Final Data Summary Report for the Characterization of UBCs 123 and 886

August 2001

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LIST OF ACRONYMS

AL	Action Level
Am	americium
Be	beryllium
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
CA	Contamination Area
CAFA	Casing Advancement Framework Assembly
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental, Response, Compensation and Liability Act
Cs	cesium
D&D	Decontamination and Decommissioning
DOE	U. S. Department of Energy
DQA	Data Quality Assessment
DQO	Data Quality Objective
Dup	Duplicate
EDD	Electronic Disc Deliverable
EMWD	Environmental-Measurement-While-Drilling
EPA	U. S. Environmental Protection Agency
ER	Environmental Restoration
FO	Field Operations
ft	feet
FY	Fiscal Year
GC/MS	Gas Chromatography/Mass Spectrometry
GP	Geoprobe® sample location
GRS	Gamma Ray Spectrometer
HDD	Horizontal Directional Drilling
HEUN	Highly Enriched Uranyl Nitrate
HRR	Historical Release Report
IA	Industrial Area
IHSS	Individual Hazardous Substance Site
in	inch
IWCP	Integrated Work Control Package
K-H	Kaiser Hill Company
LCS	Laboratory Control Sample
LD	Laboratory Duplicate
MB	Method Blank
MDA	Minimum Detectable Activty
MDL	Method Detection Level
MH	manhole
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NFA	No Further Action
NPWL	New Process Waste Line

ACRONYMS (continued)

OPWL	Original Process Waste Line
OU	Operable Unit
PAC	Potential Area of Concern
PARCC	Precision, Accuracy, Representativeness, Completeness, and Comparability
PB	Laboratory Preparation Blank
PCE	tetrachloroethene
pCi/L	picocuries per liter
pCi/g	picocuries per gram
PCOC	Potential Contaminant of Concern
ppb	parts per billion
PPE	personal protective equipment
Pu	plutonium
PVC	Poly-Vinyl Chloride
QA/QC	Quality Assurance/Quality Control
QAPD	Quality Assurance Program Description
RCRA	Resource Conservation and Recovery Act
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RIN	Report Identification Number
RLC	Reconnaissance Level Characterization
RMRS	Rocky Mountain Remediation Services
RPD	Relative Percent Difference
RQL	Required Quantitation Limit
RSOP	RFCA Standard Operating Protocols
RWP	Radiological Work Permit
Sandia	Sandia National Laboratories, Albuquerque, New Mexico
SAP	Sampling and Analysis Plan
Site	Rock Flats Environmental Technology Site
SOR	Sum of Ratios
SP	Source Storage Pit
SVOC	Semi-Volatile Organic Compound(s)
TCFM	trichlorofluoromethane
TPU	Total Propagated Uncertainty
U	uranium
UBC	Under Building Contamination
µg/L	micrograms per liter
µg/kg	micrograms per kilogram
V	volt(s)
V&V	Verification and Validation
VOC	Volatile Organic Compound
WPS	Waste Pumping Station

1.0 INTRODUCTION

The Kaiser-Hill Company, LLC (K-H) conducted an investigation beginning in October 2000 and completed in March 2001 to characterize the potential Under Building Contamination (UBC) associated with Buildings 123 and 886 at the Rocky Flats Environmental Technology Site (RFETS) (Figure 1-1). This investigation was conducted by K-H Environmental Restoration (ER)in accordance with the *Sampling and Analysis Plan for the Characterization of Under Building Contamination of UBC 123 and Building 886, Implementing Horizontal Directional Drilling and Environmental-Measurement-While-Drilling* (SAP), (RMRS 2000).

RFETS has 31 buildings with suspected or verified UBC that is the result of suspected or documented spills or leaks from building processes, Original Process Waste Lines (OPWL), New Process Waste Lines (NPWL), or operations adjacent to the buildings. Because of the compressed schedule required to reach closure, UBC characterization must take place concurrently with building deactivation, or decontamination where deactivation is not required, and cannot disrupt building activities. Therefore, methods to characterize UBC sites with minimal impact to buildings must be developed.

In conjunction with traditional, vertical soil sampling techniques, this project demonstrated the implementation of a new technology at RFETS, Horizontal Directional Drilling (HDD) and Environmental Measurement While Drilling (EMWD). The results of this demonstration will be used in conjunction with previously collected data from UBC 123 to support no action remedial determinations and supplement the *Final Close-Out Report for the Building 123 Decommissioning Project*, (RMRS 1998). The Building 886 investigation will serve as only a partial characterization of UBC 886. Final characterization will take place in conjunction with the decontamination and decommissioning (D&D) of this building.

This report includes a summary of the analytical data collected as part of the soil characterization effort. Data collected include HDD and Geoprobe® sampling techniques and the EMWD measurements conducted by Sandia National Laboratories (Sandia) in conjunction with the HDD operations. The results of the EMWD are presented in a separate report from Sandia as Attachment A, *Characterization of Under-Building Contamination at Rocky Flats Implementing Environmental-Measurement-While-Drilling Process with Horizontal Directional Drilling, (SNL June 2001).*

1.1 Objectives

This report details the field characterization activities and analytical results performed at UBC 123 and Building 886 in support of closure of RFETS. The objectives in implementing the HDD/EMWD for this project were to:

1. Implement and test a new technology and determine its effectiveness in UBC characterization at RFETS. Data collected from soil samples along a horizontal profile will be qualitatively compared by vertical profile characterization techniques. This assessment will be used to determine the applicability of HDD/EMWD characterization at future sites around RFETS and other DOE facilities.

Figure 1-1 Is Unavailable

There are five Rocky Flats Reading Rooms in the Denver metro area. Their addresses are below.

These rooms contain a huge selection of documents produced by Rocky Flats over the years, from environmental studies and reports to statistics on budgets and employment. The main reading room is located at Front Range Community College and is the most current and comprehensive. For more information, call the Front Range Community College Reading Room at (303) 469-4435.

The five Rocky Flats Reading Rooms locations are as follows:

Front Range Community College
3705 W. 112th Ave.
Westminster, CO 80030
(303) 469-4435

Rocky Flats Citizens Advisory Board
9035 N. Wadsworth Parkway, Suite 2250
Westminster, CO 80021
(303) 420-7855

Colorado Department of Public Health & Environment
Information Center
4300 Cherry Creek Dr. South, Bldg. A
Denver, CO 80222-1530
(303) 692-2037

U.S. Environmental Protection Agency
Region VIII Superfund Records Center
999 18th Street, Suite 500
Denver, CO 80202-2466
(303) 312-6473

Standley Lake Library
8485 Kipling Street
Arvada, CO 80005
(303) 456-0806

2. Determine the presence or absence of radioactive and/or hazardous contamination in the soils beneath Building 123 associated with leaks adjacent to selected process waste lines, sumps, pits, and waste pumping stations; localized spills beneath the concrete slab; and the general condition of the subsurface area beneath the former criticality lab (Room 101) of Building 886. Data generated are intended to be valid and usable for future remedial decisions; and
3. Determine the cost effectiveness of HDD/EMWD characterization techniques as compared to vertical drilling and sample collection methods. A list of applications and limitations of the HDD/EMWD methodologies has also been included in this report.

Additional subsurface Geoprobe® and hand-auger soil collection and sampling were conducted as supplement to the HDD/EMWD characterization to better define the remediation area potentially required for UBC 123 and Building 886 and to make qualitative data comparisons.

2.0 BACKGROUND AND SITE HISTORY

2.1 UBC 123

UBC 123 is located on Central Avenue between Third and Fourth Streets in the RFETS Industrial Area (IA) (Plate 1) and consists of the Building 123 slab, soil, Individual Hazardous Substance Site (IHSS) 148, and all underground process systems (IHSS 121). The building footprint is approximately 18,444 square feet. 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 plutonium, americium (Am), uranium (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, sumps, and pumps. Potential contaminants of concern (PCOCs) beneath the slab are uranium, plutonium, cesium, metals, and volatile organic compounds (VOCs).

The D&D of Building 123 and the surrounding area was completed in 1998. The project included the removal of Buildings 123, 123S, 113, 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 the slab level.

UBC 123 was chosen for deployment of EMWD/HDD because the slab was easily accessed. There are numerous underground utilities in the vicinity, but compared to other RFETS buildings, the underground layout is relatively uncomplicated.

2.1.1 Original Process Waste Lines

IHSS 121 consists of the OPWL system which includes the plant-wide process waste system comprised of tanks and underground pipelines constructed to transport and temporarily store process wastes from point of origin to on-site treatment and discharge points. Specifically, IHSS 121 includes process waste lines P-1, P-2, and P-3. These waste lines were described in the *Final Phase I Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) Work Plan For Operable Unit 9* (DOE 1992a) and in the *Historical Release Report* (HRR) (DOE 1992b).

In 1998, the pipe chases and sumps from Rooms 125, 156, 157, and 158 were flushed with a trisodium phosphate/sodium carbonate decontamination solution during D&D of Building 123. No contaminants of concern were found to exceed Rocky Flats Cleanup Agreement (RFCA) Tier II action levels (ALs) in the associated final rinsates except for lead (56 parts per billion [ppb]) from the sump in Room 125 (RMRS 1998).

2.1.2 IHSS 148

The eastern wing of Building 123 is encompassed by IHSS 148 which was part of Operable Unit (OU) 13. The *Final Phase I RFI/RI Work Plan for Operable Unit 13, 100 Area* (DOE 1992c) described proposed characterization plans for IHSS 148. Characterization of OU 13 was conducted from September 1993 to February 1995 and the results were documented in the *Draft Data Summary 2, Operable Unit No. 13, 100 Area* (DOE 1995).

Thirty-four analytes were detected in the surface soil samples, including twenty-six inorganic compounds and eight radionuclides. Eleven analytes exceeded background concentrations at a minimum of one sample location throughout IHSS 148. Constituents that exceeded background concentrations are listed in Table 3-1 of the SAP.

A soil-gas survey was conducted on a 25-foot grid in accordance with the OU-13 RFI/RF Work Plan (DOE 1992c) and samples were analyzed in the field using Gas Chromatography/Mass Spectrometry (GC/MS). Sixty-four soil-gas locations were sampled during the survey. Thirteen samples contained VOC levels in excess of the 1 microgram per liter (µg/L) method detection limit. Benzene, toluene, ethylbenzene, and xylene (BTEX) 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. The presence of organic extraction constituents is consistent with unconfirmed reports that liquids used in radionuclide analyses were occasionally disposed onto the soil surface outside of Building 123 and allowed to evaporate. The soil-gas analytical results indicate that a potential for residual subsurface VOC contamination of soils exists at UBC 123.

Unconfirmed reports of contaminant spills have been indicated in interviews with building employees. In the late 1960's or early 1970's, 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 (SPs).

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 thorium-232 in Rooms 109 and 105, respectively (RMRS 1998).

Four associated Potential Areas of Concern (PACs), 100-601, 100-602, 100-603, and 100-611, have been identified as associated with UBC 123, as shown in Plate 1. The PACs were established as the result of documented spill incidents. PAC 100-601 was approved as a No Further Action (NFA) site in 1992.

2.2 Building 886

Building 886, located in the northeastern portion of the 800 Area, was commissioned into service in 1965 (Plate 2). In approximately 1980, Trailer 886A was built immediately east of the building and was later connected by the existing breezeway. Building 886 housed the Critical Mass Laboratory where low-level criticality experiments were performed on liquids, powder, and solid forms of fissionable materials. The building currently houses offices and a small electronics/machine shop. Enriched uranium solutions, solid enriched uranium, and plutonium metal have been used in this building. The building footprint is approximately 14,197 square feet. Highly enriched uranyl nitrate (HEUN) solutions were spilled in Rooms 101 and 103. Room 103 contained seven HEUN tanks and a tank storage pit. Various utilities are beneath the building slab and two buried tanks (T-21) are just west of the building. The date of the last criticality experiment was in October 1987.

Reconnaissance-Level Characterization (RLC) studies were conducted and focused on the identification of potential sources of chemical contamination within the building. The hazards identified during the RLC were physical and chemical (i.e., lead and metals, Polychlorinated Biphenyls (PCBs), and asbestos). Potential radiological contamination has not yet been fully characterized (RMRS, 1999).

IHSS 164.2, Radioactive Site #2, 800 Area, Building 886 Spill, surrounds Building 886 and is the result of a previous release of an unknown colorless liquid from a 500-gallon tank onto the concrete slab. Surface soils in IHSS 164.2 were sampled during the RFI/RI for Operable Unit 14. Results indicated that uranium (U)-238 was above background values at locations north, south, east, and west of Building 886; plutonium (Pu) was above background values north and east of the building; and americium (Am)-241 was above background east of Building 886 (DOE 1995b). Building 886 has no process waste lines directly underneath, however a few exist, along with a foundation drain for surface water, west of the building. These process waste lines and foundation drain are not within the scope of this project.

3.0 SAMPLE COLLECTION AND FIELD ACTIVITIES

Characterization of the two UBCs was achieved utilizing three methods of soil sampling and data collection conducted in three separate phases of sampling activities:

1. Horizontal Directional Drilling (HDD) and Environmental Measurement While Drilling (EMWD) sampling and radiological measurement collection;
2. Geoprobe® boring and sampling; and,
3. Concrete coring and hand-auger sampling.

All sampling activities and methodologies were conducted in accordance with the SAP. Additionally, all field work was conducted under the guidelines specified by the job-specific Radiological Work Permits (RWP), and As Low As Reasonably Achievable (ALARA) Job Review.

