted and a mutually suitable resolution of data and/or corrective actions will be accomplished. Actions might include qualification of data, or system modification and re-measurement if data are rejected. All remeasurements will have different identifications than their precursors.

QC Counting

All QC sources or source areas will be processed in the same manner as the in situ measurements. QC count times may be less than that for in situ measures, but may not exceed in situ measurement count times. This requirements includes using the same instrument calibration parameters, analysis algorithms, libraries, etc. QC samples will not have count rates greater than 1,000 counts per second or a dead time greater than 5 percent to reduce counting errors.

1.5.9 Continuing Calibration Checks

At the conclusion of the analysis of a measurement set, the CA measurement results will be analyzed and dispositioned.

Spectrum Assessment

All measurement spectra will be assessed and peer reviewed. Unidentified peaks will be recorded and discussed with the Contract Technical Representative (CTR). The presence of unidentified peaks will be noted and discussed in the case narrative.

1.5.10 Control Charting

The Site requires data adequate to produce control charting, if control charts are deemed necessary at some point in the project. All such data are currently captured based on requirements in the QAPjP. Examples include dates, blanks (background), and daily source checks, geometry settings, replicates, efficiencies, FWHM, CA, and results.

Control Areas

The subcontractor will perform HPGe measurements at a minimum of five locations (HPGe fields of view [FOVs]) where soil samples have been previously collected (or will be collected) to correlate HPGe results with soil samples analyzed by gamma and alpha spectrometry (wet chemistry). The purpose of these measurements is to verify the accuracy of the field measurements. One set (five measurements) will be collected at the completion of routine in situ measurements. Rather than specifying a set tolerance range of acceptability, error will be quantified by K-H project personnel to define an upper confidence limit in the measurements to support project decisions.

In summary, the following general sequence of QC measurements is required: daily source check, background measurement, calibration (as needed per each measurement set), real measurements, replicate, and CA measurement. After all real measurements are completed, five calibration verification measurements, as described above, are required.

1.5.11 Control of Key Parameters

Several parameters directly influence data reduction and final gamma spectroscopy values. For the values listed below, and any others the subcontractor deems necessary, determination of values will be clearly explained and documented with final deliverables:

- Actinide depth distribution in soil profile and averaging depth;
- Soil density;
- Soil moisture; and
- Air density.

The subcontractor will verify that model input parameters meet variable conditions in the field for soil density and soil moisture. Soil densities will be measured in situ for three geologic lithologies encountered in the investigation area, including: the Rocky Flats Alluvium, landslide deposits, and artificial fill material. The subcontractor will determine soil moisture content with bulk density measurements and collect additional samples for this determination when climatic conditions indicate that a significant increase or decrease has occurred, or at the request of K-H. Additional soil moisture content measurements will not exceed six sampling events.

MDA Determination

The initial MDA determinations for the subcontract will be consistent with Section 6.7 of the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (EPA 1997) using a 95% confidence level and at least five replicate measurements. The subcontractor will provide the algorithm and all necessary information used to calculate the MDAs. MDAs should meet the data quality objectives (DQOs) set forth in Section 3.0 of the Industrial Area Sampling and Analysis Plan (IASAP); if not, rationale must be provided.

Total Propagated Uncertainty)

TPU, not just counting error, will be reported with the result for each target analyte. The total propagated error is the square root of the sum of the squares of the 1 sigma error of each measurement or process that contributes to the measurement. TPU will be determined consistent with MARSSIM (EPA 1997), Section 6.8.3.

Traceability of Measuring and Testing Equipment

Any ancillary measurement and test equipment (MTE) used to support HPGe measurements will be traceable to associated calibration logs and standards.

1.5.12 Final Acceptability of Deliverables

Final acceptability of deliverables from the subcontractor will be determined by K-H in writing. Noncompliance with any of the requirements provides the basis for rejection of the associated deliverable(s).

1.5.13 Completeness

Data submitted must be 95 percent complete to be considered acceptable (i.e., 95 percent of the data produced must be usable for project decisions).

APPENDIX I

903 Pad Linear Regression Case Study

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ACRONYM LIST

AL	action level
Am	americium
ANOVA	Analysis of Variance
CL	confidence limit
cm	centimeter
DOE	U.S. Department of Energy
FOV	field of view
HPGe	High Purity Germanium
IA	Industrial Area
IHSS	Individual Hazardous Substance Site
ISOCS	In Situ Object Counting System
m	meter
MeV	value of energy
NBS	National Bureau of Standards
OU	Operable Unit
PAC	Potential Area of Concern
pCi/G	picocuries per gram
Pu	plutonium
R^2	correlation coefficient
RCRA	Resource Conservation and Recovery Act
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RPD	relative percent difference
SOP	Standard Operating Procedure
U	uranium
UBC	Under Building Contamination

1.0 LINEAR REGRESSION ANALYSES - CASE HISTORY

Radionuclide contamination in surface and subsurface soil will be characterized using field-deployed gamma spectroscopy technology (i.e., High Purity Germanium [HPGe] detectors). The HPGe measurements will follow the same procedures and methodologies that were effectively used during previous Rocky Flats Environmental Technology Site (RFETS) environmental restoration projects, specifically the 903 Drum Storage Area, 903 Lip Area, and Americium Zone Characterization (903 Pad Characterization [Kaiser-Hill 2000]). The "best fit" regression modeling approach used to standardize the HPGe results to alpha spectroscopy results during the 903 Pad Characterization will be implemented for the Industrial Area (IA) characterization. A similar regression modeling technique will be used for evaluating metals.

The IA characterization is similar to the 903 Pad Characterization in that radionuclides in surface soil will be analyzed in situ using a nonintrusive HPGe field method. This field analytical technique was successfully used to characterize the lateral extent of radiological contamination in the Americium Zone and a portion of the 903 Lip Area (Kaiser-Hill 2000). In addition, ex-situ HPGe measurements of subsurface soil samples will be performed in a mobile laboratory. This appendix provides an overview of the HPGe methodologies used in the 903 Pad Characterization. Topics of discussion include (1) sample collection techniques for the alpha spectroscopy analyses, which were used to standardize the HPGe results; (2) the physics of the HPGe in-situ measurements; (3) the results of the "best fit" linear regression model used to standardize the HPGe results; and (4) the application of in-situ HPGe survey methods to be used for the IA characterization.

2.0 OVERVIEW OF THE 903 PAD CHARACTERIZATION FIELD HPGE SURVEY

2.1 SURFACE SOIL INVESTIGATION

Delineation of radiologically contaminated soil in the Americium Zone was performed in situ using gamma ray spectroscopy methods and an HPGe instrument. The HPGe instrument was used to obtain 1,110 contiguous gamma ray measurements with a circular field of view (FOV) of 10 meters (m) in diameter within the investigation area. The activities of Americium (Am)-241, Plutonium (Pu)-239, Uranium (U)-234, U-235, and U-238 in surface soil within the Americium Zone and a portion of the 903 Lip Area were measured or estimated in situ using an HPGe survey. The HPGe measurements were standardized by correlation with laboratory-derived alpha spectroscopy measurements.

2.1.1 In-Situ HPGe Methodology

The sensitivity of the HPGe instrument is capable of measuring in-situ activities of Am-241, U-235, and U-233. For the 903 Pad Characterization, the HPGe measurement had a FOV of 10 m in diameter with the detector placed 1 m over the ground surface. The Compendium of In Situ Radiological Methods and Applications at Rocky Flats Plant (EG&G 1993) provides a detailed discussion on the physics of in-situ measurement of radionuclides in the environment.

The HPGe survey was primarily performed in the Americium Zone (Figure I1) and includes all surface soil with elevated activities of Pu-239/240 and/or Am-241 identified during the Operable Unit (OU) 2 Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) including:

- The 35 HPGe measurements that exhibited elevated (above 10 picocuries per gram [pCi/g]) Am-241 activities;
- The area directly below the culvert that drains the 903 Pad and Lip Area where sediments are deposited during surface runoff events; and
- The five 2.5-acre plots where surface soil exceeds Rocky Flats Cleanup Agreement (RFCA) Tier I action levels (ALs).

The HPGe system used to perform in-situ measurements for the investigation employed the Canberra In Situ Object Counting System (ISOCS) software. To estimate counting efficiencies, this software requires the entry of various parameters that accurately represent the actual field conditions at the site. One important parameter is the vertical distribution of radionuclides. In the HPGe investigation area, contamination was deposited via airborne and/or surface water releases. This resulted in a distribution with high activities near the surface and decreasing activities with depth, which may follow an exponential function. Surface soil sampling was previously performed in the study area to determine the vertical distributions.

In general, the radionuclides are concentrated in the top 5 centimeters (cm). Based on available data, the ISOCS model assumes all contamination is contained in the top 5 cm, and is distributed with 66 percent in the top 3 cm and 33 percent in the next 2 cm. This distribution was used to be consistent with the surface soil sampling methodologies (RMRS 1998a), which specifies sampling surface soil to a depth of 2 inches (5 cm). In addition, the contribution from Am-241 below a depth of 5 cm in soil is quite small in undisturbed surface soil. It is possible that the actual distributions in the top 5 cm may be more concentrated near the surface or more uniformly distributed throughout the 5-cm layer.

A set of efficiencies with different vertical distributions was prepared and the standard acquisition was analyzed. As shown in Table I1, the overall error of a likely range of possible distributions is approximately +1- 10 %.[1]

Table I1
Am-241 Activity Profile

Sample Layer	Am-241 pCi/g
Default 2 layers 0-3 cm 66%, 3-5 cm 33%	12.2
Single layer, 0-5 cm uniform	14.3
3 layers, 0-1.5 cm 50%, 1.5-3 cm 30%, 3-5 cm 20%	11.6
3 layers, default with 1-cm grass cover	13.2
2 layers with 0-3 cm 60%, 3-5 cm 40%	12.2

[1] These ISOCS modeling parameters used to define the vertical distribution of radionuclides will initially be used for in-situ screening during the IA characterization. However, these modeling parameters may be reevaluated as additional data are collected and adjusted accordingly to meet the site-specific conditions. For HPGe screening of subsurface samples, modeling parameters will be adjusted according to the specifications of the sample container.

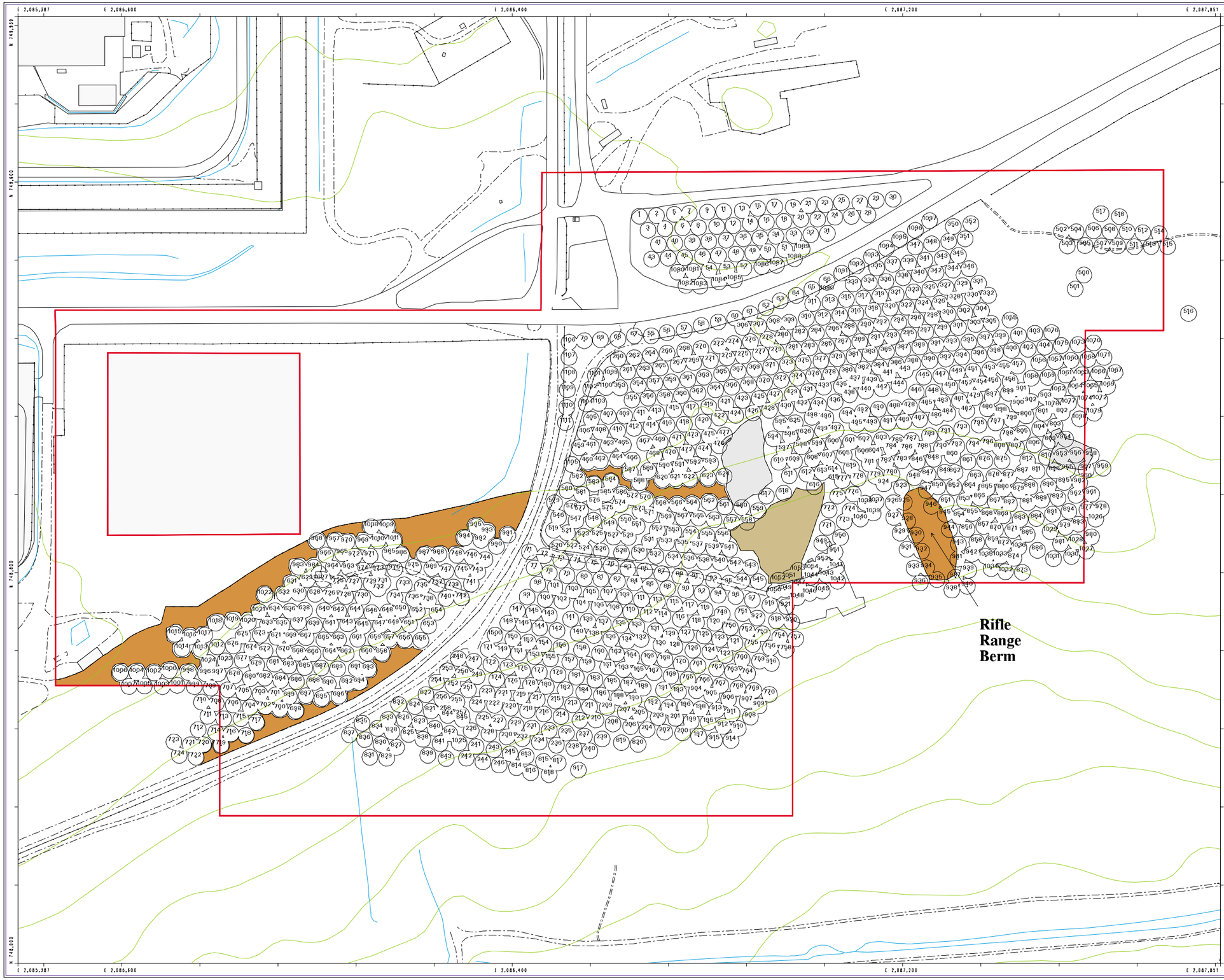


Figure I1

HPGe Measurement Location Map

EXPLANATION

Investigation Area

FOV (Field of View)
Stake Number

Standard Map Features

- Steep Topography
- Wetland Area
- Cement
- Buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Topographic Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:

Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

Topographic contours were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~ 10 meter resolution. DEM post-processing performed by MK, Winter 1997.

DISCLAIMER:

Neither the United States Government nor Kaiser Hill Co., nor DynCorp I&ET, nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights.

Scale = 1 : 2370
1 inch represents approximately 198 feet

50 0 100 200ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by: DynCorp THE ART OF TECHNOLOGY

Prepared for: KAISER•HILL COMPANY

MAP ID: 99-0408

September 06, 2001

NT_Svr w:/projects/fy99/99-0408/hpge_fov_b-fig-i1.aml

2.2 VERIFICATION SAMPLING CORRELATION TECHNIQUE

To "standardize" the in-situ method, a double sampling technique was employed whereby soil samples were collected from select HPGe measurement locations (RMRS 1998a). These samples were analyzed in the laboratory for Am-241, Pu-239/240, U-233/234, U-235, and U-238 using alpha spectroscopy, and gamma spectroscopy for Am-241 and U-235. The gamma spectroscopy data were collected by the laboratory to simply "validate" the alpha spectroscopy results, and the two sets of results show a high degree of correlation as indicated by their linear relationship (e.g., correlation coefficient [R^2] > 0.90).

