COMPLETION REPORT

Former Hazardous Waste Management Facility
Perimeter Area
Soil Remediation

Brookhaven National Laboratory
Upton, New York

December 2009

Prepared for:
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Executive Summary

Radiological contamination was identified in surface soil in the perimeter area of the former HWMF (near Brookhaven Avenue) in 2005, referred to herein as the former HWMF Perimeter Area. Additional investigation identified radiological contamination within an area of 18,750 ft^2 (1,750 m^2) north of Brookhaven Avenue, referred to herein as the contiguous area, as well as in eleven discrete locations within wooded areas adjacent to the northeastern, northwestern, and southeastern corners of the former HWMF boundaries. The contamination is believed to be a result of historical operations associated with the transfer of wastes to the former HWMF and historical stormwater runoff from contaminated soils within the facility.

The cleanup of the former HWMF Perimeter Area was performed as a non-time-critical removal action authorized by the *Final Action Memorandum, Removal Action for Contaminated Soil from the Former Hazardous Waste Management Facility Perimeter Area* (June, 2009). The cleanup of this area used the same cleanup goals and methodology required for radiologically contaminated soils in the Operable Unit (OU) I Record of Decision (ROD).

The soil cleanup objectives for radiological contamination were based on a dose, from remaining concentrations of all radionuclides present, of less than or equal to 15 millirem per year (mrem/year) above background to a resident (non-farmer) after 50 years of institutional control.

Soil remediation activities for the former HWMF Perimeter Area commenced in June, 2009 and were completed in November, 2009. The following summarizes the as-left conditions at the former HWMF Perimeter Area and how they satisfy the requirements of the OU I ROD:

- The average Cs-137 and Ra-226 concentrations within the contiguous area following remediation are 4.38 picocurie per gram (pCi/g) and 0.65 pCi/g, respectively. Sr-90 concentrations were below laboratory detection limits (1.1 PCi/g). The as-left average concentrations are well below the site cleanup goals (Cs-137=23 pCi/g, Sr-90=15 pCi/g and Ra-226=5pCi/g). The maximum concentrations for the contiguous area survey unit were as follows: 11.0 pCi/g Cs-137, <1.1 pCi/g Sr-90, and 0.76 pCi/g Ra-226.

- The as-left concentrations for discrete areas that were located outside of the contiguous area but within the scope of this project were below the site cleanup goals. The maximum concentrations for discrete areas were as follows: 15.10 pCi/g Cs-137, <1.1 pCi/g Sr-90, and 0.593 Ra-226.

- Chemical results for soil samples analyzed for mercury and lead also indicated that residual soil concentrations for these contaminants are within the respective

cleanup goals, i.e., 400 mg/kg for lead and 1.84 mg/kg for mercury. Soil sample results from the contiguous area and discrete areas ranged from 9.86 mg/kg to 13.0 mg/kg for lead and were below laboratory detection limits for mercury.

- The maximum projected dose to a resident (non-famer) after 50 years of institutional controls is 5.6 millirem/yr. The maximum projected dose to an industrial worker with no decay time is 3.1 millirem/yr. The results of the dose assessment are below the dose objective of 15 millirem/yr and the New York State Department of Environmental Conservation ALARA goal of 10 millirem/yr established in the Action Memorandum.

- Site restoration was completed at the former HWMF Perimeter Area in December 2009. Restoration included backfilling with topsoil, re-grading, and reseeding the site with Long Island native grasses.

The planned scope for the former HWMF Perimeter Area meets all of the completion requirements specified in Office of Solid Waste and Emergency Response (OSWER) Directive 9320.2-09-A-P, *Closeout Procedures for National Priorities List Sites*. Additional contamination was identified outside the planned scope area and will be addressed separately. Post remediation operation and maintenance activities at the former HWMF Perimeter Area will be performed by BNL's Groundwater Protection (formerly Long Term Response Action) Group to ensure that land uses remain protective of public health and the environment. These activities will include institutional controls (land use controls, notifications and restrictions, work planning controls such as digging permits, and government ownership). The topsoil cover, placed during site restoration to bring the site back to original grades, will also be inspected for signs of erosion.

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ACRONYM LIST

AF	Area Factor
ALARA	As Low As Reasonably Achievable
AOC	Area of Concern
AM	Action Memorandum
ARRA	American Recovery and Reinvestment Act
BGRR	Brookhaven Graphite Research Reactor
BNL	Brookhaven National Laboratory
BSA	Brookhaven Science Associates
CAC	Community Advisory Council
CDM	CDM Federal Programs
CPM	Counts Per Minute
CERCLA	Comprehensive Environmental Response, Compensation & Liability Act
CY	Cubic Yards
DAC-Hr	Derived Air Concentration-Hour
DOE	Department Of Energy
EMC	Elevated Measurement Comparison
EPA	United States Environmental Protection Agency
EPD	Environmental Protection Division
ERP	Environmental Restoration Projects
FS	Feasibility Study
FSS	Final Status Survey
GEL	General Engineering Laboratory
GPS	Global Positioning System
HFBR	High Flux Beam Reactor
HWMF	Hazardous Waste Management Facility
IAG	Interagency Agreement
IH	Industrial Hygiene
ISOCS	In Situ Object Counting System
IVS	Independent Verification Survey
JRA	Job Risk Assessment
LUCMP	Land Use Controls Management Plan
M^2	Square Meter
mg/kg	Milligrams per Kilograms
MARSSIM	Multi-Agency Radiological Survey and Site Investigation Manuel
Mrem/yr	millirem per year
NaI	Sodium Iodide
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
ORISE	Oak Ridge Institute for Science and Education
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PCB	Polychlorinated Biphenyl
pCi/g	Picocuries per Gram
PPE	Personal Protection Equipment

QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RCD	Radiological Controls Division
RCT	Radiological Controls Technician
RDIP	Remedial Design Implementation Plan
RESRAD	Residual Radioactivity Computer Code
RI	Remedial Investigation
ROD	Record of Decision
SCDHS	Suffolk County Department of Health Services
SI	Supplemental Investigation
RWP	Radiological Work Permit
SAIC	Science Application International Corporation
SOP	Standard Operating Procedure
SU	Survey Unit
TAGM	Technical and Administrative Guidance Memorandum
TCLP	Toxicity Characteristic Leaching Procedure
TLD	Thermoluminscent Dosimeter
UIC	Underground Injection Control
URS	URS Corporation
USC	United States Code
WAC	Waste Acceptance Criteria
WCS	Waste Confirmation Sample
WLA	Waste Loading Area
WP	Work Procedure

1.0 INTRODUCTION

1.1 Purpose

The purpose of this completion report is to document remedial activities completed at the former Hazardous Waste Management Facility (HWMF) Perimeter Area, Brookhaven National Laboratory (BNL), performed with funding under the American Recovery and Reinvestment Act (ARRA) and in accordance with *Closeout Procedures at National Priority List Sites, OSWER Directive 9320.2-09A-P* (EPA, 2000a). Activities include:

- The excavation of contaminated soil above site cleanup goals;
- The results of the final status survey (FSS) and sampling, including Oak Ridge Institute for Science and Education (ORISE) independent verification survey (IVS) and sampling results;
- The post closure dose assessment in accordance with the Residual Radioactivity Computer Code (RESRAD);
- The characterization and disposal of soil and debris at Energy Solutions Disposal Facility of Clive, Utah; and
- Site restoration.

Remedial activities at the former HWMF Perimeter Area were performed by BNL's Environmental Restoration Projects (ERP), ERP seconded and task order subcontractors, Brookhaven Science Associates (BSA) Radiological Control Division (RCD) and Environmental Protection Division (EPD) personnel. Verification radiological surveys and sampling were performed by the Oak Ridge Institute for Science and Education (ORISE).

Work was performed in accordance with the Operable Unit (OU) I Record of Decision (ROD) and the *Final Action Memorandum, Removal Action for Contaminated Soil from the Former Hazardous Waste Management Facility Perimeter Area* (June, 2009). The final status survey (FSS) was performed in accordance with the *Former Hazardous Waste Management Facility Perimeter Area Field Sampling Plan* (BNL, June 2009). This remedial work is identified throughout this document as the Former HWMF Perimeter Area Project.

The scope of work for the Former HWMF Perimeter Area Project included the following:

- Remove radiologically contaminated soils above prescribed cleanup goals as identified in "*Investigation and Characterization of the Brookhaven Avenue Cs-137 Contamination*" (BNL, 2007);
- Package, transport, and dispose of radiologically and chemically contaminated soils and debris at an off-site permitted facility;
- Collect and analyze discrete area endpoint samples to ensure cleanup goals have been achieved;

- Perform Final Status Survey;
- Perform site restoration; and
- Prepare a dose assessment and a completion report.

1.2 Site Description and Operational History

BNL site is located in Suffolk County, New York, and is comprised of approximately 5,320 acres. Approximately 1,650 acres are developed. The U.S. Army occupied the BNL site, formerly Camp Upton, during World Wars I and II. Between the wars, the Civilian Conservation Corps operated the site. It was transferred to the Atomic Energy Commission in 1947, to the Energy Research and Development Administration in 1975, and to the U.S. DOE in 1977. A map illustrating the location of the BNL site is presented as Figure 1-1.

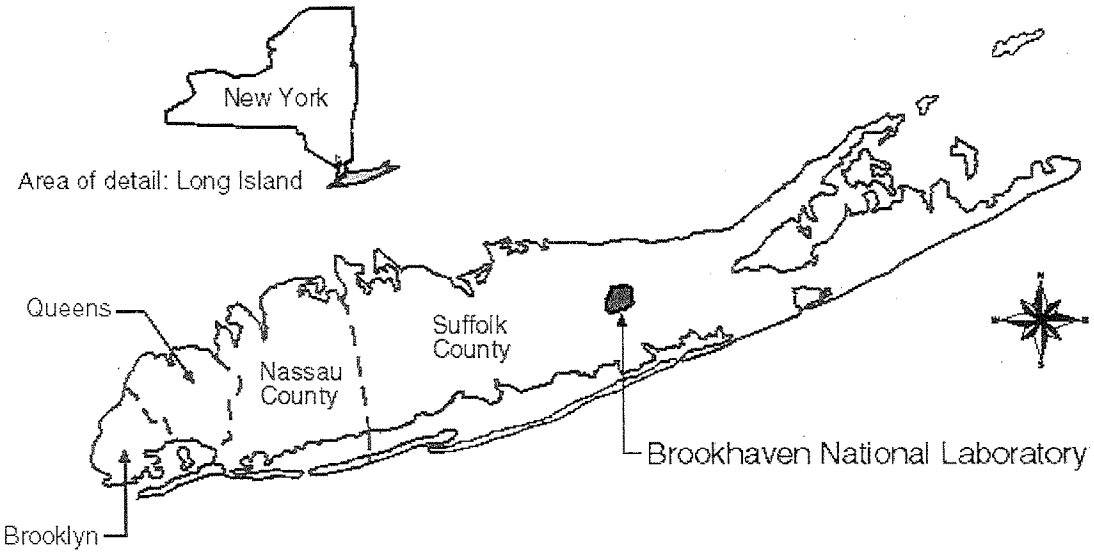

Figure 1-1. Location of Brookhaven National Laboratory

The former HWMF, which comprises about 12 acres, is located in the southeastern portion of the BNL site (Figure 1-2). It was used from the 1940s to 1997 as the central receiving facility for processing, limited treatment (neutralization), and storage of radioactive waste, hazardous waste, and mixed waste generated at BNL. The former HWMF operated as a Resource Conservation and Recovery Act (RCRA) permitted facility from 1992 until it underwent RCRA closure in 1998. As a result of several spills of hazardous and radioactive materials during operations at the former HWMF, the soils became contaminated with levels of cesium-137 (Cs-137), strontium-90 (Sr-90), mercury, and lead. Remediation of the former HWMF was completed in September, 2005, as documented by *Former Hazardous Waste Management Facility Soil Remediation Closeout Report* (Envirocon, September 2005).

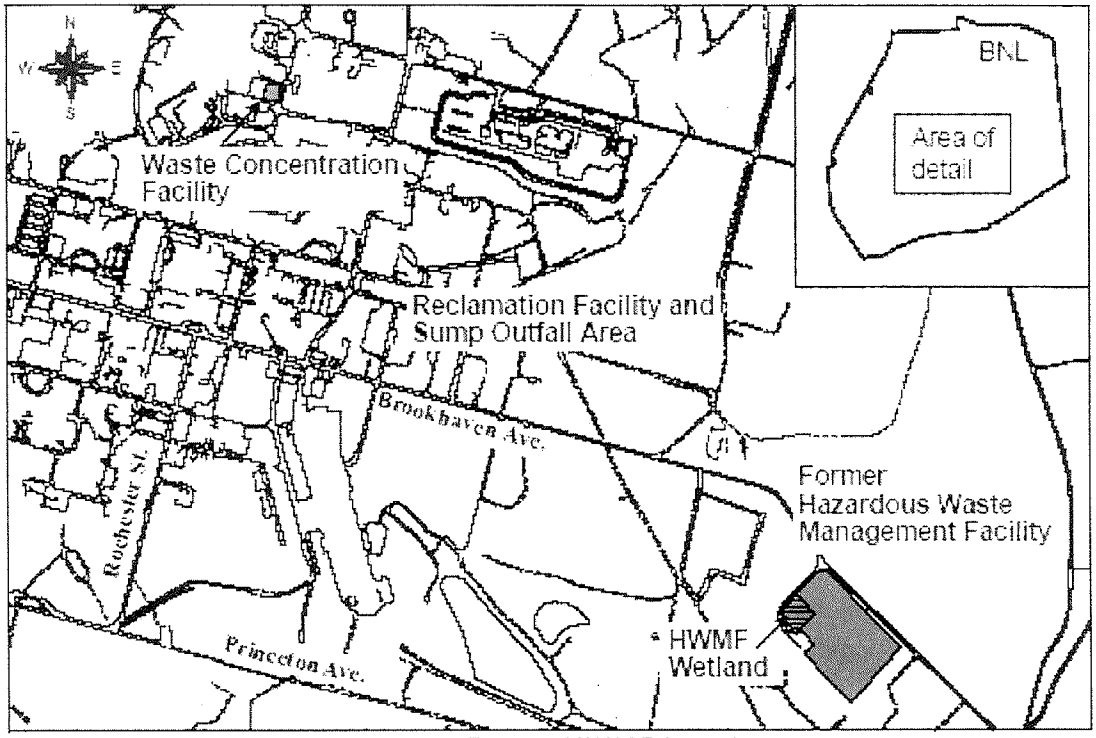

Figure 1-2 Former HWMF Location

In 2005, approximately two acres were segregated from the former HWMF and were designated as the Waste Loading Area (WLA). The remediation of the WLA soils was completed in 2008, as documented by *High Flux Beam Reactor Waste Loading Area Area of Concern 31 Soil Remediation Completion Report*, (BNL, June 2009). The WLA has been designated as a staging area for loading bulk waste into railcars from the Former HWMF, Building 811 and Brookhaven Graphite Research Reactor (BGRR) Projects.

Radiological contamination was identified in surface soil in the perimeter area of the former HWMF (near Brookhaven Avenue) as the result of a radiological walkover survey that was performed in 2005. The contamination is believed to be a result of historical operations associated with the transfer of wastes to the former HWMF and historical stormwater runoff from contaminated soils within the facility. Additional site investigations relative to the former HWMF Perimeter Area (*Investigation and Characterization of the Brookhaven Avenue Cs-137 Contamination,* BNL, 2007), as well as the extent of soil contamination and site cleanup criteria are discussed in subsequent sections of this report.

1.3 Regulatory and Enforcement History

In 1980, the BNL site was placed on New York State's Department of Environmental Conservation (NYSDEC) list of Inactive Hazardous Waste Sites. On December 21, 1989, the BNL site was included on the U.S. Environmental Protection Agency (EPA)

National Priorities List because of soil and groundwater contamination that resulted from BNL's past operations. Subsequently, the EPA, NYSDEC, and DOE entered into a Federal Facilities Agreement (herein referred to as the Interagency Agreement; [IAG]) that became effective in May 1992 (Administrative Docket Number: II-CERCLA-FFA-00201) to coordinate the cleanup.

The IAG identified AOCs that were grouped into OUs to be evaluated for response actions. The IAG required a Remedial Investigation/Feasibility Study (RI/FS) for OU I, pursuant to 42 United States Code (USC) 9601 et. seq., to meet Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) requirements. OU I consists of areas of soil contamination at the BNL site where waste was historically managed or disposed, including the former HWMF. The OUs and AOCs identified by the IAG are discussed further in Sections 1.6 and 2.0.

Upon completion and review of the results of a Remedial Investigation (RI) and Feasibility Study (FS) for OU I, the OU I Record of Decision (ROD) was signed in August, 1999. The OU I ROD specified the excavation and off-site disposal of radiologically and chemically contaminated soils.

The decision to complete the removal of radiologically contaminated soil from the former HWMF Perimeter Area Project was documented by the *Final Action Memorandum, Removal Action for Contaminated Soil from the Former Hazardous Waste Management Facility Perimeter Area* (June, 2009). The memorandum specified that the residential cleanup goals for radiologically contaminated soils in the OU I ROD be used for the former HWMF Perimeter Area Project.

1.4 Site Investigation

A radiological walkover survey performed in 2005 identified contamination the former HWMF Perimeter Area surface soils. Additional investigation and characterization of the former HWMF Perimeter Area was performed in 2007: *Investigation and Characterization of the Brookhaven Avenue Cs-137 Contamination* (BNL, 2007). The investigation identified Cs-137 contamination in the former HWMF Perimeter Area surface soils, specifically in areas north/northeast and east of the former HWMF, as well as to the west along Brookhaven Avenue. Surface soil (0-6") concentrations ranged from near background to 43 pCi/g in the contiguous area, while localized areas of contamination, referred to herein as discrete areas, ranged from 2.8 pCi/g to 322 pCi/g. Concentrations of Cs-137 were not detected above site cleanup criteria in deeper soil sample intervals (>6"). The locations of Cs-137 identified within the former HWMF Perimeter Area are illustrated by Figure 1-3.

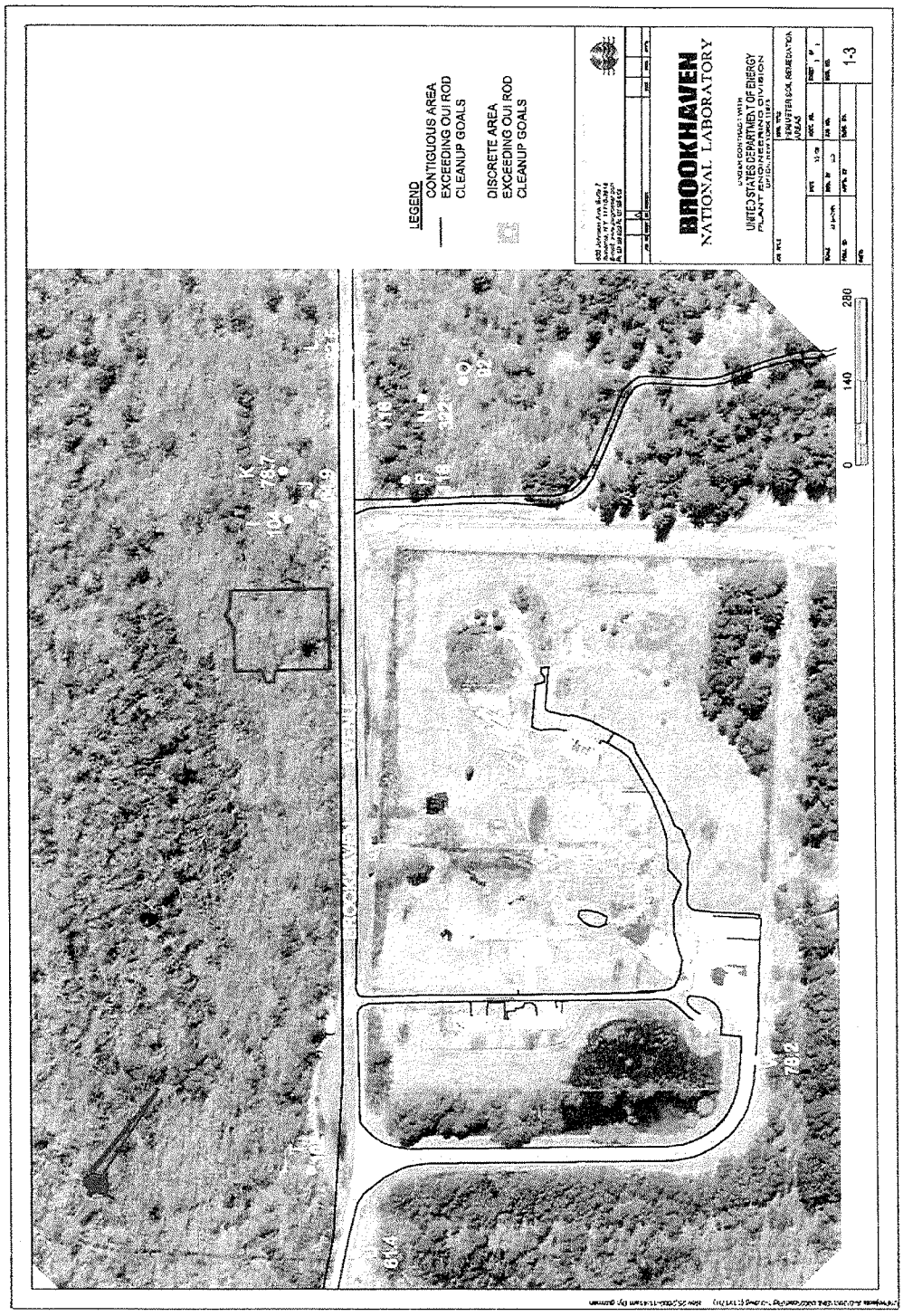

Figure 1-3 Locations of Cs-137 contamination detected during 2007 investigation at the former HWMF Perimeter Area

1.5 Previous Remedial Activities

Limited excavation of several areas within the former HWMF Perimeter Area with Cs-137 concentrations exceeding cleanup goals was performed between August and September, 2008. Discrete areas I, K, T, U, and W were remediated or partially remediated.

1.6 BNL Operable Units

As part of remedial efforts at BNL, 30 AOCs were identified and grouped into seven OUs. The seven OUs were subsequently reduced to six OUs as a result of combining OU II and OU VII. The former HWMF was designated as AOC 1 within OU I. In February 2009, AOC 31, comprising the HFBR complex and the WLA, was established.

This report documents completion of the remedial action for the former HWMF Perimeter Area, which is outside of the boundaries of both AOC 1 and AOC 31. As described in Section 2.1, the cleanup goals established in the OU I ROD were used for the Former HWMF Perimeter Area Project.

2.0 OPERABLE UNIT BACKGROUND

2.1 Site Cleanup Criteria

The radiological contaminants of concern for the former HWMF Perimeter Area are the same as those for OU I radiologically contaminated soils: Cs-137, Ra-226, and Sr-90. The cleanup goals for specific radionuclides were calculated using RESRAD, but a residential scenario is considered for the former HWMF Perimeter Area Project, while an industrial scenario was used for the former HWMF and the WLA. The dose limit used was 15 millirem per year (mrem/yr) above background (*OSWER Directive 9200.4-1., EPA, 1997*), residential land use with 50 years of institutional control by the DOE, and industrial land use with no decay time (0 years). In addition, the NYSDEC cleanup guideline of 10 mrem/yr, from Technical Administrative Guidance Memorandum (TAGM) 4003, was adopted as an ALARA goal. The primary radiological isotope present at the site was Cs-137; its cleanup goal established in the OU I ROD is 23 pCi/g, and this value was used for the former HWMF Perimeter Area as documented in the Action Memorandum (AM).

The potential for radiologically contaminated soil to impact groundwater was also considered. A soil cleanup goal of 15 pCi/g was calculated for Sr-90, based on its potential to impact the groundwater. The goal also protects both residential and industrial uses. A cleanup goal of 5 pCi/g was selected for Radium-226 (Ra-226) based on DOE Order 5400.5, *Radiation Protection of the Environment and the Public.*

The chemical contaminants of concern for the former HWMF Perimeter Area are the same as those at the former HWMF: mercury and lead. The cleanup goal established for mercury is 1.84 mg/kg, based on the EPA's soil screening level guidance (*OSWER Directive 9355.4-23*) for protecting groundwater and residential use. A cleanup goal of 400 mg/kg for lead was also chosen based on the EPA's soil screening level guidance; this level is protective of residential use. The cleanup goals for these chemical contaminants were developed for the Former HWMF Soils Removal Project and applied to the former HWMF Perimeter Area as documented in the AM.

Radionuclides and chemical contaminants of concern for the former HWMF Perimeter Area are listed in Table 2-1.

Table 2-1

Radionuclides and Chemical Contaminants of Concern in the Former HWMF Perimeter Area

Radionuclides of Concern	Cleanup Value (pCi/g)	Source of Cleanup Goal Value
Cs-137	23	OU I ROD (BNL, 2009)
Sr-90	15	OU I ROD (BNL, 2009)
Ra-226	5	OU I ROD (BNL, 2009) and DOE 5400.5
H-3	9.6 E+15*	CDM 1996, Table 6.2-10
Co-60	1,100	CDM 1996, Table 6.2-10
U-235	11	CDM 1996, Table 6.2-10
U-238	9	CDM 1999, Table 1-3
Pu-238	65	CDM 1996, Table 6.2
Pu-239/, Pu-240	40	CDM 1996, Table 6.2
Am-241	39	CDM 1996, Table 6.2-10
Chemical Contaminant	**Soil Cleanup Level (mg/kg)**	**Source of Cleanup Goal Value**
Mercury	1.84	OUI ROD (BNL, 1999)
Lead	400	OUI ROD (BNL, 1999)

* The value of 9.6E+15 is listed for tritium in the RESRAD output; however, the value of 424 pCi/g would be used if tritium is detected in soils. The value of 424 pCi/g is based on the conservative assumptions of a residential scenario and 0 years decay.

2.2 Design Criteria

Technical specifications and design criteria for the former HWMF Perimeter Area Project were established in the *Final Action Memorandum, Removal Action for Contaminated Soil from the Former Hazardous Waste Management Facility Perimeter Area*, June 2009 and the *Field Sampling Plan for the Former Hazardous Waste Management Facility Perimeter Area*, August 2009.

The remedial design included:

- A plan and process for ensuring the total exposure from all radioisotopes does not exceed 15 mrem/yr above background following the 50-year period for institutional control for the site;
- Methods to reduce waste volumes that require offsite disposal;
- Establishing a correlation of concentrations to counts per minute (cpm) to be used in guiding excavation activities, and
- An approach for post-remediation sampling to confirm that cleanup goals have been achieved.

2.3 Community Relations Activities

2.3.1 BNL Community Relations

The BNL Community Involvement Plan was published April 15, 1999. It is supplemented by project-specific plans. In the case of the HFBR, a Communications Plan for the Regulatory Decision-Making Process for Decommissioning the High Flux Beam Reactor was developed. In accordance with these two plans and CERCLA Sections 113 (k)(2)(B)(i-v) and 117, the Community Relations Program focuses on informing and involving the public in the decision-making process to ensure that the views of the internal and external stakeholder communities are considered. A variety of activities are used to provide information and to seek public participation, including distribution of materials to a stakeholders' mailing list; holding community meetings, information sessions, tours, and workshops; and preparing and distributing fact sheets. The Administrative Record, which documents the basis for removal and remedial actions, was established and is maintained at the libraries listed below:

Brookhaven National Laboratory
Research Library
Bldg. 477A
Upton, NY 11973
631-344-3483 or 631-344-3489

Stony Brook University
Melville Library
Special Collections and University Archives
Room E-2320
Stony Brook, NY 11794
Phone: (631) 632-7119

U.S. EPA - Region II
Records Room
290 Broadway, 18th Floor
New York, New York 10007
212-637-4308

2.3.2 Community Involvement

After radiological contamination was identified in the Former HWMF Perimeter Area soils, the BNL Community Advisory Council (CAC) was briefed on February 9, 2006. The cleanup of the soils using ARRA funds was discussed with the CAC on April 15, 2009 and November 12, 2009.

The cleanup of the soils was performed using the OU I cleanup goals and methodology as specified in the *Final Action Memorandum, Removal Action for Contaminated Soil from the Former Hazardous Waste Management Facility Perimeter Area.*

3.0 CONSTRUCTION ACTIVITIES

All pre-construction tasks were completed prior to beginning cleanup activities, including equipment mobilization, radiological walkover surveys, site inspections, excavation area mark-outs, silt fence installation, and securing the general work area.

As noted in Section 1.2, radiological contamination identified in surface soil in the former HWMF Perimeter Area is believed to be a result of historical operations associated with the transfer of wastes to the former HWMF and historical runoff from contaminated soils within the facility. The objective of the former HWMF Perimeter Area Project was to safely characterize, remediate, and dispose of radiologically and chemically contaminated soil in accordance with the AM, as well as the project specific plans. Following the soil excavation activities, a final status survey (FSS), endpoint sampling, and a dose assessment were performed by BNL ERP. The FSS and endpoint sampling were independently verified by ORISE. This work is further discussed in Section 3.2. The FSS was completed using the *Multi-Agency Radiological Survey and Site Investigation Manual* (*MARSSIM*) guidelines.

A Job Risk Assessment (JRA), Radiological Work Permit (RWP), and project specific work procedures were developed to address hazards and work steps associated with the Former HWMF Perimeter Area Project. The information presented in the project plans was reviewed by the site workers prior to initiating the project work activities. Copies of project plans were available onsite at all times for site workers to thoroughly review.

The *Former Hazardous Waste Management Facility Perimeter Area Field Sampling Plan* (BNL, June 2009) was prepared and detailed the data quality objectives (DQOs) and quality assurance (QA) requirements for the FSS. The FSP also presented the radiological survey level (21,500 cpm with unshielded sodium iodide detector) to be used in guiding the excavation and in determining when the excavation was completed.

Photograph 1 – Pre-Excavation Conditions at the former HWMF Perimeter Area

A pre-excavation radiological walkover survey of the former HWMF Perimeter Area was performed in June, 2009. It indicated that radiological contamination was present within a contiguous area north of Brookhaven Avenue where gamma survey results were greater than 21,500 counts per minute (cpm), as shown in Figure 3-1.

The contiguous area was considered for a Final Status Survey (FSS). The contiguous area of Cs-137 contaminated soils is approximately 18,750 ft^2 (1,750 m^2). In accordance with the *MARSSIM* guidelines for survey unit (SU) classification and size, this was designated as one SU, a physical area of structure or land area of specified size and shape for which a separate decision will be made on whether or not cleanup goals are met. Soils contaminated above cleanup goals were designated as Class 1 survey units. The maximum suggested area for Class 1 soil area survey units is 2,000 m^2.

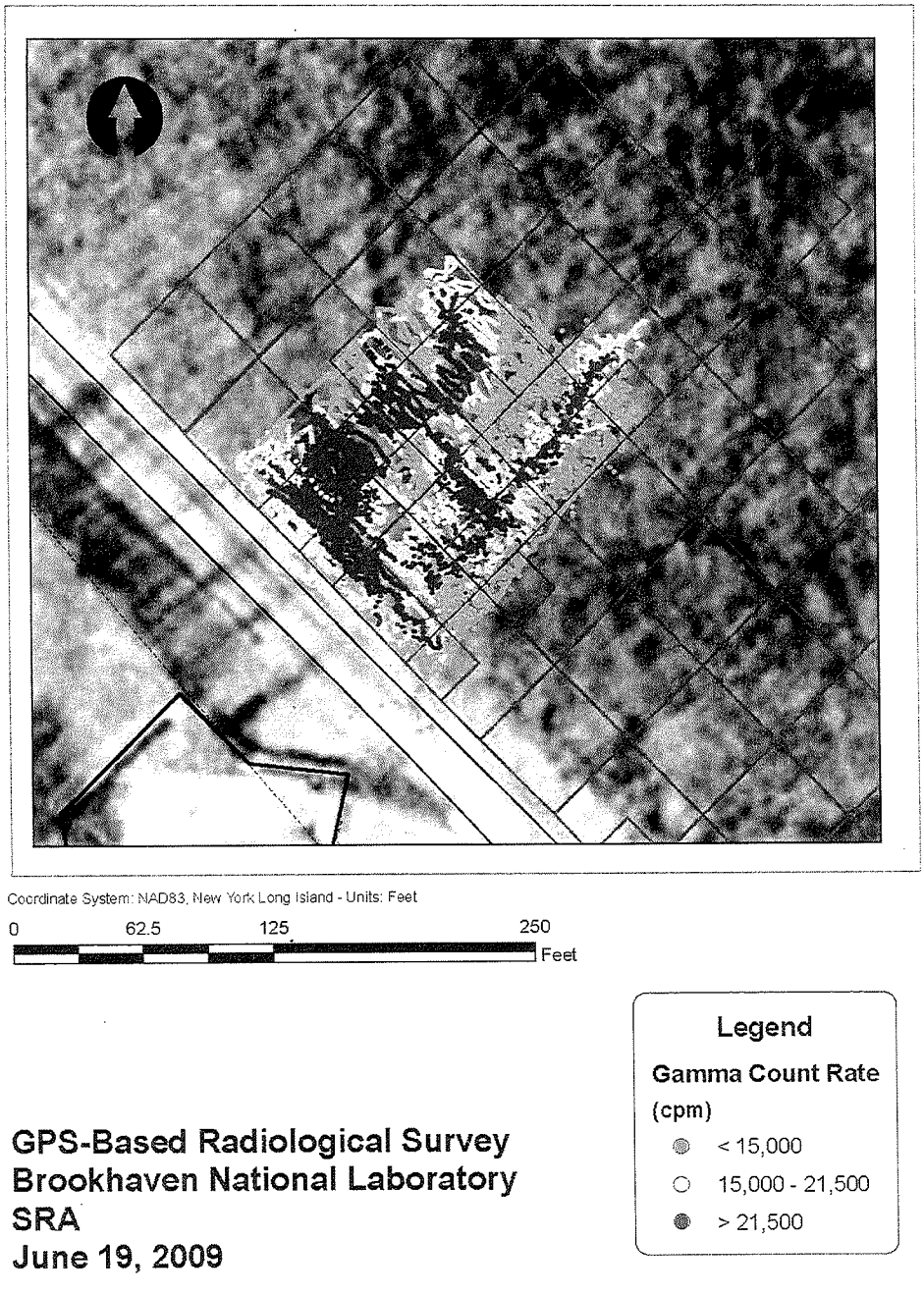

Figure 3-1 – Former HWMF Perimeter Area (Contiguous Area) Pre-Remediation Radiological Walkover Survey Results

In addition to the contiguous area, a pre-excavation survey was performed at eleven isolated areas identified during 2007 characterization activities. These isolated areas, referred to herein as discrete areas, were detected in the wooded areas adjacent to the northeastern, northwestern, and southeastern corners of the former HWMF boundaries. The eleven discrete areas were designated I through P, T, U and W, as shown in Figure 3-2. Based upon the pre-excavation walkover survey several of the areas (K, T, and U), which were previously remediated, did not require additional excavation.

As discussed further in Section 3.1, additional areas of elevated radioactivity were detected during pre-remediation radiological surveys adjacent to the eleven discrete areas. These additional areas of elevated radioactivity were not remediated since they were considered to be outside of the scope of the ARRA-funded former HWMF Perimeter Area Project. Furthermore, the presence of these areas of elevated radioactivity precluded the completion of a FSS in the vicinity of the eleven discrete areas. Instead, each discrete area within the scope of the Former HWMF Perimeter Area Project was addressed separately during surveying, sampling and soil remediation.

Additional characterization activities for the areas identified adjacent to the former HWMF Perimeter Area Project are being performed by BNL EPD. These characterization activities will be reported during weekly IAG teleconferences, as necessary.

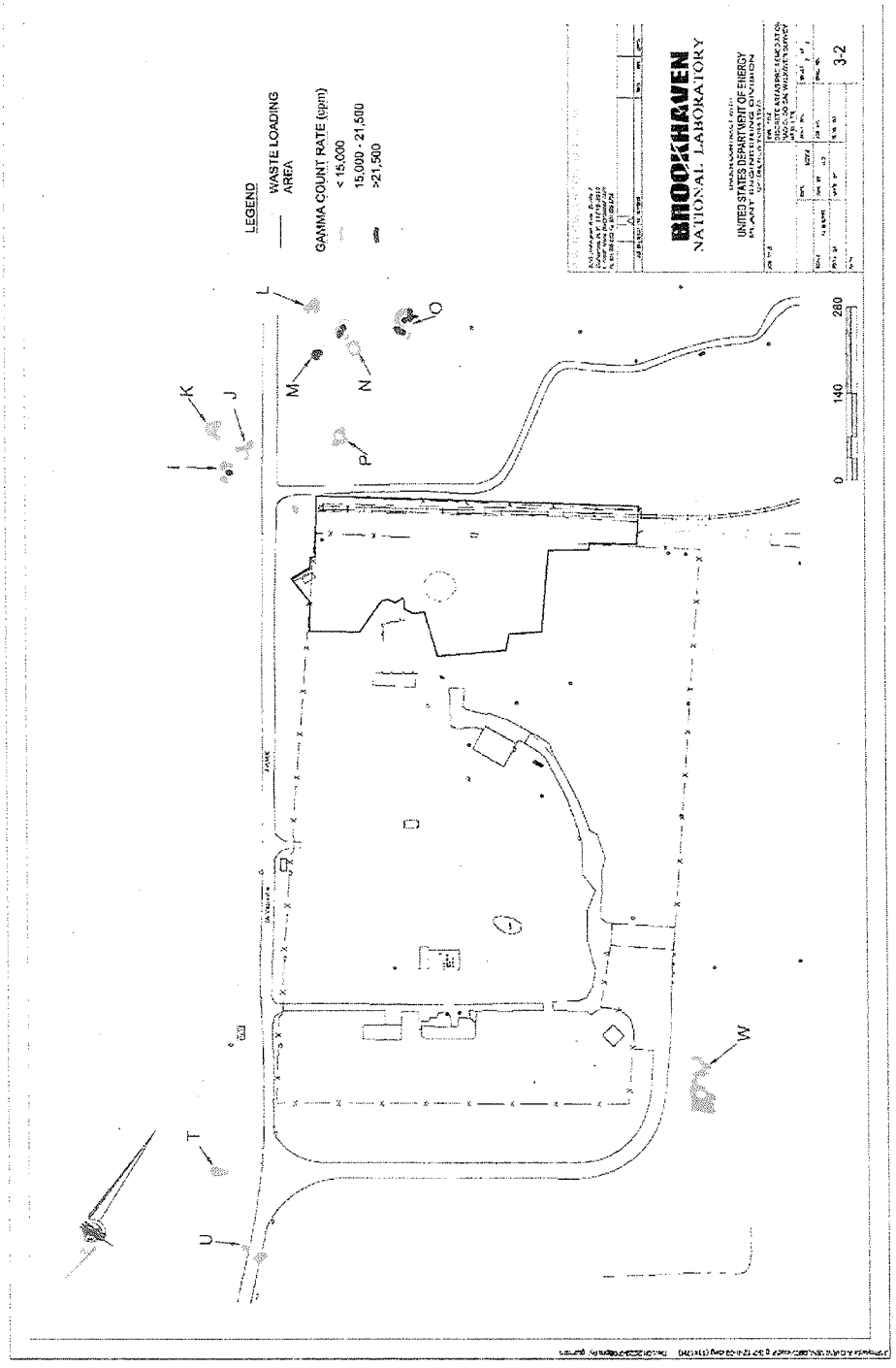

Figure 3-2 – Former HWMF Perimeter Area (Discrete Areas) Pre-Remediation Radiological Walkover Survey Results

3.1 Soil Excavation

Prior to the start of excavation activities, clearing, grubbing and size reduction of vegetation was performed in the contiguous area and in the vicinity of the discrete areas where concentrations greater than 21,500 cpm were detected during pre-excavation radiological surveys. This material was stockpiled, chipped to reduce volume, characterized and shipped via truck in intermodal containers to Energy Solutions Disposal Facility of Clive, Utah as detailed in Section 3.3. Vegetation characterization results are included with waste verification results in Appendix F.

Upon completion of the clearing and grubbing, the survey unit boundaries for the contiguous area and the discrete areas were marked. Contaminated soil was excavated in six-inch lifts. In process field screening was performed using a Sodium Iodide (NaI) gamma scintillation detector after each lift to determine if additional excavation was required. Soil was removed with an excavator with an attached cutting edge and placed into an onsite soil stockpile or direct loaded into a staged Lift Liner. The Lift Liners were then sealed and loaded into railcars for shipment and final disposal at Energy Solutions Disposal Facility of Clive, Utah, as described further in Section 3.3.

Cs-137 was the primary radiological contaminant driving the remediation of the site. As a result, gamma count rates using field instruments (NaI gamma scintillation detectors) were used to identify areas requiring excavation to meet the site cleanup goals. In accordance with the *Field Sampling Plan for the Former Hazardous Waste Management Facility Perimeter Area* (BNL, August 2009), an excavation action level of 21,500 cpm for the unshielded NaI gamma scintillation detector was established as the criterion for determining when excavations were complete. This criterion was determined using a correlation between data from NaI gamma scintillation detector surveys, onsite In-situ Object Counting System (ISOCS) analyses, and offsite gamma spectroscopy analyses at GEL Laboratories, LLC of Charleston, South Carolina. Correlation curves and the associated data used in establishing the excavation action level are presented and further discussed in Appendix B of the *Field Sampling Plan for the Former Hazardous Waste Management Facility Perimeter Area* (BNL, August 2009).

Although mercury and lead were also considered contaminants of concern, radiological surveys determined the excavation depth and endpoint samples were collected to ensure cleanup goals were met for chemical contaminants. Additional excavating was not necessary to meet the site cleanup criteria for mercury and lead, as discussed in Section 3.2.2.

Photograph 2 – Soil removal at the former HWMF Perimeter Area.

3.1.1 Contiguous Area Excavation

The 18,750 ft^2 (1,750 m^2) contiguous area of contamination was characterized and excavated as a single Class 1 SU. Once in-process field screenings with NaI gamma scintillation detectors indicated that site cleanup criteria were met (<21,500 cpm), preliminary soil samples were collected and analyzed using an on-site ISOCS to confirm the field screening results. Approximately 50 soils samples were collected from the contiguous area and analyzed before beginning the FSS. None of the soil samples collected from the excavation exceeded 23 pCi/g. The FSS was performed, as discussed in Section 3.2, upon completing the removal of soil above site cleanup criteria. A map showing the final excavation depths within the Class 1 SU is presented as Figure 3-3.

