



Rocky Mountain  
Remediation Services, L.L.C.  
*... protecting the environment*

**Operable Unit 9  
Pipe Excavation Project at the  
Rocky Flats Environmental Technology Site**

**Geoprobe Characterization Report**

**Revision 0**

**Rocky Mountain Remediation Services, L. L. C.**

**November 1996**

**ADMIN RECORD**

IA -A-00043

# OPERABLE UNIT 9 PIPE EXCAVATION PROJECT GEOPROBE CHARACTERIZATION REPORT

## 1.0 INTRODUCTION

Due to its interference with Phase III of the Sewage Treatment Plant Upgrades, approximately 150 feet of the 6 inch vitrified clay pipe, designated as Operable Unit (OU) 9 was scheduled to be removed by excavation under a subcontract (Reference Purchase Requisition No. P498599). This project will be conducted within an OU, but is not considered to be an Environmental Restoration (ER) activity. Before excavation of the overburden began, watertight plugs were placed in the pipe on both sides of the section to be removed. Characterization of a composite of the pipe and associated soils was taken on June 11, 1996 and June 18, 1996 in accordance with the Waste Characterization and Management Plan for Excavation of OU 9 Piping (Rocky Mountain Remediation Services, L. L. C. Memorandum No. GMA-002-96, dated May 7, 1996). The results and locations of the samples taken during field excavation are presented in Appendix A. Preliminary results indicated slightly elevated levels of radioactivity in the soil; however, no RCRA hazardous constituents were detected above regulatory threshold limits. Data for Total Metals, Volatile Organics Sweep, and PCBs are presented in this report in Appendix A; the results demonstrated that these parameters were below regulatory concern for RCRA constituents measured in the area of the OU 9 trench soils. Portable organic vapor monitors were also used in the field during excavation for industrial hygiene purposes, but no vapors were detected. Groundwater standing in the OU 9 trenches had elevated gross alpha/beta values. Due to the detection of radioactive contaminants in the soil in the proposed area of excavation, a geoprobe sampling plan was developed to identify potential areas of radioactive contamination within the effluent tank construction zone. This report describes the methods utilized for collection of the soil samples and presents the results of the analysis.

## 2.0 PURPOSE AND SCOPE

Due to the detection of radioactive contaminants in the soil in the proposed area of excavation for the Phase III Sewage Treatment Plant Upgrades, a Sampling Plan was developed to identify potential areas of radioactive contamination and areas that are considered to be clean and to quantify the extent of contamination detected in the soils, where found. The intent of the sampling was to establish if contamination was narrowly confined to the vicinity of the pipe, in which case, the soil could be removed and the construction of the tanks could proceed or broadly distributed at radioactive waste concentration levels, which would make the project economically unattractive, due to the fact that soils would need to be containerized and disposed of as low-level waste. The results of the radioactive soil analysis was to be compared to the proposed Tier I and Tier II "Action Levels" being negotiated with the state described further below.

Radioactive soils at Rocky Flats Environmental Technology Site (RFETS) are managed as waste or "clean" soils dependent upon the levels of isotopes present in the mixture. In addition, RFETS is currently in the process of negotiating "put-back" levels of contamination for sites which have slightly elevated levels of radioactivity in the soils (reference Appendix D). Preliminary data on samples taken in the field indicated that the values obtained would be low enough to qualify as "put-back" levels; however, a representative number of samples needed to be taken in a systematic manner in order to properly characterize the area to be excavated. The "Action Levels for Radionuclides in Soils for the Rocky Flats Cleanup Agreement" are presented below and in Appendix D. It is understood that the use of these values would need to be negotiated with the regulators on a case by case basis as they apply to this project.

## 3.0 SAMPLING PLAN SUMMARY

Prior to sampling, meetings were held with representatives from Radiological Engineering and ER to establish a viable plan for proceeding with the Geoprobe Sampling. The original plans called

for sampling the soil column both above and below the water table; however, during field sampling activities there were only two sample locations which encountered groundwater (D-4 and B-3) and field measurements demonstrated background contamination values for all 2 foot sections of the core samples taken.

A Grid System was established in the proposed Effluent Tank construction area during the week of July 8, 1996 area to identify sample points which would allow systematic sampling of the entire construction area and provide a unique alpha-numeric identifier for each sample. The nodes were set at 12.5 foot intervals at predetermined elevations (see Appendix B). Elevations from a topographic map were used to establish predetermined desired depths for Geoprobe core samples to be taken to the depth of tank construction. This method would allow for representative sampling of the areas identified for tank construction, and did not include areas outside the immediate construction zone. Appendix B shows the sample locations, depths, and elevations associated with the Geoprobe samples. The locations selected for sampling included Node Numbers A1, B5, B3, B4, C4, C7, D3, D4, D6, D7, E3, E5, and E7. In addition, the nodes which fell at C3 and C5 were previously sampled during the trenching of OU 9 on June 11, 1996 and June 18, 1996. Note that split samples were taken at B3 and B4 due to a percentage of these samples having a black sludge present. The sludge was physically separated from the soil sample in the field and segregated into separate sample containers. Note that there were no significant differences in the radiological data for the soil/sludge split samples. Groundwater samples from standing water were also taken on June 11, 1996 in the C5 location and on June 18, 1996 at the C3 location. These results are presented in Appendix C.

During sampling, all 2 foot sections of the core removed were first monitored with a hand-held probe and then monitored with the Field Instrument for the Detection of Low Energy Radiation (FIDLER) for radioactive contamination. An organic vapor detector was also used to monitor each section of the core for Industrial Hygiene purposes; however, no organics were detected. Each 2 foot core was monitored, swiped, and composited (hand-mixed with a trowel) into a stainless steel bucket, monitored again with the FIDLER, and then a composite sample was taken from the bucket to represent the entire core from the node. The analysis requested included Alpha/Beta Screen, gross alpha/beta, and isotopics for radioactive isotopes included in the action levels for clean-up. Analytical and Quality Assurance procedures used by the Analytical Projects Office (APO) are standard methods and are described in detail in Appendix E.

#### **4.0 INSTRUMENTATION**

Soil samples were taken using a van mounted Geoprobe sampling rig further described in Section 5.0 of this report. Radiological contamination monitoring was performed in the field using hand-held probes for total fixed plus removable and removable alpha and beta/gamma contamination. The FIDLER was also used to monitor equipment and soils during field sampling activities. Equipment was monitored for radiological contamination during sampling activities and the equipment decontaminated between each core taken.

#### **5.0 FIELD PROCEDURES**

A van-mounted Geoprobe sampling rig was driven into the construction area on July 16, 1996. The rig was used to collect a total of 13 cores from each location with depths ranging from 2 feet to 12 feet. Details on the sample depths and elevations is presented in Appendix B. The equipment was operated in accordance with procedure 4-S64-ER-OPS-GT.39, Push Subsurface Soil Sample. The samples were enclosed in liners contained within the sampling assembly. The cores from each two-foot intervals were hand surveyed for radiological contamination prior to compositing the cores for a given node into a stainless steel container. The cores were mixed into a homogeneous mixture, hand-surveyed for contamination with a probe, and composited into a single sample container to be analyzed for gross alpha/beta and isotopics at the Building 881 laboratories.

Field screening and analysis was conducted for samples taken by the APO sampling team on June 11, 1996 (location C5) and again on June 18, 1996 (location C3). These samples were taken directly from the OU 9 trench and are presumed to have the highest levels of radioactive contamination present in the construction area (field measurements were 3000 to 5000 CPM).

## 6.0 ANALYTICAL PROCEDURES

All analysis was performed by Building 881 Analytical Laboratories. Gross alpha and gross beta activities are measured by evaporating an aliquot of the prepared sample onto a counting planchet and counting the alpha and beta activities in a low background, thin windowed, gas proportional counter. Isotopics analysis is performed when isotopes are separated from the prepared sample using ion-exchange and chromatographic extraction techniques, followed by electrodeposition onto counting planchets, and then analyzed by alpha spectrometry. A detailed description of the methods and procedures used for performing gross alpha/beta as well as isotopics for the samples analyzed are presented in Appendix D.

