FINAL
CLOSEOUT REPORT

Removal of the Building 801-811 Waste Transfer Lines (A/B Waste Lines with Co-Located Piping) Area of Concern 31

Brookhaven National Laboratory
Upton, New York

July 2010

Prepared for:

Brookhaven Science Associates, LLC
Building No. 460
Upton, NY 11973

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Prepared By:
P.W. Grosser Consulting, Inc.

Executive Summary

The Building 801-811 Waste Transfer Lines (A/B Waste Lines with Co-located Piping), referred to herein as the "Waste Transfer Lines," consist of: the A-, B- and original D-waste lines; the non-acid off-gas pipe; the steam line; and the replacement stand-alone D-waste line. The Waste Transfer Lines are associated with Area of Concern (AOC) 31, High Flux Beam Reactor (HFBR), at Brookhaven National Laboratory (BNL). The Waste Transfer Lines Project is part of the HFBR remedial actions described as near-term decontamination and dismantlement (D&D) in the *Record of Decision – Area of Concern 31, High Flux Beam Reactor* (BNL, February, 2009) (HFBR ROD). The project was performed with funding under the American Recover and Reinvestment Act (ARRA) and in accordance with *Closeout Procedures at National Priority List Sites, OSWER Directive 9320.2-09A-P* (EPA, 2000a).

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

Remedial activities associated with the Waste Transfer Lines Project commenced in July 2009 and were completed in December 2009. The following summarizes the as-left conditions for the Waste Transfer Lines and how they satisfy the requirements of the HFBR ROD:

- The average Cs-137 and Ra-226 concentrations remaining in the soil following excavation are 0.15 picocuries per gram (pCi/g) and 0.39 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=5 pCi/g). The maximum concentrations detected in soil samples were as follows: 1.01 pCi/g Cs-137, <1.1 pCi/g Sr-90, and 0.61 pCi/g Ra-226.
- Chemical results for soil samples analyzed for mercury, lead, nickel, and thallium also indicated that residual soil concentrations for these contaminants are within the respective cleanup goals, i.e., 400 mg/kg for lead, 1.84 mg/kg for mercury, 13 mg/kg for nickel, and 0.35 mg/kg for thallium.
- The maximum projected dose to a resident (non-famer) after 50 years of institutional controls is 0.2 millirem/yr. The maximum projected dose to an industrial worker with no decay time is 0.1 millirem/yr. The results of the dose assessment are below the objectives established in the HFBR ROD, including the dose objective of 15 millirem/yr and the New York State Department of Environmental Conservation cleanup guideline of 10 millirem/yr from TAGM 4003, which was adopted as an ALARA goal.

- Site restoration for the Waste Transfer Lines Project was completed in March 2010. Restoration included backfilling, spreading topsoil, re-grading, re-paving roadways, and reseeding lawn areas with Long Island native grasses.

The Waste Transfer Lines site meets all the completion requirements as specified in Office of Solid Waste and Emergency Response (OSWER) Directive 9320.2-09-A-P, *Closeout Procedures for National Priorities List Sites*. Post-remediation operation and maintenance activities for the Waste Transfer Lines site 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 inspections of the topsoil cover (placed during site restoration) for signs of erosion, and institutional controls (signs, land-use and real controls, notifications and restrictions, work planning controls such as digging permits, and government ownership).

Table of Contents

FIGURES

TABLES

PHOTOGRAPHS

APPENDICES

ACRONYM LIST

AF	Area Factor
ALARA	As Low As Reasonably Achievable
AOC	Area of Concern
ARRA	American Recover and Reinvestment Act
BNL	Brookhaven National Laboratory
BSA	Brookhaven Science Associates
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
FRDP	Facility Review Disposition Project
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
LLRW	Low-Level Radioactive Waste
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

PRAP	Proposed Remedial Action Plan
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RCD	Radiological Controls Division
RCT	Radiological Controls Technician
RESRAD	Residual Radioactivity Computer Code
RI	Remedial Investigation
ROD	Record of Decision
SCDHS	Suffolk County Department of Health Services
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
UN	United Nation
USC	United States Code
WAC	Waste Acceptance Criteria
WCS	Waste Confirmation Sample
WP	Work Procedure

1.0 INTRODUCTION

1.1 Purpose

The purpose of this of this Closeout Report is to document the remedial actions associated with the removal of the Building 801-811 Waste Transfer Lines (A/B Waste Lines with Co-located Piping), referred to herein as the "Waste Transfer Lines." This work is referred to herein as the "Waste Transfer Lines Project." The Waste Transfer Lines are associated with Area of Concern (AOC) 31, High Flux Beam Reactor (HFBR), at Brookhaven National Laboratory (BNL). The Waste Transfer Lines Project is part of the HFBR remedial actions described as near-term decontamination and dismantlement (D&D) in the *Record of Decision – Area of Concern 31, High Flux Beam Reactor* (BNL, February, 2009) (*HFBR ROD*). The project was performed with funding under the American Recover and Reinvestment Act (ARRA) and in accordance with *Closeout Procedures at National Priority List Sites*, *OSWER Directive 9320.2-09A-P* (EPA, 2000a). Activities included:

- The removal of the Waste Transfer Lines;
- The excavation of contaminated soil above site cleanup goals associated with the Waste Transfer Lines;
- Completion of a final status survey (FSS), including an independent verification survey (IVS) performed by the Oak Ridge Institute for Science and Education (ORISE);
- Completion of a post-closure dose assessment using 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 associated with the Waste Transfer Lines Project 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 HFBR ROD and the Remedial Design/Remedial Action Work Plan for the Removal of the Building 801-811 Waste Transfer Lines (A/B Waste Lines with Co-Located Piping) (BNL, July 2009). The Final Status Survey (FSS) was performed in accordance with the Field Sampling Plan for the Removal of the Building 801-811 Waste Transfer Lines (BNL, September 2009).

The scope of work for the Waste Transfer Lines Project included the following:

- Remove the Waste Transfer Lines as well as the associated concrete culvert and contaminated soils;
- Package, transport, and dispose of radiologically and chemically contaminated soils and debris at an off-site permitted facility;
- Collect and analyze soil samples in the Building 811 yard to document as-left conditions;
- Perform an FSS and IVS of the Waste Transfer Lines trench to ensure site cleanup criteria have been met;
- Perform site restoration; and
- Prepare a dose assessment and a closeout report.

1.2 Site Description and Operational History

The BNL site covers almost 5,300 acres, much of which is wooded. It is an irregular polygon, and each side is approximately 2.5 miles long. The developed portion of the BNL site includes the principal facilities, which are located near the center of the BNL site on relatively high ground. The developed portion is approximately 1,650 acres, 500 acres of which were originally developed for U.S. Army use. Large, specialized research facilities occupy 200 acres and another 400 acres are occupied by roads, parking lots and connecting areas. The remaining 550 acres are occupied by outlying facilities including an apartment area, Biology Field, Former Hazardous Waste Management Area, Sewage Treatment Plant, firebreaks, and the Former Landfill Area. The terrain is gently rolling, with elevations varying between 40 to 120 ft above mean sea level. The land lies on the western rim of the shallow Peconic River watershed, with a tributary of the Peconic River rising in marshy areas in the northern section of the tract. The sole-source aquifer beneath BNL comprises three water-bearing units: the upper glacial deposits, the Magothy Formation, and the Lloyd Sand Member of the Raritan Formation. These units are hydraulically connected and make up a single zone of saturation with varying physical properties extending from a depth of 5 to 1,500 ft below the land surface. These three water-bearing units are designated as a "sole source aquifer" by the U.S. Environmental Protection Agency (EPA) and serve as the primary source of drinking water for Nassau and Suffolk counties.

A map illustrating the location of the BNL site is presented as Figure 1-1.

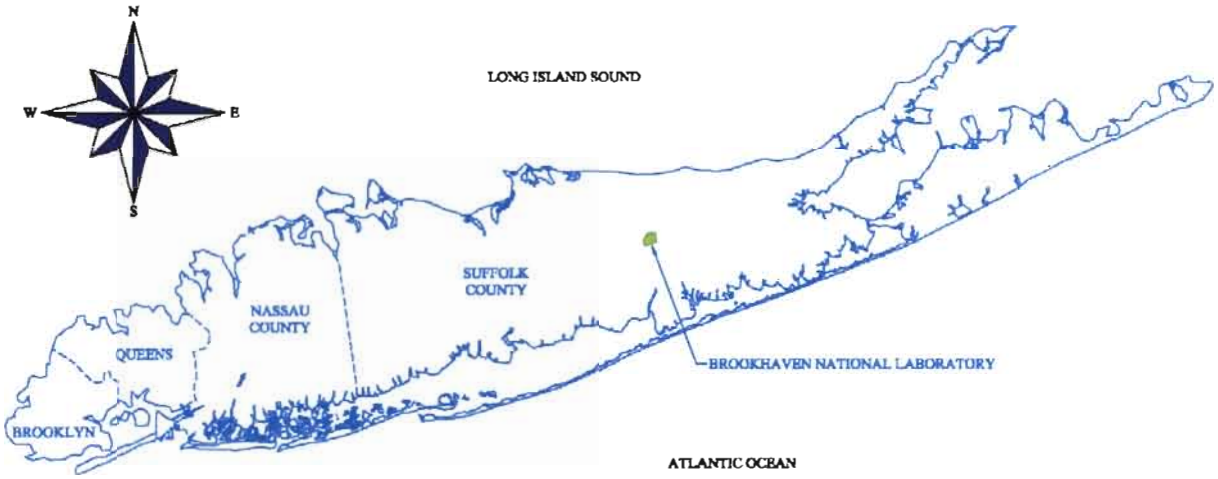

Figure 1-1. Location of Brookhaven National Laboratory

Figure 0-2 Waste Transfer Lines Location at BNL

The Waste Transfer Lines are centrally located within the BNL site, as shown in Figure 1-2. The Waste Transfer Lines previously transferred radioactive liquid wastes from Building 801 (Hot Laboratory Building) to storage tanks at Building 811 (Waste Concentration Facility), as shown on Figure 1-3.

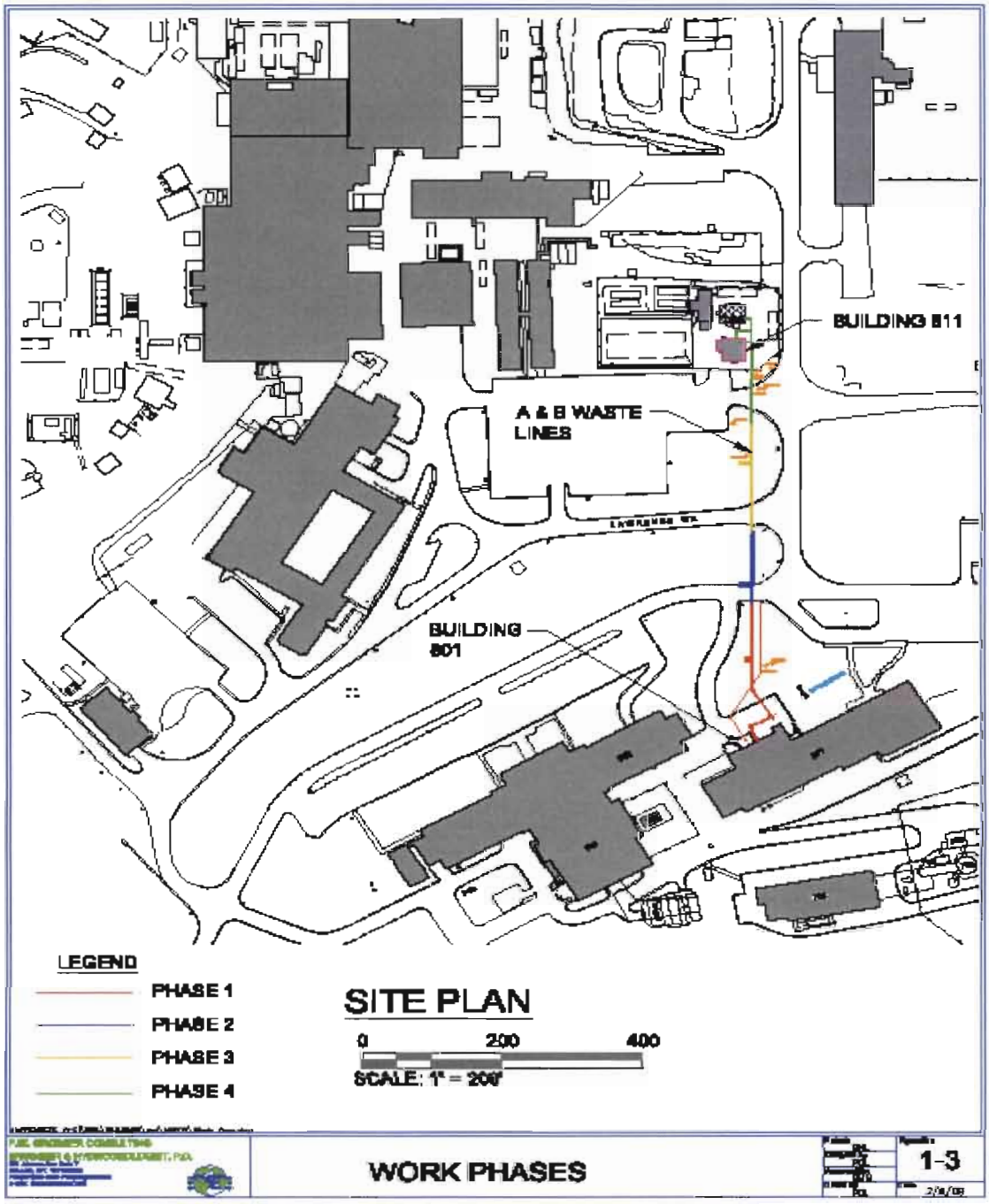

Figure 1-3 Waste Transfer Lines Site Plan

A concrete culvert approximately 700′ long and 3′-8½" wide was used as a secondary containment for the Waste Transfer Lines. The concrete culvert was covered with a half-section of 3′-diameter galvanized steel drainage pipe. The enclosure was buried between 2½′ to 10′ below grade, measured to the top of the enclosure from grade.

Within the concrete culvert were three abandoned radioactive waste transfer pipes and one out-of-service steam pipe. The waste transfer pipes consisted of a 2"-diameter stainless steel pipe for transferring liquid radioactive waste containing high concentrations of transuranic materials (A-waste line), a 2" stainless steel pipe for transferring liquid radioactive waste containing lower concentrations of transuranic material (B-waste line), and a 4"-diameter mild steel pipe for transferring liquid radioactive waste with gross beta greater than 90 pCi/mL (original D-waste line). The steam pipe was a 2½"-diameter steel pipe insulated with asbestos material.

A 10" diameter terra cotta ventilation pipe (Non-Acid Off-Gas Pipe) was buried approximately 2′-9" east of the concrete culvert centerline at approximately the same depth as the culvert. This pipe was formerly used to ventilate the six underground A&B tanks in the Building 811 yard, which were removed in 2005.

A 1-½" stainless steel pipe within a 4" polyvinyl chloride (PVC) clamshell containment pipe was buried approximately 6′-3" east of the concrete culvert centerline and approximately 2'-6" below grade. This pipe was used for transferring radioactive waste (new standalone D-waste line).