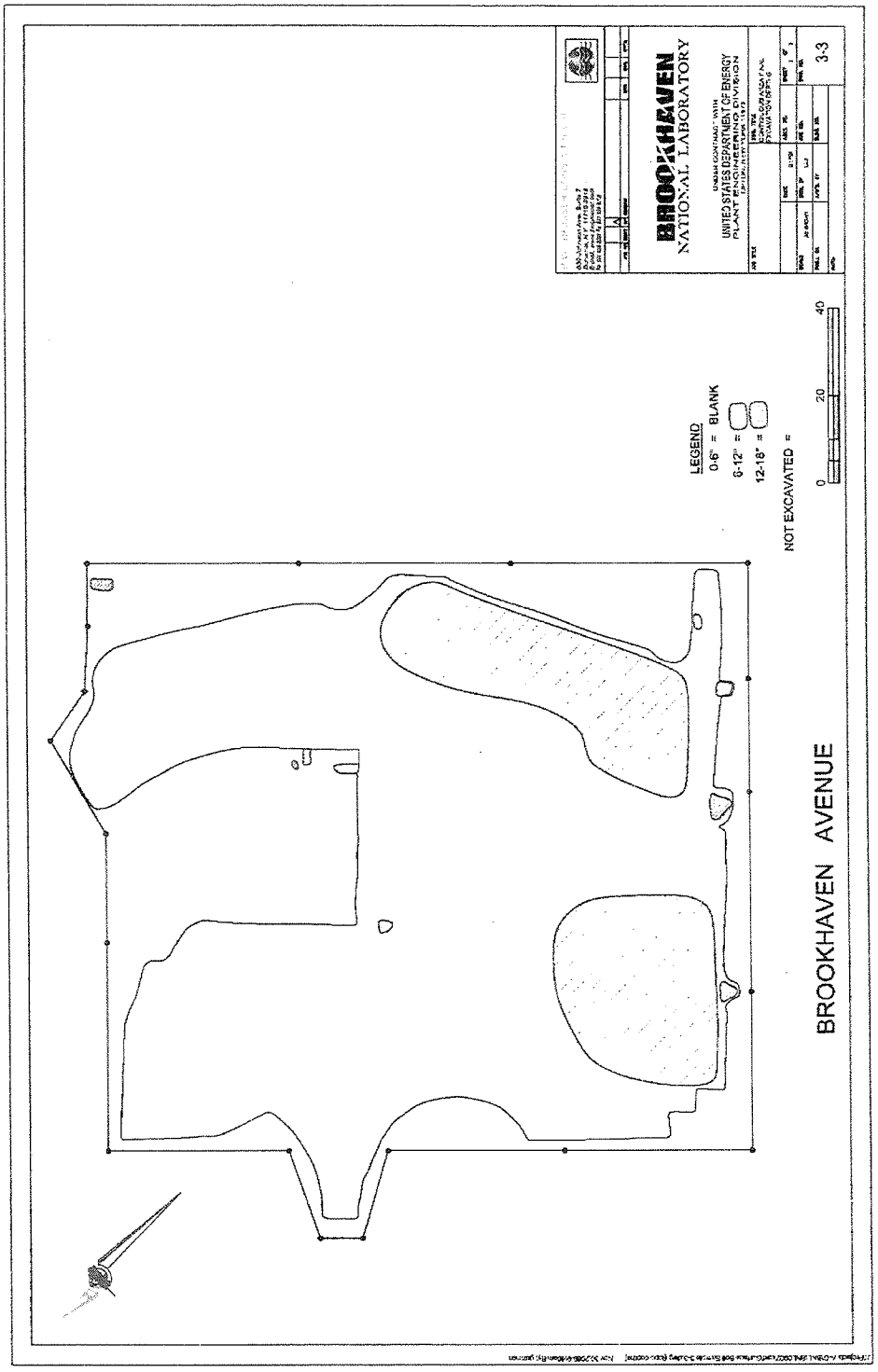

Figure 3-3 – Final Excavation Depths within the Contiguous Area

3.1.2 Discrete Area Excavation and Sampling

Eight discrete areas (I, J, L through P, and W) were remediated outside of the contiguous area (discrete areas K, T, and U were remediated in 2007 and did not require additional excavation). The discrete areas were located near the northeastern, northwestern, and southeastern corners of the former HWMF boundaries. As previously discussed, additional discrete areas that were considered to be outside of the scope of the former HWMF Perimeter Area Project were detected in the vicinity of discrete areas I through P during pre-remediation radiological surveys. The presence of these additional discrete areas precluded the completion of a FSS for these areas. Instead, the eleven discrete areas within the scope of the former HWMF Perimeter Area Project were treated separately during surveying, sampling and soil remediation. At each location, contaminated soil was removed until field screenings with NaI gamma scintillation detectors indicated that the remaining soil was below the excavation action level (21,500 cpm). Endpoint soil samples were collected at each location and analyzed for the radionuclides of concern to confirm that the site cleanup criteria were met (including discrete areas K, T, and U). In addition, a composite sample consisting of an aliquot from each of the eleven discrete areas was analyzed for mercury and lead. The eleven discrete area endpoint sample locations are illustrated below by Figure 3-4.

Discrete area endpoint samples were analyzed at an offsite laboratory to confirm that the site cleanup criteria were met. Results for the eleven endpoint samples were below the cleanup criteria for the radionuclides of concern. The maximum concentrations for discrete areas were as follows: 15.10 pCi/g Cs-137, <1.1 pCi/g Sr-90, and 0.593 Ra-226.

Chemical results for the composite sample analyzed for mercury and lead also indicated that residual soil concentrations for these contaminants at the eleven discrete areas are within their respective cleanup goals. The composite soil sample results were 0.0222 mg/kg for mercury and 9.22 mg/kg for lead.

Radiological and chemical results for the discrete area endpoint samples are summarized in Appendix A.

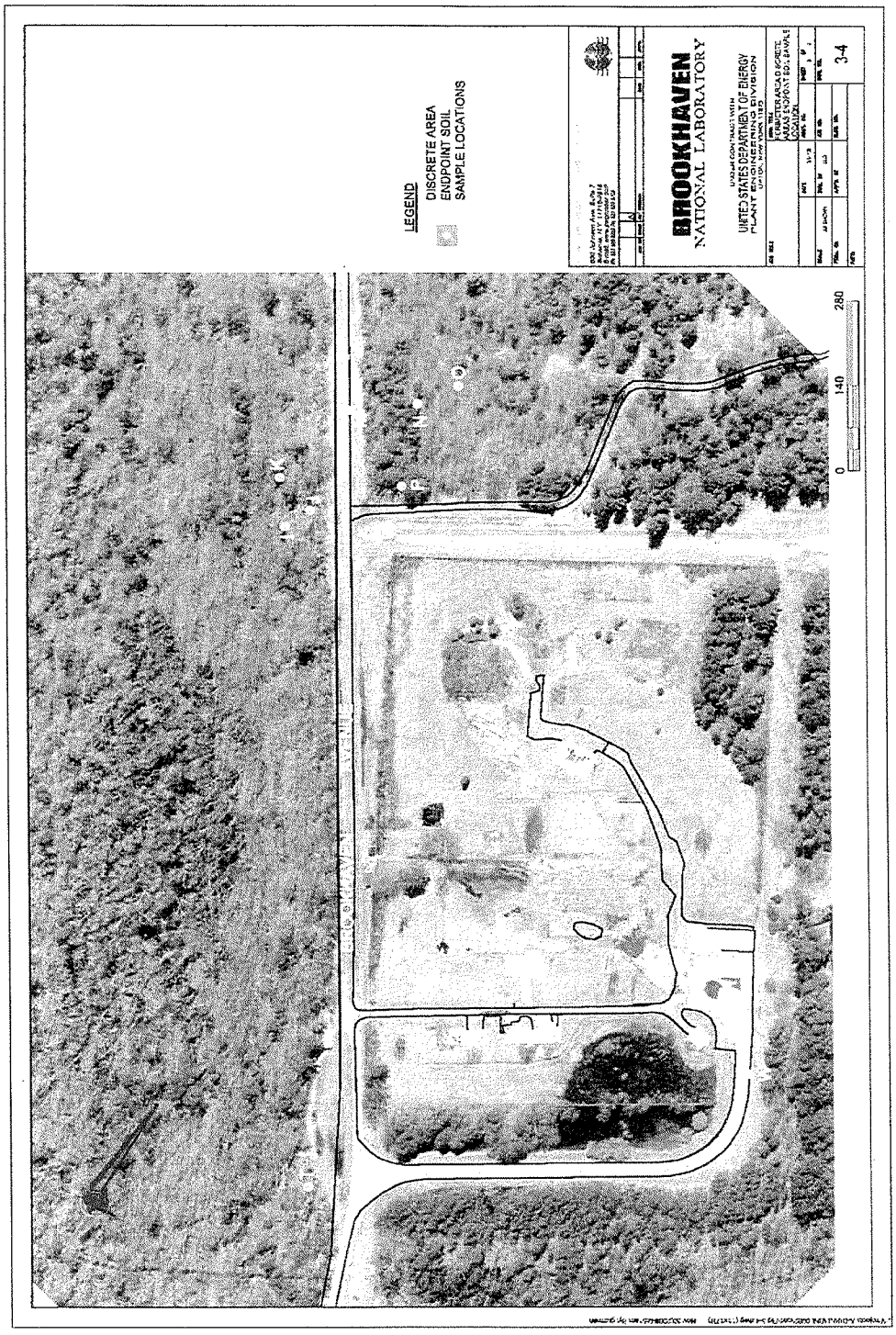

Figure 3-4 – Discrete Area Endpoint Soil Sample Locations

3.2 Final Status Survey and Sampling

As indicated in Section 3.1, excavation of radiologically contaminated soils was controlled by conducting excavation surveys with gamma scintillation detectors. Gamma count rates were used to determine when the excavations were complete in each area. During excavation activities, walkover surveys were performed and soil samples were collected and analyzed for Cs-137 using the onsite ISOCS unit. Following completion of the excavation surveys, a FSS was performed as specified in Section 3.2.1.

As discussed in Section 2.1, the primary radionuclides of concern, based on exposure potential, were Sr-90, Cs-137 and Ra-226. Other radionuclides of concern that were monitored include Am-241, Pu-238, Pu-239/240, U-235, U-238, Co-60 and tritium. These additional radionuclides were present in the former HWMF prior to remediation, so it is possible that they would be present in the former HWMF Perimeter Area. Several samples were also collected for analysis of mercury and lead, which were previously detected within the former HWMF but not anticipated in the former HWMF Perimeter Area.

3.2.1 Final Status Survey Design

The area to the north of Brookhaven Ave. was designated as the contiguous area of contamination. One Class 1 survey unit is established for this contiguous area. The suggested maximum size area for a Class 1 survey unit is 2000 m^2 for soil areas. The contiguous area is approximately 1750 m^2, and is considered a single survey unit for the FSS.

A two-step approach to cleanup confirmation for radiological soil contamination was followed using *MARSSIM* for the former HWMF Perimeter Area Project. The first step consisted of a GPS-based gamma scintillation walkover survey of the contiguous area. Gamma walkover surveys were conducted using unshielded two-inch-by-two-inch NaI detectors in conjunction with a Ludlum Model 2221 scaler/ratemeter and a PRO XR Satellite Receiver Trimble model TSCe Data Logger (Trimble Unit). The second step involved the collection of 18 soil samples, in accordance with BNL EM standard operating procedures (SOP) for offsite analysis to verify that residual radiological contamination levels were sufficiently low to meet the cleanup goals established for the site.

In addition, one composite soil sample and one grab sample was collected from the contiguous area. The samples were analyzed for mercury and lead to ensure site cleanup goals for these compounds were met.

The final dimension of the contiguous area Class 1 SU and the associated FSS soil sample locations are illustrated below by Figure 3-5.

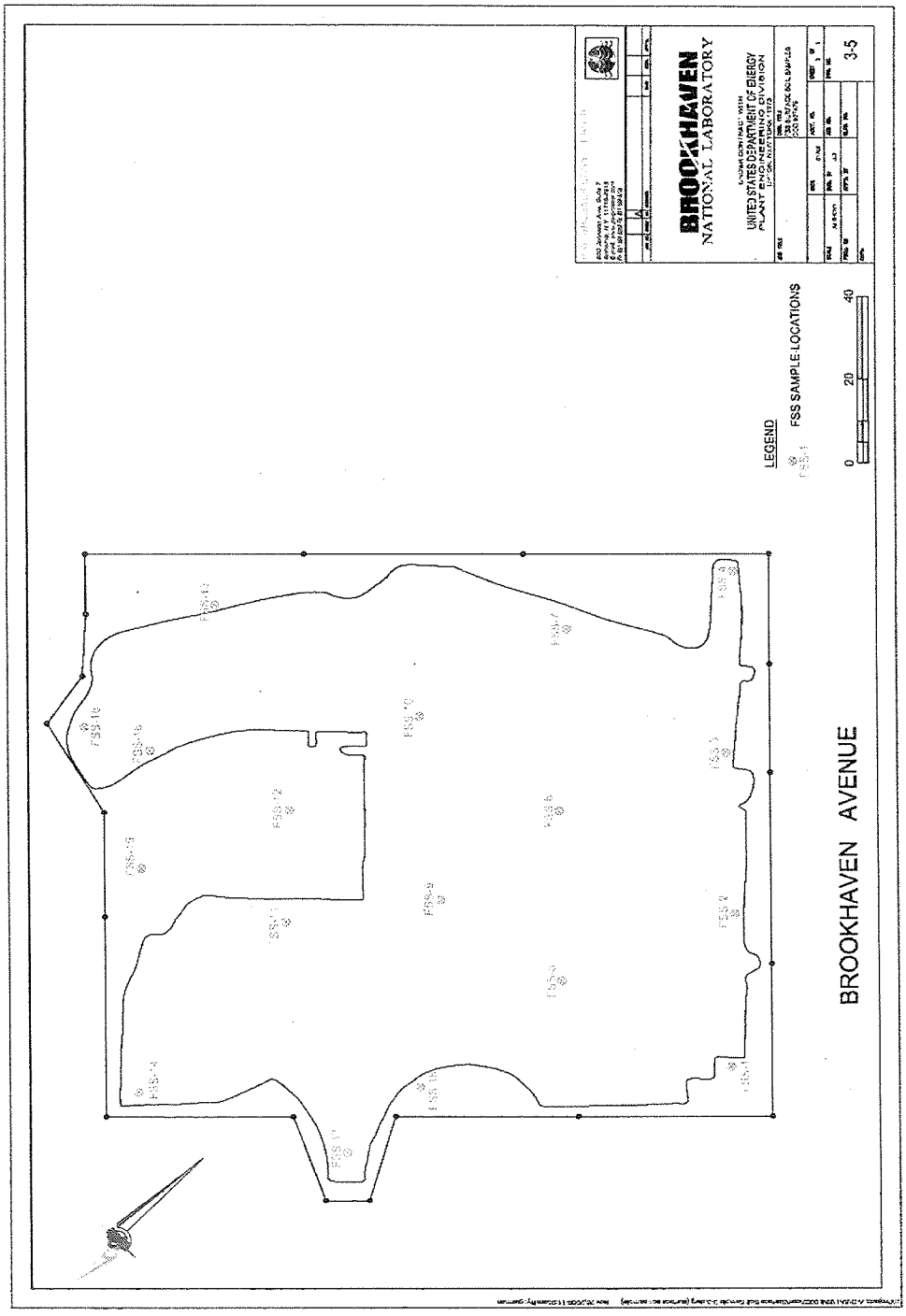

Figure 3-5 – Former HWMF Perimeter Soils Area FSS Survey Unit Soil Sample Locations

3.2.2 Final Status Survey and Sampling Results

The results of the final status radiological walkover survey exhibit count rates below 21,500 cpm for all areas within the contiguous area of the former HWMF Perimeter Area, as shown in Figure 3-6. Figure 3-6 also shows the post-excavation walkover survey results for discrete areas outside of the contiguous area, which were remediated as described in Section 3.1.2. As specified in Appendix B of the *Field Sampling Plan for the Former Hazardous Waste Management Facility Perimeter Area* (BNL, August 2009), the 21,500 cpm count rate was determined to approximate a Cs-137 concentration of 15 pCi/g in soil, or two-thirds of the cleanup goal for Cs-137 in soil when using the unshielded NaI gamma scintillation detector. Radiological walkover surveys indicated that about 80-90% of the area was less than 15,000 cpm, and about 10-20% of the area ranged up to 21,500 cpm. In addition, individual one-minute fixed count measurements were taken with the NaI probe at each of the 18 BNL sample points. The results ranged from 8,552 to 17,201 cpm. Radiological survey forms for gamma walkover and fixed point readings are provided in Appendix A.

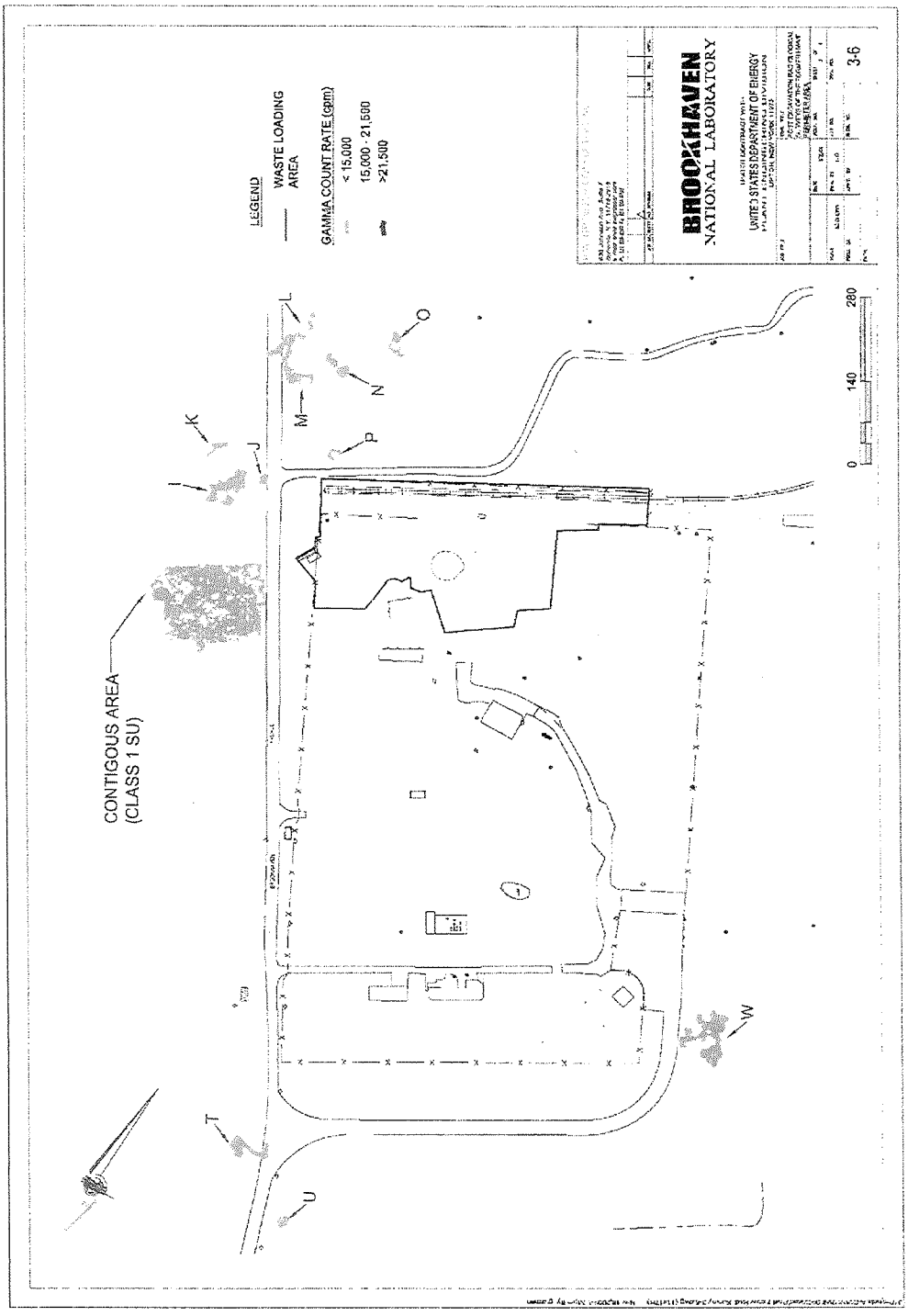

Figure 3-6 – Former HWMF Perimeter Area Post-Remediation Radiological Walkover Survey Results

BNL selected 18 soil sample locations based on a random start location. All the soil samples were below the site cleanup goals for Cs-137, Sr-90 and Ra-226, 23 pCi/g, 15 pCi/g and 5 pCi/g, respectively. A summary of the soil sample results are provided below in Table 3.1.

Table 3-1 Summary of Former HWMF Perimeter Soils Area Soil Sample Results for Radionuclides

	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Ra-226 (pCi/g)
Cleanup Goal	23	15	5
Average	4.38	1.1 (detection level on composite sample)	0.65
Maximum	11.0	1.1	0.76

Chemical results for soil samples analyzed for mercury and lead also indicated that residual soil concentrations for these contaminants are within their respective cleanup goals, i.e., 400 mg/kg for lead and 1.84 mg/kg for mercury. Lead results ranged from 9.86 to 13.0 mg/kg and mercury results ranged from 0.02 to 0.03 mg/kg. The mercury results were detectable but below the reporting level of 0.2 mg/kg.

Radiological and chemical results for offsite laboratory soil sample analysis are provided in Appendix A.

3.2.3 Sign Test and Elevated Measurement Comparison

Since no samples exceeded the cleanup criteria, the survey unit does not require testing with the sign test or the elevated measurement comparison. The sign test checks whether a sufficient number of sample locations are less than the cleanup criteria. Although the sign test was not required, it was performed, and Table 3-2 presents the sign test results along with survey data for the 18 points and provides the individual readings for each of the radionuclides of concern.

Table 3-2 Soil Sample Results and Sign Test Statistic

Location (BNL Sample No)	Cs-137 (pCi/g)	Fraction of Limit for Cs-137	Ra-226 (pCi/g)	Fraction of Limit for Ra-226	Ratios including Sr-90	DCGL (1.0) - Sum	Sign
SU-1	5.34	0.23	0.66	0.13	0.44	0.56	+
SU-2	1.43	0.06	0.63	0.13	0.26	0.74	+
SU-3	8.03	0.35	0.71	0.14	0.56	0.44	+
SU-4	11.00	0.48	0.54	0.11	0.66	0.34	+
SU-5	2.05	0.09	0.73	0.15	0.31	0.69	+
SU-6	8.73	0.38	0.62	0.12	0.58	0.42	+
SU-7	1.69	0.07	0.50	0.10	0.25	0.75	+
SU-8	4.72	0.21	0.69	0.14	0.42	0.58	+
SU-9	3.91	0.17	0.65	0.13	0.37	0.63	+
SU-10	2.22	0.10	0.52	0.10	0.27	0.73	+
SU-11	0.52	0.02	0.76	0.15	0.25	0.75	+
SU-12	1.85	0.08	0.70	0.14	0.29	0.71	+
SU-13	2.30	0.10	0.64	0.13	0.30	0.70	+
SU-14	2.89	0.13	0.62	0.12	0.32	0.68	+
SU-15	9.02	0.39	0.63	0.13	0.59	0.41	+
SU-16	3.57	0.16	0.69	0.14	0.37	0.63	+
SU-17	2.67	0.12	0.63	0.13	0.32	0.68	+
SU-18	6.91	0.30	0.72	0.14	0.52	0.48	+
Average	**4.38**	**0.19**	**0.65**	**0.13**	**0.39**	**# of positives**	**18**

The sign test is not necessary if no samples exceed the ratio of 1.0. However, it is shown here for completeness. From Table I.3 of MARSSIM, for 18 sample points and alpha = 0.05, at least 12 values of the sign test must be positive. Since there are 18 positive values, this SU would pass the sign test based on this data.

Note that Ra-226 background on BNL property had previously been established at approximately 0.56 pCi/g (CDM, 1996), and previous work on the former HWMF indicated an average of 0.49 pCi/g (Envirocon, 2005). Therefore, the average Ra-226 value of 0.65 pCi/g from the WLA is close to background levels. For determination of acceptable levels of cleanup, the value of 0.65 pCi/g was used as a conservative measure, with no subtraction of background Ra-226 in the soil. However, when performing the post-remediation dose assessment using RESRAD, background is subtracted to obtain a more accurate result.

3.2.4 Post Remediation Dose Assessment

A dose assessment was conducted to evaluate radiological dose impacts from residual radioactive materials remaining following the completion of the former HWMF Perimeter Area Project. The dose assessment for the soil excavation areas was conducted using RESRAD, Version 6.4 (ANL, 2001). The average concentration for each radionuclide was used as input to the model in order to determine the projected dose. As described in section 3.2.2, the Ra-226 concentrations were close to background concentrations (0.65 pCi/g average, compared to 0.56 pCi/g background). The RESRAD model was run with no background subtract Ra-226 = 0.65 pCi/g) and with full background subtract (Ra-226 = 0.65 – 0.56 = 0.09 pCi/g).

Two potential radiological dose scenarios were evaluated following remediation. The first assessment considered the radiation dose to a hypothetical future resident (non-farmer) assuming 50 years of institutional control. The second assessment considers the radiation dose to a current industrial worker (no decay). The parameters and pathways used in the dose assessment for the former HWMF Perimeter Area were used for this dose assessment, and the RESRAD summary reports are included as Appendix B.

The results of the dose assessment are shown in Table 3-3 below. The maximum projected dose to a resident Year 50 (5.6 mrem/year) at the former HWMF Perimeter Area would be below the dose objective (non-farmer) of 15 mrem/year. For an industrial worker with no decay time, the maximum projected dose to a industrial worker at Year 0 (3.1 mrem/year) is also less than 15 mrem/year. The results also indicate that the NYSDEC TAGM 4003 guideline of 10 mrem/yr would also be met under each of the two scenarios described above. If background was not subtracted for Ra-226 (use 0.65 pCi/g without background subtracted), then the residential and industrial doses would be 14.7 and 4.4 mrem/yr, respectively.

Table 3-3 Summary of Post-Remediation Dose Assessment Results

	Resident at 50 years (mrem/yr)	**Industrial Worker at 0 years (mrem/yr)**
Dose	**5.6**	**3.1**

3.2.5 Final Status Survey Conclusions

As indicated above, results of the FSS and sampling following the completion of the remediation of the contiguous portion of the former HWMF Perimeter Area demonstrate conformance to the site cleanup goals established for the project.

3.2.6 Final Status Survey Independent Verification

The Independent Verification Survey (IVS) was conducted by an ORISE survey team. The ORISE survey team conducted surveying and sampling during a visit in October 2009.

ORISE performed a gamma walkover survey, which was used, in part, to specify judgmental sample locations for soil analysis. Six randomly selected locations and three judgmental locations were used to collect soil samples in the contiguous area. Of the random locations, one sample indicated that the sum of the ratios to the limit exceeded 1.0 (result was 1.03). Two of the three judgmental samples indicated Cs-137 results above the cleanup goals, and they are discussed in the ORISE Verification Report (ORISE, 2009).

With additional data available in the survey unit, statistical tests were performed on the combination of BNL and ORISE samples to determine if the combined sample population would meet the cleanup criteria.

Using the total 24 sample points (18 BNL plus 6 ORISE), the MARSSIM Table I.3 is used to determine the number of acceptable values. In the sign test method, a sample point that has a positive value is below the cleanup criteria. From Table I.3 of *MARSSIM*, for 24 sample points and alpha = 0.05, at least 16 values of the sign test must be positive. Since there are 23 positive values, this survey unit passes the sign test.

The one sample location that exceeded the sum of the fractions limit is considered in the Elevated Measurement Comparison (EMC). As described in the Field Sample Plan, Area Factors have been developed for various sized areas down to 1 m^2. The area of contamination was small, and the Area Factor (AF) for 1 m^2 is applicable (AF = 9.6). The results of this test indicate a sum of the fractions of 0.49. This is less than 1.0, and the survey unit would pass the Elevated Measurement Comparison.

Although the three judgmental samples do not need to be included in the sign test or the EMC, the survey unit would still pass both statistical tests if the data was included.

RESRAD was re-run with the ORISE data included to see if the results of the dose assessment would be below the dose objective for the residential and industrial worker scenarios. Note that the 6 random plus 3 judgmental locations in the contiguous survey unit were included in the soil average to add a level of conservatism. Results are summarized in Table 3-4.

Table 3-4 Summary of Post-Remediation Dose Assessment Results with ORISE Data Included

	Resident at 50 years (mrem/yr)	Industrial Worker at 0 years (mrem/yr)
Dose	**7.2**	**5.5**

The two areas within the contiguous area and three additional areas of Cs-137 concentrations above the 23 pCi/g cleanup goal adjacent to discrete areas T and W identified by ORISE, were subsequently remediated by hand excavation in October 2009. Post-excavation radiological survey and end-point sampling results from these five areas are documented on radiological survey forms included in Appendix A.

The results of the IVS are documented in *Independent Verification Survey Report for the Former HWMF Perimeter Soils Area, Brookhaven National Laboratory, Upton, New York* (ORISE, October, 2009), provided in Appendix C.

3.3 Waste Management

3.3.1 Waste Characterization and Handling

The waste management strategy, waste characterization, packaging, handling, and storage were performed in accordance with the *Waste Management Plan for Removal of Radioactive Soil and Debris from the Former HWMF Perimeter Area Remediation Project* (BNL, April, 2009).

Excavated soil contaminated above cleanup goals was placed in Lift Liners and loaded into railcars for shipment to Energy Solutions Disposal Facility of Clive, Utah for final disposal. Wood from the former HWMF Perimeter Area, as well as constructions debris and plastic used during remedial activities, were size reduced and placed into intermodal containers for shipment via truck, or sealed in Lift Liners and loaded into railcars for shipment and final disposal at Energy Solutions Disposal Facility of Clive, Utah.

Photograph 3 – Loading Lift Liner containing contaminated soil into railcar at the WLA.

Waste verification sampling for soil and debris disposal was performed, in accordance with the *Waste Management Plan for Removal of Radioactive Soil and Debris from the Former HWMF Perimeter Area Remediation Project* (BNL, April, 2009). Three waste verification samples were collected for the five railcars and three intermodal containers that were shipped (total of 307 CY of waste soil and debris). Samples were analyzed for comparison to Energy Solution's Waste Acceptance Criteria (WAC), which includes complete TCLP, gamma spectroscopy, Strontium-90 analysis, alpha spectroscopy, gross beta, PCBs/Pesticides, and physical parameters (pH, Reactivity, flashpoint). Waste verification samples were collected by ERP personnel and analyzed by GEL Laboratories, LLC of Charleston, South Carolina. According to these sample results, the soil and debris shipped met the Energy Solutions WAC. Waste verification results were submitted to BNL's Waste Management Division. Waste verification data is included in Appendix D.

3.3.2 Waste Shipment and Disposal

MHF Services provided railcars for transportation of the waste soil and debris to Energy Solutions Disposal Facility of Clive, Utah. After the railcars arrived on site, they were inspected and released for loading. The bottom of the inside of each railcar was covered with a geotextile liner prior to the placement of the loaded and sealed Lift Liners. Approximately 60-90 tons of waste was placed into each rail car and approximately

11,500 to 12,500 pounds of waste was placed into each intermodal container. The weights of the soil and debris were determined utilizing a scale on the crane used to hoist Lift Liners into the railcars. Either a hard or soft tarp cover was secured over each railcar prior to shipment.

Waste loading and shipping was initiated on June 23, 2009 and was completed on September 12, 2009. A total of five railcars and three intermodal containers were loaded and transported to Energy Solutions Disposal Facility of Clive, Utah for final disposal, which equates to approximately 427 tons (307 CY) of soil and debris. All waste shipped as part of the former HWMF Perimeter Area Soil Removal Project was accepted by Energy Solutions. Waste soil and debris shipments are summarized in a table included in Appendix E.

3.3.3 Pollution Prevention and Waste Minimization Opportunities

Waste minimization and pollution prevention methods employed during remedial activities at the FHWMF include:

- Operating equipment outside of the controlled areas as much as possible to minimize contact with contaminated areas;
- Excavation in as small a lift as possible to minimize excavation of soil below cleanup goals;
- Constructing run-on berms around excavations to prevent the spread of surface contamination;
- Size reducing waste to meet the Energy Solutions WAC; and
- Judicious use of consumables (PPE).

3.4 Site Restoration

Site restoration of the former HWMF Perimeter Area included backfilling and re-grading of the contiguous area with topsoil, to bring the site back to its original grade, from BNL's composting operations, which contains material that had been tested to ensure compliance with NYSDEC guidelines. The contiguous area was reseeded with native Long Island grasses. Site restoration activities were completed in December 2009. Future site controls are discussed in Section 7.0.

Photograph 4 – Former HWMF Perimeter Area (Contiguous Area) After Site Restoration

4.0 CHRONOLOGY OF EVENTS

The following table lists a chronology of the main remedial events and the associated plans/reports for the former HWMF Perimeter Area:

Table 4-1
Chronology of Remedial Events for the Former HWMF

Date	Remedial Event or Document
October 2005	Radiological contamination identified in areas surrounding the former HWMF
November 2007	Issued report *Investigation and Characterization of the Brookhaven Avenue Cs-317 Contamination*
June 2009	Issued final *Action Memorandum, Removal Action for Contaminated Soil from the Former Hazardous Waste Management Facility Perimeter Area*
June-August 2009	Excavated contaminated soil above cleanup goals at the former HWMF Perimeter Area
August-September 2009	Performed FSS and IVS of former HWMF Perimeter Area, completed waste shipments
October 2009	Remediate five areas identified by ORISE
October – December 2009	Site restoration of the former HWMF Perimeter Area

5.0 PERFORMANCE STANDARDS AND CONSTRUCTION QUALITY CONTROL

As discussed in Section 3.2.2, the concentrations for Cs-137, Sr-90, and Ra-226 in soil were below the cleanup goals of 23 pCi/g, 15 pCi/g and 5 pCi/g, respectively. The calculated radiological doses from all radioisotopes were also below the levels stipulated in the AM. In addition, concentrations of mercury and lead in soil were below the cleanup goals of 1.84 mg/kg and 400 mg/kg, respectively.

Physical and radiological inspections were conducted on both incoming and outgoing railcars. Inspections were also conducted on stormwater control measures as well as excavation operations. Excavation monitoring and field sampling procedures were also reviewed periodically.

Quality control/quality assurance (QA/QC) samples were collected in accordance with *Field Sampling Plan for the Former Hazardous Waste Management Facility Perimeter Area* (BNL, August 2009). Field duplicates were collected at a frequency of one per twenty soil samples and analyzed for the radiological and chemical contaminants of concern. QA/QC results are summarized provided in Appendix A.

6.0 FINAL INSPECTION AND CERTIFICATIONS

As described in Section 3.2., the IVS was performed by ORISE upon the completion of FSS performed by ERP. Based on the results of the FSS, an evaluation of the dose from the remaining activity was performed using RESRAD, and results were within the design criteria described in Section 2.2.

There was strict adherence to industrial safety and radiological safety precautions during the remediation. Work was performed under written and approved procedures, and any potentially hazardous steps were highlighted in the procedure to ensure understanding and compliance. A Job Risk Analysis was performed and approved for the remediation work. Radiological safety was accomplished by the presence of Radiation Control Technicians and performance of all work under a Radiological Work Permit.

6.1 Industrial Hygiene Oversight

IH oversight was conducted by ERP personnel in accordance with ERP procedures. The JRA identified hazards associated with each of the tasks identified and specified the required controls for each hazard. A designated Site Health and Safety Officer was onsite during cleanup activities to ensure controls were in place as specified in the JRA, including the use of safety equipment and safe work practices.

6.2 Radiological Monitoring

Radiological monitoring was conducted by BNL Radiological Control Technicians (RCTs) during cleanup activities. Radiological monitoring included general area air sample collection. General area air samples were collected with Science Application International Corporation (SAIC) low volume air samplers positioned downwind of cleanup activities and at the soil and debris dumping/railcar loading area. General area air sample results were used to track derived air concentration-hour (DAC-Hr) exposures. All general area air sample results were below 0.5 DAC.

Thermoluminescent dosimeters (TLD) were worn by each individual entering the work zone. No worker received a measurable dose by TLD while working on the Former HWMF Perimeter Area Project.

Workers entering the work zone were also required to have an annual whole body count prior to starting work on the project. In addition workers were required to complete a whole body monitoring using a PCM-1B or equivalent hand held instrument each time they exited the site, in accordance with BNL Radiological Control Manual requirements.

In addition to personal and general area monitoring, equipment used during cleanup activities was monitored for radiological contamination. All equipment that was released

from the work zone was surveyed in accordance with FS-SOP-1005, *Radiological Surveys Required For Release of Materials from Areas Controlled For Radiological Purposes* (BNL, November 2007).

7.0 OPERATION AND MAINTENANCE ACTIVITES

Land use and institutional control information for the former HWMF Perimeter Area will be included in a BNL *Factsheet: Former Hazardous Waste Management Facility Perimeter Area.* In addition, the BNL LUCMP will be revised to include the former HWMF Perimeter Area.

Post remediation operation and maintenance activities at the former HWMF Perimeter Area will be similar to those detailed in the *Operable Unit 1 Soils and Operable Unit V Long-Term Monitoring and Maintenance Plan* (BNL, May 2006) to ensure that land uses remain protective of public health and the environment. These activities will include institutional controls (land use controls, notifications and restrictions, work planning controls such as digging permits, and government ownership).

BNL's Groundwater Protection Group will perform operation and maintenance activities, in addition to maintaining institutional controls. This group will ensure that the controls listed above are in place. The DOE will ensure enforcement of all institutional controls.

8.0 SUMMARY OF PROJECT COSTS

The remediation of soils at the former HWMF Perimeter Area cost approximately $950,000 to complete. The original estimate cost for former HWMF Perimeter Area remediation was $1,062,000.

The clean-up costs of the former HWMF Perimeter Area included the following details:

Engineering and planning	$ 150,000
Remediation & Restoration	$ 550,000
Waste Transportation & Disposal	$ 250,000
Total Cost	$ 950,000

Costs associated with the characterization and initial remediation of former HWMF Perimeter Area soils is approximately $100,000.

9.0 OBSERVATIONS AND LESSONS LEARNED

The following is a summary of the lessons learned from this project and the corrective actions for future projects:

- Used a railcar soft top that was installed using bungee cords instead of tie downs. The soft top was easier to install and provided for a better fitting cover.

- The project team was not successful in renting a forklift that could be approved for use with the lifting rack used to transfer loaded Lift Liners. Ultimately an attachment to a front end loader was approved for use. However, the rated capacity for the loader attachment was approximately 10,000 lbs less than the maximum rated capacity for the lifting rack and package. In the future an appropriately sized forklift needs to be identified early on in the planning process.

- Excavating in 6-inch lifts minimized the volume of soil removed. Installation of a smooth cutting edge on the excavator was important in being able to achieve the small lifts.

- When clearing wooded areas for excavation large trees should be left behind and only small saplings and underbrush removed to minimize waste volumes and time spent clearing and grubbing. If subsequent radiological surveys identify contamination around trees they can be removed individually.

10.0 PROTECTIVENESS

The removal of contaminated soils at the former HWMF Perimeter Area (associated with the scope of the project) as well as the implementation of monitoring and institutional controls will protect human health and the environment. The removal of these wastes has minimized both the risk of exposure to on-site workers and the risks associated with future-use scenarios by decreasing radiation dose levels at the site. These actions have also minimized the potential for the migration of contaminants into the underlying groundwater.

11.0 FIVE YEAR REVIEW

Five-year reviews will be conducted to determine whether the remedy implemented continues to be protective of human health and the environment. These reviews will be performed in accordance with the *Comprehensive Five-Year Review Guidance, OSWER No. 9355.7-03B-P* (EPA, June 2001). The former HWMF, including the Perimeter Area, will be included in the second sitewide Five-Year Review in 2011.