3.1 HDD Sample Collection and EMWD Measurements

The HDD portion of the project differs from traditional horizontal drilling and was specifically developed by the project staff and drilling subcontractor for use at RFETS to minimize drilling wastes. Also referred to as the Casing Advancement Frame Assembly (CAFA), this horizontal drilling mechanism utilized a 900 lb. pneumatic hammer on a 20-foot steel frame to simultaneously drive the drill bit and 4-inch exterior steel casing and create the boreholes. This method of advance casing drilling displaced the surrounding soils throughout borehole advancement and used no drilling muds/fluids. This process resulted in zero drilling returns and greatly reduced the amount of wastes generated by the characterization project. Use of the 4-inch casing was necessary to keep the borehole open in the alluvial soils and industrial fill present at RFETS. A detailed description of directional drilling/hammering and soil sampling operating procedures is provided in the *Standard Operating Procedure, Directional Under Building Casing Advancement and Soil Sampling* (Corrocon 2000).

Five boreholes were drilled with the CAFA and a total of 21 real soil samples were collected along OPWLs P-1 and P-2 (see Plate 1). EMWD measurements were collected the entire length of each boring in one-foot intervals from within the 4-inch steel casing.

The CAFA (refer to Picture 1, Attachment C) is a non-rotary, pneumatically powered hammer which drives the casing and drill stems into the ground in a horizontal position at relatively low angles of inclination (less than 12 degrees). The CAFA assembly is horizontally situated on a 20-foot steel frame which operates directly on the ground surface and is powered by two connecting air compressors and multiple hydraulic lines. Directional steering of the borehole is accomplished by orienting the steering bit to a position which will achieve the desired directional control. Drilling distance, drill bit orientation, and angle of pitch are monitored by radio signal readings transmitted from the subsurface sonde, located directly behind the drill bit, to the operator and to above ground Digi-Trak receiver. The Digi-Trak is a hand held unit and requires the operator to be able to stand directly over the current extent of the borehole as well as its projected path (see Picture 2).

Due to the limited flexibility of the 4-inch casing and operational requirements of the CAFA unit, borehole initiation first required specific positioning of the CAFA and support equipment. HDD Lines 1, 2, 3, and 6 each required a trench excavation adequately sized for the operators to work within and graded to an appropriate slope to achieve the desired borehole depths. The excavations were typically 6-feet wide x 20 to 25-feet long and no deeper than 4 feet at any point. The trenches allowed for the point of entry to be closer to the desired sampling depths, i.e., the process waste lines located approximately 5 to 6-feet below the Building 123 slab. This method reduced the additional layback distance and drilling time that would have been otherwise needed if the borehole was initiated from ground or slab level. Additionally, the borehole then had to be initiated by coring an 8-inch diameter hole through the foundation wall at HDD Lines 1, 2, 4, and 6 prior to the commencement of the HDD process.

Of the five boreholes planned for installation and sampling for this project, only HDD Line 4 was completed as described in the SAP. Deviations from the planned drill paths were due to contact with unforeseen subsurface obstacles and casing compromise. However, sufficient characterization was achieved at UBC 123 from the compilation of data collected from previous D&D sampling with this HDD and Geoprobe® characterization project. Borehole-specific information is provided in Table 3-1.

Table 3-1 HDD Borehole Drilling Information

Borehole ID	Length of Boring (in ft)	Location	No. of HDD Soil Samples Collected	EMWD Measurements Collected?	Comments
HDD Line 1	43	UBC 123	0	Yes	Hit building footer, no HDD soil samples collected
HDD Line 2	137	UBC 123	8	Yes	Collected last soil sample at 127 ft (HDD-2-09); Casing bent at ~100 ft
HDD Line 3	63	UBC 123	5	Yes	Casing bent
HDD Line 4	114	UBC 123	6	Yes	All samples collected
HDD Line 6	18	UBC 886 Rm 101	2	Yes	Hit obstruction at 18 ft, unable to collect 3rd soil sample

Soil sample collection was achieved by tripping out the 1 ¾-inch drill stem and directional steering bit from within the 4-inch steel casing, leaving the casing in the ground. The directional bit was then removed from the stems and a 3-inch x 24-inch stainless steel split spoon soil sampler was attached and reinserted into the casing. Once at total horizontal depth, sample collection was achieved by horizontally hammering the spoon into the undisturbed soil just in front of the furthest extent of the casing thereby driving the soil into the sampling tube. The drill stem was then tripped out again and the sample was then collected. The process was then repeated as desired. Table 3-2 provides the actual HDD soil sampling locations in UBCs 123 and 886 as shown in Plates 1 and 2, respectively.

Table 3-2 HDD Sample Locations and Specifications

HDD Line Sample ID	Location/Area of Interest[1]	Horizontal Distance of Sample Location from Borehole Entry[2]	Actual Soil Interval Collected (Inches below top of slab)	Sample Recovery (Inches)	Percent Recovery	Comments (Distances are Horizontal)
HDD Line 1 (UBC123)						**Initiated at North foundation wall**
HDD-1-01 to –06	P1 (1972)	n/a	n/a	n/a	n/a	Not Collected- Hit foundation wall at 43 ft
HDD Line 2 (UBC123)						**Initiated at North foundation wall**
HDD-2-01	Room 107A	8"	47	7	29%	Immediately inside foundation wall
HDD-2-02	P2 (1952) North Hallway	n/a	n/a	n/a	n/a	Not Collected due to close proximity of HDD-4-06
HDD-2-03	P2 (1952) Rm 122	27' 3"	62	24	100%	
HDD-2-04	P2 (1952) Rm 123	42' 3"	68	21	88%	
HDD-2-05	P2 (1952) Rm 124	54' 4"	65	21	88%	
HDD-2-06	P2 (1952) Rm 125	74' 2"	63	24	100%	
HDD-2-07	P2 (1952) Rm 125	92' 2"	62.5	22	92%	4" Casing bent at ~100 ft down hole
HDD-2-08	P2 (1952) Rm 126C	107'	62	12	50%	
HDD-2-09	P2 (1952) Rm 127	122'	61.5	12	50%	
HDD-2-10	P2 (1952) Rm128	137'	61	n/a	n/a	Not Collected - Casing Bent
HDD-2-11 to –13	P2 (1952) Rms 128,143,144	n/a	n/a	n/a	n/a	Not Collected - Casing Bent; Drilling never advanced to these points
HDD Line 3 (UBC123)						**Initiated South of West Wing**
HDD-3-01	P1 (1972) Parking Lot Area South of Building	0'	52	17	71%	HDD-3 depths from concrete TOS
HDD-3-02		18'	62	24	100%	
HDD-3-03		33'	76	24	100%	Wet, well-sorted sand in sample-Trench
HDD-3-04		48'	87	24	100%	
HDD-3-05		63'	85	17	71%	
HDD-3-06 to –11	P3 (1968)	n/a	n/a	n/a	n/a	Not Collected - Casing Bent
HDD Line 4 (UBC123)						**Initiated at East foundation wall**
HDD-4-01	P2 (1952) North Hallway	112' 11"	76	24	100%	
HDD-4-02		102' 1"	74	24	100%	
HDD-4-03		87'	71	24	100%	
HDD-4-04		72' 3"	64	24	100%	
HDD-4-05		57'	58	24	100%	
HDD-4-06		43' 6"	47	24	100%	
HDD Line 6 (UBC886)						**Initiated at East side of foundation wall**
HDD-6-01	Room 101	4'	24 to 30	24	100%	
HDD-6-02	Room 101	14'	24 to 30	16	67%	
HDD-6-03 & -04	Room 101	n/a	n/a	n/a	n/a	Not Collected due to uknown subsurface obstruction
				Average Recovery	86%	

[1]P1, P2, and P3 are Process Waste Lines identified in Plate 1.
[2]All HDD soil samples were collected in a horizontal orientation utilizing a 3-inch by 24-inch stainless steel split-spoon sampler.

3.1.1 EMWD Measurements

Immediately prior to the collection of each HDD soil sample, a down-hole Gamma Ray Spectrometer (GRS) was tripped into the casing to its furthest extent. Real-time radiological measurements were then collected at this point, inclusive of the undisturbed soil to be sampled at the casings edge. The GRS was then pulled back at one-foot intervals and one-minute readings were subsequently collected at each point along the casing, logging the intervals previously drilled. Results of the EMWD/GRS data collection for each HDD borehole has been provided by Sandia as Attachment A of this report.

3.2 Geoprobe® Sample Collection

Geoprobe® soil sampling was conducted at the Building 123 slab and on the west side of Building 886, the locations of which are specified in Plates 1 and 2, respectively. The eastern wing of Building 123 is encompassed by IHSS 148 which was part of OU 13. 27 locations were sampled at UBC 123 which correlated to historical and process knowledge points of interest and HDD Line collocation areas (refer to Plate 1). In addition, four locations were sampled outside and immediately west of Building 886 (Plate 2). The purpose of Geoprobe® sampling at Building 123 was to further characterize UBC 123 and to make qualitative data comparisons to several previously collected HDD soil sample locations. The Building 886 locations were collected to characterize the soil beneath two existing external concrete pads. One pad previously supported an above ground tank just north of Building 828, and the second pad formerly supported a filter plenum on the west exterior wall of Room 101.

For the 123 and 886 Geoprobe® characterization sampling, a Geoprobe® model 54LT and a two-inch diameter stainless steel Macro-Core sampler were utilized at all collection locations (see Picture 3). Sampling was initiated by coring a three-inch diameter hole through the concrete slab at each sample location. The slab thickness varied from 6 to 15 inches at the Building 123 slab and 7 to 10 inches on the two slabs west of Building 886. Once the concrete cores were removed and the underlying soil exposed, the Geoprobe® was positioned over the hole and the soil sample intervals were collected in accordance with Site procedure RMRS/OPS-PRO.124, *Push Subsurface Soil Sampling*, and the specifications and requirements of the SAP and Integrated Work Control Package (IWCP). The specific sample intervals collected are identified in Tables 3-3 and 3-4 below.

Table 3-3 Geoprobe® Sample Locations along HDD Boreholes

Geoprobe® Sample ID	Collocated HDD Line Sample ID	Location/Area of Interest	Target Soil Interval (ft below slab)	Actual Soil Interval Collected (depth below top of slab)	Recovery (Inches)	Percent Recovery	Comments
Geoprobe® Locations South of HDD Line 1							
GP-1-01	HDD-1-01 (n/a)	Rm 156 Sump	3'2" to 5'2"	4' to 6'	4	17%	Sump bottom is 4'2" BGS
GP-1-02	n/a	OPWL- Rm 157 Area	n/a	4' to 6'	15	63%	Additional Sample- Target OPWL
GP-1-03	HDD-1-03 (n/a)	Rm 157 Sump	4'0" to 6'0"	4' to 6'	18	75%	Sump bottom is 5'0" BGS- DUP Collected
GP-1-04	HDD-1-04 (n/a)	Rm 158 Sump	4'3" to 6'3"	4' to 6'	20	83%	Sump bottom is 5'3" BGS
GP-1-07	HDD-1-07 (n/a)	MH-1	5' to 7'	Not Collected	-	-	Intended to bound HDD-1-07 by one foot above & below
Geoprobe® Locations Along HDD Line 2							
GP-2-01	HDD-2-01	Northern footing Rm 107	5' to 7'	Not Collected	-	-	Not Collected- Substitute location at GP-2-03
GP-2-03	HDD2-03	Room 122 Area, OPWL	n/a	4'2" to 6'2"	15	63%	Additional Sample- Target OPWL
GP-2-04	HDD-2-04	P-1/P-2 Intersection	5' to 7'	4'4" to 6'4"	16	67%	Bound HDD-2-04 by one foot above & below (64")
GP-2-06	HDD-2-06	WPS P-1/OPWL P-2	0' to 2'	8" to 32"	11.5	48%	Collect 1st 2 feet of soil (8" Concrete Core)
GP-2-06	HDD-2-06	WPS P-1/OPWL P-2	5' to 7'	4'3" to 6'3"	16.5	69%	Bound HDD-2-06 by one foot above & below (63")
GP-2-08	HDD-2-08	Room 126 Area	5' to 7'	4'2" to 6'2"	18	75%	Bound HDD-2-08 by one foot above & below (62")
GP-2-10	HDD-2-10	Room 128 Area	5' to 7'	4' to 6'	11	46%	Bound OPWL depth by one foot above & below; HDD-2-10 not collected due to refusal
GP-2-11	n/a	OPWL- Rm 127 Area	n/a	4' to 6'	11	46%	Additional Sample- Target OPWL
GP-2-13	HDD-2-13	S. edge of Rm 144/146	5' to 7'	4' to 6'	16	67%	HDD-2-13 not collected
Geoprobe® Locations Along HDD Line 3							
GP-3-01	HDD-3-01	~3 Ft west of MH-1	5' to 7'	Not Collected	-	-	Not Collected- Substitute by adding GP-3-02
GP-3-02	n/a	Just east of MH-1	n/a	4'2" to 6'2"	19.5	81%	Additional-Bound HDD-3-02 by one foot above & below (62")
GP-3-04	HDD-3-04	Comparison	5' to 7'	4' to 6'	9	38%	Bound HDD-3-04 by one foot above & below
GP-3-07	HDD-3-07	MH-2	5' to 7'	4' to 6'	13	54%	Bound HDD-3-07 by one foot above & below
GP-3-09	HDD-3-09	Comparison	5' to 7'	4' to 6'	12	50%	Bound HDD-3-09 by one foot above & below
GP-3-11	HDD-3-11	MH-3	5' to 7'	Not Collected	-	-	Not Collected- Out of IHSS and Area of Interest
Geoprobe® Locations Along HDD Line 4							
GP-4-01	HDD-4-01	NE corner of Rm 111	5' to 7'	5' to 7'	17	71%	Bound HDD-4-1 by one foot above & below
GP-4-04	HDD-4-04	Room 119 Area	5' to 7'	4'4" to 6'4"	11	46%	Bound HDD-4-04 by one foot above & below (64")
GP-4-06	HDD-4-06	NW corner of RM 122	5' to 7'	3' to 5'	11.5	48%	Bound HDD-4-06 by one foot above & below (47")
					Average Recovery	58%	