## 7.0 SAMPLING DATA

Sampling data is presented in Appendix A for all radioactive samples taken, including APO events for the OU 9 trench on June 11, 1996 and June 18, 1996 and the Geoprobe samples taken during the week of July 16, 1996. The highest values recorded for the site soils occurred at locations C5 and C3 trenches. Node C5 results included Plutonium (Pu) 239/240 measurements of 1.72 pCi/g and Americium (Am) 241 at 6.49 pCi/g; node sample C3 had sample results of 4.5 pCi/g for Pu 239/240 and 18.1 pCi/g for Am 241. Results for all other locations were low; Pu 241 ranged from .079 to .533 pCi/g and Am 241 from .066 to 1.72 pCi/g. Results for Uranium 233/234, 235 and 238 were all below background values for this area.

Standing groundwater encountered during excavation of the OU 9 trenches had values of 77 pCi/g gross alpha and 18 pCi/g gross beta for water collected at C5 on June 11, 1996; and 370 pCi/g gross alpha and 150 pCi/g gross beta for the C3 location collected on June 18, 1996. These samples were reported to have a high degree of sediment in them. The samples were obtained after allowing groundwater to accumulate for several hours in the contaminated OU 9 trenches.

## 8.0 SUMMARY AND CONCLUSIONS

The intent of the sampling was to establish if contamination was narrowly confined to the vicinity of the pipe, in which case, the soil could be removed and the construction of the tanks could proceed; or broadly distributed at concentrations that would designate the soil as low-level waste, which would make the project economically unattractive. The results of the analysis would then be compared to the proposed Tier I and Tier II "Action Levels" being negotiated with the state as presented in Appendix D.

The highest values recorded for the site soils, as discussed previously, occurred at the locations C3 and C5 within the OU 9 trench area. Node C5 results included Pu 239/240 measurements of 1.72 pCi/g and Am 241 at 6.49 pCi/g; node sample C3 had samples results of 4.5 pCi/g for Pu 239/240 and 18.1 pCi/g for Am 241. Although these were the highest soil values recorded for the construction site, the values are still significantly below the "Hypothetical Resident Tier II Action Level Ratio Sum to 15 mrem" as shown in the Tier II Action Level Table. These values are low enough to qualify as potential "put-back" levels for soils within the construction zone. Again the applicability of these values would need to be discussed with the regulators prior to a final decision on placement of the soil.

Results from the additional 13 nodes sampled have significantly lower values for gross

alpha/beta and isotopics and are representative for background level typically found at the RFETS site, with the exception of Am-241 and Pu-239/240 which are slightly elevated for some nodes. The exception was that nodes E3, E5, and D3 had higher than background levels for Am 241; however, the reported values were still significantly lower than the Tier II action level for Am 241 of 40.4 pCi/g.

Groundwater results (Appendix C) collected from the OU 9 trenches at locations C3 and C5 demonstrated that for standing water in the trench, the values were above dischargeable levels. Due to the fact that these samples were collected after the water was allowed to stand for a few days in sediment, these results may not be representative of the groundwater for this area. Further sampling would need to be conducted during construction to properly characterize groundwater in the immediate area. Groundwater will be pumped to a portable tank, analyzed and discharged if no contaminants are detected.

## **9.0 RECOMMENDATIONS**

Review of the data indicates that there are slightly elevated values in the soil for gross alpha/beta and isotopics in the area of the OU 9 pipe excavation, specifically at locations C3 and C5. Groundwater associated with the OU 9 trench also demonstrated higher than dischargeable limits for gross alpha/beta. The additional 13 nodes sampled within the construction zone were slightly elevated above background with the exception of nodes D3, E3, and E5 which showed elevated levels for Am 241. Note that all soils sampled were below the "put-back" values for Tier I and Tier II Action Levels.

The data indicates that the source of radioactive contamination is associated with the OU 9 pipe excavation and is probably related to releases from the pipe. Removal of the pipe and associated contaminated soil should proceed prior to the construction of the effluent tanks to, thereby, eliminate the source of contamination. Soils from this excavation should be segregated from surrounding soil to facilitate sampling the soils once excavated to determine radioactive levels for the excavated dirt in order for it to be properly managed.

Data from the construction areas outside of the OU 9 trench area indicate that the levels of radioactivity in soils are close to background and excavation, in these areas, could proceed as planned if soil is closely monitored during construction. Groundwater results in the construction area showed elevated gross alpha/beta levels; therefore, run-off would need to be collected and monitored during construction to prevent releases from the site.

**APPENDIX A**  
**SOIL SAMPLE RESULTS**  
**Radioactive Isotopics**  
**RCRA Constituents**

KAISER-HILL COMPANY, LLC.  
 ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE  
 P.O. BOX 464  
 GOLDEN, COLORADO 80402

ENVIRONMENTAL LABORATORY  
 BUILDING 881

RADIOCHEMISTRY GROSS ALPHA/BETA REPORT SDG NUMBER:96L2568 DATE: 07/30/96

Gross Alpha/Gross Beta Analysis Results

NODE	APO ID	LIMS ID	Gross Alpha	Gross Beta	Units	QC Batch
A-1	C4745-001	117301	14 ± 4 MDA 5	23 ± 2 MDA 2	pCi/g	96AB144
B-5	C4746-002	117376	16 ± 3 MDA 4	19 ± 2 MDA 2	pCi/g	96AB144
B-3s	C4747-003	117436	15 ± 3 MDA 4	26 ± 3 MDA 3	pCi/g	96AB147
B-4s	C4748-004	117434	16 ± 3 MDA 3	24 ± 3 MDA 3	pCi/g	96AB147
B-3sL	C4749-005	117437	11 ± 3 MDA 3	24 ± 3 MDA 3	pCi/g	96AB147
B-4sL	C4750-006	117435	20 ± 4 MDA 4	31 ± 3 MDA 3	pCi/g	96AB147
B-4sL	C4750-008	117435 D	19 ± 3 MDA 4	28 ± 3 MDA 3	pCi/g	96AB147
C-4	C4751-007	117439	12 ± 3 MDA 3	22 ± 3 MDA 3	pCi/g	96AB147
C-7	C4752-008	117438	12 ± 3 MDA 3	23 ± 3 MDA 3	pCi/g	96AB147
D-4	C4753-009	117371	16 ± 4 MDA 6	24 ± 2 MDA 2	pCi/g	96AB144
D-3	C4754-010	117372	29 ± 5 MDA 5	24 ± 2 MDA 2	pCi/g	96AB144
D-3	C4754-010	117372 D	24 ± 4 MDA 5	23 ± 2 MDA 2	pCi/g	96AB144
D-7	C4755-011	117373	14 ± 3 MDA 4	20 ± 2 MDA 2	pCi/g	96AB144
D-6	C4756-012	117304	15 ± 4 MDA 5	21 ± 2 MDA 2	pCi/g	96AB144
E-3	C4757-013	117305	20 ± 4 MDA 6	24 ± 2 MDA 2	pCi/g	96AB144
E-5	C4758-014	117303	24 ± 5 MDA 6	23 ± 2 MDA 2	pCi/g	96AB144
E-7	C4759-015	117302	17 ± 4 MDA 6	23 ± 2 MDA 2	pCi/g	96AB144

**RFETS**  
**881 GENERAL LABORATORY**  
**FAX FORM**

Report: 96L2044

Date: 7/25/96

Distribution (FAX)  
M. Aycock, 8244  
APO, 3400

From  
K.M. Hagglund, x7799

Node	Lab Sample ID	Customer Sample ID	Gross Alpha Activity (DPM/g) (MDA)	Gross Beta Activity (DPM/g) (MDA)	Units
C-3	115743	C4237002	159 ± 13	13 ± 3	pCi/g
C-3	115743 D	C4237002	111 ± 10	18 ± 3	pCi/g

**COMMENTS:**

These data are for reanalyses of the soil sampled on 6/18/96. The reanalyses were performed upon customer request due to variability observed in the data from the initial analysis. The reanalysis data also exhibit more variability than is typically obtained with this method. This further substantiates the initial supposition that the sample matrix is heterogeneous and contains "hot" particles. The best estimate of activity in such matrices is generally the average of all of the analyses. The activities are reported based on dry weight of soil.