A typical cross-section of the Waste Transfer Lines is provided below (Figure 1-4, Typical Cross-Section of Waste Transfer Lines).

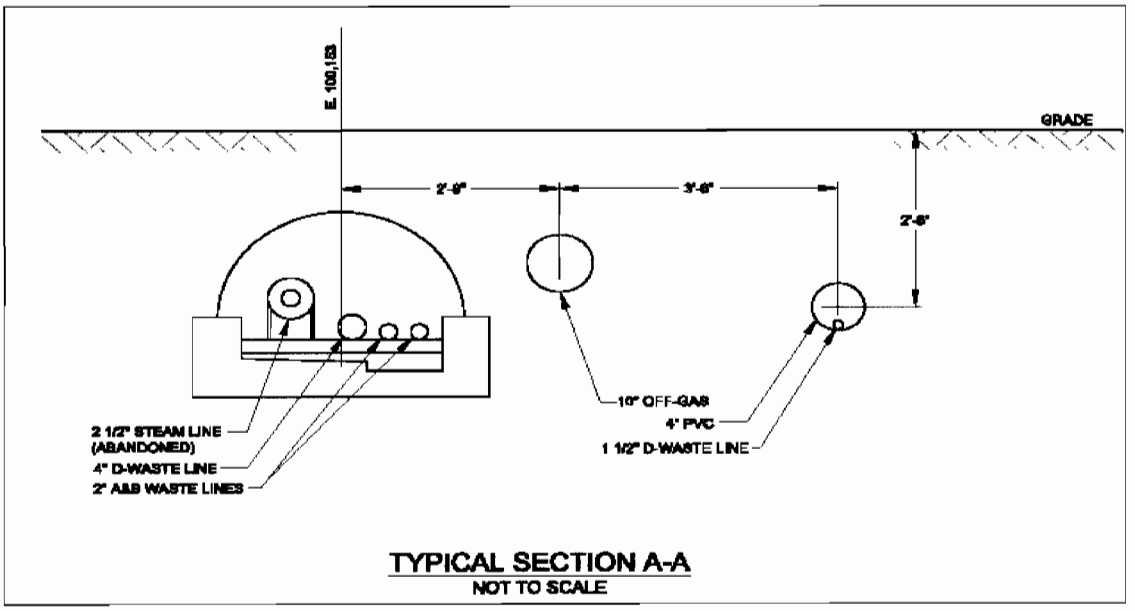

Figure 1-4 Typical Cross-Section of the Waste Transfer Lines

The A-waste line, B-waste line, original D-waste line, steam line, and Non-Acid Off-Gas Pipe were installed in 1949. The A- and B-waste lines operated from 1952 until they were abandoned-in-place in 1961. The original 4" D-waste line operated briefly in 1952, but was abandoned-in-place after the pipe developed leaks. The steam line was abandoned in 2001.

A replacement stand-alone 1½" D-waste line was installed outside the concrete culvert and operated from 1952 to 1995. However, this pipe developed leaks and was removed in 1995, after which time a new stand-alone 1½" D-waste line was installed in the same trench as the replacement D-waste line. The new stand-alone D-waste line operated from 1995 until it was abandoned-in-place in January 2001 after the secondary containment failed to pass a tightness test. The D-waste line was subsequently bypassed with new piping to a pump-out station located outside the north wall of Building 801.

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, 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. The OUs and AOCs identified by the IAG are discussed further in Sections 1.5 and 2.0.

Upon completion and review of the results of a Remedial Investigation (RI) and Feasibility Study (FS) for OU I, the *Record of Decision – Operable Unit I and Radiologically Contaminated Soils (Including Areas of Concern 6, 8, 10, 16, 17, and 18)* (OUI ROD), was signed in August 1999. The OU I ROD specified the excavation and off-site disposal of radiologically and chemically contaminated soils.

In April 2009, the *Record of Decision – Area of Concern 31, High Flux Beam Reactor* (HFBR ROD) was finalized. The HFBR ROD includes the removal of the Waste Transfer Lines as well as removal of the associated contaminated soil utilizing the dose-based cleanup goal and methodology specified in the OU I ROD.

1.4 Previous Remedial Activities and Site Investigation

In 1995, the replacement stand-alone 1½" D-waste line was removed and replaced with the new stand-alone 1½" D-waste line. Following the removal of contaminated soil in the stand-alone D-waste line trench, soil sampling showed that no radionuclides or chemicals were found exceeding residential land use standards. However, some soil samples had thallium and nickel above levels allowed by the NYSDEC Target and Administrative Guidance Memorandum (TAGM) #4046. The remedial activities are documented in the *Final Operable Units II/VII Investigation Report* (IT Corporation, February 1999).

The 2004 removal of six A- and B-waste storage tanks from the Building 811 yard was documented in the *Closeout Report, Brookhaven National Laboratory, Operable Unit I, Area of Concern 10 (AOC 10), Waste Concentration Facility* (Weston Solutions, September 2005). Along with the A- and B-waste storage tanks, the remedial activities included removal of a section of the corrugated steel trench cover, A-, B-, and D-waste pipes, and Non-Acid Off-Gas Pipe.

1.5 BNL Operable Units

As part of remedial efforts at BNL, thirty 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. In February 2009, AOC 31, comprising the HFBR complex and the Waste Transfer Lines, was established.

This report documents completion of the remedial action for the Waste Transfer Lines, which is part of AOC 31. As described in Section 2.1, the cleanup goals established in the OU I ROD were used for the Waste Transfer Lines Project.

2.0 OPERABLE UNIT BACKGROUND

2.1 Site Cleanup Criteria

The primary radiological contaminants of concern for the Waste Transfer Lines are the same as those for OU 1 radiologically contaminated soils: Cs-137, Ra-226, and Sr-90. The cleanup goals for specific radionuclides were calculated using RESRAD, considering a residential scenario. 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 TAGM 4003, was adopted as an ALARA goal. The primary radiological isotope present at the site was Cs-137; its cleanup goal, as established in the OU 1 ROD and specified in the HFBR ROD, is 23 pCi/g.

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* (DOE, 1993).

Since the Waste Transfer Lines historically transported radionuclides that were not addressed in the OU 1 ROD, additional radionuclides were evaluated. The *Scoping Study for Building 801/811 Radioactive Waste Transfer Lines and Non-Acid Off-Gas Pipe* (PWGC, 2003) identified radionuclides in sludge from the D-waste line, A-waste storage tank, and B-waste storage tank. These radionuclides were considered as additional radiological contaminants of concern and are listed with their respective cleanup goals in Table 2-1.

The primary chemical contaminants of concern for the Waste Transfer Lines are the same as those for OU I chemically contaminated soils: 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. The choice of a cleanup goal of 400 mg/kg for lead also was based on the EPA's soil screening level guidance; this level is protective of residential use. The cleanup goals for these chemical contaminants were established in the OU 1 ROD and specified in the HFBR ROD.

Thallium and nickel were also were also considered chemical contaminants of concern since they were both detected above NYSDEC TAGM #4046 (NYSDEC, 1994) limits in soil within the stand-alone D-waste line trench in 1995. The NYSDEC TAGM limits for nickel (13 mg/kg) and thallium (0.35 mg/kg) were used for site cleanup goals.

Radionuclides and chemical contaminants of concern for the Waste Transfer Lines Project are listed in Table 2-1.

Table 2-1

Radionuclides and Chemical Contaminants of Concern for the Waste Transfer Lines Project

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)
H-3	424 (2)	CDM 1996, Table 6.2-10
Na-22	Not referenced (1)	N/A
Co-60	1,100 (3)	CDM 1996, Table 6.2-10
Tc-99	Not referenced (1)	N/A
Eu-152	49 (3)	CDM, 1999, Table 1-8
Eu-154	170 (3)	CDM, 1999, Table 1-8
I-129	Not referenced (1)	N/A
Th-230	5	DOE 5400.5
Th-232	5	DOE 5400.5
U-234	13 (3)	CDM 1999, Table 1-8
U-235	11 (3)	CDM 1996, Table 6.2-10
U-238	9 (3)	CDM 1999, Table 1-3
Pu-238	65 (3)	CDM 1996, Table 6.2
Pu-239/, Pu-240	40 (3)	CDM 1996, Table 6.2
Pu-242	Not referenced (1)	N/A
Am-241	39 (3)	CDM 1996, Table 6.2-10
Am-243	Not referenced (1)	N/A
Cm-244	Not referenced (1)	N/A
Chemical Contaminant	**Soil Cleanup Level (mg/kg)**	**Source of Cleanup Goal Value**
Mercury	1.84	OUI ROD (BNL, 2009)
Lead	400	OUI ROD (BNL, 2009)
Nickel	13	NYSDEC TAGM
Thallium	0.35	NYSDEC TAGM

(1) Note: For those nuclides "not referenced," the estimated cleanup levels were not listed in either the OU I ROD nor in other BNL remediation references. If these nuclides were detected, RESRAD was used as described in Section 3.1.3.3 of the project FSP to develop the cleanup levels that will meet the 15 mrem/yr criteria.

(2) Note: The value is based on a RESRAD evaluation for a residential scenario with no decay.

(3) Note: The value was previously approved in the referenced source document and is based on a RESRAD evaluation for a residential scenario with 50 years of decay.

2.2 Design Criteria

Technical specifications and design criteria for the Waste Transfer Lines Project were established in the HFBR ROD and the *Field Sampling Plan for the Removal of the Building 801-811 Waste Transfer Lines* (BNL, September 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; 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

The community involvement activities conducted for the remedy selection process for the HFBR (including the remediation of the Waste Transfer Lines using the OU I cleanup goals and methodology) included a formal public review of the HFBR Proposed Remedial Action Plan (PRAP). The public comment period began January 10, 2008 and ended March 17, 2008. Two information sessions and a public meeting were held during the public comment period. Public comments received indicate that there is considerable community support for DOE's preferred remedial alternative identified in the PRAP (Alternative C, Phased Decontamination and Dismantlement with Near-Term Control Rod Blades Removal). DOE's responses to public comments and concerns are included in the HFBR ROD Responsiveness Summary.

The implementation of the Waste Transfer Lines Project using ARRA funds was discussed with the BNL Community Advisory Council on April 15, 2009 and November 12, 2009.

As discussed further in Section 3.3, the majority of the waste generated during the Waste Transfer Lines Project was packaged in intermodal containers and shipped via rail from BNL to Energy Solutions Disposal Facility of Clive, Utah. The intermodal containers carried waste with levels of radioactivity below the Department of Transportation limits that would require the Radioactive Class 7 placard; however the containers also carried waste asbestos pipe insulation and were therefore labeled with the proper United Nations (UN) number for asbestos. The Long Island Railroad and emergency response personnel from all counties on Long Island were notified to ensure that there would be no interruptions of service and that all responsible personnel were informed of the hazards associated with the waste.

3.0 CONSTRUCTION ACTIVITIES

As previously shown in Figure 1-3, the run of the Waste Transfer Lines between Building 801 and Building 811 was divided into four separate work phases. All pre-construction tasks for each work phase were completed prior to beginning cleanup activities within the associated work area, including equipment mobilization, radiological walkover surveys, site inspections, excavation area mark-outs, silt fence installation, and securing the general work area. In additional, traffic controls were established in accordance with the project Traffic Control Plan prior to initiating project activities in roadways.

The objective of the Waste Transfer Lines Project was to safely remove and dispose of the Waste Transfer Lines and safely characterize, remediate, and dispose of the associated radiologically and chemically contaminated soil in accordance with the HFBR ROD and project specific plans. Following the Waste Transfer Lines removal and soil excavation activities, an FSS and a dose assessment were performed by BNL ERP. The FSS was 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 Waste Transfer Lines 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 *Field Sampling Plan for the Removal of the Building 801-811 Waste Transfer Lines* (BNL, September 2009) was prepared and detailed the data quality objectives (DQOs) and quality assurance (QA) requirements for the FSS. The plan also presented the field screening value (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 Waste Transfer Lines site (Phases 1–3)

3.1 Soil Excavation and Waste Transfer Lines Removal

Prior to the start of excavation activities, 18 soil samples were collected at various depths along the Waste Transfer Lines to characterize overburden soils. An additional 589 overburden soil samples were collected during excavation activities. Overburden soil samples were analyzed for Cs-137 and other gamma emitters with an onsite In Situ Object Counting System (ISOCS). Overburden soil with Cs-137 concentrations of less than 11.5 pCi/g (1/2 the site cleanup criteria) was used as backfill, as discussed in Section 3.4. Of the 589 overburden soil samples collected during excavation activities, onsite ISOCS results were greater than 11.5 pCi/g in three samples. This overburden soil was segregated, re-sampled to confirm the results and shipped in an intermodal container to Energy Solutions Disposal Facility of Clive, Utah, as discussed in Section 3.3. On-site ISOCS results for overburden soil samples are summarized in Appendix A. The methodology for surveying and sampling overburden soils is discussed further below.

Overburden soil was removed with an excavator with an attached cutting edge to expose the concrete culvert and co-located piping. The overburden soil was placed in a designated staging area in mounds of 10 cubic yards (CY). These mounds were then spread out at a depth of 2 feet or less to enable the completion of a radiological walkover survey with a Sodium Iodide (NaI) gamma scintillation detector. In addition, two soil

samples were collected for each 10 CY mound, one near the center and one at the location of the highest radiological walkover survey result. These samples were analyzed with an onsite ISOCS, as discussed above.

Photograph 2 – Overburden soil stockpiles at the Waste Transfer Lines site

Cs-137 was the primary radiological contaminant driving soil remediation and determining whether overburden soils could be re-used as backfill for the Waste Transfer Lines Project. As a result, gamma count rates using field instruments (NaI gamma scintillation detectors) were used to determine if soils met site cleanup criteria. In accordance with the *Field Sampling Plan for the Removal of the Building 801-811 Waste Transfer Lines* (BNL, September 2009), a field screening value of 21,500 cpm for the unshielded NaI gamma scintillation detector was established as the criterion for determining when excavations were complete; and one half of the field screening value (10,750 cpm) was established to determine whether overburden soils could be re-used for backfill. This criterion was determined using a correlation between data from NaI gamma scintillation detector surveys, onsite 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 Removal of the Building 801-811 Waste Transfer Lines* (BNL, September 2009).

Any active underground utilities encountered during excavation activities were protected and braced in accordance with the project Excavation Plan. Upon exposing the concrete culvert, as well as the adjacent terra cotta ventilation pipe and new standalone D-waste line, the corrugated steel culvert cover was removed to allow access to the steam line and A-, B-, and original D-waste lines. The asbestos wrap around the steam line was then removed by personnel licensed in asbestos abatement (BNL Facility and Operations Steam Shop) and the exposed Waste Transfer Lines were inspected for liquids, holes, and

evidence of leaks. Locations of potential leaks, concrete joints, and expansion cracks were identified with a flag or spray paint for additional characterization, including radiological walkover surveys and the collection of soil samples for onsite ISOCS analysis.