Table 3-4 Geoprobe® Sample Locations in Additional Areas of Interest

Geoprobe® Sample I.D.	Sample Name/ Rationale	Location/Area of Interest	Target Soil Interval (ft below slab)	Actual Soil Interval Collected (depth below top of slab)	Recovery (Inches)	Percent Recovery	Comments
Geoprobe® Locations at Additional Areas of Interest – Building 123							
SP-1	Source Pit #1	Source Storage Pits Room 109	0" to 24"	6" to 30"	4	17%	Collect soil to bound bottom of pit elevation by one foot above & below
SP-2	Source Pit #2	Source Storage Pits Room 109	4” to 28”	6" to 30"	11	46%	Collect soil to bound bottom of pit elevation (16") by one foot above & below
SP-3	Source Pit #3	Source Storage Pits Room 109	4” to 28”	6" to 30" & 30" to 42"	5.5	15%	Collect soil to bound bottom of pit elevation (16")- Poor recoveries
SP-4	Source Pit #4	Source Storage Pits Room 109B	4” to 28”	15" to 39"	17	71%	Collect soil to bound bottom of pit elevation (16")- Collect only VOA & RadScreen- Slab was 15"
WPS-1	Waste Pumping Station #1	Immediately east (downgradient) of WPS-1	0” to 24”	Not Collected- GP-2-06 covers this area of interest		N/A	Collect soil to bound bottom of concrete pit elevation (12”) by one foot above & below
WPS-2	Waste Pumping Station #2	Immediately east (downgradient) of WPS-2	0” to 24”	6" to 30"	15	63%	Above ground WPS, no pit. Collect first 24” of soil beneath slab (6" Concrete Core)
WPS-3	Waste Pumping Station #3	Immediately east (downgradient) of WPS-3	0” to 24”	5" to 29"	22	92%	Above ground WPS, no pit. Collect first 24” of soil beneath slab (5" Concrete Core)
WPS-4	Waste Pumping Station #4	Immediately east (downgradient) of WPS-4	0” to 24”	6" to 30"	8	33%	Above ground WPS, no pit. Collect first 24” of soil beneath slab (6" Concrete Core)
WPS-5	Waste Pumping Station #5	Immediately east (downgradient) of WPS-5	1’ 3” to 3’3”	Refusal- Unable to Collect		N/A	Refusal at 15” – Possibly contacted subsurface concrete slab from old loading dock
WPS-6	Waste Pumping Station #6	Immediately east (downgradient) of WPS-6	1’ 3” to 3’3”	Refusal- Unable to Collect		N/A	Refusal at 15” – Possibly contacted subsurface concrete slab from old loading dock
Lab-1	Suspected Cesium spill	Soil adjacent to drains of Room 105 Lab	0” to 24”	8" to 32"	9.5	40%	Collect first 24" of soil beneath slab near drain (8" Concrete Core)
Lab-2	Suspected Cesium spill	Soil adjacent to drains of Room 105 Lab	0” to 24”	8" to 32"	16	67%	Collect first 24" of soil beneath slab (8" Concrete Core)
Geoprobe® Locations on Concrete Pads West of Building 886							
GP-886-Pad-1	Above-ground tank slab	Soil immediately beneath tank slab	Additional Sample- n/a	6” to 30”	24	100%	Collect 1st 24” below slab; Slab 6”
GP-886-Pad-2	Above-ground tank slab	Soil immediately beneath tank slab	Additional Sample- n/a	6” to 30”	24	100%	Collect 1st 24” below slab; Slab 6”
GP-886-Plenum-1	Room 101 Filter Plenum slab	Soil immediately beneath Plenum slab	Additional Sample- n/a	8” to 38”	7	23%	Collect 1st 24” below slab; Slab 8”
GP-886-Plenum-2	Room 101 Filter Plenum slab	Soil immediately beneath Plenum slab	Additional Sample- n/a	8” to 32”	9	38%	Collect 1st 24” below slab; Slab 8”
					Average Recovery	54%	

3.3 Hand-Auger Sample Collection

For all Geoprobe® and Hand-Augering sample locations, it was necessary to initiate sampling by coring through the building's concrete slab in order to access the underlying soils. A Hilti wet-diamond coring machine was used to core through the reinforced concrete slab. A point source negative pressure system was used in conjunction with the wet method coring to prevent the potential for any migration of airborne or water contamination in the work areas.

For this project, the areas of interest of UBC 886 were the soils immediately beneath the concrete slab and underlying gravel base. Concrete coring revealed that the reinforced slab and gravel layer thicknesses varied significantly and were inconsistent with the as-built building drawings. The thicknesses of the four concrete cores removed from Room 101 ranged from 9 ½ to 19 inches but the seven concrete cores removed from the Room 103 Pit area varied only from 9 to 10 inches thick. The underlying gravel base varied from 8 to 26 inches in thickness at the sample locations in each room.

Eleven soil samples were collected from under Building 886 to characterize the general conditions of the UBC; four from within Room 101, and seven from within the Room 103 Pit (Table 3-5). The sample locations were selected based on historical process knowledge and documented HEUN spills. The eleven samples were collected from beneath the building's concrete slab from within the building utilizing a stainless steel hand-auger and a Hilti concrete coring machine (refer to Picture 4). Generally, each sample consisted of a composite of the first 12 to 24 inches of soil beneath the sub-slab gravel layer. The gravel layers beneath the slabs varied from 6 to 19 inches in thicknesses. The Geoprobe® unit was not used inside the building due to access limitations, health and safety concerns, and potential contamination issues.

Table 3-5 Hand-Auger Sample Locations within Building 886

Sample I.D.	Sample Location/Area of Interest	Concrete Slab Thickness (Inches)	Soil Interval Collected (Inches below top of slab)	Comments
Room 101				
886-101-01	NE corner of Room	19	19 to 32	Gravel layer matrixed w/ soil & clay
886-101-04	NW corner of Room near trench	16	16 to 23	Utilized stainless steel Hand Auger only
886-101-05	SE corner of Room	10	10 to 29	Gravel layer matrixed w/ soil & clay
886-101-06	SW corner of Room	10	10 to 29	Gravel layer matrixed w/ soil & clay
Room 103 Pit Area				
886-103-01	Pit Floor – See Plate 2	9	17 to 29	Composite 12” of Soil
886-103-02	Pit Floor – See Plate 2	9	18 to 28	Composite 10” of Soil
886-103-03	Pit Floor – See Plate 2	9	19 to 29	Composite 10” of Soil
886-103-04	Pit Floor – See Plate 2	10	16 to 28	Composite 12” of Soil
886-103-05	Pit Floor – See Plate 2	9	15 to 3	Composite 15” of Soil
886-103-06	Pit Floor – See Plate 2	9	16 to 31	Composite 15” of Soil
886-103-07	Pit Floor	8	N/A	Sample not collected; Electrical conduit utility immediately under slab
886-103-08	Pit Floor – See Plate 2	10	15 to 39	Composite 24” of Soil

These variations in subsurface conditions resulted in an increase in time and effort in collecting the soil samples. In order to access underlying soils, a combination of sampling techniques was performed. It became necessary to remove the gravel by hand, by drilling methods (using the concrete coring machine), and with hand-augers. These steps were often performed several times per location in order to establish an open borehole. In addition, 3-inch Poly-Vinyl Chloride (PVC) pipe was occasionally driven into various sampling holes to prevent the gravel from caving which allowed for hand-augering and mechanical coring through the PVC pipe. Once the underlying soils were exposed, the samples were extracted from the ground by means of the stainless steel hand auger or by a 3-inch Hilti concrete coring bit. This combination of sampling methods ultimately proved effective in collecting the soils underlying the building’s concrete slab and gravel fill.

3.4 Borehole Abandonment

Upon completion of each HDD, Geoprobe®, and hand auger sampling, each borehole was properly abandoned with grout and/or bentonite in accordance with RMRS/OPS-PRO.117, *Plugging and Abandonment of Boreholes*. For HDD Lines 1-4 and 6, the 4-inch steel casing was abandoned in place beneath the slabs and capped. The CAFA excavation trenches were backfilled with the material previously excavated, compacted to the original grade, and reseeded.

3.5 Equipment Decontamination and Waste Disposition

Reusable sampling equipment was decontaminated between each sampling event in accordance with procedure FO.03, *Field Decontamination Operations*. Decontamination waters generated during the project were managed according to procedure RMRS/OPS-PRO.112, *Handling of Field Decontamination Water* and were dispositioned to the Building 891 treatment facility.

The design of this project allowed for only minimal amounts of waste to be generated throughout this project. Several types of waste media were generated. Table 3-6 below lists the types, total quantities and disposition destinations of these wastes.

Table 3-6 Project Generated Wastes

Waste Media	Location Generated	Quantity	Units	Dispositioned to
Asphalt	HDD Line 3 Trench	3	Cubic Yards	Sanitary Landfill
Decon/Concrete Coring Water	B123 Slab	80	Gallons	B891 Treatment Facility
Decon/Concrete Coring Water	B886, Room 101	50	Gallons	B891 Treatment Facility
Decon/Concrete Coring Water	B886, Room 103	45	Gallons	B891 Treatment Facility
PPE (Tyvek, gloves, paper, etc.)	B123 Slab	3.5	55-Gallon Drums	Sanitary Landfill
PPE (Tyvek, gloves, paper, etc.)	B886 Exterior	0.5	55-Gallon Drums	Sanitary Landfill
PPE (Tyvek, gloves, paper, etc.)	B886 Rooms 101/103	1	55-Gallon Drums	Low-Level Waste
Excess Soil Samples	B123 Slab Sampling	0.5	55-Gallon Drums	Points of Excavation[1]
Excess Soil Samples	B886 Int/Ext Sampling	0.5	55-Gallon Drums	Points of Excavation[1]

[1]Disposition will be determined upon finalization of RFCA Standard Operating Protocols (RSOP) for Soil and Asphalt Management.

4.0 MODIFICATIONS TO THE WORK SCOPE AND SAMPLING AND ANALYSIS PLAN

Five of the six planned HDD boreholes were installed, and more vertical (Geoprobe® and hand auger) soil sampling was conducted than proposed in the SAP. However, it was necessary to modify scope specified in the SAP due to actual conditions in the field. The alterations to the work scope and the SAP and their respective justifications are provided in Table 4-1 below and were executed to benefit the project as a whole and in the interest of worker safety.

Table 4-1 Work Scope Modifications

Scope Modified or Deleted	Rationale
Building 123	
Horizontal soil sampling not conducted along HDD Line 1	HDD Line 1 boring contacted concrete building footer at the south end of Room 111 at 43 feet (prior to reaching sample locations) and could not be redirected. Sample locations HDD-1-01 to 04 were therefore not collected.
Omit HDD-2-10 through 13 sample locations	Exterior steel casing became bent and borehole strayed too far east of area of interest.
Geoprobe® soil samples at locations WPS-5, WPS-6, and WPS-1 were not collected	Numerous Geoprobe® attempts but refusal at 15" at and around WPS-5 & -6. Possible cause may be due to a large subsurface concrete slab in former loading area. GP-2-06 is close to WPS-1 location and was collected in its stead.
Omit HDD-2-02 sample collection	Sample location too close to HDD-4-06 sample location.
Omit HDD-3-10 & 11 and GP-3-11 sample collection	These three sample locations are east of IHSS and UBC boundaries and too many underground utilities exist in the proposed bore path to be safely collected.
Building 886	
Omit drilling and sampling of HDD Line 5 (beneath Room 103 Pit area) from scope of work	• Potential of introducing highly contaminated soils to surface and areas open to environment • Potential of not being able to free release drill equipment if contaminated • HDD/EMWD operations at B886 were demonstrated by HDD Line 6
Add four vertical samples within Room 103 to existing four samples	To help offset the cancellation of HDD Line 5 by additional hand-auger sampling to better characterize the soils beneath Room 103. The hand-auger sampling method replaced the proposed Geoprobe® sampling method as proposed in the SAP. The Geoprobe® was not utilized within Room 103.
Add four Geoprobe® samples outside of Building 886, West of Room 101 (Pad-1&2 and Plenum 1&2)	Four shallow soil sample locations added to characterize soil beneath two pads for historical spills. "Pad" slab supported above ground tank and "Plenum" slab supported Room 101 filter plenum (tank and plenum previously removed).

5.0 HDD/EMWD APPLICATIONS AND LIMITATIONS

A description of the applications and limitations of the HDD/EMWD system are provided below.

5.1 Pros

1. Waste minimization (2000 DOE Pollution Prevention Award); no mud was utilized with pneumatic hammering method of drilling.
   - Eliminates the generation and spread of potentially contaminated drilling returns
   - Total displacement of soils during drilling/borehole advancement
   - Only media returned to surface is media sample collected with split spoon
   - Wastes generated include only residual soil samples, Personal Protective Equipment (PPE), and sampling tool decontamination wash-water
   - Less than one 55-gallon drum filled with residual soil sample wastes
   - Greatly reduced waste disposition costs.
2. The EMWD allowed for remote characterization sampling of potentially contaminated soils beneath buildings and structures prior to their decommissioning.

This method helped to promote worker safety by implementing ALARA and reducing contact with unknown contamination.

3. EMWD provided information to the workers before each sample event. Although time consuming in logging the data, it provided useful information before the sample was extracted.

5.2 Cons

Significant costs incurred by utilizing HDD Subcontractor, support equipment, and labor. Refer to Cost Comparison Analysis in Section 5-3.