**RFETS**  
**881 GENERAL LABORATORY**  
**FAX FORM**

Report: 96L2044

Date: 6/20/96

**Distribution (FAX)**

A. Dennis/ M. Aycock, 8244  
APO, 3400

**From**

K.M. Hagglund, x7799

*Sampling on*

*6/11/96*

<i>NODE</i>	Lab Sample ID	Customer Sample ID	Gross Alpha Activity OV ± 2σ (MDA)	Gross Beta Activity OV ± 2σ (MDA)	Units
<i>C-5 6/11</i>	115255	96L204404 (Soil)	22 ± 3 (4)	18 ± 2 (1)	pCi/g
<i>C-5</i>	115255 D	96L204404 (Soil)	45 ± 5 (6)	26 ± 2 (2)	pCi/g
<i>C-5</i>	115255	96L204404 (Pipe)	0.7 ± 0.1 (0.1)	0.1 ± 0.1 (0.2)	pCi/g

**COMMENTS:**

These are final results. A complete, formal report will follow when all samples for this project submitted under report 96L2044 have been completed.

The poor precision between the duplicate analyses of the soil sample is likely due to non-homogeneous sample matrix. This heterogeneity was also observed in the isotopic analysis data. Upon request from the customer, the piece of pipe in the sample was analyzed as a separate sample. The pipe was analyzed for surface contamination by doing a hot, nitric acid leach of the pipe. No attempt was made to dissolve the pipe since the contamination would be expected to be primary on the surface, if present. If you have any questions, please call.

General Lab, Building 881

Lab Number: 96L2044 AMENDED

Report Date: 7/31/96  
Sample Date: 06/18/96

RADIOCHEMISTRY REPORT  
ISOTOPIC ANALYSIS RESULTS BY ALPHA SPECTROMETRY

NODE	SAMPLE ID	URANIUM 238 (pCi/g)	BATCH #
C-3	C423702	0.589 ± 0.064 (MDA 0.058)	ISO96-065
	SAMPLE ID	URANIUM 235 (pCi/g)	BATCH #
C-3	C423702	0.025 ± 0.013 (MDA 0.017)	ISO96-065
	SAMPLE ID	URANIUM 234/233 (pCi/g)	BATCH #
C-3	C423702	0.971 ± 0.082 (MDA 0.017)	ISO96-065

General Lab, Building 881

Lab Number: 96L2044  
AMENDEDReport Date: 7/31/96  
Sample Date: 06/18/96

C-3

RADIOCHEMISTRY REPORT  
ISOTOPIC ANALYSIS RESULTS BY ALPHA SPECTROMETRY

NODE	SAMPLE ID	PLUTONIUM 239/240 (pCi/g)	BATCH #
C-3	C423702	4.5 ± 0.3 (MDA 0.038)	ISO96-065

  

	SAMPLE ID	AMERICIUM 241 (pCi/g)	BATCH #
C-3	C423702	18.1 ± 0.9 (MDA 0.036)	ISO96-065

General Lab, Building 881

Lab Number: 96L2044

Report Date: 6/21/96

\* Sample Date: 06/11/96

**RADIOCHEMISTRY REPORT  
ISOTOPIC ANALYSIS RESULTS BY ALPHA SPECTROMETRY**

Node	SAMPLE ID	URANIUM 238 (pCi/g)	BATCH #
C-5	96L204402 SOIL	0.624 ± 0.051 (MDA 0.006)	ISO96-056
C-5	96L204402 SOIL D	0.411 ± 0.033 (MDA 0.005)	ISO96-056
C-5	96L204402 PIPE	0.906 ± 0.060 (MDA 0.005)	ISO96-056

  

	SAMPLE ID	URANIUM 235 (pCi/g)	BATCH #
C-5	96L204402 SOIL	0.017 ± 0.006 (MDA 0.006)	ISO96-056
C-5	96L204402 SOIL D	0.019 ± 0.006 (MDA 0.005)	ISO96-056
C-5	96L204402 PIPE	0.032 ± 0.008 (MDA 0.005)	ISO96-056

  

	SAMPLE ID	URANIUM 234/233 (pCi/g)	BATCH #
C-5	96L204402 SOIL	0.571 ± 0.048 (MDA 0.006)	ISO96-056
C-5	96L204402 SOIL D	0.216 ± 0.022 (MDA 0.005)	ISO96-056
C-5	96L204402 PIPE	0.906 ± 0.060 (MDA 0.017)	ISO96-056

*Numbers have been corrected for background - use as actual values.*

*About one week for further samples*

*Rick: 5417 FAX copy of PIAN*

General Lab, Building 881

Lab Number: 96L2044

Report Date: 6/20/96  
 Sample Date: 06/11/96

**RADIOCHEMISTRY REPORT**  
**ISOTOPIC ANALYSIS RESULTS BY ALPHA SPECTROMETRY**

C-5

NODE	SAMPLE ID	PLUTONIUM 239/240 (pCi/g)	BATCH #
C-5	96L204402 SOIL	1.25 ± 0.05 (MDA 0.01)	ISO96-056
C-5	96L204402 SOIL D	1.72 ± 0.08 (MDA 0.01)	ISO96-056
C-5	96L204402 PIPE	0.024 ± 0.004 (MDA 0.006)	ISO96-056

	SAMPLE ID	AMERICIUM 241 (pCi/g)	BATCH #
C-5	96L204402 SOIL	4.54 ± 0.24 (MDA 0.02)	ISO96-056
C-5	96L204402 SOIL D	6.49 ± 0.31 (MDA 0.01)	ISO96-056
C-5	96L204402 PIPE	0.090 ± 0.021 (MDA 0.012)	ISO96-056

RADIOCHEMISTRY REPORT  
ISOTOPIC ANALYSIS RESULTS BY ALPHA SPECTROMETRY

SAMPLE ID	URANIUM 238 (pCi/g)	BATCH #
A-1	C4745001 0.560 ± 0.061 (MDA 0.017)	ISO96-065
A-1 D	C4745001 D 0.588 ± 0.066 (MDA 0.049)	ISO96-065
B-5	C4746002 0.382 ± 0.051 (MDA 0.018)	ISO96-065
D-4	C4753009 0.586 ± 0.066 (MDA 0.019)	ISO96-065
D-7	C4755011 0.381 ± 0.052 (MDA 0.018)	ISO96-065
D-6	C4756012 0.544 ± 0.065 (MDA 0.053)	ISO96-065
E-3	C4757013 0.557 ± 0.065 (MDA 0.063)	ISO96-065
E-5	C4758014 0.555 ± 0.066 (MDA 0.065)	ISO96-065
E-7	C4759015 0.610 ± 0.070 (MDA 0.020)	ISO96-065
D-3	C4754010 0.594 ± 0.060 (MDA 0.015)	ISO96-069
B-3S	C4747003 0.552 ± 0.058 (MDA 0.042)	ISO96-069
B-3S D	C4747003 D *0.676 ± 0.075 (MDA 0.070)	ISO96-069
B-4S	C4748004 0.535 ± 0.062 (MDA 0.018)	ISO96-069
B-3SL	C4749005 0.470 ± 0.056 (MDA 0.056)	ISO96-069
B-4SL	C4750006 0.792 ± 0.070 (MDA 0.015)	ISO96-069
C-4	C4751007 0.513 ± 0.058 (MDA 0.017)	ISO96-069
C-7	C4752008 0.500 ± 0.054 (MDA 0.015)	ISO96-069