Liquids observed within the Waste Transfer Lines or the associated trench were sampled and analyzed for radiological constituents at Test America of Earth City, Missouri. Approximately 6 ounces of liquid mercury was drained from the original D-waste line and segregated for disposal at Energy Solutions Disposal Facility of Clive, Utah. Water observed within the waste transfer lines and the associated trench was containerized and transferred for disposal under the HFBR Stabilization Project as described below:

- 1 250-gallon container of water was generated from draining the waste transfer lines. The containers were transferred to BNL's Waste Management Facility where the water was solidified for disposal. The solidified waste (approx. 2.5 CY) was shipped via closed box truck for disposal at the Nevada Test Site Disposal Facility of Nevada.
- 17 250-gallon containers of water were generated from draining stormwater from the waste transfer lines trench after unexpected inclement weather. The water was sampled and found to contain low concentrations of Sr-90, which were above the established release criteria. The containers were transferred to BNL's Waste Management Facility and will be shipped for disposal at the Nevada Test Site Disposal Facility of Nevada.

Water analytical results are provided in Appendix A.

Photograph 3 – Exposed Waste Transfer Lines beneath braced active underground utilities

Each pipe was segmented in lengths of 20 feet or less and packaged in intermodal containers. Once the pipes were removed, a radiological survey of the exposed surfaces of the concrete culvert was performed and concrete samples were collected for onsite ISOCS analysis. The concrete culvert was then demolished and the associated debris removed from the trench. Uncontaminated concrete debris was released to the BNL recycling facility and contaminated debris was staged in intermodal containers for offsite disposal, as further detailed in Section 3.3.

Due to the potential of damaging an intersecting electrical duct bank, approximately 30 feet of the concrete culvert and culvert cover within the Phase 1 area were free released in accordance with BNL radiological control procedures, grouted in place, and left in the ground after the Waste Transfer Lines were removed. The free release of this segment of culvert was detailed in an approved Addendum to the *Field Sampling Plan for the Removal of the Building 801-811 Waste Transfer Lines* (BNL, September 2009).

In addition to the 30 feet of concrete culvert and culvert cover, 570 feet of concrete was free released in accordance with BNL radiological control procedures. Of the 570 feet, 250 feet was free released in Phase 1 and left in the ground after the waste transfer lines were removed and an additional 320 feet was free released from Phases 3 and 4 to the BNL recycling facility. The free release of this segment of culvert was also detailed in an approved Addendum to the *Field Sampling Plan for the Removal of the Building 801-811 Waste Transfer Lines* (BNL, September 2009). Onsite ISOCS results for concrete culvert samples collected from the 30 feet of culvert left in place in Phase 1 are provided in Appendix A. BNL radiological survey forms and the associated data collected for the free

release of the concrete culvert during the Waste Transfer Lines Project are provided in Appendix B.

Photograph 4 – Segment of Phase 1 concrete culvert left in ground

Once the waste transfer lines and concrete culvert were removed, the trench walls and floor were surveyed and sampled in accordance with the *Field Sampling Plan for the Removal of the Building 801-811 Waste Transfer Lines* (BNL, September 2009). Contaminated soil was excavated in 6" lifts. In-process field screening was performed using a 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 direct-loaded into a staged intermodal container. Intermodal containers were shipped for disposal via truck or rail to Energy Solutions Disposal Facility of Clive, Utah, as described further in Section 3.3.

Although mercury, lead, nickel, and thallium 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.

The final dimensions of the Waste Transfer Lines excavation are provided in Figure 3-1.

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 along the piping runs. 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, an 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. Although less likely to be present, certain other radionuclides were monitored and include I-129, Ni-63, Co-60, Na-22, tritium, and certain isotopes of Americium, Thorium, Plutonium, and Europium. These additional radionuclides were transferred through some of the piping and may potentially be present if the piping had leaked. The chemical contaminants of concern were mercury, lead, thallium, and nickel.

3.2.1 Final Status Survey Design

The piping trench is estimated to be about 800 feet long, which includes several side branches. Two Class 1 SUs were established in order to divide the total area into segments. The suggested maximum area for a Class 1 SU is 2,000 m^2 for soil areas, and each SU is well below that value. Fixed sample locations were selected approximately every 30 feet along the excavation.

A two-step approach to cleanup confirmation for radiological soil contamination was followed using the MARSSIM approach for the Waste Transfer Lines Project. The first step consisted of a GPS-based gamma scintillation walkover survey using unshielded 2" by 2" NaI detectors in conjunction with a Ludlum Model 2221 scaler/ratemeters and a with the PRO XR Satellite Receiver Trimble model TSCe Data Logger (Trimble Unit). The second step involved the collection of 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, core samples were taken to determine if there is contamination at depth, and composite samples were taken to analyze for chemical contaminants, alpha emitters, and other potential radiological contaminants.

The approximate dimensions of the Class 1 SUs and FSS sample locations are shown in Figures 3-2 and 3-3.

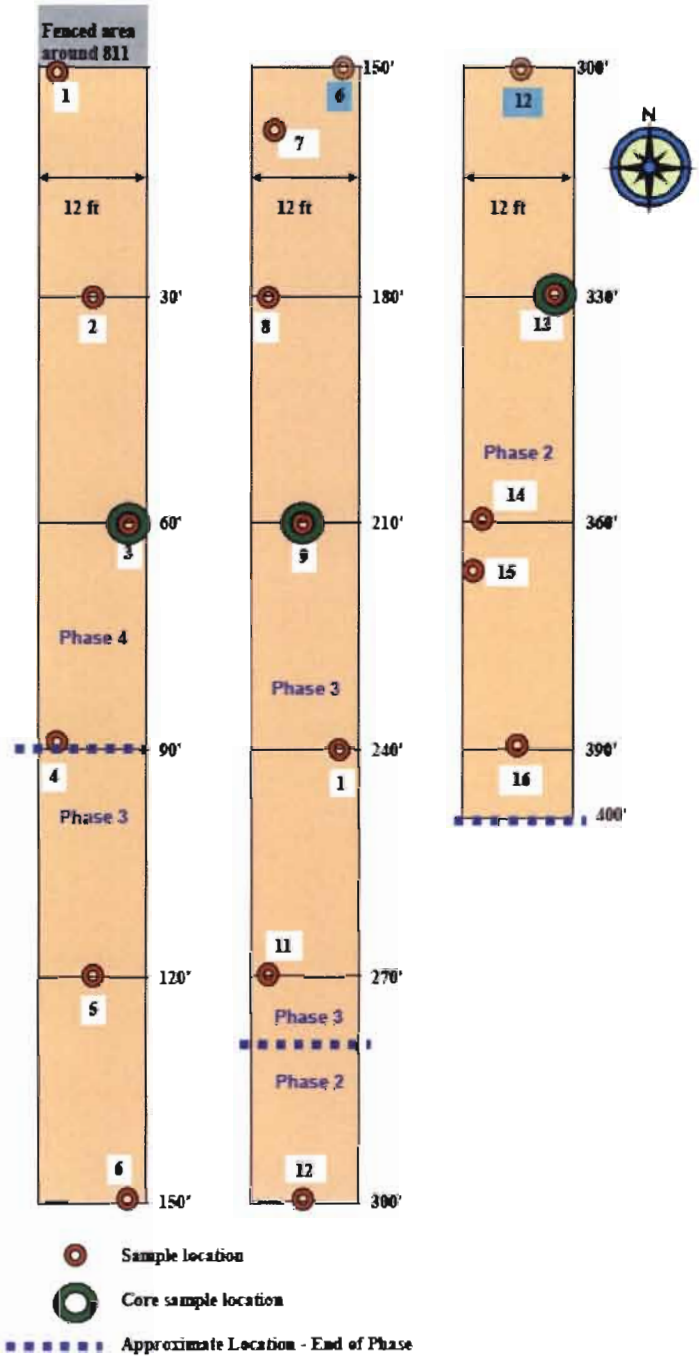

Figure 3-2 – Waste Transfer Line Survey Unit 1 soil and core sample locations

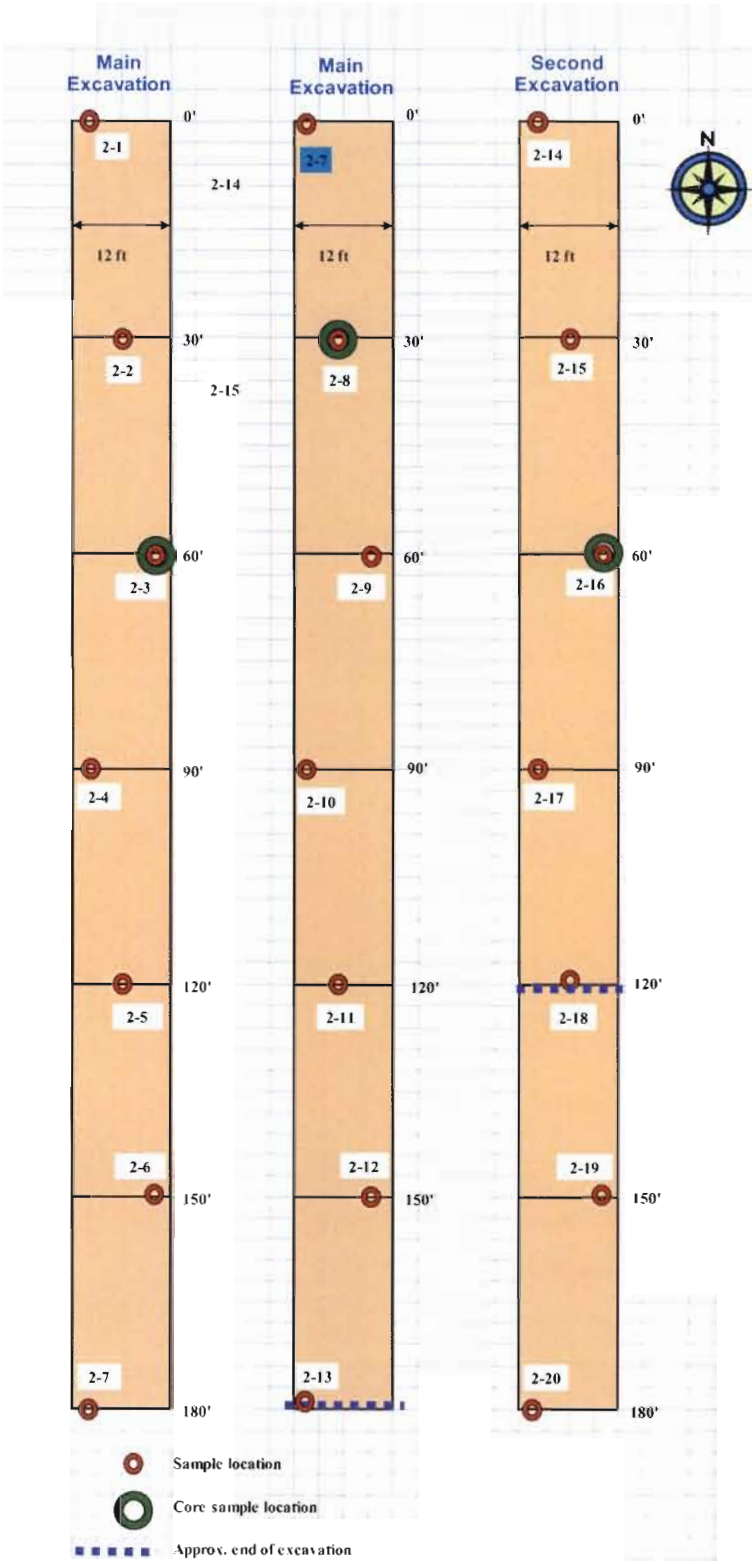

Figure 3-3 – Waste Transfer Line Survey Unit 2 soil and core sample locations

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 SUs, as shown in Figure 3-4. As specified in Appendix B of the *Field Sampling Plan for the Removal of the Building 801-811 Waste Transfer Lines* (BNL, October 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 about 95% of the area was less than 15,000 cpm, and the elevated readings for the remaining 5% were associated with high background in the vicinity of Building 801 (see Figure 3-4). In addition, individual 1-min. fixed-count measurements were taken with the NaI probe at each of the fixed sample points. The results ranged from 3,100 to 13,614 cpm. Radiological survey forms for gamma walkover and fixed-point readings are provided in Appendix B.

As described in Section 3.1, 30 feet of the concrete culvert and culvert cover within the Phase 1 area was free released with remote surveying in accordance with BNL radiological control procedures and left in the ground after the waste transfer lines were removed. This area is indicated by a gap in the radiological walkover survey results at the north end of the Phase 1 area, as shown on Figure 3-4.

Figure 3-4 – Waste Transfer Lines post-remediation Radiological Walkover Survey results

BNL selected 28 soil sample locations (both SUs) in accordance with the Field Sampling Plan, which specified the collection of one sample approximately every 30 feet along the Waste Transfer Lines trench.All the soil samples were below the site cleanup goals for Cs-137, Sr-90 and Ra-226, which are 23 pCi/g, 15 pCi/g, and 5 pCi/g, respectively. A summary of the soil sample results is provided in Table 3-1.

Table 3-1 Summary of Waste Transfer Lines Soil Sample Results for Radionuclides

	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Ra-226 (pCi/g)
Cleanup Goal	23	15	5
Average	0.15	<1.1 (detection level on composite samples)	0.39
Maximum	1.01	<1.1	0.61

Chemical results for soil samples analyzed for mercury, lead, nickel, and thallium also indicated that residual soil concentrations for these contaminants are within their respective cleanup goals, i.e., 400 mg/kg for lead, 1.84 mg/kg for mercury, 13 mg/kg for nickel, and 0.35 mg/kg for thallium. Maximum chemical concentrations were 25.9 mg/kg for lead, 0.0796 mg/kg for mercury, 2.87 mg/kg for nickel, and 0.115 mg/kg for thallium.

Radiological and chemical results for offsite vendor soil sample analysis are provided in Appendix B.

3.2.3 Sign Test and Elevated Measurement Comparison

Since no samples exceeded the cleanup criteria, the SUs do 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. Table 3-2 presents the soil sample results for each of the 28 sample locations and calculates the sum of the fractions. All are less than 1.0, so the SUs pass.

Table 3-2 Soil Sample Results – Survey Units 1 and 2 Combined

Location No	Cs-137 (pCi/g)	Fraction of Limit for Cs-137	Ra-226 (pCi/g)	Fraction of Limit for Ra-226	Sr-90* (pCi/g)	Fraction of Limit for Sr-90	Sum of Fractions
1-1	1.01	0.04	0.61	0.12	1.10	0.07	0.24
1-2	0.19	0.01	0.34	0.07	1.10	0.07	0.15
1-3	0.06	0.00	0.37	0.07	1.10	0.07	0.15
1-4	0.03	0.00	0.43	0.09	1.10	0.07	0.16
1-5	0.13	0.01	0.40	0.08	1.10	0.07	0.16
1-6	0.16	0.01	0.37	0.07	1.10	0.07	0.15
1-7	0.04	0.00	0.52	0.10	1.10	0.07	0.18
1-8	0.00	0.00	0.33	0.07	1.10	0.07	0.14
1-9	0.41	0.02	0.29	0.06	1.10	0.07	0.15
1-10	0.02	0.00	0.27	0.05	1.10	0.07	0.13
1-11	0.24	0.01	0.49	0.10	1.10	0.07	0.18
2-1	0.15	0.01	0.43	0.09	1.10	0.07	0.17
2-2	0.05	0.00	0.42	0.08	1.10	0.07	0.16
2-3	0.32	0.01	0.35	0.07	1.10	0.07	0.16
2-4	0.24	0.01	0.36	0.07	1.10	0.07	0.16
2-5	0.03	0.00	0.52	0.10	1.10	0.07	0.18
2-6	0.30	0.01	0.35	0.07	1.10	0.07	0.16
2-7	0.03	0.00	0.33	0.07	1.10	0.07	0.14
2-8	0.06	0.00	0.40	0.08	1.10	0.07	0.16
2-9	0.06	0.00	0.42	0.08	1.10	0.07	0.16
2-10	0.06	0.00	0.32	0.06	1.10	0.07	0.14
2-11	0.00	0.00	0.23	0.05	1.10	0.07	0.12
2-12	0.04	0.00	0.39	0.08	1.10	0.07	0.15
2-13	0.28	0.01	0.37	0.07	1.10	0.07	0.16
2-14	0.06	0.00	0.45	0.09	1.10	0.07	0.17
2-15	0.09	0.00	0.40	0.08	1.10	0.07	0.16
2-16	0.20	0.01	0.38	0.08	1.10	0.07	0.16
2-17	0.00	0.00	0.32	0.06	1.10	0.07	0.14
Average	**0.15**	**0.01**	**0.39**	**0.08**	**1.10**	**0.07**	**0.16**

Since all samples were less than the limit, the sign test and the elevated measurement comparison check are not necessary.