1. Pneumatic hammer/casing advancement method requires significantly more time than the more traditional rotary method of Horizontal Directional Drilling to complete borings and soil sampling.
    - EMWD measurements cannot be collected simultaneously when drilling due to hammer-action and the fragility of the EMWD equipment. Drilling must pause and drill stems and bit must be tripped out by hand prior to EMWD data collection and tripped back in prior to restart of drilling.
    - Pneumatic hammer method is a non-rotary method which results in having to “steer” the direction on the bore-path by rotating drill stem and bit with hand methods.
    - Limited flexibility for directional steering due to drill casing.
    - Because of limited flexibility, shallow trenches were excavated to position the CAFA (Casing Advancement Framework Assembly) near the required elevation of drilling to minimize the layback distance.
    - Steel casing required to maintain open borehole for extracting soil samples due to all alluvium instability and dry drilling methods used.
2. Limitations on achieving desired borehole lengths (horizontal depths).
    - Steel casing can often collapse or bend resulting in refusal of borehole advancement (often at approximately 100 feet total depth).
    - Directional bit and drill stem can frequently get stuck down-hole in casing due to casing compromising.
3. Limited steering capabilities with pneumatic hammer/advance casing method as compared to traditional HDD drilling.
    - Casing is not very flexible so direction requires additional boring length to make steering adjustments, if possible.
4. High levels of noise (>100 decibels) generated in work area during operation of hammer and support equipment.
5. The drill bit typically follows path of least resistance in soils. A sandy lens of material will have a preferential pathway versus harder bedrock or other obstructions.
6. Numerous radio signal interferences created problems for the Digi-Trak identifying the location of the bit. This was possibly due to the concrete or rebar in the concrete slabs and/or by the casing and other unidentified subsurface obstructions. The transmitter had to penetrate through all of this medium before the receiver (Digi-Trak) could receive the bit locating information.

7. The hammer drilling generates excessive vibration which repeatedly created problems with the sonde transmitter. Work had to be paused routinely for battery replacement and sonde repair throughout operations.

5.3 Cost Analysis for HDD/EMWD – UBC 123

Table 5-1 below shows the linear footage and associated costs of horizontal drilling and sample collection performed under the scope of this project. This information is being provided to assist in comparing cost effectiveness of horizontal drilling with other available characterization methods for future projects.

Table 5-1 Costs for HDD/EMWD Work Scope Completed

Actual Scope of Work Performed			
Borehole ID	**No. of HDD Samples Collected**	**Length of Boring (ft)**	**Cost per Borehole[1]**
HDD Line 1	0	43	$22,679
HDD Line 2	8	137	$54,891
HDD Line 3	5	63	$37,403
HDD Line 4	6	114	$40,167
HDD Line 6	2	18	$27,865
Totals	**21**	**375 ft**	**$183,005**
Cost per Linear Foot			**$488**
Additional Associated Costs			
Mob/Demob			$67,555
EMWD Retrofit to HDD Rig			$19,630
Health and Safety Plans, Job Hazards Analyses, and Bonds			$28,526
Total Project Costs			**$298,716**
Total Project Costs per Linear Foot			**$797**

[1] HDD Costs – Includes setup, materials, and labor for hammer drilling, soil sampling, and abandonment.

6.0 DATA QUALITY ASSESSMENT

The Data Quality Objectives (DQO) of this project, as defined in the SAP, were achieved based on the Data Quality Assessment (DQA) provided herein, which details project discussion and Verification and Validation of project data. The DQOs were designed to ensure that the type, quantity, and quality of environmental data used in decision making are appropriate. Data requirements to support this project were developed and implemented using criteria established in *Guidance for the Data Quality Objective Process*, QA/G-4 (EPA 2000).

Data used in making management decisions for remediation and waste management must be of adequate quality to support the decisions. Adequate data quality for decision-making is required by the Kaiser-Hill Team Quality Assurance Program Manual (K-H, 2000), as well as by the customer (DOE, RFFO; Order 414.1A, Quality Assurance, §4.b.(2)(b)). Regulators and the public also expect decisions and data that are technically

and legally defensible. Verification and validation of the data ensure that data used in decommissioning and waste management decisions are usable and defensible.

Verification and validation (V&V) of the data are the primary components of the DQA. The final data are compared with original DQOs of the project, and evaluated with respect to project decisions, uncertainty within the decisions, quality criteria associated with the data, particularly precision, accuracy, representativeness, completeness, comparability, and sensitivity. Data sets subject to V&V consist of all analytical and radiochemical results presented in the report.

Chemical and radiological media sample results were validated consistent with the following RFETS-specific documents and industry guidelines:

- KH V&V Guidelines
  - ✓ *General Guidelines for Data Verification and Validation*, DA-GR01-v1, December 3, 1997
  - ✓ *V&V Guidelines for Isotopic Determinations by Alpha Spectrometry*, DA-RC01-v1, 2/13/98
  - ✓ *V&V Guidelines for Volatile Organics*, DA-SS01-v1, 12/3/97
  - ✓ *V&V Guidelines for Semivolatile Organics*, DA-SS02-v1, 12/3/97
- EPA 540/R-94/013, USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review
- EPA 540/R-94/012, USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review
- Lockheed-Martin, 1997. Evaluation of Radiochemical Data Usability, ES/ER/MS-5.

This report will be submitted to the Comprehensive Environmental, Response, Compensation and Liability Act (CERCLA) Administrative Record for permanent storage within 30 days of approval by the regulators (CDPHE). Until that time, all quality records reside with the Project.

6.1 DQO Decisions

Consistent with the original DQO decision rules of the project, a sum-of-ratios (SOR) calculation was performed for radiological and non-radiological contaminants across each UBC area of interest. The maximum value for each contaminant of concern was divided by its corresponding RFCA Action Level (Tier I and Tier II, respectively, for Open Space exposure scenarios, except for lead, where only an Industrial Area scenario is published) for subsurface soil and cumulatively summed. Per the DQO decision logic, if the summation for radiological or non-radiological constituents, using maximum values, does not exceed one (1), then no further action is required.

Calculations and query logic may be found in the files referenced below. Execution of the cited queries will reproduce the results as stated in this report. Radiological action levels used “industrial” exposure scenarios, whereas all other action levels used “open space” exposure scenarios. Use of these numbers generally represent the most conservative comparison of values (i.e., presenting the most likely scenario for sample results to exceed associated RFCA Action Levels).

6.2 UBC 123 Data Summary

A data summary table for all samples collected at UBC 123 is provided in Table D-1 of Attachment D. This table displays the number of analyses performed by the labs and provides a means to easily compare maximum values for each analyte/radionuclide with RFCA action levels (DOE 1996) and/or background concentrations (DOE 1995b).

6.2.1 UBC 123 Radiological Results

Calculation of the sum-of-ratios for the five radiological contaminants of concern (Am-241, Pu-239/240, U-234, U-235, and U-238) yielded a value of 0.04 for Tier II (0.01 for Tier I), well below the action level of one. Therefore, no environmental remediation action is required relative to radionuclides at UBC 123.

6.2.1.1 UBC 123 Cesium Results

The soils adjacent to the abandoned subsurface source pits (sample locations SP-2, SP-3, and SP-4) were analyzed for Cesium-137 as required by the SAP. Of the three sample locations, the highest activity measured for Cesium-137 was estimated (J-qualified) at 0.097 picocuries per gram (pCi/g), well below the Site background value of 1.685 pCi/g. SP-2 and SP-4 each resulted in non-detectable values.

6.2.2 UBC 123 Chemical Results

Calculation of the sum-of-ratios for non-radiological constituents yielded the following values:

	Tier I	Tier II
Metals	**3.64**	**10.32**
Organics	0.05	**5.19**
TOTAL SOR	**3.69**	**15.22**

Values exceeding unity are bolded above. The exceedances of Tier I and 2 Action Levels for both metals and organics are shown in Attachment D.

Metals exceedances are due to lead, beryllium, and arsenic. Only one lead sample (LAB-1) exceeded both background and the Tier I Action Level, as indicated in Table 6-1 below. Although beryllium exceeded Tier II Action Levels, it did not exceed background levels, and therefore, its presence is not considered contamination. Arsenic exceeded Tier II levels for two samples, (HDD-2-09 and GP-1-1) but exceeded background levels only twice at less than 2 milligrams per kilogram (mg/kg) difference (see Table 6-1). Therefore, the two arsenic concentrations are considered insignificant because it is well within the range background concentrations. All background values used in database queries, including those quoted below, are defined as the arithmetic mean plus 2 standard deviations of the background sample sets, DOE, 1993 (Table D-16).

Table 6-1 Samples Exceeding RFCA Action Levels – UBC 123

RIN #	Sample Location	Analytical Concentration	Tier I Action Level	Tier II Action Level	Background Concentration[1]
01R0013-009.003	HDD-2-09	As - 14.7 mg/kg	381 mg/kg	3.81 mg/kg	13.14 mg/kg
01R0021-022.003	GP-1-1	As - 14.4 mg/kg	381 mg/kg	3.81 mg/kg	13.14 mg/kg
01R0021-013.003	LAB-1	Pb - 3470 mg/kg	1000 mg/kg	1000 mg/kg	24.97 mg/kg

[1]Source: DOE, 1993. Background Geochemical Report, Table D-16, RFETS, September, 1993.

The SOR exceedance of Tier II by organics was due wholly to methylene chloride detections, which are attributed to laboratory cross-contamination of the soil samples. Rationale for concluding methylene chloride concentrations as being due to lab cross-contamination is detailed within the Section 6.4.2.

6.3 UBC 886 Data Summary

A data summary table for all samples collected at UBC 123 is provided in Attachment D. This table displays the number of analysis runs performed by the labs and provides a means to easily compare maximum values for each analyte/radionuclide with RFCA action levels (DOE 1996) and/or background concentrations (DOE 1995b). Interpretation of the data work up for the radiological and chemical results are presented in the subsections below.

6.3.1 UBC 886 Radiological Results

Calculation of the sum-of-ratios for the five radiological contaminants of concern yielded a value of 0.04 for Tier II (0.01 for Tier I), well below the action level of one. Therefore, no environmental remediation action is required relative to radionuclides at UBC 886.

6.3.2 UBC 886 Chemical Results

Calculation of the sum-of-ratios for non-radiological constituents yielded the following values:

	Tier I	Tier II
Metals	0.14	**5.05**
Organics	0.05	**4.60**
TOTAL SOR	0.19	**9.65**

Tier I Action Levels were not exceeded. Values exceeding unity are bolded above. Exceedance of Tier II Action Levels for both metals and organics is explained as follows.

Metals exceedances are due to arsenic alone; however, because all arsenic detections are below the subsurface background level of 13.14 mg/kg, the presence of arsenic is not considered contamination. Tier II Action Levels for organics were exceeded due to methylene chloride and 1,1,2,2-Tetrachloroethane. The methylene chloride is due to lab

cross-contamination as explained in Section 6.4.2. An estimated value of 3 micrograms per kilogram (ug/kg) ("J" qualified by the lab) was measured in sample 886-101-04 at Room 101 (See Plate 2 for physical location).

Because this estimated value is below the detection limit, there is not adequate confidence to conclude that it is truly a detection *above the action level*. Stated differently, this estimated value should be treated no differently than nondetect values at the detection limit, where the detection limit exceeds Tier II, typical of this compound and many others. In such cases where Method Detection Levels (MDLs), derived from standard SW-846 methodology, exceed associated RFCA Action Levels, it is suggested that Action Levels be adjusted to equal the MDLs, if current analytical technology does offer greater analytical sensitivity (i.e., lower MDLs).

6.4 Verification and Validation of Results

Verification ensures that data produced and used by the project are documented and traceable per quality requirements. Validation consists of a technical review of all data that directly support the project decisions, such that any limitations of the data relative to project goals are delineated, and the associated data are qualified (caveated) accordingly. The V&V process was graded relative to the original DQOs of the project, as defined in Section 3.1, and specific criteria, as they pertain to Precision, Accuracy, Representativeness, Completeness, Comparability and Sensitivity (PARCCS) parameters described below.

1.0 Chain-of-Custody;
2.0 Preservation and hold-times;
3.0 Instrument Calibrations;
4.0 Preparation Blanks;
5.0 Interference Check Samples (metals);
6.0 Matrix Spikes/Matrix Spike Duplicates (MS/MSD);
7.0 Lab Control Samples (LCS);
8.0 Field Duplicate measurements;
9.0 Chemical yield (radiochemistry);
10.0 Required Quantitation Limits/Minimum Detectable Activities (sensitivity of chemical and radiochemical measurements, respectively); and,
11.0 Sample Analysis and Preparation methods.

PARCCS parameters are indicators of data quality. Analytical data collected in support of the EMWD/HDD were evaluated using the guidance in procedure RF/RMRS-98-2000, *Evaluation of Data for Usability in Final Reports*. This procedure establishes the guidelines for evaluating analytical data with respect to the PARCC parameters. The following paragraphs define these PARCC parameters in conjunction with this project.

6.4.1 Precision

Radiochemistry (Alpha Spectroscopy)

Results from laboratory duplicates (replicates) indicate adequate reproducibility based on duplicate results within statistical tolerance values (>95% confidence of equivalency between the original sample and the duplicate).

Chemical Results

There are no qualifications to any chemical results based on evaluation of quality criteria listed in the last section.

Three (3) field duplicates were acquired to evaluate sampling precision for samples collected at UBC 123. Relative percent difference (RPD) values were calculated for *each detected analyte* to evaluate repeatability of the sampling process. All RPD values were ≤25%, which is satisfactory for lab precision within a soil matrix, hence, also satisfactory for repeatability within the field sampling process.