\* Passes at 3 sigma

SAMPLE ID	URANIUM 235 (pCi/g)	BATCH #
A-1	C4745001 0.025 ± 0.012 (MDA 0.017)	ISO96-065
A-1 D	C4745001 D 0.014 ± 0.010 (MDA 0.018)	ISO96-065
B-5	C4746002 0.033 ± 0.015 (MDA 0.018)	ISO96-065
D-4	C4753009 0.007 ± 0.016 (MDA 0.066)	ISO96-065
D-7	C4755011 0.027 ± 0.014 (MDA 0.018)	ISO96-065
D-6	C4756012 0.021 ± 0.016 (MDA 0.053)	ISO96-065
E-3	C4757013 0.034 ± 0.015 (MDA 0.019)	ISO96-065
E-5	C4758014 0.043 ± 0.017 (MDA 0.019)	ISO96-065
E-7	C4759015 0.045 ± 0.018 (MDA 0.020)	ISO96-065
D-3	C4754010 0.011 ± 0.008 (MDA 0.015)	ISO96-069
B-3S	C4747003 0.051 ± 0.017 (MDA 0.015)	ISO96-069
B-3S D	C4747003 D 0.023 ± 0.013 (MDA 0.020)	ISO96-069
B-4S	C4748004 0.040 ± 0.016 (MDA 0.018)	ISO96-069
B-3SL	C4749005 0.012 ± 0.012 (MDA 0.044)	ISO96-069
B-4SL	C4750006 0.034 ± 0.014 (MDA 0.015)	ISO96-069
C-4	C4751007 0.006 ± 0.014 (MDA 0.058)	ISO96-069
C-7	C4752008 0.016 ± 0.010 (MDA 0.015)	ISO96-069

S = SOIL  
SL = SLUDGE

RADIOCHEMISTRY REPORT  
ISOTOPIC ANALYSIS RESULTS BY ALPHA SPECTROMETRY

NODE	SAMPLE ID	URANIUM 233/234 (pCi/g)	BATCH #
A-1	C4745001	0.523 ± 0.059 (MDA 0.017)	ISO96-065
A-1D	C4745001 D	0.649 ± 0.070 (MDA 0.049)	ISO96-065
B-5	C4746002	0.421 ± 0.054 (MDA 0.018)	ISO96-065
D-4	C4753009	0.614 ± 0.069 (MDA 0.052)	ISO96-065
D-7	C4755011	0.340 ± 0.049 (MDA 0.018)	ISO96-065
D-6	C4756012	0.652 ± 0.072 (MDA 0.053)	ISO96-065
E-3	C4757013	0.763 ± 0.076 (MDA 0.052)	ISO96-065
E-5	C4758014	1.19 ± 0.10 (MDA 0.06)	ISO96-065
E-7	C4759015	0.843 ± 0.084 (MDA 0.056)	ISO96-065
D-3	C4754010	0.634 ± 0.062 (MDA 0.015)	ISO96-069
B-3S	C4747003	0.518 ± 0.056 (MDA 0.015)	ISO96-069
B-3S D	C4747003 D	0.488 ± 0.062 (MDA 0.020)	ISO96-069
B-4S	C4748004	0.488 ± 0.059 (MDA 0.018)	ISO96-069
B-3SL	C4749005	0.567 ± 0.060 (MDA 0.016)	ISO96-069
B-4SL	C4750006	0.821 ± 0.071 (MDA 0.015)	ISO96-069
C-4	C4751007	0.594 ± 0.063 (MDA 0.017)	ISO96-069
C-7	C4752008	0.594 ± 0.059 (MDA 0.015)	ISO96-069

S = SOIL  
SL = SLUDGE

RADIOCHEMISTRY REPORT  
 ISOTOPIC ANALYSIS RESULTS BY ALPHA SPECTROMETRY

	SAMPLE ID	PLUTONIUM-239/240 (pCi/g)	BATCH #
A-1	C4745001	0.079 ± 0.018 (MDA 0.026)	ISO96-065
A-1 D	C4745001 D	0.111 ± 0.021 (MDA 0.010)	ISO96-065
B-5	C4746002	0.021 ± 0.013 (MDA 0.040)	ISO96-065
D-4	C4753009	0.076 ± 0.020 (MDA 0.014)	ISO96-065
D-7	C4755011	0.053 ± 0.017 (MDA 0.014)	ISO96-065
D-6	C4756012	0.107 ± 0.022 (MDA 0.030)	ISO96-065
E-3	C4757013	0.025 ± 0.012 (MDA 0.032)	ISO96-065
E-5	C4758014	0.533 ± 0.051 (MDA 0.039)	ISO96-065
E-7	C4759015	0.197 ± 0.029 (MDA 0.026)	ISO96-065
D-3	C4754010	1.47 ± 0.12 (MDA 0.032)	ISO96-069
B-3S	C4747003	0.144 ± 0.028 (MDA 0.036)	ISO96-069
B-3S	C4747003 D	0.166 ± 0.027 (MDA 0.040)	ISO96-069
B-4S	C4748004	0.004 ± 0.009 (MDA 0.036)	ISO96-069
B-3SL	C4749005	0.023 ± 0.009 (MDA 0.009)	ISO96-069
B-4SL	C4750006	0.007 ± 0.008 (MDA 0.032)	ISO96-069
C-4	C4751007	0.086 ± 0.018 (MDA 0.026)	ISO96-069
C-7	C4752008	0.317 ± 0.038 (MDA 0.034)	ISO96-069

	SAMPLE ID	AMERICIUM 241 (pCi/g)	BATCH #
A-1	C4745001	0.066 ± 0.015 (MDA 0.009)	ISO96-065
A-1 D	C4745001 D	0.069 ± 0.019 (MDA 0.034)	ISO96-065
B-5	C4746002	0.080 ± 0.017 (MDA 0.024)	ISO96-065
D-4	C4753009	0.132 ± 0.028 (MDA 0.040)	ISO96-065
D-7	C4755011	0.068 ± 0.018 (MDA 0.037)	ISO96-065
D-6	C4756012	0.352 ± 0.044 (MDA 0.012)	ISO96-065
E-3	C4757013	1.48 ± 0.10 (MDA 0.03)	ISO96-065
E-5	C4758014	1.72 ± 0.11 (MDA 0.03)	ISO96-065
E-7	C4759015	0.370 ± 0.039 (MDA 0.024)	ISO96-065
D-3	C4754010	6.18 ± 0.34 (MDA 0.04)	ISO96-069
B-3S	C4747003	0.156 ± 0.025 (MDA 0.010)	ISO96-069
B-3S	C4747003 D	0.167 ± 0.026 (MDA 0.010)	ISO96-069
B-4S	C4748004	0.020 ± 0.009 (MDA 0.011)	ISO96-069
B-3SL	C4749005	0.029 ± 0.013 (MDA 0.034)	ISO96-069
B-4SL	C4750006	0.013 ± 0.013 (MDA 0.048)	ISO96-069
C-4	C4751007	0.065 ± 0.016 (MDA 0.026)	ISO96-069
C-7	C4752008	0.064 ± 0.017 (MDA 0.028)	ISO96-069

S = SOIL  
 SL = SLUDGE

RADIOCHEMISTRY REPORT  
ISOTOPIC ANALYSIS RESULTS BY ALPHA SPECTROSCOPY

## Quality Assurance/Quality Control Data

ANALYSIS		CSL CONTROL		CONTROL STANDARD (d/m/ml)	
BATCH #	DATE	ID NUMBER	ISOTOPE	OBSERVED VALUE	STANDARD VALUE
ISO96-065	7/30/96	CSL 610796	U-238	*10.9 ± 0.8	9.8 ± 0.5
ISO96-065	7/30/96	CSL 610796	U-233/234	10.4 ± 0.5	10.1 ± 0.5
ISO96-069	8/5/96	CSL 610796	U-238	10.6 ± 0.5	9.8 ± 0.5
ISO96-069	8/5/96	CSL 610796	U-233/234	10.0 ± 0.4	10.1 ± 0.5
ISO96-065	7/30/96	CSL 650165	PU-239/240	1.89 ± 0.12	2.04 ± 0.04
ISO96-069	8/5/96	CSL 650165	PU-239/240	1.89 ± 0.13	2.04 ± 0.04
ISO96-065	7/30/96	CSL 610720	AM-241	2.13 ± 0.13	2.02 ± 0.02
ISO96-069	8/5/96	CSL 610720	AM-241	*2.20 ± 0.20	2.02 ± 0.02