* Sr-90 was not detected above the detection limit of about 1.1 pCi/g. For conservatism, this value of 1.1 pCi/g was used in this table calculating the sum of the fractions.

Note that Ra-226 background on BNL property had previously been established at approximately 0.56 pCi/g (CDM, 1996). Therefore, the average Ra-226 value of 0.39 pCi/g from the Waste Transfer Line area is below established background. For determination of acceptable levels of cleanup, the value of 0.39 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 Waste Transfer Lines 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 3.2.3, the Ra-226 concentrations were below established BNL background concentrations (0.39 pCi/g average, compared to 0.56 pCi/g background). The RESRAD model was run with "no background subtract" (Ra-226 = 0.39 pCi/g) and with "full background subtract" (Ra-226 ~ 0 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 considered the radiation dose to a current industrial worker (no decay). The parameters and pathways used in this dose assessment for the Waste Transfer Lines are shown in the RESRAD summary reports (Appendix C).

The results of the dose assessment are shown in Table 3-3 below. The maximum projected dose to a resident in Year 50 (0.2 mrem/year) at the Waste Transfer Lines would be below the dose objective (non-farmer) of 15 mrem/year. The RESRAD Summary Report in Appendix C indicates that the amount of time required to reach the 15 mrem/yr criteria is 0 years. That is, the projected dose to a resident without decay is 0.7 mrem/yr, and this value meets both the 15 mrem/yr criteria and the NYSDEC TAGM guideline of 10 mrem/yr. For an industrial worker with no decay time, the maximum projected dose to an industrial worker at Year 0 (0.1 mrem/year) is also less than 15 mrem/year. The results also indicate that the NYSDEC TAGM 4003 guideline of 10 mrem/yr would be met under each of the two scenarios described above. If background was not subtracted for Ra-226 (use 0.39 pCi/g without background subtract), then the residential and industrial doses would be 6.5 and 1.0 mrem/yr, respectively.

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

	Resident at 50 years	Industrial Worker at 0 years
Dose (mrem/yr)	0.2	0.1

3.2.5 Final Status Survey Conclusions

As indicated above, results of the FSS and sampling following the completion of the removal of the Waste Transfer Lines and remediation of the associated contaminated soil demonstrate conformance to the site cleanup goals established for the project.

3.2.6 Final Status Survey Independent Verification

The Independent Verification Survey (IVS) of the Waste Transfer Lines was performed by an ORISE survey team. The ORISE survey team conducted surveying and sampling during two separate visits. The IVS for Phases 3 and 4 was performed on September 28, 2009. The IVS for Phases 1 and 2 was performed on December 10, 2009.

ORISE collected soil samples and had them analyzed for Cs-137, Ra-226, and Sr-90. The average results are as follows, along with a comparison to BNL's average results:

Table 3-4 Summary of FSS and ORISE IVS Results

Radionuclide	ORISE Average pCi/g		BNL Average pCi/g
	North A/B Transfer Line (Survey Unit 1)	South A/B Transfer Line (Survey Unit 2)	
Cs-137	0.09	0.05	0.15
Ra-226	0.33	0.35	0.39
Sr-90	-0.01	-0.12	Not detected (<1.1 pCi/g)

ORISE also performed a gamma walkover survey and did not identify any areas for further investigation.

The results of the IVS are documented in the *Revised Final Report - Independent Verification Survey of the A and B Radioactive Waste Transfer Lines Trench, Brookhaven National Laboratory, Upton, New York* (ORISE, 2010), provided in Appendix D.

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, Piping and Debris from the Building 801-811 Waste Transfer Line Remediation Project* (BNL, June, 2009).

Waste Transfer Lines debris and excavated soil that was classified as low-level radioactive waste (LLRW) was placed into intermodal containers for shipment via rail or truck. Mixed waste was placed into B-6 or B-12 shipping containers for shipment via

truck. Piping was size-reduced prior to packaging to meet the disposal facility's waste acceptance criteria (WAC). Construction debris and plastic used during remedial activities were also size-reduced and placed into intermodal containers for shipment via truck or rail. Approximately 6 ounces of liquid mercury was drained from the original D-waste line and segregated for disposal. Soil, debris and liquid mercury waste was shipped for final disposal at Energy Solutions Disposal Facility of Clive, Utah.

As discussed in Section 3.1, water removed from the waste transfer lines and the associated trench was containerized and transferred to BNL's Waste Management Facility for treatment, packaging and shipment for disposal under the HFBR Stabilization Project. This waste was shipped to the Nevada Test Site Disposal Facility of Nevada.

Photograph 5 – Packaging of Waste Transfer Lines debris.

Debris and soil characterization data collected during remedial activities were used to characterize the waste in accordance with the *Waste Management Plan for Removal of Radioactive Soil, Piping and Debris from the Building 801-811 Waste Transfer Line Remediation Project* (BNL, June, 2009). According to characterization results, the soil and debris shipped met the Energy Solutions WAC. Waste verification results were submitted to BNL's Waste Management Division.

3.3.2 Waste Shipment and Disposal

MHF Services (rail) and Hittman Transport Services (truck) provided shipping containers/services for transportation of the waste soil and debris to Energy Solutions Disposal Facility of Clive, Utah. After the railcars and shipping containers arrived on site, they were inspected and released for loading. Approximately 18,000 to 32,000 pounds of LLRW waste was placed into each intermodal container. Approximately 1,260 to 1,750 pounds of mixed waste was placed into each of the four B-12 shipping containers, and approximately 1,800 pounds of mixed waste was placed into the B-6 shipping container. The weight of the shipped soil and debris was determined with a scale on the crane used to hoist shipping containers onto the railcars or trucks.

Waste loading and shipping was initiated on December 2, 2009 and was completed on March 6, 2010. A total of 14 intermodal containers (224 CY of LLRW) were loaded onto either railcars or trucks for shipment. Four B-12 containers (7.1 CY mixed waste) and one B-6 container (0.9 CY of mixed waste) were shipped via truck for disposal. In addition, 6 ounces of liquid mercury was shipped for disposal. All contaminated soil and debris waste (total of 232 CY) was transported to Energy Solutions Disposal Facility of Clive, Utah for final disposal. All waste shipped as part of the Waste Transfer Lines Project was accepted by Energy Solutions. Waste soil and debris shipments are summarized in a table included in Appendix E.

Water removed from the waste transfer lines and the associated trench was containerized and transferred to BNL's Waste Management Facility for treatment, packaging and shipment for disposal under the HFBR Stabilization Project, as described below:

- 1-250 gallon container of water was generated from draining the waste transfer lines. The containers were transferred to BNL's Waste Management Facility where the water was solidified for disposal. The solidified waste (approx. 2.5 CY) was shipped via closed box truck for disposal at the Nevada Test Site Disposal Facility of Nevada.
- 17-250 gallon containers of water were generated from draining stormwater from the waste transfer lines trench after unexpected inclement weather. The water was sampled and found to contain low concentrations of Sr-90, which were above the established release criteria. The containers were transferred to BNL's Waste Management Facility and will be shipped for disposal at Nevada Test Site Disposal Facility of Nevada.

3.3.3 Pollution Prevention and Waste Minimization Opportunities

Waste minimization and pollution prevention methods employed during the Waste Transfer Lines Project included:

- Operating equipment outside of the controlled areas as much as possible to minimize contact with contaminated areas;

- Excavating as small a lift as possible to minimize the excavation of soil below cleanup goals;
- Characterizing overburden soils for the purpose of using the overburden for backfill during site restoration activities;
- Cutting lines and draining liquid mercury to reduce the amount of project mixed waste;
- Characterizing the concrete culvert for the purpose of free release. Approximately 47 CY of concrete culvert was left in the ground and approximately 53 CY of concrete culvert was shipped to the BNL recycling facility;
- Size-reducing waste to meet the Energy Solutions WAC; and
- Judicious use of consumables (Personal Protection Equipment).

3.4 Site Restoration

Site restoration of the Waste Transfer Lines included backfilling the trench, both with clean overburden soils that were characterized and stockpiled during excavation activities, as well as soil from an offsite source that was analyzed to ensure compliance with NYSDEC guidelines. An offsite backfill source was used to ensure adequate compaction in roadways, as discussed further in Section 9.0. In areas that were to be reseeded, a 6" layer of topsoil was placed above the backfill and re-graded to ensure acceptable drainage. These areas were reseeded with native Long Island grasses. Backfill compaction tests were performed in each of the three roadways that were intersected by the Waste Transfer Lines trench. Re-grading, paving, and curb replacement were performed after each of the three areas passed the compaction tests. Backfill compaction test results and offsite soil analysis results are provided in Appendix F.

Site restoration activities were completed in March 2010. Future site controls are discussed in Section 7.0.

Photograph 6 – Site restoration (compaction) in Phase 4 of the Waste Transfer Lines

4.0 CHRONOLOGY OF EVENTS

The following table lists a chronology of the main remedial events and the associated plans/reports for the Waste Transfer Lines Project:

Table 4-1 Chronology of Remedial Events for the Waste Transfer Lines

Date	Remedial Event
1995	Replacement of the stand-along D-waste line
2004	Removal of the A & B waste storage tanks
April 2009	HFBR ROD finalized
July-December 2009	Removal of the Waste Transfer Lines
September-December 2009	Performed FSS and IVS of the Waste Transfer Lines
December 2009-March 2010	Shipment of project waste to Energy Solutions Disposal Facility of Clive, Utah
January-March 2010	Site restoration of the Waste Transfer Lines work area.

5.0 PERFORMANCE STANDARDS & 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 HFBR ROD. In addition, concentrations of mercury, lead, nickel, and thallium in soil were below the cleanup goals of 1.84 mg/kg, 400 mg/kg, 13 mg/kg, and 0.35 mg/kg, respectively.

Physical and radiological inspections were conducted on both incoming and outgoing intermodal containers. 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 Removal of the Building 801-811 Waste Transfer Lines* (BNL, September 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 with the FSS results provided in Appendix B.

6.0 FINAL INSPECTION AND CERTIFICATIONS

As described in Section 3.2.6, the IVS was performed by ORISE upon the completion of the FSS performed by ERP. Based on the results of the FSS, an evaluation of the dose from the remaining activity was performed using RESRAD; 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 Assessment was performed and approved for the remediation work. Radiological safety was accomplished by the presence of Radiation Control Technicians (RCTs), and performance of all work under a Radiological Work Permit.

6.1 Industrial Hygiene Oversight & Monitoring

IH oversight and monitoring 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, safe work practices and asbestos controls during the cutting of the steam line. IH monitoring included confined space monitoring during work in the Building 811 basement and mercury vapor monitoring while handling the original D-waste line.

6.2 Radiological Oversight & Monitoring

Radiological oversight and monitoring was conducted by BNL RCTs during cleanup activities. Radiological monitoring included general area air sample collection downwind of excavation activities and the collection of air samples within 1 foot of pipe cutting operations. Air samples were collected with Science Application International Corporation (SAIC) low-volume air samplers. Air sample results were used to track derived air concentration (DAC) per 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 Waste Transfer Lines Project.

Workers entering the work zone were also required to have an annual whole body count prior to starting work on the project. Workers were also required to complete a whole body monitoring using a PCM-1B or equivalent hand-held instrument each time they left

a Soil Contamination Area, in accordance with BNL Radiological Control Manual requirements. In addition, workers who performed the cutting of radiologically contaminated piping were required to submit a pre- and post-job urine bioassay.

In addition to personal and general area monitoring, radiological surveys were routinely performed whenever a new area of the Waste Transfer Lines culvert was exposed. Equipment used during remediation activities was also 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 ACTIVITIES

Land use and institutional control information for the Waste Transfer Lines will be included in *BNL Factsheet: Waste Concentration Facility (Building 811).* In addition, the BNL LUCMP will be revised to include the Waste Transfer Lines area, and the BNL site utility drawings will be updated.

Post remediation operation and maintenance activities for the Waste Transfer Lines 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). The topsoil cover, placed during site restoration, will also be inspected for signs of erosion.

ERP will perform operation and maintenance activities, in addition to maintaining institutional controls for the Waste Transfer Lines area, until the HFBR complex is transferred to BNL's Groundwater Protection Group. This group will ensure that the controls listed above are in place and that routine monitoring/inspections are performed. DOE will ensure enforcement of all institutional controls.

8.0 SUMMARY OF PROJECT COSTS

The Waste Transfer Lines Project was performed with funding under the ARRA; however some project cots (e.g., water disposal) were covered BNL Base funding. The removal of the Waste Transfer Lines and remediation of the associated contaminated soils cost approximately $2,389,000 to complete. The original estimate cost for the Waste Transfer Lines Project was $2,276,000. The additional cost was associated with working multiple shifts to recover Phases 1 and 2 concurrently from the heavy rain and snow storms.

The clean-up costs for the Waste Transfer Lines Project included the following details:

Engineering and planning	$ 196,000
Remediation and Restoration	$ 1,819,000
Waste Transportation and Disposal	$ 374,000
Total Cost	$ 2,389,000

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:

- A direct buried 480 V cable (lead-jacketed) that supplied power to Building 811 was exposed during excavation, although the drawing reviewed during the planning phase indicated that the cable was housed in 4" conduit. Upon this discovery, an additional drawing was located that indicated the cable was direct buried for most of the extent of excavation. Building 811 was repowered and this feed was shut down for the duration of the project. Verification of drawings details will be performed for future excavations.
- The clean overburden soil used as backfill material did not pass initial compaction tests performed in roadways (Lawrence Rd. and 4th St.). The failed test was thought to be the result of a high volume of organics, water, and silt in the overburden soil. Additional compaction, several months of drying time, and the addition of recycled concrete aggregate was necessary for these areas to pass subsequent compaction tests. Sand was brought from an offsite source to ensure adequate compaction at Rutherford Drive. This practice is suggested where compaction of 95% or better is required.
- The characterization of overburden soils, in accordance with project plans, required the sampling and management of approximately 300 soil stockpiles. Of the 300 soil stockpiles, characterization results indicated that only two were contaminated and the associated material had been excavated from a known underground contaminated area. Substantial time and resources can be saved on future projects if, to the extent possible, the sampling of overburden soils is performed prior to excavation.
- Plastic orange construction fence purchased from local shops was used to secure the excavation boundaries. The fencing often ripped during high winds and other extraordinary weather conditions, requiring the fence to be replaced. A high-quality construction fence or equivalent should be used for excavation security for all projects that will last longer than a week.
- A sudden and severe rainstorm flooded the Waste Transfer Lines trench and resulted in the submersion of previously cut pipes. Additional measures were subsequently taken to prevent excessive flooding. These measures included the construction of runoff berms, re-sloping of excavation sidewalls, and the construction of drainage ditches inside the excavation to direct flow away from the concrete culvert. These stormwater controls should be in place for future excavation projects, and pump-out equipment and containers should be staged prior to initiating excavation activities. In addition, the Job Supervisor, with guidance from the Facility Support Representative and Project Engineer, should verify that the methods used to cap/seal the open ends of pipes are adequate for

the unexpected weather events and they are properly stored/staged to prevent infiltration of rainwater at the end of each work shift.