Two (2) field duplicates were acquired to evaluate sampling precision for samples collected at UBC 886. RPD values were calculated for *each detected analyte* to evaluate repeatability of the sampling process. Field duplicates were also blind to the laboratory to prevent any potential analytical bias. All RPD values were ≤26%, which is satisfactory for lab precision within a soil matrix, hence, also satisfactory for repeatability within the field sampling process.

6.4.2 Accuracy (and Bias)

Distance measurements recorded on maps are within 3% of actual distances based on the laser technology used for distance measurements associated with the surveys.

Radiochemistry (Alpha Spectroscopy)

The frequency of laboratory Quality Control (QC) samples was adequate, at greater than a 1:10 ratio of LCS samples to real samples for batch control (Tables D-1 and D-3). Blank samples were also analyzed at a satisfactory frequency for batch control (>1:10).

Accuracy of radiochemistry results was generally within 20% of full scale measurement, and about ±1 pCi/g and for all actinides of interest at or near contractually required detection limits (i.e., 0.3 pCi/g or pCi/l for 241Am, 239,240Pu; 1 pCi/g or pCi/l for the U species). Sample-specific accuracies are reported on the laboratory reports as either total error (e.g., total propagated uncertainty [TPU]), or counting error. Accuracy of radiochemistry results was controlled through periodic laboratory calibrations, use of lab control samples, and measurement of chemical yields. Recoveries of laboratory control samples (LCS) were within ±20% of the spike amount, consistent with contractually required- and industry standards. Other quality controls, such as sample-specific yield percentages, are maintained in the original laboratory data packages managed by K-H Analytical Services Division in Building 881.

Blanks yielded no concentrations significant enough to cause a high bias in the corresponding real samples; stated differently, there are no false positive results due to blank contamination.

Chemical Results

Building 123 –

A summary of the V&V for all electronic records indicates a minor percentage of rejects (<5% of all records) limited to VOCs and semi-volatile organic compounds (SVOCs). The frequency of laboratory QC samples was adequate, at greater than a 1:10 ratio of LCS samples to real samples for batch control (Tables 6-4 and 6-5). Blank samples were also analyzed at a satisfactory frequency for batch control (>1:10).

Table 6-2 UBC 123, Summary of Validated Records

VAL_QUALIFIER	Total Of	Alpha Spec	SW-846 8260	SW-846 8270B	SW-6010+Hg
	1491	45	534	540	372
1	6047	141	3890	1626	390
J	181		6		175
J1	73		8	23	42
R1	80		6	74	
U	6		2	4	
U1	1		1		
V	1849		684	369	796
V1	2120	224	356	1248	292
JB	2			2	
JB1	40		23	17	
UJ	213		114	21	78
UJ1	3586		2080	1476	30
V1	1		1		
Total V&V Percent	**90%**	**89%**	**93%**	**90%**	**83%**

Several records containing LCS information are indeterminate. Some “LC1” lab qualifiers are reported as non-detects, though associated verification/validation information does not recognize the association as a quality problem.

Methylene chloride results were biased high due to blank contamination for both data sets (UBCs 123 and 886). Use of the 10x rule as provided by the EPA (EPA 1994) indicates that detections of the contaminant in real samples are not significant, but are caused by laboratory cross-contamination. Ratios of real sample concentrations to blank concentrations did not exceed 5 for any given lab batch. All samples were represented by batch control samples for Building 886; 10 of 11 were represented for 123. Those samples with methylene chloride detections not represented by batch control may be inferred as being due to lab cross-contamination based on the large majority of batch control represented.

Building 886 -

A summary of the V&V for all Electronic Data Deliverable (EDD) records indicates no rejection of the data. The ramifications of blank contamination – the same for Building 886 results as for Building 123 -- were discussed above. All estimated values were well less than associated RFCA Action Levels.

Table 6-3 UBC 886, Summary of Validated Records

VAL_QUALIFIER	Total Of	Alpha Spec	SW-846 8260	SW-846 8270B	SW-6010+Hg
	2963		871	1314	778
1	1304	108	635	281	280
J1	77		9	19	49
V1	639	110	183	195	151
JB	6			6	
JB1	11		11		
UJ	192			192	
UJ1	647		309	314	24
Total V&V Percent	**49%**	**100%**	**57%**	**43%**	**39%**

6.4.3 Representativeness

Samples acquired for the project are representative based on the following criteria:

1. Familiarity with facilities -- multiple walk-downs and collaborations by management and technical staff;
2. Implementation of industry-standard Chain-of-Custody protocols;
3. Compliance with sample preservation and hold times;
4. Documented and Site approved methods, particularly RSPs for scans/surveys and the following documents for alpha spectroscopy; and
5. In accordance with the SAP.

All real samples were subsurface soil samples.

6.4.4 Completeness

Sampling completeness is addressed in Table D-1 below.

QC samples were taken at adequate frequencies for all QC sample types, >>5% QC/real sample ratio, for both UBC data sets.

Table 6-4 123 UBC Sample Completeness Summary

# Samples Planned (incl. Media; Real & QC Samples)	# Samples Taken (Real & QC Samples)	Project Decisions (Conclusions) & Uncertainty	Comments
VOC			
37 HDD Real 30 Geoprobe® Real 3 Field Dups	50 (total) 47 Real, 3 Field Dups 5 LCS 4 MS 16 MB	No contamination per SOR calculation	14 Samples not Collected – Refer to Table 4-1
SVOC			
37 HDD Real 30 Geoprobe® Real 3 Field Dups	49 (total) 46 Real, 3 Field Dups 9 LCS 9 MB	No contamination per SOR calculation	14 Samples not Collected – Refer to Table 4-1
METALS			
37 HDD Real 30 Geoprobe® Real 3 Field Dups	49 (total) 46 Real, 3 Field Dups 9 LCS 4 MS 9 MB	No contamination per SOR calculation (As, Pb, and Be exceed Tier II, but at or below background levels)	14 Samples not Collected – Refer to Table 4-1
RADIOCHEMCIAL (Alpha Spec)			
37 HDD Real 30 Geoprobe® Real 3 Field Dups	49 (total) 46 Real, 3 Field Dups 10 LCS 10 LD 10 PB	No contamination per SOR calculation	14 Samples not Collected – Refer to Table 4-1
4 Geoprobe® Real (SP-1 through SP-4)	3 (Total) Cesium 3 Real, 0 Dups	No Contamination-Levels below Background	Not enough sample recovery in SP-1

Acronyms:
Dups = Duplicate Sample
LCS = Lab Control Sample
LD = Lab Duplicate
MB = Method Blank
MS = Matrix Spike
PB = Preparation Blank

Table 6-5 886 UBC Sample Completeness Summary

# Samples Planned (incl. Media; Real & QC Samples)	# Samples Taken (Real & QC Samples)	Project Decisions (Conclusions) & Uncertainty	Comments
VOC			
13 Total 4 HDD Real 8 Geoprobe® Real 1 Field Dup	15 (total) 13 Real, 2 Field Dups 2 LCS 2 MS 5 MB	No contamination per SOR calculation	No VOCs collected outside of B886 (Pad –1&2 and Plenum- 1&2)
SVOC			
13 Total 4 HDD Real 8 Geoprobe® Real 1 Field Dup	19 (total) 17 Real, 2 Field Dups 4 LCS 5 MB	No contamination per SOR calculation	4 Samples added to scope during operations (Pad-1&2, Plenum-1&2)
METALS			
13 Total 4 HDD Real 8 Geoprobe® Real 1 Field Dup	19 (total) 17 Real, 2 Field Dups 8 LCS 4 MS 8 MB	No contamination per SOR calculation (As and Be exceed Tier II, but are below background levels)	4 Samples added to scope during operations (Pad-1&2, Plenum-1&2)
RADIOCHEMCIAL (Alpha Spec)			
13 Total 4 HDD Real 8 Geoprobe® Real 1 Field Dup	19 (total) 17 Real, 2 Field Dups 7 LCS 7 LD 7 PB	No contamination per SOR calculation	4 Samples added to scope during operations (Pad-1&2, Plenum-1&2)

6.4.5 Comparability

All results presented are comparable with CERCLA data on a site- and DOE complex-wide basis. This comparability is based on:

1. Use of standardized engineering units in the reporting of measurement results;
2. Consistent sensitivities of measurements (≤ the Required Quantitation Limit [RQL] or MDA);
3. Use of site-approved procedures (Contractual Statements of Work for lab analyses, §1.1);
4. Systematic quality controls; and
5. Thorough documentation of the planning, sampling/analysis process, and data reduction into formats designed for making decisions posed from the project's original data quality objectives.

6.4.6 Sensitivity

Adequate sensitivities, in units of ug/kg for SVOCs and VOCs, mg/kg for metals, and pCi/g, were attained for most analytes, with a listing of the exceptions given below. Most of the analytes given in Table 6-6 did not fail the Tier II SOR calculations because nondetect results – at the detection limit value – were not factored into the equation. Ideally, detection limits are at least one-half the action level; for those exceedances listed below, the RFCA Tier II Action Levels are currently under review.

Table 6-6 Analytes with Detection Limits Exceeding Tier II Action Levels

123 UBC ANALYTE NAME	886 UBC ANALYTE NAME
cis-1,3-Dichloropropene	cis-1,3-Dichloropropene
Trans-1,3-Dichloropropene	Trans-1,3-Dichloropropene
2,4-Dimethylphenol	1,4-Dichlorobenzene
1,4-Dichlorobenzene	4-Chloroaniline
4-Chloroaniline	bis(2-Chloroethyl)ether
bis(2-Chloroethyl)ether	Hexachlorobenzene
Hexachlorobenzene	2,4-Dichlorophenol
Anthracene	2,4-Dinitrotoluene
1,2,4-Trichlorobenzene	2,4-Dinitrophenol
2,4-Dichlorophenol	Dibenzo(a,h)anthracene
2,4-Dinitrotoluene	Benzo(a)anthracene
Indeno(1,2,3-cd)pyrene	2,6-Dinitrotoluene
Benzo(b)fluoranthene	N-Nitroso-di-n-propylamine
Benzo(a)pyrene	Hexachloroethane
2,4-Dinitrophenol	Vinyl Chloride
Dibenzo(a,h)anthracene	Methylene Chloride
Benzo(a)anthracene	Isophorone
2,6-Dinitrotoluene	1,1,2,2-Tetrachloroethane
N-Nitroso-di-n-propylamine	N-Nitrosodiphenylamine (1)
Hexachloroethane	Pentachlorophenol
Vinyl Chloride	2,4,6-Trichlorophenol
Methylene Chloride	3,3'-Dichlorobenzidine
Isophorone	2,4,5-Trichlorophenol
1,1,2,2-Tetrachloroethane	Nitrobenzene
Butylbenzylphthalate	
N-Nitrosodiphenylamine (1)	
Hexachlorobutadiene	
Pentachlorophenol	
2,4,6-Trichlorophenol	
3,3'-Dichlorobenzidine	
2-Methylphenol	
1,2-Dichlorobenzene	
2-Chlorophenol	
2,4,5-Trichlorophenol	
Nitrobenzene	

6.5 Qualitative Data Comparison (Horizontal vs. Vertical Profiles)

As stated in the SAP, one of the primary objectives of this project was to make a qualitative comparison of the data collected from soil samples along a horizontal profile (HDD) with the data collected by vertical profile (Geoprobe®) characterization techniques. The intent of this assessment is to assist in determining the potential of utilizing HDD or HDD/EMWD characterization techniques at future sites around RFETS and at other DOE facilities. This assessment is achieved by determining whether or not the data from the two sampling methodologies compare favorably, given two comparable, or immediately adjacent, sample locations from which a sample was collected by each method.

Table 6-7 below identifies the collocated HDD and Geoprobe® sample locations collected as part of this project. In all cases, the Geoprobe® collection interval (a 24-inch composite interval) vertically bound the HDD 24-inch horizontal composite interval by one-foot above to one-foot below. Tables 2 and 3 identify the actual depths collected by each method. Plates 1 and 2 show the respective locations of these samples in relationship to the Buildings 123 and 886 structures.

Table 6-7 HDD and Geoprobe® Collocated Sample Identification

HDD Sample Location and RIN/Event IDs		Collocated Geoprobe Sample Location and RIN/Event IDs		Sample Interval Depths-HDD/Geoprobe[1]
UBC 123				
HDD-2-03	01R0012.003	GP-2-03	01R0021.008	62”/ 50” to 74”
HDD-2-04	01R0012.004	GP-2-04	01R0021.007	68”/ 52” to 76”
HDD-2-06	01R0012.006	GP-2-06	01R0021.006	63”/ 51” to 75”
HDD-2-08	01R0013.008	GP-2-08	01R0021.004	62”/ 50” to 74”
HDD-3-02	01R0016.002	GP-3-02	01R0021.028	62”/ 50” to 74”
HDD-3-04	01R0020.001	GP-3-04	01R0021.029	87”/ 48” to 72”[3]
HDD-4-01	01R0007.001	GP-4-01	01R0021.017	76”/ 60” to 84”
HDD-4-04	01R0007.004	GP-4-04	01R0021.010	64”/ 52” to 76”
HDD-4-06	01R0007.006	GP-4-06	01R0021.009	47”/ 36” to 50”
Building 886				
HDD-6-01	01R0024.001	886-101-01[2]	01R0081.002	27”/ 19” to 32”

[1]Sample depths measured from top of concrete slab.
[2]Sample location 886-101-01 collected utilizing a hand auger.
[3]HDD sample location too deep; field decision to bound depth of OPWL instead of HDD sample.

The results of the data from the above sample locations are summarized in Tables D-1 and D-2 of Attachment D. All data indicate either non-detects or values below RFCA Action Levels for all Contaminants of Concern. Therefore, the data are considered comparable between the two sample collection methods.