\* Passes at 3 sigma

## REAGENT BLANK

BATCH #	DATE	ID NUMBER	ISOTOPE	ACTIVITY	UNITS
ISO96-065	7/30/96	U96-501-065	U-238	0.000 ± 0.011	pCi/g
ISO96-065	7/30/96	U96-501-065	U-233/234	0.061 ± 0.022	pCi/g
ISO96-069	8/5/96	U96-544-069	U-238	0.020 ± 0.012	pCi/g
ISO96-069	8/5/96	U96-544-069	U-233/234	0.047 ± 0.020	pCi/g
ISO96-065	7/30/96	PU96-501-065	PU-239/240	0.014 ± 0.010	pCi/g
ISO96-069	8/5/96	PU96-544-069	PU-239/240	-0.004 ± 0.010	pCi/g
ISO96-065	7/30/96	AM96-501-065	AM-241	0.038 ± 0.012	pCi/g
ISO96-069	8/5/96	AM96-544-069	AM-241	0.000 ± 0.005	pCi/g

FORM 1D  
PESTICIDES/PCB ORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.  
**C4237009**

Lab Name: RFETS RADIOACTIVE ORGANIC LAB SDG NO: 96L2044

Matrix:	<u>SOIL</u>	Lab Sample ID:	<u>JUN203</u>
Sample wt/vol:	<u>9.91 (g/ml)</u>	Lab File ID:	<u>JUN203</u>
Concentrated Extrat Volume:	<u>10 ml</u>	Date Received:	<u>6/19/96</u>
Injection Volume:	<u>1.0 ul</u>	Date Extracted:	<u>6/20/96</u>
Dilution Factor:	<u>1</u>	Date Analyzed:	<u>6/20/96</u>

CAS NO.	COMPOUND	CONCENTRATION	UNITS:	ug/l
12674-11-2	Aroclor-1016	0.01		U
11104-28-2	Aroclor-1221	0.09		U
11141-16-5	Aroclor-1232	0.09		U
53469-21-9	Aroclor-1242	0.13		U
12672-29-6	Aroclor-1248	0.09		U
11097-69-1	Aroclor-1254	0.31		
11096-82-5	Aroclor-1260	0.17		U

RCRA Constituents

1A  
VOLATILE ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.

C4237004

Lab Name: RFETS - ROL Contract: NA  
 Project No.: NA Site: RFETS Location: B559 Group: ROL  
 Matrix: (soil/water) SOIL Lab Sample ID: VOAH02  
 Sample wt/vol: 2.0189 (g/mL) G Lab File ID: VOAH02.D  
 Level: (low/med) LOW Date Received: 6/19/96  
 % Moisture: not dec. Date Analyzed: 6/20/96  
 GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 2.5  
 Soil Extract Volume: \_\_\_\_\_ (uL) Soil Aliquot Volume: \_\_\_\_\_ (uL)

CAS No.	Compound	Concentration Units:		Q
		(ug/L or ug/Kg)	ug/Kg	
74-87-3	Chloromethane	25		U
75-01-4	Vinyl chloride	25		U
74-83-9	Bromomethane	25		U
75-00-3	Chloroethane	25		U
75-35-4	1,1-Dichloroethene	13		U
67-64-1	Acetone	10		JB
75-15-0	Carbon disulfide	13		U
75-09-2	Methylene chloride	2.9		JB
156-60-5	trans-1,2-Dichloroethene	13		U
75-34-3	1,1-Dichloroethane	13		U
156-59-2	cis-1,2-Dichloroethene	13		U
78-93-3	2-Butanone	25		U
67-66-3	Chloroform	13		U
71-55-6	1,1,1-Trichloroethane	13		U
56-23-5	Carbon tetrachloride	13		U
71-43-2	Benzene	13		U
107-06-2	1,2-Dichloroethane	13		U
79-01-6	Trichloroethene	13		U
78-87-5	1,2-Dichloropropane	13		U
75-27-4	Bromodichloromethane	13		U
10061-01-5	cis-1,3-Dichloropropene	13		U
108-10-1	4-Methyl-2-pentanone	25		U
108-88-3	Toluene	13		U
10061-02-6	trans-1,3-Dichloropropene	13		U
79-00-5	1,1,2-Trichloroethane	13		U
127-18-4	Tetrachloroethene	13		U
591-78-6	2-Hexanone	25		U
124-48-1	Chlorodibromomethane	13		U
108-90-7	Chlorobenzene	13		U
100-41-4	Ethylbenzene	13		U
	m,p-Xylene	13		U
95-47-6	o-Xylene	13		U
100-42-5	Styrene	13		U

**PRELIMINARY REPORT** 3/90  
**RESULTS NOT VALIDATED**



1E  
VOLATILE ORGANICS ANALYSIS DATA SHEET  
TENTATIVELY IDENTIFIED COMPOUNDS

SAMPLE NO.

C4237004

Lab Name: RFETS - ROL

Contract: NA

Project No.: NA

Site: RFETS

Location: B559

Group: ROL

Matrix: (soil/water) SOIL

Lab Sample ID: VOAH02

Sample wt/vol: 2.0189 (g/mL) G

Lab File ID: VOAH02.D

Level: (low/med) LOW

Date Received: 6/19/96

% Moisture: not dec.

Date Analyzed: 6/20/96

GC Column: DB-624

ID: 0.53 (mm)

Dilution Factor: 2.5

Soil Extract Volume: \_\_\_\_\_ (uL)

Soil Aliquot Volume: \_\_\_\_\_ (uL)

Concentration Units:

Number TICs found: 2

(ug/L or ug/Kg) ug/Kg

JUN-24-96 MON 13:38

CAS Number	Compound Name	RT	Est. Conc.	Q
1.	Carbon Dioxide	5.70	32	J
2.	Carbon Dioxide	5.93	54	J
3.				
4.				
5.				
6.				
7.				
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9.				
10.				
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28.				
29.				
30.				

FORM I VOA-TIC

**PRELIMINARY REPORT**  
**RESULTS NOT VALIDATED** 3/90

1A  
VOLATILE ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.

VBLK01

Lab Name: RFETS - ROL Contract: NA  
 Project No.: NA Site: RFETS Location: B559 Group: ROL  
 Matrix: (soil/water) SOIL Lab Sample ID: MBS0620  
 Sample wt/vol: 5.0 (g/mL) G Lab File ID: MBS0620.D  
 Level: (low/med) LOW Date Received: \_\_\_\_\_  
 % Moisture: not dec. \_\_\_\_\_ Date Analyzed: 6/20/96  
 GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0  
 Soil Extract Volume: \_\_\_\_\_ (uL) Soil Aliquot Volume: \_\_\_\_\_ (uL)

CAS No.	Compound	Concentration Units:		Q
		(ug/L or ug/Kg)	ug/Kg	
74-87-3	Chloromethane	10		U
75-01-4	Vinyl chloride	10		U
74-83-9	Bromomethane	10		U
75-00-3	Chloroethane	10		U
75-35-4	1,1-Dichloroethene	5		U
67-64-1	Acetone	2.2		J
75-15-0	Carbon disulfide	5		U
75-09-2	Methylene chloride	1.3		J
156-60-5	trans-1,2-Dichloroethene	5		U
75-34-3	1,1-Dichloroethane	5		U
156-59-2	cis-1,2-Dichloroethene	5		U
78-93-3	2-Butanone	10		U
67-66-3	Chloroform	5		U
71-55-6	1,1,1-Trichloroethane	5		U
56-23-5	Carbon tetrachloride	5		U
71-43-2	Benzene	5		U
107-06-2	1,2-Dichloroethane	5		U
79-01-6	Trichloroethene	5		U
78-87-5	1,2-Dichloropropane	5		U
75-27-4	Bromodichloromethane	5		U
10061-01-5	cis-1,3-Dichloropropene	5		U
108-10-1	4-Methyl-2-pentanone	10		U
108-88-3	Toluene	5		U
10061-02-6	trans-1,3-Dichloropropene	5		U
79-00-5	1,1,2-Trichloroethane	5		U
127-18-4	Tetrachloroethene	5		U
591-78-6	2-Hexanone	10		U
124-48-1	Chlorodibromomethane	5		U
108-90-7	Chlorobenzene	5		U
100-41-4	Ethylbenzene	5		U
	m,p-Xylene	5		U
95-47-6	o-Xylene	5		U
100-42-5	Styrene	5		U



1E  
VOLATILE ORGANICS ANALYSIS DATA SHEET  
TENTATIVELY IDENTIFIED COMPOUNDS

SAMPLE NO.