In order to acquire a good duplicate sampling correlation over the anticipated range of Am-241 activities, eight HPGe measurement locations were selected that encompass five Am-241 activity intervals; 0-10 pCi/g (three measurements), 10-20 pCi/g, 20-50pCi/g (two measurements), 50-100pCi/g, and 100-200 pCi/g. These intervals were selected based on detection frequencies of Am-241 activities measured in surface soil samples collected in support of the OU2 Phase II RFI/RI (DOE 1995; RMRS 1998a) and to bound the high and low measurements collected in the field during the HPGe investigation.

Multiple HPGe measurements were taken at some of the double sampling locations for quality control. These results are provided in Table I2. In these cases, the measurements at each duplicate sampling location were averaged to create the HPGe data set used in the correlation. Table I2 also indicates the HPGe measurements at each duplicate sampling location are relatively uniform.

Table I2
HPGe Gamma Spectroscopy Measurements – Precision Summary

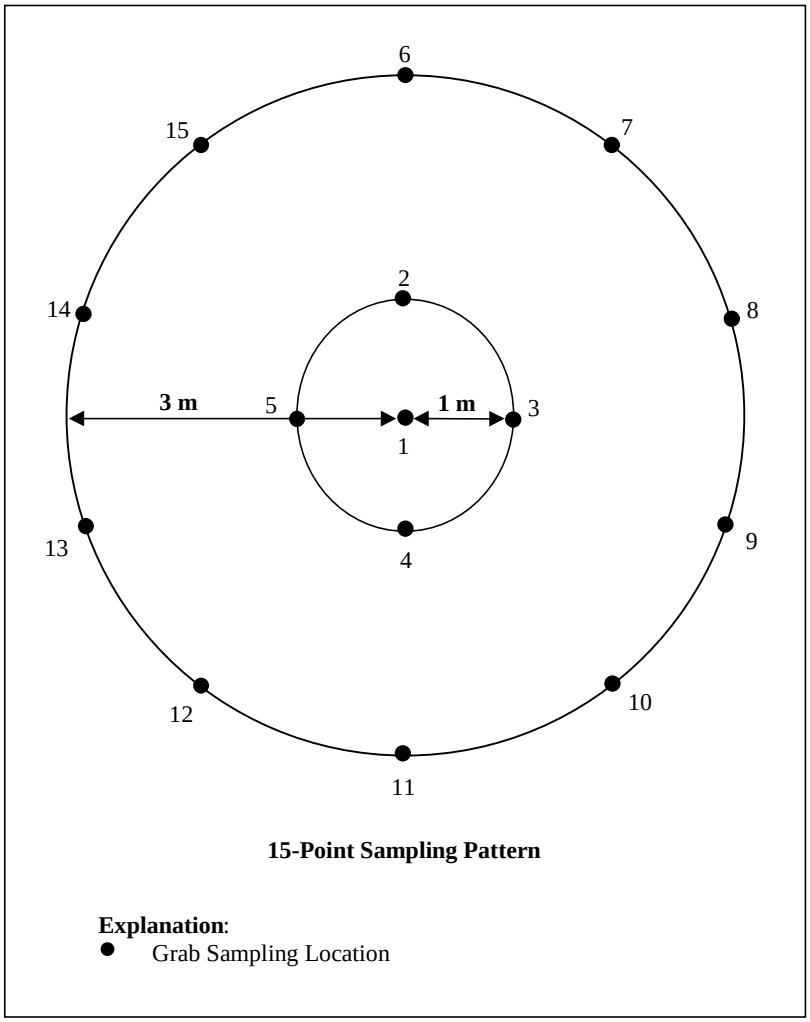
HPGe Measurement 30		HPGe Measurement 104		HPGe Measurement 265		HPGe Measurement 266		HPGe Measurement 305		HPGe Measurement 406		HPGe Measurement 460		HPGe Measurement 669	
Am-241 (pCi/g)	RPD %	Am-241 (pCi/g)	RPD %	Am-241 (pCi/g)	RPD %	Am-241 (pCi/g)	RPD %	Am-241 (pCi/g)	RPD %	Am-241 (pCi/g)	RPD %	Am-241 (pCi/g)	RPD %	Am-241 (pCi/g)	RPD %
1.1	NA	14.5	19.4	34.3	2.2	9.1	NA	7.0	21.3	70.2	8.2	106.3	7.0	32.2	8.3
		17.6	0.1	39.0	10.6			7.5	28.1	62.9	2.8	113.2	13.3	32.8	6.5
		20.6	15.6	39.1	10.9			4.7	18.4	61.7	4.7	80.2	21.1	39.5	12.1
		15.5	12.8	37.3	6.2			6.0	6.0	62.6	3.2	98.3	0.8	35.3	0.9
		22.6	24.8	31.7	10.1			4.9	14.2	65.9	1.9	115.7	15.5	35.2	0.6
		17.6	0.1	29.2	18.3			5.7	0.9			80.8	20.3		
		23	26.5	31.3	11.4			5.4	4.5						
		15.1	15.4	39.3	11.4			4.0	34.2						
		17.6	0.1	34.4	1.9										
		13	30.2												
		18.6	5.4												
		19.4	9.6												
		15.8	10.9												
		15.8	10.9												
1.1[a]		17.6[a]		35.1[a]		9.1[a]		5.7[a]		64.7[a]		99.1[a]		35[a]	

RPD relative percent difference between individual measurements and group mean

[a] group mean

Fifteen grab samples were then collected at each duplicate sampling location: 1 grab sample from the center, 4 grab samples collected at a 1-m radius, and 10 grab samples from a 3-m radius. Figure I2 provides this surface soil sampling geometry, which was developed by the U.S. Department of Energy (DOE) (1997) at the Fernald Environmental Management Project site in Ohio to correlate HPGe results to surface soil results. The 1-m and 3-m radius grab samples were then composited into a 1-m and 3-m sample representative of each individual band. Therefore, three separate alpha (and gamma) spectroscopy analyses were performed at each duplicate sampling location. Samples were collected in this "bulls eye" pattern to mimic the averaging done by the field HPGe detector over the instrument's FOV. The HPGe detector receives gamma ray photons from every point within the circle; however, it receives more gamma rays from soil closer to the detector than from soil farther from the detector. If the circle is divided into concentric bands, the relative weighting factor for each band can be calculated based upon the percentage of influence of gamma photons at the detector which originates from a given band of soil, assuming a uniform source distribution with depth and a 1 value of energy (MeV) photon energy. The relative weighting factor is the relative importance of each band with respect to the probability of gamma rays emitted from within that band being detected by the HPGe.

Figure I2
HPGe 15-Point Surface Soil Sampling Pattern



The sample results were multiplied by the weighting factor per band, then the products were summed to determine the activity of the soil in the FOV area. It should be noted that these results were adjusted for moisture content in order to report results on a wet weight or "in situ moisture" basis. At every duplicate sampling location, the "real" and "duplicate" data were averaged (denoted as "combined"), and the "combined" data were used in the weighted averaging process to develop the data for the correlation.

2.2.1 Alpha Spectroscopy: HPGe Pu-239/240 and Am-241 Correlations

The linear regressions (using the method of least squares) between the alpha spectrometry data (Am-241 and Pu-239/240) and the HPGe data (Am-241) show very high degrees of correlation (Figures I3 and I4). The correlation coefficients (R) are greater than or equal to 0.97. The Am-241 (alpha spectrometry) to Am-241 (HPGe) correlation has a slope (1.25) near 1.0 and a small intercept (4.43 pCi/g) near 0 as would be expected when correlating the activities of the same radionuclide (Figure I3). The Pu-239/240 (alpha spectrometry) to Am-241 (HPGe) correlation has a slope of 8.08, which is within the expected range of Pu-239/240 to Am-241 activity ratios considering the in-growth of Am-241 in weapons-grade Pu over 30 to 40 years (elapsed time since the release). The intercept (3.24 pCi/g) is also small in magnitude (Figure I4). These results indicate the regression lines are appropriate models to correlate HPGe data to alpha spectroscopy data.

The Pu-239/240/Am241 ratio derived from the "best fit" line regression model compares favorably to those ratios derived from previous studies. The National Bureau of Standards (NBS) (1980) collected soil samples from RFETS for isotopic analyses, which were eventually used as a standard radioactive source reference. The NBS (1980) sampling and analysis of RFETS soil indicated a Pu-239/240 to Am-241 ratio of 6.42. A second study performed by Ibrahim et al. (1996) included an isotopic inventory (using alpha spectroscopy) of RFETS soil to determine the activity ratio of Pu-239/240 to Am-241. The regression model between Am-241 and Pu-239/240 resulted in a strong correlation (R=0.96) between the two radionuclides, and a Pu-239/240 to Am-241 activity ratio of 5.29. Based on their findings, Ibrahim et al. (1996) concluded that Pu-239/240 values could be inferred from gamma spectroscopy results of Am-241. The Pu-239/240 to Am-241 ratio (8.08) derived from the "best fit" line regression model compares favorably to the 6.42 and 5.29 ratios derived from the NBS (1980) and lbrahim et al. (1996) studies, respectively. It is also conservatively high with respect to Pu-239/240/Am-241 ratios for estimating Pu-239/240 activities from Am-241 activities.

2.2.2 Alpha Spectroscopy: HPGe U-235 and U-236 Correlations

As shown in Figures I5 and I6, correlations for the alpha spectroscopy/HPGe data for U-235 and U-238 were not performed because in both cases the U isotopes were not detected by in-situ HPGe. The plots show minimum detectable activities when the isotopes were nondetect. Also, alpha spectroscopy did not measure detectable levels of U-235, and only in a few instances was U-238 detected at estimated activities. Therefore, U-235 and U-238 results derived from the HPGe survey were used directly as the surface soil radiological data for these isotopes (i.e., values were not standardized to laboratory alpha spectroscopy measurements). The lack of correlation for the U data does not impact the findings reported in the 903 Pad Characterization Report (Kaiser-Hill 2000), because the activities for U isotopes are well below the Tier II ALs throughout the investigation area.