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APPENDIX A

Former HWMF Perimeter Soils Area
Final Status Survey and Endpoint Results

1- BNL FSS and Endpoint Sample Results
2- BNL Radiological Survey Form s – Gamma Walkover Survey and Fixed Point Readings
3- Analytical Results

Final Status Survey Surface Soil Sample Radiological Results

Sample ID		Lab ID	GEL Result (pCi/g)																																			
Location	Depth (ft)		Am-241			Be-7			Cs-134			Cs-137			Co-57			Co-60			Eu-152			Eu-154			Eu-155			Mn-54			Pu-238			Pu-239/240			Ra-226			Na-22			Sr-90			H-3			U-235/236			U-238			Zn-65		
FSS-1	0-0.5	27479-001	J-UI	0.0507		U	0.01		UI	0.0483			5.34		U	0.00324		U	0.00702		U	0.00825		U	-0.0308		U	0.0408		U	0.00439		U	-0.013		U	0.00			0.663		U	-0.0122		U	-0.435		U	1.86		U	0.00		J	0.437		J-UI	0.0844
FSS-2	0-0.5	27479-002		U	0.0742		U	-0.0334		UI	0.0709		J	1.43		U	-0.00272		U	0.00695		U	-0.0156		U	0.01		U	0.0417		J-UI	0.0235			NA			NA			0.626		U	0.00298			NA			NA			NA			NA		U	-0.023
FSS-3	0-0.5	27479-003		U	0.0204		U	0.0196		UI	0.0498			8.03		U	0.00653		U	-0.00271		U	-0.0585		U	-0.0146		U	0.0616		U	0.0043			NA			NA			0.713		U	-0.0062			NA			NA			NA			NA		U	-0.0194
FSS-4	0-0.5	27479-004		U	0.0999		DL	0.131		UI	0.0736			11.0		DL	0.00576		U	-0.00976		U	-0.0529		U	-0.0203		U	0.0577		J-UI	0.0244			NA			NA			0.535		U	-0.0111			NA			NA			NA			NA		U	-0.034
FSS-5	0-0.5	27479-005		U	-0.0196		U	0.116		UI	0.0506		J	2.05		U	0.00657		U	-0.00374		U	-0.00724		U	-0.0211		J-UI	0.109		U	0.00381			NA			NA			0.729		U	-0.0075			NA			NA			NA			NA		U	0.228
FSS-6	0-0.5	27479-006		U	0.00643		DL	-0.0259		UI	0.0501			8.73		U	-0.00794		U	0.00103		U	-0.0318		U	0.00129		J-UI	0.085		U	0.0153			NA			NA			0.624		U	0.000677			NA			NA			NA			NA		U	0.0394
FSS-7	0-0.5	27479-007		U	0.0551		U	0.0274		UI	0.056		J	1.69		U	-0.00126		U	0.000565		U	-0.0358		U	0.00427		U	0.040		U	0.00456			NA			NA			0.502			0.00196			NA			NA			NA			NA		U	6.36E-05
FSS-8	0-0.5	27479-008		U	0.0793		U	-0.226		UI	0.0497			4.72		DL	0.00467		U	0.00656		U	0.0383		U	0.023		U	0.0724		U	0.00368			NA			NA			0.692			0.00788			NA			NA			NA			NA		U	-0.0213
FSS-9	0-0.5	27479-009	J-UI	0.0412		DL	0.0919		UI	0.0451			3.91		U	0.00443		U	-0.00395		U	-0.00034		U	0.00852		U	0.0352		U	0.0074			NA			NA			0.649		U	0.00282			NA			NA			NA			NA		U	-0.0216
FSS-10	0-0.5	27479-010		U	-0.00713		U	0.0279		UI	0.0619		J	2.22		U	0.00297		U	0.0106		U	0.00414		U	-0.00595		U	0.0463		U	0.00196			NA			NA			0.521		U	-0.00257			NA			NA			NA			NA		U	-0.0228
FSS-11	0-0.5	27479-011		U	0.0414		U	0.151		UI	0.0596		J	0.517		U	0.00748		U	-0.0164		U	0.0012		U	-0.0331		U	0.023		U	0.00236			NA			NA			0.758		U	-0.012			NA			NA			NA			NA		U	0.0323
FSS-12	0-0.5	27479-012		U	0.0415		U	-0.0879		UI	0.0716		J	1.85		DL	-0.00835		U	-0.00185		U	-0.00186		U	0.0098		U	0.00863		U	-0.00232			NA			NA			0.698		U	0.00362			NA			NA			NA			NA		U	0.0357
FSS-13	0-0.5	27479-013		J-UI	0.138		U	0.0683		UI	0.0627		J	2.30		U	-0.00339		U	0.000361		U	-0.0291		U	0.00698		U	0.0323		U	0.00359			NA			NA			0.639		U	0.00287			NA			NA			NA			NA		U	-0.0398
FSS-14	0-0.5	27479-014		U	0.00287		U	-0.175		UI	0.0858			2.89		U	0.00316		U	8.73E-06		U	-0.00166		U	-0.00113		U	0.0333		U	-0.00088			NA			NA			0.624		U	-0.00029			NA			NA			NA			NA		U	0.0107
FSS-15	0-0.5	27479-015		U	0.00858		U	0.052		UI	0.0519			9.02		U	0.00128		U	0.00531		U	0.00724		U	0.0243		U	0.0581		U	0.0139			NA			NA			0.632		U	0.00901			NA			NA			NA			NA		U	-0.0149
FSS-16	0-0.5	27479-016		U	0.0652		U	-0.108		UI	0.0525			3.57		U	0.000873		U	0.00349		U	0.0256		U	0.0328		U	0.0665		U	-0.00285			NA			NA			0.692		U	0.0112			NA			NA			NA			NA		U	0.0114
FSS-17	0-0.5	27479-017		U	0.0719		U	-0.0483		UI	0.0411			2.67		U	-0.00041		U	0.00385		U	-0.0376		U	0.0355		U	0.0469		U	0.0174			NA			NA			0.626		U	0.00739			NA			NA			NA			NA		U	-0.0176
FSS-18	0-0.5	27479-018		U	0.0345		DL	0.0531		J-UI	0.0387			6.91		U	-0.00045		U	-0.00864		U	-0.0763		U	-0.0236		U	0.0778		U	-0.00812			NA			NA			0.717		U	-0.00792			NA			NA			NA			NA		U	0.0306
FSS-COMP	0-0.5	27479-019		U	0.0262		U	0.0378		UI	0.0505			3.69		U	-0.00191		U	-0.00623		U	-0.0515		U	-0.0137		U	0.0451		U	0.00451		U	-0.179		U	-0.0139			0.657		U	-0.00646		U	0.106		U	6.76		U	0.00		J	0.644		U	0.0116

Final Status Survey Soil Boring Results

Sample ID		Lab ID	GEL Result (pCi/g)																																			
Location	Depth (ft)		Am-241			Be-7			Cs-134			Cs-137			Co-57			Co-60			Eu-152			Eu-154			Eu-155			Mn-54			Ra-226			Na-22			Sr-90			Zn-65		
FSS-2	0-2	27477-001		U	0.0305		U	-0.071		UI	0.0469		J	0.177		U	-0.00455		U	0.00753		U	-0.0424		U	-0.0354		U	0.0592		U	0.0199			0.759		U	-0.0132		U	-0.0486		U	-0.0103		
FSS-2	2-4	27477-002		U	0.00766		DL	-0.0756		UI	0.135		U	-0.00243		DL	0.00417		U	-0.0131		U	-0.0161		U	-0.031		U	0.0892		DL	0.0508			1.14		DL	-0.0104		U	-0.342		U	0.0441		
FSS-2	4-6	27477-003		U	0.0979		U	-0.0142		UI	0.0668		U	0.0143		U	-0.00226		U	-0.00219		U	-0.00482		U	0.0063		U	0.0258		U	0.00143			0.616		U	0.00338		U	0.467		U	0.02		
FSS-2	6-8	27477-004		U	0.0289		U	0.0889		UI	0.0461		U	-0.00649		U	-0.00448		U	-0.0282		U	-0.0498		U	-0.0349		U	0.0259		U	0.00219			0.453		U	-0.0119		U	-0.736		U	0.00357		
FSS-9	0-2	27477-005		U	0.0274		U	-0.0801		UI	0.071		J	0.433		U	-0.00133		U	-0.00116		U	-0.0455		U	-0.00636		J-UI	0.0947		U	0.000712			0.698		U	0.000682		U	-0.235		U	-0.0364		
FSS-9	2-4	27477-006		U	0.0468		U	0.021		UI	0.0993		U	0.0204		U	0.00834		U	0.000238		U	0.00069		U	-0.0689		U	0.0603		U	0.00512			0.819		U	-0.0243		U	-0.37		U	-0.0599		
FSS-9	4-6	27477-007		U	0.0957		U	-0.044		UI	0.0745		U	-0.0159		U	0.00148		U	-0.0116		U	0.00926		U	-0.0366		J-UI	0.100		U	0.0237			0.945		U	-0.0105		U	-0.179		U	0.00308		
FSS-9	6-8	27477-008		U	0.0247		U	0.0194		UI	0.0589		U	-0.0111		U	0.00285		U	0.0068		U	-0.0289		U	0.00785		U	0.0108		U	-0.00966			0.517		U	-0.00106		U	0.185		U	0.0201		
FSS-16	0-2	27477-009		U	0.0912		DL	0.0462		UI	0.0551			3.27		DL	0.0132		U	-0.00026		U	-0.0237		U	-0.0515		U	0.00164		U	0.00582			0.747		U	-0.0178		U	0.0116		U	0.00458		
FSS-16	2-4	27477-010		U	0.0403		DL	-0.181		UI	0.0715		U	0.000452		DL	0.00772		U	0.0159		U	-0.0105		U	-0.0402		J-UI	0.0962		U	-0.0365			1.01		U	-0.0144		U	-0.0446		U	0.00966		
FSS-16	4-6	27477-011		U	-0.217		U	-0.0953		UI	0.0663		U	0.0125		DL	-0.0112		U	0.00902		U	0.0313		U	0.029		U	0.078		U	-0.00193			0.904		U	0.00978		U	0.397		U	-0.00755		
FSS-16	6-8	27477-012		U	0.0211		U	0.0361		UI	0.0535		U	-0.00212		U	0.00477		U	0.0136		U	-0.0121		U	-0.0156		U	0.0345		U	-0.0103			0.502		U	-0.00567		U	-0.0103		U	0.0103		

Final Status Survey Surface Soil Sample Chemical Results

Sample ID		Lab ID	GEL Result (mg/kg)				
Location	Depth (ft)		Mercury			Lead	
FSS-1 (Contiguous Area)	0-0.5	27479-001	J	0.0195			9.86
FSS-COMP (Contiguous Area)	0-0.5	27479-019	J	0.0315			13.0

NOTES:
U - Undetected; sample result <MDA
UI - Uncertain indentification for gamma spectroscopy
J - Estimated Value; the sample result was greater than the MDA but less than the required detection limit
ND - Non-detect
DL - Sample result reported from diluted aliquot of the sample

Discrete Area Soil Sample Radiological Results

Sample ID		Lab ID	GEL Result (pCi/g)																																			
Location	Depth (ft)		Am-241		Be-7		Cs-134		Cs-137		Co-57		Co-60		Eu-152		Eu-154		Eu-155		Mn-54		Pu-238		Pu-239/240		Ra-226		Na-22		Sr-90		H-3		U-235/236		U-238		Zn-65	
FSS-I	0-0.5	27484-001	U	0.00775	DL	0.215	UI	0.0599		4.22	DL	-0.00724	U	-0.00455	U	-0.0363	U	-0.0352	U	0.0395	U	0.0224		NA		NA		0.476	U	-0.0124		NA		NA		NA		NA	U	-0.0305
FSS-J	0-0.5	27484-002	U	-3.32E-05	U	0.109	U	0.032		2.66	U	-0.00505	U	0.016	U	-0.0282	U	0.000387	J-UI	0.0795	U	0.00692		NA		NA		0.576	U	0.000137		NA		NA		NA		NA	U	0.0283
FSS-K	0-0.5	27484-003	U	0.0411	DL	-0.199	UI	0.0565		10.0	DL	0.0067	U	0.00266	U	-0.0463	U	0.0346	U	0.0862	U	0.012		NA		NA		0.585	U	0.0124		NA		NA		NA		NA	U	-0.0153
FSS-L	0-0.5	27484-004	U	0.0323	U	0.102	UI	0.0581		4.16	U	0.00158	U	-0.00413	U	-0.0196	U	-0.0121	J-UI	0.0899	J-UI	0.0193		NA		NA		0.527	U	-0.00631		NA		NA		NA		NA	U	0.000466
FSS-M	0-0.5	27484-005	U	0.0172	U	0.0994	UI	0.0612		5.68	U	-0.00211	U	0.00822	U	0.0123	U	-0.00859	J-UI	0.0898	U	0.00347		NA		NA		0.572	U	-0.00353		NA		NA		NA		NA	U	0.014
FSS-N	0-0.5	27484-006	J-UI	0.0538	DL	0.0293	UI	0.0595		15.10	U	0.00759	U	-0.00929	U	-0.0395	U	-0.0112	U	0.0534	U	-0.00374		NA		NA		0.593	U	-0.00361		NA		NA		NA		NA	U	-0.00458
FSS-O	0-0.5	27484-007	U	0.0234	U	-0.192	U	0.0266		8.92	U	0.00764	U	0.00798	U	-0.0156	U	-0.05	J-UI	0.083	U	-0.00275		NA		NA		0.503	U	-0.0183		NA		NA		NA		NA	U	0.0462
FSS-P	0-0.5	27484-008	U	0.0604	DL	0.135	UI	0.0479		8.98	U	-0.00336	U	-0.00116	U	-0.00483	U	-0.025	U	0.0331	U	-0.00538		NA		NA		0.571	U	-0.00924		NA		NA		NA		NA	U	0.0112
FSS-T	0-0.5	27484-009	U	0.017	U	0.0557	U	0.0149	J	0.86	U	-0.00035	U	0.00166	U	-0.0306	U	0.0114	U	0.0147	U	0.00546		NA		NA		0.222	U	0.0019		NA		NA		NA		NA	U	-0.00616
FSS-U	0-0.5	27484-010	U	0.0469	J-UI	0.224	UI	0.057	J	1.18	U	0.0062	U	0.00411	U	-0.00273	U	-0.0297	U	0.0561	U	0.00488		NA		NA		0.351	U	-0.0107		NA		NA		NA		NA	U	-0.0366
FSS-W	0-0.5	27484-011	U	0.0517	U	9.06	J-UI	0.0398	J	1.42	U	-0.00509	U	-0.00289	U	-0.042	U	-0.0266	U	0.0613	U	-0.00268		NA		NA		0.419	U	-0.00984		NA		NA		NA		NA	U	0.00203
FSS-COMP	0-0.5	27484-012	U	-0.163		NA		NA		NA		NA		NA		NA		NA		NA		NA	U	0.0886	U	0.00		NA		NA	U	0.109	U	-13.9	U	-0.0202	J	0.427		NA

Diescrete Area Soil Sample Chemical Results

Sample ID		Lab ID	GEL Result (mg/kg)			
Location	Depth (ft)		Mercury		Lead	
FSS-COMP (Discrete Areas)	0-0.5	27484-013	J	0.0222		9.92

NOTES:
U - Undetected; sample result <MDA
UI - Uncertain indentification for gamma spectroscopy
J - Estimated Value; the sample result was greater than the MDA but less than the required detection limit
ND - Non-detect
DL - Sample result reported from diluted aliquot of the sample

Radiological Quality Control/Quality Assurance Sample Results

Sample ID		Lab ID	GEL Result (pCi/g)																																					
Location	Depth (ft)		Am-241		Be-7		Cs-134		Cs-137		Co-57		Co-60		Eu-152		Eu-154		Eu-155		Mn-54		Pu-238		Pu-239/240		Ra-226		Na-22		Sr-90		H-3		U-235/236		U-238		Zn-65	
FB-1	0	27477-013	U	-0.0032	U	-0.0333	U	0.0204	U	-0.00279	U	0.00473	U	-0.00652	U	-0.00863	U	-0.0138	U	0.0182	U	0.0105		NA		NA		0.215	U	-0.00518	U	0.409		NA		NA		NA	U	-0.00312
BD-1	0-2	27477-014	U	0.0813	U	0.102	UI	0.0562	J	0.181	DL	0.00655	U	-0.00671	U	-0.0627	U	-0.0161	U	0.0454	U	-0.00057		NA		NA		0.646	U	-0.00567	U	-0.274		NA		NA		NA	U	-0.0407
BD-1	2-4	27477-015	U	0.0212	U	-0.0119	UI	0.075	U	-0.00057	U	0.00673	U	5.70E-05	U	-0.0128	U	-0.0153	J-UI	0.0671	J-UI	0.0368		NA		NA		0.699	U	-0.00656	U	0.372		NA		NA		NA	U	0.0129
BD-1	4-6	27477-016	U	0.069	U	0.00836	UI	0.0679	U	-0.018	DL	-0.00662	U	-0.00026	U	-0.00629	U	-0.0283	U	0.0994	U	-0.0228		NA		NA		1.18	U	-0.00938	U	-0.0656		NA		NA		NA	U	-0.0318
BD-1	6-8	27477-017	U	0.0458	U	0.00892	UI	0.047	U	-0.0129	U	-0.00056	U	-0.0158	U	-0.00014	U	-0.0472	U	0.0287	U	0.00382		NA		NA		0.521	U	-0.0146	U	-0.165		NA		NA		NA	U	-0.0243
BD-1	0-0.5	27479-020	U	0.169	DL	0.122	UI	0.0748		8.58	U	-0.00917	U	0.00577	U	-0.0709	U	-0.0417	U	0.0217	U	0.012		NA		NA		0.766	U	-0.0157		NA		NA		NA		NA	U	-0.0125
FB-1	0	27479-021	U	0.0175	U	-0.0385	U	0.0178	U	-0.0108	U	-0.00172	U	0.00772	U	-0.00318	U	0.0215	U	0.024	U	-0.00185	U	0.00406	U	0.00203		0.197	U	0.00785	U	0.221	U	-5.41	U	0.133	U	0.20	U	0.00609
BD-1	0-0.5	27484-014	U	0.0205	U	0.0997	UI	0.0792		4.42	U	-0.00035	U	0.00193	U	-0.0087	U	0.0377	U	0.00704	U	0.00392		NA		NA		0.610	U	0.0056		NA		NA		NA		NA	U	-0.0422
FB-1	0	27484-015	U	0.0457	U	0.042	U	0.0229	U	0.00275	U	0.0029	U	-0.00892	U	0.0165	U	-0.00526	U	0.0142	U	-0.00034	U	0.00	U	0.0397		0.262	U	-0.00076	U	0.0963	U	-4.15	U	0.00	U	-0.00946	U	0.00965

Chemical Quality Control/Quality Assurance Sample Results

Sample ID		Lab ID	GEL Result (mg/kg)			
Location	Depth (ft)		Mercury		Lead	
FB-1	0	27479-021	U	ND		0.859

NOTES:
U - Undetected; sample result <MDA
UI - Uncertain indentification for gamma spectroscopy
J - Estimated Value; the sample result was greater than the MDA but less than the required detection limit
ND - Non-detect
DL - Sample result reported from diluted aliquot of the sample

Radionuclide Concentrations By Gamma Spectroscopy
Procedure CP1 - Revision 16

Reported Data

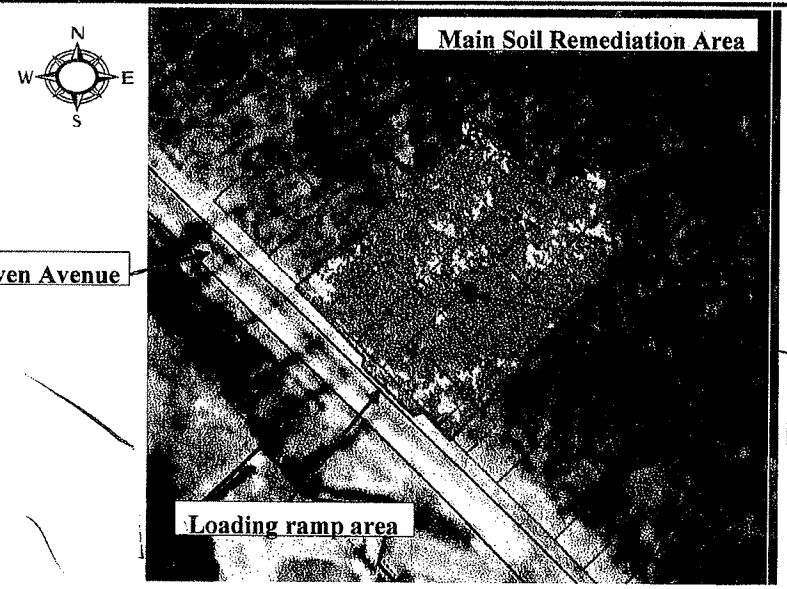
ORISE Sample ID	Sample Date	Geom.	SQ	Detector No.	Cs-137 pCi/g			MDC
5062S0001	9/29/2009	LM	636.67	DET07	54.3	±	4.7	0.16
5062S0002	9/29/2009	LM	638.18	DET08	30.5	±	2.8	0.13
5062S0003	9/29/2009	FM	871	DET07	4.86	±	0.65	0.05
5062S0004	9/29/2009	LM	728.78	DET08	20.9	±	1.9	0.08
5062S0005	9/29/2009	LM	596.91	DET07	2.31	±	0.22	0.06
5062S0006	9/29/2009	LM	689.61	DET08	9.82	±	0.92	0.06
5062S0007	9/29/2009	LM	705.23	DET06	1.55	±	0.13	0.04
5062S0008	9/29/2009	LM	730.88	DET09	5.10	±	0.47	0.07
5062S0009	9/29/2009	LM	494.01	DET06	8.40	±	0.60	0.07
5062S0010	9/29/2009	LM	661.5	DET07	18.2	±	1.6	0.10
5062S0011	9/29/2009	LM	519.66	DET08	26.6	±	2.5	0.10
5062S0012	9/29/2009	LM	733.92	DET09	30.8	±	2.8	0.13
5062S0013	9/29/2009	LM	654.7	DET09	47.5	±	4.3	0.19
5062S0014	9/29/2009	LM	592.29	DET06	1.51	±	0.13	0.05
5062S0015	9/29/2009	LM	584.89	DET07	0.96	±	0.11	0.05
5062S0016	9/29/2009	LM	524.94	DET08	1.79	±	0.18	0.05
5062S0017	9/29/2009	LM	521.02	DET09	1.07	±	0.12	0.06
5062S0018	9/29/2009	LM	470.12	DET06	2.43	±	0.20	0.06
5062S0019	9/29/2009	LM	446.91	DET07	1.88	±	0.19	0.06
5062S0020	9/29/2009	LM	799.82	DET08	0.18	±	0.03	0.02
5062S0021	9/29/2009	FM	890.82	DET09	0.03	±	0.01	0.03
5062S0022	9/29/2009	FM	861.63	DET07	0.06	±	0.02	0.03
5062S0023	9/29/2009	FM	965.43	DET08	0.10	±	0.02	0.02

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine _____ ☐ Special _____
☒ RWP# 2009-ERP- 010 ☐ WP

Location / Equipment: F.H.W.M.F., @ M.S.R.A.
Date: 08/12/09
Time: 17:00

Survey: Final status GPS walk over of the main soil remediation area, post excavation



Note:

The dark spots / marks inside of the MSRA are standing trees and large root infra structure.

Note:

(A) The above GPS map of the main soil remediation area is indicative of post excavation / walk over with the standard Ludlum - 2221[2], and follow up final status walk over using the Trimble / Ludlum - 2221[1]. as indicated on the attached map legend, all grid squares inside of this area regarding activity are < 21, 500 cpm.

(B) All equipment and tools used inside of the MSRA have been removed and all activity checks of the same were ≈ Bkgd. and / or < 1K dpm, see RWP and contamination / activation log for surveys.

(C) See page 2 of 2 [attached sheet] for cpm and distance legend.

INSTRUMENT

Model #	Serial #	CAL DUE
Trimble ProXRS	022027631	N/A
LUD-2221[1]	254783	01/12/10
LUD-2221[2]	211784	01/10/10
N/A		

LEGEND

○ - SMEAR SURVEY LOCATION
△ - AIR SAMPLE LOCATION
▨ - MASSLINN SURVEY LOCATION
DIRECT FRISK LOCATION
C̄ - CONTAMINATION
✻ CONTACT
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis µCi/cc	% DAC
N/A					

DOSE RATE (HIGHEST)

CONTACT READING	N/A
GENERAL AREA READING	N/A

MASSLINN SURVEY RESULTS (in dpm)

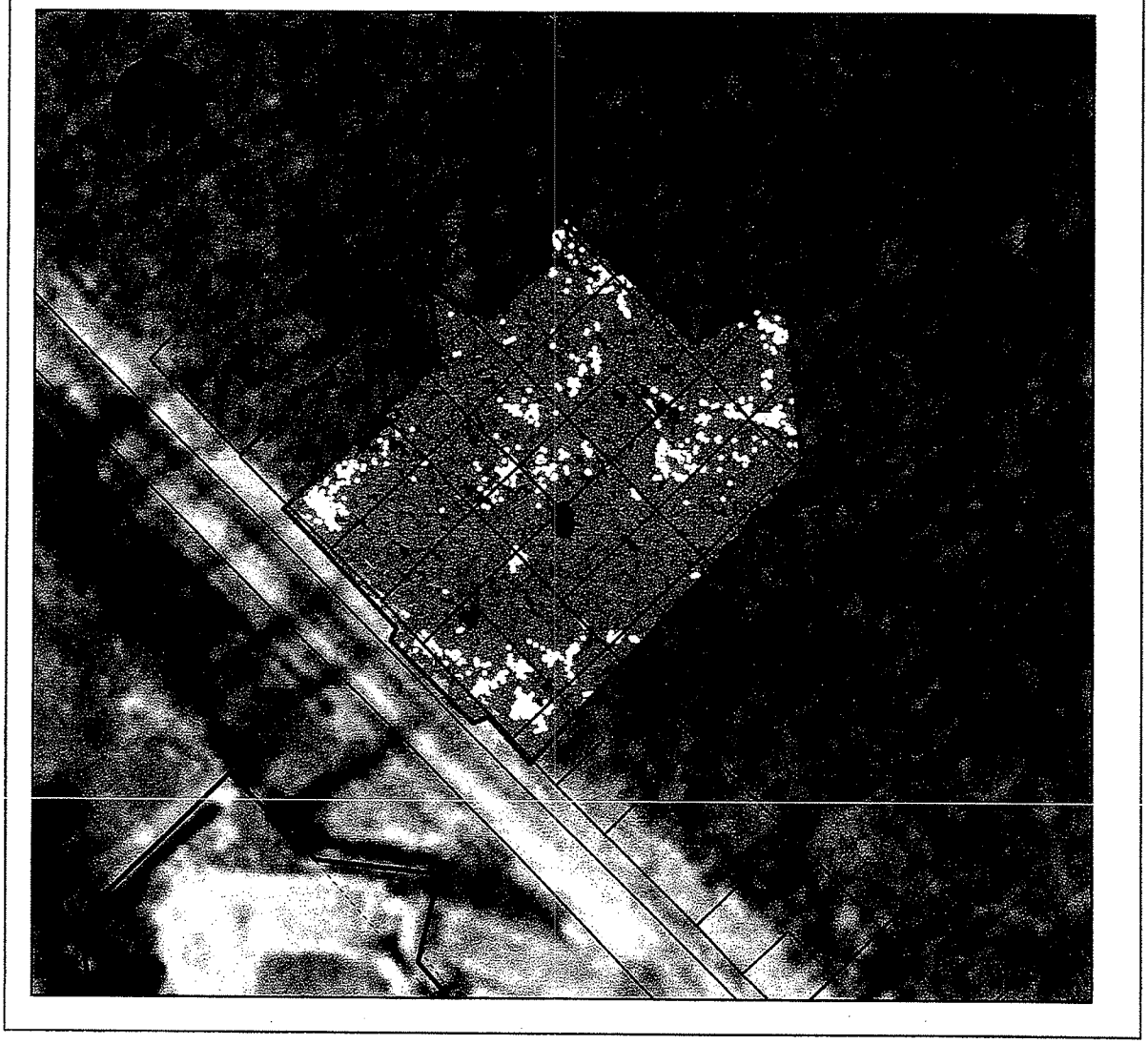
1.	N/A	5.	N/A
2.		6.	
3.		7.	
4.		8.	

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

1.	N/A	8.	N/A	15.	N/A
2.		9.		16.	
3.		10.		17.	
4.		11.		18.	
5.		12.		19.	
6.		13.		20.	
7.		14.		21.	

Surveyed By: Sean A. Gully Date: 09/03/09 Reviewed By: Date: 9/9/09

FS-SOP-1000
Attachment 9. 2



Coordinate System: NAD83, New York Long Island - Units: Feet

0 62.5 125 250

Feet

Legend

FHWMF Survey Perimeter

Gamma Count Rate

(cpm)

- < 15,000
- 15,000 - 21,500
- > 21,500

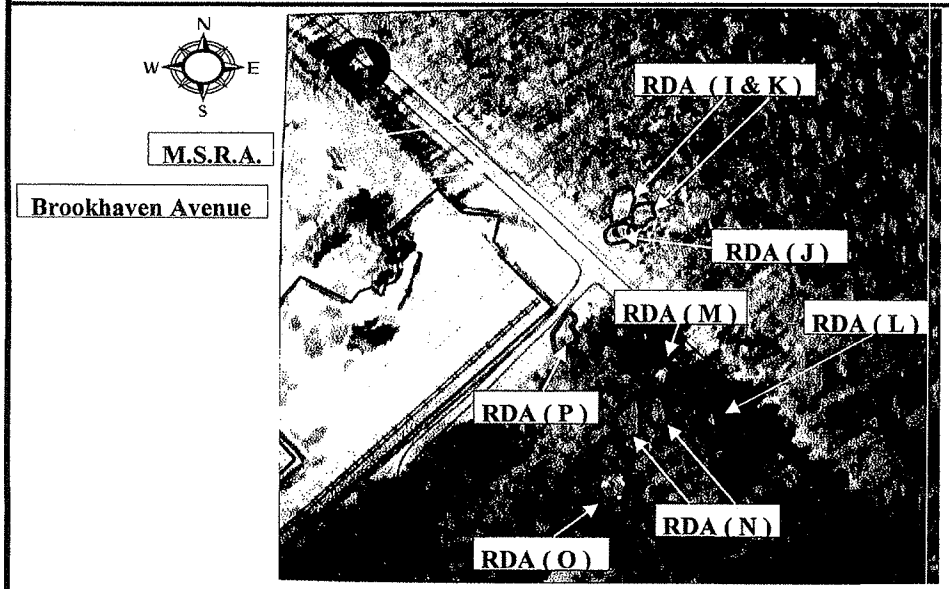
GPS-Based Radiological Survey
Brookhaven National Laboratory
SRA
August 12, 2009

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine _____ ☐ Special _____
☒ RWP# 2009-ERP- 010 ☐ WP

Location / Equipment: F.H.W.M.F., @ M.S.R.A.
Date: 08/18/09
Time: 17:00

Survey: Post excavation GPS final status walk over of the Remote Discrete Area locations [J-K-I-L-M-N-O & P].



Note:

(A) The above GPS map showing the remote discrete area locations. Initial post excavation use of the standard Ludlum 2221[2] meter perusing the original remote discrete area locations and the follow up final status survey [above] using the GPS / Ludlum 2221[1] meter.

(B) All tools and equipment used inside of the RDA have been removed and all activity checks of the same were ≈ Bkgd. and / or < 1K dpm, see RWP and contamination / activation log for surveys.

(C) See page 2 of 2 [attached sheet] for cpm and distance legend.

(D) For information only, the larger remote discrete area on the south side of brookhaven avenue has been posted as a Soil Contamination Area, due to new hot spots found [not part of the original survey].

INSTRUMENT

Model #	Serial #	CAL DUE
Trimble ProXRS	022027631	N/A
LUD-2221[1]	254783	01/12/10
LUD-2221[2]	211784	01/10/10
N/A →		

LEGEND
○ - SMEAR SURVEY LOCATION
△ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION
DIRECT FRISK LOCATION
C - CONTAMINATION
* CONTACT
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis µCi/cc	% DAC
N/A →					

DOSE RATE (HIGHEST)

CONTACT READING	N/A
GENERAL AREA READING	N/A

MASSLINN SURVEY RESULTS (in dpm)

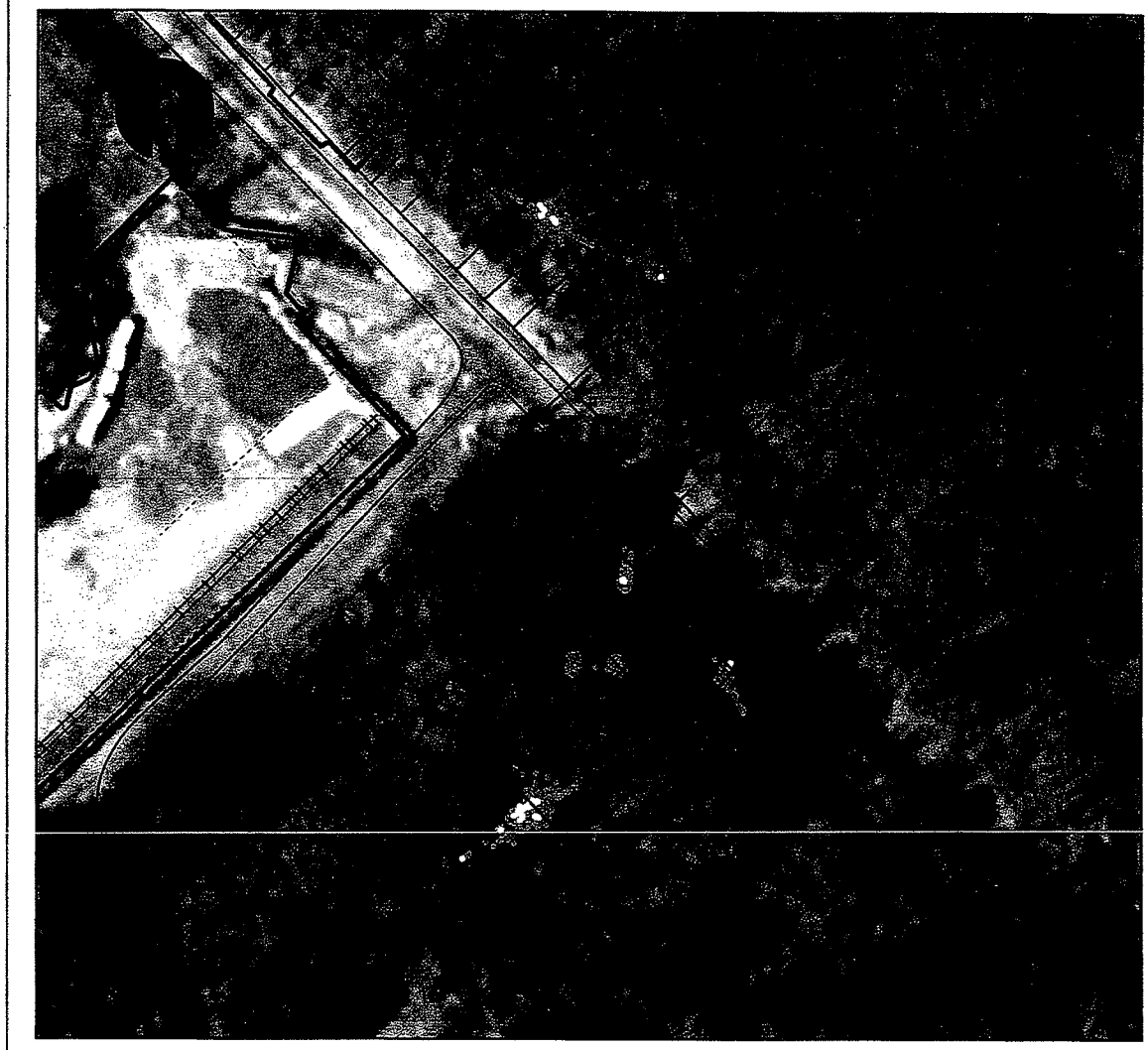
1.	N/A	5.	N/A
2.		6.	
3.		7.	
4.		8.	

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

1.	N/A	8.	N/A	15.	N/A
2.		9.		16.	
3.		10.		17.	
4.		11.		18.	
5.		12.		19.	
6.		13.		20.	
7.		14.		21.	

Surveyed By: Sean A. Gully Date: 09/04/09 Reviewed By: Date: 9/9/09

FS-SOP-1000
Attachment 9. 2



Coordinate System: NAD83, New York Long Island - Units: Feet

0 62.5 125 250

Feet

Legend

FHWMF Survey Perimeter

Gamma Count Rate

(cpm)

- < 15,000
- 15,000 - 21,500
- > 21,500

GPS-Based Radiological Survey
Brookhaven National Laboratory
Remote Discrete Areas
August 17, 2009

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine _____ ☐ Special _____
☒ RWP# 2009-ERP-010 ☐ WP

Location / Equipment: F.H.W.M.F., M.S.R.A. | Date: 08/19/09 | Time: 17:00

Survey: GPS walk over of the main soil remediation area, showing the final status sample point locations.

Note:

(A) The attached GPS map [page 2 of 2] is indicative of the eighteen (18) sample point locations from which the final status soil samples were taken. Using a Ludlum 2221[1] ≈ meter with a 44-10 NaI 2 x 2 probe.

(B) As per procedure, prior to taking the samples, one minute static counts were taken using a Ludlum 2221[2] meter with a 44-10 NaI 2 x 2 probe. The following static count results are in cpm and correlate with the visual sample locations, see attached page 2 of 2.

SL #1 ≈ 17, 201 cpm.
SL #2 ≈ 9, 615 cpm.
SL #3 ≈ 12, 856 cpm.
SL #4 ≈ 13, 810 cpm.
SL #5 ≈ 12, 876 cpm.
SL #6 ≈ 12, 293 cpm.
SL #7 ≈ 8, 552 cpm.
SL #8 ≈ 10, 695 cpm.
SL #9 ≈ 12, 084 cpm.
SL #10 ≈ 9, 967 cpm.
SL #11 ≈ 10, 334 cpm.
SL #12 ≈ 9,751cpm.
SL #13 ≈ 9,244cpm.
SL #14 ≈ 10, 473cpm.
SL #15 ≈ 11, 881cpm.
SL #16 ≈ 13, 182cpm.
SL #17 ≈ 10, 781cpm.
SL #18 ≈ 11, 838cpm.

INSTRUMENT

Model #	Serial #	CAL DUE
Trimble Pro XRS	0220276431	N/A
LUD-2221 [1]	254783	01/12/10
LUD-2221 [2]	211784	01/10/10
N/A		

LEGEND
○ - SMEAR SURVEY LOCATION
AIR - AIR SAMPLE LOCATION
▨ - MASSLINN SURVEY LOCATION
DIRECT FRISK LOCATION
C̄ - CONTAMINATION
✻ CONTACT
XXXY/ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis µCi/cc	% DAC
N/A					

DOSE RATE (HIGHEST)

CONTACT READING	N/A
GENERAL AREA READING	N/A

MASSLINN SURVEY RESULTS (in dpm)

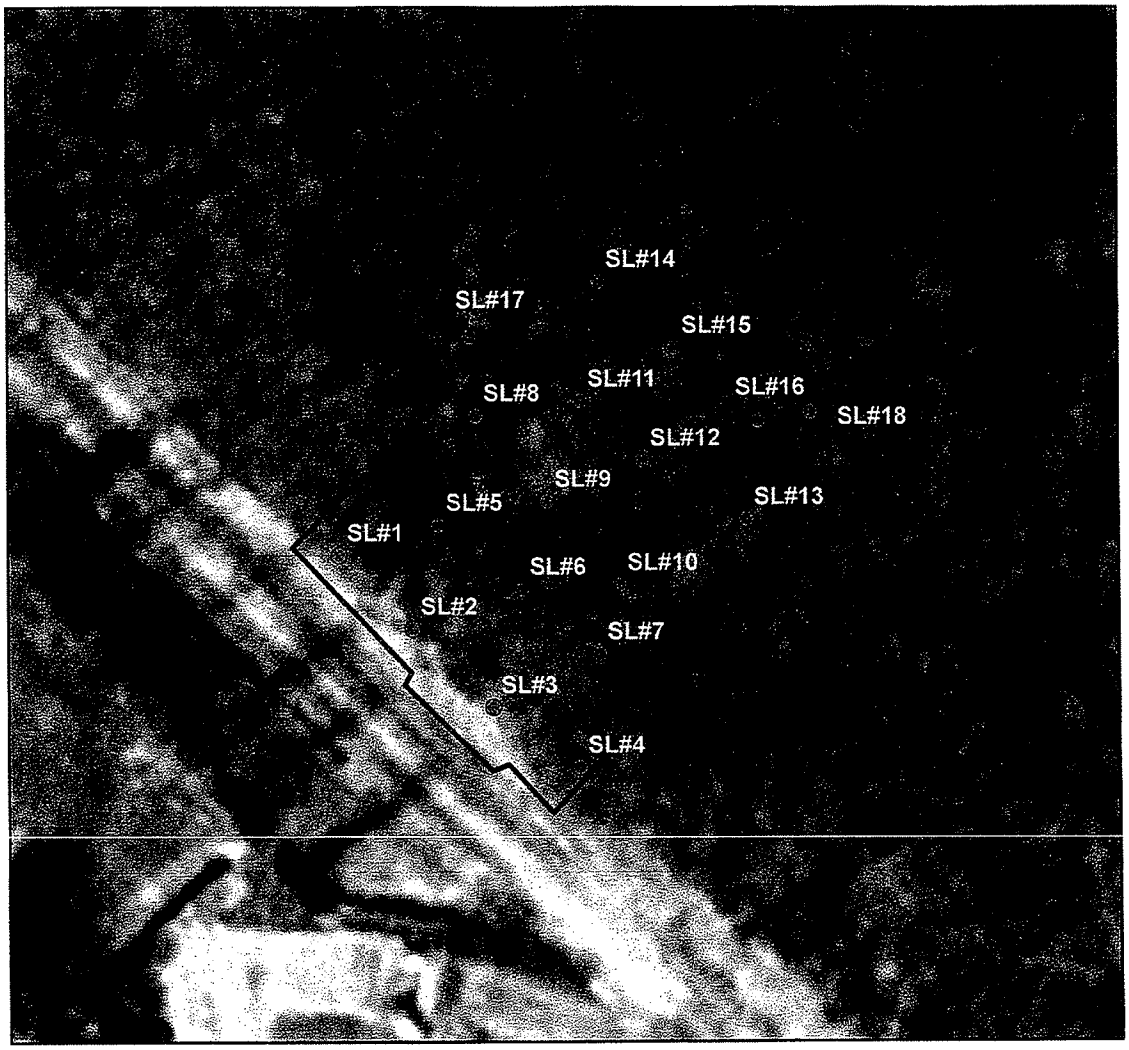
1.	N/A	5.	N/A
2.		6.	
3.		7.	
4.		8.	

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ^{3}H

1.	N/A	8.	N/A	15.	N/A
2.		9.		16.	
3.		10.		17.	
4.		11.		18.	
5.		12.		19.	
6.		13.		20.	
7.		14.		21.	

Surveyed By: Sean A. Gully Date: 09/02/09 Reviewed By: Date: 9/9/09

8-19-09



Coordinate System: NAD83, New York Long Island - Units: Feet

0 62.5 125 250

Feet

GPS-Based Radiological Survey
Brookhaven National Laboratory
SRA Sample Locations
August 27, 2009

Legend

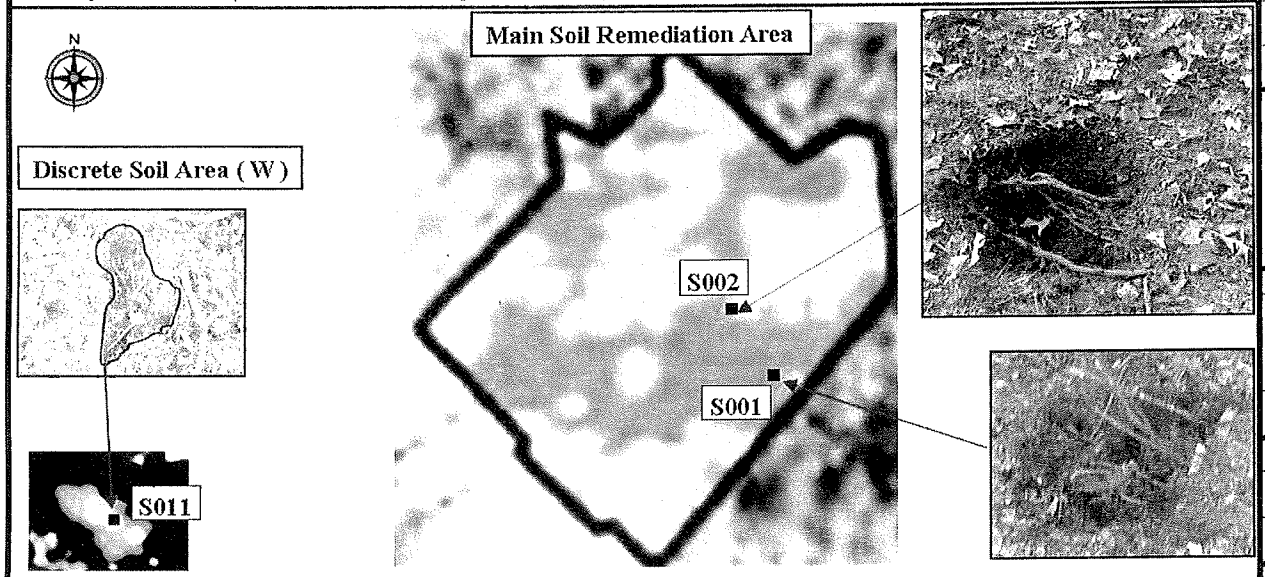
- SRA Sample Locations
- FHWMF Survey Perimeter

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine _____ ☐ Special _____
☒ RWP# 2009-ERP-010 ☐ WP

Location / Equipment: M.S.R.A. and D.S.R.A. | **Date:** 10/20/09 | **Time:** 13:00

Survey: Remediate M.S.R.A. locations [S001-S002-], and D.S.R.A. location [S011].



Note:

(A) Post remediation of S001, perusal of affected area with NaI probe ≈ 12K cpm to 18K cpm and a one minute static count ≈ 17, 909 cpm. And the outer surrounding area [2 ft. from edge] is 4K cpm to 6K cpm.

Post remediation of S002, perusal of affected area with NaI probe ≈ 14K cpm to 17K cpm and a one minute static count ≈ 16,995 cpm. And the outer surrounding area [2 ft. from edge] is 4K cpm to 6K cpm.

Post remediation of S011, perusal of affected area with NaI probe ≈ 15K cpm to 18K cpm and a one minute static count ≈ 17,800 cpm. And the outer surrounding area [2 ft. from edge] is 12K cpm to 15.7 cpm.

(B) Marinelli samples [S001A-S002A-S011A] taken for ISOCS.
ISOCS Results:
001-S001A weighed 627 grams, Cs137 15. 4 pCi / Grams.
002-S002A weighed 578 grams, Cs137 7. 6 pCi / Grams.
003-S011A weighed 482 grams, Cs137 11. 07pCi / Grams.

(C) Smear results for external sample containers and equipment used, see page 2 of 2.