VBLK01

Lab Name: RFETS - ROL

Contract: NA

Project No.: NA

Site: RFETS

Location: B559

Group: ROL

Matrix: (soil/water) SOIL

Lab Sample ID: MBS0620

Sample wt/vol: 5.0 (g/mL) G

Lab File ID: MBS0620.D

Level: (low/med) LOW

Date Received: \_\_\_\_\_

% Moisture: not dec. \_\_\_\_\_

Date Analyzed: 6/20/96

GC Column: DB-624

ID: 0.53 (mm)

Dilution Factor: 1.0

Soil Extract Volume: \_\_\_\_\_ (uL)

Soil Allquot Volume: \_\_\_\_\_ (uL)

Concentration Units:

Number TICs found: 0

(ug/L or ug/Kg) ug/Kg

JUN-24-96 MON 13:39

CAS Number	Compound Name	RT	Est. Conc.	Q
1.				
2.				
3.				
4.				
5.				
6.				
7.				
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9.				
10.				
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12.				
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21.				
22.				
23.				
24.				
25.				
26.				
27.				
28.				
29.				
30.				

Lab Name: \_\_\_\_\_

Project No.: \_\_\_\_\_

Matrix: \_\_\_\_\_

Level: \_\_\_\_\_

Location: \_\_\_\_\_

GC Column: \_\_\_\_\_

ID: \_\_\_\_\_

Soil Extract Volume: \_\_\_\_\_

Soil Allquot Volume: \_\_\_\_\_

Date Received: \_\_\_\_\_

Date Analyzed: \_\_\_\_\_

FORM I VOA-TIC

**PRELIMINARY REPORT**  
**RESULTS NOT VALIDATED** 3/90

A. DENNIS

8244

GENERAL LABS PRELIMINARY RESULTS  
DATE: June 17, 1996 FROM: Carol Gies  
TO: Laura Johnson, APO

INFORMATION ONLY

TOTAL METALS

REPORT DATE: 17-JUN-1996

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

ANALYTICAL LABORATORIES  
SAMPLE NO.

INORGANIC ANALYSIS DATA SHEET

96L204403

Lab Name: BLDG. 881 GENERAL LABORATORIES

Matrix (soil/water): SOIL

SDG No.: JUN13A.386

Level (low/med): LOW

Lab Sample ID: 96L204403

% Solids (0.0 = N/A): 0.0 Date Taken: 11-JUN-1996 Date Received: 11-JUN-1996

JUN-17-96 MON 8:30

BLDG 881 ROOM 212

FAX NO. 303 966 3400

Concentration Units: mg/Kg

Cas No.	Analyte	Concentration	C	Q	M
7429-90-5	ALUMINUM	4340		*	P
7440-36-0	ANTIMONY	2.8	U	N	P
7440-38-2	ARSENIC	14.6	U		P
7440-39-3	BARIUM	37.2		*N	P
7440-41-7	BERYLLIUM	0.19	B		P
7440-43-9	CADMIUM	0.36	U		P
7440-70-2	CALCIUM	1300		*	P
7440-47-3	CHROMIUM	8.7		*	P
7440-48-4	COBALT	3.0	B		P
7440-50-8	COPPER	8.2			P
7439-89-6	IRON	9460			P
7439-92-1	LEAD	8.1	B		P
7439-93-2	LITHIUM	4.9	B		P
7439-95-4	MAGNESIUM	1320			P
7439-96-5	MANGANESE	143		*	P
7439-98-7	MOLYBDENUM	1.2	U		P
7440-02-0	NICKEL	2.9	B		P
7440-09-7	POTASSIUM	1310			P
7782-49-2	SELENIUM	5.2	U		P
7440-22-4	SILVER	2.9		N	P
7440-23-5	SODIUM	131	B	N	P
7440-24-6	STRONTIUM	12.2	B		P
7440-28-0	THALLIUM				NR
7440-31-5	TIN	2.0	U		P
7440-32-6	TITANIUM	277			P
11-09-6	URANIUM	12.0	U		P
7440-62-2	VANADIUM	17.0		N	P
7440-66-6	ZINC	26.6			P

20 TCLP

Color Before: BROWN  
Color After: YELLOW

Clarity Before: OPAQUE  
Clarity After: CLEAR

Texture:  
Artifacts:

Comment: Results are reported for a two-fold dilution of the sample made at the time of analysis for matrix effects.

Thallium is not reported for this sample because the thallium channel for the ICPEs is not functioning.

**APPENDIX B**  
**SAMPLE LOCATIONS AND DEPTHS**



Date	Node	Depth	Elevation	Field Survey	Gross Alpha pCi/g	Gross Beta pCi/g	Pu 239/240 pCi/g	Am 241 pCi/g
6/11/96	C-5	9'	5923'	<5000 CPM	45	26	1.72	6.49
6/18/96	C-3	12'	5924'	<5000 CPM	159	13	4.5	18.1
7/16/96	E-3	5'	5917'	BACKGROUND	20	24	0.025	1.48
7/16/96	E-5	2'	5914'	BACKGROUND	24	23	0.533	1.72
7/16/96	E-7	1'	5912'	BACKGROUND	17	23	0.197	0.37
7/16/96	D-6	5'	5817'	BACKGROUND	15	21	0.107	0.352
7/17/96	D-3	7'	5919'	BACKGROUND	29	24	1.47	6.18
7/17/96	D-4	7'	5919'	BACKGROUND	16	24	0.076	0.132
7/17/96	D-7	4'	5916'	BACKGROUND	14	20	0.053	0.068
7/17/96	B-4	12'	5928'	BACKGROUND	16	24	0.004	0.02
7/17/96	B-5	12'	5927'	BACKGROUND	16	19	0.021	0.08
7/18/96	B-3	12'	5927'	BACKGROUND	15	26	0.144	0.156
7/18/96	C-4	11'	5923'	BACKGROUND	12	22	0.086	0.065
7/18/96	C-7	8'	5920'	BACKGROUND	12	23	0.317	0.064
7/16/96	A-1	12'	5931'	BACKGROUND	14	23	0.079	0.066

**APPENDIX C**  
**GROUNDWATER RESULTS**



## Facsimile Transmission

Attention: MARY AYCOCK

Company:

Telephone #: 5309

Fax #: 8244

Subject:

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Sender: BILL HAYES

Sender Telephone #: 2181

Sender Fax #: 2623

You should receive \_\_\_\_\_ pages, including this cover sheet. If you do not receive all the pages, please call the number above.

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COMMENTS: MARY —

LAB REPORT # 96L2133 IS FOR THE  
SAMPLE TAKEN 6/11 AT OUG NEAR B995.