Figure I3
Linear Regression Am-241

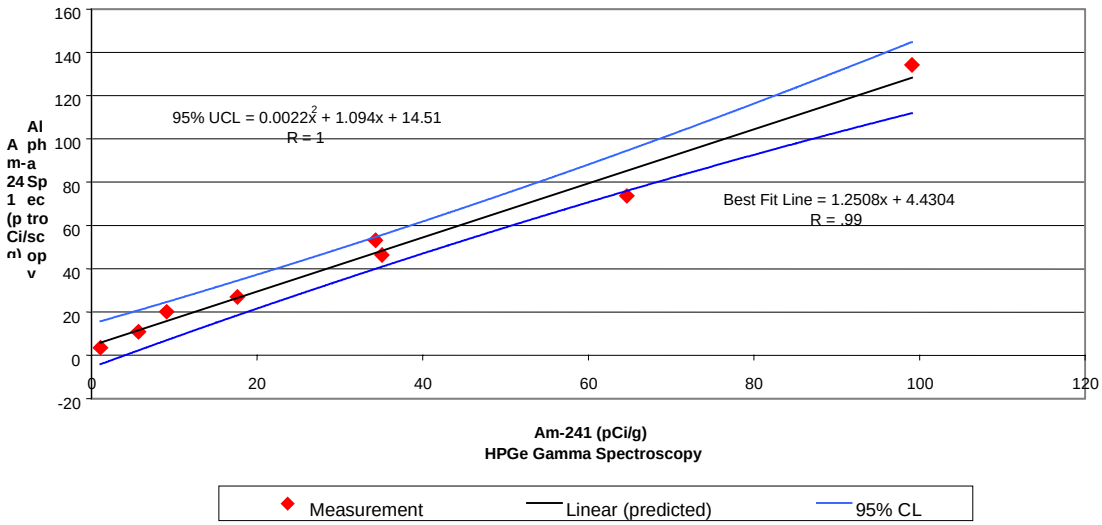


Figure I4
Linear Regression Pu-239/240

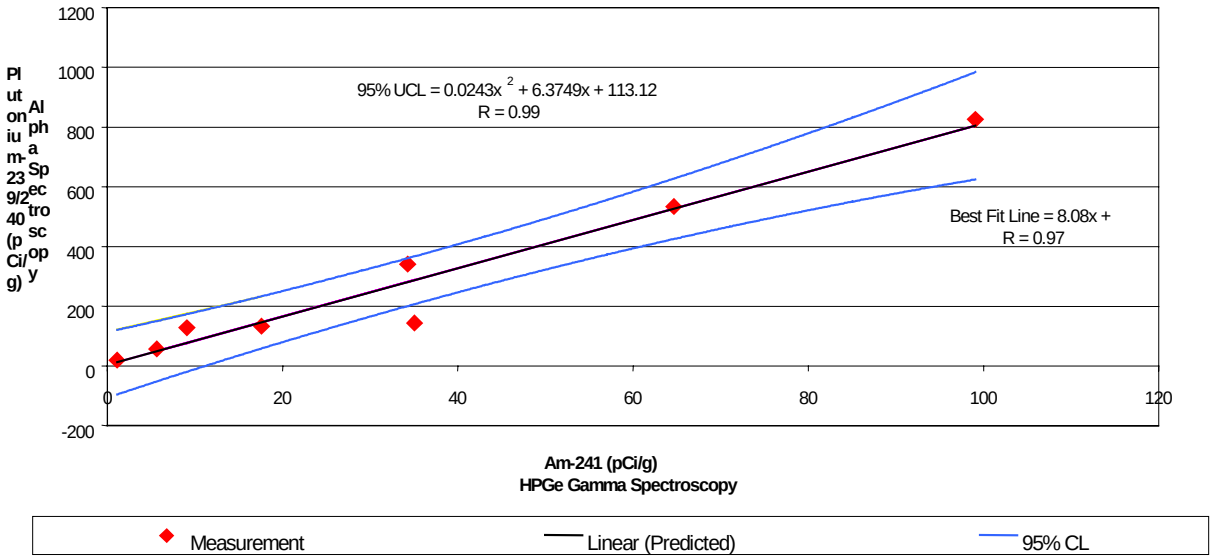


Figure I5
Minimum Detectable Activities U-235

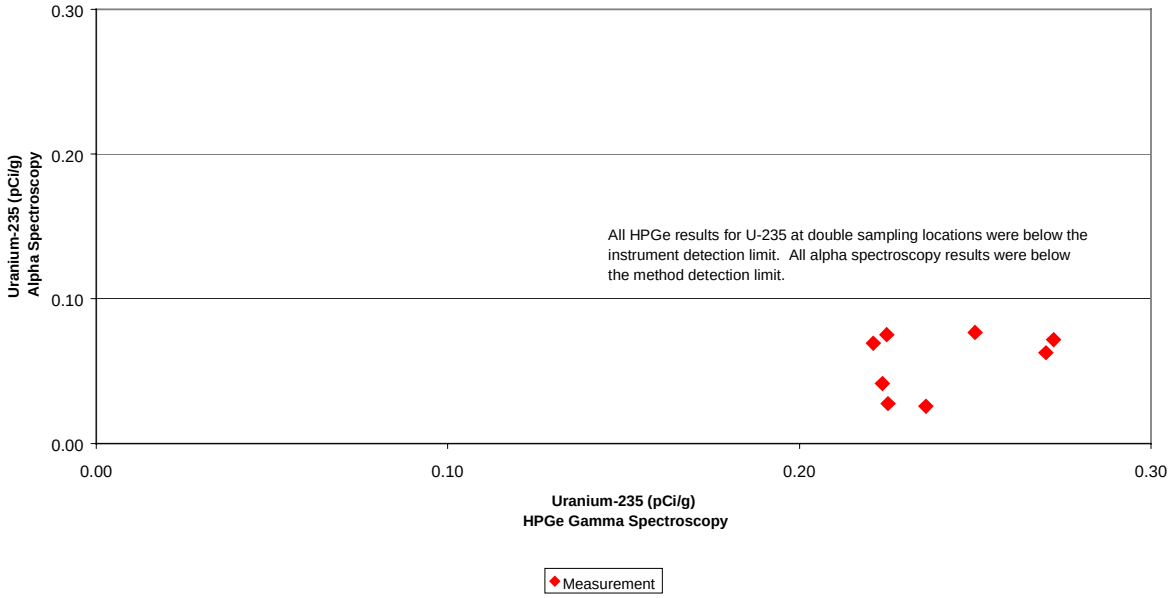
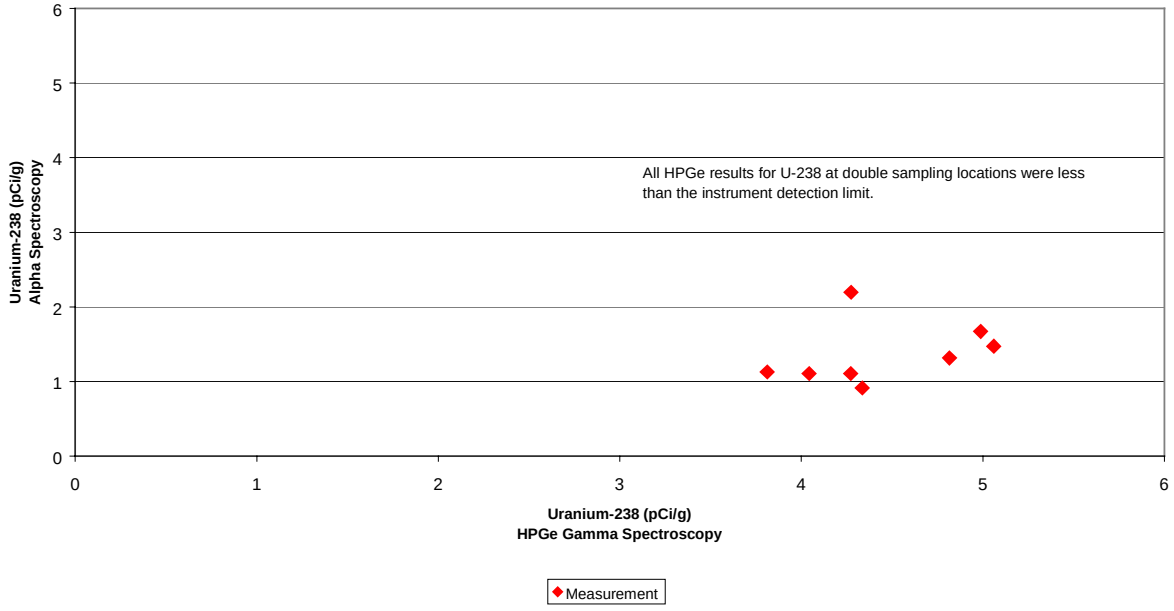


Figure I6
Minimum Detectable Activities U-238



The activity of U-233/234 was estimated based on the fact that under natural conditions, U-234 is in equilibrium with U-238 (the contribution of U-233 activity is insignificant). The equilibrium between the radioactive parent (U-238) and daughter (U-234) suggests the activity ratio between these two isotopes should be 1.0. Surface soil data collected in support of the OU 2 Phase II RFI/RI support this relationship with an average activity ratio of 0.97 between the two isotopes. Therefore, the activity of U-233/234 in surface soil was assigned the value measured by the HPGe survey for U-238.

3.0 HPGE METHODS TO BE EMPLOYED DURING THE IA CHARACTERIZATION

The fundamental approach of the HPGe methodology used during the 903 Pad Characterization will be incorporated into the IA characterization. This will provide a basis for establishing the setup parameters for the HPGe detector and regression modeling for standardizing the HPGe measurements. However, variation in physical conditions and process knowledge (i.e., spills and releases of hazardous constituents) of specific Individual Hazardous Substance Sites (IHSSs), Potential Areas of Concern (PACs), and Under Building Contamination (UBC) Sites may warrant changes in the HPGe methodology. Despite such changes, the physics and fundamental processes of the HPGe measurements will remain the same. The HPGe methodology discussed previously in Sections 2.1 and 2.2 will provide the outline for the HPGE techniques to be employed during the IA characterization.

3.1 LINEAR REGRESSION MODELS

The "best fit" regression modeling approach used to standardize the HPGe Am-241 and Pu-239/240 alpha spectroscopy measurements for the 903 Pad Characterization will also be used for the IA characterization. The following equations will initially be used to standardize the HPGe measurements:

$$\mathrm{Pu-239/240}_{yi} = 8.08 *_{xi} + 3.24 \qquad \text{(Equation I1)}$$

$$\mathrm{Am-241}_{yi} = 1.25 *_{xi} + 4.43 \qquad \text{(Equation I2)}$$

Where:

xi = Am-241 activity measured by the HPGe instrumentation

Equations I1 and I2 will provide the basis for standardizing the HPGe measurements however may be changed as additional data are obtained during the IA characterization (see Section 3.1.1). As discussed in Section 2.2.1, the majority of the U-235 and U-238 measurements were nondetectable, which prevented a correlation between HPGe and laboratory alpha spectroscopy measurements. Therefore, for lower activities, U-235 and U-238 activities will be obtained by direct HPGe measurements. However, activity levels of U-235 and U-238 measured by HPGe near or above the ALs may warrant verification sampling (i.e., soil sampling) for analysis by laboratory alpha spectroscopy. If a linear relationship is observed between the HPGe and laboratory U-235 and U-238 activities, then the HPGe results will be standardized using the appropriate regression equation. Activities of U-233/234 will be based on the HPGe direct reading of U-238, given the equilibrium state between the two isotopes (i.e., 1:1 ratio).

3.1.1 Verification of "Best Fit" Regression Model

The "best fit" regression models (Equations I1 and I2) will be verified by routine duplicate sampling events. As discussed in Section 5.1.1, Linear Regression Analysis, observations within the range of interest will be obtained to validate the acceptability of the regression model. Validity of the observations will be evaluated relative to the 95% confidence limit (CL) of the "best fit" regression line (Figures I3 and I4). The 95% CL defines the range about the sample mean where the true population mean is expected to lie at a 95% level of probability. This type of evaluation not only provides quantified boundaries about the "best fit" regression line, but also provides a quick visual inspection of the data sets. Observations that fall outside the 95% CL indicate a higher degree of variability about the "best fit" regression line (or predicted values) and therefore, may warrant a reevaluation of the regression model. The acceptability criteria of the regression model(s) will be based on a high degree of correlation ($R^2 > 0.90$) and statistical comparison between the predicted values and independent variables using an Analysis of Variance (ANOVA) and corresponding F-Test.

Regression models will need to be developed for subsurface soil samples. Unlike the HPGe survey of surficial soil, these samples will be analyzed ex situ. The HPGe instrumentation will have to account for such variations as the FOV and physical and chemical properties of the sample container. In addition, some IHSS, UBC Sites and PACs may require a site-specific regression model that varies slightly from Equations I1 and I3. For example, the presence of enriched Am-241 in soil at OU 4 will likely result in a reduction in the Pu-239/240/Am-241 ratio of 8.08 (Equation I1). In general, the regression model should be appropriate for the given site conceptual model.

3.2 HPGE SURVEY DESIGN

In-situ HPGe surveys to be conducted during the IA characterization will follow the methodology presented in Section 2.1.1. The instrumentation FOV (10 m in diameter), detector height above the soil (1m), and ISOCS modeling parameters will be consistent with those settings used during the 903 Pad Characterization. However, these settings/parameters may be altered to account for changes in site conditions and materials being measured (e.g., asphalt is denser than natural soil). Ex-situ measurements of subsurface soil samples will follow standard guidelines presented in Determination of Radionuclides by Gamma Spectroscopy, Module RC03-A.1 (RMRS 1998b).

Methods to be employed for the verification sampling and analysis (i.e., duplicate sampling) will follow the methods presented in Section 2.2. However, some deviations for ex-situ HPGe measurements of subsurface soil will be performed. For subsurface soil samples, core samples will be homogenized prior to being placed in containers. Final sample preparation will follow the guidelines presented in Standard Operating Procedure (SOP) GT.08. It should be noted that normal procedure requires that coarse-grained fragments be separated from the finer-grained fragments because Pu and Am have a tendency to absorb to the fine-grained fraction. However, sieving out the coarse-grained fragments may result in a high bias in the HPGe and alpha spectroscopy results. Therefore, deviations to the existing SOPs may be implemented to minimize the apparent sample bias.

4.0 REFERENCES

DOE, 1995, Final Phase II RFI/RI Report, 903 Pad, Mound, East Trenches Area, Operable Unit No. 2, RF/ER-95-0079.UN, U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado.

DOE, 1997, Comparability of In-Situ Gamma Spectrometry and Laboratory Data 20701-RF-001, U.S. Department of Energy, Fernald Area Office, Fernald, Ohio.

EG&G, 1993, Compendium of In Situ Radiological Methods and Applications at Rocky Flats Plant, EG&G Rocky Flats Inc., Rocky Flats Plant, Golden, Colorado, December 1.

Ibrahim, S.A., M.J. Schierman, and F.W. Whicker, 1996, Comparative Distribution Of 241Am and 239/240Pu In Soils Around The Rocky Flats Environmental Technology Site, 1996 Health Physics Society, Volume 70, Number 4, pp 520-526.

Kaiser-Hill, 2000, Site Characterization Report for the 903 Drum Storage Area, 903 Lip Area, and Americium Zone, RF/RMRS-99-427.UN, June 26.

NBS, 1980, National Bureau of Standards Certificate, Standard Reference Material 4353, Environmental Radioactivity, December 1.

RMRS, 1998a, Sampling and Analysis Plan for the Site Characterization of the 903 Drum Storage Area, 903 Lip Area and Americium Zone, RF/RMRS-97-084, Rev. 1, Rocky Flats Environmental Technology Site, Golden, Colorado, August.

RMRS, 1998b, Determination of Radionuclides by Gamma Spectroscopy, Module RC03-A.1 Statement of Work Prepared by the Analytical Services Division, Rocky Flats Environmental Technology Site, March 24.

APPENDIX J

Example Data Aggregation Problem

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ACRONYM LIST

AL	action level
AOC	Area of Concern
df	degrees of freedom
EMC	elevated measurement comparison
HCB	hexachlorobenzene
HS	hot spot
IHSS	Individual Hazardous Substance Site
mg/kg	milligrams per kilogram
PAC	Potential Area of Concern
pCi/g	picocuries per gram
Pu	plutonium
RFCA	Rocky Flats Cleanup Agreement
UBC	Under Building Contamination
UCL	upper confidence limit

Example Problem

This appendix consists of an example problem that illustrates how the Industrial Area Sampling and Analysis Plan statistical methods will be implemented. The locations, buildings, and analytical results that appear in this appendix have been fabricated and do not provide data for any part of the Rocky Flats Environmental Technology Site. This appendix includes the following:

Map 1 – Existing sampling locations and analytical data for Individual Hazardous Substance Site (IHSS) 1.1. This map is used to determine whether additional data are needed to characterize the IHSS.

Map 2 – A triangular grid superimposed over IHSS 1.1 using a random start point. This map is used to illustrate the 36-foot triangular grid that has been proposed for IHSS, Potential Area of Concern (PAC), and Under Building Contamination (UBC) Site characterization.

Map 3 – Additional soil sampling points at the nodes of the grid system

Map 4 – Analytical results from new sampling points

Map 5 – Contoured Rocky Flats Cleanup Agreement (RFCA) Tier I and Tier II exceedances

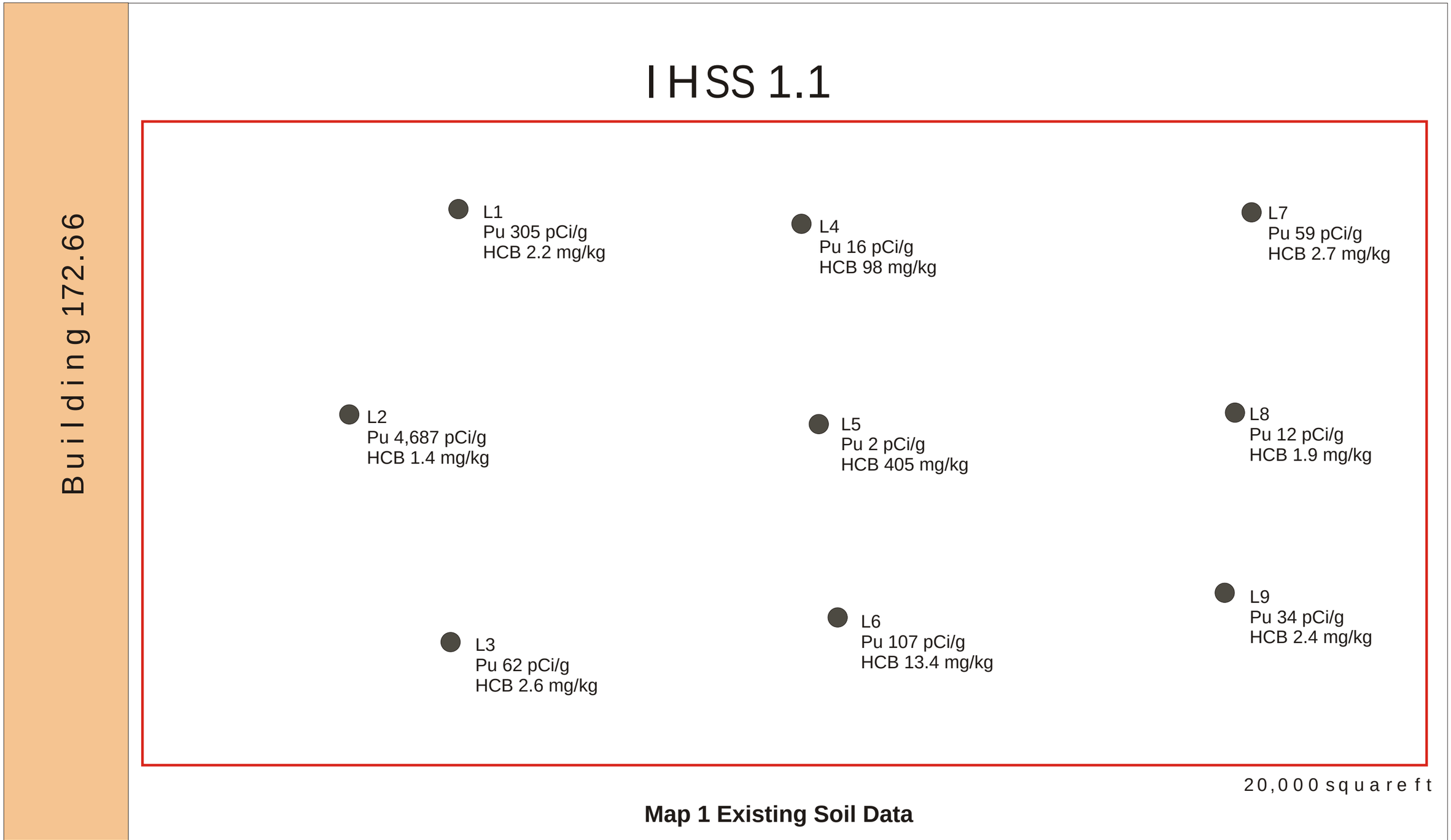
Map 6 – Remediation confirmation sampling locations for nonradionuclide analytes