INSTRUMENT

Model #	Serial #	CAL DUE
LB5100S4	32487	07/17/09
LUD2221	211784	01/10/10
LUD-3	74417	03/27/10
N/A		

LEGEND
○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION # DIRECT FRISK LOCATION
C - CONTAMINATION * CONTACT
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis µCi/cc	% DAC
N/A					

DOSE RATE (HIGHEST)

CONTACT READING	N/A
GENERAL AREA READING	N/A

MASSLINN SURVEY RESULTS (in dpm)

1.	< 1K	5.	N/A
2.		6.	
3.		7.	
4.		8.	

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ^{3}H

1.	See	8.	Attached	15.	Results
2.	Batch	9.	Number	16.	662
3.		10.		17.	
4.		11.		18.	
5.		12.		19.	
6.		13.		20.	
7.		14.		21.	

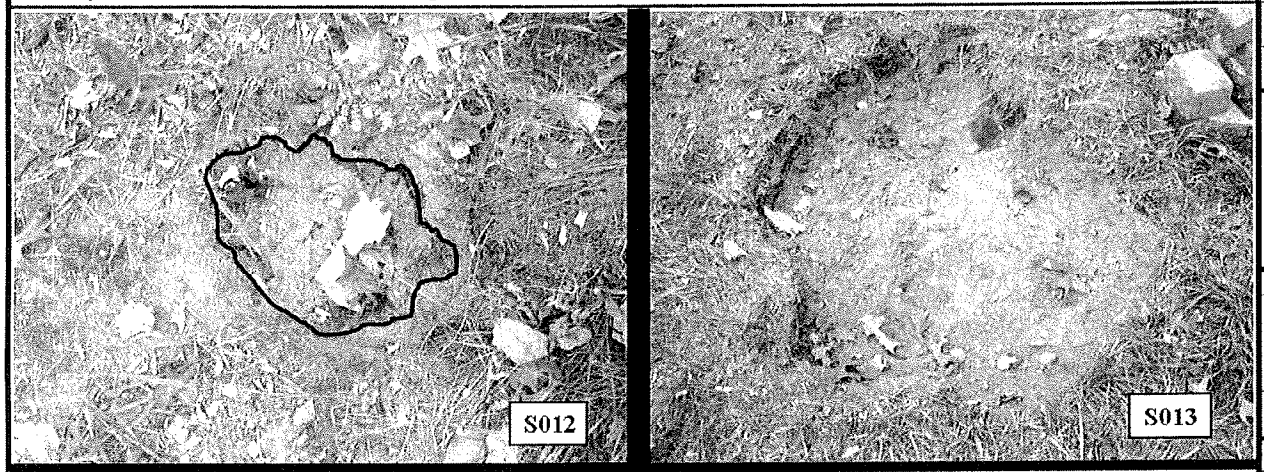
Surveyed By: Sean A. Gully Date: 10/22/09 Reviewed By: Date:

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine _____ ☐ Special _____
☒ RWP# 2009-ERP-010 ☐ WP

Location/Equipment: Discrete Soil Remediation Area T | **Date:** 10/22/09 | **Time:** 11:30

Survey: Remediate D.S.R.A. "T" sample locations [S012 and S013].



Note:

(A) Post remediation of S012, perusal of affected area with NaI probe ≈ 11K cpm to 15K cpm and a one minute static count ≈ 14,640 cpm. And the outer surrounding perimeter [2 ft. from the edge] is 9K cpm to 16K cpm.

(B) Post remediation of S013, perusal of affected area with NaI probe ≈ 9K cpm to 16K cpm and a one minute static count ≈ 15,223 cpm. And the outer surrounding perimeter [2 ft. from the edge] is 11K cpm to 17K cpm.

(C) Marinelli samples [S012A and S013A] taken to WMD for ISOCS.
ISOCS Results:

004-S012A weighed 985 grams, Cs137 15. 2 pCi / Grams.

005-S013A weighed 1017 grams, Cs137 7. 5 pCi / Grams.

(D) Smear results for external sample containers and equipment used, see page 2 of 2.

(E) Contact and general area dose rate on both sample containers was ≈ Bkgd. [6 µrem/hr.].

INSTRUMENT

Model #	Serial #	CAL DUE
LB5100S4	32487	07/17/10
LUD-2221	211784	01/10/10
LUD-3	74417	03/27/10
BICRON	CO94E	04/13/10

LEGEND
○ - SMEAR SURVEY LOCATION
△ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION
DIRECT FRISK LOCATION
C̄ - CONTAMINATION
✻ CONTACT
XXXY / ZZZ — XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis µCi/cc	% DAC
N/A					

DOSE RATE (HIGHEST)

CONTACT READING	6 µrem/hr.
GENERAL AREA READING	N/A

MASSLINN SURVEY RESULTS (in dpm)

1.	< 1K	5.	< 1K
2.		6.	
3.		7.	
4.		8.	

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ^{3}H

1.	See	8.	Attached	15.	Results
2.	Batch	9.	Number	16.	677
3.		10.		17.	
4.		11.		18.	
5.		12.		19.	
6.		13.		20.	
7.		14.		21.	

Surveyed By: Sean A. Gully Date: 10/22/09 Reviewed By: _____ Date: _____

Appendix B

RESRAD Dose Assessment Summary Reports

Summary : FHWMF-Perimeter-Res-Non-Farm-BKG-subtract-prelim
File : F:\RESRAD_FAMILY\RESRAD\FHWMF-PERIMETER-RES-NON-FARM-BKG-SUBTRACT-PRELIM.RAD

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary
Dose Library: FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
A-1	DCF's for external ground radiation, (mrem/yr)/(pCi/g)			
A-1	At-218 (Source: FGR 12)	5.847E-03	5.847E-03	DCF1(1)
A-1	Ba-137m (Source: FGR 12)	3.606E+00	3.606E+00	DCF1(2)
A-1	Bi-210 (Source: FGR 12)	3.606E-03	3.606E-03	DCF1(3)
A-1	Bi-214 (Source: FGR 12)	9.808E+00	9.808E+00	DCF1(4)
A-1	Cs-137 (Source: FGR 12)	7.510E-04	7.510E-04	DCF1(5)
A-1	Pb-210 (Source: FGR 12)	2.447E-03	2.447E-03	DCF1(6)
A-1	Pb-214 (Source: FGR 12)	1.341E+00	1.341E+00	DCF1(7)
A-1	Po-210 (Source: FGR 12)	5.231E-05	5.231E-05	DCF1(8)
A-1	Po-214 (Source: FGR 12)	5.138E-04	5.138E-04	DCF1(9)
A-1	Po-218 (Source: FGR 12)	5.642E-05	5.642E-05	DCF1(10)
A-1	Ra-226 (Source: FGR 12)	3.176E-02	3.176E-02	DCF1(11)
A-1	Rn-222 (Source: FGR 12)	2.354E-03	2.354E-03	DCF1(12)
A-1	Sr-90 (Source: FGR 12)	7.043E-04	7.043E-04	DCF1(13)
A-1	Tl-210 (Source: no data)	0.000E+00	-2.000E+00	DCF1(14)
A-1	Y-90 (Source: FGR 12)	2.391E-02	2.391E-02	DCF1(15)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(1)
B-1	Pb-210+D	2.320E-02	1.360E-02	DCF2(2)
B-1	Ra-226+D	8.594E-03	8.580E-03	DCF2(3)
B-1	Sr-90+D	1.308E-03	1.300E-03	DCF2(4)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(1)
D-1	Pb-210+D	7.276E-03	5.370E-03	DCF3(2)
D-1	Ra-226+D	1.321E-03	1.320E-03	DCF3(3)
D-1	Sr-90+D	1.528E-04	1.420E-04	DCF3(4)
D-34	Food transfer factors:			
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(1,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(1,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(1,3)
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(2,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(2,3)
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(3,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(3,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(3,3)
D-34	Sr-90+D , plant/soil concentration ratio, dimensionless	3.000E-01	3.000E-01	RTF(4,1)
D-34	Sr-90+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-03	8.000E-03	RTF(4,2)
D-34	Sr-90+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(4,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Cs-137+D , fish	2.000E+03	2.000E+03	BIOFAC(1,1)
D-5	Cs-137+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(1,2)

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(2,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(2,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(3,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(3,2)
D-5				
D-5	Sr-90+D , fish	6.000E+01	6.000E+01	BIOFAC(4,1)
D-5	Sr-90+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(4,2)

#For DCF1(xxx) only, factors are for infinite depth & area. See ETFG table in Ground Pathway of Detailed Report.
*Base Case means Default.Lib w/o Associate Nuclide contributions.

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	2.290E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	5.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	2.500E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	5.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	5.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	5.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Cs-137	4.380E+00	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Ra-226	9.000E-02	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Sr-90	1.100E+00	0.000E+00	---	S1(4)
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---	W1(1)
R012	Concentration in groundwater (pCi/L): Ra-226	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Sr-90	not used	0.000E+00	---	W1(4)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.660E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	3.300E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.400E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	5.000E+03	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.900E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	4.600E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.230E+00	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.600E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.660E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	3.300E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.400E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	2.000E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	2.000E+04	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	4.800E-03	2.000E-02	---	HGWT
R014	Saturated zone b parameter	4.900E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.800E+01	1.000E+01	---	DWIBWT

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	0.000E+00	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.660E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	3.300E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.400E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	2.000E-01	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	4.900E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	5.000E+03	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	2.800E+02	4.600E+03	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	2.800E+02	4.600E+03	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	2.800E+02	4.600E+03	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.889E-04	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.154E-03	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Sr-90				
R016	Contaminated zone (cm**3/g)	3.000E+01	3.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	3.000E+01	3.000E+01	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	3.000E+01	3.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.685E-03	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.082E-04	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R017	Inhalation rate (m**3/yr)	7.300E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	8.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.500E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	4.380E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	7.000E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R019	Mass loading for foliar deposition (g/m**3)	1.000E-05	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

Summary : FHWMF-Perimeter-Res-Non-Farm-BKG-subtract-prelim
File : F:\RESRAD_FAMILY\RESRAD\FHWMF-PERIMETER-RES-NON-FARM-BKG-SUBTRACT-PRELIM.RAD

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	2290.00 square meters	Cs-137	4.380E+00
Thickness:	5.00 meters	Ra-226	9.000E-02
Cover Depth:	0.00 meters	Sr-90	1.100E+00

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 1.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
TDOSE(t):	1.479E+01	1.448E+01	1.331E+01	1.199E+01	5.600E+00	2.802E+00	1.046E+00	4.713E-01
M(t):	9.859E-01	9.652E-01	8.871E-01	7.994E-01	3.733E-01	1.868E-01	6.970E-02	3.142E-02

Maximum TDOSE(t): 1.479E+01 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	8.652E+00	0.5851	6.596E-06	0.0000	0.000E+00	0.0000	7.533E-01	0.0509	0.000E+00	0.0000	0.000E+00	0.0000	7.111E-03	0.0005
Ra-226	5.945E-01	0.0402	3.845E-05	0.0000	0.000E+00	0.0000	4.238E-01	0.0287	0.000E+00	0.0000	0.000E+00	0.0000	4.233E-03	0.0003
Sr-90	1.576E-02	0.0011	6.784E-05	0.0000	0.000E+00	0.0000	4.330E+00	0.2928	0.000E+00	0.0000	0.000E+00	0.0000	5.449E-03	0.0004
Total	9.262E+00	0.6263	1.129E-04	0.0000	0.000E+00	0.0000	5.507E+00	0.3724	0.000E+00	0.0000	0.000E+00	0.0000	1.679E-02	0.0011

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.462E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.711E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.413E+00	0.6365
Ra-226	2.419E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.685E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.023E+00	0.0692
Sr-90	1.849E-03	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	1.377E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.353E+00	0.2943
Total	2.105E-03	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	1.555E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.479E+01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	8.452E+00	0.5838	6.443E-06	0.0000	0.000E+00	0.0000	7.359E-01	0.0508	0.000E+00	0.0000	0.000E+00	0.0000	6.946E-03	0.0005
Ra-226	5.936E-01	0.0410	4.139E-05	0.0000	0.000E+00	0.0000	4.405E-01	0.0304	0.000E+00	0.0000	0.000E+00	0.0000	4.873E-03	0.0003
Sr-90	1.535E-02	0.0011	6.607E-05	0.0000	0.000E+00	0.0000	4.217E+00	0.2912	0.000E+00	0.0000	0.000E+00	0.0000	5.307E-03	0.0004
Total	9.061E+00	0.6259	1.139E-04	0.0000	0.000E+00	0.0000	5.393E+00	0.3725	0.000E+00	0.0000	0.000E+00	0.0000	1.713E-02	0.0012

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	4.321E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.060E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.195E+00	0.6351
Ra-226	7.858E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	5.663E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.040E+00	0.0718
Sr-90	5.441E-03	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	4.186E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.243E+00	0.2931
Total	6.270E-03	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	4.783E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.448E+01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	7.697E+00	0.5784	5.868E-06	0.0000	0.000E+00	0.0000	6.701E-01	0.0504	0.000E+00	0.0000	0.000E+00	0.0000	6.326E-03	0.0005
Ra-226	5.899E-01	0.0443	5.218E-05	0.0000	0.000E+00	0.0000	5.009E-01	0.0376	0.000E+00	0.0000	0.000E+00	0.0000	7.229E-03	0.0005
Sr-90	1.380E-02	0.0010	5.943E-05	0.0000	0.000E+00	0.0000	3.793E+00	0.2850	0.000E+00	0.0000	0.000E+00	0.0000	4.773E-03	0.0004
Total	8.301E+00	0.6238	1.175E-04	0.0000	0.000E+00	0.0000	4.964E+00	0.3730	0.000E+00	0.0000	0.000E+00	0.0000	1.833E-02	0.0014

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.449E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.055E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.374E+00	0.6293
Ra-226	3.765E-03	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	2.750E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.102E+00	0.0828
Sr-90	1.808E-02	0.0014	0.000E+00	0.0000	0.000E+00	0.0000	1.412E-03	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	3.831E+00	0.2879
Total	2.199E-02	0.0017	0.000E+00	0.0000	0.000E+00	0.0000	1.698E-03	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	1.331E+01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	6.847E+00	0.5710	5.220E-06	0.0000	0.000E+00	0.0000	5.962E-01	0.0497	0.000E+00	0.0000	0.000E+00	0.0000	5.627E-03	0.0005
Ra-226	5.853E-01	0.0488	6.374E-05	0.0000	0.000E+00	0.0000	5.654E-01	0.0471	0.000E+00	0.0000	0.000E+00	0.0000	9.754E-03	0.0008
Sr-90	1.209E-02	0.0010	5.205E-05	0.0000	0.000E+00	0.0000	3.322E+00	0.2771	0.000E+00	0.0000	0.000E+00	0.0000	4.181E-03	0.0003
Total	7.445E+00	0.6209	1.210E-04	0.0000	0.000E+00	0.0000	4.484E+00	0.3739	0.000E+00	0.0000	0.000E+00	0.0000	1.956E-02	0.0016

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.465E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.804E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.449E+00	0.6213
Ra-226	9.035E-03	0.0008	0.000E+00	0.0000	0.000E+00	0.0000	6.609E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	1.170E+00	0.0976
Sr-90	3.045E-02	0.0025	0.000E+00	0.0000	0.000E+00	0.0000	2.384E-03	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	3.371E+00	0.2812
Total	3.973E-02	0.0033	0.000E+00	0.0000	0.000E+00	0.0000	3.063E-03	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	1.199E+01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.686E+00	0.4797	2.048E-06	0.0000	0.000E+00	0.0000	2.339E-01	0.0418	0.000E+00	0.0000	0.000E+00	0.0000	2.208E-03	0.0004
Ra-226	5.494E-01	0.0981	1.081E-04	0.0000	0.000E+00	0.0000	8.062E-01	0.1440	0.000E+00	0.0000	0.000E+00	0.0000	1.956E-02	0.0035
Sr-90	4.191E-03	0.0007	1.804E-05	0.0000	0.000E+00	0.0000	1.152E+00	0.2056	0.000E+00	0.0000	0.000E+00	0.0000	1.449E-03	0.0003
Total	3.240E+00	0.5785	1.282E-04	0.0000	0.000E+00	0.0000	2.192E+00	0.3914	0.000E+00	0.0000	0.000E+00	0.0000	2.322E-02	0.0041

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+01 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	4.684E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	3.443E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.923E+00	0.5219
Ra-226	8.102E-02	0.0145	0.000E+00	0.0000	0.000E+00	0.0000	5.927E-03	0.0011	0.000E+00	0.0000	0.000E+00	0.0000	1.462E+00	0.2611
Sr-90	5.358E-02	0.0096	0.000E+00	0.0000	0.000E+00	0.0000	4.204E-03	0.0008	0.000E+00	0.0000	0.000E+00	0.0000	1.215E+00	0.2170
Total	1.351E-01	0.0241	0.000E+00	0.0000	0.000E+00	0.0000	1.017E-02	0.0018	0.000E+00	0.0000	0.000E+00	0.0000	5.600E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	8.340E-01	0.2977	6.358E-07	0.0000	0.000E+00	0.0000	7.261E-02	0.0259	0.000E+00	0.0000	0.000E+00	0.0000	6.854E-04	0.0002
Ra-226	5.075E-01	0.1812	1.145E-04	0.0000	0.000E+00	0.0000	8.289E-01	0.2959	0.000E+00	0.0000	0.000E+00	0.0000	2.125E-02	0.0076
Sr-90	1.115E-03	0.0004	4.799E-06	0.0000	0.000E+00	0.0000	3.063E-01	0.1093	0.000E+00	0.0000	0.000E+00	0.0000	3.854E-04	0.0001
Total	1.343E+00	0.4792	1.200E-04	0.0000	0.000E+00	0.0000	1.208E+00	0.4311	0.000E+00	0.0000	0.000E+00	0.0000	2.232E-02	0.0080

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.919E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	2.146E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.076E-01	0.3239
Ra-226	1.825E-01	0.0652	0.000E+00	0.0000	0.000E+00	0.0000	1.335E-02	0.0048	0.000E+00	0.0000	0.000E+00	0.0000	1.554E+00	0.5546
Sr-90	3.030E-02	0.0108	0.000E+00	0.0000	0.000E+00	0.0000	2.379E-03	0.0008	0.000E+00	0.0000	0.000E+00	0.0000	3.404E-01	0.1215
Total	2.131E-01	0.0761	0.000E+00	0.0000	0.000E+00	0.0000	1.575E-02	0.0056	0.000E+00	0.0000	0.000E+00	0.0000	2.802E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	7.198E-05	0.0001	5.488E-11	0.0000	0.000E+00	0.0000	6.267E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.916E-08	0.0000
Ra-226	2.690E-01	0.2573	6.291E-05	0.0001	0.000E+00	0.0000	4.519E-01	0.4322	0.000E+00	0.0000	0.000E+00	0.0000	1.174E-02	0.0112
Sr-90	2.790E-08	0.0000	1.201E-10	0.0000	0.000E+00	0.0000	7.668E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.650E-09	0.0000
Total	2.691E-01	0.2574	6.291E-05	0.0001	0.000E+00	0.0000	4.519E-01	0.4322	0.000E+00	0.0000	0.000E+00	0.0000	1.174E-02	0.0112

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+02 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.342E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.872E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.845E-05	0.0001
Ra-226	2.914E-01	0.2787	0.000E+00	0.0000	0.000E+00	0.0000	2.131E-02	0.0204	0.000E+00	0.0000	0.000E+00	0.0000	1.045E+00	0.9999
Sr-90	7.432E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.836E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.507E-06	0.0000
Total	2.914E-01	0.2787	0.000E+00	0.0000	0.000E+00	0.0000	2.131E-02	0.0204	0.000E+00	0.0000	0.000E+00	0.0000	1.046E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	5.989E-10	0.0000	4.565E-16	0.0000	0.000E+00	0.0000	5.214E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.922E-13	0.0000
Ra-226	1.217E-01	0.2582	2.845E-05	0.0001	0.000E+00	0.0000	2.044E-01	0.4336	0.000E+00	0.0000	0.000E+00	0.0000	5.308E-03	0.0113
Sr-90	4.942E-14	0.0000	2.128E-16	0.0000	0.000E+00	0.0000	1.358E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.709E-14	0.0000
Total	1.217E-01	0.2582	2.845E-05	0.0001	0.000E+00	0.0000	2.044E-01	0.4336	0.000E+00	0.0000	0.000E+00	0.0000	5.308E-03	0.0113

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.428E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.786E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.541E-10	0.0000
Ra-226	1.304E-01	0.2766	0.000E+00	0.0000	0.000E+00	0.0000	9.536E-03	0.0202	0.000E+00	0.0000	0.000E+00	0.0000	4.713E-01	1.0000
Sr-90	1.269E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.965E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.501E-11	0.0000
Total	1.304E-01	0.2766	0.000E+00	0.0000	0.000E+00	0.0000	9.536E-03	0.0202	0.000E+00	0.0000	0.000E+00	0.0000	4.713E-01	1.0000

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Thread Fraction	DSR(j,t) At Time in Years (mrem/yr)/(pCi/g) 0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137+D	Cs-137+D	1.000E+00	2.149E+00	2.099E+00	1.912E+00	1.701E+00	6.673E-01	2.072E-01	1.791E-05	1.493E-10
Ra-226+D	Ra-226+D	1.000E+00	1.125E+01	1.123E+01	1.118E+01	1.112E+01	1.065E+01	1.009E+01	5.797E+00	2.613E+00
Ra-226+D	Pb-210+D	1.000E+00	1.191E-01	3.208E-01	1.062E+00	1.879E+00	5.601E+00	7.176E+00	5.819E+00	2.623E+00
Ra-226+D	äDSR(j)		1.136E+01	1.155E+01	1.225E+01	1.300E+01	1.625E+01	1.726E+01	1.162E+01	5.237E+00
Sr-90+D	Sr-90+D	1.000E+00	3.957E+00	3.857E+00	3.483E+00	3.065E+00	1.105E+00	3.095E-01	7.733E-06	1.365E-11

The DSR includes contributions from associated (half-life ó 180 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 1.500E+01 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137	6.980E+00	7.145E+00	7.846E+00	8.819E+00	2.248E+01	7.239E+01	8.375E+05	1.004E+11
Ra-226	1.320E+00	1.298E+00	1.225E+00	1.154E+00	9.232E-01	8.689E-01	1.291E+00	2.864E+00
Sr-90	3.791E+00	3.889E+00	4.307E+00	4.894E+00	1.358E+01	4.847E+01	1.940E+06	1.099E+12

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Cs-137	4.380E+00	0.000E+00	2.149E+00	6.980E+00	2.149E+00	6.980E+00
Ra-226	9.000E-02	143.5 ñ 0.3	1.739E+01	8.625E-01	1.136E+01	1.320E+00
Sr-90	1.100E+00	0.000E+00	3.957E+00	3.791E+00	3.957E+00	3.791E+00

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	DOSE(j,t), mrem/yr							
		t=	0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137	Cs-137	1.000E+00	9.413E+00	9.195E+00	8.374E+00	7.449E+00	2.923E+00	9.076E-01	7.845E-05	6.541E-10
Ra-226	Ra-226	1.000E+00	1.012E+00	1.011E+00	1.007E+00	1.001E+00	9.582E-01	9.078E-01	5.217E-01	2.352E-01
Pb-210	Ra-226	1.000E+00	1.072E-02	2.887E-02	9.557E-02	1.691E-01	5.041E-01	6.458E-01	5.237E-01	2.361E-01
Sr-90	Sr-90	1.000E+00	4.353E+00	4.243E+00	3.831E+00	3.371E+00	1.215E+00	3.404E-01	8.507E-06	1.501E-11

THF(i) is the thread fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	S(j,t), pCi/g							
		t=	0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137	Cs-137	1.000E+00	4.380E+00	4.279E+00	3.897E+00	3.466E+00	1.360E+00	4.222E-01	3.644E-05	3.032E-10
Ra-226	Ra-226	1.000E+00	9.000E-02	8.986E-02	8.929E-02	8.858E-02	8.313E-02	7.679E-02	4.070E-02	1.841E-02
Pb-210	Ra-226	1.000E+00	0.000E+00	2.751E-03	1.288E-02	2.375E-02	6.653E-02	7.496E-02	4.175E-02	1.888E-02
Sr-90	Sr-90	1.000E+00	1.100E+00	1.071E+00	9.636E-01	8.440E-01	2.926E-01	7.781E-02	1.948E-06	3.450E-12

THF(i) is the thread fraction of the parent nuclide.

RESCALC.EXE execution time = 1.65 seconds

Summary : FHWMF-Perim-Ind-Bkg-subtract-prelim
File : F:\RESRAD_FAMILY\RESRAD\FHWMF-PERIMETER-INDUST-BKG-SUBTRACT-PRELIM.RAD

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary

Dose Library: FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
A-1	DCF's for external ground radiation, (mrem/yr)/(pCi/g)			
A-1	At-218 (Source: FGR 12)	5.847E-03	5.847E-03	DCF1(1)
A-1	Ba-137m (Source: FGR 12)	3.606E+00	3.606E+00	DCF1(2)
A-1	Bi-210 (Source: FGR 12)	3.606E-03	3.606E-03	DCF1(3)
A-1	Bi-214 (Source: FGR 12)	9.808E+00	9.808E+00	DCF1(4)
A-1	Cs-137 (Source: FGR 12)	7.510E-04	7.510E-04	DCF1(5)
A-1	Pb-210 (Source: FGR 12)	2.447E-03	2.447E-03	DCF1(6)
A-1	Pb-214 (Source: FGR 12)	1.341E+00	1.341E+00	DCF1(7)
A-1	Po-210 (Source: FGR 12)	5.231E-05	5.231E-05	DCF1(8)
A-1	Po-214 (Source: FGR 12)	5.138E-04	5.138E-04	DCF1(9)
A-1	Po-218 (Source: FGR 12)	5.642E-05	5.642E-05	DCF1(10)
A-1	Ra-226 (Source: FGR 12)	3.176E-02	3.176E-02	DCF1(11)
A-1	Rn-222 (Source: FGR 12)	2.354E-03	2.354E-03	DCF1(12)
A-1	Sr-90 (Source: FGR 12)	7.043E-04	7.043E-04	DCF1(13)
A-1	Tl-210 (Source: no data)	0.000E+00	-2.000E+00	DCF1(14)
A-1	Y-90 (Source: FGR 12)	2.391E-02	2.391E-02	DCF1(15)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(1)
B-1	Pb-210+D	2.320E-02	1.360E-02	DCF2(2)
B-1	Ra-226+D	8.594E-03	8.580E-03	DCF2(3)
B-1	Sr-90+D	1.308E-03	1.300E-03	DCF2(4)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(1)
D-1	Pb-210+D	7.276E-03	5.370E-03	DCF3(2)
D-1	Ra-226+D	1.321E-03	1.320E-03	DCF3(3)
D-1	Sr-90+D	1.528E-04	1.420E-04	DCF3(4)
D-34	Food transfer factors:			
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(1,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(1,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(1,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(2,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(2,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(3,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(3,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(3,3)
D-34				
D-34	Sr-90+D , plant/soil concentration ratio, dimensionless	3.000E-01	3.000E-01	RTF(4,1)
D-34	Sr-90+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-03	8.000E-03	RTF(4,2)
D-34	Sr-90+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(4,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Cs-137+D , fish	2.000E+03	2.000E+03	BIOFAC(1,1)
D-5	Cs-137+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(1,2)
D-5				

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(2,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(2,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(3,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(3,2)
D-5				
D-5	Sr-90+D , fish	6.000E+01	6.000E+01	BIOFAC(4,1)
D-5	Sr-90+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(4,2)

#For DCF1(xxx) only, factors are for infinite depth & area. See ETFG table in Ground Pathway of Detailed Report.
*Base Case means Default.Lib w/o Associate Nuclide contributions.

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	2.290E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	5.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	2.500E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	5.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	5.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	5.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Cs-137	4.380E+00	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Ra-226	9.000E-02	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Sr-90	1.100E+00	0.000E+00	---	S1(4)
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---	W1(1)
R012	Concentration in groundwater (pCi/L): Ra-226	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Sr-90	not used	0.000E+00	---	W1(4)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.660E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	3.300E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.400E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	5.000E+03	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.900E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	4.600E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.230E+00	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.660E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	3.300E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.400E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	2.000E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	2.000E+04	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	4.800E-03	2.000E-02	---	HGWT
R014	Saturated zone b parameter	4.900E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.800E+01	1.000E+01	---	DWIBWT

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	not used	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	0.000E+00	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.660E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	3.300E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.400E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	2.000E-01	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	4.900E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	5.000E+03	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	2.800E+02	4.600E+03	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	2.800E+02	4.600E+03	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	2.800E+02	4.600E+03	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.285E-04	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.127E-04	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Sr-90				
R016	Contaminated zone (cm**3/g)	3.000E+01	3.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	3.000E+01	3.000E+01	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	3.000E+01	3.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.124E-03	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.393E-04	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	2.500E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	8.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	6.000E-02	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	1.700E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	3.500E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	not used	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	not used	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	not used	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	not used	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	not used	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	not used	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	suppressed
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

Summary : FHWMF-Perim-Ind-Bkg-subtract-prelim
File : F:\RESRAD_FAMILY\RESRAD\FHWMF-PERIMETER-INDUST-BKG-SUBTRACT-PRELIM.RAD

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	2290.00 square meters	Cs-137	4.380E+00
Thickness:	5.00 meters	Ra-226	9.000E-02
Cover Depth:	0.00 meters	Sr-90	1.100E+00

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 1.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
TDOSE(t):	3.112E+00	3.046E+00	2.798E+00	2.519E+00	1.150E+00	5.442E-01	2.327E-01	1.193E-01
M(t):	2.074E-01	2.031E-01	1.866E-01	1.680E-01	7.665E-02	3.628E-02	1.552E-02	7.956E-03

Maximum TDOSE(t): 3.112E+00 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.902E+00	0.9326	3.272E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.817E-03	0.0006
Ra-226	1.994E-01	0.0641	1.907E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.082E-03	0.0003
Sr-90	5.286E-03	0.0017	3.366E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.393E-03	0.0004
Total	3.107E+00	0.9983	5.601E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.292E-03	0.0014

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	4.213E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.904E+00	0.9331
Ra-226	9.192E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.006E-01	0.0645
Sr-90	7.200E-04	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.433E-03	0.0024
Total	8.161E-04	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.112E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.835E+00	0.9307	3.197E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.775E-03	0.0006
Ra-226	1.992E-01	0.0654	2.054E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.246E-03	0.0004
Sr-90	5.151E-03	0.0017	3.280E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.357E-03	0.0004
Total	3.039E+00	0.9977	5.654E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.378E-03	0.0014

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.250E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.837E+00	0.9313
Ra-226	2.986E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.007E-01	0.0659
Sr-90	2.120E-03	0.0007	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.661E-03	0.0028
Total	2.431E-03	0.0008	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.046E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.582E+00	0.9228	2.912E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.617E-03	0.0006
Ra-226	1.981E-01	0.0708	2.592E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.850E-03	0.0007
Sr-90	4.643E-03	0.0017	2.957E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.224E-03	0.0004
Total	2.785E+00	0.9953	5.840E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.690E-03	0.0017

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	4.196E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.584E+00	0.9234
Ra-226	1.429E-03	0.0005	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.014E-01	0.0720
Sr-90	7.054E-03	0.0025	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.295E-02	0.0046
Total	8.525E-03	0.0030	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.798E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.298E+00	0.9121	2.591E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.439E-03	0.0006
Ra-226	1.968E-01	0.0781	3.170E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.499E-03	0.0010
Sr-90	4.079E-03	0.0016	2.598E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.075E-03	0.0004
Total	2.499E+00	0.9919	6.026E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.012E-03	0.0020

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	7.139E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.299E+00	0.9127
Ra-226	3.426E-03	0.0014	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.027E-01	0.0805
Sr-90	1.190E-02	0.0047	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.708E-02	0.0068
Total	1.539E-02	0.0061	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.519E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	9.036E-01	0.7859	1.019E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.659E-04	0.0005
Ra-226	1.865E-01	0.1622	5.421E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.055E-03	0.0044
Sr-90	1.446E-03	0.0013	9.208E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.810E-04	0.0003
Total	1.092E+00	0.9494	6.444E-05	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.002E-03	0.0052

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+01 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.359E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.044E-01	0.7865
Ra-226	3.082E-02	0.0268	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.225E-01	0.1935
Sr-90	2.116E-02	0.0184	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.300E-02	0.0200
Total	5.212E-02	0.0453	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.150E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.814E-01	0.5171	3.173E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.762E-04	0.0003
Ra-226	1.744E-01	0.3205	5.813E-05	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.554E-03	0.0102
Sr-90	3.955E-04	0.0007	2.519E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.042E-04	0.0002
Total	4.562E-01	0.8382	6.097E-05	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.834E-03	0.0107

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	8.488E-05	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.817E-01	0.5175
Ra-226	6.989E-02	0.1284	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.499E-01	0.4592
Sr-90	1.215E-02	0.0223	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.266E-02	0.0233
Total	8.213E-02	0.1509	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.442E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.488E-05	0.0001	2.806E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.558E-08	0.0000
Ra-226	1.018E-01	0.4374	3.515E-05	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.377E-03	0.0145
Sr-90	1.239E-08	0.0000	7.892E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.266E-09	0.0000
Total	1.018E-01	0.4375	3.515E-05	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.377E-03	0.0145

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+02 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	3.971E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.494E-05	0.0001
Ra-226	1.275E-01	0.5478	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.327E-01	0.9999
Sr-90	3.792E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.949E-07	0.0000
Total	1.275E-01	0.5478	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.327E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio- Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.134E-10	0.0000	2.406E-16	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.336E-13	0.0000
Ra-226	5.194E-02	0.4352	1.793E-05	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.723E-03	0.0144
Sr-90	2.906E-14	0.0000	1.850E-16	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.656E-15	0.0000
Total	5.194E-02	0.4352	1.793E-05	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.723E-03	0.0144

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio- Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	7.339E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.142E-10	0.0000
Ra-226	6.566E-02	0.5502	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.193E-01	1.0000
Sr-90	8.589E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.958E-13	0.0000
Total	6.566E-02	0.5502	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.193E-01	1.0000

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Thread Fraction	DSR(j,t) At Time in Years (mrem/yr)/(pCi/g) 0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137+D	Cs-137+D	1.000E+00	6.629E-01	6.477E-01	5.900E-01	5.250E-01	2.065E-01	6.431E-02	5.693E-06	4.891E-11
Ra-226+D	Ra-226+D	1.000E+00	2.228E+00	2.227E+00	2.223E+00	2.217E+00	2.175E+00	2.124E+00	1.425E+00	7.240E-01
Ra-226+D	Pb-210+D	1.000E+00	1.029E-03	3.290E-03	1.514E-02	3.532E-02	2.965E-01	6.529E-01	1.160E+00	6.020E-01
Ra-226+D	äDSR(j)		2.229E+00	2.230E+00	2.238E+00	2.253E+00	2.472E+00	2.777E+00	2.586E+00	1.326E+00
Sr-90+D	Sr-90+D	1.000E+00	6.757E-03	7.874E-03	1.177E-02	1.552E-02	2.091E-02	1.151E-02	3.590E-07	8.143E-13

The DSR includes contributions from associated (half-life ó 180 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 1.500E+01 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137	2.263E+01	2.316E+01	2.543E+01	2.857E+01	7.265E+01	2.333E+02	2.635E+06	3.067E+11
Ra-226	6.729E+00	6.726E+00	6.703E+00	6.659E+00	6.069E+00	5.402E+00	5.801E+00	1.131E+01
Sr-90	2.220E+03	1.905E+03	1.274E+03	9.662E+02	7.174E+02	1.304E+03	4.178E+07	1.842E+13

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Cs-137	4.380E+00	0.000E+00	6.629E-01	2.263E+01	6.629E-01	2.263E+01
Ra-226	9.000E-02	262.3 ñ 0.5	3.518E+00	4.264E+00	2.229E+00	6.729E+00
Sr-90	1.100E+00	35.09 ñ 0.07	2.210E-02	6.787E+02	6.757E-03	2.220E+03

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	DOSE(j,t), mrem/yr							
		t=	0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137	Cs-137	1.000E+00	2.904E+00	2.837E+00	2.584E+00	2.299E+00	9.044E-01	2.817E-01	2.494E-05	2.142E-10
Ra-226	Ra-226	1.000E+00	2.005E-01	2.004E-01	2.000E-01	1.996E-01	1.958E-01	1.911E-01	1.283E-01	6.516E-02
Pb-210	Ra-226	1.000E+00	9.261E-05	2.961E-04	1.363E-03	3.179E-03	2.668E-02	5.876E-02	1.044E-01	5.418E-02
Sr-90	Sr-90	1.000E+00	7.433E-03	8.661E-03	1.295E-02	1.708E-02	2.300E-02	1.266E-02	3.949E-07	8.958E-13

THF(i) is the thread fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	S(j,t), pCi/g							
		t=	0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137	Cs-137	1.000E+00	4.380E+00	4.279E+00	3.898E+00	3.468E+00	1.364E+00	4.247E-01	3.756E-05	3.220E-10
Ra-226	Ra-226	1.000E+00	9.000E-02	8.988E-02	8.940E-02	8.880E-02	8.414E-02	7.867E-02	4.592E-02	2.343E-02
Pb-210	Ra-226	1.000E+00	0.000E+00	2.752E-03	1.289E-02	2.380E-02	6.725E-02	7.664E-02	4.699E-02	2.397E-02
Sr-90	Sr-90	1.000E+00	1.100E+00	1.072E+00	9.663E-01	8.488E-01	3.009E-01	8.230E-02	2.579E-06	6.046E-12

THF(i) is the thread fraction of the parent nuclide.

RESCALC.EXE execution time = 1.57 seconds

Summary : FHWMF-Perimeter-Res-Non-Farm-BKG-subtract-1a-orise
File : F:\RESRAD_FAMILY\RESRAD\FHWMF-PERIMETER-RES-NON-FARM-BKG-SUBTRACT-1A-121609.RAD

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary

Dose Library: FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
A-1	DCF's for external ground radiation, (mrem/yr)/(pCi/g)			
A-1	At-218 (Source: FGR 12)	5.847E-03	5.847E-03	DCF1(1)
A-1	Ba-137m (Source: FGR 12)	3.606E+00	3.606E+00	DCF1(2)
A-1	Bi-210 (Source: FGR 12)	3.606E-03	3.606E-03	DCF1(3)
A-1	Bi-214 (Source: FGR 12)	9.808E+00	9.808E+00	DCF1(4)
A-1	Cs-137 (Source: FGR 12)	7.510E-04	7.510E-04	DCF1(5)
A-1	Pb-210 (Source: FGR 12)	2.447E-03	2.447E-03	DCF1(6)
A-1	Pb-214 (Source: FGR 12)	1.341E+00	1.341E+00	DCF1(7)
A-1	Po-210 (Source: FGR 12)	5.231E-05	5.231E-05	DCF1(8)
A-1	Po-214 (Source: FGR 12)	5.138E-04	5.138E-04	DCF1(9)
A-1	Po-218 (Source: FGR 12)	5.642E-05	5.642E-05	DCF1(10)
A-1	Ra-226 (Source: FGR 12)	3.176E-02	3.176E-02	DCF1(11)
A-1	Rn-222 (Source: FGR 12)	2.354E-03	2.354E-03	DCF1(12)
A-1	Sr-90 (Source: FGR 12)	7.043E-04	7.043E-04	DCF1(13)
A-1	Tl-210 (Source: no data)	0.000E+00	-2.000E+00	DCF1(14)
A-1	Y-90 (Source: FGR 12)	2.391E-02	2.391E-02	DCF1(15)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(1)
B-1	Pb-210+D	2.320E-02	1.360E-02	DCF2(2)
B-1	Ra-226+D	8.594E-03	8.580E-03	DCF2(3)
B-1	Sr-90+D	1.308E-03	1.300E-03	DCF2(4)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(1)
D-1	Pb-210+D	7.276E-03	5.370E-03	DCF3(2)
D-1	Ra-226+D	1.321E-03	1.320E-03	DCF3(3)
D-1	Sr-90+D	1.528E-04	1.420E-04	DCF3(4)
D-34	Food transfer factors:			
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(1,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(1,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(1,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(2,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(2,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(3,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(3,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(3,3)
D-34				
D-34	Sr-90+D , plant/soil concentration ratio, dimensionless	3.000E-01	3.000E-01	RTF(4,1)
D-34	Sr-90+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-03	8.000E-03	RTF(4,2)
D-34	Sr-90+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(4,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Cs-137+D , fish	2.000E+03	2.000E+03	BIOFAC(1,1)
D-5	Cs-137+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(1,2)
D-5				

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(2,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(2,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(3,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(3,2)
D-5				
D-5	Sr-90+D , fish	6.000E+01	6.000E+01	BIOFAC(4,1)
D-5	Sr-90+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(4,2)

#For DCF1(xxx) only, factors are for infinite depth & area. See ETFG table in Ground Pathway of Detailed Report.
*Base Case means Default.Lib w/o Associate Nuclide contributions.