# 96L2144 WAS TAKEN 6/18 AT

BLDG. 988 (WEST PIT). IF YOU

NEED MORE INFO CALL IAN PATON AT XZ680

(I'LL BE ON VACATION UNTIL AUG. 5)

BILL HAYES





**APPENDIX D**

**ACTION LEVELS FOR RADIOACTIVE NUCLIDES IN SOILS FOR THE  
ROCKY FLATS CLEANUP AGREEMENT**

*R.S. Roberts*

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**ACTION LEVELS FOR RADIONUCLIDES IN SOILS  
FOR THE  
ROCKY FLATS CLEANUP AGREEMENT**

**PRELIMINARY DRAFT**

**US DEPARTMENT OF ENERGY  
US ENVIRONMENTAL PROTECTION AGENCY  
COLORADO DEPARTMENT OF PUBLIC HEALTH AND THE ENVIRONMENT**

**JUNE 27, 1996**

REVIEWED FOR CLASSIFICATION

BY S. L. CUNNINGHAM

Date 6/26/96 *CMU*  
*Public Release ok*

**TABLE ES-1  
SOIL ACTION LEVELS**

**Tier I Action Level - Hypothetical Resident**

Radionuclide	Hypothetical Resident Tier I Action Level 85 mrem (a) (pCi/gram)	Hypothetical Resident Tier I Action Level Ratio Sum to 85 mrem (b) (pCi/gram)
Americium-241	229	145
Plutonium-239/240	2001	728
Uranium-234	2042	
Uranium-235	136.8	
Uranium-238	613.9	

**Tier I Action Level - Office Worker**

Radionuclide	Office Worker Tier I Action Level 15 mrem (pCi/gram)	Office Worker Tier I Action Level Ratio Sum to 15 mrem (a) (pCi/gram)
Americium-241	227.7	130.8
Plutonium-239/240	1536	653.9
Uranium-234	2003	
Uranium-235	114.7	
Uranium-238	533.6	

**Tier II Action Level - Hypothetical Resident**

Radionuclide	Hypothetical Resident Tier II Action Level 15 mrem (pCi/gram)	Hypothetical Resident Tier II Action Level Ratio Sum to 15 mrem (a) (pCi/gram)
Americium-241	40.4	25
Plutonium-239/240	353.2	128
Uranium-234	360.4	
Uranium-235	24.1	
Uranium-238	108.3	

(a) - This applies to single radionuclides only which does not exist at RFETS. The "Sum of Ratios" method will be applied at RFETS so that multiple radionuclides are correctly assessed.

(b) - This assumes that the Am-241/Pu-239 activity ratio equals 0.20 and that only Pu-239 and Am-241 are present

**DRAFT DATA  
FOR THE OU9 EXCAVATION OF SOILS**

**SAMPLE DATA**

RADIOISOTOPES (pCi/gram)	Sample Number (1)																				
	A-1	A-1 D	B-5	D-4	D-7	D-6	E-3	E-5	E-7	D-3	B-3S	B-3SD	B-4S	B-3SL	B-4SL	C-4	C-7	C-3	C-5	C-5 D	C-5 P
Americium-241	0.066	0.069	0.080	0.132	0.068	0.352	1.480	1.720	0.370	6.180	0.156	0.167	0.020	0.029	0.013	0.065	0.064	18.10	4.540	6.490	0.090
Plutonium-239/240	0.079	<del>0.079</del>	0.021	0.076	0.053	0.107	0.025	0.533	0.197	<del>0.197</del>	0.144	0.166	0.004	0.023	0.007	0.086	0.317	<del>0.317</del>	1.980	<del>1.980</del>	0.024
Uranium-234	0.523	0.649	0.421	0.614	0.340	0.652	0.763	1.190	0.843	0.634	0.518	0.488	0.488	0.567	0.821	0.594	0.594	0.971	0.571	0.216	0.906
Uranium-235	0.025	0.014	0.033	0.007	0.027	0.021	0.034	0.043	0.045	0.011	0.051	0.023	0.040	0.012	0.034	0.006	0.016	0.025	0.017	0.019	0.032
Uranium-238	0.560	0.588	0.382	0.586	0.381	0.544	0.557	0.555	0.610	0.594	0.552	0.676	0.535	0.470	0.792	0.513	0.500	0.589	0.624	0.411	0.906

(1) - S = Soil; SL = Sludge; D = Duplicate; P = Pipe

**DRAFT SUMMARY STATISTICS  
FOR THE OU9 EXCAVATION OF SOILS**

**SUMMARY STATISTICS**

Radionuclides (pCi/gram)	Minimum	Maximum	Mean	Standard Deviation	Number of Samples	Background Mean + 2*Sigma (1)	95% Confidence Interval (2)	95% UCL Concentration (3)
Americium-241	0.01	18.10	1.92	4.22	21	0.023	1.807	3.723
Plutonium-239/240	0.00	4.50	0.52	1.04	21	0.066	0.446	0.966
Uranium-234	0.22	1.19	0.64	0.22	21	2.253	(4)	(4)
Uranium-235	0.01	0.05	0.03	0.01	21	0.094	(4)	(4)
Uranium-238	0.38	0.91	0.57	0.12	21	2.000	(4)	(4)

(1) - From Radiological Engineering Procedure REP-1006, "Radiological Characterization of Bulk or Volume Materials"

(2) - Based on a normal distribution

(3) - This represents the 95% Upper Confidence Level on the mean concentration

(4) - The maximum concentration is not above background so an action level comparison is not required for these radionuclides

## DRAFT TIER I ACTION LEVEL COMPARISON FOR THE OU9 EXCAVATION OF SOILS

### 85 mrem Residential Action Level Comparison

Radionuclide	Action Level (pCi/gram)	95% UCL Activity (pCi/gram)	Activity to Action Level Ratio
Americium-241	229	3.723	1.63E-02
Plutonium-239	2001	0.966	4.83E-04
TOTAL			1.67E-02

## DRAFT TIER II ACTION LEVEL COMPARISON FOR THE OU9 EXCAVATION OF SOILS

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### 15 mrem Residential Action Level Comparison

Radionuclide	Action Level (pCi/gram)	95% UCL Activity (pCi/gram)	Activity to Action Level Ratio
Americium-241	40.4	3.723	9.22E-02
Plutonium-239	353.2	0.966	2.73E-03
TOTAL			9.49E-02

**APPENDIX E**  
**LABORATORY ANALYTICAL METHODS**

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## CASE NARRATIVE

SDG NUMBER: 96L2568  
DATE: 07/30/96  
DATA PACKAGE: RADIOCHEMISTRY GROSS ALPHA/BETA ANALYSIS REPORT

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### SAMPLE DESCRIPTIONS:

<u>APO ID</u>	<u>Bottle #</u>	<u>LIMS #</u>
C4745-001	96L2568-01	117301
C4746-002	96L2568-02	117376
C4747-003	96L2568-03	117436
C4748-004	96L2568-04	117434
C4749-005	96L2568-05	117437
C4750-006	96L2568-06	117435
C4751-007	96L2568-07	117439
C4752-008	96L2568-08	117438
C4753-009	96L2568-09	117371
C4754-010	96L2568-10	117372
C4755-011	96L2568-11	117373
C4756-012	96L2568-12	117304
C4757-013	96L2568-13	117305
C4758-014	96L2568-14	117303
C4759-015	96L2568-15	117302

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### Method Summary

Gross alpha and gross beta activities are measured by evaporating an aliquot of the prepared sample onto a counting planchet and counting the alpha and beta activities in a low background, thin-windowed, gas flow proportional counter. Organics or combustible solids are ashed, the residue dissolved in acid, and the solution or an aliquot of the solution is evaporated onto a counting planchet. Aqueous samples are concentrated and then evaporated onto a counting planchet. Soil and sludge samples are initially prepared for analysis as described in L-6298, "Initial Preparation of Soils, Sludges, and Sediment for Dissolution." Analysis of aqueous samples and prepared non-aqueous samples is described in detail in Rocky Flats Procedure, L-6240, "Sample Preparation for Analysis of Gross Alpha-Gross Beta Activity in Aqueous Samples." Preparation of oils, solvents and other combustible organics is described in L-6194, "Preparation of Oils and Solvents for Analysis of Gross Alpha and Gross Beta Activity." The counting procedure is described in procedure L-6295, "Operation of the Tennelec LB4100 Gas Proportional Counters."

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#### Method Summary (continued)

The detector counting efficiency and self-absorption effects of the salt residue on the planchet are determined from calibration curves which are generated by counting several planchets prepared with a known amount of alpha or beta activity and increasing amounts of salt (0 to 100 mg). Americium-241 is used as the spike for the alpha curves and a solution of Sr-90, Y-90 is used for the beta curves. These standards are traceable to the National Institute of Standards Technology (NIST).