Map 7 – Remediation confirmation sampling locations for radionuclide analytes

Table J1 Sum of Ratios and Elevated Measurement Comparison (EMC) for Hot Spots

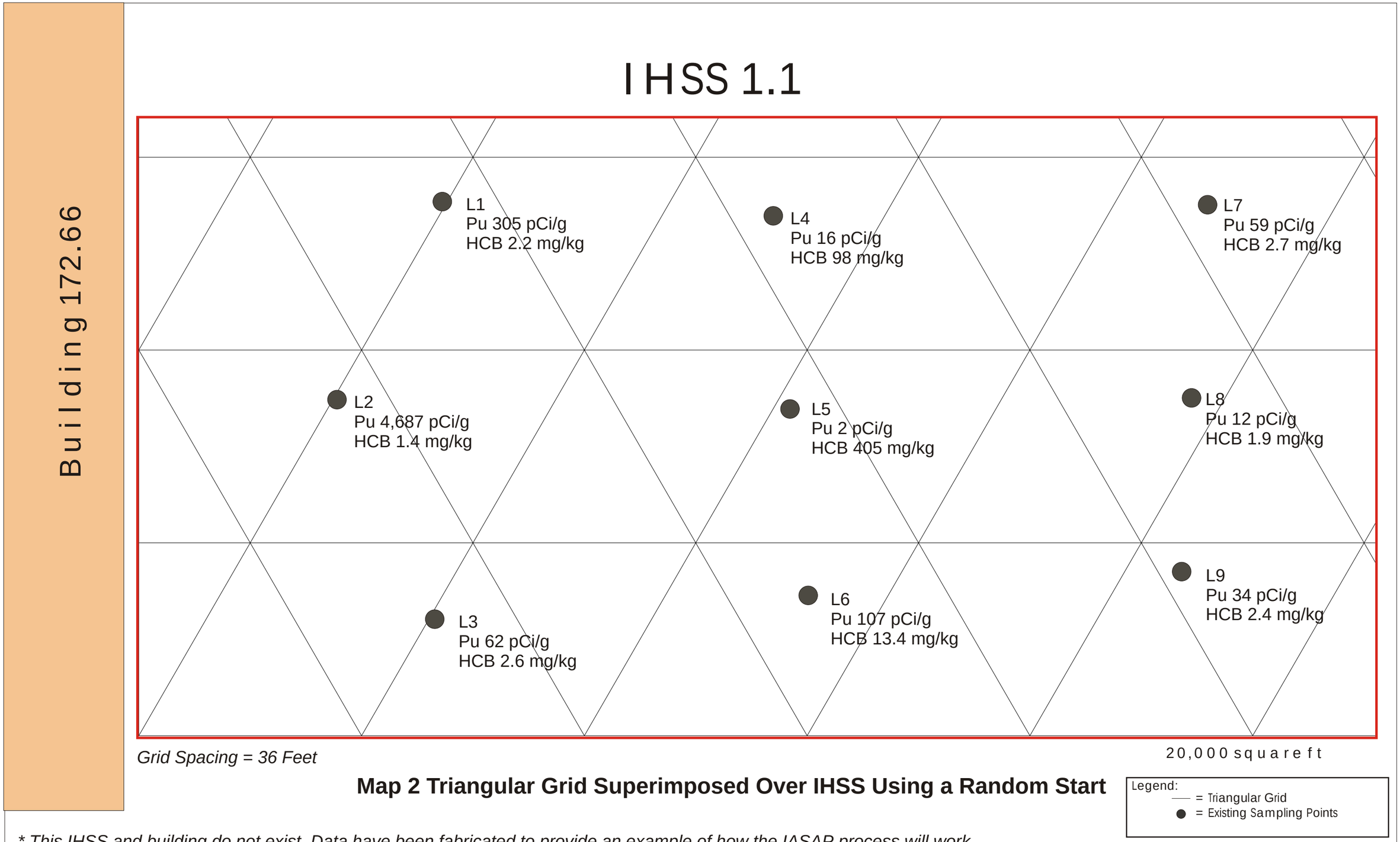
Table J1
Hot Spot Methodology Sample Problem Data

Sampling Location	Sample Results		Tier I Exceedance	Tier II Exceedance	2nd Term of EMC Sum>Tier 1
	Pu (pCi/g)	HCB (mg/kg)			
S1	232	2			
S2	235	2.2			
S3	4	3.2		HCB	
S4	41	4.1		HCB	
S5	41	2.6			
S6	30	2.1			
S7	5521	1.8	Pu	Pu	0.3350
S8	4712	2.1	Pu	Pu	0.2845
S9	101	11.2		HCB	
S10	8	320	HCB	HCB	0.0462
S11	11	9.6		HCB	
S12	12	2.1			
S13	968	1.6		Pu	
S14	301	2.6		Pu	
S15	129	39		HCB	
S16	48	10.1		HCB	
S17	30	2.5			
S18	17	0.8			
S19	12	1.1			
S20	14	2.4			
S21	20	2.5			
S22	72	1.9			
S23	32	2.8			
S24	12	0.9			
L1	305	2.2		Pu	
L2	4687	1.4	Pu	Pu	0.2830
L3	62	2.6			
L4	16	98		HCB	
L5	2	405	HCB	HCB	0.0590
L6	107	13.4		HCB	
L7	59	2.7			
L8	12	1.9			
L9	34	2.4			
No. of Sample Results	33	33			
Mean Concentration (excl. > Tier 1)	98.9	7.6			
Standard Deviation (excl. > Tier 1)	185.6	18.2			
t =	1.699	1.697			
n =	30	31			
df = (n-1) =	29	30			
Tier 1 Action Level	1429	299			
Area AOC (sq feet)	20000	20000			
Area HS (sq feet)	1785	900			
95% UCL AOC	156.46	13.16			
95% UCL/AL	0.109	0.044			
Tier 1 EMC =	**1.012**	**0.149**			
Shaded cells indicate Tier I exceedence					



Map 1 Existing Soil Data

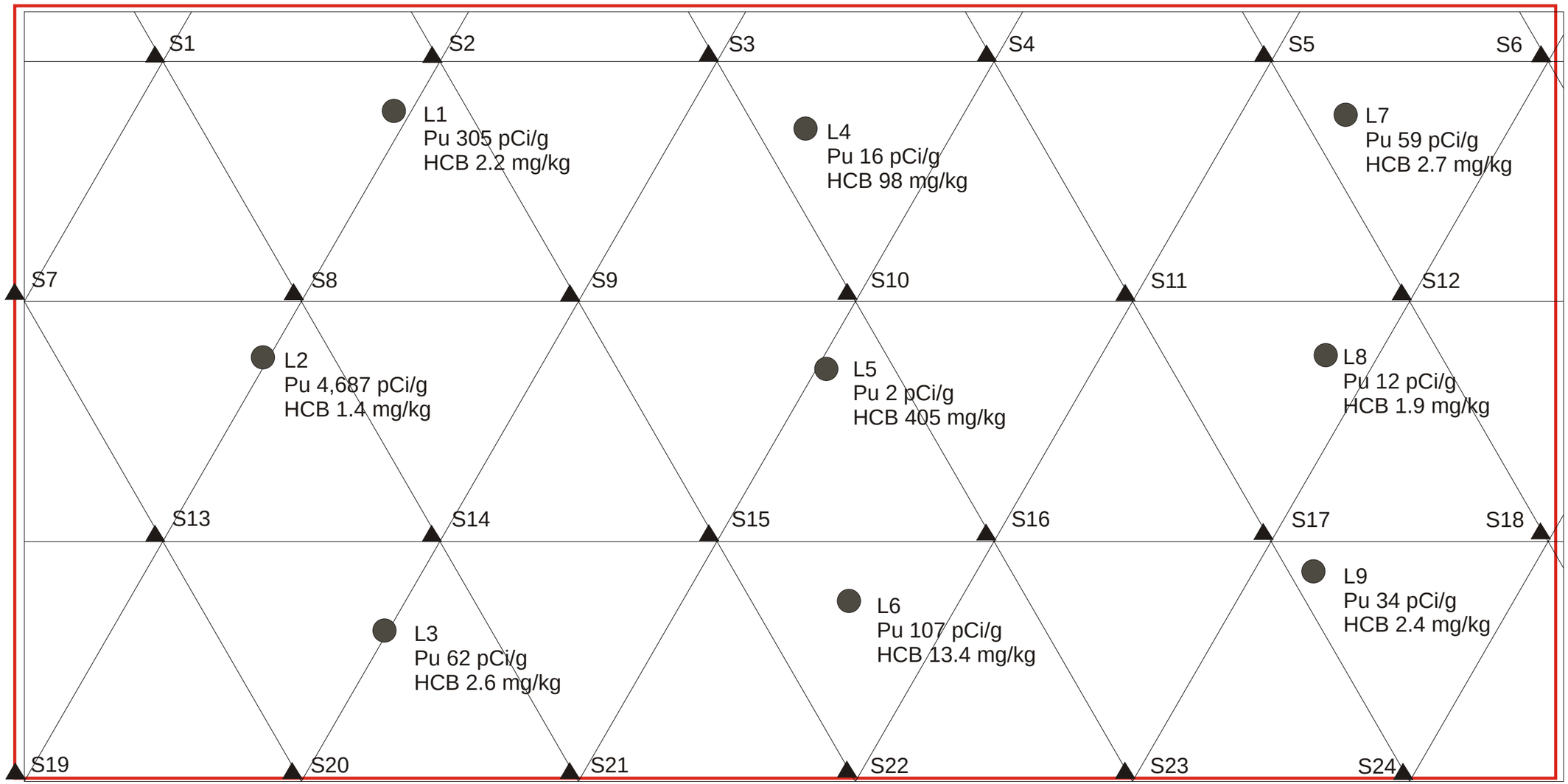
** This IHSS and building do not exist. Data have been fabricated to provide an example of how the IASAP process will work.*



Map 2 Triangular Grid Superimposed Over IHSS Using a Random Start

** This IHSS and building do not exist. Data have been fabricated to provide an example of how the IASAP process will work.*

IHSS 1.1

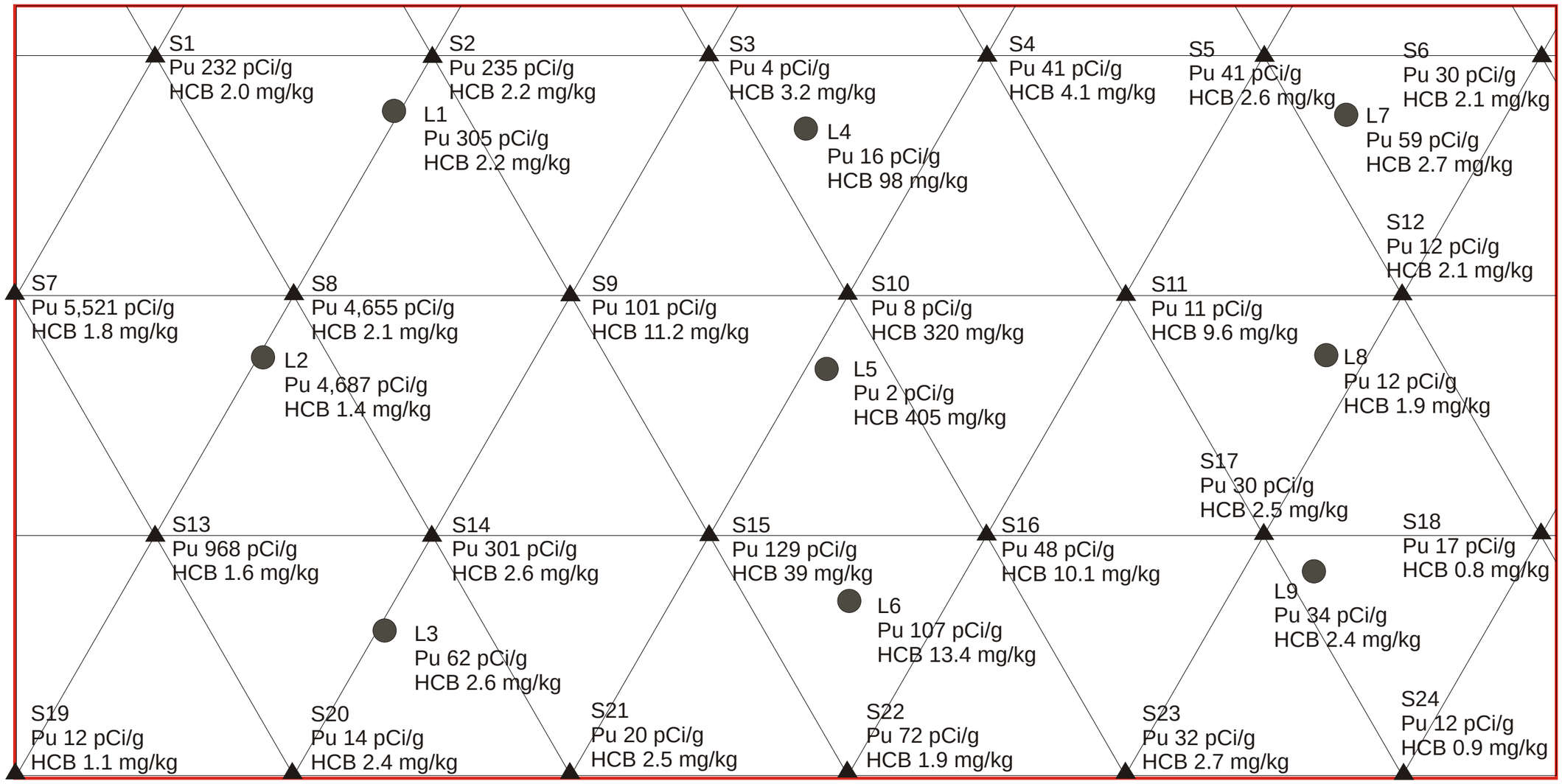


Map 3 Additional Soil Sampling Points Designated

** This IHSS and building do not exist. Data have been fabricated to provide an example of how the IASAP process will work.*