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	2.290E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	5.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	2.500E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	5.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	5.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	5.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Cs-137	8.020E+00	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Ra-226	6.000E-02	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Sr-90	7.800E-01	0.000E+00	---	S1(4)
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---	W1(1)
R012	Concentration in groundwater (pCi/L): Ra-226	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Sr-90	not used	0.000E+00	---	W1(4)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.660E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	3.300E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.400E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	5.000E+03	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.900E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	4.600E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.230E+00	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.600E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.660E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	3.300E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.400E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	2.000E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	2.000E+04	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	4.800E-03	2.000E-02	---	HGWT
R014	Saturated zone b parameter	4.900E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.800E+01	1.000E+01	---	DWIBWT

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	0.000E+00	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.660E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	3.300E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.400E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	2.000E-01	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	4.900E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	5.000E+03	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	2.800E+02	4.600E+03	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	2.800E+02	4.600E+03	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	2.800E+02	4.600E+03	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.889E-04	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.154E-03	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Sr-90				
R016	Contaminated zone (cm**3/g)	3.000E+01	3.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	3.000E+01	3.000E+01	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	3.000E+01	3.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.685E-03	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.082E-04	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R017	Inhalation rate (m**3/yr)	7.300E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	8.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.500E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	4.380E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	7.000E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R019	Mass loading for foliar deposition (g/m**3)	1.000E-05	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

Summary : FHWMF-Perimeter-Res-Non-Farm-BKG-subtract-1a-orise
File : F:\RESRAD_FAMILY\RESRAD\FHWMF-PERIMETER-RES-NON-FARM-BKG-SUBTRACT-1A-121609.RAD

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	2290.00 square meters	Cs-137	8.020E+00
Thickness:	5.00 meters	Ra-226	6.000E-02
Cover Depth:	0.00 meters	Sr-90	7.800E-01

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 1.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
TDOSE(t):	2.100E+01	2.054E+01	1.878E+01	1.681E+01	7.188E+00	2.939E+00	6.971E-01	3.142E-01
M(t):	1.400E+00	1.369E+00	1.252E+00	1.121E+00	4.792E-01	1.959E-01	4.647E-02	2.095E-02

Maximum TDOSE(t): 2.100E+01 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.584E+01	0.7543	1.208E-05	0.0000	0.000E+00	0.0000	1.379E+00	0.0657	0.000E+00	0.0000	0.000E+00	0.0000	1.302E-02	0.0006
Ra-226	3.964E-01	0.0189	2.563E-05	0.0000	0.000E+00	0.0000	2.825E-01	0.0135	0.000E+00	0.0000	0.000E+00	0.0000	2.822E-03	0.0001
Sr-90	1.117E-02	0.0005	4.811E-05	0.0000	0.000E+00	0.0000	3.070E+00	0.1462	0.000E+00	0.0000	0.000E+00	0.0000	3.864E-03	0.0002
Total	1.625E+01	0.7737	8.581E-05	0.0000	0.000E+00	0.0000	4.732E+00	0.2253	0.000E+00	0.0000	0.000E+00	0.0000	1.971E-02	0.0009

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.677E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.778E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.723E+01	0.8206
Ra-226	1.613E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.123E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.819E-01	0.0325
Sr-90	1.311E-03	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	9.764E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.087E+00	0.1470
Total	1.499E-03	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	1.107E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.100E+01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.548E+01	0.7535	1.180E-05	0.0000	0.000E+00	0.0000	1.347E+00	0.0656	0.000E+00	0.0000	0.000E+00	0.0000	1.272E-02	0.0006
Ra-226	3.957E-01	0.0193	2.759E-05	0.0000	0.000E+00	0.0000	2.937E-01	0.0143	0.000E+00	0.0000	0.000E+00	0.0000	3.249E-03	0.0002
Sr-90	1.088E-02	0.0005	4.685E-05	0.0000	0.000E+00	0.0000	2.990E+00	0.1456	0.000E+00	0.0000	0.000E+00	0.0000	3.763E-03	0.0002
Total	1.588E+01	0.7733	8.624E-05	0.0000	0.000E+00	0.0000	4.631E+00	0.2255	0.000E+00	0.0000	0.000E+00	0.0000	1.973E-02	0.0010

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	7.913E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.602E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.684E+01	0.8198
Ra-226	5.239E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.775E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.932E-01	0.0338
Sr-90	3.858E-03	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	2.968E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.009E+00	0.1465
Total	4.461E-03	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	3.402E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.054E+01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.409E+01	0.7503	1.074E-05	0.0000	0.000E+00	0.0000	1.227E+00	0.0653	0.000E+00	0.0000	0.000E+00	0.0000	1.158E-02	0.0006
Ra-226	3.932E-01	0.0209	3.479E-05	0.0000	0.000E+00	0.0000	3.339E-01	0.0178	0.000E+00	0.0000	0.000E+00	0.0000	4.819E-03	0.0003
Sr-90	9.787E-03	0.0005	4.214E-05	0.0000	0.000E+00	0.0000	2.689E+00	0.1432	0.000E+00	0.0000	0.000E+00	0.0000	3.385E-03	0.0002
Total	1.450E+01	0.7718	8.767E-05	0.0000	0.000E+00	0.0000	4.250E+00	0.2263	0.000E+00	0.0000	0.000E+00	0.0000	1.979E-02	0.0011

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.653E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.932E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.533E+01	0.8163
Ra-226	2.510E-03	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	1.834E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.347E-01	0.0391
Sr-90	1.282E-02	0.0007	0.000E+00	0.0000	0.000E+00	0.0000	1.001E-03	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	2.716E+00	0.1446
Total	1.560E-02	0.0008	0.000E+00	0.0000	0.000E+00	0.0000	1.204E-03	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	1.878E+01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.254E+01	0.7458	9.558E-06	0.0000	0.000E+00	0.0000	1.092E+00	0.0649	0.000E+00	0.0000	0.000E+00	0.0000	1.030E-02	0.0006
Ra-226	3.902E-01	0.0232	4.250E-05	0.0000	0.000E+00	0.0000	3.769E-01	0.0224	0.000E+00	0.0000	0.000E+00	0.0000	6.503E-03	0.0004
Sr-90	8.573E-03	0.0005	3.691E-05	0.0000	0.000E+00	0.0000	2.356E+00	0.1401	0.000E+00	0.0000	0.000E+00	0.0000	2.965E-03	0.0002
Total	1.294E+01	0.7695	8.896E-05	0.0000	0.000E+00	0.0000	3.824E+00	0.2275	0.000E+00	0.0000	0.000E+00	0.0000	1.977E-02	0.0012

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	4.513E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.303E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.364E+01	0.8114
Ra-226	6.023E-03	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	4.406E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.801E-01	0.0464
Sr-90	2.159E-02	0.0013	0.000E+00	0.0000	0.000E+00	0.0000	1.691E-03	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	2.391E+00	0.1422
Total	2.807E-02	0.0017	0.000E+00	0.0000	0.000E+00	0.0000	2.164E-03	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	1.681E+01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	4.918E+00	0.6843	3.750E-06	0.0000	0.000E+00	0.0000	4.282E-01	0.0596	0.000E+00	0.0000	0.000E+00	0.0000	4.042E-03	0.0006
Ra-226	3.663E-01	0.0510	7.204E-05	0.0000	0.000E+00	0.0000	5.375E-01	0.0748	0.000E+00	0.0000	0.000E+00	0.0000	1.304E-02	0.0018
Sr-90	2.972E-03	0.0004	1.279E-05	0.0000	0.000E+00	0.0000	8.165E-01	0.1136	0.000E+00	0.0000	0.000E+00	0.0000	1.028E-03	0.0001
Total	5.288E+00	0.7356	8.858E-05	0.0000	0.000E+00	0.0000	1.782E+00	0.2479	0.000E+00	0.0000	0.000E+00	0.0000	1.811E-02	0.0025

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+01 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	8.577E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	6.304E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.352E+00	0.7445
Ra-226	5.402E-02	0.0075	0.000E+00	0.0000	0.000E+00	0.0000	3.951E-03	0.0005	0.000E+00	0.0000	0.000E+00	0.0000	9.748E-01	0.1356
Sr-90	3.799E-02	0.0053	0.000E+00	0.0000	0.000E+00	0.0000	2.981E-03	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	8.615E-01	0.1199
Total	9.287E-02	0.0129	0.000E+00	0.0000	0.000E+00	0.0000	6.995E-03	0.0010	0.000E+00	0.0000	0.000E+00	0.0000	7.188E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.527E+00	0.5196	1.164E-06	0.0000	0.000E+00	0.0000	1.329E-01	0.0452	0.000E+00	0.0000	0.000E+00	0.0000	1.255E-03	0.0004
Ra-226	3.384E-01	0.1151	7.636E-05	0.0000	0.000E+00	0.0000	5.526E-01	0.1880	0.000E+00	0.0000	0.000E+00	0.0000	1.416E-02	0.0048
Sr-90	7.903E-04	0.0003	3.403E-06	0.0000	0.000E+00	0.0000	2.172E-01	0.0739	0.000E+00	0.0000	0.000E+00	0.0000	2.733E-04	0.0001
Total	1.866E+00	0.6350	8.093E-05	0.0000	0.000E+00	0.0000	9.027E-01	0.3071	0.000E+00	0.0000	0.000E+00	0.0000	1.569E-02	0.0053

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	5.345E-04	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	3.930E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.662E+00	0.5654
Ra-226	1.217E-01	0.0414	0.000E+00	0.0000	0.000E+00	0.0000	8.900E-03	0.0030	0.000E+00	0.0000	0.000E+00	0.0000	1.036E+00	0.3524
Sr-90	2.149E-02	0.0073	0.000E+00	0.0000	0.000E+00	0.0000	1.687E-03	0.0006	0.000E+00	0.0000	0.000E+00	0.0000	2.414E-01	0.0821
Total	1.437E-01	0.0489	0.000E+00	0.0000	0.000E+00	0.0000	1.063E-02	0.0036	0.000E+00	0.0000	0.000E+00	0.0000	2.939E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.318E-04	0.0002	1.005E-10	0.0000	0.000E+00	0.0000	1.148E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.083E-07	0.0000
Ra-226	1.793E-01	0.2573	4.194E-05	0.0001	0.000E+00	0.0000	3.013E-01	0.4322	0.000E+00	0.0000	0.000E+00	0.0000	7.824E-03	0.0112
Sr-90	1.979E-08	0.0000	8.519E-11	0.0000	0.000E+00	0.0000	5.437E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.842E-09	0.0000
Total	1.795E-01	0.2575	4.194E-05	0.0001	0.000E+00	0.0000	3.013E-01	0.4322	0.000E+00	0.0000	0.000E+00	0.0000	7.824E-03	0.0112

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+02 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.457E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.808E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.436E-04	0.0002
Ra-226	1.943E-01	0.2787	0.000E+00	0.0000	0.000E+00	0.0000	1.421E-02	0.0204	0.000E+00	0.0000	0.000E+00	0.0000	6.969E-01	0.9998
Sr-90	5.270E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.138E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.032E-06	0.0000
Total	1.943E-01	0.2787	0.000E+00	0.0000	0.000E+00	0.0000	1.421E-02	0.0204	0.000E+00	0.0000	0.000E+00	0.0000	6.971E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.097E-09	0.0000	8.359E-16	0.0000	0.000E+00	0.0000	9.547E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.012E-13	0.0000
Ra-226	8.111E-02	0.2582	1.897E-05	0.0001	0.000E+00	0.0000	1.362E-01	0.4336	0.000E+00	0.0000	0.000E+00	0.0000	3.538E-03	0.0113
Sr-90	3.504E-14	0.0000	1.509E-16	0.0000	0.000E+00	0.0000	9.629E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.212E-14	0.0000
Total	8.111E-02	0.2582	1.897E-05	0.0001	0.000E+00	0.0000	1.362E-01	0.4336	0.000E+00	0.0000	0.000E+00	0.0000	3.538E-03	0.0113

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	4.446E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.271E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.198E-09	0.0000
Ra-226	8.692E-02	0.2766	0.000E+00	0.0000	0.000E+00	0.0000	6.357E-03	0.0202	0.000E+00	0.0000	0.000E+00	0.0000	3.142E-01	1.0000
Sr-90	8.999E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.066E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.065E-11	0.0000
Total	8.692E-02	0.2766	0.000E+00	0.0000	0.000E+00	0.0000	6.357E-03	0.0202	0.000E+00	0.0000	0.000E+00	0.0000	3.142E-01	1.0000

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Thread Fraction	DSR(j,t) At Time in Years (mrem/yr)/(pCi/g) 0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137+D	Cs-137+D	1.000E+00	2.149E+00	2.099E+00	1.912E+00	1.701E+00	6.673E-01	2.072E-01	1.791E-05	1.493E-10
Ra-226+D	Ra-226+D	1.000E+00	1.125E+01	1.123E+01	1.118E+01	1.112E+01	1.065E+01	1.009E+01	5.797E+00	2.613E+00
Ra-226+D	Pb-210+D	1.000E+00	1.191E-01	3.208E-01	1.062E+00	1.879E+00	5.601E+00	7.176E+00	5.819E+00	2.623E+00
Ra-226+D	äDSR(j)		1.136E+01	1.155E+01	1.225E+01	1.300E+01	1.625E+01	1.726E+01	1.162E+01	5.237E+00
Sr-90+D	Sr-90+D	1.000E+00	3.957E+00	3.857E+00	3.483E+00	3.065E+00	1.105E+00	3.095E-01	7.733E-06	1.365E-11

The DSR includes contributions from associated (half-life ó 180 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 1.500E+01 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137	6.980E+00	7.145E+00	7.846E+00	8.819E+00	2.248E+01	7.239E+01	8.375E+05	1.004E+11
Ra-226	1.320E+00	1.298E+00	1.225E+00	1.154E+00	9.232E-01	8.689E-01	1.291E+00	2.864E+00
Sr-90	3.791E+00	3.889E+00	4.307E+00	4.894E+00	1.358E+01	4.847E+01	1.940E+06	1.099E+12

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Cs-137	8.020E+00	0.000E+00	2.149E+00	6.980E+00	2.149E+00	6.980E+00
Ra-226	6.000E-02	143.5 ñ 0.3	1.739E+01	8.625E-01	1.136E+01	1.320E+00
Sr-90	7.800E-01	0.000E+00	3.957E+00	3.791E+00	3.957E+00	3.791E+00

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	DOSE(j,t), mrem/yr							
		t=	0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137	Cs-137	1.000E+00	1.723E+01	1.684E+01	1.533E+01	1.364E+01	5.352E+00	1.662E+00	1.436E-04	1.198E-09
Ra-226	Ra-226	1.000E+00	6.747E-01	6.740E-01	6.710E-01	6.673E-01	6.388E-01	6.052E-01	3.478E-01	1.568E-01
Pb-210	Ra-226	1.000E+00	7.145E-03	1.925E-02	6.371E-02	1.127E-01	3.361E-01	4.306E-01	3.491E-01	1.574E-01
Sr-90	Sr-90	1.000E+00	3.087E+00	3.009E+00	2.716E+00	2.391E+00	8.615E-01	2.414E-01	6.032E-06	1.065E-11

THF(i) is the thread fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	S(j,t), pCi/g							
		t=	0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137	Cs-137	1.000E+00	8.020E+00	7.835E+00	7.135E+00	6.347E+00	2.490E+00	7.730E-01	6.672E-05	5.551E-10
Ra-226	Ra-226	1.000E+00	6.000E-02	5.990E-02	5.953E-02	5.906E-02	5.542E-02	5.119E-02	2.713E-02	1.227E-02
Pb-210	Ra-226	1.000E+00	0.000E+00	1.834E-03	8.584E-03	1.584E-02	4.435E-02	4.997E-02	2.783E-02	1.259E-02
Sr-90	Sr-90	1.000E+00	7.800E-01	7.596E-01	6.832E-01	5.985E-01	2.075E-01	5.517E-02	1.381E-06	2.446E-12

THF(i) is the thread fraction of the parent nuclide.

RESCALC.EXE execution time = 1.59 seconds

Summary : FHWMF-Perim-Ind-Bkg-subtract-2A-orise
File : F:\RESRAD_FAMILY\RESRAD\FHWMF-PERIMETER-INDUST-BKG-SUBTRACT-2A.RAD

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary

Dose Library: FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
A-1	DCF's for external ground radiation, (mrem/yr)/(pCi/g)			
A-1	At-218 (Source: FGR 12)	5.847E-03	5.847E-03	DCF1(1)
A-1	Ba-137m (Source: FGR 12)	3.606E+00	3.606E+00	DCF1(2)
A-1	Bi-210 (Source: FGR 12)	3.606E-03	3.606E-03	DCF1(3)
A-1	Bi-214 (Source: FGR 12)	9.808E+00	9.808E+00	DCF1(4)
A-1	Cs-137 (Source: FGR 12)	7.510E-04	7.510E-04	DCF1(5)
A-1	Pb-210 (Source: FGR 12)	2.447E-03	2.447E-03	DCF1(6)
A-1	Pb-214 (Source: FGR 12)	1.341E+00	1.341E+00	DCF1(7)
A-1	Po-210 (Source: FGR 12)	5.231E-05	5.231E-05	DCF1(8)
A-1	Po-214 (Source: FGR 12)	5.138E-04	5.138E-04	DCF1(9)
A-1	Po-218 (Source: FGR 12)	5.642E-05	5.642E-05	DCF1(10)
A-1	Ra-226 (Source: FGR 12)	3.176E-02	3.176E-02	DCF1(11)
A-1	Rn-222 (Source: FGR 12)	2.354E-03	2.354E-03	DCF1(12)
A-1	Sr-90 (Source: FGR 12)	7.043E-04	7.043E-04	DCF1(13)
A-1	Tl-210 (Source: no data)	0.000E+00	-2.000E+00	DCF1(14)
A-1	Y-90 (Source: FGR 12)	2.391E-02	2.391E-02	DCF1(15)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(1)
B-1	Pb-210+D	2.320E-02	1.360E-02	DCF2(2)
B-1	Ra-226+D	8.594E-03	8.580E-03	DCF2(3)
B-1	Sr-90+D	1.308E-03	1.300E-03	DCF2(4)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(1)
D-1	Pb-210+D	7.276E-03	5.370E-03	DCF3(2)
D-1	Ra-226+D	1.321E-03	1.320E-03	DCF3(3)
D-1	Sr-90+D	1.528E-04	1.420E-04	DCF3(4)
D-34	Food transfer factors:			
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(1,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(1,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(1,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(2,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(2,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(3,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(3,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(3,3)
D-34				
D-34	Sr-90+D , plant/soil concentration ratio, dimensionless	3.000E-01	3.000E-01	RTF(4,1)
D-34	Sr-90+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-03	8.000E-03	RTF(4,2)
D-34	Sr-90+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(4,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Cs-137+D , fish	2.000E+03	2.000E+03	BIOFAC(1,1)
D-5	Cs-137+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(1,2)
D-5				

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(2,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(2,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(3,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(3,2)
D-5				
D-5	Sr-90+D , fish	6.000E+01	6.000E+01	BIOFAC(4,1)
D-5	Sr-90+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(4,2)

#For DCF1(xxx) only, factors are for infinite depth & area. See ETFG table in Ground Pathway of Detailed Report.
*Base Case means Default.Lib w/o Associate Nuclide contributions.

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	2.290E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	5.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	2.500E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	5.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	5.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	5.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Cs-137	8.020E+00	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Ra-226	6.000E-02	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Sr-90	7.800E-01	0.000E+00	---	S1(4)
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---	W1(1)
R012	Concentration in groundwater (pCi/L): Ra-226	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Sr-90	not used	0.000E+00	---	W1(4)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.660E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	3.300E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.400E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	5.000E+03	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.900E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	4.600E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.230E+00	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.660E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	3.300E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.400E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	2.000E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	2.000E+04	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	4.800E-03	2.000E-02	---	HGWT
R014	Saturated zone b parameter	4.900E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.800E+01	1.000E+01	---	DWIBWT

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	not used	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	0.000E+00	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.660E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	3.300E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.400E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	2.000E-01	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	4.900E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	5.000E+03	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	2.800E+02	4.600E+03	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	2.800E+02	4.600E+03	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	2.800E+02	4.600E+03	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.285E-04	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.127E-04	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Sr-90				
R016	Contaminated zone (cm**3/g)	3.000E+01	3.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	3.000E+01	3.000E+01	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	3.000E+01	3.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.124E-03	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.393E-04	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	2.500E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	8.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	6.000E-02	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	1.700E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	3.500E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	not used	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	not used	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	not used	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	not used	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	not used	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	not used	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	suppressed
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

Summary : FHWMF-Perim-Ind-Bkg-subtract-2A-orise
File : F:\RESRAD_FAMILY\RESRAD\FHWMF-PERIMETER-INDUST-BKG-SUBTRACT-2A.RAD

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	2290.00 square meters	Cs-137	8.020E+00
Thickness:	5.00 meters	Ra-226	6.000E-02
Cover Depth:	0.00 meters	Sr-90	7.800E-01

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 1.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
TDOSE(t):	5.456E+00	5.334E+00	4.875E+00	4.358E+00	1.821E+00	6.913E-01	1.552E-01	7.956E-02
M(t):	3.637E-01	3.556E-01	3.250E-01	2.905E-01	1.214E-01	4.609E-02	1.035E-02	5.304E-03

Maximum TDOSE(t): 5.456E+00 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	5.313E+00	0.9739	5.992E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.327E-03	0.0006
Ra-226	1.329E-01	0.0244	1.272E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.212E-04	0.0001
Sr-90	3.748E-03	0.0007	2.387E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.877E-04	0.0002
Total	5.450E+00	0.9990	4.258E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.036E-03	0.0009

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	7.713E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.317E+00	0.9745
Ra-226	6.128E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.337E-01	0.0245
Sr-90	5.105E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.270E-03	0.0010
Total	5.795E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.456E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	5.191E+00	0.9731	5.853E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.251E-03	0.0006
Ra-226	1.328E-01	0.0249	1.369E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.306E-04	0.0002
Sr-90	3.652E-03	0.0007	2.326E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.624E-04	0.0002
Total	5.327E+00	0.9987	4.280E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.044E-03	0.0009

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.288E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.194E+00	0.9738
Ra-226	1.991E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.338E-01	0.0251
Sr-90	1.503E-03	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.141E-03	0.0012
Total	1.725E-03	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.334E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	4.728E+00	0.9699	5.332E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.961E-03	0.0006
Ra-226	1.321E-01	0.0271	1.728E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.233E-03	0.0003
Sr-90	3.293E-03	0.0007	2.097E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.676E-04	0.0002
Total	4.864E+00	0.9977	4.358E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.062E-03	0.0010

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	7.682E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.731E+00	0.9706
Ra-226	9.524E-04	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.343E-01	0.0275
Sr-90	5.002E-03	0.0010	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.183E-03	0.0019
Total	6.031E-03	0.0012	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.875E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	4.208E+00	0.9656	4.745E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.635E-03	0.0006
Ra-226	1.312E-01	0.0301	2.113E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.666E-03	0.0004
Sr-90	2.892E-03	0.0007	1.842E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.621E-04	0.0002
Total	4.342E+00	0.9963	4.429E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.063E-03	0.0012

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.307E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.210E+00	0.9662
Ra-226	2.284E-03	0.0005	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.352E-01	0.0310
Sr-90	8.436E-03	0.0019	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.211E-02	0.0028
Total	1.085E-02	0.0025	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.358E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio- Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.655E+00	0.9089	1.866E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.036E-03	0.0006
Ra-226	1.243E-01	0.0683	3.614E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.370E-03	0.0019
Sr-90	1.025E-03	0.0006	6.529E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.702E-04	0.0001
Total	1.780E+00	0.9777	4.454E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.676E-03	0.0026

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+01 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio- Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.489E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.656E+00	0.9096
Ra-226	2.055E-02	0.0113	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.483E-01	0.0815
Sr-90	1.501E-02	0.0082	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.631E-02	0.0090
Total	3.580E-02	0.0197	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.821E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	5.153E-01	0.7453	5.810E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.227E-04	0.0005
Ra-226	1.163E-01	0.1682	3.875E-05	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.702E-03	0.0054
Sr-90	2.804E-04	0.0004	1.786E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.390E-05	0.0001
Total	6.318E-01	0.9139	4.112E-05	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.099E-03	0.0059

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.554E-04	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.157E-01	0.7460
Ra-226	4.660E-02	0.0674	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.666E-01	0.2410
Sr-90	8.619E-03	0.0125	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.975E-03	0.0130
Total	5.537E-02	0.0801	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.913E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	4.556E-05	0.0003	5.137E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.853E-08	0.0000
Ra-226	6.787E-02	0.4373	2.343E-05	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.251E-03	0.0145
Sr-90	8.788E-09	0.0000	5.596E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.316E-09	0.0000
Total	6.791E-02	0.4376	2.343E-05	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.251E-03	0.0145

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+02 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	7.270E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.566E-05	0.0003
Ra-226	8.499E-02	0.5477	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.551E-01	0.9997
Sr-90	2.689E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.800E-07	0.0000
Total	8.499E-02	0.5477	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.552E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	3.907E-10	0.0000	4.405E-16	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.446E-13	0.0000
Ra-226	3.463E-02	0.4352	1.196E-05	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.149E-03	0.0144
Sr-90	2.060E-14	0.0000	1.312E-16	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.429E-15	0.0000
Total	3.463E-02	0.4352	1.196E-05	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.149E-03	0.0144

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.344E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.922E-10	0.0000
Ra-226	4.377E-02	0.5502	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.956E-02	1.0000
Sr-90	6.090E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.352E-13	0.0000
Total	4.377E-02	0.5502	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.956E-02	1.0000

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Thread Fraction	DSR(j,t) At Time in Years (mrem/yr)/(pCi/g) 0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137+D	Cs-137+D	1.000E+00	6.629E-01	6.477E-01	5.900E-01	5.250E-01	2.065E-01	6.431E-02	5.693E-06	4.891E-11
Ra-226+D	Ra-226+D	1.000E+00	2.228E+00	2.227E+00	2.223E+00	2.217E+00	2.175E+00	2.124E+00	1.425E+00	7.240E-01
Ra-226+D	Pb-210+D	1.000E+00	1.029E-03	3.290E-03	1.514E-02	3.532E-02	2.965E-01	6.529E-01	1.160E+00	6.020E-01
Ra-226+D	äDSR(j)		2.229E+00	2.230E+00	2.238E+00	2.253E+00	2.472E+00	2.777E+00	2.586E+00	1.326E+00
Sr-90+D	Sr-90+D	1.000E+00	6.757E-03	7.874E-03	1.177E-02	1.552E-02	2.091E-02	1.151E-02	3.590E-07	8.143E-13

The DSR includes contributions from associated (half-life ó 180 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 1.500E+01 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137	2.263E+01	2.316E+01	2.543E+01	2.857E+01	7.265E+01	2.333E+02	2.635E+06	3.067E+11
Ra-226	6.729E+00	6.726E+00	6.703E+00	6.659E+00	6.069E+00	5.402E+00	5.801E+00	1.131E+01
Sr-90	2.220E+03	1.905E+03	1.274E+03	9.662E+02	7.174E+02	1.304E+03	4.178E+07	1.842E+13

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Cs-137	8.020E+00	0.000E+00	6.629E-01	2.263E+01	6.629E-01	2.263E+01
Ra-226	6.000E-02	262.3 ñ 0.5	3.518E+00	4.264E+00	2.229E+00	6.729E+00
Sr-90	7.800E-01	35.09 ñ 0.07	2.210E-02	6.787E+02	6.757E-03	2.220E+03

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	DOSE(j,t), mrem/yr							
		t=	0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137	Cs-137	1.000E+00	5.317E+00	5.194E+00	4.731E+00	4.210E+00	1.656E+00	5.157E-01	4.566E-05	3.922E-10
Ra-226	Ra-226	1.000E+00	1.337E-01	1.336E-01	1.334E-01	1.330E-01	1.305E-01	1.274E-01	8.551E-02	4.344E-02
Pb-210	Ra-226	1.000E+00	6.174E-05	1.974E-04	9.083E-04	2.119E-03	1.779E-02	3.918E-02	6.963E-02	3.612E-02
Sr-90	Sr-90	1.000E+00	5.270E-03	6.141E-03	9.183E-03	1.211E-02	1.631E-02	8.975E-03	2.800E-07	6.352E-13

THF(i) is the thread fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	S(j,t), pCi/g							
		t=	0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137	Cs-137	1.000E+00	8.020E+00	7.835E+00	7.137E+00	6.351E+00	2.497E+00	7.777E-01	6.877E-05	5.897E-10
Ra-226	Ra-226	1.000E+00	6.000E-02	5.992E-02	5.960E-02	5.920E-02	5.610E-02	5.244E-02	3.061E-02	1.562E-02
Pb-210	Ra-226	1.000E+00	0.000E+00	1.834E-03	8.593E-03	1.587E-02	4.483E-02	5.109E-02	3.132E-02	1.598E-02
Sr-90	Sr-90	1.000E+00	7.800E-01	7.600E-01	6.852E-01	6.019E-01	2.134E-01	5.836E-02	1.829E-06	4.287E-12

THF(i) is the thread fraction of the parent nuclide.

RESCALC.EXE execution time = 1.55 seconds

Appendix C

Oak Ridge Institute for Science and Education Independent Verification Survey Report For the Former HWMF Perimeter Soils

ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

December 10, 2009

Ms. Terri Kneitel
U.S. Department of Energy
Brookhaven Site Office
53 Bell Ave., Building 464
Upton, NY 11973

DOE CONTRACT NO. DE-AC05-06OR23100

SUBJECT: VERIFICATION REPORT— INDEPENDENT VERIFICATION SURVEY REPORT FOR THE FORMER HAZARDOUS WASTE MANAGEMENT FACILITY PERIMETER SOILS AREA, BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
DCN: 5062-SR-02-0

Dear Ms. Kneitel:

The Oak Ridge Institute for Science and Education (ORISE) is pleased to provide the enclosed verification survey report for the Former Hazardous Waste Management Facility Perimeter Soils Area. Please contact me at 865.576.5321 or Ben Estes at 865.241.3841 should you have any questions.

Sincerely,

Phyllis C. Weaver
Health Physics Project Leader
Survey Projects

PCW:bf

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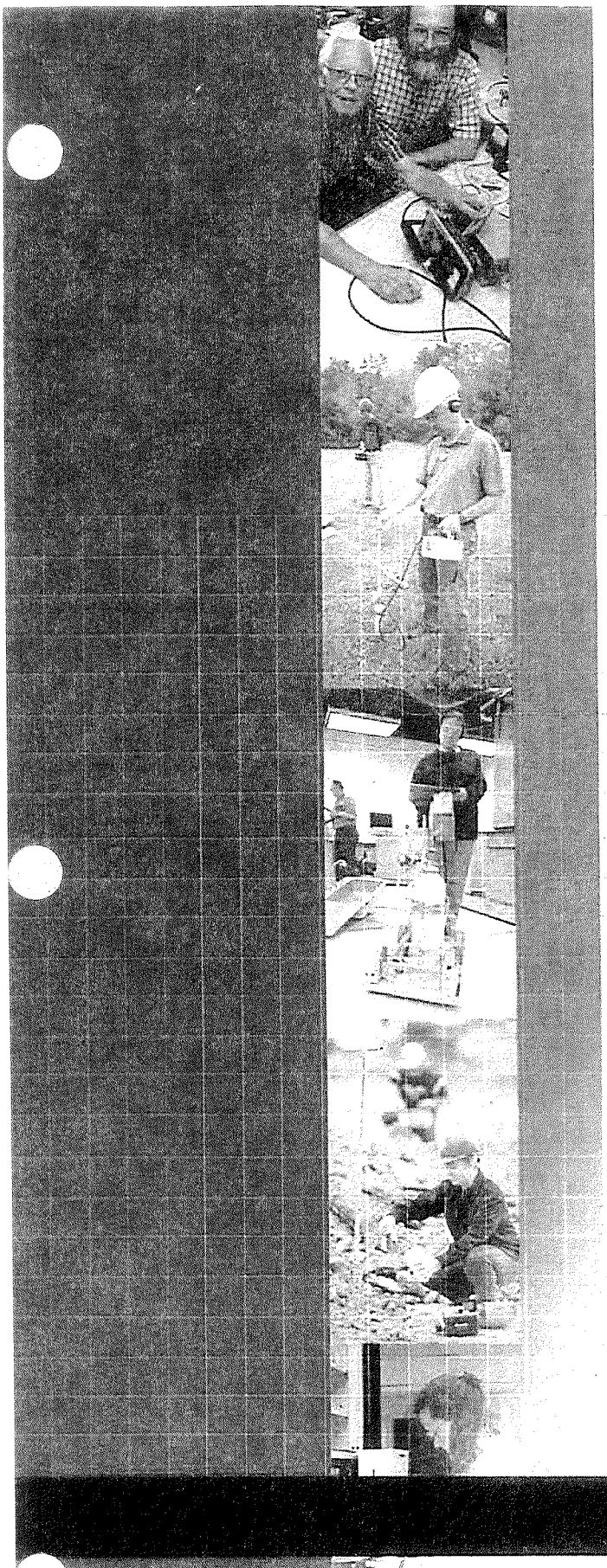

INDEPENDENT VERIFICATION SURVEY REPORT FOR THE FORMER HAZARDOUS WASTE MANAGEMENT FACILITY PERIMETER SOILS AREA, BROOKHAVEN NATIONAL LABORATORY UPTON, NEW YORK

P. C. Weaver

Prepared for the
U.S. Department of Energy

ORISE
Oak Ridge Institute for Science and Education

The Oak Ridge Institute for Science and Education (ORISE) is a U.S. Department of Energy facility focusing on scientific initiatives to research health risks from occupational hazards, assess environmental cleanup, respond to radiation medical emergencies, support national security and emergency preparedness, and educate the next generation of scientists. ORISE is managed by Oak Ridge Associated Universities. Established in 1946, ORAU is a consortium of 97colleges and universities.

NOTICES

INDEPENDENT VERIFICATION SURVEY REPORT FOR THE FORMER HAZARDOUS WASTE MANAGEMENT FACILITY PERIMETER SOILS AREA, BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Prepared by

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Oak Ridge Institute for Science and Education
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Prepared for the
U.S. Department of Energy

FINAL REPORT

ORISE

December 2009

This report is based on work performed by the Oak Ridge Institute for Science and Education under contract number DE-AC05-06OR23100 with the Department of Energy.

INDEPENDENT VERIFICATION SURVEY REPORT
FOR THE
FORMER HAZARDOUS WASTE MANAGEMENT FACILITY
PERIMETER SOILS AREA,
BROOKHAVEN NATIONAL LABORATORY,
UPTON, NEW YORK

Prepared by: _____ Date: 12/9/09
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ABBREVIATIONS AND ACRONYMS

AEC	Atomic Energy Commission
AOC	area of concern
µg	micrograms
µR/h	microroentgens per hour
µrem/h	microrem per hour
BAO	Brookhaven Area Office
BKG	background
BNL	Brookhaven National Laboratory
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	centimeter
cm^2	square centimeter
CO	cleanup objectives
COC	contaminants of concern
cpm	counts per minute
Cs-137	cesium-137
DCGL	derived concentration guideline level
DOE	U.S. Department of Energy
D&D	decontamination and decommissioning
EPA	Environmental Protection Agency
FHWMF	Former Hazardous Waste Management Facility
FIPS	Federal Information Processing Standard
FSP	Field Sampling Plan
FSS	final status survey
FSSR	final status survey report
g	gram
GPS	global positioning system
HS	hot spot
IAG	Interagency Agreement
ISM	Integrated Safety Management
ITP	Intercomparison Testing Program
IV	independent verification
IVT	Independent Verification Team
JHA	job hazard analysis
keV	kiloelectron volts
kg	kilogram
m	meter
mg	milligram
MAPEP	Mixed Analyte Performance Evaluation Program
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
MDCR	minimum detectable count rate

ABBREVIATIONS AND ACRONYMS
(continued)

MeV	million electron volts
m^2	square meter
min	minute
mm	millimeter
mrem	millirem
NaI	sodium iodide
NIST	National Institute of Standards and Technology
NPL	National Priorities List
NRIP	NIST Radiochemistry Intercomparison Program
NYSDEC	New York State Department of Environmental Conservation
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
OU	Operable Unit
pCi/g	picocuries per gram
PSA	perimeter soils area
PSP	project-specific plan
RA	remedial actions
Ra-226	radium-226
RCRA	Resource Conservation and Recovery Act
ROD	record of decision
RSS	ranked set sampling
sec	second
SOR	sum of ratios
SPCS	State Plane Coordinate System
Sr-90	strontium-90
SU	survey unit
TAP	total absorption peak
VSP	visual sampling plan
WLA	Waste Loading Area
yr	year
yd^3	cubic yard

INDEPENDENT VERIFICATION SURVEY REPORT FOR THE FORMER HAZARDOUS WASTE MANAGEMENT FACILITY PERIMETER SOILS AREA, BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

INTRODUCTION AND SITE HISTORY

The Brookhaven National Laboratory (BNL) located in Upton, Suffolk County, New York conducts research and development for the Department of Energy (Figure A-1). BNL was originally occupied by the U.S. Army as Camp Upton during both World Wars I and II. In 1947, the site was transferred to the Atomic Energy Commission (AEC). The AEC was resolved into the Energy Research and Development Administration, and later into the Department of Energy (DOE) Brookhaven Area Office (BAO).

Research operations and processes conducted at the site have produced a variety of radioactive and hazardous materials and wastes. On December 21, 1989, BNL was included on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priority List (BNL 1999). In May 1992, the DOE entered into an Interagency Agreement (IAG) with the Environmental Protection Agency (EPA) and New York State Department of Environmental Conservation (NYSDEC) under CERCLA, Section 120 to establish the framework and schedule for characterizing, assessing, and remediating the site in accordance with CERCLA and the Resource Conservation and Recovery Act (RCRA) requirements (EPA 1997). BNL generated the Response Strategy Document that identified various Areas of Concern (AOC) and grouped each AOC into seven "Operable Units" (OU). OU-1 is the Former Hazardous Waste Management Facility (FHWMF); a 12-acre controlled compound that once served as the central receiving facility for processing, limited treatment, and storage of radioactive wastes during the late 1940s to 1997. RCRA hazardous wastes were handled at the facility from 1976 until it closed in 1997. In 2003, remediation of the FHWMF began with the removal of several building structures and operations areas and remediation of soils and subsurface structures was completed in 2005 (ORISE 2008a).

BNL has recently performed remediation of several locations outside of the FHWMF designated as the Perimeter Soils Areas (PSAs) (BNL 2009a). In 2007, this area east of Brookhaven Avenue across from the FHWMF was surveyed by BNL and soil samples were collected for Cs-137 and

Sr-90, and gamma analysis. Additional surveying also identified other small discrete areas of contaminated soil contiguous to the FHWMF which includes small areas to the northwest and north, east, and several discrete spots just to the south beyond the former Waste Loading Area (WLA) also associated with the FHWMF. BNL suspects that the contamination identified in these areas is a result of operations associated with the transport and transfer of waste materials to the FHWMF, spills, and runoff from contaminated soils within the FHWMF (ORISE 2009a).

DOE-BAO is responsible for oversight of remedial actions that are conducted at the BNL. It is the policy of the DOE to perform independent (third party) verification of final status survey (FSS) activities (DOE 2006). The purpose of independent verification (IV) is to confirm that remedial actions have been effective in meeting established guidelines and that documentation accurately and adequately describes the final site conditions. Oak Ridge Institute for Science and Education (ORISE) has been requested by DOE-BAO to perform IV of the PSA. Through a third party, DOE can provide a level of assurance to the stakeholders that the as-left radiological concentration in the PSA will be well below the approved remediation guidelines. ORISE had previously performed IV of the larger phase of FHWMF remediation and the WLA (ORISE 2005 and 2008a).

OBJECTIVE

The objective of the verification survey was to obtain evidence by means of measurements and sampling to confirm that the final radiological conditions were less than the established release criteria. This objective was achieved via multiple verification components including document reviews to determine the accuracy and adequacy of FSS documentation

PROCEDURES

ORISE personnel visited the BNL site September 28 and 29, 2009 to perform visual inspections and independent measurements and sampling. The verification activities were conducted in accordance with the project-specific verification plan, the IEAV Survey Procedures, and Quality Program Manuals (ORISE 2009a and 2008b, and ORAU 2009). The collective site areas verified consisted of several small isolated locations; the largest of which is approximately 2000 m^2. All survey units (SUs) were designated Class 1 due to the nature of the activities conducted in the nearby area and the contaminants associated with the process activities. ORISE defined these units as SU 1 (the

largest of the PSA), SU 2 (located adjacent to SU 1), and SU 3 which was further subdivided into survey units 3A through 3D (Figure A-2).

REFERENCE SYSTEM

ORISE used a global positioning system (GPS) for documenting survey area boundaries and tracking data. The specific geographical reference system used was the State Plane Coordinate System (SPCS) New York Long Island Federal Information Processing Standard (FIPS) 3104. A shape file for each SU boundary and dimension was created and then loaded into a GPS for use by the Independent Verification Team (IVT) for tracking survey data and identifying measurement and sampling locations. Coordinate measurements collected using the GPS were accurate to within one meter.

SURFACE SCANS

High density scans for gamma radiation were performed within the accessible areas associated with the PSA. Surfaces scans were performed using NaI scintillation detectors coupled to ratemeters or ratemeter-scalers with audible indicators. Detectors were coupled to GPS systems that enable real-time gamma count rate and position data capture. Locations of elevated direct radiation, suggesting the presence of residual contamination, were marked and identified for further investigation.

SOIL SAMPLING

The Visual Sampling Plan (VSP) software was used to generate random coordinates for gamma measurements and soil sampling. These measurement/sample points were down-loaded to the GPS and were based upon the reference system established by the site. These predetermined random field assessment and the resultant soil sample locations were designed and generated based on the ranked set sampling (RSS) approach (EPA 2002). A one-minute static gamma count rate measurement was performed at 18 pre-determined assessment locations. The data within a given cycle-set were then ranked as exhibiting either the lowest, medium, or highest gamma count. Table B-1 provides the RSS cycle set with field assessment data and ranked set soil sample identification. Surface soil samples were also collected from judgmental locations where elevated direct gamma radiation was detected. Figure A-2 identifies both random and judgmental locations.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and data were returned to the ORISE/IEAV laboratory in Oak Ridge, Tennessee for analysis and interpretation. Sample analyses were performed in accordance with the ORISE Laboratory Procedures Manual (ORISE 1999). Soil samples were analyzed by gamma spectroscopy for Ra-226 and Cs-137. The spectra were reviewed for other identifiable photopeaks. Sr-90 was quantified by radiochemical separation and counting on a low background proportional counter. Soil sample results were reported in units of picocuries per gram (pCi/g).

APPLICABLE SITE GUIDELINES

The radiological contaminants of concern and the soil cleanup levels are shown in Table 1 and have been previously identified in the OU I ROD (BNL 2009a). This Field Sampling Plan (FSP) relies on the previously developed cleanup goals and derived concentration guideline levels (DCGL), due to the proximity of the PSA to the FHWMF. Since multiple contaminants are present, application of the unity rule is involved requiring calculation of the sum-of-ratios (SORs) in accordance with the following equation:

$$\frac{Conc._{Ra-226}}{DCGL_{Ra-226}} + \frac{Conc._{Cs-137}}{DCGL_{Cs-137}} + \frac{Conc._{Sr-90}}{DCGL_{Sr-90}} \leq 1$$

TABLE 1
RADIONUCLIDES OF CONCERN IN THE PERIMETER SOILS AREA
FORMER HAZARDOUS WASTE MANAGEMENT FACILITY
RESIDENTIAL LAND USE CLEAN-UP GOALS

Radionuclide	OU I ROD (pCi/g)
Cs-137	23
Sr-90	15
Ra-226	5

FINDINGS AND RESULTS

The results for each verification component at the PSA are discussed below.

SURFACE SCANS

The gamma scan pattern and count rates are provided in Figures A-3 to A-6. Scan density varied in the survey units typically between 50 percent to upwards of 75 percent or greater of accessible areas, with the exception of SU 3D. Due to the low lying brush and the fact that ORISE was aware that additional work would be required, scanning was scaled back to just those locations that were remediated for this scope of work. This was not unexpected as BNL had also identified additional areas to be remediated during future activities. Additionally, Figure A-3 (SU 1) does not illustrate the complete scan results for this survey unit as a portion of the position-correlated gamma data was not captured by the recording instrument. Per ORISE procedure, the surveyor determines whether there is elevated gamma radiation present in real time based on the audio output of the detector.

Ambient background gamma radiation levels ranged from about 1,300 to 3,800 cpm and averaged just slightly greater than 2,300 cpm. Gamma scan count rates within the PSA survey units generally ranged from 2,300 to approximately 7,500 counts per minute (cpm). Gamma surface scans identified several locations of radioactivity greater than two times the localized ambient levels that were marked for additional evaluation in SUs 1, 2, 3A, 3C, and 3D. The highest count rate of 48,000 cpm was found in SU 3D. The count rate frequency distributions for gamma radiation scans are illustrated in Figures A-7 to A-12.

SOIL SAMPLING

Twelve surface soil samples were collected from RSS locations. Additionally, seven judgmental samples were collected where elevated direct gamma radiation was detected during surface scans (Figure A-2). Judgmental soil samples collected were S001 to S003 from SU 1; S010 and S011 from SU 3A; and S012 and S013 from SU 3C (Figure A-2). Although scans identified elevated gamma radioactivity in SU 3D, no judgmental samples were collected because of BNLs plan to address this soil under a different scope of work.