The theoretical minimum detectable activity (MDA) for the analysis is based on the detector background, detector efficiency and self-absorption effects, count time and quantity of sample analyzed. The MDA for each analysis is calculated and is also reported. If the reported result is based on the average of two or more counts, the average MDA is reported.

#### Quality Control Summary

A sample batch consists of eleven or fewer samples, a duplicate of one of the samples, an alpha and a beta laboratory control sample, and a preparation blank. Each set of samples forms a "QC Batch" and is assigned a QC batch number. A sample can be traced back to its corresponding quality control samples through the QC Batch number.

The preparation blank (PB), an aliquot of deionized, distilled water, is prepared and analyzed with the samples to confirm that the samples were not contaminated during the analysis. The activities reported for samples and standards were not corrected for preparation blank activity.

The alpha and beta laboratory control samples are aqueous standards of <sup>241</sup>Am and <sup>90</sup>Sr, respectively. The standards are prepared by RFETS Chemistry Standards Laboratory (CSL) and are NIST traceable.

The duplicate, designated as the sample ID followed by a "D", is a second aliquot of one of the samples in the QC Batch which is carried through the procedure as a separate sample. If the duplicates for any QC Batches referred to in this report were performed on samples other than those in this report, the Narrative section will reference the report which contains the data from the duplicate analysis.

The instrument QC includes determining instrument backgrounds weekly, counting a control standard on each detector weekly, and counting an instrument check source daily on the Tennelec LB4100 multidetector gas proportional counters. The instrument backgrounds are based on the average of at least five, and normally ten or more, 4 hour counts. The control standard, prepared from an EPA-EMSL-LV crosscheck sample, is counted weekly to verify the accuracy of the calibration curves and instrument backgrounds. Instrument check sources are counted daily to verify that the efficiencies of the detectors have not changed. This information is available in the laboratory archives.

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### Significant Figures

The results are reported to the nearest 0.01 pCi for activities less than 0.1 pCi, to the nearest 0.1 pCi for activities from 0.1 to 1 pCi and to the nearest 1 pCi or pCi for activities from 1 to 99 pCi. The measurement uncertainties, denoted as +/-, are reported at 2 sigma, unless otherwise noted.

### Definition of Data Qualifiers

Data qualifiers have not been defined for reporting radiochemical data.

### Exceptions or Deviations to Base Methods

The procedure is based on EPA SW-846 methods. Analysis of sample matrices other than aqueous samples is not discussed in SW-846. Preparation methods for other sample matrices will be discussed in the Narrative section of the report, if necessary.

### Narrative

These samples were analyzed using procedures L-6298, "*Initial Preparation of Soils, Sludges, and Sediment for Dissolution*", and L-6240, "*Sample Preparation for Analysis of Gross Alpha-Gross Beta Activity in Aqueous Samples*." The counting procedure is described in procedure L-6295, "*Operation of the Tennelec LB4100 Gas Proportional Counters*." Activities are based on dry weight of sample.

The samples were analyzed in QC batches 96AB144 and 96AB147. There were no problems noted with these analyses and all QC data were acceptable.

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RADIOCHEMISTRY ISOTOPICS REPORT

SDG NUMBER: 96L2568

DATE: 07-30-96

Method summary

Depending upon the sample matrix, pretreatment of the sample (as determined by the responsible chemist) may be required to obtain an aqueous solution which is necessary to perform the isotopic separation chemistry. Plutonium (Pu-239,240), uranium (U-233,234, U-235 and U-238) and americium (Am-241) isotopes are separated from the prepared sample using ion-exchange and chromatographic extraction techniques, followed by electrodeposition onto counting planchets, and analyzed by alpha spectrometry. Each sample is spiked with a Chemistry Standards Laboratory (CSL) certified tracer of an isotope (Pu-242, U-232 or Cm-244) which behaves chemically identical to the analyte (Pu-239, U-234, -235, -238 or Am-241) and whose alpha energy can be isolated with no other alpha interference's. Procedure L-6235, "Isolation of Plutonium, Americium and Uranium From Aqueous Samples" and L-6266, "Analysis of U, Pu, and Am in Soil/Sludge, Sediment by Ion Chromatography and Extraction Chromatography," are used to perform the isotopic separations. The areas of the tracer and analyte peaks or regions of interest are ratioed and the analyte activity in disintegrations per minute (dpm) is solved from the proportion. All analyte and tracer peak areas in counts per minute (cpm) are corrected for the detector background cpm in the particular region of interest. In addition, since the standard tracers are not isotopically pure and may contain small quantities of the analyte, a preparation blank is required with each batch of samples for each analyte. The blank consists of the tracer aliquot only, and from it, the amount of interferant is quantitated. The sample's analyte activity in dpm is then corrected for the preparation blank and the result in Pico-curies per liter or per gram (pCi/L or pCi/g) is calculated using the blank corrected dpm and the sample volume or weight analyzed. For Environmental Restoration samples the blank consists of the tracer aliquot only, and from it, the amount of interferant is quantitated, but the sample results are not blank corrected. However the blank results are reported.

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RADIOCHEMISTRY ISOTOPICS REPORT

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Quality Control Summary

The samples are analyzed in batches where each batch consists of a maximum of 9 samples, a preparation blank, a CSL certified control and a laboratory duplicate (at least 10 percent of the samples are analyzed in duplicate). Again, each of these is spiked with a known quantity of standard tracer. The batch in which a sample was analyzed is denoted by the "Batch #" and all quality control samples are traceable to any particular sample by the QC batch number.

The MDA (minimum detectable activity) for this analytical method is dependent on the uncertainty of the preparation blank activity, for Environmental Restoration samples the MDA for this analytical method is dependent on the detector background. Both methods are also dependent on detector efficiency, chemical recovery and volume or weight of sample analyzed. The chemical recovery represents the percentage of standard tracer that was recoverable through the sample preparation process. The result uncertainty is calculated by propagation of the uncertainties due to counting statistics of the sample and of the preparation blank. The uncertainties are stated at the two sigma level.

Significant Figures

The results and uncertainties are reported in pCi/l or pCi/g as follows:

<u>Sample Raw Result</u>	<u>Reported Sample Result and Uncertainty</u>
<1.0	nearest thousandth digit (0.001)
1.0 to 9.9	nearest hundredth digit (0.01)
10.0 to 99.9	nearest tenth digit (0.1)
100.0 to 999.9	nearest 1's digit (whole number)
1000 to 9999	nearest 10's digit

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RADIOCHEMISTRY ISOTOPICS REPORT

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#### Report Format Description

The sample isotopic activities and uncertainties are reported in the "Isotopic Analysis Results" section of the report. The result uncertainty in pCi/L or pCi/g is designated as the "+/-" value and represents the uncertainty at the 2 sigma level. The letter "D" prefix indicates a field duplicate sample (a sample which is taken in duplicate while in the field). This differs from a laboratory duplicate which is a sample analyzed in duplicate.

The associated QA/QC results for the CSL controls analyzed in each respective batch number are reported in the "Quality Assurance/Quality Control Data" section of the report. The "Analysis Date" refers to the date the analysis was completed.

#### Definition of Data Qualifiers

There are no data qualifier symbols defined for Radiochemistry. All qualified data are explained in the narrative section of this report. Qualified results may be flagged with "\*" followed by an explanation.

#### Exceptions or Deviations to Base Methods

Depending upon the sample matrix and if there are solids or particulates present, deviations from procedure L-6235 or L-6266 may be required. These deviations are detailed in a procedure filed with the raw data.

#### Narrative for 96L2568

Fifteen OU9 Soil sample was delivered to the lab for the analysis of Plutonium, Americium and Uranium. The soils were run according to procedure L-6266, and L-6235. The samples were split into two batches. This report will be amended at a later time to include the batch currently being run. MDAs are slightly elevated due to the small sample size of 0.5 grams. This however does not affect the results of the analysis due to the values being above the reported MDA. Samples are reported in dry weight. Wet to dry ratios can be