- Additional maintenance on the Waste Transfer Lines trench was required to facilitate the turnaround time of the ORISE IVS. BNL personnel collected additional samples for offsite analysis so that backfilling at risk could be performed before receiving the IVS results.
- The Waste Transfer Lines trench was sloped, rather than shored. Trench boxes were on stand-by, but not used. Shoring materials were not procured. Properly sloping an excavation is a sufficient method to safely perform work; however, utilizing trench boxes or shoring should be considered to manage excavations in roadways. Trench boxes and shoring may minimize damage to the roadways and minimize the amount of soil that is required to be excavated, resulting in expediting work and minimizing costs in the long run.
- After the sudden and severe rain and snow events, resources were added to the Building 801-811 Waste Transfer Lines Project to perform project recovery. This prompt addition of resources enabled the recovery of both Phases 1 and 2 to be performed concurrently, and the timely completion of the project. The additional personnel were able to work multiple shifts, procure the necessary equipment and prepare for future weather events.

10.0 PROTECTIVENESS

The removal of the Waste Transfer Lines and the associated contaminated soils, as well as the implementation of monitoring and institutional controls, is protective of human health and the environment. The removal of these wastes has minimized both the risk of exposure to onsite 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.

10.1 Facility Review Disposition Project Issues

The Facility Review Disposition Project (FRDP) was initiated in 1998 to resolve the issues identified during the preceding BNL Facility Review Project. The removal of the waste transfer lines during this Project satisfies the closure requirements associated with the FRDP issues summarized in Table 10-1.

Table 10-1 Waste Transfer Lines FRDP Issues Summary

FRDP I.D. #	Building	BNL Issue Description
632	801	Ventilation ducts– Possible contamination and water intrusion.
644	801	Underground Radioactive waste lines– Tanks in basement.
3032	801	Underground piping– Possible contamination and water intrusion.
570	811	Underground Waste lines from 801 to 811 – A, B, D-waste lines from 801 to 811. Possible contamination and water intrusion.
2728	811	General concern.

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 Waste Transfer Lines will be included in the next sitewide Five-Year Review in 2011.

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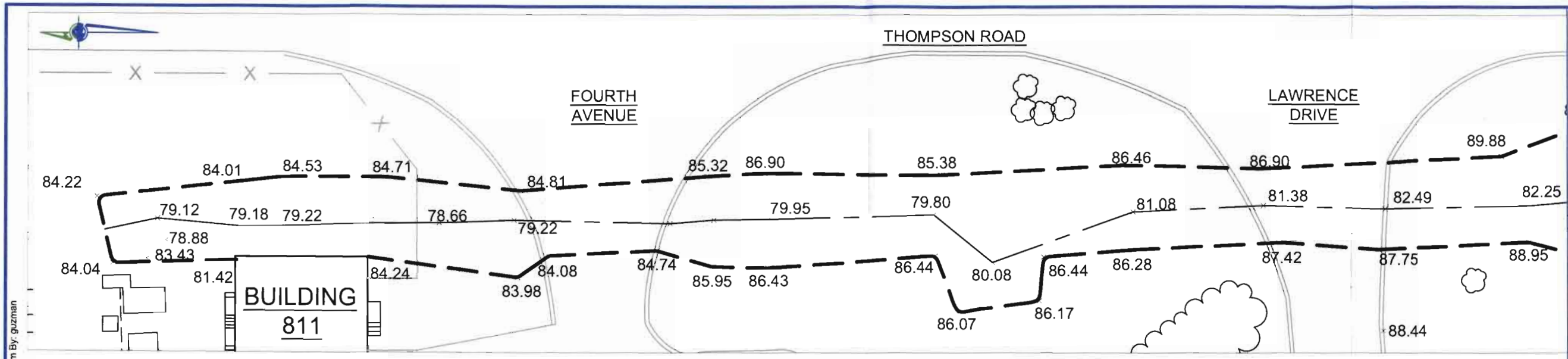
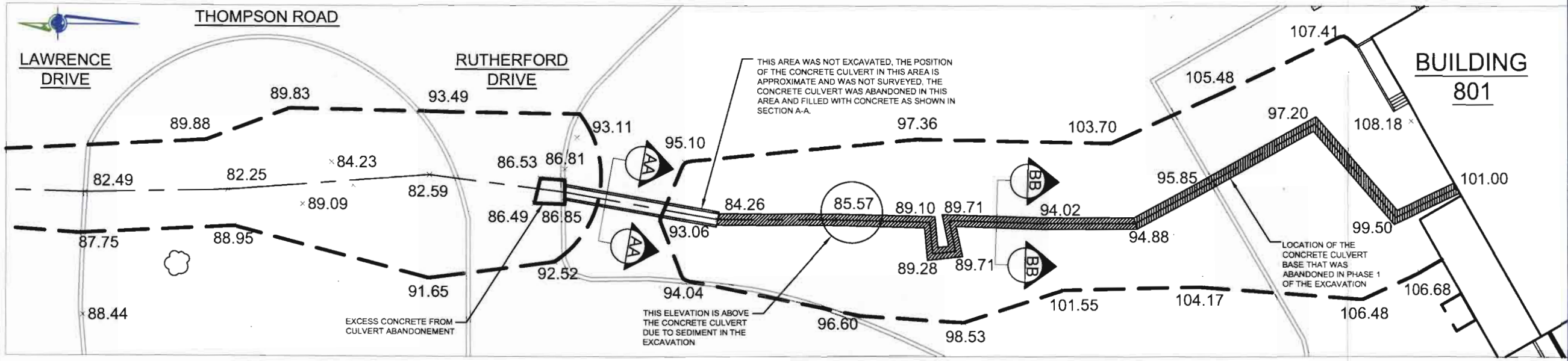
FIGURE 3-1

Waste Transfer Lines
Survey of Final Excavation



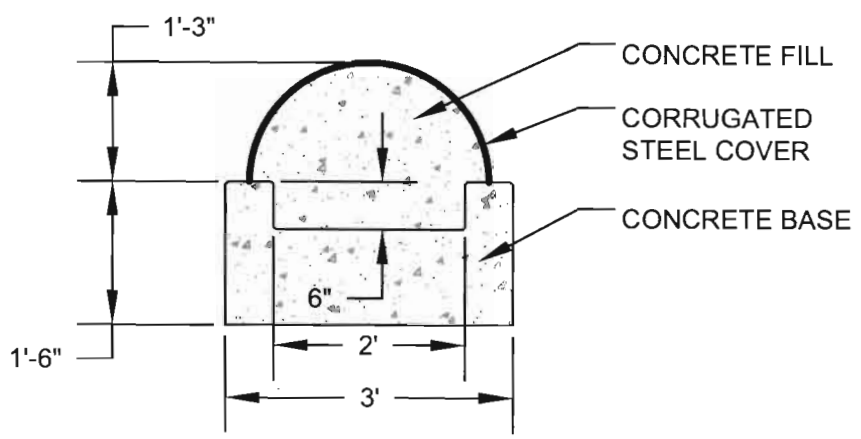
A&B WASTE TRANSFER LINES EXCAVATION: 0 TO 375'

SCALE: 1" = 30'-0"



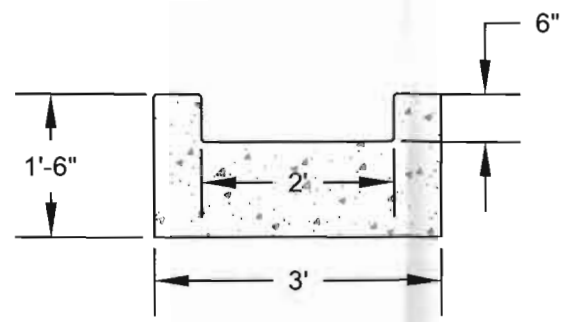
A&B WASTE TRANSFER LINES EXCAVATION: 375' TO 740'

SCALE: 1" = 30'-0"



SECTION A-A

SCALE: 3/4" = 1'-0"



SECTION B-B

SCALE: 3/4" = 1'-0"

LEGEND

- EXTENTS OF EXCAVATION
- CENTER LINE OF EXCAVATION
- CULVERT BASE ABANDONED IN PLACE (SEE SECTION B-B)
- 106.48 SPOT ELEVATION

BASEMAP PROVIDED BY:
BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING AS OF JUNE 2009

P.W. GROSSER CONSULTING ENGINEER AND HYDROGEOLOGIST, P.C.
630 JOHNSON AVE. - SUITE 7
BOHEMIA - NY - 11716-2618
PH: (631)589-6353 - FX: (631)589-8705
E-MAIL: INFO@PWGROSSER.COM
CONSULTANTS

DRAWINGS PREPARED FOR

REVISION	DATE	INITIAL	COMMENTS

DRAWING INFORMATION

PROJECT:	BNL0918	APPROVED BY:	PKB
DESIGNED BY:	PDL	DATE:	1-27-2010
DRAWN BY:	PDL	SCALE:	AS NOTED

SHEET TITLE

BUILDING 801-811
WASTE TRANSFER LINES

SURVEY OF FINAL EXCAVATION

FIGURE NO 3-1

SHEET 1 OF 1

J:\Projects A-D\BNL\2009\2009 -BOA- Contract 133964 (10-1-09 to 12-31-09)\0918 - ERP Support Svcs\CADA\A&B WASTE LINES\11 X 17 FIGURE.dwg (11X17 FIG) Feb 12,2010-12:44pm By: guzman

APPENDIX A

Overburden Soil, Concrete, and Water Sample Results

Overburden Soil Concrete
Onsite ISOCS Cs-137 Results

COC	SOIL SAMPLE NUMBER	SAMPLE LOCATION	Cs-137 (pCi/g)
27877	Pre-Excavation-1	Phases 1-4	0.06
27877	Pre-Excavation-2	Phases 1-4	0.08
27877	Pre-Excavation-3	Phases 1-4	0.1
27877	Pre-Excavation-4	Phases 1-4	0.05
27877	Pre-Excavation-5	Phases 1-4	0.11
27877	Pre-Excavation-6	Phases 1-4	0.1
27877	Pre-Excavation-7	Phases 1-4	0.07
27877	Pre-Excavation-8	Phases 1-4	0.12
27877	Pre-Excavation-9	Phases 1-4	0.1
27877	Pre-Excavation-10	Phases 1-4	0.14
27877	Pre-Excavation-11	Phases 1-4	0.13
27877	Pre-Excavation-12	Phases 1-4	0.09
27877	Pre-Excavation-13	Phases 1-4	0.25
27877	Pre-Excavation-14	Phases 1-4	0.29
27878	Pre-Excavation-15	Phases 1-4	0.28
27878	Pre-Excavation-16	Phases 1-4	0.12
27878	Pre-Excavation-17	Phases 1-4	0.12
27878	Pre-Excavation-18	Phases 1-4	0.56
27873	1	Phase 4	0.85
27873	2	Phase 4	0.73
27873	3	Phase 4	0.14
27873	4	Phase 4	0.21
27873	5	Phase 4	1.87
27873	6	Phase 4	3.76
27874	7	Phase 4	1.6
27874	8	Phase 4	0.80
27874	9	Phase 4	0.54
27874	10	Phase 4	0.216
27877	11	Phase 4	5.9
27877	12	Phase 4	1.9
27877	13	Phase 4	**55.6**
27877	14	Phase 4	**22.7**
27878	15	Phase 4	3.9
27878	16	Phase 4	0.02
27878	17	Phase 4	0.34
27878	18	Phase 4	**12.3**
27879	19	Phase 4	1.6
27879	20	Phase 4	1.6
27879	21	Phase 4	0.07
27879	22	Phase 4	0.3
27879	23	Phase 4	1.7
27879	24	Phase 4	4.4
27879	25	Phase 4	1.2
27879	26	Phase 4	1.3
27880	27	Phase 4	6.7
27880	28	Phase 4	1.3
27880	29	Phase 4	3.5
27880	30	Phase 4	1.97
27880	31	Phase 4	0.09
27880	32	Phase 4	0.08
27880	33	Phase 4	0.23
27880	34	Phase 4	0.18
27880	35	Phase 4	0.1
27880	36	Phase 4	0.18
27880	37	Phase 4	0.2
27454	38	Phase 4	0.93
27454	39	Phase 4	0.44
27454	40	Phase 4	BG
27454	41	Phase 4	1.2
27454	42	Phase 4	BG
27454	43	Phase 4	BG
27454	44	Phase 4	BG
27454	45	Phase 4	BG
27454	46	Phase 4	BG
27454	47	Phase 4	BG
27454	48	Phase 4	BG
27454	49	Phase 4	BG
27454	50	Phase 3	BG
27454	51	Phase 3	BG
27881	52	Phase 3	BG
27881	53	Phase 3	BG
27881	54	Phase 3	0.13
27881	55	Phase 3	0.128
27881	56	Phase 3	0.07