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES

The gamma count rate data used for selecting the RSS sample locations can be found in Table B-1. The mean radionuclide concentration data for each survey unit are summarized in Table B-2. The data for the radionuclide concentrations in individual samples and the sum-of-ratios are provided in Table B-3. The concentration of Ra-226 in random samples ranged from 0.50 to 0.71 pCi/g, Cs-137

ranged from 0.96 to 9.82 pCi/g, and Sr-90 ranged from -0.02 to 0.37 pCi/g. The highest concentration of Cs-137 (54.3 pCi/g) was identified in the judgmental sample S001from SU 1. BNL was notified that several samples exceeded the Cs-137 clean-up goal (ORISE 2009c).

COMPARISON OF RESULTS WITH GUIDELINES

The final radionuclide concentration for the PSA must meet the guidance per the BNL FSP for each individual soil sample and the SOR for the average concentration of each radionuclide of interest must be less than one. Six soil samples exceeded the SOR of 1 due primarily to the level of Cs-137 concentration remaining in the soil. Five of the six samples were from judgmental locations: S001, S002, S003, S011, S012, and S013. The sixth sample, S004 was a random location. Sample S004 is just slightly over the SOR at 1.03. The SOR for each individual sample location is included in Table B-3. Cs-137 concentrations in the random samples ranged from 0.96 to 20.9 pCi/g (includes samples S004 to S009 and S014 to S019). Cs-137 concentrations in judgmental samples ranged from 4.86 pCi/g to 54.3 pCi/g. The survey unit mean concentrations for Cs-137 were within clean-up goals except for SU 3C with a concentration of 39.1 pCi/g. All Ra-226 and Sr-90 concentration results were well below the site clean-up goals as provided in Table 1.

ORISE provided preliminary gamma spectroscopy results for Cs-137 to BNL indentifying those locations that exceeded the site clean-up goal of 23 pCi/g (ORISE 2009c). BNL immediately remediated each of the five sample locations which exceeded the Cs-137 cleanup goals. All the areas were between approximately 1to 5 ft^2 in size. Endpoint sample results reported by BNL at ORISE sample corresponding locations S001A, S002A, S011A, S012A, and S013A were 15.4pCi/g, 7.6pCi/g, 11.07pCi/g, 15.2pCi/g, and 7.5pCi/g, respectfully (BNL 2009b). All are below the Cs-137 clean-up goal. After the completion of radiochemical analysis, sample S004 was just slightly greater than the SOR. However, the SOR has not been adjusted for the contribution from background activity. Therefore, the net SOR would be less than 1.

SUMMARY

During the period between September 28 and 29, 2009, an independent verification team with the Oak Ridge Institute for Science and Education conducted measurements and sampling of the Perimeter Soils Areas at the Brookhaven National Laboratory site. The PSAs are a small group of

localized contaminated areas located at the northeast end of the 12 acre Former Hazardous Waste Management Facility. The PSA consists of at least six distinct areas. However, the two larger distinct areas were defined as SU 1 and SU 2 and the four other smaller areas were grouped as SU 3 and further subdivided A through D.

Gamma scans identified a few small areas of elevated radiation in SUs 1, 2, 3A, 3C, and 3D. Seven judgmental soil samples were collected from locations identified during walkover scans. ORISE also collected 12 random soil samples using the RSS methodology. Samples were analyzed by gamma spectroscopy and wet chemistry. Preliminary data identified five of the seven judgmental samples were above the cleanup goal for Cs-137. Cs-137 concentrations in soil samples ranged from 0.96 to 54.3 pCi/g. BNL was notified of the findings and responded by remediating these locations.

Additionally, one random sample location just slightly exceeded the SOR. Although the concentration of Cs-137 in the random sample was below the clean-up goal, the multiple radionuclides of concern pushed it slightly over the limit at 1.03, without adjusting for the background contribution. The survey units mean concentrations for Cs-137 were within the clean-up goals when considering only random sample location results.

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APPENDIX A

FIGURES

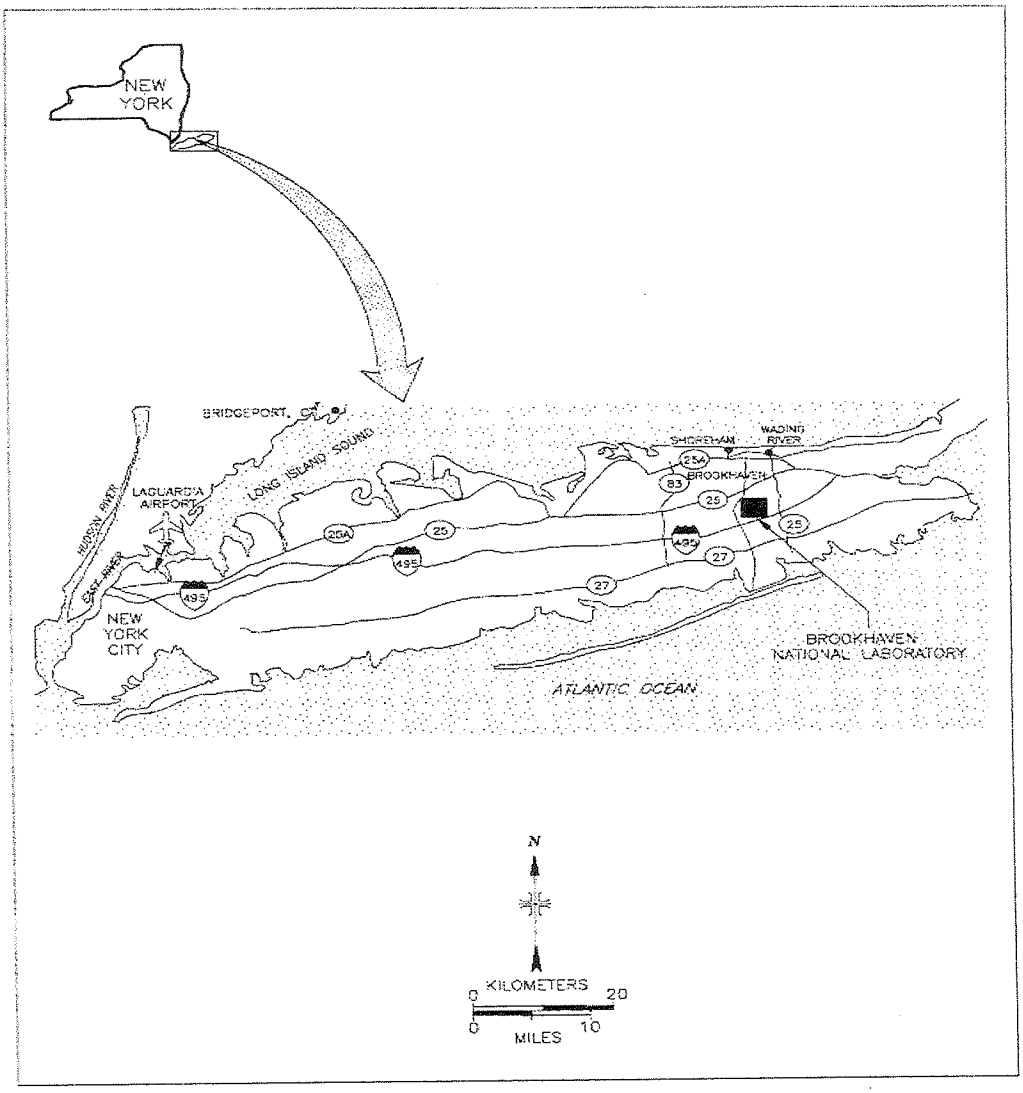

Figure A-1. Location of Brookhaven National Laboratory, Upton, New York

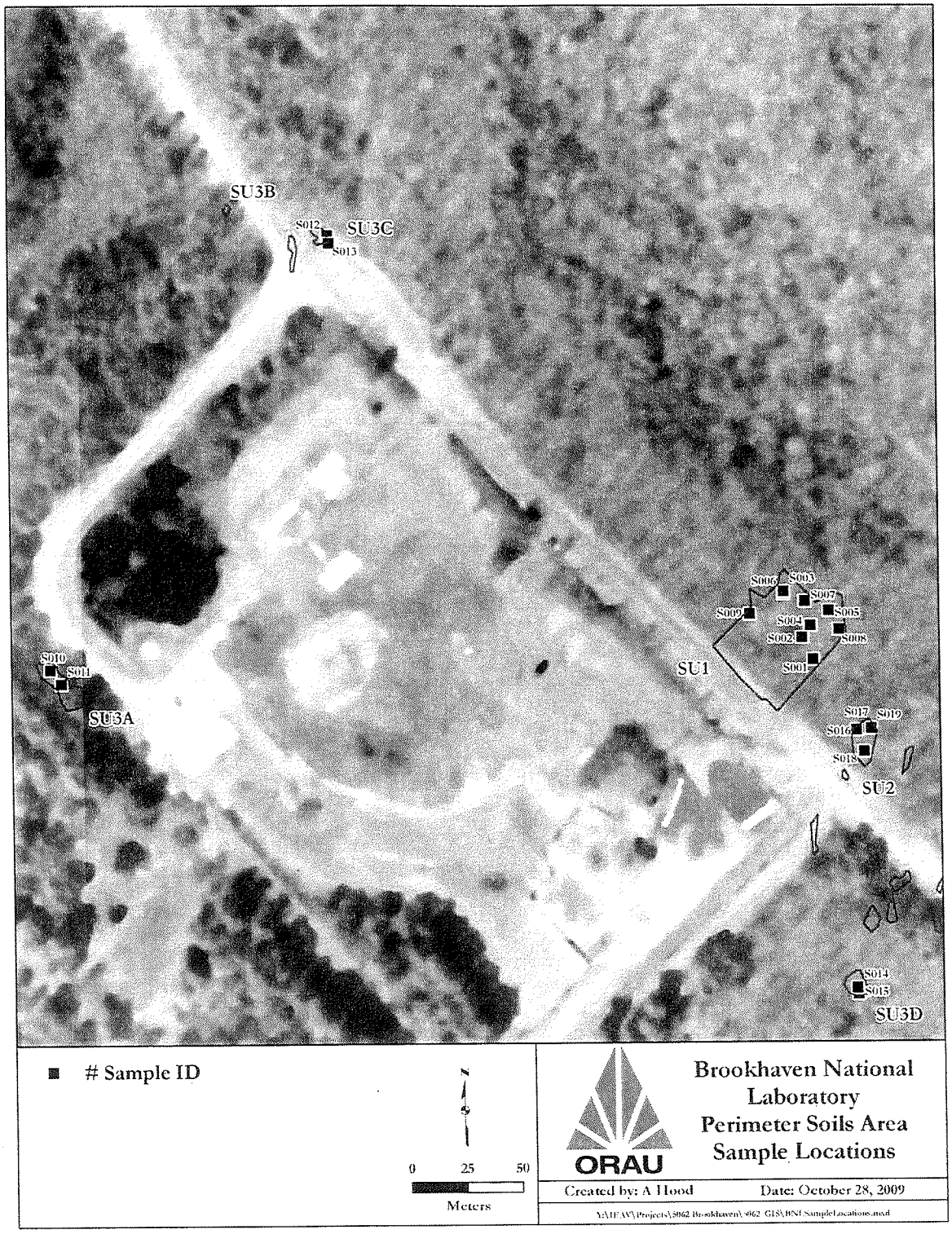

Figure A-2. Perimeter Soils Area Sample Locations

Figure A-3. Perimeter Soils Area Gamma Count Rate Scan Survey Units 1 and 2

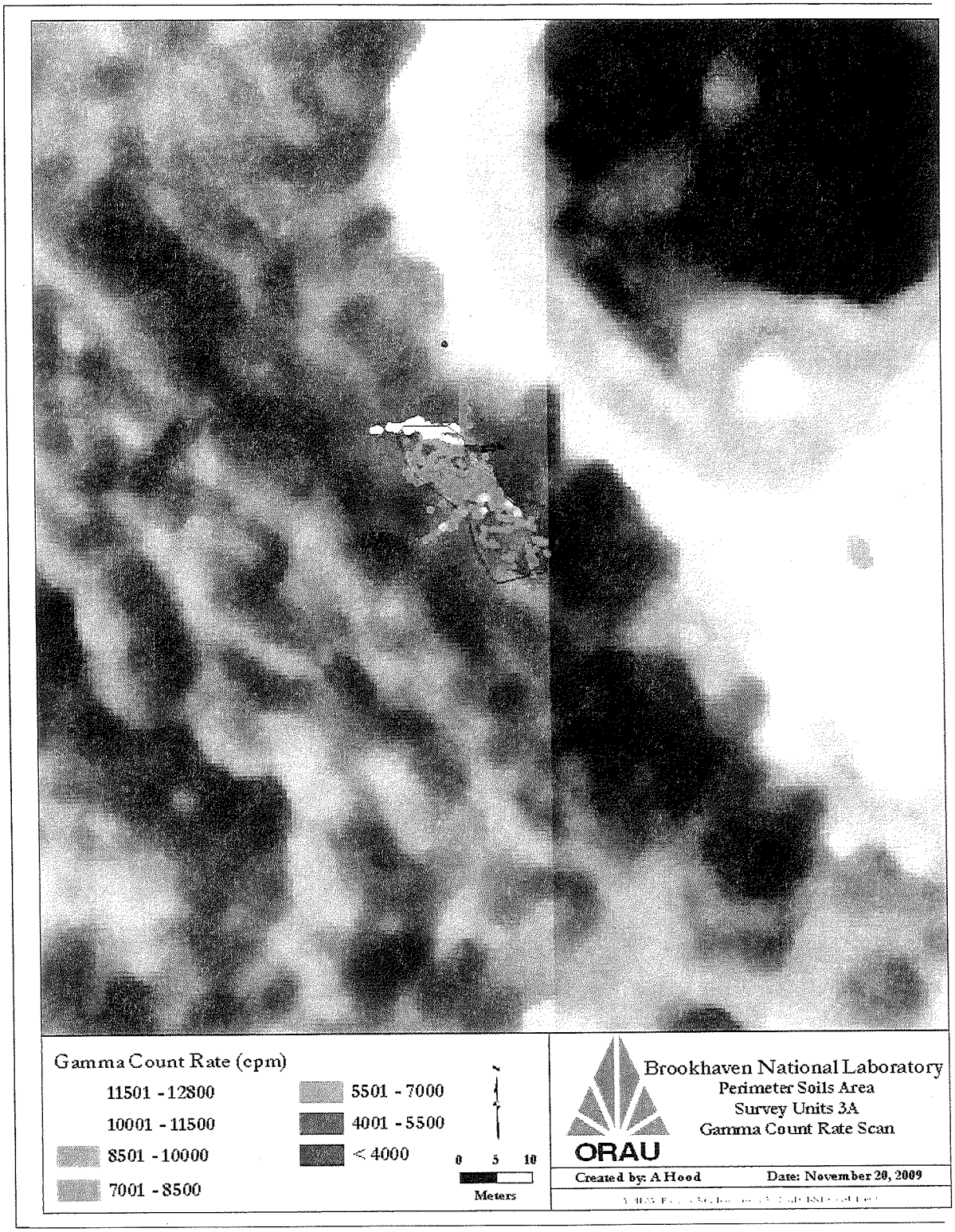

Figure A-4. Perimeter Soils Area Gamma Count Rate Scan Survey Unit 3A

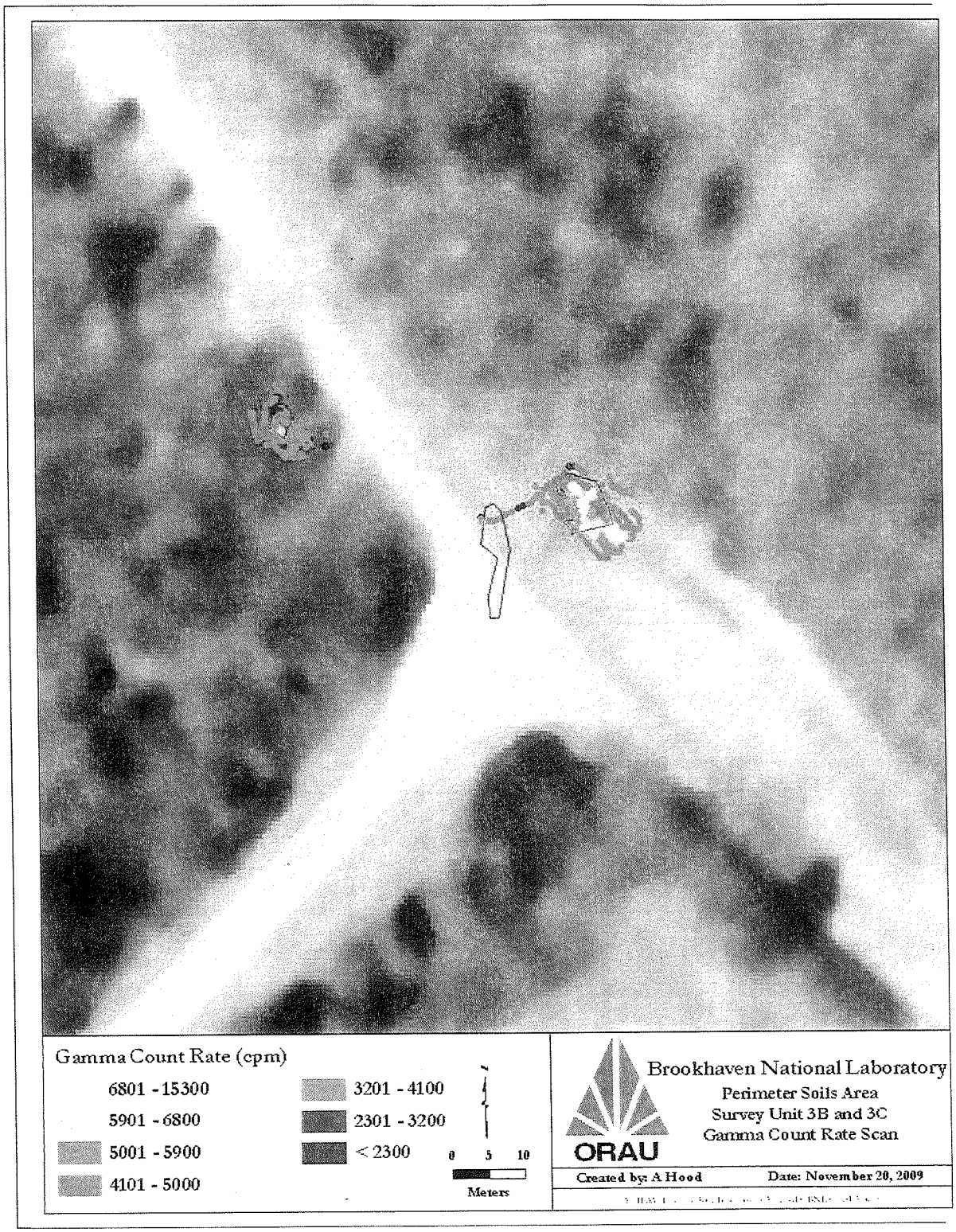

Figure A-5. Perimeter Soils Area Gamma Count Rate Scan Survey Units 3B and 3C

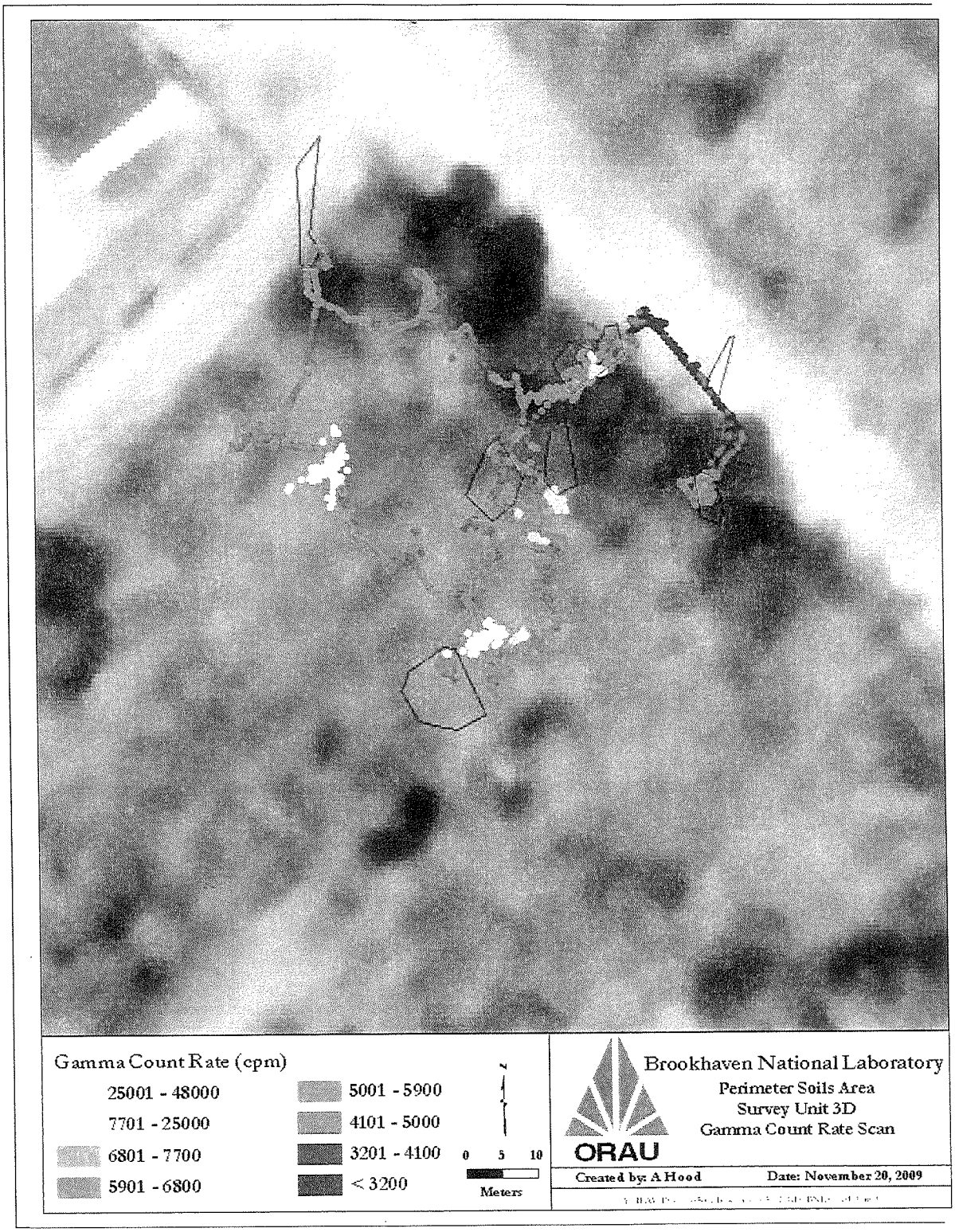

Figure A-6. Perimeter Soils Area Gamma Count Rate Scan Survey Unit 3D

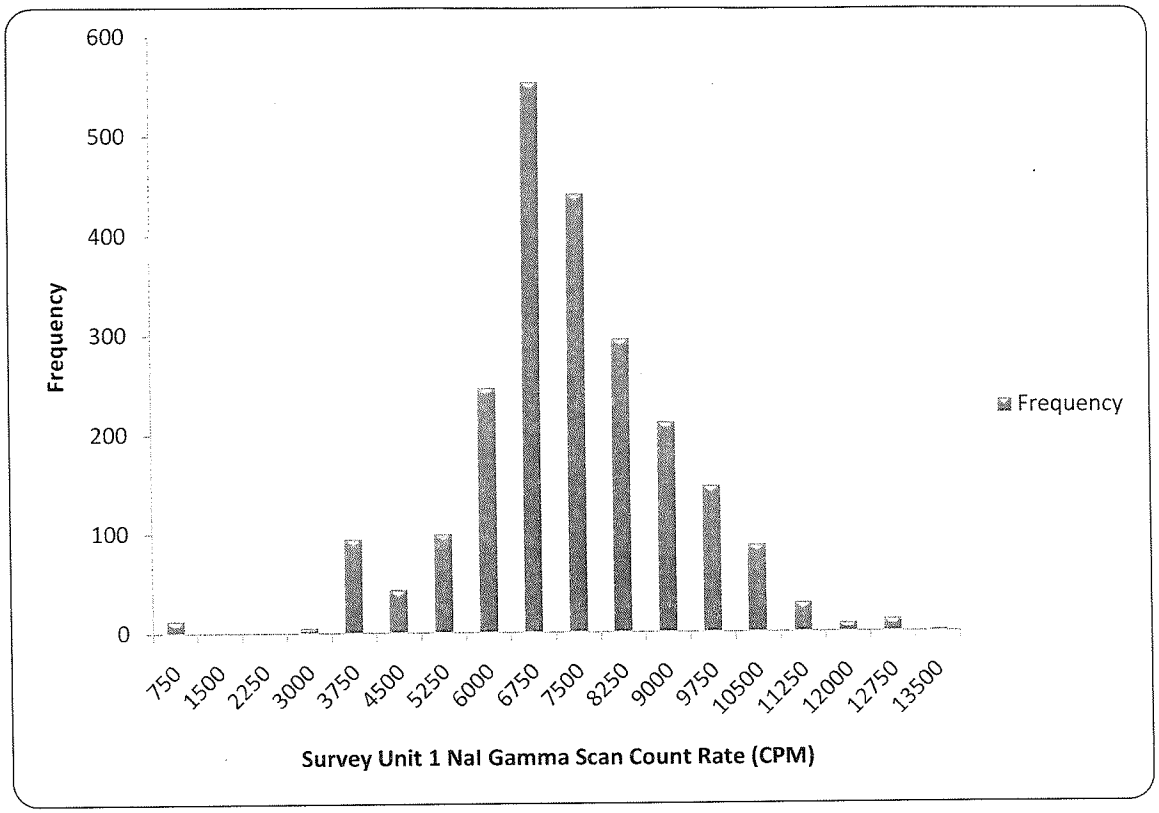

Figure A-7. Perimeter Soils Area Gamma Count Rate Scan Survey Unit 1

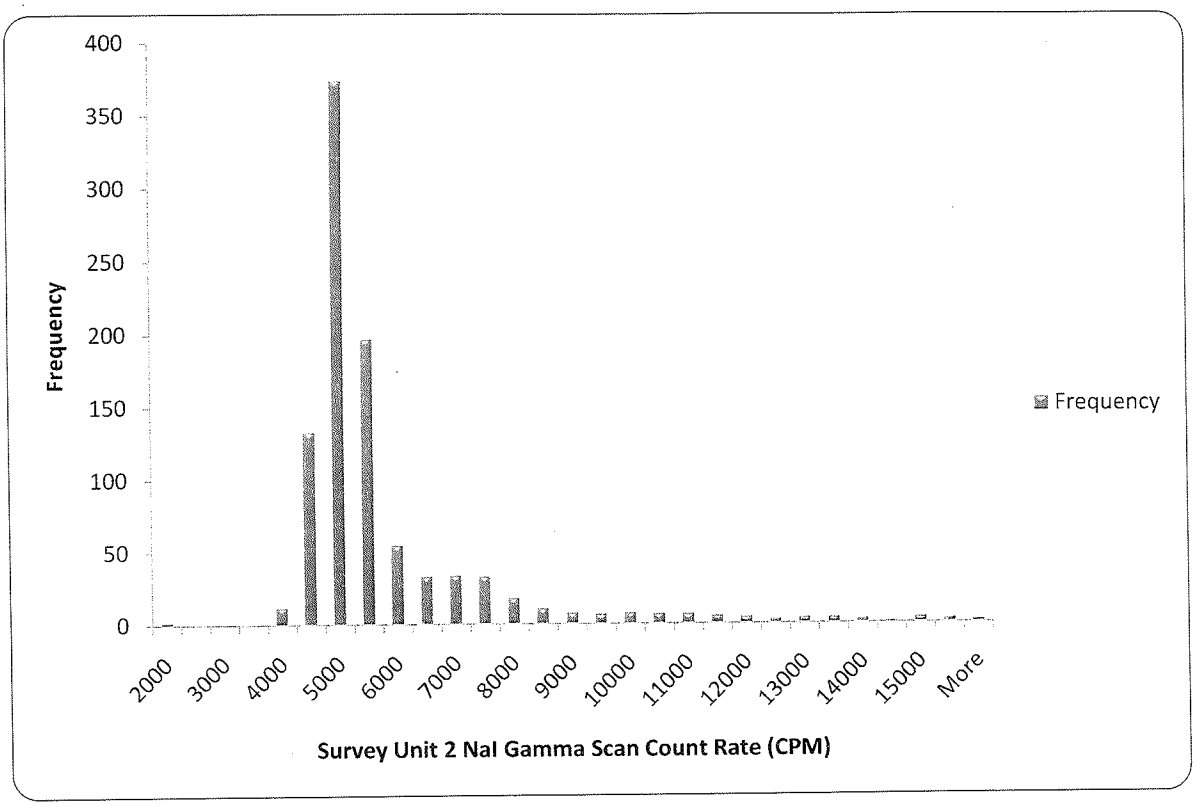

Figure A-8. Perimeter Soils Area Gamma Count Rate Scan Survey Unit 2

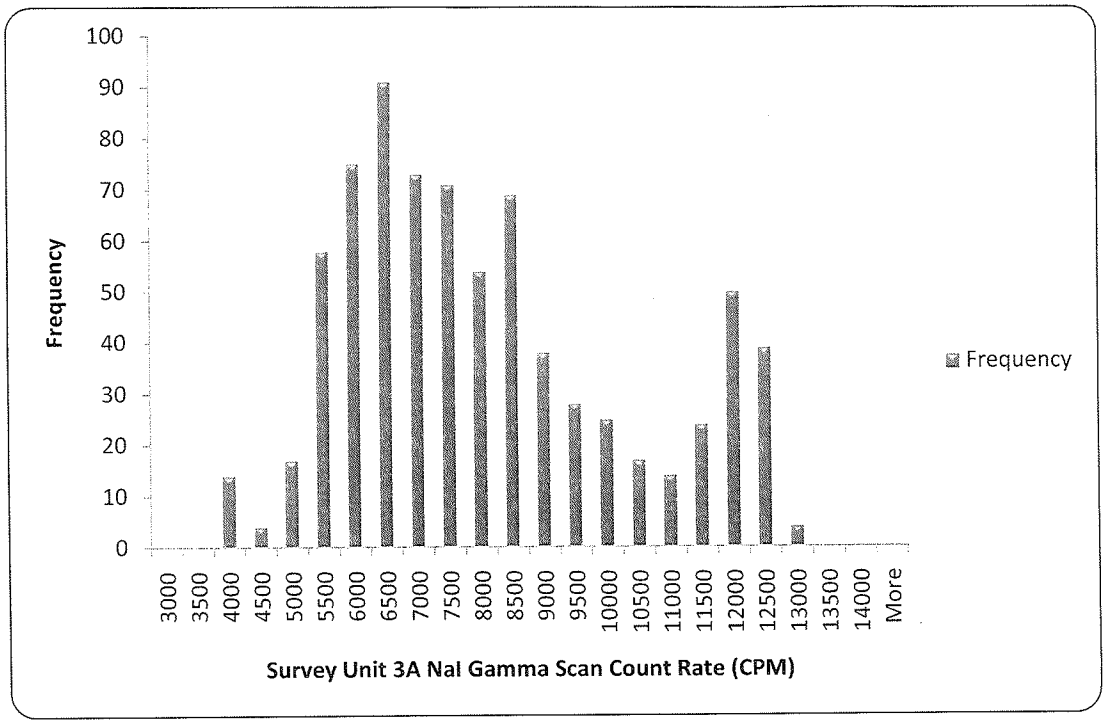

Figure A-9. Perimeter Soils Area Gamma Count Rate Scan Survey Unit 3A

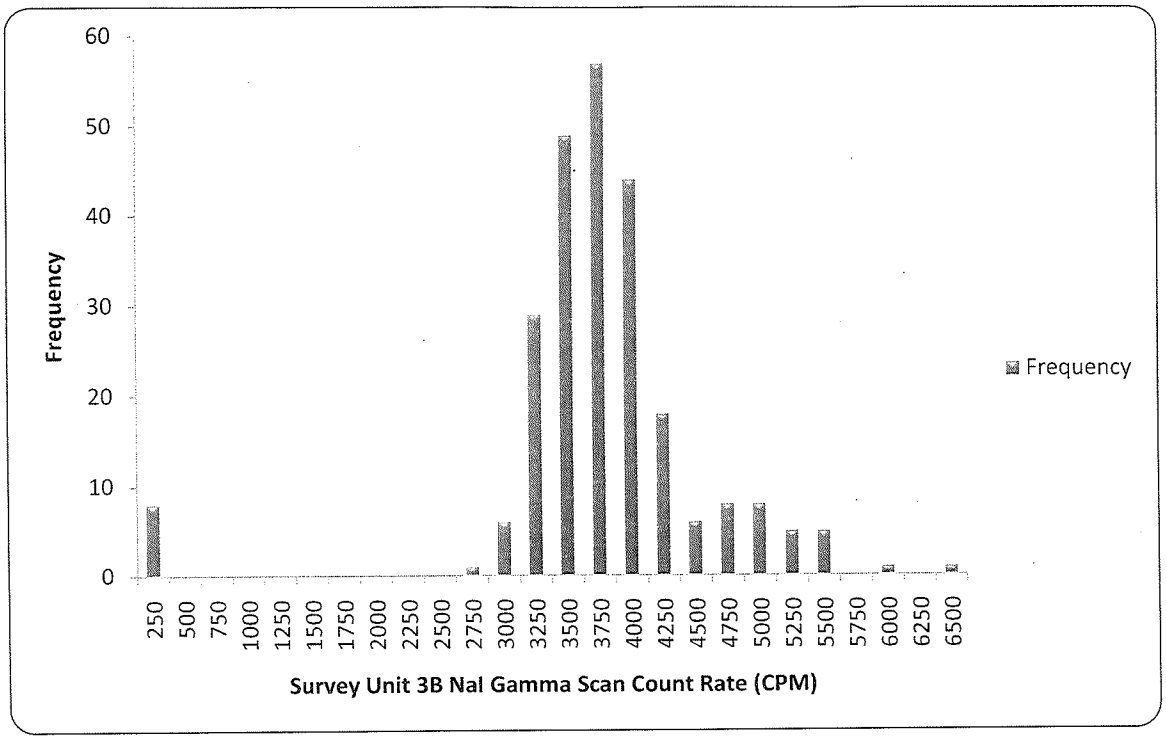

Figure A-10. Perimeter Soils Area Gamma Count Rate Scan Survey Unit 3B

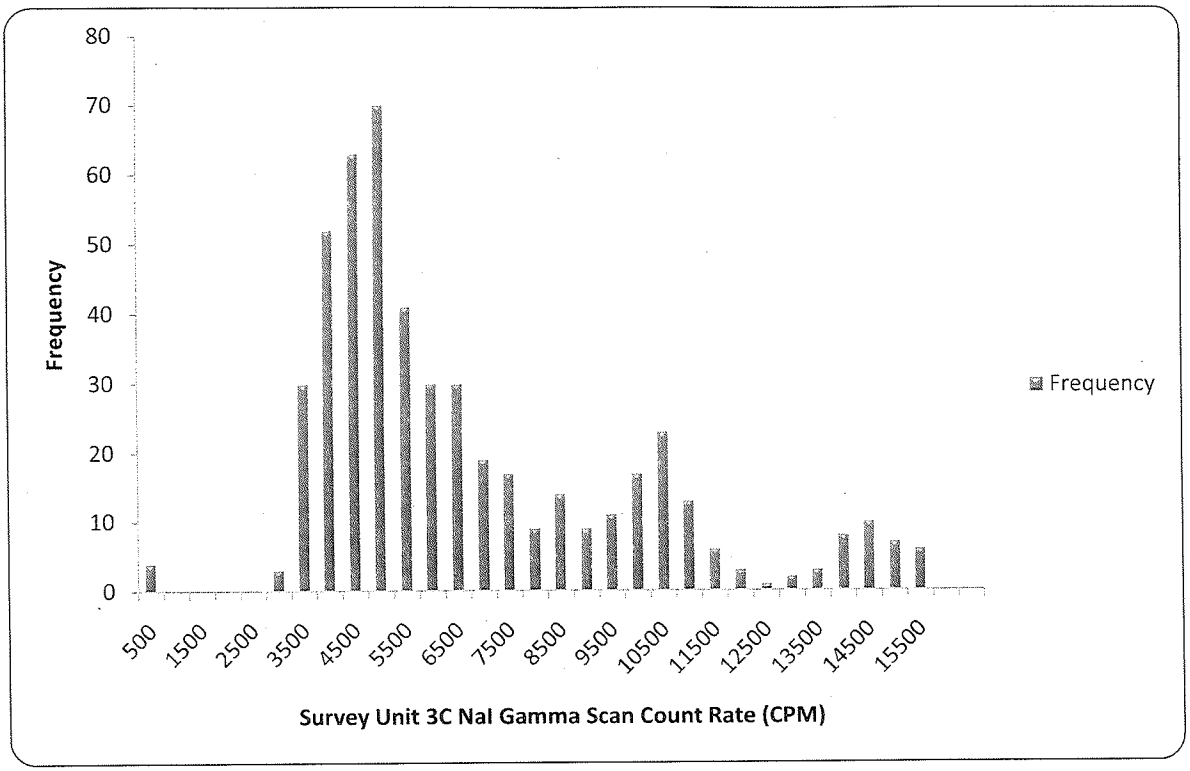

Figure A-11. Perimeter Soils Area Gamma Count Rate Scan Survey Unit 3C

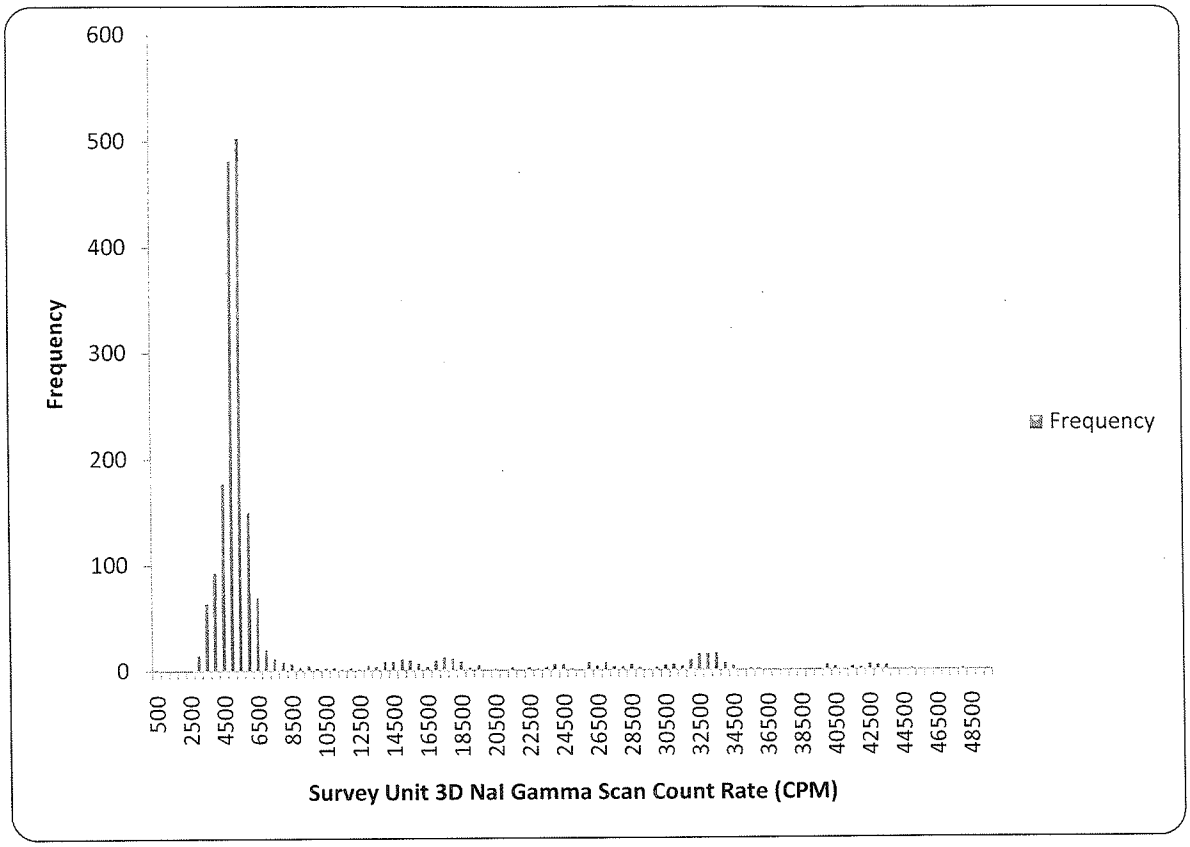

Figure A-12. Perimeter Soils Area Gamma Count Rate Scan Survey Unit 3D

APPENDIX B

TABLES

TABLE B-1
RANKED SET SAMPLING GAMMA MEASUREMENTS
PERIMETER SOILS AREA
FORMER HAZARDOUS WASTE MANAGEMENT FACILITY
BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK

LOCATION NAD 83 SPCS NY Long Island FIPS 3104 Easting, Northing	Ranked Set Sampling Cycle-Set-Loc	Gamma cpm	Sample Select[b]/ID L=Low M=Medium H=High	SOIL SAMPLE
1300426, 255007	1-1-1■	4304	L	
1300403, 254973	1-1-2■	2459	**L**	S004
1300305, 254928	1-1-3■	2833	L	
1300430, 254995	1-2-1▲	2496	**M**	S005
1300431, 254982	1-2-2▲	1950	M	
1300367, 255009	1-2-3▲	4253	M	
1300384, 254939	1-3-1●	1822	H	
1300430, 254960	1-3-2●	1499	H	
1300363, 255020	1-3-3●	4471	**H**	S006
1300394, 255009	2-1-1■	2457	**L**	S007
1300308, 254942	2-1-2■	3084	L	
1300321, 254959	2-1-3■	3957	L	
1300369, 254912	2-2-1▲	1726	M	
1300330, 254871	2-2-2▲	3304	M	
1300445, 254967	2-2-3▲	2188	**M**	S008
1300428, 255009	2-3-1●	4111	H	
1300313, 254991	2-3-2●	3859	**H**	S009
1300442, 254948	2-3-3●	1664	H	

[a]Refer to Figure A-2.

TABLE B-1 (cont.)
RANKED SET SAMPLING GAMMA MEASUREMENTS
PERIMETER SOILS AREA
FORMER HAZARDOUS WASTE MANAGEMENT FACILITY
BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK

LOCATION NAD 83 SPCS NY Long Island FIPS 3104 Easting, Northing	Ranked Set Sampling Cycle-Set-Loc	Gamma cpm	Sample Select[b]/ID L=Low M=Medium H=High	SOIL SAMPLE
1300488, 254821	1-1-1■	1897	**L**	S017
1300469, 254783	1-1-2■	2214	L	
1300448, 254827	1-1-3■	2127	L	
1300470, 254819	1-2-1▲	2520	**M**	S016
1300474, 254809	1-2-2▲	2747	M	
1300485, 254799	1-2-3▲	2426	M	
1300497, 254806	1-3-1●	2339	H	
1300481, 254787	1-3-2●	2550	**H**	S018
1300469, 254787	1-3-3●	1944	H	
1300481, 254796	2-1-1■	2235	L	
1300480, 254819	2-1-2■	2520	L	
1300491, 254821	2-1-3■	2004	**L**	S019
1300592, 254585	2-2-1▲	1364	M	
1299543, 255583	2-2-2▲	3096	M	
1300467, 254429	2-2-3▲	2468	**M**	S015
1300454, 254455	2-3-1●	2443	H	
1300462, 254461	2-3-2●	2657	H	
1300466, 254438	2-3-3●	2733	**H**	S014

[a]Refer to Figure A-2.