Building 172.66

IHSS 1.1



Grid Spacing = 36 Feet

20,000 square ft

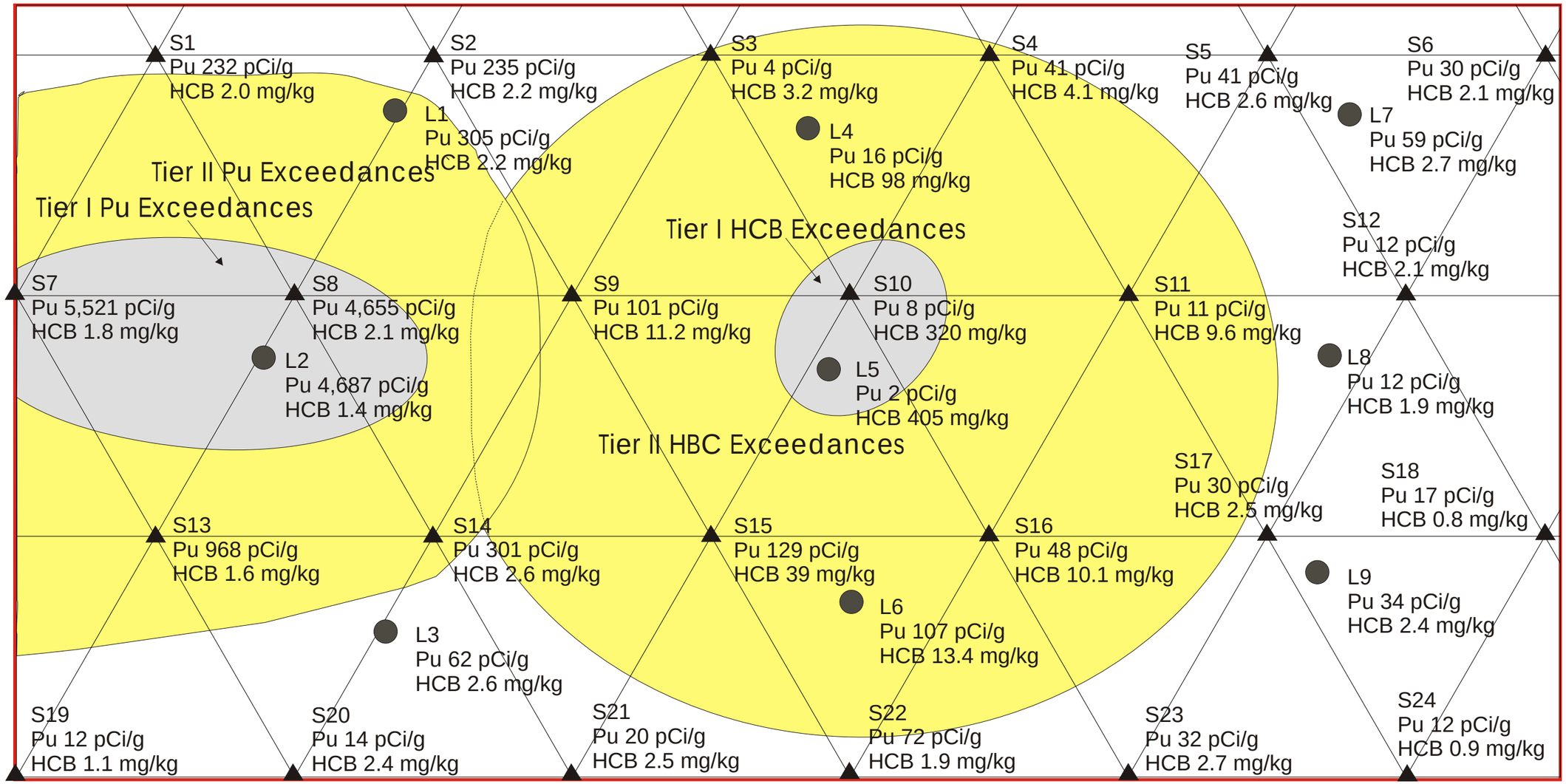
Map 4 Analytical Results

Legend:
- = Triangular Grid
- ● = Existing Sampling Points
- ▲ = New Additional Sampling Points

** This IHSS and building do not exist. Data have been fabricated to provide an example of how the IASAP process will work.*

Building 172.66

IHSS 1.1



Grid Spacing = 36 Feet

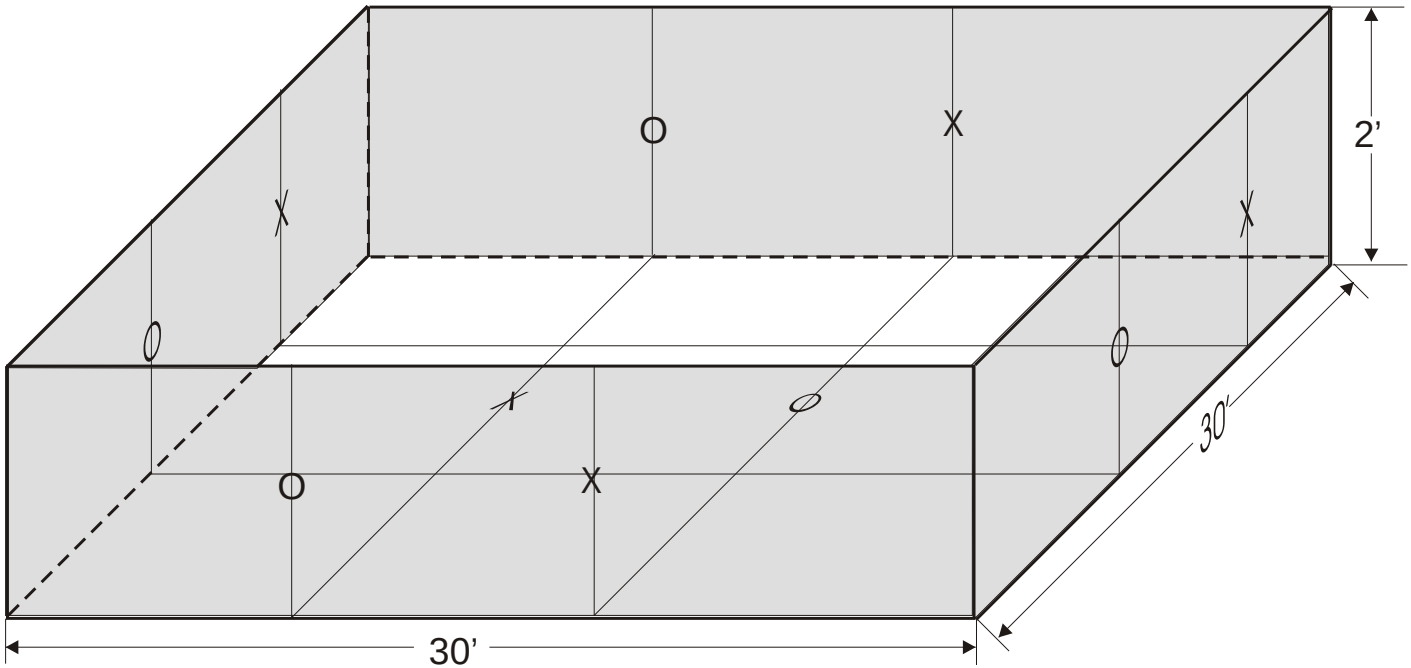
20,000 square ft

Legend:
— = Triangular Grid
● = Existing Sampling Points
▲ = New Additional Sampling Points

Map 5 Tier I and Tier II Excedences

** This IHSS and building do not exist. Data have been fabricated to provide an example of how the IASAP process will work.*

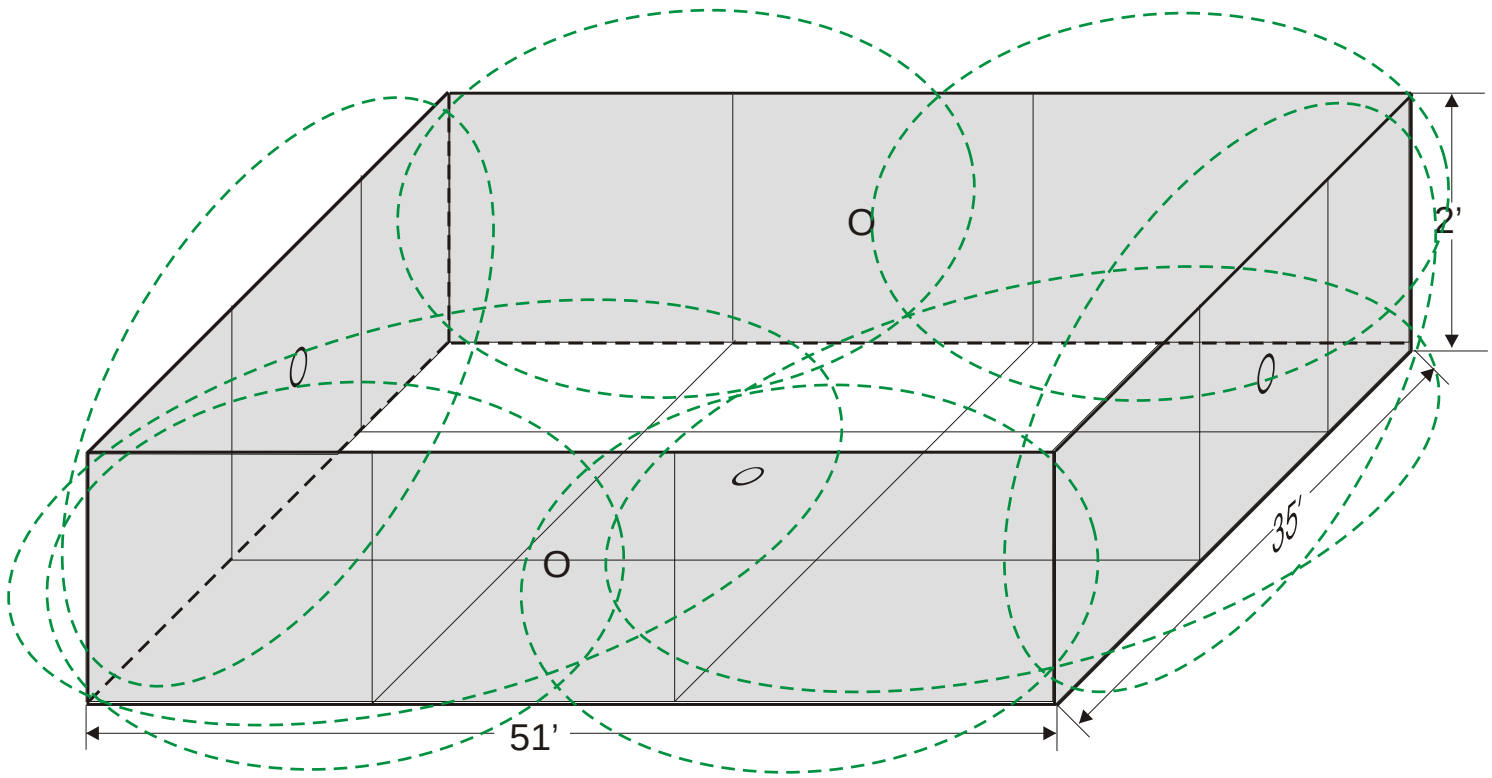
Map 6
HCB > Tier I Remedial Area
With Confirmation Samples



X = Field Analytical Sample Collection Point
O = Analytical Sample Collection Point

900 Sq. Ft. Area
1,800 ft^3 Soil Removal

Map 7
Pu > Tier I Remedial Area
With Confirmation Samples



= HPGe Sample Location
O = Analytical Sample Collection Point

1785 Sq. Ft. Area
3570 ft^3 Soil Removal

	Comment	Response
1	Page 2, Section 1.1 – This section and this document need to be more specific about has this SAP fits into the integration of functions (characterization, remediation, and closure) that occur in an accelerated action.	A diagram (Figure 2) has been added to illustrate how the IASAP and other IA Strategy elements correlate with the accelerated action process.
2	Page 3, Section 1.3 – A) Any addenda to this SAP must be reviewed and approved by the regulatory agencies. We recognize due to the cyclical nature of the DQO's that multiple rounds of sampling may be conducted under a SAP Addendum. Once an addendum is approved it may be appropriate to work on a concurrence basis for the follow-up rounds of sampling. It is not clear how data will be reported to the agencies. The State and the site should discuss details of how real-time data used for decision making will be provided to the regulators. B) RFETS submitted revised language on this section, our comments on that revision are: 1. Add bullets for the Elements of the IASAP which are applied and the Rationale for the use of the sampling methodology. 2. The methodologies (biased, Smartsampling, and statistical gridding) are not adequately included in this document. 3. There is no language in RFCA to define what "non-concurrence" of the LRA means, however, "non-approval" is defined by a process in RFCA.	A) The Addenda approval process is currently being discussed with the agencies and Sections 1.2 and 1.3 of the IASAP have been revised to reflect these discussions. A data management system that will couple database and GIS capabilities is being developed. This system will allow the regulatory agencies and RFETS to view the same data at the same time so that proposed sampling locations can be discussed. A new section has been added to Section 6 to describe this system. B) 1. A bullet stating that the "Sampling methodology for each IHSS, PAC, or UBC Site" was added to Section 1.3. 2. The IASAP Addenda will note what methodology was used to identify proposed sampling locations. The methodologies are described in the IASAP and are not re-described in the Addenda. 3. The phrases "non-concurrence" and "non-approval" do not appear in the Draft IASAP or in the revised text.

	4. We think 15 working days from the receipt of an addendum document is an attainable turnaround for approval.	4. As agreed with the regulatory agencies, there will be a 14-calendar day approval period.
3	Section 2.3.2 OU9 – Original Process Waste Lines - The test references Figure 4, which shows only the outside tanks. The process waste lines are shown in Figures 22 through Figure 25D, which should also be referenced.	This section provides an overview of the former OU 9 and is not intended to provide complete information on the OPWL. An additional figure, that shows the location of the OPWL, has been added.
4	Section 3.1.1 – A) This section has been reviewed with the understanding that some of the previous assumptions regarding Tier I and Tier II levels may change based the choice of restricted or unrestricted use action levels. Currently there is little or no difference between the Tiers for surface soils and subsurface soils. Based on the RSALs process and the Project Coordinator's agreements the concentration values could be changed based on priorities set by those groups. B) How well are the MDL's in Appendix D. known before the contract for each field method is completed? C) Inputs to the Decisions (pages 21 and 26) The following replacement text is suggested for items 4.f) and 6.f) in these sections respectively: For sites with soil data values exceeding Tier I	A) The IASAP DQOs will be reevaluated if RFCA Tier I and Tier II action levels change. B) Instrument MDLs proposed in Appendix D are currently being evaluated. If MDLs for proposed instruments cannot be met, other instrumentation with MDLs below RFCA Tier II values will be evaluated. C) The text has been revised to the suggested text, with the underlined changes: For sites with soil data values exceeding ~~Tier I and/or~~ Tier

		and/or Tier II ALs, the spatial extent of the AOC will be established by delineating detectable contamination; i.e., PCOC values above the background mean plus two standard deviations for inorganics and radionuclides, and PCOC values above detection limits for organics. Additionally, PCOC values above Tier I ALs and PCOC values above Tier II Als will be delineated. There is no lower limit on the size of an AOC; however, no single AOC will exceed (TBD; equal to the size of the smallest exposure unit used in the CRA) acres. Data will be aggregated over the AOC according to the decision rules. The 95% upper confidence limit (UCL) of the mean for each PCOC will be compared to the Tier I and Tier II ALs in order to make appropriate remedial decisions. When evaluation of a Tier I exceedance indicates an area of very limited extent (i.e., a hot spot), data aggregation may not be appropriate. The methodology for determining potential hot spots is described in Section 4.3.	II ALs, the spatial extent of the AOC will be established by delineating ~~detectable contamination; i.e.,~~ PCOC values above the background mean plus two standard deviations for inorganics and radionuclides, and PCOC values above detection limits for organics. ~~Additionally,~~ PCOC values above Tier I ALs and PCOC values above Tier II Als will be delineated. There is no lower limit on the size of an AOC; however, no single AOC will exceed ~~(TBD; equal to the size of the smallest exposure unit used in the CRA)~~ 10 acres or an approved EU. ~~or.~~ The process for determining the AOC is shown in Figure 15 and described below: • Compare data for inorganics and radionuclides to the background mean plus two standard deviations, compare data for organics to detection limits; • Establish AOCs based on the spatial distribution of data; • ~~Data will be~~ aggregate~~d~~ data over the ~~over the~~ AOC according to the decision rules~~.~~ ; • Compare ~~T~~the 95% upper confidence limit (UCL) of the mean for each PCOC ~~will be compared~~ to the Tier I and Tier II ALs ~~in order to make appropriate remedial decisions.~~ • When evaluation of a Tier I exceedance indicates an area of very limited extent (i.e., a hot spot), data aggregation may not be appropriate. The methodology for determining potential hot spots is described in Section 4.3.