Notes:
BG - Result equalt to background concnetrations

Overburden/Soil Concrete
Onsite ISOCS Cs-137 Results

COC	SOIL SAMPLE NUMBER	SAMPLE LOCATION	Cs-137 (pCi/g)
27881	57	Phase 3	BG
27881	58	Phase 3	BG
27881	59	Phase 3	BG
27882	60	Phase 3	0.11
27882	61	Phase 3	0.095
27882	62	Phase 3	BG
27882	63	Phase 3	BG
27882	64	Phase 3	BG
27882	65	Phase 3	BG
27882	66	Phase 3	BG
27882	67	Phase 3	0.048
27882	68	Phase 3	BG
27882	69	Phase 3	BG
27882	70	Phase 3	BG
27882	71	Phase 3	BG
27882	72	Phase 3	BG
27882	73	Phase 3	BG
27883	74	Phase 3	BG
27883	75	Phase 3	BG
27883	76	Phase 3	BG
27883	77	Phase 3	BG
27883	78	Phase 3	BG
27883	79	Phase 3	BG
27478	80	Phase 3	BG
27478	81	Phase 3	BG
27478	82	Phase 3	BG
27478	83	Phase 3	BG
27478	84	Phase 3	BG
27478	85	Phase 3	BG
27478	86	Phase 3	BG
27478	87	Phase 3	BG
27478	88	Phase 3	BG
27478	89	Phase 3	BG
27478	90	Phase 3	BG
27478	91	Phase 3	BG
27487	92	Phase 2	BG
27487	93	Phase 2	BG
27487	94	Phase 2	0.098
27487	95	Phase 2	BG
27487	96	Phase 2	BG
27487	97	Phase 2	BG
27487	98	Phase 2	0.031
27487	99	Phase 2	BG
27487	100	Phase 2	BG
27487	101	Phase 2	BG
27487	102	Phase 2	BG
27487	103	Phase 2	BG
27487	104	Phase 2	BG
27486	105	Phase 2	BG
27486	106	Phase 2	BG
27486	107	Phase 2	BG
27486	108	Phase 2	0.11
27486	109	Phase 2	BG
27486	110	Phase 2	BG
27486	111	Phase 2	BG
27486	112	Phase 2	BG
27486	113	Phase 2	BG
27486	114	Phase 2	BG
27486	115	Phase 2	0.11
27486	116	Phase 2	BG
27486	117	Phase 2	BG
27488	118	Phase 2	BG
27488	119	Phase 2	BG
27488	120	Phase 2	BG
27488	121	Phase 2	BG
27488	122	Phase 2	BG
27488	123	Phase 2	BG
27488	124	Phase 2	0.139
27488	125	Phase 2	BG
27489	126	Phase 2	BG
27489	127	Phase 2	0.296
27489	128	Phase 2	BG
27489	129	Phase 2	BG
27489	130	Phase 2	BG
27489	131	Phase 2	BG

Notes:
BG - Result equalt to background concnetrations
Bold/Shaded text denotes concentrations exceeding site cleanup criteria

Overburden/Soil Concrete
Onsite ISOCS Cs-137 Results

COC	SOIL SAMPLE NUMBER	SAMPLE LOCATION	Cs-137 (pCi/g)
27489	132	Phase 2	BG
27489	133	Phase 2	0.11
27489	134	Phase 2	BG
27489	135	Phase 2	BG
27489	136	Phase 2	BG
27489	137	Phase 2	BG
27490	138	Phase 2	BG
27490	139	Phase 2	0.172
27490	140	Phase 2	BG
27490	141	Phase 2	0.11
27491	142	Phase 2	BG
27491	143	Phase 2	BG
27491	144	Phase 2	BG
27491	145	Phase 2	BG
27491	146	Phase 2	BG
27491	147	Phase 2	BG
27491	148	Phase 2	BG
27491	149	Phase 2	BG
27491	150	Phase 2	BG
27491	151	Phase 2	BG
27491	152	Phase 2	BG
27491	153	Phase 2	BG
27491	154	Phase 2	BG
27491	155	Phase 2	BG
27942	156	Phase 2	0.817
27942	157	Phase 2	BG
27942	158	Phase 2	BG
27942	159	Phase 2	BG
27942	160	Phase 2	BG
27942	161	Phase 2	0.104
28186	162	Phase 1	BG
28186	163	Phase 1	BG
28186	164	Phase 1	BG
28186	165	Phase 1	BG
28186	166	Phase 1	BG
28186	167	Phase 1	BG
28186	168	Phase 1	0.046
28186	169	Phase 1	BG
28186	170	Phase 1	BG
28186	171	Phase 1	BG
28186	172	Phase 1	BG
28186	173	Phase 1	BG
28186	174	Phase 1	BG
28186	175	Phase 1	BG
28186	176	Phase 1	BG
28186	177	Phase 1	BG
28189	178	Phase 1	BG
28189	179	Phase 1	BG
28189	180	Phase 1	BG
28189	181	Phase 1	BG
28189	182	Phase 1	BG
28189	183	Phase 1	BG
28189	184	Phase 1	BG
28189	185	Phase 1	BG
28189	186	Phase 1	BG
28189	187	Phase 1	BG
28189	188	Phase 1	BG
28189	189	Phase 1	BG
28190	190	Phase 1	BG
28190	191	Phase 1	BG
28190	192	Phase 1	BG
28190	193	Phase 1	0.057
28190	194	Phase 1	BG
28190	195	Phase 1	BG
28190	196	Phase 1	0.048
28190	197	Phase 1	BG
28190	198	Phase 1	BG
28190	199	Phase 1	BG
28190	200	Phase 1	BG
28190	201	Phase 1	BG
28190	202	Phase 1	BG
28190	203	Phase 1	BG
28191	204	Phase 1	BG
28191	205	Phase 1	BG
28191	206	Phase 1	BG

Notes:
BG - Result equalt to background concnetrations
Bold/Shaded text denotes concentrations exceeding site cleanup criteria

Overburden Soil Concrete
Onsite ISOCS Cs-137 Results

COC	SOIL SAMPLE NUMBER	SAMPLE LOCATION	Cs-137 (pCi/g)
28191	207	Phase 1	BG
28191	208	Phase 1	BG
28191	209	Phase 1	BG
28191	210	Phase 1	BG
28191	211	Phase 1	BG
28191	212	Phase 1	BG
28191	213	Phase 1	BG
28191	214	Phase 1	BG
28191	215	Phase 1	BG
28191	216	Phase 1	BG
28191	217	Phase 1	BG
28191	218	Phase 1	BG
28191	219	Phase 1	BG
28191	220	Phase 1	BG
28191	221	Phase 1	BG
28197	222	Phase 1	BG
28197	223	Phase 1	BG
28197	224	Phase 1	BG
28197	225	Phase 1	BG
28197	226	Phase 1	BG
28197	227	Phase 1	BG
28197	228	Phase 1	BG
28197	229	Phase 1	BG
28197	230	Phase 1	BG
28197	231	Phase 1	BG
28197	232	Phase 1	BG
28197	233	Phase 1	BG
28197	234	Phase 1	BG
28197	235	Phase 1	BG
28197	236	Phase 1	BG
28197	237	Phase 1	BG
28197	238	Phase 1	BG
28197	239	Phase 1	BG
28197	240	Phase 1	BG
28197	241	Phase 1	BG
28197	242	Phase 1	BG
28197	243	Phase 1	BG
28197	244	Phase 1	BG
28197	245	Phase 1	BG
28197	246	Phase 1	BG
28197	247	Phase 1	0.114
28197	248	Phase 1	BG
28197	249	Phase 1	BG
28197	250	Phase 1	BG
28197	251	Phase 1	BG
28197	252	Phase 1	BG
28197	253	Phase 1	BG
28197	254	Phase 1	BG
28197	255	Phase 1	BG
28197	256	Phase 1	BG
28196	257	Phase 1	BG
28196	258	Phase 1	BG
28196	259	Phase 1	BG
28196	260	Phase 1	BG
28196	261	Phase 1	BG
28196	262	Phase 1	BG
28196	263	Phase 1	BG
28196	264	Phase 1	BG
28196	265	Phase 1	BG
28196	266	Phase 1	BG
28196	267	Phase 1	BG
28196	268	Phase 1	BG
28196	269	Phase 1	BG
28196	270	Phase 1	BG
28196	271	Phase 1	BG
28196	272	Phase 1	BG
28196	273	Phase 1	BG
28196	274	Phase 1	BG
28196	275	Phase 1	BG
28196	276	Phase 1	BG
28196	277	Phase 1	BG
28196	278	Phase 1	BG
28196	279	Phase 1	BG
28199	280	Phase 1	0.598
28199	281	Phase 1	BG

Notes:
BG - Result equalt to background concnetrations
Bold/Shaded text denotes concentrations exceeding site cleanup criteria

Overburde[illegible]il Concrete
Onsite ISOCS Cs-137 Results

COC	SOIL SAMPLE NUMBER	SAMPLE LOCATION	Cs-137 (pCi/g)
28199	282	Phase 1	BG
28199	283	Phase 1	BG
28199	284	Phase 1	BG
28199	285	Phase 1	BG
28199	286	Phase 1	BG
28199	287	Phase 1	BG
28199	288	Phase 1	BG
28199	289	Phase 1	BG
28199	290	Phase 1	BG
28199	291	Phase 1	BG
28199	292	Phase 1	BG
28199	293	Phase 1	0.096
28199	294	Phase 1	0.069
28199	295	Phase 1	BG
28199	296	Phase 1	BG
28199	297	Phase 1	BG
28199	298	Phase 1	BG
28199	299	Phase 1	BG
28199	300	Phase 1	BG
28199	301	Phase 1	BG
28199	302	Phase 1	0.076
28199	303	Phase 1	BG
28199	304	Phase 1	BG
28199	305	Phase 1	BG
28199	306	Phase 1	BG
28199	307	Phase 1	BG
28199	308	Phase 1	BG
28199	309	Phase 1	BG
28199	310	Phase 1	BG
28199	311	Phase 1	BG
28200	312	Phase 1	BG
28200	313	Phase 1	BG
28200	314	Phase 1	BG
28200	315	Phase 1	BG
28200	316	Phase 1	BG
28200	317	Phase 1	BG
28200	318	Phase 1	BG
28200	319	Phase 1	BG
28200	320	Phase 1	BG
28200	321	Phase 1	BG
28200	322	Phase 1	BG
28200	323	Phase 1	BG
28200	324	Phase 1	BG
28200	325	Phase 1	BG
28200	326	Phase 1	BG
28200	327	Phase 1	BG
28200	328	Phase 1	BG
28200	329	Phase 1	BG
28200	330	Phase 1	BG
28200	331	Phase 1	BG
28200	332	Phase 1	BG
28200	333	Phase 1	BG
28200	334	Phase 1	BG
28200	335	Phase 1	BG
28200	336	Phase 1	BG
28200	337	Phase 1	BG
28200	338	Phase 1	0.073
28200	339	Phase 1	BG
28200	340	Phase 1	BG
28200	341	Phase 1	BG
28200	342	Phase 1	BG
28200	343	Phase 1	BG
28200	344	Phase 1	BG
28200	345	Phase 1	0.06
28200	346	Phase 1	BG
28200	347	Phase 1	BG
28200	348	Phase 1	BG
28200	349	Phase 1	BG
28200	350	Phase 1	BG
28200	351	Phase 1	0.11
28200	352	Phase 1	BG
28200	353	Phase 1	BG
28201	354	Phase 1	BG
28201	355	Phase 1	BG
28201	356	Phase 1	BG

Notes:

BG - Result equalt to background concnetrations

[illegible]centrations exceeding site cleanup criteria

Overburden Concrete
Onsite ISOCS Cs-137 Results

COC	SOIL SAMPLE NUMBER	SAMPLE LOCATION	Cs-137 (pCi/g)
28201	357	Phase 1	BG
28201	358	Phase 1	BG
28201	359	Phase 1	BG
28201	360	Phase 1	BG
28201	361	Phase 1	BG
28201	362	Phase 1	BG
28201	363	Phase 1	BG
28201	364	Phase 1	BG
28201	365	Phase 1	BG
28201	366	Phase 1	BG
28201	367	Phase 1	BG
28201	368	Phase 1	BG
28201	370	Phase 1	BG
28201	371	Phase 1	BG
28201	373	Phase 1	BG
28201	374	Phase 1	BG
28201	375	Phase 1	BG
28201	376	Phase 1	BG
28201	377	Phase 1	BG
28201	378	Phase 1	BG
28201	379	Phase 1	BG
28201	380	Phase 1	BG
28201	381	Phase 1	BG
28201	382	Phase 1	BG
28201	383	Phase 1	BG
28201	384	Phase 1	BG
28201	385	Phase 1	BG
28201	386	Phase 1	BG
28201	387	Phase 1	0.033
28201	388	Phase 1	BG
28201	389	Phase 1	BG
28201	390	Phase 1	BG
28201	391	Phase 1	BG
28201	392	Phase 1	BG
28201	393	Phase 1	BG
28201	394	Phase 1	BG
28201	395	Phase 1	BG
28201	396	Phase 1	BG
28201	397	Phase 1	BG
28201	398	Phase 1	BG
28201	399	Phase 1	BG
28201	400	Phase 1	BG
28201	401	Phase 1	BG
28201	402	Phase 1	BG
28201	403	Phase 1	BG
28201	404	Phase 1	BG
28201	405	Phase 1	BG
28201	406	Phase 1	BG
28201	407	Phase 1	BG
28201	408	Phase 1	BG
28201	409	Phase 1	BG
28202	410	Phase 1	BG
28202	411	Phase 1	BG
28202	412	Phase 1	BG
28202	413	Phase 1	BG
28202	414	Phase 1	BG
28202	415	Phase 1	BG
28202	416	Phase 1	BG
28202	417	Phase 1	BG
28202	418	Phase 1	BG
28202	419	Phase 1	BG
28202	420	Phase 1	BG
28202	421	Phase 1	BG
28202	422	Phase 1	BG
28202	423	Phase 1	BG
28202	424	Phase 1	BG
28202	425	Phase 1	BG
28202	426	Phase 1	BG
28202	427	Phase 1	BG
28202	428	Phase 1	BG
28202	429	Phase 1	BG
28202	430	Phase 1	BG
28202	431	Phase 1	BG
28202	432	Phase 1	BG
28202	433	Phase 1	BG

Notes:
BG - Result equalt to background concnetrations

Overburden and Concrete
Onsite ISOCS Cs-137 Results

COC	SOIL SAMPLE NUMBER	SAMPLE LOCATION	Cs-137 (pCi/g)
28202	434	Phase 1	BG
28202	435	Phase 1	BG
28202	436	Phase 1	BG
28202	437	Phase 1	BG
28202	438	Phase 1	BG
28202	439	Phase 1	BG
28202	440	Phase 1	BG
28202	441	Phase 1	BG
28202	442	Phase 1	BG
28202	443	Phase 1	BG
28202	444	Phase 1	BG
28202	445	Phase 1	BG
28202	446	Phase 1	BG
28202	447	Phase 1	BG
28202	448	Phase 1	BG
28202	449	Phase 1	BG
28202	450	Phase 1	BG
28202	451	Phase 1	BG
28202	452	Phase 1	BG
28202	453	Phase 1	BG
28202	454	Phase 1	BG
28202	455	Phase 1	BG
28202	456	Phase 1	BG
28202	457	Phase 1	BG
28202	458	Phase 1	0.106
28202	459	Phase 1	BG
28202	460	Phase 1	BG
28202	461	Phase 1	BG
28202	462	Phase 1	BG
28202	463	Phase 1	BG
28202	464	Phase 1	BG
28202	465	Phase 1	BG
28202	466	Phase 1	BG
28202	467	Phase 1	BG
28202	468	Phase 1	BG
28202	469	Phase 1	BG
28202	470	Phase 1	BG
28202	471	Phase 1	BG
28202	472	Phase 1	BG
28202	473	Phase 1	BG
28202	474	Phase 1	BG
28202	475	Phase 1	BG
28203	476	Phase 1	BG
28203	477	Phase 1	BG
28203	478	Phase 1	BG
28203	479	Phase 1	BG
28203	480	Phase 1	BG
28203	481	Phase 1	BG
28203	482	Phase 1	BG
28203	483	Phase 1	BG
28203	484	Phase 1	BG
28203	485	Phase 1	BG
28203	486	Phase 1	BG
28203	487	Phase 1	BG
28203	488	Phase 1	BG
28203	489	Phase 1	BG
28203	490	Phase 1	BG
28203	491	Phase 1	BG
28203	492	Phase 1	BG
28203	493	Phase 1	BG
28203	494	Phase 1	BG
28203	495	Phase 1	0.054
28203	496	Phase 1	BG
28203	497	Phase 1	BG
28203	498	Phase 1	BG
28203	499	Phase 1	BG
28203	500	Phase 1	BG
28203	501	Phase 1	BG
28203	502	Phase 1	BG
28203	503	Phase 1	BG
28203	504	Phase 1	BG
28203	505	Phase 1	BG
28203	506	Phase 1	BG
28203	507	Phase 1	BG
28203	508	Phase 1	BG