TABLE B-2
RADIONUCLIDE CONCENTRATION RANGES IN SOIL SAMPLES
SUMMARY RESULTS
PERIMETER SOILS AREA
FORMER HAZARDOUS WASTE MANAGEMENT FACILITY

Survey Unit	Ra-226 (pCi/g)	Cs-137 (pCi/g)	Sr-90 (pCi/g)
Random Samples			
Survey Unit 1	0.51 to 0.71	1.55 to 20.9	-0.02 to 0.37
Mean Survey Unit Concentration[a]	*0.58*	*8.01*	*0.16*
Survey Unit 2	0.55 to 0.67	1.07 to 2.43	0.11 to 0.16
Mean Survey Unit Concentration	*0.61*	*1.79*	*0.14*
Survey Unit 3D	0.50 to 0.52	0.96 to 1.51	0.01 to 0.09
Mean Survey Unit Concentration	*0.51*	*1.24*	*0.05*
Judgmental Samples			
Survey Unit 1	0.52 to 0.59	4.86 to 54.3	0.11 to 0.12
Survey Unit 3A	0.43 to 0.54	18.2 to 26.6	0.11 to 0.21
Survey Unit 3C	0.30 to 0.35	30.8 to 47.5	0.13 to 0.23

[a]The mean survey unit concentration does not include judgmental samples.

TABLE B-3
RADIONUCLIDE CONCENTRATION IN SOILS
PERIMETER SOILS AREA
FORMER HAZARDOUS WASTE MANAGEMENT FACILITY
BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK BROOKHAVEN NATIONAL LABORATORY
UPTON, NY

Sample ID/Location[a]	Radionuclide Concentration (pCi/g)			
	Cs-137	Sr-90	Ra-226	SOR[b]
S001	54.3 ± 4.7[c]	0.12 ± 0.24	0.52 ± 0.14	2.47[d]
S002	30.5 ± 2.8	0.11 ± 0.28	0.59 ± 0.09	1.45[d]
S003	4.86 ± 0.65	0.11 ± 0.24	0.53 ± 0.08	0.32[d]
S004	20.9 ± 1.9	0.24 ± 0.25	0.54 ± 0.07	1.03
S005	2.31 ± 0.22	-0.02 ± 0.23	0.71 ± 0.09	0.24
S006	9.82 ± 0.92	0.10 ± 0.23	0.57 ± 0.07	0.55
S007	1.55 ± 0.13	0.37 ± 0.25	0.57 ± 0.07	0.21
S008	5.10 ± 0.47	0.07 ± 0.24	0.56 ± 0.07	0.34
S009	8.40 ± 0.60	0.21 ± 0.23	0.51 ± 0.08	0.48
S010	18.2 ± 1.6	0.21 ± 0.22	0.43 ± 0.09	0.89[d]
S011	26.6 ± 2.5	0.11 ± 0.22	0.54 ± 0.09	1.27[d]
S012	30.8 ± 2.8	0.23 ± 0.23	0.30 ± 0.08	1.41[d]
S013	47.5 ± 4.3	0.13 ± 0.21	0.35 ± 0.10	2.14[d]
S014	1.51 ± 0.13	0.09 ± 0.21	0.50 ± 0.07	0.17
S015	0.96 ± 0.11	0.01 ± 0.22	0.52 ± 0.07	0.15
S016	1.79 ± 0.18	0.16 ± 0.22	0.55 ± 0.06	0.20
S017	1.07 ± 0.12	0.16 ± 0.24	0.67 ± 0.08	0.19
S018	2.43 ± 0.20	0.13 ± 0.26	0.60 ± 0.08	0.23
S019	1.88 ± 0.19	0.11 ± 0.21	0.63 ± 0.09	0.22

[a]Refer to Figure A-2.
[b]Sum of the ratios.
[c]Uncertainties are at the 95% confidence level based on total propagated uncertainties.
[d]Identifies judgmental sample location.

APPENDIX C

MAJOR INSTRUMENTATION

APPENDIX C

MAJOR INSTRUMENTATION

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the author or her employer.

SCANNING INSTRUMENT/DETECTOR COMBINATIONS

Ludlum NaI Scintillation Detector Model SPA-3, Crystal: 2 inch x 2 inch
(Ludlum Measurements, Inc., Sweetwater, TX)
Coupled to
Ludlum Ratemeter-Scaler Model 2221
Coupled to
Trimble GeoXH Receiver and Data Logger (Trimble Navigation Limited, Sunnyvale, CA)

Fluke NaI Scintillation Detector Model 489-55, Crystal: 3.2 cm x 3.8 cm
(Fluke, Cleveland, OH)
Coupled to
Ludlum Ratemeter-Scaler Model 2221
Coupled to
Trimble GeoXH Receiver and Data Logger (Trimble Navigation Limited, Sunnyvale, CA)

LABORATORY ANALYTICAL INSTRUMENTATION

High Purity Extended Range Intrinsic Detector
CANBERRA/Tennelec Model No: ERVDS30-25195
(Canberra, Meriden, CT)
Used in conjunction with:
Lead Shield Model G-11
(Nuclear Lead, Oak Ridge, TN) and
Multichannel Analyzer
DEC ALPHA Workstation
(Canberra, Meriden, CT)

High Purity Extended Range Intrinsic Detector
Model No. GMX-45200-5
(AMETEK/ORTEC, Oak Ridge, TN)
used in conjunction with:
Lead Shield Model SPG-16-K8
(Nuclear Data)
Multichannel Analyzer
DEC ALPHA Workstation
(Canberra, Meriden, CT)

LABORATORY ANALYTICAL INSTRUMENTATION (CONT.)

High-Purity Germanium Detector
Model GMX-30-P4, 30% Eff.
(AMETEK/ORTEC, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-16
(Gamma Products, Palos Hills, IL) and
Multichannel Analyzer
DEC ALPHA Workstation
(Canberra, Meriden, CT)

Low background alpha/beta counting system
Canberra/Tennelec LB5100W
(Canberra, Inc., Meriden, CT)

APPENDIX D

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX D

SURVEY AND ANALYTICAL PROCEDURES

PROJECT HEALTH AND SAFETY

The survey and sampling procedures were evaluated to ensure that any hazards inherent to the procedures themselves were addressed in current job hazard analyses (JHAs). All survey and laboratory activities were conducted in accordance with ORISE health and safety and radiation protection procedures.

Pre-survey activities included an overview of potential health and safety issues. Representatives with the Brookhaven National Laboratory provided site-specific safety awareness training for each individual ORISE survey effort. In-process and verification surveys were performed according to the ORISE generic health and safety plan, site-specific integrated safety management (ISM) pre-job hazard checklist, and safety procedures discussed during the on-site training.

QUALITY ASSURANCE

Analytical and field survey activities were conducted in accordance with procedures from the following ORAU and ORISE documents:

- Survey Procedures Manual
- Laboratory Procedures Manual
- Quality Program Manual

The procedures contained in these manuals were developed to meet the requirements of 10 CFR 830 Subpart A, *Quality Assurance Requirements*, Department of Energy Order 414.1C *Quality Assurance*, and the U.S. Nuclear Regulatory Commission *Quality Assurance Manual for the Office of Nuclear Material Safety and Safeguards* and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Participation in MAPEP, NRIP, and ITP Laboratory Quality Assurance Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

CALIBRATION

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to the National Institute of Standards and Technology (NIST), when such standards/sources were available. In cases where they were not available, standards of an industry-recognized organization were used.

SURVEY PROCEDURES

Surface Scans

Scans for elevated gamma radiation were performed by passing the detector slowly over the surface. The distance between the detector and surface was maintained at a nominal of about 1 to 5 cm. NaI scintillation detectors were coupled to GPS units that enabled real-time recording of position in one-second intervals. Identification of elevated radiation levels was based on increases in the audible signal from the instrument. Positioning data files were downloaded from field data loggers for plotting using commercially available software (http://trl.trimble.com/docushare/dsweb/Get/Document-261826/GeoExpl2005_100A_GSG_ENG.pdf).

The scan minimum detectable concentrations (MDCs) for the NaI scintillation detector for the contaminants of concern in surface soil were obtained directly from NUREG-1507 when available or estimated using the calculational approach described in NUREG-1507[1]. A typical NaI 2 inch by 2 inch detector MDC for Cs-137 is 6.4 pCi/g. An audible increase in the activity rate was

[1]NUREG-1507. Minimum Detectable Concentrations With Typical Radiation Survey Instruments for Various Contaminants and Field Conditions. U.S. Nuclear Regulatory Commission. Washington, DC; June 1998.

investigated by ORISE. It is standard procedure for the ORISE staff to pause and investigate any locations where gamma radiation is distinguishable from background levels.

Soil Sampling

Approximately 0.5 to 1 kg of soil was collected at each sample location. Collected samples were placed in plastic bags, sealed, and labeled in accordance with ORISE survey procedures.

RADIOLOGICAL ANALYSIS

DETECTION LIMITS

Detection limits, referred to as MDC, were based on 3 plus 4.65 times the standard deviation of the background count [$3 + (4.65\ (BKG)^{1/2})$]. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument.

Strontium Analysis

Soil samples were dissolved by a combination of potassium hydrogen fluoride and pyrosulfate fusions. The fusion cake was dissolved and strontium was coprecipitated on lead sulfate. The strontium was separated from residual calcium and lead by reprecipitating strontium sulfate from EDTA at a pH of 4.0. Strontium was separated from barium by complexing the strontium in DTPA while precipitating barium as barium chromate. The strontium was ultimately converted to strontium carbonate and counted on a low-background gas proportional counter. The typical MDC of the procedure is 0.4 pCi/g for a one hour count time.

Gamma Spectroscopy

Samples of soil were dried, mixed, crushed, and/or homogenized as necessary, and a portion sealed in a 0.5-liter Marinelli beaker or other appropriate container. The quantity placed in the beaker was chosen to reproduce the calibrated counting geometry. Net material weights were determined and the samples counted using intrinsic germanium detectors coupled to a pulse height analyzer system. Background and Compton stripping, peak search, peak identification, and concentration calculations were performed using the computer capabilities inherent in the analyzer system. All total absorption peaks (TAP) associated with the radionuclides of concern were reviewed for consistency of activity.

Total absorption peaks used for determining the activities of radionuclides of concern and the typical associated MDCs for a one-hour count time were:

Radionuclide	TAP (MeV)	MDC (pCi/g)
Cs-137	0.662	0.05
Ra-226 (from Pb-214)	0.351	0.08

Spectra were also reviewed for other identifiable TAPs.

Uncertainties

The uncertainties associated with the analytical data presented in the tables of this report represent the total propagated uncertainties for those data. These uncertainties were calculated based on both the gross sample count levels and the associated background count level.

Appendix D

Former HWMF Perimeter Area Waste Verification Results

ASL Prefix No. 232172 | Page 1 of 1

BROOKHAVEN NATIONAL LABORATORY

Carrier/Waybill # _____ | P.O. # _____ | Chain of Custody No. 27274

Requires EDD X | DQL ____

SAMPLING CHAIN OF CUSTODY

Analysis Requested By	Sampling Contractor	Analytical Laboratory
Name: Andy Lockwood	Name: PW Grosser Consulting	Name: GEL
Life No: Q7566 Ext.	Contact: Adrian Steinhauff	Address: 2040 Savage Rd.
Acct. No: 65100/65103 Dept: ER	Phone: 631-589-6353	City: Charleston St: SC Zip: 29407
Email Reports To:	Email/Fax: 631-589-8705	Contact:
1 Nleadrith@bnl.gov	Sampler: Adrian Steinhauff	Phone:
2 Krubino@bnl.gov		Email/Fax:
Project Name: Perimeter FHWMF	Project Manager: Andy Lockwood	Field Engineer: Adrian Steinhauff

Comments:

Type LID	Type UID	Smp	Coll	Sample Information: Site ID/Bldg/Life #	Depth/RWP	Date	Time	Matrix	Additional Sample Information: Name/Description	Cont. Vol/Units	Cont. Type	# of Cont.	Preservative	Analysis Requested: Alpha/Beta Uranium, AM, TH, PU, Gross Beta	Tritium	Gamma Spec	Strontium -90	524.2	624	Nuclide-specific Alpha*	PCBs / Pesticides	Metals	pH, Mercury, TCLP	Bulk Density
	001	EG		PFHWMF	0-6"	6/9	1000	S	~~Soil #1~~ WCS-1	1L	500mCG	4	—	X	X	X	X				X	X	X	X
	002	↓		PFHWMF	0-6"		1005		~~Soil #2~~ WCS-2	↓	↓	↓	—	X	X	X	X				X	X	X	X
	003	↓		PFHWMF	0-6"	↓	1010	↓	~~Soil #3~~ WCS-3	↓	↓	↓	—	X	X	X	X				X	X	X	X

1 Relinquished By/Date/Time	2 Relinquished By/Date/Time	3 Relinquished By/Date/Time
Print Adrian Steinhauff 6/19/09	Print	Print
Signature [signature] 6/19/09	Signature	Signature
1 Received By/Date/Time	2 Received By/Date/Time	3 Received By/Date/Time
Print Patricia Dent 6/20/09	Print	Print
Signature P. Dent 09:30	Signature	Signature

Contractor Lab Sample Disposal
- ☐ Return To Client
- ☐ Archive For ____ Months
- X Disposal by Lab

Data Package: X Full ☐ Summary

Turn-Around Time Required:
- ☐ Rush (1 Day) ☐ 14 Days ☐ 30 Days
- X 7 Days ☐ Other ( )

GEL Laboratories LLC

SAMPLE RECEIPT & REVIEW FORM

Client: BRKH	**SDG/ARCOC/Work Order:** 232172
Received By: P. Dent	**Date Received:** June 20, 2009

Suspected Hazard Information	Yes	No	*If Counts > x2 area background on samples not marked "radioactive", contact the Radiation Safety Group of further investigation.
COC/Samples marked as radioactive?		X	Maximum Counts Observed*: 40 C.P.M.
Classified Radioactive II or III by RSO?		X	
COC/Samples marked containing PCBs?		X	
Shipped as a DOT Hazardous?		X	Hazard Class Shipped: UN#:
Samples identified as Foreign Soil?		X	

	Sample Receipt Criteria	Yes	NA	No	Comments/Qualifiers (Required for Non-Conforming Items)
1	Shipping containers received intact and sealed?	X			Circle Applicable: seals broken damaged container leaking container other (describe)
2	Samples requiring cold preservation within 0 ≤ 6 deg. C?	X			Preservation Method: ice bags blue ice dry ice none other (describe) 2,4C
3	Chain of custody documents included with shipment?	X			
4	Sample containers intact and sealed?	X			Circle Applicable: seals broken damaged container leaking container other (describe)
5	Samples requiring chemical preservation at proper pH?	X			Sample ID's, containers affected and observed pH: If Preservation added, Lot#:
6	VOA vials free of headspace (defined as < 6mm bubble)?	X			Sample ID's and containers affected:
7	Are Encore containers present?			X	(If yes, immediately deliver to Volatiles laboratory)
8	Samples received within holding time?	X			Id's and tests affected:
9	Sample ID's on COC match ID's on bottles?	X			Sample ID's and containers affected:
10	Date & time on COC match date & time on bottles?	X			Sample ID's affected:
11	Number of containers received match number indicated on COC?	X			Sample ID's affected:
12	COC form is properly signed in relinquished/received sections?	X			

Comments: FED EX #'S
9800 5391 7290-2C
9800 5391 7201-4C

PM (or PMA) review: Initials EM Date 6/20/09

Subject: RE: Regarding Perimeter FHWMF Samples
From: "Lockwood, Andrew" <lockwood@bnl.gov>
Date: Wed, 24 Jun 2009 11:29:18 -0400
To: "LaToya Hughes" <lat01423@gel.com>

That's fine. Thanks.

Andrew Lockwood
Project Manager
Building 701, ERP
Brookhaven National Laboratory
Upton, NY 11973-5000
Cell: (516) 315-9238

-----Original Message-----
From: LaToya Hughes [mailto:lat01423@gel.com]
Sent: Wednesday, June 24, 2009 10:14 AM
To: Lockwood, Andrew
Cc: team.skradski
Subject: Regarding Perimeter FHWMF Samples

Good morning Mr. Lockwood,

Due to the delay with adding the correct tests for the analysis of your samples, the lab is asking if a possible due date of July 2nd would be an acceptable date; with the complete package to follow a week later.

Please let us know if this is acceptable.

Thank you in advance,
LaToya Hughes

--
LaToya D. Hughes
Project Manager Assistant
General Engineering Laboratories, LLC
2040 Savage Road
Charleston, SC (USA) 29407
Direct: 843.769.7376 x4707
Main: 843.556.8171
Fax: 843.766.1178
E-mail: LaToya.Hughes@gel.com
Web: www.gel.com

Subject: [Fwd: FHWMF PA]
From: Jake Crook <jhc@gel.com>
Date: Wed, 24 Jun 2009 08:33:48 -0400
To: LaToya Norman <lat01423@gel.com>

-------- Original Message --------
Subject: FHWMF PA
Date: Wed, 24 Jun 2009 07:03:13 -0400
From: Lockwood, Andrew <lockwood@bnl.gov>
To: <jhc@gel.com>

Jake,

Sorry for the confusion, I am back in the office today and have the COC here. We only need TCLP for mercury and lead, as well as TAL metals. 7 day TAT is not critical. Just send me an e-mail confirming receipt of this and when you think we can get the data. Thanks.

Andrew Lockwood

Project Manager

Building 701, ERP

Brookhaven National Laboratory

Upton, NY 11973-5000
Cell: (516) 315-9238

--

Jake Crook
Project Manager
GEL Laboratories, LLC
2040 Savage Road
Charleston, SC (USA) 29407
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Main: 843.556.8171
Fax: 843.766.1178
E-mail: jhc@gel.com
Web: www.gel.com

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 – (843) 556–8171 – www.gel.com

Certificate of Analysis

Company : Brookhaven National Laboratory
Address : Building 51
Upton, New York 11973—5000

Report Date: July 7, 2009

Contact: Mr. John Burke
Project: **Perimeter FHWMF**

Client Sample ID:	27274–001	Project:	BRKL00309
Sample ID:	232172001	Client ID:	BRKL005
Matrix:	Solid	COC:	27274
Collect Date:	09–JUN–09 10:00	Samp Recv.:	
Receive Date:	20–JUN–09 09:30	Client Desc.:	PFHWMF
Collector:	Client	Vol. Recv.:	
Moisture:	36.9%		

Parameter	Qualifier	Result	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Electrode Analysis Federal										
SW9045C pH Federal "As Received"										
pH at Temp 21.7C	H	5.41	0.010	0.100	SU	1	RXG2 06/24/09	1423	879796	1
Flow Injection Analysis Federal										
SW 7.3.3 Reactivity, Releasable "Dry Weight Corrected"										
Reactive Releasable Cyanide	<	250000		250000	ug/kg	1	AXC2 06/29/09	1204	878896	2
Hazardous Waste Federal										
ASTM_D5057 Bulk Density Soil "As Received"										
Density		1.71	0.010	0.100	g/mL	1	NXM 06/23/09 1	1330	879400	3
Mercury Analysis–CVAA										
TCLP Hg in Solid "As Received"										
Mercury	U	ND	0.00067	0.002	mg/L	1	JXL1 06/26/09	0949	880001	4
Metals Analysis–ICP										
TCLP ICP Metals for Solid "As Received"										
Lead	U	ND	0.025	0.100	mg/L	1	HSC 06/25/09	1555	879982	5
3050S/6010 Lead Federal "Dry Weight Corrected"										
Aluminum		10200	10.6	31.1	mg/kg	1	HSC 06/26/09	0214	879277	6
Antimony	J	0.485	0.482	1.56	mg/kg	1				
Arsenic		2.80	0.778	2.33	mg/kg	1				
Barium		28.2	0.156	0.778	mg/kg	1				
Beryllium	J	0.360	0.156	0.778	mg/kg	1				
Cadmium	U	ND	0.156	0.778	mg/kg	1				
Calcium		893	4.67	15.6	mg/kg	1				
Chromium		8.91	0.156	0.778	mg/kg	1				
Cobalt		1.60	0.311	0.778	mg/kg	1				
Copper		12.0	0.467	1.56	mg/kg	1				
Iron		7340	3.89	15.6	mg/kg	1				
Lead		42.7	0.389	1.56	mg/kg	1				
Magnesium		717	13.2	46.7	mg/kg	1				
Manganese		113	0.311	1.56	mg/kg	1				
Nickel		6.16	0.156	0.778	mg/kg	1				
Potassium		241	7.78	23.3	mg/kg	1				
Selenium		5.48	0.778	2.33	mg/kg	1				
Silver	J	0.427	0.156	0.778	mg/kg	1				
Sodium		31.7	7.00	23.3	mg/kg	1				
Thallium	J	1.49	0.778	3.11	mg/kg	1				

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Report Date: July 7, 2009

Contact: Mr. John Burke
Project: **Perimeter FHWMF**

Client Sample ID: 27274-001
Sample ID: 232172001

Project: BRKL00309
Client ID: BRKL005

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Metals Analysis-ICP											
3050S/6010 Lead Federal "Dry Weight Corrected"											
Vanadium		19.9	0.156	0.778	mg/kg	1					
Zinc		27.8	0.311	1.56	mg/kg	1					
Semi-Volatiles-PCB Federal											
8082/3550B PCB soil-Fed "Dry Weight Corrected"											
Aroclor-1016	U	ND	1.76	5.28	ug/kg	1	YS1	06/25/09	1332	879470	7
Aroclor-1221	U	ND	1.76	5.28	ug/kg	1					
Aroclor-1232	U	ND	1.76	5.28	ug/kg	1					
Aroclor-1242	U	ND	1.76	5.28	ug/kg	1					
Aroclor-1248	U	ND	1.76	5.28	ug/kg	1					
Aroclor-1254	U	ND	1.76	5.28	ug/kg	1					
Aroclor-1260	U	ND	1.76	5.28	ug/kg	1					
Semi-Volatiles-Pesticide Federal											
8081A/3550B Pesticide Soil Federal "Dry Weight Corrected"											
4,4'-DDD	U	ND	0.527	2.11	ug/kg	1	JXM	06/25/09	1351	879634	9
Aldrin	U	ND	0.264	1.05	ug/kg	1					
Chlordane (tech.)	U	ND	2.64	13.2	ug/kg	1					
Dieldrin	U	ND	0.527	2.11	ug/kg	1					
Endosulfan I	U	ND	0.264	1.05	ug/kg	1					
Endosulfan II	U	ND	0.527	2.11	ug/kg	1					
Endrin	U	ND	0.527	2.11	ug/kg	1					
Endrin aldehyde	U	ND	0.527	2.11	ug/kg	1					
Endrin ketone	U	ND	0.527	2.11	ug/kg	1					
Heptachlor	U	ND	0.264	1.05	ug/kg	1					
Heptachlor epoxide	U	ND	0.264	1.05	ug/kg	1					
Methoxychlor	U	ND	2.64	10.5	ug/kg	1					
Toxaphene	U	ND	8.78	52.7	ug/kg	1					
alpha-BHC	U	ND	0.264	1.05	ug/kg	1					
beta-BHC	U	ND	0.264	1.05	ug/kg	1					
delta-BHC	U	ND	0.264	1.05	ug/kg	1					
gamma-BHC (Lindane)	U	ND	0.264	1.05	ug/kg	1					
4,4'-DDE		11.6	0.527	2.11	ug/kg	1	JXM	06/25/09	1351	879634	10
4,4'-DDT		5.88	0.527	2.11	ug/kg	1					
Endosulfan sulfate	J	0.886	0.527	2.11	ug/kg	1					
Titration Analysis Federal											
Reactive Sulfide SW846 Chapter 7.3.4 "Dry Weight Corrected"											
Reactive Releasable Sulfide	<	500		500	mg/kg		TXT1	06/25/09	1506	880225	11

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
SW846 1311	SW846 1311 TCLP Leaching	RXD2	06/23/09	1600	879420

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Contact: Mr. John Burke
Project: **Perimeter FHWMF**

Client Sample ID: 27274-001
Sample ID: 232172001

Project: BRKL00309
Client ID: BRKL005

Parameter	Qualifier	Result	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
SW846 1311	SW846 1311 TCLP Leaching -FEDERAL			RXD2	06/23/09	1600	879420			
SW846 3010A	ICP-TRACE TCLP by SW846 3010A			FGA	06/24/09	1630	879981			
SW846 3050B	846 3050BS PREP			AXG2	06/24/09	0820	879276			
SW846 3550B	3550B PCB Prep Soil FED			NXP2	06/23/09	1600	879469			
SW846 3550B	3550B Pesticide/PCB Prep Soil			NXP2	06/23/09	1600	879633			
SW846 7.3.3 Prep	SW 7.3.3 Reactivity, Releasable Cyanide-			AXS5	06/26/09	0903	878894			
SW846 7470A Prep	EPA 7470A Mercury Prep TCLP Liquid			TXB3	06/25/09	1345	880000			

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	SW846 9045C/9045D	
2	SW846 7.3.3	
3	ASTM D 5057	
4	SW846 7470A	
5	SW846 3010/6010B	
6	SW846 3050B/6010B	
7	SW846 8082	
8	SW846 8082	
9	SW846 8081A	
10	SW846 8081A	
11	SW846 Chpt. 7.3.4-TIT	

Surrogate/Tracer recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
4cmx	8082/3550B PCB soil-Fed "Dry Weight Corrected"	4.91 ug/kg	10.6	46.5	(34%-105%)
Decachlorobiphenyl	8082/3550B PCB soil-Fed "Dry Weight Corrected"	6.04 ug/kg	10.6	57.2	(33%-115%)
4cmx	8081A/3550B Pesticide Soil Federal "Dry Weight Corrected"	38.7 ug/kg	52.7	73.4	(34%-105%)
Decachlorobiphenyl	8081A/3550B Pesticide Soil Federal "Dry Weight Corrected"	35.9 ug/kg	52.7	68.1	(33%-115%)

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Report Date: July 7, 2009

Contact: Mr. John Burke
Project: **Perimeter FHWMF**

Client Sample ID:	27274-002	Project:	BRKL00309
Sample ID:	232172002	Client ID:	BRKL005
Matrix:	Solid	COC:	27274
Collect Date:	09-JUN-09 10:05	Samp Recv.:	
Receive Date:	20-JUN-09 09:30	Client Desc.:	PFHWMF
Collector:	Client	Vol. Recv.:	
Moisture:	21.6%		

Parameter	Qualifier	Result	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Electrode Analysis Federal										
SW9045C pH Federal "As Received"										
pH at Temp 21.6C	H	5.11	0.010	0.100	SU	1	RXG2 06/24/09	1426	879796	1
Flow Injection Analysis Federal										
SW 7.3.3 Reactivity, Releasable "Dry Weight Corrected"										
Reactive Releasable Cyanide	<	250000		250000	ug/kg	1	AXC2 06/29/09	1206	878896	2
Hazardous Waste Federal										
ASTM_D5057 Bulk Density Soil "As Received"										
Density		1.96	0.010	0.100	g/mL	1	NXM 06/23/09 1	1341	879400	3
Mercury Analysis-CVAA										
TCLP Hg in Solid "As Received"										
Mercury	U	ND	0.00067	0.002	mg/L	1	JXL1 06/26/09	0957	880001	4
Metals Analysis-ICP										
TCLP ICP Metals for Solid "As Received"										
Lead	U	ND	0.025	0.100	mg/L	1	HSC 06/25/09	1610	879982	5
3050S/6010 Lead Federal "Dry Weight Corrected"										
Aluminum		11800	8.38	24.6	mg/kg	1	HSC 06/26/09	0249	879277	6
Antimony	U	ND	0.382	1.23	mg/kg	1				
Arsenic	J	1.53	0.616	1.85	mg/kg	1				
Barium		17.4	0.123	0.616	mg/kg	1				
Beryllium	J	0.262	0.123	0.616	mg/kg	1				
Cadmium	U	ND	0.123	0.616	mg/kg	1				
Calcium		61.6	3.70	12.3	mg/kg	1				
Chromium		11.1	0.123	0.616	mg/kg	1				
Cobalt		2.09	0.246	0.616	mg/kg	1				
Copper		3.80	0.370	1.23	mg/kg	1				
Iron		7790	3.08	12.3	mg/kg	1				
Lead		7.80	0.308	1.23	mg/kg	1				
Magnesium		939	10.5	37.0	mg/kg	1				
Manganese		36.1	0.246	1.23	mg/kg	1				
Nickel		5.23	0.123	0.616	mg/kg	1				
Potassium		158	6.16	18.5	mg/kg	1				
Selenium		4.62	0.616	1.85	mg/kg	1				
Silver	J	0.333	0.123	0.616	mg/kg	1				
Sodium		29.7	5.54	18.5	mg/kg	1				
Thallium	J	1.85	0.616	2.46	mg/kg	1				

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Contact: Mr. John Burke
Project: **Perimeter FHWMF**

Client Sample ID: 27274-002
Sample ID: 232172002

Project: BRKL00309
Client ID: BRKL005

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Metals Analysis-ICP											
3050S/6010 Lead Federal "Dry Weight Corrected"											
Vanadium		16.8	0.123	0.616	mg/kg	1					
Zinc		10.6	0.246	1.23	mg/kg	1					
Semi-Volatiles-PCB Federal											
8082/3550B PCB soil-Fed "Dry Weight Corrected"											
Aroclor-1016	U	ND	1.42	4.25	ug/kg	1	YS1	06/25/09	1403	879470	7
Aroclor-1221	U	ND	1.42	4.25	ug/kg	1					
Aroclor-1232	U	ND	1.42	4.25	ug/kg	1					
Aroclor-1242	U	ND	1.42	4.25	ug/kg	1					
Aroclor-1248	U	ND	1.42	4.25	ug/kg	1					
Aroclor-1254	U	ND	1.42	4.25	ug/kg	1					
Aroclor-1260	U	ND	1.42	4.25	ug/kg	1					
Semi-Volatiles-Pesticide Federal											
8081A/3550B Pesticide Soil Federal "Dry Weight Corrected"											
4,4'-DDD	U	ND	0.425	1.70	ug/kg	1	JXM	06/25/09	1431	879634	9
4,4'-DDE	U	ND	0.425	1.70	ug/kg	1					
4,4'-DDT	U	ND	0.425	1.70	ug/kg	1					
Aldrin	U	ND	0.212	0.849	ug/kg	1					
Chlordane (tech.)	U	ND	2.12	10.6	ug/kg	1					
Dieldrin	U	ND	0.425	1.70	ug/kg	1					
Endosulfan I	U	ND	0.212	0.849	ug/kg	1					
Endosulfan II	U	ND	0.425	1.70	ug/kg	1					
Endosulfan sulfate	U	ND	0.425	1.70	ug/kg	1					
Endrin	U	ND	0.425	1.70	ug/kg	1					
Endrin aldehyde	U	ND	0.425	1.70	ug/kg	1					
Endrin ketone	U	ND	0.425	1.70	ug/kg	1					
Heptachlor	U	ND	0.212	0.849	ug/kg	1					
Heptachlor epoxide	U	ND	0.212	0.849	ug/kg	1					
Methoxychlor	U	ND	2.12	8.49	ug/kg	1					
Toxaphene	U	ND	7.07	42.5	ug/kg	1					
alpha-BHC	U	ND	0.212	0.849	ug/kg	1					
beta-BHC	U	ND	0.212	0.849	ug/kg	1					
delta-BHC	U	ND	0.212	0.849	ug/kg	1					
gamma-BHC (Lindane)	U	ND	0.212	0.849	ug/kg	1					
Titration Analysis Federal											
Reactive Sulfide SW846 Chapter 7.3.4 "Dry Weight Corrected"											
Reactive Releasable Sulfide	<	500		500	mg/kg		TXT1	06/25/09	1514	880225	10

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
SW846 1311	SW846 1311 TCLP Leaching	RXD2	06/23/09	1600	879420

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Report Date: July 7, 2009

Contact: Mr. John Burke
Project: **Perimeter FHWMF**

Client Sample ID: 27274-002
Sample ID: 232172002

Project: BRKL00309
Client ID: BRKL005

Parameter	Qualifier	Result	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
SW846 1311	SW846 1311 TCLP Leaching -FEDERAL			RXD2	06/23/09	1600	879420			
SW846 3010A	ICP-TRACE TCLP by SW846 3010A			FGA	06/24/09	1630	879981			
SW846 3050B	846 3050BS PREP			AXG2	06/24/09	0820	879276			
SW846 3550B	3550B PCB Prep Soil FED			NXP2	06/23/09	1600	879469			
SW846 3550B	3550B Pesticide/PCB Prep Soil			NXP2	06/23/09	1600	879633			
SW846 7.3.3 Prep	SW 7.3.3 Reactivity, Releasable Cyanide-			AXS5	06/26/09	0903	878894			
SW846 7470A Prep	EPA 7470A Mercury Prep TCLP Liquid			TXB3	06/25/09	1345	880000			

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	SW846 9045C/9045D	
2	SW846 7.3.3	
3	ASTM D 5057	
4	SW846 7470A	
5	SW846 3010/6010B	
6	SW846 3050B/6010B	
7	SW846 8082	
8	SW846 8082	
9	SW846 8081A	
10	SW846 Chpt. 7.3.4-TIT	

Surrogate/Tracer recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
4cmx	8082/3550B PCB soil-Fed "Dry Weight Corrected"	3.87 ug/kg	8.51	45.5	(34%-105%)
Decachlorobiphenyl	8082/3550B PCB soil-Fed "Dry Weight Corrected"	3.34 ug/kg	8.51	39.3	(33%-115%)
4cmx	8081A/3550B Pesticide Soil Federal "Dry Weight Corrected"	32.9 ug/kg	42.5	77.4	(34%-105%)
Decachlorobiphenyl	8081A/3550B Pesticide Soil Federal "Dry Weight Corrected"	29.2 ug/kg	42.5	68.7	(33%-115%)

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Report Date: July 7, 2009

Contact: Mr. John Burke
Project: **Perimeter FHWMF**

Client Sample ID:	27274–003	Project:	BRKL00309
Sample ID:	232172003	Client ID:	BRKL005
Matrix:	Solid	COC:	27274
Collect Date:	09–JUN–09 10:10	Samp Recv.:	
Receive Date:	20–JUN–09 09:30	Client Desc.:	PFHWMF
Collector:	Client	Vol. Recv.:	
Moisture:	18.3%		

Parameter	Qualifier	Result	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Electrode Analysis Federal										
SW9045C pH Federal "As Received"										
pH at Temp 21.5C	H	5.53	0.010	0.100	SU	1	RXG2 06/24/09	1428	879796	1
Flow Injection Analysis Federal										
SW 7.3.3 Reactivity, Releasable "Dry Weight Corrected"										
Reactive Releasable Cyanide	<	250000		250000	ug/kg	1	AXC2 06/29/09	1207	878896	2
Hazardous Waste Federal										
ASTM_D5057 Bulk Density Soil "As Received"										
Density		1.91	0.010	0.100	g/mL	1	NXM 06/23/09 1	1345	879400	3
Mercury Analysis–CVAA										
TCLP Hg in Solid "As Received"										
Mercury	U	ND	0.00067	0.002	mg/L	1	JXL1 06/26/09	0958	880001	4
Metals Analysis–ICP										
TCLP ICP Metals for Solid "As Received"										
Lead	U	ND	0.025	0.100	mg/L	1	HSC 06/25/09	1614	879982	5
3050S/6010 Lead Federal "Dry Weight Corrected"										
Aluminum		9900	8.04	23.6	mg/kg	1	HSC 06/26/09	0256	879277	6
Antimony	U	ND	0.366	1.18	mg/kg	1				
Arsenic		2.05	0.591	1.77	mg/kg	1				
Barium		15.1	0.118	0.591	mg/kg	1				
Beryllium	J	0.308	0.118	0.591	mg/kg	1				
Cadmium	U	ND	0.118	0.591	mg/kg	1				
Calcium		129	3.55	11.8	mg/kg	1				
Chromium		10.5	0.118	0.591	mg/kg	1				
Cobalt		2.55	0.236	0.591	mg/kg	1				
Copper		4.86	0.355	1.18	mg/kg	1				
Iron		10600	2.96	11.8	mg/kg	1				
Lead		5.50	0.296	1.18	mg/kg	1				
Magnesium		1150	10.0	35.5	mg/kg	1				
Manganese		94.3	0.236	1.18	mg/kg	1				
Nickel		5.77	0.118	0.591	mg/kg	1				
Potassium		226	5.91	17.7	mg/kg	1				
Selenium		7.37	0.591	1.77	mg/kg	1				
Silver	J	0.323	0.118	0.591	mg/kg	1				
Sodium		37.2	5.32	17.7	mg/kg	1				
Thallium	J	1.75	0.591	2.36	mg/kg	1				

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Report Date: July 7, 2009

Contact: Mr. John Burke
Project: **Perimeter FHWMF**

Client Sample ID: 27274-003
Sample ID: 232172003

Project: BRKL00309
Client ID: BRKL005

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Metals Analysis-ICP											
3050S/6010 Lead Federal "Dry Weight Corrected"											
Vanadium		16.9	0.118	0.591	mg/kg	1					
Zinc		11.2	0.236	1.18	mg/kg	1					
Semi-Volatiles-PCB Federal											
8082/3550B PCB soil-Fed "Dry Weight Corrected"											
Aroclor-1016	U	ND	1.36	4.07	ug/kg	1	YS1	06/25/09	1419	879470	7
Aroclor-1221	U	ND	1.36	4.07	ug/kg	1					
Aroclor-1232	U	ND	1.36	4.07	ug/kg	1					
Aroclor-1242	U	ND	1.36	4.07	ug/kg	1					
Aroclor-1248	P	17.8	1.36	4.07	ug/kg	1					
Aroclor-1260	U	ND	1.36	4.07	ug/kg	1					
Aroclor-1254		13.8	1.36	4.07	ug/kg	1	YS1	06/25/09	1419	879470	8
Semi-Volatiles-Pesticide Federal											
8081A/3550B Pesticide Soil Federal "Dry Weight Corrected"											
4,4'-DDD	U	ND	0.408	1.63	ug/kg	1	JXM	06/25/09	1445	879634	9
4,4'-DDE	U	ND	0.408	1.63	ug/kg	1					
4,4'-DDT	U	ND	0.408	1.63	ug/kg	1					
Aldrin	U	ND	0.204	0.816	ug/kg	1					
Chlordane (tech.)	U	ND	2.04	10.2	ug/kg	1					
Dieldrin	U	ND	0.408	1.63	ug/kg	1					
Endosulfan I	U	ND	0.204	0.816	ug/kg	1					
Endosulfan II	U	ND	0.408	1.63	ug/kg	1					
Endosulfan sulfate	U	ND	0.408	1.63	ug/kg	1					
Endrin	U	ND	0.408	1.63	ug/kg	1					
Endrin aldehyde	U	ND	0.408	1.63	ug/kg	1					
Endrin ketone	U	ND	0.408	1.63	ug/kg	1					
Heptachlor	U	ND	0.204	0.816	ug/kg	1					
Heptachlor epoxide	U	ND	0.204	0.816	ug/kg	1					
Methoxychlor	U	ND	2.04	8.16	ug/kg	1					
Toxaphene	U	ND	6.79	40.8	ug/kg	1					
alpha-BHC	U	ND	0.204	0.816	ug/kg	1					
beta-BHC	U	ND	0.204	0.816	ug/kg	1					
delta-BHC	U	ND	0.204	0.816	ug/kg	1					
gamma-BHC (Lindane)	U	ND	0.204	0.816	ug/kg	1					
Titration Analysis Federal											
Reactive Sulfide SW846 Chapter 7.3.4 "Dry Weight Corrected"											
Reactive Releasable Sulfide	<	500		500	mg/kg		TXT1	06/25/09	1517	880225	10

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
SW846 1311	SW846 1311 TCLP Leaching	RXD2	06/23/09	1600	879420

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Report Date: July 7, 2009

Contact: Mr. John Burke
Project: **Perimeter FHWMF**

Client Sample ID: 27274–003
Sample ID: 232172003

Project: BRKL00309
Client ID: BRKL005

Parameter	Qualifier	Result	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
SW846 1311	SW846 1311 TCLP Leaching –FEDERAL			RXD2	06/23/09	1600	879420			
SW846 3010A	ICP–TRACE TCLP by SW846 3010A			FGA	06/24/09	1630	879981			
SW846 3050B	846 3050BS PREP			AXG2	06/24/09	0820	879276			
SW846 3550B	3550B PCB Prep Soil FED			NXP2	06/23/09	1600	879469			
SW846 3550B	3550B Pesticide/PCB Prep Soil			NXP2	06/23/09	1600	879633			
SW846 7.3.3 Prep	SW 7.3.3 Reactivity, Releasable Cyanide–			AXS5	06/26/09	0903	878894			
SW846 7470A Prep	EPA 7470A Mercury Prep TCLP Liquid			TXB3	06/25/09	1345	880000			

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	SW846 9045C/9045D	
2	SW846 7.3.3	
3	ASTM D 5057	
4	SW846 7470A	
5	SW846 3010/6010B	
6	SW846 3050B/6010B	
7	SW846 8082	
8	SW846 8082	
9	SW846 8081A	
10	SW846 Chpt. 7.3.4–TIT	

Surrogate/Tracer recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
4cmx	8082/3550B PCB soil–Fed "Dry Weight Corrected"	5.86 ug/kg	8.15	72.0	(34%–105%)
Decachlorobiphenyl	8082/3550B PCB soil–Fed "Dry Weight Corrected"	5.20 ug/kg	8.15	63.8	(33%–115%)
4cmx	8081A/3550B Pesticide Soil Federal "Dry Weight Corrected"	32.1 ug/kg	40.8	78.6	(34%–105%)
Decachlorobiphenyl	8081A/3550B Pesticide Soil Federal "Dry Weight Corrected"	31.9 ug/kg	40.8	78.2	(33%–115%)

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Report Date: July 7, 2009

Contact: Mr. John Burke
Project: **Perimeter FHWMF**

Client Sample ID:	27274-001	Project:	BRKL00309
Sample ID:	232172001	Client ID:	BRKL005
Matrix:	Solid	COC:	27274
Collect Date:	09-JUN-09 10:00	Samp Recv.:	
Receive Date:	20-JUN-09 09:30	Client Desc.:	PFHWMF
Collector:	Client	Vol. Recv.:	
Moisture:	36.9%		