		The 10-acre size for the AOC is as stated in the RFCA Appendix 3, Section 3.7.2. The determination of the AOC language is taken from the IGD.
	D) Page 20 - Analyzing for a complete PCOC list is compatible with the site's desire to accomplish as much sampling as possible in one phase and would eliminate data gaps in the analyte by analyte evaluation for the CRA.	D) Soil in IA Groups will be analyzed for specific PCOCs when process knowledge or existing analytical data indicated that there is a restricted list of PCOCs for the group. In areas where process knowledge or existing analytical data do not indicate a restricted PCOC list, or there is no process knowledge or existing analytical data to constrain the list, analytes listed in the RFCA ALF will be included on the PCOC list.
	E) Page 23 - The Decision Rules for characterization sampling could be simplified by assuming that action levels account for background levels; i.e., if a background level for an organic or radionuclide is higher than its Tier II AL, the background level becomes the de facto soil AL. This procedure is similar to the protocol for groundwater ALs (RFCA Attachment 5, 3.3.C.3). Comparisons to background or detection levels would then be superfluous to comparisons to ALs.	E) The DQOs, including decision rules, were developed with the regulatory agencies. The comparison to background and detection limits is specified for determining the AOC.
	F) Page 23 - In Decision Rule #5, it is unclear which PCOC in a sum of ratios that exceeds 1 becomes a COC. These DQOs do not incorporate our comment that the text should say, "some action has to be taken".	F) The decision rules have been modified and a new figure (Figure 18) has been added to clarify when a PCOC becomes a COC (see attached figure and text). Decision rule #5 does not lead to an action, it leads to Decision Rules #7, 8, and 9

	Data evaluation and aggregation are not the only possible actions that should come out of this step. G) It is unclear what kind of data will be acceptable for the CRA, and what will not. Some sections differ from conclusions reached during meetings with the regulators. H) 1. Section 3.1.3 Final Characterization of the Industrial Area for the Comprehensive Risk Assessment - Inputs to the Decisions (page 31) It is not clear exactly what kind of data from pre-demolition survey reports, or pre-remediation data collected for AL comparisons will be used for the CRA. More detail needs to be provided here. 2. Section 4.1 In-Process Sampling (page 35) This section seems to indicate that field data could be used for the CRA. This would only be acceptable if the field data has been demonstrated to be of similar quality and to attain similar detection limits as more standard laboratory procedures. This needs to be stated here.	which incorporate the actions. G) Existing data that has passed through the Data Quality Filter and is consistent with risk assessment needs and new characterization and confirmation sampling data collected according to IASAP DQOs and passing the Data Quality Filter may be used in the risk assessment. The Draft CRA Methodology includes DQOs that specify data requirements. H) 1. Existing data that has passed through the Data Quality Filter and is consistent with risk assessment needs and new characterization and confirmation sampling data collected according to IASAP DQOs and passing the Data Quality Filter may be used in the risk assessment. The Draft CRA Methodology includes DQOs that specify data requirements. 2. The statement "Field analytical instrument data will be used for the CRA if appropriate data quality can be demonstrated." has been added.
5	Page 32 Section 3.1.3 – Which modeling studies are/will be approvable?	Text has been changed to "Data used for CRA modeling must meet Actinide Migration Evaluation (AME) modeling criteria" to be consistent with the Draft CRA Methodology.
6	The IA Data Quality filter needs to be included in this	The IA Data Quality Filter has been added after the first reference

	document.	to the filter (Section 3.1.1).
7	Section 4.3 Hot Spot Methodology (page 39) Three sections, 4.3, 5.2.2, and 5.3 deal directly with hot spots. It seems more appropriate and efficient to have all this guidance and protocol together in one section, then reference that section as necessary. A) This section states that separate hot spot methodologies will be discussed for each of the three area designations, but only one methodology is needed. Elevated Measurement Comparisons (EMCs) should only be necessary in Class 1 areas. Any direct measurement or sample that is >$DCGL_{EMC}$ (or the EMC for non-radionuclides) in Class 1 areas should be flagged for further investigation. If the elevated measurement is real, then any concentration greater than the $DCGL_{EMC}$ would be included in the calculation of the average hot spot concentration. "…[A]reas of elevated activity should not exist in Class 2 or Class 3 areas." (MARSSIM Rev. 1, p. 8-23) and "Measurements exceeding $DCGL_w$ in Class 2 or Class 3 areas may indicate survey unit mis-classification." (MARSSIM Rev. 1, p. 8-22) Rather than applying a hot spot methodology to areas not expected to have action level exceedances, the IASAP should focus on clarifying and better defining the classifications and how areas can be re-classified. Action level exceedances in a Class 2 area should lead	Section 4.3 introduces the hot spot methodology and concepts. Section 5.2.2 is a description of the Tier I and Tier II comparison and is frequently referred to as a hot measurement test. This is not the Hot Spot Methodology. Section 5.2.3 describes the equations used in determining the hot spot. The equations were included in a Data Evaluation section so the reader would not get lost in equations before understanding the sampling and analysis process. A) This section discusses the hot spot methodology for the 2 designations within the IA. The third designation is the outer BZ and is discussed in the BZSAP. Three hot spot methodologies – one for the IA, inner buffer zone, and outer buffer zone were developed at the request of the regulatory agencies. RFETS staff agree that there should not be any hot spots in Class 2 or 3 areas. However, methodology was developed to assure the regulatory agencies that RFETS would not try to overlook potential hot spots in areas outside IHSSs, PACs, and UBC Sites. MARSSIM has been referenced and used as guidance where MARSSIM concepts are useful to the IASAP approach. Modifications to MARSSIM approaches were made because of the additional COCs (metals, VOCs, SVOCs) at the Site.

	to further investigation. The result may be reclassifying the area of elevated measurements as Class 1 and increasing the sampling density. B) The IASAP appears to rely only on statistically placed grids or SmartSampling to determine where hot spots occur. Additional scanning, as recommended in MARSSIM is not included. Therefore, the level of confidence that hot spots not caught by the gridded sampling will not be as great for this methodology as it is for the MARSSIM methodology. C) DOE Order 5400.5 specifically puts a lower limit on the size of a hot spot, namely 25 square meters, so that there is an upper limit to the allowable concentration of a contaminant in a hot spot that can be left on-site. DOE Orders are "To-Be-Considered" during cleanups, apparently this criterion was not considered for the IASAP. What is the justification for not following this criterion? Incidentally, RAC recommended and Weldon Springs placed lower limits on the size (and therefore upper concentration limits) on hot spots.	B) The IASAP is consistent with MARSSIM requirements. The scanning coverage proposed in the IASAP for HPGe provides a 90% probability of detecting a hot spot. This scanning coverage is consistent with the 903 Pad characterization and is close to the MARSSIM required scan coverage of 100% for Class 1 areas. Additionally, this coverage is consistent with the IASAP DQOs. C) The requirements in DOE Order 5400.5 were reviewed and are incorporated in the IASAP. DOE Order 5400.5 does not actually put a lower limit on the size of a hot spot. It states that a hot spot methodology must be developed if areas of contamination can be less than 25 square meters. DOE Order 5400.5 Section IV.4.a.(1): If the average concentration in any surface or below-surface area less than or equal to 25 square meters exceeds the limit or guideline by a factor of (100/A), [Where A is the area (in square meters) of the region in which concentrations are elevated], limits for “hot-spots” shall also be developed and applied.”
8	Page 41 Section 4.3.2 – The SmartSampling variogram range should be determined for each area and contaminant. What is the basis for the statement that it provides good correlation with the 10,000 m^2 hot spot?	The text has been change to the following: “ The hot spot size of 10,000 m^2 will provide appropriate sampling frequency and spatial information for SmartSampling analysis of the white space and inner BZ.
9	Page 42 Section 4.4.1 – It would be helpful to summarize	The text references Section 4.10, which includes sampling

	the procedures in this SOP as not everyone reviewing this document has easy access to the SOP documents. Will SOP's be developed for the field instruments? Since it is possible that bedrock materials could be contaminated as well, sampling methods for consolidated materials should be included here.	procedures. Procedures will be developed for field instruments. The use of hollow-stem augers is described in Section 4.10.2.
10	Table 4 – This table does not appear to be complete. Why are no samples listed for the Solar Evaporation Ponds IHSS when the table indicates sampling is complete? We would like to see an aggregation of this data with SmartSampling that demonstrates no additional sampling is needed. Other areas for which we believe there is sampling data do not indicate that it exists.	Table 4 has been updated. The Solar Evaporation Ponds have been extensively characterized through 2 RFI/RIs as documented in the IM/IRA. The Solar Evaporation Ponds' data will be used in an IA-wide SmartSampling analysis.
11	Page 53 Section 4.5.1 – The MDL and associated lab error must be below the Tier II action levels for confirmation samples to be taken with field instrumentation. For example the MDL of the field method for beryllium would not allow sufficient confidence for confirmation samples.	Field analytical instrument data will be used for confirmation samples if appropriate MDLs can be achieved and appropriate data quality can be demonstrated. MDLs include statistical error and are appropriate for comparison with RFCA ALs.
12	Section 4.5.2 Sampling Locations In the August 3, 2000 IASAP working group meeting, the State stated that a percentage of HPGE sampling needed to be supplemented with alpha spectrometry so that site-specific correlations could be determined. This comment was not incorporated into the IASAP document.	As stated in 4.5.2, correlation between field and laboratory instruments, including HPGe, will need to be demonstrated.
13	Page 59 Section 4.8.5 – We are concerned about the lack of detail in this section. We don't believe enough is known about the process waste lines to be able to characterize leaks with biased sampling. Not	Biased sampling at OPWL, NPWL, sanitary sewers, and storm drains provides a place to start the sampling process. As stated in Section 4.8.5, "This in-process approach will allow tracking of contamination along a pipeline…". Contamination found at,

	characterizing the interiors of the lines and leaving them in place may allow contaminants well above Tier I levels to remain in the subsurface environment. There is a high probability of failure for those structures before any radioactive contamination would decay to safe levels, therefore they should be characterized and treated as other subsurface contamination that has escaped containment.	for example, a known leak, would be tracked in both directions from the leak. More detail on characterization of the OPWL, NPWL, sanitary sewers, and storm drains will be included in the appropriate addenda. Additionally, RFETS staff expects that there will be continuing dialog with the regulatory agencies about this issue prior to characterization. Remediation of the OPWL, NPWL, sanitary sewers, and storm drains will be addressed in the ER RSOP.
14	Page 62 Sections 4.9.1 to 4.9.3 – The information referenced here is not yet included in Appendix G.	The information will be included in the final draft.
15	Page 64 Section 4.10.2 – Surface vegetation may be removed but subsurface organic matter should be included in the soil samples	The text has been revised to indicate that surface vegetation will be removed.
16	Page 64 Section 4.10.3 – What provision will be made to keep contamination from migrating down a borehole and causing lower samples to appear contaminated?	As stated in Section 4.10.3, the exterior surfaces of soil samples will be "peeled" to remove material that is in direct contact with the sampler/corer. This will remove material that may have "migrated" down the borehole. Additionally, sampling equipment will be decontaminated between sample intervals.
17	Page 66 Section 4.10.4 – We are interested in the results and evaluation of the HDD and EMWD projects.	The HDD/EMWD fieldwork was completed in December. A report on the results will be completed when laboratory data becomes available.
18	Page 70 Section 5.1.2 – Level III and Level IV measurements are not defined for this calculation.	Level III data is field analytical data. Level IV data is laboratory analytical data. The text has been modified to clarify what kind of measurements are included in the calculation.
19	Page 70 section 5.1.4 – How will the number of verification samples be determined when field or onsite analytical methods are not of adequate quality?	Quantity and comparability of verification samples will only be related to other samples that have had appropriate verification and validation. Rejected samples or results, i.e., samples or

		results of inadequate quality will not be used in evaluation of verification data.
20	Page 71 Section 5.2 – Although decision errors were previously mentioned it would be appropriate to restate them in this section and discuss their implication. It would also be useful to illustrate the discussion with probability diagrams for contaminants of interest such as beryllium and vinyl chloride showing the overlap of the analytical gray area (plus or minus 20% or 30% according to acceptable data guidelines) with the alpha and beta errors around the action level. Other diagrams such as cadmium, uranium, or plutonium can also be presented to illustrate how safe it is to make decisions based on the field instruments.	Probability diagrams, as well as other useful graphics, will be used as appropriate to illustrate gray regions and concentrations compared with action levels. These diagrams are graphical supplements. Statistical and/or numerical formulae will be used to calculate the numbers actually used in decisions and not the referenced graphs themselves.
21	Page 72 Section 5.2.1 – What level of geologic logging will be done for the many shallow boreholes that will be drilled?	Detailed geologic logging will not be performed. Soil color (GSA Munsell Soil Color System), type, contacts, changes, and other unique features will be described in the project logbook and archived in the data management system.
22	Section 5.3 Elevated Measurement Comparison - A) The elevated measurement concentration (EMC) is not equal to the equation listed on page 75. It appears that too many steps have been combined into one equation. The sum of the ratio of the average concentration in an AOC to the action level plus the ratio of the average hotspot concentration to the action level for that size hotspot does not equal the EMC. This sum should be less than 1 in order to make sure that the 25 mrem dose standard or any other action level will not be	A) The process outlined in this section is consistent with the "Elevated Measurement Comparison" methodology in MARSSIM. The only differences are that the Tier I and Tier II ALs are being used as the $DCGL_W$ and the contaminant-specific AL is being area weighted instead of area weighting the $DCGL_W$ to obtain the $DCGL_{EMC}$.

	exceeded. However, it is incorrect to equate this sum to the EMC. The EMC, or $DCGL_{EMC}$ was defined by MARSSIM as the radionuclide-specific activity concentration within a survey unit corresponding to the release criterion. In other words, it is the concentration of a particular radionuclide in a particular sized hotspot that would result in a 25 mrem/y dose (or any other risk-based limit). MARSSIM calculates the $DCGL_{EMC}$ by multiplying $DCGL_w$ by the appropriate Area Factor for the hot spot size. In order to be consistent with MARSSIM's definition, for radionuclides, $EMC = DCGL_{EA} = AL \times (DCGL_{hotspot} / DCGL_w) = AL \times \text{Area Factor}$ For non-radionuclides, $EMC = AL \times (Area_{AOC} / Area_{hotspot}) = AL \times \text{Area Factor}$. The elevated measurement comparison should be done by directly comparing each measurement to the above appropriate EMCs. Equations 5-3 and 5-4 are used to indicate whether a remedy occurs or not; however they should not be equated to the EMC. B) This section needs to clearly delineate the sequence of events that should happen during the elevated measurement comparison. This may be done best in a flow chart, should include the following steps:	B) A flowchart has been prepared (Figure 32) that outlines the elevated measurement comparison process.