Notes:
BG - Result equalt to background concnetrations
Bold/Shaded text denotes concentrations exceeding site cleanup criteria

Overburden and Concrete
Onsite ISOCS Cs-137 Results

COC	SOIL SAMPLE NUMBER	SAMPLE LOCATION	Cs-137 (pCi/g)
28203	509	Phase 1	BG
28203	510	Phase 1	BG
28203	511	Phase 1	BG
28203	512	Phase 1	BG
28203	513	Phase 1	BG
28203	514	Phase 1	BG
28203	515	Phase 1	BG
28203	516	Phase 1	BG
28203	517	Phase 1	BG
28203	518	Phase 1	BG
28203	519	Phase 1	BG
28203	520	Phase 1	BG
28203	521	Phase 1	BG
28203	522	Phase 1	BG
28203	523	Phase 1	BG
28203	524	Phase 1	BG
28203	525	Phase 1	BG
28203	526	Phase 1	BG
28203	527	Phase 1	BG
28203	528	Phase 1	BG
28203	529	Phase 1	BG
28203	530	Phase 1	BG
28203	531	Phase 1	BG
28203	532	Phase 1	BG
28203	533	Phase 1	BG
28203	534	Phase 1	BG
28203	535	Phase 1	BG
28203	536	Phase 1	BG
28203	537	Phase 1	BG
28203	538	Phase 1	BG
28203	539	Phase 1	BG
28203	540	Phase 1	BG
28203	541	Phase 1	BG
28203	542	Phase 1	BG
28203	543	Phase 1	BG
28203	544	Phase 1	BG
28203	545	Phase 1	BG
28203	546	Phase 1	BG
28203	547	Phase 1	BG
28203	548	Phase 1	BG
28203	549	Phase 1	BG
28204	550	Phase 1	BG
28204	551	Phase 1	BG
28204	552	Phase 1	BG
28204	553	Phase 1	BG
28204	554	Phase 1	0.74
28204	555	Phase 1	BG
28204	556	Phase 1	BG
28204	557	Phase 1	BG
28204	558	Phase 1	BG
28204	559	Phase 1	BG
28204	560	Phase 1	BG
28204	561	Phase 1	BG
28204	562	Phase 1	BG
28204	563	Phase 1	BG
28204	564	Phase 1	BG
28204	565	Phase 1	BG
28204	566	Phase 1	BG
28204	567	Phase 1	BG
28204	568	Phase 1	BG
28204	569	Phase 1	BG
28204	570	Phase 1	BG
28204	571	Phase 1	BG
28204	572	Phase 1	BG
28204	573	Phase 1	BG
28204	574	Phase 1	BG
28204	575	Phase 1	BG
28204	576	Phase 1	BG
28204	577	Phase 1	BG
28204	578	Phase 1	BG
28204	579	Phase 1	BG
28204	580	Phase 1	BG
28204	581	Phase 1	BG
28204	582	Phase 1	BG
28204	583	Phase 1	BG

Notes:
BG - Result equalt to background concnetrations
Bold/Shaded text denotes concentrations exceeding site cleanup criteria

Overburde[illegible]il Concrete
Onsite ISOCS Cs-137 Results

COC	SOIL SAMPLE NUMBER	SAMPLE LOCATION	Cs-137 (pCi/g)
28204	584	Phase 1	BG
28204	585	Phase 1	BG
28204	586	Phase 1	BG
28204	587	Phase 1	BG
28204	588	Phase 1	BG
28204	589	Phase 1	BG
28188	Concrete Culvert-1	Phase 4	1.53
28188	Concrete Culvert-2	Phase 4	0.12
28188	Concrete Culvert-3	Phase 4	BG
28188	Concrete Culvert-4	Phase 4	BG
28188	Concrete Culvert-5	Phase 4	BG
28188	Concrete Culvert-6	Phase 4	BG
28188	Concrete Culvert-7	Phase 4	BG
28188	Concrete Culvert-8	Phase 4	BG
28188	Concrete Culvert-9	Phase 4	BG
28188	Concrete Culvert-10	Phase 4	BG
28188	Concrete Culvert-11	Phase 4	BG
28188	Concrete Culvert-12	Phase 4	0.23
28188	Concrete Culvert-13	Phase 4	0.23
28188	Concrete Culvert-14	Phase 4	BG
28188	Concrete Culvert-15	Phase 4	0.072
28188	Concrete Culvert-16	Phase 4	0.19
28193	Hot Pile-1		6.6
28193	Hot Pile-2		7.24
28193	Hot Pile-3		**16.4**
28193	Hot Pile-4		8.33
28193	Hot Pile-5		**11.21**

Notes:
BG - Result equalt to background concnetrations

Concrete Samples
Buildings 801 to 811
Waste Transfer Lines

Summary of Data for Radiochemical Analysis

Brookhaven National Laboratory
Upton, NY 11973

Parameter	Site Cleanup Criteria	30035-001		30035-002		30035-003		30035-004	
Americium-241	39	0.0717	U	-0.0966	U	0.0278	U	0.037	U
Curium-242	-	0.143	U	-0.0209	U	-0.0357	U	0.00	U
Curium-243/244	-	0.00575	U	-0.0185	U	-0.0158	U	0.00	U
Curium-245/246	-	0.313	U	0.00	U	0.152	U	0.136	U
Plutonium-239/240	40	0.0764	U	-0.0554	U	-0.0408	U	0.0122	U
Uranium-233/234	13	-0.0889	U	0.561	J	0.133	U	0.289	U
Uranium-235/236	11	0.134	U	-0.0148	U	0.145	U	0.0742	U
Uranium-238	9	0.286	J	0.348	J	0.235	U	0.146	U
Beryllium-7	-	0.0471	DL	-0.0108	DL	0.0754	DL	-0.00738	DL
Cesium-137	23	0.472		0.209		0.428		0.470	
Colbalt-57	-	0.00968	DL	0.000458	DL	0.00233	DL	-0.000914	DL
Colbalt-60	1,100	0.0095	DL	-0.000248	U	-0.00912	DL	0.014	DL
Manganese-54	-	-0.0364	DL	-0.00108	DL	-0.00633	DL	-0.000457	DL
Potassium-40	-	3.14		2.91		4.04		4.80	
Radium-226	5	0.231		0.238		0.271		0.184	
Sodium-22	-	0.0163	DL	-0.00823	DL	-0.0137	DL	-0.00117	DL
Thorium-228	-	0.323		0.354		0.309		0.343	
Tritium	424	-45.7	U	-81.5	U	-143	U	22.6	U
Nickel-63	-	0.137	U	0.406	U	0.184	U	-1.48	U

Notes
DL - Below the detection limit
ND - Not detected
J - Indicates an estimated concentration
U - Indicates that the compound was analyzed for, but was not detected
Bold/Shaded text denotes concentrations exceeding OU1 Action Levels.
All units are pCi/g
Gamma Spec results only reported for those parameters that were recorded during the analys

Rainwater from Trench

Summary of Data for Hazardous and Radiochemical Analysis

Brookhaven National Laboratory
Upton, NY 11973

Building 801 to 811

Parameter	OU1 Action Levels [1]	28205-001	
Americium-241		3 8	U
Beryllium-7		0 2	U
Cesium-134		4 3	U
Cesium-137		5 0	U
Cobalt-57		-0.1	U
Cobalt-60		0 0	U
Europium-152		-10	U
Europium-154		-13	U
Europium-155		6	U
Manganese-54		-2.0	U
Sodium-22		0 0	U
Zinc-65		0	U
Actinium 228		99	
Gross Alpha		1140	
Gross Beta		750	
Plutonium 238		-0.16	U
Plutonium 239/40		-0.051	U
Americium-241		0.07	U

Notes.
1

DL - Below the dectection limit
ND - Not detected
J - Indicates an estimated concentration

U - Indicates that the compound was analyzed for, but was not detected

Bold/Shaded text denotes concentrations exceeding OU1 Action Levels.

All units are pCi/g
Gamma Spec results only reported for those parameters that were recorded during the analysis

Rainwater from Waste Tansfer Lines Trench

Summary for Hazardous and Radiochemical Analysis
Brookhaven National Laboratory
Upton, NY 11973

Parameter	OU1 Action Levels[1]	28065-001	28065-002	28065-003
Mercury Analysis-CVAA *7470 Cold Vapor Hg Liquid*				
Mercury		1.83	ND U	2.51
Metals Analysis-ICP *6010 TAL Metls Liquid Fed*				
Aluminum		466000	7910	1310
Antimony		ND U	ND U	18.6
Barium		731	14.3 J	11.0
Beryllium		8.88	ND U	36300
Cadmium		3.02 J	ND U	570
Calcium		17800	1840 J	140
Chromium		354	6.69 J	478
Cobalt		70.4	5.71 J	494000
Copper		257	6.01 J	44000
Iron		314000	5560	4570
Magnesium		24000	942 J	303
Magnanese		2190	39.7	ND U
Nickel		169	4.71 J	15100
Potassium		13800	968 J	908
Silver		6.14 J	ND U	3570
Sodium		14300	13400	870000
Vanadium		643	11.4 J	ND U
Zinc		1830	37.1	19500
Metals Analysis-ICP-MS *3005/6020 Arsenic Federal*				
Arsenic		123	3.10 J	100
Lead		494	7.91	818
Selenium		3.97 J	ND U	2.47 J
Thallium		2.45	ND U	2.87

Notes:
-1

DL - Below the dectection limit

ND - Not detected

J - Indicates an estimated concentration

U - Indicates that the compound was analyzed for, but was not detected

Bold/Shaded text denotes concentrations exceeding OU1 Action Levels.

All units are mg/L

Appendix B

Waste Transfer Lines
Final Status Survey Data

1. **BNL FSS and Endpoint Sample Results**
2. **BNL Radiological Survey Forms – Gamma Walkover Survey and Fixed Point Readings**
3. **BNL Radiological Survey Forms and GEL Data – Free Release of Concrete Culvert**

Final Status Survey
Buildings 801 to 811
Waste Transfer Lines

Summary of Data for Hazardous and Radiochemical Analysis

Brookhaven National Laboratory
Upton, NY 11973

Parameter	Site Cleanup Criteria	27632-001	27632-002	27632-003	27632-004	27632-005	27632-006	27632-007	27632-008	27632-009	27632-010	27632-011	27632-012	27632-013	27632-014	27632-015	27632-016	27632-017	27632-018	27632-019	27632-020	27632-021	27632-022	27632-023
		0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-2 ft	2-4 ft	4-6 ft	6-8 ft	0-2 ft	2-4 ft	4-6 ft	6-8 ft	0-0.5 ft	Composite	Blind Duplicate	Field Blank
Americium-241	39	0.0254 U	0.0314 U	0.0113 U	0.00825 U	0.432 U	0.028 U	0.00903 U	0.00222	0.0428 U	0.0149 U	0.0278 U	-0.00212 U	0.0254 U	0.0229 U	0.0241 U	0.0254 U	0.00982 U	0.0232 J-UI	0.0283 U			0.0289 J-UI	0.0111 U
Cesium-137	23	1.0*	0.186	0.0628	0.029	0.1316	0.163	0.0386 UI	0.0000515 DL	0.413	0.0234	0.244	0.0449	0.0313	-0.00805 DL	0.00862 DL	0.306	0.0147 UI	0.0142 DL	-0.00325 DL			1.15	0.00114 DL
Iodine-129	-	-	-	-	-																0.0466 U	0.0111 U		
Lead-212	-	-	-	-	-																			0.36
Lead-214	-	-	-	-	-																			0.231
Potassium-40	-	-	-	-	-																			3.16
Radium-226	5	0.611	0.341	0.370	0.434	0.400	0.368	0.522	0.329	0.293	0.273	0.489	0.293	0.258	0.301	0.243	0.48	0.299	0.332	0.293			0.578	0.712 J
Radium-228	-																							0.323 J
Strontium-90	15												-0.0583 U	0.342 U	0.00851 U	0.112 U	-0.0634 U	0.306 U	-0.0416 U	0.976 U	0.120 U	0.034 U	0.628 U	0.0025 J
Tritium	424	-	-																		4.14 U	3.24 U		
Technetium-99	-	-																			1.06 U	0.499 U		

Notes
DL Below the detection limit
ND Not detected
UI Uncertain identification for gamma spectroscopy
J Indicates an estimated concentration
U Indicates that the compound was analyzed for but was not detected
Bold/Shaded text denotes concentrations exceeding OU1 Action Levels.
All units are pCi/g
Gamma Spec results only reported for those parameters that were recorded during the analysis

Final Status Survey
Buildings 801 to 811
Waste Transfer Lines

Brookhaven National Laboratory
Upton, NY 11973

Parameter	Site Cleanup Criteria	28880-001	28880-002	28880-003	28880-004	28880-005	28880-006	28880-007	28880-008	28880-009	28880-010	28880-011	28880-012	28880-013	28880-014	28880-015
		0-2 ft	2-4 ft	4-6 ft	6-8 ft	0-2 ft	2-4 ft	4-6 ft	6-8 ft	0-2 ft	2-4 ft	4-6 ft	6-8 ft	Composite	0-0.5 ft	28880-001 duplicate
Beryllium-7	-	0 0759 DL	0 0186 DL	0.0138 DL	-0.105 DL	0.00	0.116 DL	0.0305 DL	-0.102 DL	-0.0108 DL	0.00353 DL	-0.0134 DL	-0.0156 DL	-	-	-0.018 DL
Cesium-137	23	0 039	0 00652 DL	-0 00455 DL	-0.00133 DL	0.350	0.241	-0.00264 DL	-0.00793 DL	0.00183 DL	-0.000998 DL	0 00253 DL	-0.000965 DL	-	-	-0.00145 DL
Cobalt-57	-	0 0011 DL	-0.00356 DL	-0 00427 DL	0.000654 DL	0.00319 DL	-0.00149 DL	-0.00585 DL	0.000102 DL	-0.000146 DL	0.00104 DL	-0.011 DL	-0.000465 DL	-	-	0 00152 DL
Cobalt-60	1,100	-0.00143 DL	-0.00655 DL	0.00962 DL	0.00319 DL	-0.000391 DL	0.0069 DL	0.00936 DL	-0.00563 DL	0 00196 DL	0.00459 DL	-0.00468 DL	-0.000384 U	-	-	0.00222 U
Iodine-129	-	-	-	-	-	-	-	-	-	-	-	-	-	-0.0231 U	0 0479 U	-
Manganese-54	-	0 0124 DL	0 00514 DL	0.00459 DL	0.00	0.00282 DL	0 00512 DL	-0.000632 DL	0.00861 DL	0.00739 DL	0.000221 DL	0.00636 DL	-0.000324 DL	-	-	0.00309 DL
Potassium-40	-	5 84	5.23	6 76	6.80	11.1	9.69	8 00	7.65	4.14	3.27	3.67	2.75	-	-	5.44
Radium-226	5	0 344	0 317	0 370	0.368	0.684	0 641	0.658	0.580	0.331	0.253	0.283	0.216	-	-	0.316
Sodium-22	-	0 00591 DL	0 00336 DL	-0 00253 DL	-0 00203 DL	-0 00253 DL	-0.00337 DL	-0.0137 DL	-0.0124 DL	0.00412 DL	0.00234 DL	-0.00259 DL	0.00173 DL	-	-	-0.00249 DL
Thorium-228	-	0.540	0 476	0.541	0.554	1.00	1.02	1 17	1 09	0.515	0.425	0.464	0.445	-	-	0.495
Strontium-90	15	0 0778 U	0 523 U	0.375 U	-1.14 U	0.769 U	-0.209 U	-0.0328 U	0.201 U	-0 0143 U	0.482 U	0.102 U	-0 0867 U	0.0133 U	-0.269 U	-0.0965 U
Technetium-99	-	-	-	-	-	-	-	-	-	-	-	-	-	1.70 U	0.898 U	-
Tritium	424	-	-	-	-	-	-	-	-	-	-	-	-	-63 U	-42 7 U	-

Notes.