7.0 SUMMARY

This characterization effort was performed to make remedial and waste disposition decisions for the subsurface soils at UBCs 123 and 886. The characterization included all potential contaminants, both radiological and chemical, based on previous sampling in the industrial area and process knowledge of the buildings. The data presented in this report have been verified and validated for the purpose of corroborating decisions to acceptable levels of confidence as stated in the project's original data quality objectives.

UBC 123

With the exception of arsenic and lead at three isolated sample locations, the results of the data indicate that no radiological or chemical contamination exists in excess of RFCA Tier I or Tier II Action Levels at the sample locations collected in UBC 123. Removal and disposal of the former Building 123 foundation and slab is currently scheduled for fiscal year (FY) 2002.

UBC 886

Results indicate that no radiological or chemical contamination exists in excess of RFCA Tier I or Tier II Action Levels at the sample locations collected in UBC 886. D&D of Building 886 is currently scheduled for FY 2002.

This project was completed in a safe and efficient manner with no lost work time. Additionally, the project was successful in accomplishing its objective of making qualitative data comparisons between the vertical and horizontal sampling methods.

8.0 REFERENCES

Corrocon 2000, *Standard Operating Procedure, Directional Under Building Casing Advancement and Soil Sampling,* KH 002244.

EPA 2000, *Guidance for the Data Quality Objective Process*, QA/G-4.

DOE 1992a, *Final Phase I RFI/RI Work Plan for Operable Unit 9, Original Process Waste Lines,* February.

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DOE 1992c, *Final Phase I RFI/RI Work Plan for Operable Unit 13, 100 Area*, October.

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RMRS 1998, *Final Close-Out Report Building 123 Decommissioning Project, RF/RMRS-98-253.UN, Rev.0,* September.

RMRS 1999, *In-Process Characterization Plan for the Building 886 Closure Project, RF/RMRS-99-349, Rev.0,* October.

RMRS 2000, *Sampling and Analysis Plan for the Characterization of Under Building Contamination of UBC 123 and Building 886, Implementing Horizontal Directional Drilling and Environmental-Measurement-While-Drilling*, RF/RMRS-2000-018, May.

Sandia National Laboratory 2001, *Characterization of Under-Building Contamination at Rocky Flats Implementing Environmental-Measurement-While-Drilling Process with Horizontal Directional Drilling, SAND2001-1809,* June 2001.

ATTACHMENTS

Attachment A
EMWD Results Report
Sandia National Labs

EDDIE
Environmental Data Dynamic Information Exchange

Attachment A Is Unavailable

There are five Rocky Flats Reading Rooms in the Denver metro area. Their addresses are below.

These rooms contain a huge selection of documents produced by Rocky Flats over the years, from environmental studies and reports to statistics on budgets and employment. The main reading room is located at Front Range Community College and is the most current and comprehensive. For more information, call the Front Range Community College Reading Room at (303) 469-4435.

The five Rocky Flats Reading Rooms locations are as follows:

Front Range Community College
3705 W. 112th Ave.
Westminster, CO 80030
(303) 469-4435

Rocky Flats Citizens Advisory Board
9035 N. Wadsworth Parkway, Suite 2250
Westminster, CO 80021
(303) 420-7855

Colorado Department of Public Health & Environment
Information Center
4300 Cherry Creek Dr. South, Bldg. A
Denver, CO 80222-1530
(303) 692-2037

U.S. Environmental Protection Agency
Region VIII Superfund Records Center
999 18th Street, Suite 500
Denver, CO 80202-2466
(303) 312-6473

Standley Lake Library
8485 Kipling Street
Arvada, CO 80005
(303) 456-0806

Attachment B
Plates 1 and 2

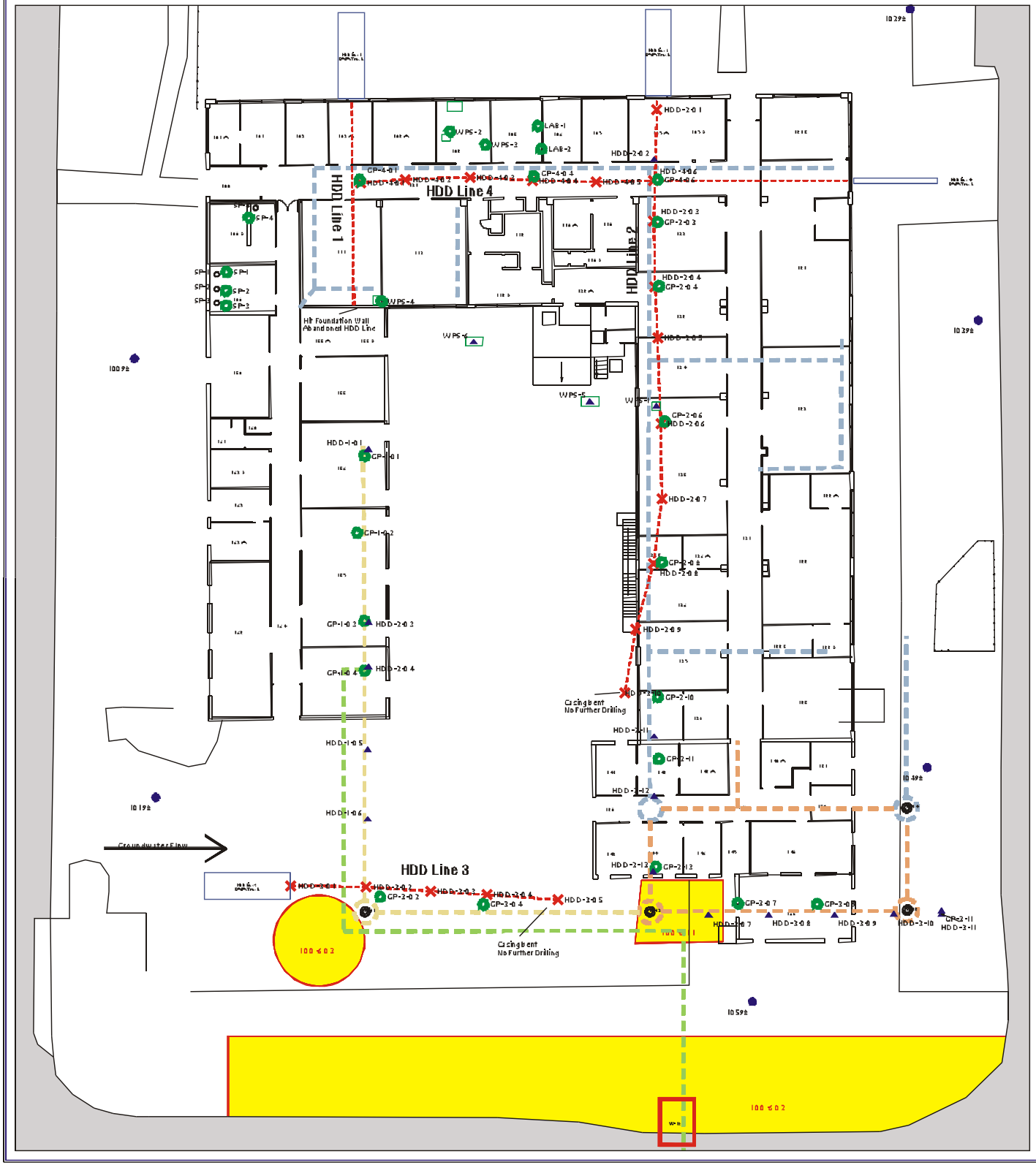

PLATE 1
Building 123 HDD Lines Process Waste Lines and Soil Sample Location Map

EXPLANATION

- Manhole
- Groundwater Wells
- Geoprobe Soil Sample Location
- HDD Soil Sample Location
- HDD or Geoprobe Soil Samples Not Collected
- Source Pit

Process Waste Lines

- P3 1968
- P2 1952
- P1 1972
- P1 1989
- Horizontal Borehole

Potential Areas of Concern

- Potential Area of Concern
- Casing Advancement Frame Assembly (CAFA) Trench Location
- Valve Vault Locations
- Waste Pumping Stations

Standard Map Features

- Buildings and other structures
- Paved roads/fill
- Fences and other barriers
- Paved roads

NOTE

WV = Valve Vault
WPS = Waste Pumping Station
CP = Source Pit
MH = Manhole

The Right, Title and Interest in and to the land and improvements shown on this map, including the buildings and structures located thereon, are owned by the United States of America, acting by and through the United States Department of Energy.

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

MAP ID: 01-05-18

May 13, 2001

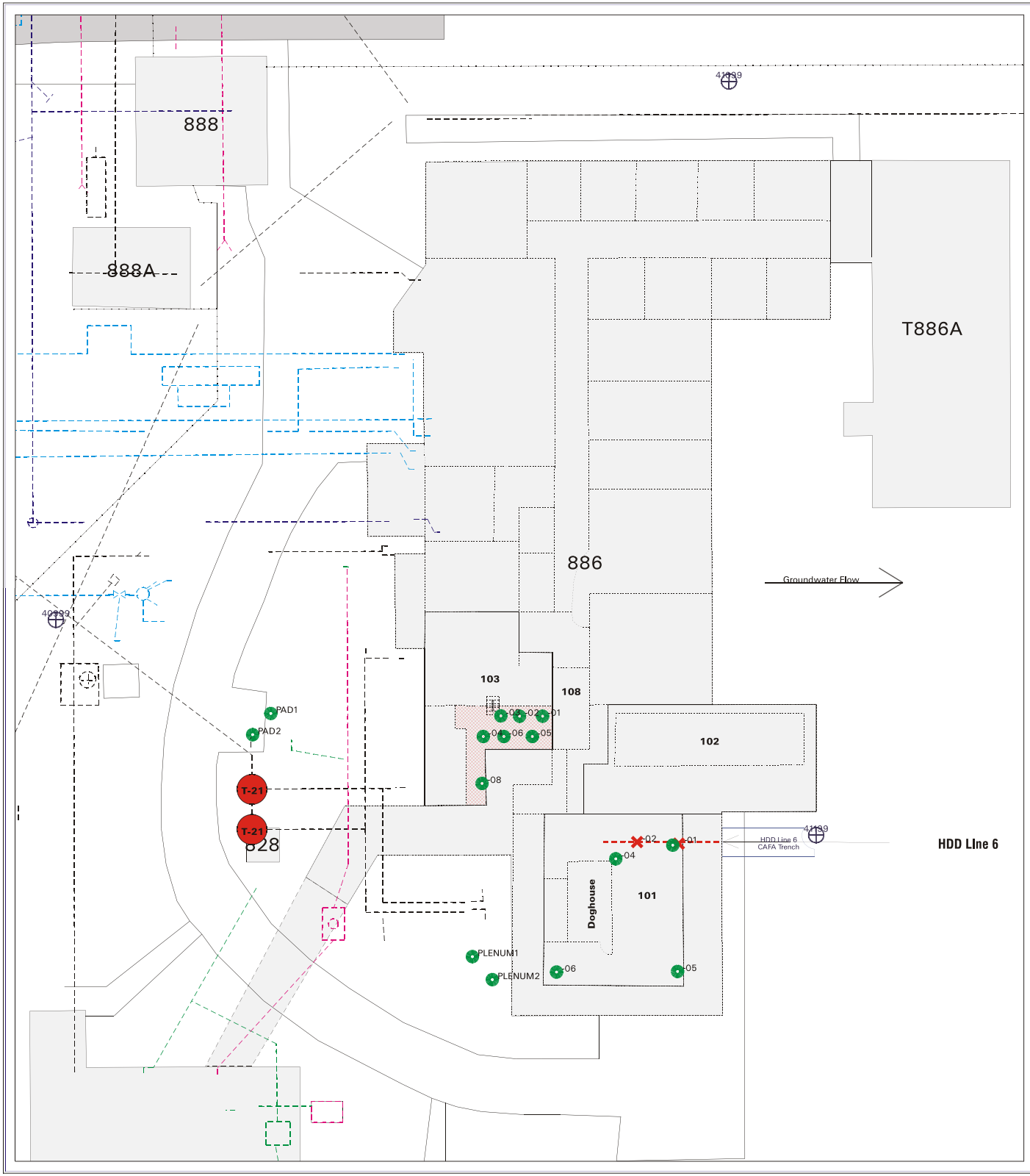

PLATE 2
Building 886 HDD Lines Process Waste Lines and Soil Sample Location Map

EXPLANATION

- Geoprobe Soil Sample Location
- HDD Soil Sample Location
- Horizontal Borehole
- New Groundwater Monitoring Well (Preliminary Survey Location)

General Utilities

- Water Lines
- Natural Gas Lines
- Process Waste Lines
- Storm Sewer Lines
- Sewer Lines
- Electric Lines
- Casing Advancement Frame Assembly (CAFA) Trench Location
- Tanks of Concern
- Building 886 Room 103 Pit Area

Standard Map Features

- Buildings and other structures
- Paved roads fill
- Demolished buildings
- Fences and other barriers
- Paved roads

NOTE:
The Original and New Process Waste Line locations shown on map are approximate and should not be used for determining the line location when performing excavation work.

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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

MAP ID: 01-0550

May 23, 2001

Original map contents are preserved. Logo and date have changed.