	• Calculate an EMC ($DCGL_{EMC}$) based on the size of the grid area. • Do a point by point comparison to the appropriate EMC. • If a point is greater than the EMC, it should be investigated further, i.e., • Is the hot spot real, or merely an anomalous analytical result? • If the hot spot is real, how big is it? (nature and extent of the hot spot) • If the hot spot is confirmed, recalculate the EMC for the specific area of the hot spot, A'. • Is the average concentration in the hot spot greater than the hot spot-specific EMC? (Using the area factor $F_{A'}$ for the area A', the average concentration in the area, A' (95% UCL on the mean) should not exceed the product ($F_{A'}$ x $DCGL_W$) in order for the survey unit to meet the release criterion.	
	C) Equations 5-3 and 5-4 use the terms $95\%UCL_{ipu}$ and $Area_{ipu}$. As stated in the second paragraph of this section, the applicable area is the AOC, not the generally drawn IHSS, PAC or UBC areas. The terms, therefore, should be the $95\%UCL_{AOC}$ and $Area_{AOC}$.	C) The term ipu will be changed to AOC.
	D) Please provide a more complete rationale, such as written up in MARSSIM (Aug.2000) page D-22 & 23 for internal radionuclides that justifies the validity of	D) For non-radionuclides, it is well established within the CERCLA risk assessment paradigm that an individual is exposed to contaminants across an exposure area. This is the basis for allowing the use of the 95% UCL of the mean

	simply comparing areas of the AOC and of the hot spot as a surrogate for the Area Factor for non-radionuclides.	concentration as the exposure point concentration for an individual in a CERCLA risk assessment. Therefore, using area weighting is an appropriate technique for non-radionuclides in an AOC. An AOC is a surrogate for the exposure area.
	E) In the August 3, 2000 IASAP working group meeting, the State had asked that the potential for acute toxicity be factored in to the evaluation of whether a hot spot should remain or not. This document uses a value of three times the AL as an upper limit for re-evaluation, and states that this is consistent with RESRAD's release criteria. What is the basis for considering "three times" a chronic action level as safe from an acute standpoint across the board? It appears more toxicologically justifiable to evaluate the potential for individual PCOCs to produce acute effects.	E) The EPA endorses the use of an average concentration for the exposure point concentration in a number of guidance documents. As a matter of fact, risk assessments routinely use an average concentration for the exposure point concentration. Using an average for the exposure point concentrations is appropriate because an individual will randomly contact contaminants over a large area given a long exposure period. It seems to be a reasonable assumption that the upper end of contaminant concentrations could be 3 times the average concentration with no deleterious acute effects even if the average concentration equals the action level. It would certainly be inappropriate to assess acute effects for sample results that just exceed the action level. Toxicity will be evaluated in the CRA.
	F) What are the standard units for the parameters in this equation?	F) The units for the analyte concentration and the action level need to be consistent so they cancel each other in the equation. The units for the area of the hot spot and the AOC need to be consistent so they cancel each other in the equation as well. Units will be added to the equation to illustrate this concept.
23	Page 77 Section 6.0 – The geologic data management system is not mentioned here or in Table 9.	The geologic data management system will not be used. A new data management system that integrates analytical data with GIS

		will be used.
24	Page 80 Section 6.1.7 – It is not clear here and elsewhere in this document what data or reports will be submitted for regulatory approval. Please include discussion of how and when evaluations of field data that lead to a decision to stop or continue sampling and remediation will be provided to the regulators.	A data management system is being developed that will allow the regulatory agencies and RFETS staff to view analytical data on maps. Final data summaries for each IHSS Group will be included in the Closeout report. Remediation decisions are describe in the ER RSOP.
25	Page 82 Section 6.1.9 - What classification system will be used for soil horizons?	The Unified Soil Classification System will be used.
26	Page 83 Table 10 – Is the GPS system able to provide accurate locations for closely spaced sampling grids?	Current, commercially available GPS systems are accurate to approximately 0.10 ft. K-H will require the characterization contractor to meet standard land surveying units.
27	Page 84 Section 6.1.11 - What is the current and/or anticipated future laboratory capability for radiological samples above the DOT criteria?	Appropriate laboratory capability will be assured. Samples above the DOT 2,000 pCi/g total radioactivity threshold will be shipped in accordance with hazardous materials transportation shipping regulations to offsite analytical laboratories.
28	Page 87 Section 9.0 - The State is especially concerned with H&S requirements for Beryllium.	DOE is concerned about H&S requirements for beryllium and has special H&S requirements for beryllium projects.
29	Figure 13 – The decision to disqualify a PCOC from further consideration should not be made before the nature and extent question is answered.	See response 4F.
	Figures 14 - It is also unclear how the last decision box in this flow diagram leads to “Remedial Decision” if the decision is “No.”	An additional decision diamond has been added to address analytical results greater than RFCA Tier I ALs.
30	Figure 15 - It isn't clear why the initial input (blue box) is limited to "characterization sample analytical results". Won't confirmation sampling, plus any characterization sampling for areas where no remediation was necessary be the inputs here? Most of the characterization sampling	The initial input box has been changed to include existing analytical data as well as confirmation data.

	will no longer represent the area where remediation has occurred since the locations will no longer exist.	
31	Figure 17- What are the inputs to this decision? In evaluating the remedial locations the cost to remediate to an ALARA level should be included in the decision. A) The NFA circles at the top of this flow diagram should be revised so they are consistent with the first two corresponding steps of Figure 18. B) The criteria for how the decision is made that "the data indicate a hot spot" needs to be specifically listed, e.g., spatial distribution, concentration > $DCGL_{EMC}$. C) References to the text would make all of the flow diagrams most useful.	An input box has been added to this diagram. Remedial costs are included in the ER RSOP as is the decision of when and how much to remediate. A) Figure 17 has been changed to be consistent with Figure 18. B) Figure 17 is for SmartSampling. The hot spot decision diamond is used to flow potential hot spot data into the EMC as SmartSampling is not necessarily used for hot spot evaluation. C) In the final draft, the figures will follow the text and will not be at the end of the document.
32	Figure 18 - uses PCOC and COC inconsistently.	The inconsistency was fixed.
Comments on Appendix A, Draft Industrial Area Sampling and Analysis Plan Addendum Industrial Area Group 700-4		
1	Page 1 Section 2.0 - The locations within Buildings 771 and 774 should be located on the reference map.	Appendix A is included as an example of what an IASAP Addendum will look like. The IASAP Addendum for this IHSS Group will be based on building specific and existing data. An addendum for sampling within Building 771 is currently being developed. Figures 3 and 4 show where samples will be taken. Additional information on rooms within the buildings is UCNI classified.
2	Page 11 Section 2.0 – The nitric acid dumpster is not identified on any maps, there is one biased sample just to	The nitric acid dumpster is considered part of Building 771.

	the north of a gray rectangle in the area described in the text, does the rectangle represent this dumpster?	
3	Map 2k-0404 is difficult to read and interpret. It is not labeled with a figure number although the text seems to reference it as Figure 2. The IHSS layer covers the building boundaries so interior and exterior IHSS's are hard to distinguish. Sometimes the IHSS is labeled with an IHSS number and sometimes with a tank number, this inconsistency makes it difficult to match the description to the location. Neither IHSS 124.1, 124.2, 124.3 or the associated tank numbers could be located on this map. It would be helpful to include the PCOC list for a tank or IHSS. The surface soil data posted seems to show several common soil parameters above the background plus two standard deviations and very few PCOC's. Perhaps there is another way to screen the data for this posting that eliminates the clutter caused by highly variable background parameters.	The figure number (2) has been added. The following changes have been made to the figure: • The color of the UBC Sites has been changed; • IHSSs and PACs have been labeled. The data was screened according the IASAP DQOs (Section 3.0 of the IASAP).
4	Page 18 Table 1- IHSS 124.1, 124.2, 124.3, and 125 - Why is only surface soil being sampled for these IHSS? Uranium and nitrate in solution are able to infiltrate to subsurface depths. All descriptions indicate there were liquid spills.	The IASAP Addendum for this IHSS Group will be based on building specific and existing data. An addendum for sampling within Building 771 is currently being developed.
5	Figures 3 & 4 – It appears that some gridded sample locations are the same as some biased sample locations, what is the difference between the two types of samples? What do the irregular blue crosshatched areas represent? If these are lakes and ponds as indicated on the larger map have the sediments been sampled? If not, these areas	Biased sample locations are based on the location of known leaks and OPWL. These locations will be revised as more is learned about potential contamination through D&D characterization in the buildings. The gridded sample locations represent the standard statistical approach described previously in Section 4.2.2. As stated earlier, Appendix A is included as an

	should be included in the second round of gridded sampling.	example. The water features are part of different IHSS groups and will be evaluated as part of those groups. Areas outside of IHSS groups will be sampled as part of White Space sampling.
6	IHSS 150.1 – A biased sampling location is listed in the table but there is no sample location posted on the map. The existing data posted on the map does not include radionuclides. Why is this IHSS not included in the second round of grid sampling when the numerous contamination events are not specifically located within the area?	IHSS 150.1 has 8 sample locations biased to collect surface soil data and subsurface soil data about the OPWL beneath the IHSS. There are 10 existing samples locations with acceptable analytical data.
7	Section 3.0 - In general the sampling rationale has not been well developed in this document. Sampling methods should be specified in the addendum. The posted existing data does not provide any information on the PCOCs. The sample locations are generally located with no information as to where a biased sample will be collected. Information on why biased samples were located or how they will be chosen should be included. It would be helpful to number the samples and include a table with the rationale for each biased sample. Does biased sampling mean a single sample, a composite sample, or multiple locations based on professional judgment in the field? Will samples be removed from the borehole for analysis? How will they be collected? What sample size is needed?	The IASAP Addendum for this IHSS Group will be based on building specific and existing data. An addendum for sampling within Building 771 is currently being developed. The sample rationale for each IHSS, PAC, or UBC Site was listed in Table 1. Each method is described in Section 4.2 of the IASAP. Existing analytical data greater than background plus 2 standard deviations for radionuclides as well as metals and detection limits for organics has been posted. Table 1 has been revised to include additional information.

	What analysis method will be used? What other analytes are included in the field sampling analysis besides the PCOC's?	The figures show sample locations only. Sample numbering will be in accordance with established ASD procedures as described in Section 6.1.12 of the IASAP. Sample numbers are generated several weeks before the sampling event. A biased sample is a single sample, unless it is a borehole where samples will be collected every two feet as stated in Section 4.10.3 of the IASAP. Yes, samples will be removed from the borehole for analysis. Samples will be collected as described in Section 4.10.3 of the IASAP. Sample size is dependent on the analytes of interest. Analytical method is dependent on the analytes of interest. Please refer to Appendix D. PCOCs will be identified from process knowledge and existing analytical data. Data will be evaluated based on the DQOs to determine specific COCs for each IHSS, PAC, and UBC Site.
8	Section 6.0 - The initial characterization phase should include general screening sampling and not focus on a narrow PCOC list developed from process information, at this stage of sampling there are too many unknowns. Is a six-inch sample depth from below a building really adequate to characterize what will be exposed when the building is removed?	The initial beneath-building characterization will be targeted to identifying health and safety concerns.
9	Appendix G Page 9 Section 3.1 – It is not appropriate to	All ratios used will assume the most conservative scenarios

	assume uranium contamination will have an equilibrium activity ratio. Depleted uranium is a common COC at the site and U234 could be found at concentrations greater than a 1:1 ratio with U238 would indicate.	relative to decay (activity) ranges. Derivations of the ratio have been added to Appendix H text.

	Comments from March 7, 2001	Response
1	1. Decision rules 2, and 3, mix the determination of PCOCs with the determination of AOCs. It would be clearer if the two concepts were separated as in the following: 2. If all Analytical results are nondetections or are all below the background mean plus two standard deviations, a PCOC will be disqualified from further consideration; otherwise, the PCOC will be retained. Some inorganic and radionuclide concentrations may be below background levels but above Tier II ALs. 3. AOCs will be determined based on the areal distribution of PCOC concentrations that are above detection limits and above background.	Decision rules 2 and 3 are distinct because Decision rule 2 refers to organic constituents and decision rule 3 refers to inorganic constituents. The determination of the AOC is explained in the Inputs to the Decision section of the DQOs and illustrated on Figure 15.
2	2. Response to DOE/KH's response to CDPHE comment 22. Example calculation showing the inequality of the EMC and the unity rule equation. In Section 5.3 Elevated Measurement Comparison, (equation 5.3) DOE/KH equated the EMC (elevated measurement concentration) with the unity rule equation, as follows: $EMC = \sum[95\%UCL_{ipu}] + \sum[(\text{Sample Result}_{hs} - 95\% UCL_{ipu})] \geq 1$ (Indicates Remedy or Action) $AL \qquad (AL \times Area_{ipu}) / Area_{hs}$	Equation 5.3 was written as a condition of taking an action that is consistent with the overall objective of the IASAP and RFCA. The condition of expression explicitly states that a remedy or action will be taken when the left-hand portion of the equation is greater than or equal to 1. The expression also implies that all values less than or equal to one require no remedy or action. The text was changed to indicate that if the EMC is greater than 1, action is indicated.

	As stated in our previous comment, it is incorrect to equate the EMC to the right hand side of this equation. Too many steps have been combined. We have no objections to the right hand side of the equation per se. It is simply the unity rule. If the sum of the ratio of the average concentration in an AOC to the action level plus the ratio of the average hotspot concentration to the action level for that size hotspot is greater than 1, then the 25 mrem dose standard will be exceeded, and an action should be triggered. However the EMC does not equal the right hand side of the equation. In order to be consistent with MARSSIM, for radionuclides, the EMC = $DCGL_{EA}$ = AL x ($DCGL_{hs}/DCGL_{w}$) = AL x Area Factor. The easiest way to prove our point is by substituting numbers into the equation, as an example. Therefore let: AL = 100 pCi/g, 95% UCL_{ipu} = 10 pCi/g, Sample $result_{hs}$ = 50 pCi/g, $Area_{ipu}$ = 20 m^2, $Area_{hs}$ = 5 m^2. If these values are substituted into the unity rule equation, (the right hand side of equation 5.3), one gets: $\frac{10}{100} + \frac{(50 - 10)}{(100 \times \frac{20}{5})}$ 0.1 + 0.1 = 0.2. This value, (0.2) is less than 1, therefore such a site would not exceed the 25 mrem standard, and an action would not be triggered.	