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Gravimetric Solids											
"As Received"											
Rad Alpha Spec Analysis											
Alphaspec Am241 Solid "Dry Weight Corrected"											
Americium-241	U	0.212	+/-0.234	0.333	1.00	pCi/g		HAK B 06/26/09	1455	879815	2
Alphaspec Pu, Solid "Dry Weight Corrected"											
Plutonium-238	U	-0.0293	+/-0.278	0.655	1.00	pCi/g		HAK B 06/26/09	1455	879817	3
Plutonium-239/240	U	0.0587	+/-0.165	0.372	1.00	pCi/g					
Alphaspec Th, Solid "Dry Weight Corrected"											
Thorium-228		1.25	+/-0.633	0.536	1.00	pCi/g		HAK B 06/26/09	1446	879818	4
Thorium-230	J	0.693	+/-0.475	0.495	1.00	pCi/g					
Thorium-232		1.43	+/-0.657	0.458	1.00	pCi/g					
Alphaspec U, Solid "Dry Weight Corrected"											
Uranium-233/234		1.19	+/-0.669	0.639	0.900	pCi/g		HAK B 06/26/09	1944	879819	5
Uranium-235/236	U	0.0812	+/-0.215	0.512	0.900	pCi/g					
Uranium-238	J	0.691	+/-0.479	0.259	0.900	pCi/g					
Rad Gamma Spec Analysis											
Gammaspec, Gamma, Solid (Long List) "Dry Weight Corrected"											
Actinium-227	U	-0.0105	+/-0.156	0.267	10000	pCi/g		MXR1 07/02/09	0602	879862	6
Actinium-228		1.07	+/-0.152	0.0717	0.800	pCi/g					
Americium-241	J-UI	0.126	+/-0.0675	0.106	0.200	pCi/g					
Antimony-124	U	0.0148	+/-0.0306	0.0529	0.100	pCi/g					
Antimony-125	U	-0.0145	+/-0.0433	0.0715	0.200	pCi/g					
Antimony-126	U	0.0606	+/-0.0825	0.132	10000	pCi/g					
Antimony-127	U	0.824	+/-1.96	3.38	10000	pCi/g					
Barium-133	U	0.0128	+/-0.021	0.0314	0.100	pCi/g					
Barium-137m	J	3.29	+/-0.173	0.0225	10000	pCi/g					
Barium-140	U	0.0816	+/-0.156	0.270	0.500	pCi/g					
Beryllium-7	DL	-0.0102	+/-0.174	0.288	0.074	pCi/g					
Bismuth-207	U	0.0239	+/-0.0176	0.0309	10000	pCi/g					
Bismuth-211	J-UI	2.29	+/-0.258	0.142	10000	pCi/g					
Bismuth-212		0.709	+/-0.170	0.164	0.500	pCi/g					
Bismuth-214		0.726	+/-0.0824	0.0433	0.200	pCi/g					

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Report Date: July 7, 2009

Contact: Mr. John Burke
Project: **Perimeter FHWMF**

Client Sample ID: 27274-001
Sample ID: 232172001

Project: BRKL00309
Client ID: BRKL005

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Gamma Spec Analysis											
Gammaspec, Gamma, Solid (Long List) "Dry Weight Corrected"											
Cadmium-109	J-UI	2.25	+/-0.439	0.453	10000	pCi/g					
Cadmium-115	U	-4.98	+/-51.4	0.00	10000	pCi/g					
Cerium-139	U	-0.006	+/-0.0114	0.0199	0.050	pCi/g					
Cerium-141	U	-0.00591	+/-0.0388	0.0486	0.100	pCi/g					
Cerium-143	UI	12200	+/-4500	0.00	10000	pCi/g					
Cerium-144	U	0.0262	+/-0.0904	0.133	0.500	pCi/g					
Cesium-134	J-UI	0.0708	+/-0.0243	0.0309	0.100	pCi/g					
Cesium-135	U	0.0479	+/-0.0714	0.109	10000	pCi/g					
Cesium-136	U	0.0311	+/-0.0544	0.0923	0.300	pCi/g					
Cesium-137		3.48	+/-0.184	0.0237	0.010	pCi/g					
Chromium-51	U	0.144	+/-0.192	0.329	0.600	pCi/g					
Cobalt-56	U	-0.00973	+/-0.0141	0.023	0.100	pCi/g					
Cobalt-57	DL	0.000983	+/-0.00995	0.0165	0.007	pCi/g					
Cobalt-58	U	-0.00707	+/-0.0141	0.0232	0.100	pCi/g					
Cobalt-60	DL	-0.00343	+/-0.0135	0.0225	0.011	pCi/g					
Europium-152	U	0.052	+/-0.0472	0.0719	0.200	pCi/g					
Europium-154	U	-0.0267	+/-0.0379	0.062	0.500	pCi/g					
Europium-155	J-UI	0.0887	+/-0.0513	0.0664	0.500	pCi/g					
Gadolinium-153	U	-0.00181	+/-0.0335	0.0497	10000	pCi/g					
Iodine-126	U	-0.0496	+/-0.114	0.166	10000	pCi/g					
Iodine-131	U	-0.012	+/-0.102	0.171	10000	pCi/g					
Iodine-133	U	-1.02E+06	+/-1.64E+06	0.00	10000	pCi/g					
Iodine-135	U	-7.16E+23	+/-8.59E+23	0.00	10000	pCi/g					
Iridium-192	U	0.0064	+/-0.0157	0.0268	0.100	pCi/g					
Iron-59	U	-0.0381	+/-0.0347	0.0537	0.300	pCi/g					
Lanthanum-140	J-UI	0.104	+/-0.0495	0.0855	10000	pCi/g					
Lead-210		4.87	+/-3.03	2.64	4.00	pCi/g					
Lead-211	U	-0.0248	+/-0.431	0.717	10000	pCi/g					
Lead-212		1.06	+/-0.0871	0.0394	0.100	pCi/g					
Lead-214		0.797	+/-0.0984	0.0493	0.100	pCi/g					
Manganese-54	DL	0.0212	+/-0.0136	0.0231	0.008	pCi/g					
Mercury-203	J-UI	0.0529	+/-0.0273	0.0305	0.100	pCi/g					
Molybdenum-99	J-UI	9.12	+/-34.0	0.00	10000	pCi/g					
Neodymium-147	U	-0.334	+/-0.420	0.616	1000	pCi/g					
Neptunium-239	U	-0.0193	+/-0.0724	0.120	2.00	pCi/g					
Niobium-94	U	0.0051	+/-0.0118	0.0203	1.00	pCi/g					
Niobium-95	J-UI	0.0456	+/-0.0177	0.0291	0.050	pCi/g					
Potassium-40		9.14	+/-0.806	0.176	0.180	pCi/g					
Praseodymium-144	U	-0.317	+/-0.803	1.35	10000	pCi/g					
Promethium-144	U	-0.00466	+/-0.0118	0.0198	0.080	pCi/g					
Promethium-146	U	0.00449	+/-0.0214	0.0356	1.00	pCi/g					
Promethium-149	U	-220	+/-460	0.00	10000	pCi/g					

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Report Date: July 7, 2009

Contact: Mr. John Burke
Project: **Perimeter FHWMF**

Client Sample ID: 27274-001
Sample ID: 232172001

Project: BRKL00309
Client ID: BRKL005

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Gamma Spec Analysis											
Gammaspec, Gamma, Solid (Long List) "Dry Weight Corrected"											
Protactinium-231	U	-0.0187	+/-0.640	1.05	10000	pCi/g					
Protactinium-233	U	-0.0222	+/-0.0267	0.0444	10000	pCi/g					
Protactinium-234	U	0.117	+/-0.101	0.174	10000	pCi/g					
Protactinium-234m	U	1.49	+/-3.38	3.85	10000	pCi/g					
Radium-223	U	-0.0231	+/-0.314	0.465	10000	pCi/g					
Radium-224	J-UI	2.64	+/-0.452	0.421	10000	pCi/g					
Radium-226		0.726	+/-0.0824	0.0433	0.026	pCi/g					
Radium-228		1.07	+/-0.152	0.0717	0.500	pCi/g					
Radon-219	U	0.0234	+/-0.188	0.315	10000	pCi/g					
Rhodium-106	U	0.005	+/-0.123	0.211	10000	pCi/g					
Ruthenium-103	U	0.00578	+/-0.0202	0.0336	10000	pCi/g					
Ruthenium-106	U	0.005	+/-0.123	0.211	0.800	pCi/g					
Scandium-46	U	-0.00946	+/-0.0141	0.0229	10000	pCi/g					
Selenium-75	U	-0.0181	+/-0.0215	0.0316	10000	pCi/g					
Silver-108m	U	0.0121	+/-0.0155	0.0262	10000	pCi/g					
Silver-110m	U	0.0072	+/-0.0157	0.0238	0.080	pCi/g					
Sodium-22	DL	-0.00948	+/-0.0136	0.0223	0.010	pCi/g					
Sodium-24	U	-7.33E+08	+/-1.56E+09	0.00	10000	pCi/g					
Strontium-85	J-UI	0.116	+/-0.0193	0.0345	10000	pCi/g					
Tantalum-182	U	0.00655	+/-0.0621	0.107	10000	pCi/g					
Technetium-99m	U	-2.19E+25	+/-5.54E+25	0.00	10000	pCi/g					
Tellurium-123m	U	-0.000483	+/-0.0123	0.019	10000	pCi/g					
Tellurium-125m	U	1.32	+/-4.30	6.41	10000	pCi/g					
Tellurium-132	U	0.859	+/-1.47	2.56	10000	pCi/g					
Thallium-208		0.352	+/-0.0368	0.0232	0.080	pCi/g					
Thorium-227	U	-0.0105	+/-0.156	0.267	10000	pCi/g					
Thorium-228		1.06	+/-0.0871	0.0394	0.021	pCi/g					
Thorium-229	U	-0.101	+/-0.197	0.340	10000	pCi/g					
Thorium-230	J	0.726	+/-0.0824	0.0433	1.00	pCi/g					
Thorium-231	U	-0.0231	+/-0.314	0.465	10000	pCi/g					
Thorium-232	J	1.07	+/-0.152	0.0717	10000	pCi/g					
Thorium-234	J	0.900	+/-0.817	0.830	5.00	pCi/g					
Tin-113	U	-0.0079	+/-0.0211	0.035	0.100	pCi/g					
Tin-117m	U	0.0172	+/-0.0338	0.053	10000	pCi/g					
Tin-126	J-UI	0.218	+/-0.0426	0.0443	10000	pCi/g					
Uranium-234	J	0.726	+/-0.0824	0.0433	10000	pCi/g					
Uranium-235	U	0.0307	+/-0.121	0.131	0.500	pCi/g					
Uranium-238	J	0.900	+/-0.817	0.830	1.00	pCi/g					
Vanadium-48	U	-0.0399	+/-0.0321	0.0497	10000	pCi/g					
Yttrium-88	U	-0.0106	+/-0.0128	0.0194	0.100	pCi/g					
Zinc-65	U	-0.014	+/-0.0349	0.048	0.300	pCi/g					
Zirconium-95	U	0.0342	+/-0.0269	0.0475	0.200	pCi/g					

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Report Date: July 7, 2009

Contact: Mr. John Burke
Project: **Perimeter FHWMF**

Client Sample ID: 27274–001
Sample ID: 232172001

Project: BRKL00309
Client ID: BRKL005

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Gas Flow Proportional Counting											
GFPC, Gross A/B, solid "Dry Weight Corrected"											
Alpha		10.6	+/–3.11	3.09	4.00	pCi/g		DXB5 06/30/09	0850	880115	7
Beta		19.1	+/–2.41	1.85	10.0	pCi/g					
GFPC, Sr90, solid "Dry Weight Corrected"											
Strontium–90	U	0.120	+/–0.340	0.622	2.00	pCi/g		JXR1 06/26/09	1343	880114	8

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL–RAD–A–021	DRS1	06/24/09	1142	879813

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	ASTM D 2216 (Modified)	
2	DOE EML HASL–300, Am–05–RC Modified	
3	DOE EML HASL–300, Pu–11–RC Modified	
4	DOE EML HASL–300, Th–01–RC Modified	
5	DOE EML HASL–300, U–02–RC Modified	
6	EML HASL 300, 4.5.2.3	
7	EPA 900.0/SW846 9310 Modified	
8	EPA 905.0 Modified	

Surrogate/Tracer recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
Americium–243 Tracer	Alphaspec Am241 Solid "Dry Weight Corrected"			101	(15%–125%)
Plutonium–242 Tracer	Alphaspec Pu, Solid "Dry Weight Corrected"			96.1	(15%–125%)
Thorium–229 Tracer	Alphaspec Th, Solid "Dry Weight Corrected"			93.7	(15%–125%)
Uranium–232 Tracer	Alphaspec U, Solid "Dry Weight Corrected"			80.8	(15%–125%)
Strontium Carrier	GFPC, Sr90, solid "Dry Weight Corrected"			79.8	(25%–125%)

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Report Date: July 7, 2009

Contact: Mr. John Burke
Project: **Perimeter FHWMF**

Client Sample ID:	27274-002	Project:	BRKL00309
Sample ID:	232172002	Client ID:	BRKL005
Matrix:	Solid	COC:	27274
Collect Date:	09-JUN-09 10:05	Samp Recv.:	
Receive Date:	20-JUN-09 09:30	Client Desc.:	PFHWMF
Collector:	Client	Vol. Recv.:	
Moisture:	21.6%		

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Gravimetric Solids												
"As Received"												
Rad Alpha Spec Analysis												
Alphaspec Am241 Solid "Dry Weight Corrected"												
Americium-241	U	-0.00452	+/-0.115	0.331	1.00	pCi/g		HAK B	06/26/09	1455	879815	2
Alphaspec Pu, Solid "Dry Weight Corrected"												
Plutonium-238	U	0.00	+/-0.110	0.169	1.00	pCi/g		HAK B	06/26/09	1455	879817	3
Plutonium-239/240	U	0.0428	+/-0.114	0.270	1.00	pCi/g						
Alphaspec Th, Solid "Dry Weight Corrected"												
Thorium-228		1.42	+/-0.618	0.509	1.00	pCi/g		HAK B	06/26/09	1446	879818	4
Thorium-230	J	0.765	+/-0.442	0.378	1.00	pCi/g						
Thorium-232		1.52	+/-0.604	0.297	1.00	pCi/g						
Alphaspec U, Solid "Dry Weight Corrected"												
Uranium-233/234	U	0.371	+/-0.358	0.441	0.900	pCi/g		HAK B	06/26/09	1944	879819	5
Uranium-235/236	U	-0.0473	+/-0.204	0.546	0.900	pCi/g						
Uranium-238	J	0.520	+/-0.417	0.441	0.900	pCi/g						
Rad Gamma Spec Analysis												
Gammaspec, Gamma, Solid (Long List) "Dry Weight Corrected"												
Actinium-227	U	-0.0906	+/-0.120	0.211	10000	pCi/g		MXR1	07/02/09	0603	879862	6
Actinium-228		1.04	+/-0.151	0.0619	0.800	pCi/g						
Americium-241	U	0.0309	+/-0.0555	0.0945	0.200	pCi/g						
Antimony-124	U	0.0131	+/-0.0248	0.0438	0.100	pCi/g						
Antimony-125	U	-0.0141	+/-0.0314	0.0532	0.200	pCi/g						
Antimony-126	U	0.062	+/-0.0705	0.114	10000	pCi/g						
Antimony-127	U	-0.853	+/-1.62	2.76	10000	pCi/g						
Barium-133	U	0.00818	+/-0.0153	0.0238	0.100	pCi/g						
Barium-137m	J	1.34	+/-0.0913	0.0184	10000	pCi/g						
Barium-140	U	0.0729	+/-0.131	0.220	0.500	pCi/g						
Beryllium-7	DL	-0.0344	+/-0.125	0.211	0.074	pCi/g						
Bismuth-207	U	0.0207	+/-0.0148	0.0269	10000	pCi/g						
Bismuth-211	J-UI	2.17	+/-0.234	0.111	10000	pCi/g						
Bismuth-212		0.697	+/-0.152	0.139	0.500	pCi/g						
Bismuth-214		0.668	+/-0.0763	0.0345	0.200	pCi/g						

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Report Date: July 7, 2009

Contact: Mr. John Burke
Project: **Perimeter FHWMF**

Client Sample ID: 27274-002
Sample ID: 232172002

Project: BRKL00309
Client ID: BRKL005

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Gamma Spec Analysis											
Gammaspec, Gamma, Solid (Long List) "Dry Weight Corrected"											
Cadmium-109	J-UI	2.67	+/-0.426	0.376	10000	pCi/g					
Cadmium-115	J-UI	21.7	+/-42.2	0.00	10000	pCi/g					
Cerium-139	U	-0.00532	+/-0.00951	0.0164	0.050	pCi/g					
Cerium-141	U	0.028	+/-0.0251	0.0401	0.100	pCi/g					
Cerium-143	UI	14000	+/-4360	0.00	10000	pCi/g					
Cerium-144	U	-0.0608	+/-0.0661	0.109	0.500	pCi/g					
Cesium-134	J-UI	0.0786	+/-0.0222	0.0277	0.100	pCi/g					
Cesium-135	U	0.0473	+/-0.053	0.0854	10000	pCi/g					
Cesium-136	U	-0.0139	+/-0.0441	0.0752	0.300	pCi/g					
Cesium-137		1.42	+/-0.0968	0.0195	0.010	pCi/g					
Chromium-51	U	-0.0366	+/-0.144	0.253	0.600	pCi/g					
Cobalt-56	U	0.00346	+/-0.0118	0.0203	0.100	pCi/g					
Cobalt-57	DL	0.00172	+/-0.0077	0.0138	0.007	pCi/g					
Cobalt-58	U	-0.0042	+/-0.0119	0.0199	0.100	pCi/g					
Cobalt-60	DL	0.00816	+/-0.0107	0.0187	0.011	pCi/g					
Europium-152	U	0.00814	+/-0.0333	0.0544	0.200	pCi/g					
Europium-154	U	-0.0132	+/-0.0336	0.0559	0.500	pCi/g					
Europium-155	U	0.0533	+/-0.0497	0.0556	0.500	pCi/g					
Gadolinium-153	J-UI	0.0494	+/-0.0366	0.0399	10000	pCi/g					
Iodine-126	U	0.0435	+/-0.0916	0.141	10000	pCi/g					
Iodine-131	U	-0.0413	+/-0.0739	0.127	10000	pCi/g					
Iodine-133	UI	57000	+/-1.16E+06	0.00	10000	pCi/g					
Iodine-135	U	-9.52E+23	+/-9.58E+23	0.00	10000	pCi/g					
Iridium-192	U	-0.00169	+/-0.0119	0.0209	0.100	pCi/g					
Iron-59	U	-0.0181	+/-0.0285	0.0477	0.300	pCi/g					
Lanthanum-140	U	0.0372	+/-0.0416	0.066	10000	pCi/g					
Lead-210	U	2.46	+/-2.07	2.99	4.00	pCi/g					
Lead-211	U	0.178	+/-0.362	0.532	10000	pCi/g					
Lead-212		1.12	+/-0.110	0.0299	0.100	pCi/g					
Lead-214		0.754	+/-0.090	0.0387	0.100	pCi/g					
Manganese-54	DL	-0.00215	+/-0.0116	0.0195	0.008	pCi/g					
Mercury-203	U	0.00224	+/-0.0206	0.0272	0.100	pCi/g					
Molybdenum-99	U	-9.19	+/-24.9	0.00	10000	pCi/g					
Neodymium-147	U	-0.000627	+/-0.300	0.503	1000	pCi/g					
Neptunium-239	U	-0.0421	+/-0.0555	0.0978	2.00	pCi/g					
Niobium-94	U	0.00697	+/-0.0103	0.0182	1.00	pCi/g					
Niobium-95	U	-0.00893	+/-0.021	0.0249	0.050	pCi/g					
Potassium-40		9.78	+/-0.825	0.167	0.180	pCi/g					
Praseodymium-144	U	0.0329	+/-0.710	1.23	10000	pCi/g					
Promethium-144	U	0.000484	+/-0.0104	0.0181	0.080	pCi/g					
Promethium-146	U	0.012	+/-0.0153	0.0266	1.00	pCi/g					
Promethium-149	J-UI	45.1	+/-342	0.00	10000	pCi/g					

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Company : Brookhaven National Laboratory
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Report Date: July 7, 2009

Contact: Mr. John Burke
Project: **Perimeter FHWMF**

Client Sample ID: 27274–002
Sample ID: 232172002

Project: BRKL00309
Client ID: BRKL005

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Gamma Spec Analysis											
Gammaspec, Gamma, Solid (Long List) "Dry Weight Corrected"											
Protactinium–231	U	–0.15	+/–0.471	0.834	10000	pCi/g					
Protactinium–233	U	0.0071	+/–0.0205	0.0364	10000	pCi/g					
Protactinium–234	U	0.0263	+/–0.0829	0.140	10000	pCi/g					
Protactinium–234m	U	–3.65	+/–2.80	3.54	10000	pCi/g					
Radium–223	U	0.0544	+/–0.233	0.363	10000	pCi/g					
Radium–224	J–UI	2.96	+/–0.488	0.340	10000	pCi/g					
Radium–226		0.668	+/–0.0763	0.0345	0.026	pCi/g					
Radium–228		1.04	+/–0.151	0.0619	0.500	pCi/g					
Radon–219	U	–0.0666	+/–0.137	0.234	10000	pCi/g					
Rhodium–106	U	–0.0876	+/–0.0979	0.166	10000	pCi/g					
Ruthenium–103	U	–0.00218	+/–0.0151	0.0255	10000	pCi/g					
Ruthenium–106	U	–0.0876	+/–0.0975	0.166	0.800	pCi/g					
Scandium–46	U	–0.00373	+/–0.0119	0.0197	10000	pCi/g					
Selenium–75	U	0.0106	+/–0.0157	0.0252	10000	pCi/g					
Silver–108m	U	–0.0013	+/–0.0112	0.0191	10000	pCi/g					
Silver–110m	U	0.0041	+/–0.0125	0.0192	0.080	pCi/g					
Sodium–22	DL	–0.0046	+/–0.0121	0.0201	0.010	pCi/g					
Sodium–24	U	–1.47E+09	+/–1.68E+09	0.00	10000	pCi/g					
Strontium–85	J–UI	0.051	+/–0.0154	0.0247	10000	pCi/g					
Tantalum–182	U	–0.0178	+/–0.0546	0.0917	10000	pCi/g					
Technetium–99m	UI	1.02E+25	+/–5.39E+25	0.00	10000	pCi/g					
Tellurium–123m	U	–0.00276	+/–0.00896	0.0155	10000	pCi/g					
Tellurium–125m	U	3.23	+/–3.41	5.57	10000	pCi/g					
Tellurium–132	U	–0.23	+/–1.20	2.03	10000	pCi/g					
Thallium–208		0.337	+/–0.0378	0.0178	0.080	pCi/g					
Thorium–227	U	–0.0906	+/–0.120	0.211	10000	pCi/g					
Thorium–228		1.12	+/–0.110	0.0298	0.021	pCi/g					
Thorium–229	U	0.0634	+/–0.162	0.279	10000	pCi/g					
Thorium–230	J	0.668	+/–0.0763	0.0345	1.00	pCi/g					
Thorium–231	U	0.0544	+/–0.233	0.363	10000	pCi/g					
Thorium–232	J	1.04	+/–0.151	0.0619	10000	pCi/g					
Thorium–234	J	1.05	+/–0.846	0.737	5.00	pCi/g					
Tin–113	U	0.00447	+/–0.0153	0.0267	0.100	pCi/g					
Tin–117m	U	–0.00541	+/–0.0261	0.0431	10000	pCi/g					
Tin–126	J–UI	0.259	+/–0.0414	0.0367	10000	pCi/g					
Uranium–234	J	0.668	+/–0.0763	0.0345	10000	pCi/g					
Uranium–235	U	0.00149	+/–0.105	0.109	0.500	pCi/g					
Uranium–238		1.05	+/–0.846	0.737	1.00	pCi/g					
Vanadium–48	U	–0.0277	+/–0.0284	0.045	10000	pCi/g					
Yttrium–88	U	0.00505	+/–0.0106	0.0185	0.100	pCi/g					
Zinc–65	U	–0.00616	+/–0.0281	0.0411	0.300	pCi/g					
Zirconium–95	U	0.0372	+/–0.024	0.0428	0.200	pCi/g					

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Report Date: July 7, 2009

Contact: Mr. John Burke
Project: **Perimeter FHWMF**

Client Sample ID: 27274-002
Sample ID: 232172002

Project: BRKL00309
Client ID: BRKL005

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Gas Flow Proportional Counting											
GFPC, Gross A/B, solid "Dry Weight Corrected"											
Alpha		12.8	+/-4.62	2.89	4.00	pCi/g		DXB5 06/30/09	1147	880115	7
Beta		21.5	+/-4.32	4.33	10.0	pCi/g					
GFPC, Sr90, solid "Dry Weight Corrected"											
Strontium-90	U	0.0157	+/-0.320	0.616	2.00	pCi/g		JXR1 06/26/09	1344	880114	8

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	DRS1	06/24/09	1142	879813

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	ASTM D 2216 (Modified)	
2	DOE EML HASL-300, Am-05-RC Modified	
3	DOE EML HASL-300, Pu-11-RC Modified	
4	DOE EML HASL-300, Th-01-RC Modified	
5	DOE EML HASL-300, U-02-RC Modified	
6	EML HASL 300, 4.5.2.3	
7	EPA 900.0/SW846 9310 Modified	
8	EPA 905.0 Modified	

Surrogate/Tracer recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
Americium-243 Tracer	Alphaspec Am241 Solid "Dry Weight Corrected"			100	(15%-125%)
Plutonium-242 Tracer	Alphaspec Pu, Solid "Dry Weight Corrected"			91.1	(15%-125%)
Thorium-229 Tracer	Alphaspec Th, Solid "Dry Weight Corrected"			109	(15%-125%)
Uranium-232 Tracer	Alphaspec U, Solid "Dry Weight Corrected"			90.2	(15%-125%)
Strontium Carrier	GFPC, Sr90, solid "Dry Weight Corrected"			78.7	(25%-125%)

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Report Date: July 7, 2009

Contact: Mr. John Burke
Project: **Perimeter FHWMF**

Client Sample ID:	27274-003	Project:	BRKL00309
Sample ID:	232172003	Client ID:	BRKL005
Matrix:	Solid	COC:	27274
Collect Date:	09-JUN-09 10:10	Samp Recv.:	
Receive Date:	20-JUN-09 09:30	Client Desc.:	PFHWMF
Collector:	Client	Vol. Recv.:	
Moisture:	18.3%		

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Gravimetric Solids											
"As Received"											
Rad Alpha Spec Analysis											
Alphaspec Am241 Solid "Dry Weight Corrected"											
Americium-241	U	0.0361	+/-0.181	0.425	1.00	pCi/g		HAK B	06/26/09	1455 879815	2
Alphaspec Pu, Solid "Dry Weight Corrected"											
Plutonium-238	U	0.0451	+/-0.120	0.285	1.00	pCi/g		HAK B	06/26/09	1455 879817	3
Plutonium-239/240	U	-0.057	+/-0.129	0.391	1.00	pCi/g					
Alphaspec Th, Solid "Dry Weight Corrected"											
Thorium-228	J	0.830	+/-0.524	0.577	1.00	pCi/g		HAK B	06/26/09	1446 879818	4
Thorium-230	J	0.641	+/-0.416	0.210	1.00	pCi/g					
Thorium-232	J	0.526	+/-0.384	0.336	1.00	pCi/g					
Alphaspec U, Solid "Dry Weight Corrected"											
Uranium-233/234	U	0.436	+/-0.397	0.494	0.900	pCi/g		HAK B	06/26/09	1944 879819	5
Uranium-235/236	U	0.052	+/-0.207	0.553	0.900	pCi/g					
Uranium-238	U	0.223	+/-0.277	0.388	0.900	pCi/g					
Rad Gamma Spec Analysis											
Gammaspec, Gamma, Solid (Long List) "Dry Weight Corrected"											
Actinium-227	U	-0.0131	+/-0.137	0.247	10000	pCi/g		MXR1	07/02/09	0604 879862	6
Actinium-228		0.824	+/-0.118	0.0505	0.800	pCi/g					
Americium-241	U	0.0705	+/-0.0768	0.130	0.200	pCi/g					
Antimony-124	U	0.00682	+/-0.0204	0.0351	0.100	pCi/g					
Antimony-125	U	0.00321	+/-0.0438	0.0759	0.200	pCi/g					
Antimony-126	U	0.0794	+/-0.0592	0.096	10000	pCi/g					
Antimony-127	U	0.152	+/-1.31	2.31	10000	pCi/g					
Barium-133	U	0.00591	+/-0.0196	0.0305	0.100	pCi/g					
Barium-137m	J	8.02	+/-0.391	0.0187	10000	pCi/g					
Barium-140	U	-0.16	+/-0.156	0.244	0.500	pCi/g					
Beryllium-7	DL	-0.0154	+/-0.174	0.299	0.074	pCi/g					
Bismuth-207	U	0.022	+/-0.0131	0.0236	10000	pCi/g					
Bismuth-211	J-UI	1.80	+/-0.205	0.141	10000	pCi/g					
Bismuth-212		0.624	+/-0.129	0.116	0.500	pCi/g					
Bismuth-214		0.555	+/-0.0595	0.0384	0.200	pCi/g					

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Report Date: July 7, 2009

Contact: Mr. John Burke
Project: **Perimeter FHWMF**

Client Sample ID: 27274–003
Sample ID: 232172003

Project: BRKL00309
Client ID: BRKL005

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Gamma Spec Analysis											
Gammaspec, Gamma, Solid (Long List) "Dry Weight Corrected"											
Cadmium–109	J–UI	1.76	+/–0.391	0.425	10000	pCi/g					
Cadmium–115	U	–1.94	+/–49.9	0.00	10000	pCi/g					
Cerium–139	U	–0.0068	+/–0.0103	0.0177	0.050	pCi/g					
Cerium–141	U	0.0155	+/–0.024	0.0425	0.100	pCi/g					
Cerium–143	UI	16800	+/–5150	0.00	10000	pCi/g					
Cerium–144	U	–0.0327	+/–0.0674	0.118	0.500	pCi/g					
Cesium–134	J–UI	0.0402	+/–0.0134	0.0228	0.100	pCi/g					
Cesium–135	U	0.0577	+/–0.0639	0.103	10000	pCi/g					
Cesium–136	U	–0.015	+/–0.0391	0.0645	0.300	pCi/g					
Cesium–137		8.48	+/–0.416	0.0198	0.010	pCi/g					
Chromium–51	U	0.0947	+/–0.174	0.312	0.600	pCi/g					
Cobalt–56	U	0.00287	+/–0.0101	0.0176	0.100	pCi/g					
Cobalt–57	DL	0.00176	+/–0.00834	0.0149	0.007	pCi/g					
Cobalt–58	U	–0.00639	+/–0.0095	0.0159	0.100	pCi/g					
Cobalt–60	DL	0.00184	+/–0.00934	0.0162	0.011	pCi/g					
Europium–152	U	0.00823	+/–0.0387	0.0685	0.200	pCi/g					
Europium–154	U	–0.0208	+/–0.0283	0.0468	0.500	pCi/g					
Europium–155	U	0.0384	+/–0.0342	0.0621	0.500	pCi/g					
Gadolinium–153	U	–0.016	+/–0.0281	0.0449	10000	pCi/g					
Iodine–126	U	0.0352	+/–0.0805	0.126	10000	pCi/g					
Iodine–131	U	–0.0571	+/–0.0961	0.167	10000	pCi/g					
Iodine–133	U	–1.37E+05	+/–1.35E+06	0.00	10000	pCi/g					
Iodine–135	U	–1.20E+23	+/–6.51E+23	0.00	10000	pCi/g					
Iridium–192	U	–0.0101	+/–0.0143	0.0252	0.100	pCi/g					
Iron–59	U	0.00451	+/–0.0238	0.0402	0.300	pCi/g					
Lanthanum–140	U	0.0083	+/–0.0341	0.0506	10000	pCi/g					
Lead–210	DL	2.23	+/–2.96	5.62	4.00	pCi/g					
Lead–211	U	–0.24	+/–0.436	0.708	10000	pCi/g					
Lead–212		0.873	+/–0.0761	0.0342	0.100	pCi/g					
Lead–214		0.626	+/–0.078	0.0492	0.100	pCi/g					
Manganese–54	DL	0.00651	+/–0.0142	0.0173	0.008	pCi/g					
Mercury–203	U	0.00637	+/–0.0184	0.0293	0.100	pCi/g					
Molybdenum–99	J–UI	6.23	+/–20.6	0.00	10000	pCi/g					
Neodymium–147	U	–0.0797	+/–0.350	0.590	1000	pCi/g					
Neptunium–239	U	–0.00105	+/–0.0601	0.107	2.00	pCi/g					
Niobium–94	U	0.000811	+/–0.00861	0.0151	1.00	pCi/g					
Niobium–95	J–UI	0.0242	+/–0.0128	0.021	0.050	pCi/g					
Potassium–40		7.79	+/–0.645	0.134	0.180	pCi/g					
Praseodymium–144	U	–0.084	+/–0.617	1.08	10000	pCi/g					
Promethium–144	U	–0.00123	+/–0.00906	0.0158	0.080	pCi/g					
Promethium–146	U	0.00435	+/–0.0224	0.0388	1.00	pCi/g					
Promethium–149	J–UI	75.0	+/–416	0.00	10000	pCi/g					

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Report Date: July 7, 2009

Contact: Mr. John Burke
Project: **Perimeter FHWMF**

Client Sample ID: 27274-003
Sample ID: 232172003

Project: BRKL00309
Client ID: BRKL005

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Gamma Spec Analysis											
Gammaspec, Gamma, Solid (Long List) "Dry Weight Corrected"											
Protactinium-231	U	0.284	+/-0.565	1.02	10000	pCi/g					
Protactinium-233	U	0.0088	+/-0.0242	0.0433	10000	pCi/g					
Protactinium-234	U	0.0172	+/-0.0692	0.119	10000	pCi/g					
Protactinium-234m	U	1.49	+/-1.54	2.70	10000	pCi/g					
Radium-223	U	-0.141	+/-0.283	0.436	10000	pCi/g					
Radium-224	J-UI	2.49	+/-0.485	0.389	10000	pCi/g					
Radium-226		0.555	+/-0.0595	0.0384	0.026	pCi/g					
Radium-228		0.824	+/-0.118	0.0505	0.500	pCi/g					
Radon-219	U	-0.0335	+/-0.181	0.315	10000	pCi/g					
Rhodium-106	U	0.0431	+/-0.104	0.176	10000	pCi/g					
Ruthenium-103	U	0.00308	+/-0.0202	0.0345	10000	pCi/g					
Ruthenium-106	U	0.0431	+/-0.104	0.176	0.800	pCi/g					
Scandium-46	U	0.00117	+/-0.00967	0.0166	10000	pCi/g					
Selenium-75	U	0.00316	+/-0.0189	0.0302	10000	pCi/g					
Silver-108m	U	-0.0158	+/-0.0156	0.0265	10000	pCi/g					
Silver-110m	UI	0.339	+/-0.0266	0.0413	0.080	pCi/g					
Sodium-22	DL	-0.00973	+/-0.0102	0.0168	0.010	pCi/g					
Sodium-24	UI	4.31E+08	+/-1.39E+09	0.00	10000	pCi/g					
Strontium-85	J-UI	0.0327	+/-0.0169	0.0264	10000	pCi/g					
Tantalum-182	U	-0.0039	+/-0.0461	0.0795	10000	pCi/g					
Technetium-99m	U	-1.25E+25	+/-4.33E+25	0.00	10000	pCi/g					
Tellurium-123m	U	-0.00288	+/-0.00985	0.0171	10000	pCi/g					
Tellurium-125m	U	4.13	+/-3.23	5.84	10000	pCi/g					
Tellurium-132	U	0.613	+/-1.43	2.44	10000	pCi/g					
Thallium-208		0.260	+/-0.0298	0.0198	0.080	pCi/g					
Thorium-227	U	-0.0131	+/-0.137	0.247	10000	pCi/g					
Thorium-228		0.873	+/-0.0761	0.0342	0.021	pCi/g					
Thorium-229	U	-0.09	+/-0.189	0.322	10000	pCi/g					
Thorium-230	J	0.555	+/-0.0595	0.0384	1.00	pCi/g					
Thorium-231	U	-0.141	+/-0.283	0.436	10000	pCi/g					
Thorium-232	J	0.824	+/-0.118	0.0505	10000	pCi/g					
Thorium-234	U	0.936	+/-0.854	0.956	5.00	pCi/g					
Tin-113	U	0.00905	+/-0.0201	0.0353	0.100	pCi/g					
Tin-117m	U	0.00308	+/-0.0273	0.0477	10000	pCi/g					
Tin-126	J-UI	0.171	+/-0.038	0.0416	10000	pCi/g					
Uranium-234	J	0.555	+/-0.0595	0.0384	10000	pCi/g					
Uranium-235	U	0.0754	+/-0.0689	0.121	0.500	pCi/g					
Uranium-238	U	0.936	+/-0.854	0.956	1.00	pCi/g					
Vanadium-48	U	0.00037	+/-0.0229	0.0388	10000	pCi/g					
Yttrium-88	U	0.00686	+/-0.00951	0.0167	0.100	pCi/g					
Zinc-65	U	-0.00699	+/-0.0245	0.0346	0.300	pCi/g					
Zirconium-95	J-UI	0.0415	+/-0.0213	0.0352	0.200	pCi/g					

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Report Date: July 7, 2009

Contact: Mr. John Burke
Project: **Perimeter FHWMF**

Client Sample ID: 27274-003
Sample ID: 232172003

Project: BRKL00309
Client ID: BRKL005

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Gas Flow Proportional Counting											
GFPC, Gross A/B, solid "Dry Weight Corrected"											
Alpha		11.9	+/-3.92	2.80	4.00	pCi/g		DXB5 06/30/09	0851	880115	7
Beta		20.9	+/-3.58	3.55	10.0	pCi/g					
GFPC, Sr90, solid "Dry Weight Corrected"											
Strontium-90	U	0.0276	+/-0.467	0.873	2.00	pCi/g		JXR1 06/26/09	1344	880114	8

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	DRS1	06/24/09	1142	879813

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	ASTM D 2216 (Modified)	
2	DOE EML HASL-300, Am-05-RC Modified	
3	DOE EML HASL-300, Pu-11-RC Modified	
4	DOE EML HASL-300, Th-01-RC Modified	
5	DOE EML HASL-300, U-02-RC Modified	
6	EML HASL 300, 4.5.2.3	
7	EPA 900.0/SW846 9310 Modified	
8	EPA 905.0 Modified	

Surrogate/Tracer recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
Americium-243 Tracer	Alphaspec Am241 Solid "Dry Weight Corrected"			99.8	(15%-125%)
Plutonium-242 Tracer	Alphaspec Pu, Solid "Dry Weight Corrected"			94.0	(15%-125%)
Thorium-229 Tracer	Alphaspec Th, Solid "Dry Weight Corrected"			101	(15%-125%)
Uranium-232 Tracer	Alphaspec U, Solid "Dry Weight Corrected"			93.2	(15%-125%)
Strontium Carrier	GFPC, Sr90, solid "Dry Weight Corrected"			70.1	(25%-125%)

1935579

ASL Prefix No.

Page 1 of 1

BROOKHAVEN NATIONAL LABORATORY

Carrier/Waybill # _____

P.O. # _____

Chain of Custody No. 24765

Requires EDD X DQL ____

SAMPLING CHAIN OF CUSTODY

Analysis Requested By	Sampling Contractor	Analytical Laboratory
Name: R. Lee	Name: EWMSA	Name: GEL
Life No: 20222 Ext. 3148	Contact:	Address:
Acct. No: 19741 Dept: ES	Phone:	City: St: Zip:
Email Reports To:	Email/Fax:	Contact:
1 R. Lee	Sampler: R Meth C. Morris	Phone:
2		Email/Fax:
Project Name: SSS FHWMF-SA	Project Manager: R. Lee	Field Engineer:

Comments:

* 7 day TAT

Type LID	Type UID	Smp	Coll	Sample Information: Site ID/Bldg/Life #	Depth/RWP	Date	Time	Matrix	Additional Sample Information: Name/Description	Cont. Vol/Units	Cont. Type	# of Cont.	Preservative	Analysis Requested: Alpha/Beta	Tritium	Gamma Spec.	Strontium	524.2	624	Nuclide-specific Alpha	PCBs	Metals
	001	e	C	C6-OS	0	9/6/07	1525	V	C6 outside area (Grass)	1L	G	1	—			X						
	002	e	C	C6			1535	V	C6 Bushy Plants	1L	G	1	—			X						
	003	e	C	C5-W			1540	V	C5 weeds	1L	G	1	—			X						
	004	e	C	C5-B			1545	V	C5 Bushy Plants	1L	G	1	—			X						
	005	e	C	C4			1550	V	C4 Grass	1L	G	1	—			X						
	006	e	C	D6			1600	V	D6 weeds.	1L	G	1	—			X						
	007	e	C	D5		V	1610	V	D5 Grass	1L	G	1	—			X						
	008	e	C	G5		9/10/07	1530	V	G5 Grass + weeds	1L	G	1	—			X						
	009	e	C	I5		V	1540	V	I5 Grass + weeds	1L	G	1	—			X						

1 Relinquished By/Date/Time	2 Relinquished By/Date/Time	3 Relinquished By/Date/Time
Print R Meth 9/11/07	Print	Print
Signature Robert Meth 1400	Signature	Signature
1 Received By/Date/Time	2 Received By/Date/Time	3 Received By/Date/Time
Print Ricky Albee 9/12/07	Print	Print
Signature 0930	Signature	Signature

Contractor Lab Sample Disposal:
☐ Return To Client ☒ Disposal by Lab
☐ Archive For ____ Months

Data Package: ☐ Full ☒ Summary

Turn-Around Time Required:
☐ Rush (1 Day) ☐ 14 Days ☐ 30 Days
☒ 7 Days ☐ Other ( )

BNL F 3101D

Distribution WHITE (1) - Stays with Sample; PINK (2) - Lab or Other GREEN (3) - Returned to Client with Report GOLDENROD (4) - Field Copy - (Sampler)

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 – (843) 556–8171 – www.gel.com

Certificate of Analysis

Company : Brookhaven National Laboratory
Address : Building 51
Upton, New York 11973—5000

Report Date: September 19, 2007

Contact: Mr. John Burke
Project: **Analytical Services Lab—Summary**

Client Sample ID:	24765–001	Project:	BRKL00506
Sample ID:	193557001	Client ID:	BRKL005
Matrix:	Vegatation	COC:	24765
Collect Date:	06–SEP–07 15:25	Samp Recv.:	
Receive Date:	12–SEP–07 09:30	Client Desc.:	C6–0S
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Gamma Spec Analysis											
Gammaspec, Gamma, Solid (Standard List)											
Cesium–137	U	0.121	+/–0.0808	0.140	0.200	pCi/g		MJH1 09/18/07	0910	684062	1
Potassium–40		6.88	+/–1.58	0.989	0.500	pCi/g					

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL–RAD–A–021	LXM2	09/13/07	1606	682828

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	

C6 Outside area (Grass)

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 – (843) 556–8171 – www.gel.com

Certificate of Analysis

Company : Brookhaven National Laboratory
Address : Building 51
Upton, New York 11973—5000

Report Date: September 19, 2007

Contact: Mr. John Burke
Project: **Analytical Services Lab—Summary**

Client Sample ID:	24765–002	Project:	BRKL00506
Sample ID:	193557002	Client ID:	BRKL005
Matrix:	Vegatation	COC:	24765
Collect Date:	06–SEP–07 15:35	Samp Recv.:	
Receive Date:	12–SEP–07 09:30	Client Desc.:	C6
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Gamma Spec Analysis											
Gammaspec, Gamma, Solid (Standard List)											
Cesium–137		0.651	+/–0.122	0.0885	0.200	pCi/g		MJH1 09/18/07	1112	684062	1
Potassium–40		4.41	+/–1.18	0.840	0.500	pCi/g					

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL–RAD–A–021	LXM2	09/13/07	1606	682828

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	

C6 (Bushy Plant)