Attachment C
Project Photographs

Picture 1 – Casing Advancement Frame Assembly (CAFA) and Support Equipment in HDD Line 1 Trench, Building 123 Slab

Picture 2 – HDD Bit Location with Digi-Trak Receiver, Building 123 Slab

Picture 3 – Geoprobe Soil Sampling on the Former Building 123 Concrete Slab

Picture 4 – Concrete Coring and Soil Sampling in Room 103 Pit, Building 886

Attachment D
Data Summary Tables

Table D-1 Building 123 Analytical Summary

CAS Number	Analyte Name	No. of Analysis Runs[1]	Minimum Value[2]	Maximum Value[2]	Tier I Action Level[2]	Tier II Action Level[2]	Background[3]
630-20-6	1,1,1,2-Tetrachloroethane	50	5	6*	-	-	
71-55-6	1,1,1-Trichloroethane	50	5	6*	94800	948	
79-34-5	1,1,2,2-Tetrachloroethane	50	5	6*	168	1.68	
79-00-5	1,1,2-Trichloroethane	50	5	6*	1230	12.3	
76-13-1	1,1,2-Trichlorotrifluoroethane	50	2	6	-	-	
75-34-3	1,1-Dichloroethane	50	5	6*	689000	6890	
75-35-4	1,1-Dichloroethene	50	1	6	14100	141	
563-58-6	1,1-dichloropropene	50	5	6*	-	-	
87-61-6	1,2,3-Trichlorobenzene	50	5	6*	-	-	
96-18-4	1,2,3-Trichloropropane	50	5	6*	-	-	
120-82-1	1,2,4-Trichlorobenzene	97	5	18000*	433000	4330	
95-63-6	1,2,4-Trimethylbenzene	50	5	6*	-	-	
96-12-8	1,2-Dibromo-3-chloropropane	50	5	6*	-	-	
106-93-4	1,2-Dibromoethane	50	5	6*	-	-	
95-50-1	1,2-Dichlorobenzene	98	5	18000*	1320000	13200	
107-06-2	1,2-Dichloroethane	50	5	6*	668	6.68	
78-87-5	1,2-Dichloropropane	50	5	6*	1130	11.3	
108-67-8	1,3,5-Trimethylbenzene	50	5	6*	-	-	
541-73-1	1,3-Dichlorobenzene	98	5	18000*	-	-	
142-28-9	1,3-Dichloropropane	50	5	6*	-	-	
106-46-7	1,4-Dichlorobenzene	97	5	18000*	165000	1650	
594-20-7	2,2-Dichloropropane	50	5	6*	-	-	
95-95-4	2,4,5-Trichlorophenol	48	800	45000*	279000	2790	
88-06-2	2,4,6-Trichlorophenol	48	320	18000*	10700	107	
120-83-2	2,4-Dichlorophenol	48	320	18000*	63500	635	
105-67-9	2,4-Dimethylphenol	48	320	18000*	577000	5770	
51-28-5	2,4-Dinitrophenol	48	800	45000*	5290	52.9	
121-14-2	2,4-Dinitrotoluene	47	320	18000*	50.1	0.501	
606-20-2	2,6-Dinitrotoluene	48	320	18000*	38.8	0.388	
78-93-3	2-Butanone	50	5	30	-	-	
91-58-7	2-Chloronaphthalene	48	320	18000*	-	-	
95-57-8	2-Chlorophenol	47	320	18000*	257000	2570	
95-49-8	2-Chlorotoluene	50	5	6*	-	-	
591-78-6	2-Hexanone	50	6	13*	-	-	
91-57-6	2-Methylnaphthalene	48	320	18000*	-	-	
95-48-7	2-Methylphenol	48	320	18000*	706000	7060	
88-74-4	2-Nitroaniline	48	800	45000*	-	-	
88-75-5	2-Nitrophenol	48	320	18000*	-	-	
91-94-1	3,3'-Dichlorobenzidine	48	320	18000*	484	4.84	
99-09-2	3-Nitroaniline	48	800	45000*	-	-	
534-52-1	4,6-Dinitro-2-methylphenol	48	800	45000*	-	-	
101-55-3	4-Bromophenyl-phenylether	48	320	18000*	-	-	
59-50-7	4-Chloro-3-methylphenol	47	21	18000	-	-	
106-47-8	4-Chloroaniline	48	320	18000*	43800	438	
7005-72-3	4-Chlorophenyl-phenylether	48	320	18000*	-	-	

CAS Number	Analyte Name	No. of Analysis Runs[1]	Minimum Value[2]	Maximum Value[2]	Tier I Action Level[2]	Tier II Action Level[2]	Background[3]
106-43-4	4-Chlorotoluene	50	5	6*	-	-	
99-87-6	4-Isopropyltoluene	50	2	6	-	-	
108-10-1	4-Methyl-2-pentanone	50	10	13*	-	-	
106-44-5	4-Methylphenol	48	320	18000*	-	-	
100-01-6	4-Nitroaniline	48	800	45000*	-	-	
100-02-7	4-Nitrophenol	48	800	45000*	-	-	
83-32-9	Acenaphthene	47	21	18000	5.34E+07	5.34E+05	
208-96-8	Acenaphthylene	48	320	18000*	-	-	
67-64-1	Acetone	50	4	160	2.72E+07	2.72E+05	
7429-90-5	Aluminum, Total	49	1230	28200	1.00E+06	1.00E+06	35373.17
14596-10-2	AM-241	49	-0.014	1.14	209	38	0.02
120-12-7	Anthracene	48	19	18000		11200	
7440-36-0	Antimony, Total	49	0.19	0.61	768	768	16.97
7440-38-2	Arsenic, Total	49	0.66	**14.7**	299	2.99	13.14
7440-39-3	Barium, Total	49	10.8	99.3	133000	133000	289.38
71-43-2	Benzene	50	5	6*	1410	14.1	
56-55-3	Benzo(a)anthracene	48	21	18000*	160000	1600	
50-32-8	Benzo(a)pyrene	48	23	18000*	701000	7010	
205-99-2	Benzo(b)fluoranthene	48	19	18000*	495000	4950	
191-24-2	Benzo(g,h,i)perylene	48	35	18000	-	-	
207-08-9	Benzo(k)fluoranthene	48	22	18000	4.95E+06	4.95E+04	
65-85-0	Benzoic acid	48	97	45000	1.09E+07	1.09E+05	
100-51-6	Benzyl alcohol	48	35	18000	-	-	
7440-41-7	Beryllium, Total	49	0.05	**1.9**	104	1.04	14.2
111-91-1	bis(2-Chloroethoxy)methane	48	320	18000*	-	-	
111-44-4	bis(2-Chloroethyl)ether	48	320	18000*	9.73	0.0973	
108-60-1	bis(2-Chloroisopropyl)ether	48	320	18000*	-	-	
117-81-7	bis(2-Ethylhexyl)phthalate	49	27	7500	3.11E+08	3.11E+06	
108-86-1	Bromobenzene	50	5	6*	-	-	
74-97-5	Bromochloromethane	50	5	6*	-	-	
75-27-4	Bromodichloromethane	50	5	6*	26400	264	
75-25-2	Bromoform	50	5	6*	37200	372	
74-83-9	Bromomethane	50	4	6	5980	59.8	
85-68-7	Butylbenzylphthalate	48	320	18000*		14400	
7440-43-9	Cadmium, Total	49	0.03	0.17	1920	1920	1.7
7440-70-2	Calcium, Total	49	492	74300	-	-	39382.27
75-15-0	Carbon Disulfide	50	2	6	988000	9880	
56-23-5	Carbon Tetrachloride	50	5	6*	3560	35.6	
108-90-7	Chlorobenzene	50	5	6*	83000	830	
75-00-3	Chloroethane	50	5	6*	-	-	
67-66-3	Chloroform	50	5	6*	21400	214	
74-87-3	Chloromethane	50	5	6	-	-	
7440-47-3	Chromium, Total	49	3.3	75.4	-	-	68.27
218-01-9	Chrysene	48	24	18000	-	-	
156-59-2	cis-1,2-dichloroethene	50	5	6*	-	-	
10061-01-5	cis-1,3-Dichloropropene	50	5	6*	120	1.2	

CAS Number	Analyte Name	No. of Analysis Runs[1]	Minimum Value[2]	Maximum Value[2]	Tier I Action Level[2]	Tier II Action Level[2]	Background[3]
7440-48-4	Cobalt, Total	49	1.1	21.1	115000	115000	29.04
7440-50-8	Copper, Total	49	4	293	71100	71100	38.21
84-74-2	Di-n-Butylphthalate	48	18	18000	4.26E+08	4.26E+06	
117-84-0	Di-n-Octyl phthalate	48	170	18000	-	-	
53-70-3	Dibenzo(a,h)anthracene	48	320	18000*	153000	1530	
132-64-9	Dibenzofuran	48	320	18000*	-	-	
124-48-1	Dibromochloromethane	50	5	6*	-	-	
74-95-3	Dibromomethane	50	5	6*	-	-	
75-71-8	Dichlorodifluoromethane	50	5	6*	-	-	
84-66-2	Diethylphthalate	48	320	18000*	3.10E+07	3.10E+05	
131-11-3	Dimethyphthalate	48	320	18000*	-	-	
100-41-4	Ethylbenzene	50	5	6*	932000	9320	
206-44-0	Fluoranthene	48	50	18000	5.37E+08	5.37E+06	
86-73-7	Fluorene	48	320	18000*	6.94E+07	6.94E+05	
118-74-1	Hexachlorobenzene	48	320	18000*	189000	1890	
87-68-3	Hexachlorobutadiene	98	5	18000*	201000	2010	
77-47-4	Hexachlorocyclopentadiene	48	320	18000*	3.44E+07	3.44E+05	
67-72-1	Hexachloroethane	48	320	18000*	37700	377	
193-39-5	Indeno(1,2,3-cd)pyrene	48	32	18000	1.40E+06	14000	
7439-89-6	Iron, Total	49	3630	32500	576000	576000	41046.52
78-59-1	Isophorone	48	320	18000*	20900	209	
98-82-8	Isopropylbenzene	50	5	6*	-	-	
7439-92-1	Lead, Total	49	2.1	**3470**	1000	1000	24.97
7439-93-2	Lithium, Total	49	1.8	13.4	38400	38400	34.66
7439-95-4	Magnesium, Total	49	428	2420	-	-	9315.44
7439-96-5	Manganese, Total	49	29	303	83600	83600	901.62
7439-97-6	Mercury, Total	49	0.01	2.7	576	576	1.52
75-09-2	Methylene Chloride	50	9	29	578	5.78	
7439-98-7	Molybdenum, Total	49	0.2	25.6	9610	9610	25.61
104-51-8	N-butybenzene	50	5	6*	-	-	
621-64-7	N-Nitroso-di-n-propylamine	47	320	18000*	1.89	0.0189	
86-30-6	N-Nitrosodiphenylamine (1)	48	320	18000*	78400	784	
103-65-1	N-propylbenzene	50	5	6*	-	-	
91-20-3	Naphthalene	98	5	18000*	1.01E+07	1.01E+05	
7440-02-0	Nickel, Total	49	2.3	27.5	38400	38400	62.21
98-95-3	Nitrobenzene	48	320	18000*	5390	53.9	
87-86-5	Pentachlorophenol	48	800	45000*	2110	21.1	
85-01-8	Phenanthrene	48	47	18000	-	-	
108-95-2	Phenol	47	320	18000	3.75E+06	37500	
7440-09-7	Potassium, Total	49	406	2250	-	-	6196.81
10-12-8	PU-239/240	49	-0.043	0.445	1088	252	0.02
129-00-0	Pyrene	47	50	18000	3.97E+08	3.97E+06	
110-86-1	Pyridine	48	320	18000*	-	-	
135-98-8	Sec-butylbenzene	50	5	6*	-	-	
7782-49-2	Selenium, Total	49	0.3	0.82	9610	9610	4.8

CAS Number	Analyte Name	No. of Analysis Runs[1]	Minimum Value[2]	Maximum Value[2]	Tier I Action Level[2]	Tier II Action Level[2]	Background[3]
7440-22-4	Silver, Total	49	0.1	0.34	9610	9610	24.54
7440-23-5	Sodium, Total	49	48.6	404	-	-	1251.24
7440-24-6	Strontium, Total	49	3.3	60.5	1.00E+06	1.00E+06	211.38
100-42-5	Styrene	50	5	6*	274000	2740	
98-06-6	Tert-butylbenzene	50	5	6*	-	-	
127-18-4	Tetrachloroethene	50	5	6*	3150	31.5	
7440-28-0	Thallium, Total	49	0.33	0.69	-	-	1.84
7440-31-5	Tin, Total	49	0.74	30.6	1.00E+06	1.00E+06	286.31
108-88-3	Toluene	50	1	6	707000	7070	
156-60-5	Trans-1,2-dichloroethene	50	5	6	-	-	
10061-02-6	Trans-1,3-Dichloropropene	47	5	6*	120	1.2	
79-01-6	Trichloroethene	50	5	6	3290	32.9	
75-69-4	Trichlorofluoromethane	50	1	6	-	-	
11-08-5	U-233/234	49	0.314	1.87	1627	307	2.64
15117-96-1	U-235	49	-0.014	0.114	113	24	0.12
7440-61-1	U-238	49	0.298	1.52	506	103	1.49
11-09-6	Uranium, Total	49	1.2	2.4*	-	-	
7440-62-2	Vanadium, Total	49	4.5	59.7	13400	13400	88.49
75-01-4	Vinyl Chloride	50	5	6*	347	3.47	
1330-20-7	Xylenes (Total)	50	2	6	9.74E+06	97400	
7440-66-6	Zinc, Total	49	7.2	37.7	576000	576000	139.1

[1]Estimated Number of Real and Duplicate Samples Collected.

[2]Units are µg/kg (ppb) for Organics, mg/kg for Inorganics, and pCi/g for Radionuclides. Cells noting the "-" symbol denote analytes for which Action Levels have not been established by RFCA. Cells noting an asterisk "*" symbol next to a reported value are non-detects.

[3]Source: DOE, 1993. Arithmetic Mean + 2 Standard Deviations, Background Geochemical Report, Table D-16, RFETS, September, 1993. Applies to metals and radionuclides only.