	However, the elevated measurement concentration (EMC) should not be equal to 0.2 if the action level, (AL) is equal to 100 pCi/g, since a higher concentration should be allowable if someone were to be exposed to only a small hotspot area. Rather, the EMC = AL x $\frac{Area_{ipu}}{Area_{hs}}$ = 100 x $\frac{20}{5}$ = 400 pCi/g. Thus, it appears that DOE/KH's equation 5.3 has incorrectly combined the part of the equation which indicates that the standard is likely to be exceeded with the EMC. DOE/KH must correct this error.	
3	Comment 7.B. The response addresses sampling for radionuclides, but not non-radionuclides for which there is no scanning coverage method available. Part A of EPA's Data Usability for Risk Assessments (1992) specifies a minimum 90% confidence limit for non-radionuclides. Guidance in Part B of that document suggests 95% confidence limits for radionuclides. At the comment resolution meeting, it was suggested that there is a trade-off between greater data quality and increasing the probability of detecting a hotspot using HPGe scanning. Both could be achieved by decreasing the sample spacing and increasing the number of samples.	Biased, statistical, and geostatistical methods are currently described in the IASAP as methods to locate and characterize hot spot presence and extent. The statistical sampling grid is the only method that specifies an 11-meter grid consistent with a 90% confidence of finding a 10-meter hot spot (in accordance with MARSSIM). The IASAP methodology of a triangular grid and a hot spot of 10 meters will result in approximately 3,500 sample locations over 77 acres in IHSSs, PACs, and UBC Sites. The IASAP also incorporates biased sampling to target hot spots where process knowledge or existing analytical data indicate that small spills may have occurred. Biased sampling will be used as necessary in IHSSs, PACs, and UBC Sites and will also be used to supplement the 11-meter grid sampling. The IASAP also

		incorporates geostatistical techniques that will be used as appropriate to determine sampling locations. The geostatistical technique is not tied to hot spot size, but to probability. The IASAP provides for grid coverages with a 90% confidence of finding a radionuclide hot spot, as well as provides statistical confidences for other constituents consistent with IASAP DQOs, i.e., at error rates of 10% to 20% (alpha and beta, respectively, and for both radionuclides and nonradionuclides). Further, in-situ gamma spectroscopy coverages would provide a measurement base (not a statistical base) of ~80% of the surface soil area, which is deterministic not probabilistic. The probabilistic uncertainties cited for DQOs are different than the de facto gamma spectroscopy areal scan coverages. IASAP confidences are consistently 90 to 95% (for alpha error) and consistent with specifications given in EPA, 1992. (The numbers cited from EPA, 1992 are derived differently than the IASAP DQOs, particularly in their relation to CVs and MDRAs. The IASAP DQOs are based on action levels, not background values [background values are related to the MDRAs as used in EPA, 1992]).
4	4. Comment 7.C. In the response to this comment, the exponent of the factor mentioned in the quote out of DOE Order 5400.5 is missing. The factor should be $(100/A)^{0.5}$. This Order also establishes an upper limit of 30 times the "appropriate limit for soil" on radionuclide concentrations. This limit should be included in the hotspot methodology. A limit is also appropriate for those non-radionuclides that have potential for acute toxicity. The action levels are based on	The paragraph IV 4. In DOE Order 5400.5 is specific to radium and thorium hot spots. The Order further states that "guidelines for residual concentrations of other radionuclides shall be derived from the basic dose limits by means of an environmental pathway analysis using specific property data where available." The EMC calculation in the IASAP is consistent with DQOs and provides a consistent and conservative approach to defining hot spots. Operationally, it is easier to have a consistent and conservative

	chronic exposures over time and it is appropriate to average concentrations within a certain exposure area. Short duration (acute) exposures, however, may expose an individual to a portion of the entire exposure area, which may have elevated concentrations (a hotspot). If the contaminant of concern has a potential for acute toxicity, then an upper limit must also be applied to that contaminant. See the discussion on comment 22.E. below.	approach for all hot spots when many IHSSs are being characterized and remediated than an assortment of methods. In regards to acute toxicity, please see response to comment 5.
5	Comment 22.E. DOE's response to our original comment was insufficient. In the August 3, 2000 IASAP working group meeting, the State asked that the potential for acute toxicity be factored in to the evaluation of whether a hot spot should remain or not. DOE's toxicologist at the time, Win Chromec, agreed that this was important to do from a toxicity standpoint, and agreed to do so. However, DOE's proposal in the comment response to use an arbitrary number equal to 3 times the chronic action level has no toxicological basis. The basis for using 3 times the action level should be explained and a toxicologist should review this proposal. Furthermore, DOE's statement that "It would certainly be inappropriate to assess acute effects for sample results that just exceed the (chronic) action level" also has no toxicological basis. For example, ATSDR's acute duration MRL (minimal risk level) for DDT to produce noncancer effects via the oral route is 5 E-4 mg/kg/d, based on effects on perinatal development of the nervous	According to our meeting notes, DOE did not commit to using toxicity values or to review the toxicity values, but committed to consider the issue. Upon consideration of the issue DOE decided to use a 3 x the AL as the upper limit of hot spots. This decision was made because IA remediation and the sampling to support remediation is based on RFCA ALs, not risk assessment. The text has been clarified to state that " …when the concentration of a contaminant at a hot spot is three times the Tier I AL an action is indicated." As stated in the IASAP (Section 4.3.3) the decision whether a hot spot requires remediation is not part of the IA characterization or post-remedial sampling effort. The EMC is presented in the IASAP because the EMC is consistent with IASAP DQOs for data aggregation and evaluation. Potential cleanup issues, such as acute toxicity are not part of the IASAP scope. Interim cleanup goals for RFETS are the RFCA ALs or as defined in a decision document. The comparison to the ATSDR's acute duration MRL is not a

	system in neonatal mice, with behavioral neurotoxicity manifested in adult animals. The intermediate duration oral MRL (applicable to exposures ranging from 2 weeks to 1 year duration) for DDT is also equal to 5 E-4 mg/kg/d, based on liver lesions in rats. EPA calculated its chronic RfD based on that same study, to be equal to 5 E-4 mg/kg/d. Thus, for this chemical, the chronic RfD, the intermediate duration MRL, and the acute MRL are all equal. In other words, one could expect acute toxic effects to occur at the same dose as chronic effects. For this chemical, the 3 times value clearly does not apply.	valid comparison. The MRL is a measure of the "pure contaminant" and not a measure of the contaminant in soil. The MRL would need to be put in context of soil ingestion/inhalation so that a meaningful comparison can be made to RFCA ALs. The task of evaluating acute, intermediate, or chronic values and whether they should be incorporated into RFETS remediation goals will be conducted as part of the 2001 review of Action Levels and Standards Framework for Surface Water, Ground Water, and Soils (ALF).

	Comments from May 25, 2001	Response
1	Response to Comment 1 OK. It still seems simpler and more straightforward to write these two decision rules in a logical, stepwise progression: first determine PCOCs, then determine AOCs based on those PCOCs.	The determination of PCOCs is in decision rules 2 and 3 and at the end of each of the decision rule is the statement "AOCs will be determined based on PCOC concentrations detected above background." This indicates that the PCOCs are determined before the AOC is defined. Perhaps the confusion results from the AOC description in the ***Inputs to the Decision*** section that, according to DQO guidance, is before the decision rules.
2	Response to Comment 22 OK. However, if there is more than one hotspot in an AOC, "a separate term should be included in the calculation for each area of elevated activity [or concentration]." (MARSSIM, Section 2.5.1.1)	In the Elevated Measure Comparison (EMC) the "j" term (which is summed) is the number of hot spots for a given COC. If there are 5 plutonium hot spots in an AOC they are summed in the EMC.
3	Response to Comment 7.B OK. The explanation provided in this response should form the basis of additional text.	Section 4.2.2, paragraph 4 has been rewritten as follows: A systematic sampling scheme will be used to identify and delineate hot spots within the areas of interest following procedures outlined in Gilbert (1987). Sampling locations will be positioned into equilateral grids, such as triangular grids, following the methods presented in Gilbert (1987), ~~and~~ Gilbert and Simpson (1992), and Section 4.3. Triangular grid sampling provides uniform coverage of a sampling area and increases the chances of identifying an elliptical or circular hot spot (Gilbert 1987). The following assumptions apply to the proposed sampling design:

		1. Samples will be collected on a statistical grid. 2. The sampled area is much smaller than the grid spacing. 3. Hot spots are circular or elliptical. 4. Hot spots will be defined. After the grid interval is calculated for the specified area, a random-start grid overlay will be superimposed on a map of the IHSS, PAC, or UBC Site. In some cases, biased sampling will supplement the grid interval. This methodology provides grid coverage with a 90% confidence of finding a radionuclide hot spot, as well as provides statistical confidence for other constituents consistent with DQO error rates of 10% (alpha) and 20% (beta) for both radionuclides and nonradionuclides. Confidence levels are also consistent with EPA specifications (EPA 1992). Soil samples will be collected at the intersection of each grid according to the sample collection methods described in Section 4.10. Additional samples will be collected, as needed, to determine the size of the AOC. Sampling methods for each IHSS, PAC, and UBC Site will be specified in the appropriate IASAP Addendum.
4	Response to Comment 7.C OK	OK
5	Response to Comment 22.E OK. The commitment to evaluate acute, intermediate, or	The following text has been added to Section 4.3.3 and 5.3: The "three times the AL" concept will not apply to ALs that are

	chronic effects as part of an annual ALF review sufficiently addresses this concern. However, for any action levels that are adjusted in the future to account for acute toxicity, it would be inappropriate to apply a multiplier of 3 to determine an upper limit for a hotspot. The hotspot upper limit of 3x the Action Level could be illustrated in the examples in Appendix G.	based on acute toxicity. The examples are only illustrations of how the equation works. A new paragraph has been added after the first paragraph of Appendix G. Because the EMC includes an area-weighting component, results for very small hot spots may indicate action is not necessary for very high contaminant concentrations. To reduce this effect, when the concentration of the contaminant at a hot spot is three times the Tier I AL, action is indicated. An additional example that illustrates the "three times the AL" concept has been added as Example 3 and the other examples have been renumbered. $\sum_{i=1}^{n}\left[\frac{1393.9}{4770.0}\right]_i + \sum_{j=1}^{n}\left[\frac{(15000_{hs} - 1393.9_{AOC})}{\left(\frac{4770 * 16}{1}\right)}\right]_j = .47$ Additionally, the following text has been added: The EMC calculation indicates that action is not required for this hot spot, however, as stated in Section 5.3 that action will be taken at three times the AL, action is indicated at this hot spot (4770 [AL] x 3 = 14310).
6	Response to Comment 7.A (January 12, 2001 comments)	The hot spot methodology described in Sections 4.3.1 and 4.3.2 is

	MARSSIM establishes guidelines for setting sampling densities in Class 2 and Class 3 areas, and assumes that "…areas of elevated activity should not be present in Class 2 or Class 3 survey units" (MARSSIM, Section 2.5.1.1). MARSSIM avoids calling contamination in Class 2 and Class 3 areas "hotspots" and states that areas where contamination is found should be reclassified. That approach seems more straightforward than describing two different methods of designating hotspots in the two IA areas. The Class 2 Designations (Section 4.3.2) are based on a hotspot size 100 times the hotspot size in Class 1 areas (Section 4.3.1). The term "hotspot" is also used differently in Section 4.3 than in Section 5.3. The hotspots (Elevated Measurement Comparisons) described in Section 5.3 and Appendix G are areas of elevated activity/concentration within an identified AOC. Sections 4.3.1 and 4.3.2 describe the search for points of contamination, which may lead to establishing an AOC.	used to determine the size of the sampling grid in IHSSs, PACs, UBC Sites, and White Space Areas. As Comment 6 correctly states, these sections describe the search for points of contamination and the Elevated Measurement Comparison in Section 5.3 describes areas of elevated activity/concentration within an AOC. Section 4.3 has been rewritten as follows: Hot spot size drives the grid density and number of samples for a given area of interest. To determine grid density for IA and CRA sampling, the Site has been divided into three areas~~, each with a separate hot spot methodology. This division is generally~~ based on the ~~MARSSIM (EPA 1997) designations of Class 1, Class 2, and nonimpacted areas based on contaminant potential.~~ following criteria: 1. ~~A Class 1 designation signifies~~ IHSSs, PACs, and UBC Sites are areas of known contamination ~~that~~ or have a potential for contamination (based on process knowledge or analytical data). ~~or known contamination.~~ 2. ~~A Class 2 designation signifies~~ White Space Areas in the IA and inner BZ are considered areas that have a potential for contamination ~~or known contamination; however~~ but the contamination is not expected to exceed RFCA ALs. 3. ~~A nonimpacted designation signifies~~ The outer BZ is considered a nonimpacted area ~~areas that are~~ not expected to contain contamination.

		~~IHSSs, PACs, and UBC sites in the IA and BZ are considered Class 1 areas. White Space areas in the IA and inner BZ are considered Class 2 areas, and the outer BZ is considered a nonimpacted area. The following sections describe hot spot designations in the IA.~~ Sampling location methodologies for potentially contaminated areas and areas not expected to exceed ALs are described below; sampling location methodology for nonimpacted areas is described in the Draft BZSAP (DOE 2001a). Section 4.3.2 ~~Hot spot size in IA White Space areas and the inner BZ will initially be defined, for sampling purposes only, as 10,000 square meters (m^2) (107,639 ft^2 or 2.5 acres). This hot spot size~~ Areas in the IA White Space and inner BZ are not expected to have contamination above ALs and will be sampled to support CRA analyses. Surface soil in the IA White Space and the inner BZ will be sampled at grid points located based on Gilbert's methods and the probability of finding an area of elevated contamination. The area of the IA White Space and inner BZ is approximately 1,027 acres and a grid size of 2.5 acres has been chosen for the following reasons: ~~has been selected for the following reasons:~~ 1. There is very little precedence in existing literature for determining ~~hot spot size~~ grid size at DOE Superfund sites. However, MARSSIM provides guidance on the evaluation of land areas at radionuclide sites. MARSSIM defines land areas that have a potential for contamination as not greater than 10,000 m^2 in size. The IA White Space Areas and inner

		BZ are considerably larger (approximately 1,027 acres, 45 million ft^2, or 4 million m^2) than a MARSSIM area of 10,000 m^2 (2.5 acres or 107,639 ft^2). A ~~A 10,000 m^2 hot spot~~ grid size of 2.5 acres in the IA White Space and inner BZ would be approximately 0.2 percent of the area and provides a conservative method for determining contaminant distribution. 2. The grid design based on the ~~10,000 m^2 hot spot~~ 2.5 acre grid will augment geostatistical analysis by filling in data gaps between IHSSs, PACs, and UBC Sites. 3. The ~~hot spot size of 10,000 m^2~~ grid size of 2.5 acres will provide appropriate sampling frequency and information for geostatistical analysis of White Space and the inner BZ. Areas with concentrations above RFCA Tier I and Tier II ALs will be evaluated, according to IASAP DQOs and methods described in Section 5.0, to determine whether ~~a hot spot~~ contamination is present. Figure 26 illustrates the extent of the ~~Class 2~~ IA White Space and inner BZ Areas at RFETS.
7	Appendix E For those analytes with MDLs greater than action levels, the site must propose an alternate detection method or propose a practical quantitation limit. The justification for the "disqualification" of each analyte must be reviewed and approved.	Where MDLs are greater than the AL, the MDL for the specific analytes listed in Tables E1 and E2 will be used to determine the extent of the AOC for those specific analytes. Additionally, the determination of an acceptable practical quantitation level (PQL) will be considered during the annual review of the ALF. RFETS staff will continue to research emerging analytical methods so that more sensitive analyses can be incorporated into the analytical instrument suite.

		As stated in Appendix E, PCOCs will be re-evaluated on an IHSS and AOC basis. The text has been modified as follows: Potential contaminants of concern (PCOCs) will be re-evaluated on an IHSS, PAC, or UBC Site basis during the IASAP Addendum development process to ensure that potential contaminants are not overlooked during sampling and analysis.