Table D-2 Building 886 Analytical Summary

CAS Number	Analyte Name	No. of Analysis Runs[1]	Minimum Value[2]	Maximum Value[2]	Tier I Action Level[2]	Tier II Action Level[2]	Background[3]
630-20-6	1,1,1,2-Tetrachloroethane	16	5	6*	-	-	
71-55-6	1,1,1-Trichloroethane	16	5	6*	94800	948	
79-34-5	1,1,2,2-Tetrachloroethane	16	3	6*	168	1.68	
79-00-5	1,1,2-Trichloroethane	16	5	6*	1230	12.3	
76-13-1	1,1,2-Trichlorotrifluoroethane	16	5	6*	-	-	
75-34-3	1,1-Dichloroethane	16	5	6*	689000	6890	
75-35-4	1,1-Dichloroethene	16	5	6*	14100	141	
563-58-6	1,1-dichloropropene	16	5	6*	-	-	
87-61-6	1,2,3-Trichlorobenzene	16	3	6	-	-	
96-18-4	1,2,3-Trichloropropane	16	4	6	-	-	
120-82-1	1,2,4-Trichlorobenzene	35	3	2000	433000	4330	
95-63-6	1,2,4-Trimethylbenzene	16	5	6*	-	-	
96-12-8	1,2-Dibromo-3-chloropropane	16	3	6	-	-	
106-93-4	1,2-Dibromoethane	16	5	6*	-	-	
95-50-1	1,2-Dichlorobenzene	35	5	2000*	1320000	13200	
107-06-2	1,2-Dichloroethane	16	5	6*	668	6.68	
78-87-5	1,2-Dichloropropane	16	1	6*	1130	11.3	
108-67-8	1,3,5-Trimethylbenzene	16	5	6*	-	-	
541-73-1	1,3-Dichlorobenzene	35	5	2000*	-	-	
142-28-9	1,3-Dichloropropane	16	5	6*			
106-46-7	1,4-Dichlorobenzene	35	5	2000*	165000	1650	
594-20-7	2,2-Dichloropropane	16	5	6*	-	-	
95-95-4	2,4,5-Trichlorophenol	19	830	5000*	279000	2790	
88-06-2	2,4,6-Trichlorophenol	19	350	2000*	10700	107	
120-83-2	2,4-Dichlorophenol	19	350	2000*	63500	635	
105-67-9	2,4-Dimethylphenol	19	350	2000*	577000	5770	
51-28-5	2,4-Dinitrophenol	19	830	5000*	5290	52.9	
121-14-2	2,4-Dinitrotoluene	19	350	2000*	50.1	0.501	
606-20-2	2,6-Dinitrotoluene	19	350	2000*	38.8	0.388	
78-93-3	2-Butanone	16	6	13*	-	-	
91-58-7	2-Chloronaphthalene	19	350	2000*	-	-	
95-57-8	2-Chlorophenol	19	350	2000*	257000	2570	
95-49-8	2-Chlorotoluene	16	5	6*	-	-	
591-78-6	2-Hexanone	16	9	13*	-	-	
91-57-6	2-Methylnaphthalene	19	350	2000*	-	-	
95-48-7	2-Methylphenol	19	350	2000*	706000	7060	
88-74-4	2-Nitroaniline	19	830	5000*	-	-	
88-75-5	2-Nitrophenol	19	350	2000*	-	-	
91-94-1	3,3'-Dichlorobenzidine	19	350	2000*	484	4.84	
99-09-2	3-Nitroaniline	19	830	5000*	-	-	
534-52-1	4,6-Dinitro-2-methylphenol	19	830	5000*	-	-	
101-55-3	4-Bromophenyl-phenylether	19	350	2000*	-	-	
59-50-7	4-Chloro-3-methylphenol	19	350	2000*	-	-	
106-47-8	4-Chloroaniline	19	350	2000*	43800	438	
7005-72-3	4-Chlorophenyl-phenylether	19	350	2000*	-	-	

CAS Number	Analyte Name	No. of Analysis Runs[1]	Minimum Value[2]	Maximum Value[2]	Tier I Action Level[2]	Tier II Action Level[2]	Background[3]
106-43-4	4-Chlorotoluene	16	5	6*	-	-	
99-87-6	4-Isopropyltoluene	16	5	6*	-	-	
108-10-1	4-Methyl-2-pentanone	16	7	13	-	-	
106-44-5	4-Methylphenol	19	350	2000*	-	-	
100-01-6	4-Nitroaniline	19	830	5000*	-	-	
100-02-7	4-Nitrophenol	19	830	5000*	-	-	
83-32-9	Acenaphthene	19	350	2000*	5.34E+07	5.34E+05	
208-96-8	Acenaphthylene	19	350	2000*	-	-	
67-64-1	Acetone	16	6	36	2.72E+07	2.72E+05	
7429-90-5	Aluminum, Total	24	55.1	59000	1.00E+06	1.00E+06	35373.17
14596-10-2	AM-241	19	-0.013	0.394	209	38	0.02
120-12-7	Anthracene	19	350	2000*		11200	
7440-36-0	Antimony, Total	24	0.17	0.58	768	768	16.97
7440-38-2	Arsenic, Total	24	0.89	12.3	299	2.99	13.14
7440-39-3	Barium, Total	24	0.7	796	133000	133000	289.38
71-43-2	Benzene	16	2	6*	1410	14.1	
56-55-3	Benzo(a)anthracene	19	27	2000*	160000	1600	
50-32-8	Benzo(a)pyrene	19	23	2000	701000	7010	
205-99-2	Benzo(b)fluoranthene	19	26	2000	495000	4950	
191-24-2	Benzo(g,h,i)perylene	19	21	2000	-	-	
207-08-9	Benzo(k)fluoranthene	19	22	2000	4950000	49500	
65-85-0	Benzoic acid	19	300	5000	1.09E+07	1.09E+05	
100-51-6	Benzyl alcohol	19	350	2000*	-	-	
7440-41-7	Beryllium, Total	24	0.01	0.87	104	1.04	14.2
111-91-1	bis(2-Chloroethoxy)methane	19	350	2000*	-	-	
111-44-4	bis(2-Chloroethyl)ether	19	350	2000*	9.73	0.0973	
108-60-1	bis(2-Chloroisopropyl)ether	19	350	2000*	-	-	
117-81-7	bis(2-Ethylhexyl)phthalate	19	20	1800	3.11E+08	3.11E+06	
108-86-1	Bromobenzene	16	5	6*	-	-	
74-97-5	Bromochloromethane	16	5	6*	-	-	
75-27-4	Bromodichloromethane	16	5	6*	26400	264	
75-25-2	Bromoform	16	1	6	37200	372	
74-83-9	Bromomethane	16	5	6*	5980	59.8	
85-68-7	Butylbenzylphthalate	19	350	2000*		14400	
7440-43-9	Cadmium, Total	24	0.03	0.23	1920	1920	1.7
7440-70-2	Calcium, Total	24	258	412000	-	-	39382.27
75-15-0	Carbon Disulfide	16	5	6*	988000	9880	
56-23-5	Carbon Tetrachloride	16	5	6*	3560	35.6	
108-90-7	Chlorobenzene	16	5	6*	83000	830	
75-00-3	Chloroethane	16	5	6*	-	-	
67-66-3	Chloroform	16	5	6*	21400	214	
74-87-3	Chloromethane	16	5	6*	-	-	
7440-47-3	Chromium, Total	24	0.44	35.2	-	-	68.27
218-01-9	Chrysene	19	28	2000	-	-	
156-59-2	cis-1,2-dichloroethene	16	5	6*	-	-	
10061-01-5	cis-1,3-Dichloropropene	16	5	6*	120	1.2	
7440-48-4	Cobalt, Total	24	0.28	14	115000	115000	29.04

CAS Number	Analyte Name	No. of Analysis Runs[1]	Minimum Value[2]	Maximum Value[2]	Tier I Action Level[2]	Tier II Action Level[2]	Background[3]
7440-50-8	Copper, Total	24	1.7	1190	71100	71100	38.21
84-74-2	Di-n-Butylphthalate	19	18	2000	4.26E+08	4.26E+06	
117-84-0	Di-n-Octyl phthalate	19	350	2000*	-	-	
53-70-3	Dibenzo(a,h)anthracene	19	350	2000*	153000	1530	
132-64-9	Dibenzofuran	19	350	2000*	-	-	
124-48-1	Dibromochloromethane	16	5	6*	-	-	
74-95-3	Dibromomethane	16	5	6*	-	-	
75-71-8	Dichlorodifluoromethane	16	5	6*	-	-	
84-66-2	Diethylphthalate	19	350	2000*	3.10E+07	3.10E+05	
131-11-3	Dimethyphthalate	19	350	2000*	-	-	
100-41-4	Ethylbenzene	16	2	6*	932000	9320	
206-44-0	Fluoranthene	19	54	2000	5.37E+08	5.37E+06	
86-73-7	Fluorene	19	350	2000*	6.94E+07	6.94E+05	
118-74-1	Hexachlorobenzene	19	350	2000*	189000	1890	
87-68-3	Hexachlorobutadiene	35	5	2000*	201000	2010	
77-47-4	Hexachlorocyclopentadiene	19	350	2000*	3.44E+07	3.44E+05	
67-72-1	Hexachloroethane	19	350	2000*	37700	377	
193-39-5	Indeno(1,2,3-cd)pyrene	19	350	2000*	1.40E+06	14000	
7439-89-6	Iron, Total	24	87.7	33000	576000	576000	41046.52
78-59-1	Isophorone	19	350	2000*	20900	209	
98-82-8	Isopropylbenzene	16	5	6*	-	-	
7439-92-1	Lead, Total	24	0.73	28.24	1000	1000	24.97
7439-93-2	Lithium, Total	24	0.35	14.2	38400	38400	34.66
7439-95-4	Magnesium, Total	24	17.3	4570	-	-	9315.44
7439-96-5	Manganese, Total	24	1.2	298	83600	83600	901.62
7439-97-6	Mercury, Total	22	0.02	0.15	576	576	1.52
75-09-2	Methylene Chloride	16	8	29	578	5.78	
7439-98-7	Molybdenum, Total	24	0.21	2	9610	9610	25.61
104-51-8	N-butybenzene	16	5	6*	-	-	
621-64-7	N-Nitroso-di-n-propylamine	19	350	2000*	1.89	0.0189	
86-30-6	N-Nitrosodiphenylamine (1)	19	350	2000*	78400	784	
103-65-1	N-propylbenzene	16	5	6*	-	-	
91-20-3	Naphthalene	35	5	2000*	1.01E+07	1.01E+05	
7440-02-0	Nickel, Total	24	0.39	20.1	38400	38400	62.21
98-95-3	Nitrobenzene	19	350	2000*	5390	53.9	
87-86-5	Pentachlorophenol	19	830	5000*	2110	21.1	
85-01-8	Phenanthrene	19	42	2000	-	-	
108-95-2	Phenol	19	350	2000*	3750000	37500	
7440-09-7	Potassium, Total	24	32.4	2690	-	-	6196.81
10-12-8	PU-239/240	19	-0.055	0.408	1088	252	0.02
129-00-0	Pyrene	19	58	2000	3.97E+08	3.97E+06	
110-86-1	Pyridine	19	350	2000*	-	-	
135-98-8	Sec-butylbenzene	16	5	6*	-	-	
7782-49-2	Selenium, Total	24	0.31	0.82*	9610	9610	4.8
7440-22-4	Silver, Total	24	0.06	3.8	9610	9610	24.54

CAS Number	Analyte Name	No. of Analysis Runs[1]	Minimum Value[2]	Maximum Value[2]	Tier I Action Level[2]	Tier II Action Level[2]	Background[3]
7440-23-5	Sodium, Total	24	50	994	-	-	1251.24
7440-24-6	Strontium, Total	24	3.1	322	1.00E+06	1.00E+06	211.38
100-42-5	Styrene	16	5	6*	274000	2740	
98-06-6	Tert-butylbenzene	16	5	6*	-	-	
127-18-4	Tetrachloroethene	16	5	6*	3150	31.5	
7440-28-0	Thallium, Total	24	0.3	1.1	-	-	1.84
7440-31-5	Tin, Total	24	0.65	2.8	1.00E+06	1.00E+06	286.31
108-88-3	Toluene	16	3	7*	707000	7070	
156-60-5	Trans-1,2-dichloroethene	16	5	6*	-	-	
10061-02-6	Trans-1,3-Dichloropropene	16	5	6*	120	1.2	
79-01-6	Trichloroethene	16	5	6*	3290	32.9	
75-69-4	Trichlorofluoromethane	16	5	6*	-	-	
11-08-5	U-233/234	19	0.336	3.78	1627	307	2.64
15117-96-1	U-235	19	-0.013	0.141	113	24	0.12
7440-61-1	U-238	19	0.455	1.35	506	103	1.49
11-09-6	Uranium, Total	24	1.3	3.4*	-	-	
7440-62-2	Vanadium, Total	24	0.27	64	13400	13400	88.49
75-01-4	Vinyl Chloride	16	5	6*	347	3.47	
1330-20-7	Xylenes (Total)	16	2	8	9.74E+06	9.74E+04	
7440-66-6	Zinc, Total	24	4.2	46.3	576000	576000	139.1

[1]Estimated Number of Real and Duplicate Samples Collected.

[2]Units are µg/kg (ppb) for Organics, mg/kg for Inorganics, and pCi/g for Radionuclides. Cells noting the "-" symbol denote analytes for which Action Levels have not been established by RFCA. Cells noting an asterisk "*" symbol next to a reported value are non-detects.

[3]Source: DOE, 1993. Arithmetic Mean + 2 Standard Deviations, Background Geochemical Report, Table D-16, RFETS, September, 1993. Applies to metals and radionuclides only.