DL - Below the detection limit

ND - Not detected

J - Indicates an estimated concentration

U - Indicates that the compound was analyzed for, but was not detected

Bold/Shaded text denotes concentrations exceeding OU1 Action Levels

All units are pCi/g

Gamma Spec results only reported for those parameters that were recorded during the analysis

Final Status Survey
Buildings 801 to 811
Waste Transfer Lines

Brookhaven National Laboratory
Upton, NY 11973

Parameter	Site Cleanup Criteria	28880-013		28880-014	
Metals					
Lead		8.25		10.3	
Mercury		0.0211	J	0.0213	J
Nickel		2.54		2.43	
Thallium		0.115	J	0.104	J

Notes:

DL - Below the dectection limit

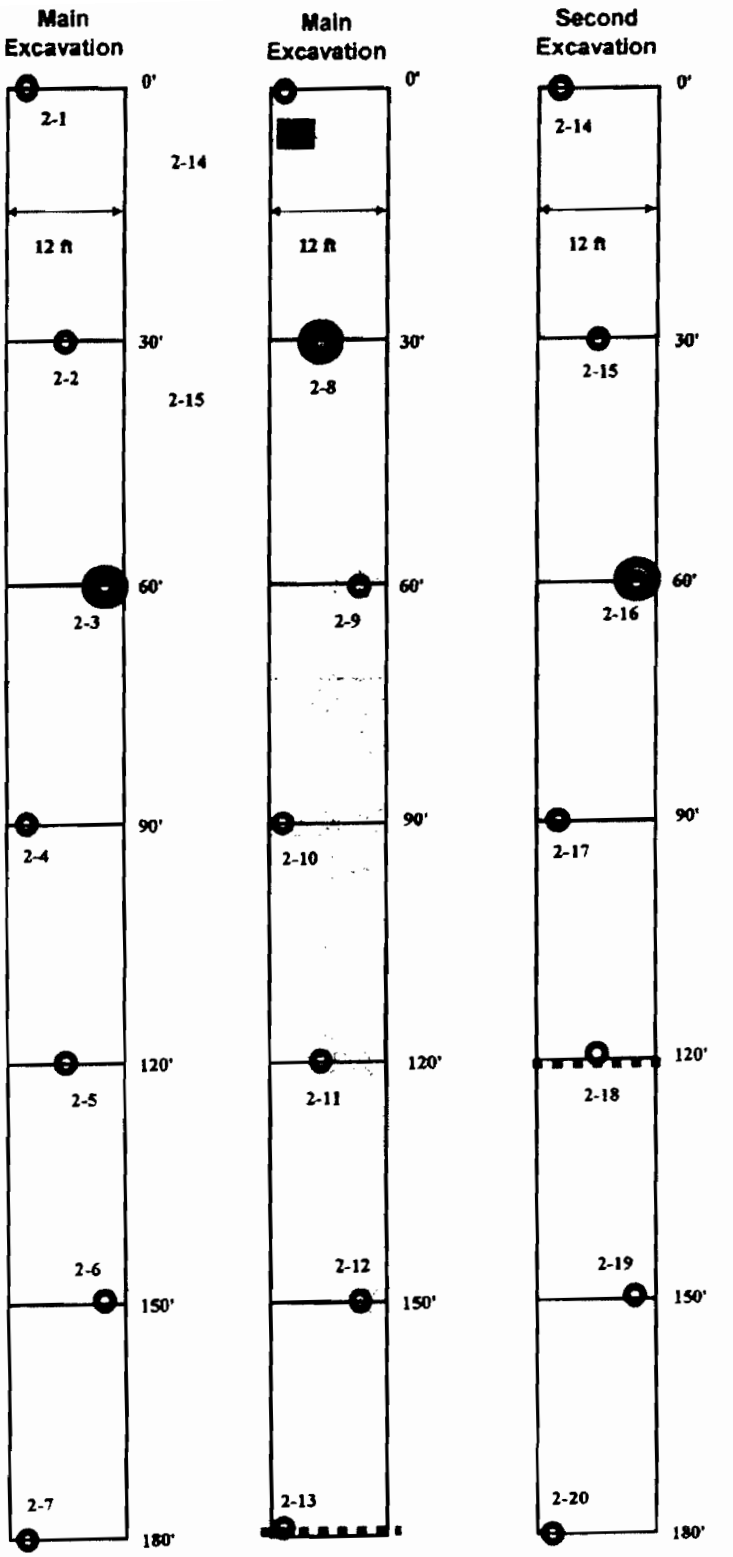
ND - Not detected

J - Indicates an estimated concentration

U - Indicates that the compound was analyzed for, but was not detected

Bold/Shaded text denotes concentrations exceeding OU1 Action Levels.

All units are mg/kg



Sample Point Locations:	Static 1 Minute Count
SPL # 2-1	8341 cpm
SPL # 2-2	8053 cpm
SPL # 2-3	8740 cpm
SPL # 2-4	8227 cpm
SPL # 2-5	9777 cpm
SPL # 2-6	7666 cpm
SPL # 2-7	6696 cpm
SPL # 2-8	8815 cpm
SPL # 2-9	8274 cpm
SPL # 2-10	11592 cpm
SPL # 2-11	10735 cpm
SPL # 2-12	13614 cpm
SPL # 2-13	13251 cpm
SPL # 2-14	3400 cpm
SPL # 2-15	3200 cpm
SPL # 2-16	3100 cpm
SPL # 2-17	3100 cpm

Note:
SPL # 2-14 thru # 2-17 were taken with a shielded NaI probe.

Sample location

Core sample location

Approx. end of excavation

Note: lengths of main and second excavations are approximate Adjust numbering as needed to ensure a sample every ~30 ft. A minimum of 16 samples are required for the SU.

COPY

Final status sample pts.

Sample Report

Batch ID:	1min. Smear - 200912081832	**Count Date:**	12/8/2009
Group:	E	**Count Minutes:**	1.0
Device:	HFBR	**Count Mode:**	Simultaneous
Batch Key:	883	**Operating Volts:**	1350
Selected Geometry:	1/8" Stainless Steel		

	Efficiency (%)			Spillover (%)			
Alpha:	28.24	±	0.08	**Alpha to**	6.01	±	0.00
Beta:	19.50	±	0.12	**Beta to**	0.07	±	0.00

Sample ID	Sample Type	Alpha (dpm)	Unc	Alpha MDA (dpm)	Beta (dpm)	Unc	Beta MDA (dpm)
20091208183257-E1	Unknown	3.53	3.54	9.58	20.20	10.26	13.87
20091208183427-E2	Unknown	3.54	3.54	9.58	9.95	7.26	13.87
20091208183547-E3	Unknown	3.53	3.54	9.58	15.07	8.89	13.87
20091208183707-E4	Unknown	0.00	0.00	9.58	10.25	7.25	13.87
20091208183817-E5	Unknown	-0.01	0.00	9.58	20.51	10.26	13.87
20091208183937-E6	Unknown	-0.01	0.00	9.58	20.51	10.26	13.87
20091208184047-E7	Unknown	-0.01	0.00	9.58	15.38	8.88	13.87
20091208184207-E8	Unknown	0.00	0.00	9.58	10.25	7.25	13.87
20091208184317-E9	Unknown	-0.01	0.00	9.58	20.51	10.26	13.87
20091208184437-E10	Unknown	0.00	0.00	9.58	5.13	5.13	13.87
20091208184557-E11	Unknown	-0.01	0.00	9.58	15.38	8.88	13.87
20091208184707-E12	Unknown	0.00	0.00	9.58	5.13	5.13	13.87
20091208184827-E13	Unknown	-0.01	0.00	9.58	20.51	10.26	13.87
20091208184937-E14	Unknown	0.00	0.00	9.58	10.25	7.25	13.87
20091208185057-E15	Unknown	-0.01	0.00	9.58	15.38	8.88	13.87
20091208185217-E16	Unknown	0.00	0.00	9.58	5.13	5.13	13.87
20091208185327-E17	Unknown	0.00	0.00	9.58	5.13	5.13	13.87
20091208185447-E18	Unknown	0.00	0.00	9.58	0.00	0.00	13.87
20091208185557-E19	Unknown	3.53	3.54	9.58	20.20	10.26	13.87
20091208185717-E20	Unknown	7.08	5.01	9.58	9.64	7.26	13.87
20091208185837-E21	Unknown	21.24	8.67	9.58	18.66	10.28	13.87
20091208185947-E22	Unknown	21.24	8.67	9.58	18.66	10.28	13.87
20091208190107-E23	Unknown	0.00	0.00	9.58	5.13	5.13	13.87
20091208190217-E24	Unknown	3.54	3.54	9.58	-0.31	0.31	13.87

Viewed by: _____

REV 010702.ELR

C:\Program Files\Tennelec Systems\Eclipse\sample report.rpt

Print Date 12/8/2009
Print Time 7:03:37PM

Recount # 2 and #5

Sample Report

Batch ID:	1min. Smear - 200912101140	**Count Date:**	12/10/200'
Group:	E	**Count Minutes:**	1.0
Device:	HFBR	**Count Mode:**	Simultaneous
Batch Key:	" 897 "	**Operating Volts:**	1350
Selected Geometry:	1/8" Stainless Steel		

	Efficiency (%)			Spillover (%)			
Alpha:	28.24	±	0.08	**Alpha to**	6.01	±	0.00
Beta:	19.50	±	0.12	**Beta to**	0.07	±	0.00

Sample ID	Sample Type	Alpha (dpm)	Unc	Alpha MDA (dpm)	Beta (dpm)	Unc	Beta MDA (dpm)
20091210114053-E2	Unknown	10.62	6.13	9.58	4.20	5.16	13.87
20091210114223-E5	Unknown	7.07	5.01	9.58	19.89	10.26	13.87

Note

Follow up Recount of Batch Key # 896

COPY

Viewed by: _____

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

0 62.5 125 250

Feet

GPS-Based Radiological Survey
Brookhaven National Laboratory
801 Waste Line Sample Locations
September 30, 2009

Legend

- Sample Locations

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ ____ ☐ ____ ROU-
■ TINE 2009-erp-019 ☐ ____

LOCATION / EQUIPMENT: 801-811 waste lines | DATE: 12/7/09 | TIME: 11:30

Phase 2 trench Final status survey

Attached is the final status survey gamma walkover of the phase 2 trench performed with the trimble unit.

INSTRUMENT

Model #	Serial #	CAL DUE
Trimble/L-2221	284757	5/4/10
N/A		
N/A		
N/A		

LEGEND

○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
☐ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCA-
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis pCi/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

See	8. Attached	15.	Survey
Results	9. Batch #	16.	N/A
	10.	17.	
	11.	18.	
	12.	19.	
	13.	20.	
	14.	21.	

Surveyed By: Hollander/Pellegren Date: 12/08/09 Reviewed by: 12/8/09

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

0 62.5 125 250

Feet

Legend

Gamma Count Rate (cpm)

- < 15,000
- 15,000 - 21,499
- > or = 21,500

GPS-Based Radiological Survey
Brookhaven National Laboratory
Phase 2 Trench FSS
December 8, 2009

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ ROU: _____
■ TINE 2009-cff-019 ☐ _____

LOCATION / EQUIPMENT: 801-811 waste transfer lines | DATE: 12/06/09 | TIME: 1600

Phase 1 trench bottom

INSTRUMENT		
Model #	Serial #	CAL DUE
Trimble/L-2221	284757	5/4/10
N/A		
N/A		
N/A		

LEGEND

○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION

☐ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCA-

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

See		8.	Attached	15.	Survey
Results		9.	Batch #	16.	N/A
		10.		17.	
		11.		18.	
		12.		19.	
		13.		20.	
		14.		21.	

Surveyed by: Zamora/Determan Date: 12/06/09 Reviewed by: _____ Date: 12/9/09

Phase 1 FSS walkover survey

Attached is a 100% scan of bottom of trench in Phase 1 and the exit path to the undress/egress area.

All surfaces of exposed concrete were included in this scan.

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

0 62.5 125 250

Feet

Legend

Gamma Count Rate (cpm)

- < 15,000
- 15,000 - 21,499
- > or = 21,500

GPS-Based Radiological Survey
Brookhaven National Laboratory
Phase 1 Trench Floor Survey
December 7, 2009

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY: ☐ TINE ☐ ROU: ■ 2009-ecp-019 ☐

LOCATION / EQUIPMENT: 801-811 waste lines | DATE: 12/08/09 | TIME: 13:15

New D line trench at phase 1

Attached is the gamma walkover final status survey for the new D line trench at phase 1 performed with the trimble unit.

A collimated probe was used due to the increased background from bldg. 801.

INSTRUMENT

Model #	Serial #	CAL DUE
Trimble/L-2221	284757	5/4/10
N/A		
N/A		
N/A		

LEGEND

○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION

☐ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCA-

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

See		8.	Attached	15.	Survey
Results		9.	Batch #	16.	N/A
		10.		17.	
		11.		18.	
		12.		19.	
		13.		20.	
		14.		21.	

Surveyed By: Zamora Date: 12/08/09 Reviewed by: Hollander Date: 12/9/09

FS-SOP-1000
Attachment 9.2

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

0 62.5 125 250

Feet

Legend

Gamma Count Rate (cpm)

- < or = 5,000
- 5,001 - 7,199
- > or = 7,200

GPS-Based Radiological Survey
Brookhaven National Laboratory
D Line Trench FSS
December 8, 2009

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ _____ ☐ _____ ROU:
■ TINE 2009-crp-019 ☐ _____

LOCATION / EQUIPMENT: 801-811 waste transfer lines | DATE: 12/07/09 | TIME: 1100

Phase 1 trench sides

Phase 1 FSS walkover survey

Attached is a 25% scan of sides of trench in Phase 1 and the exit path to the undress/egress area.

INSTRUMENT		
Model #	Serial #	CAL DUE
Trimble/L-2221	284757	5/4/10
N/A		
N/A		
N/A		

LEGEND

○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION

☐ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCA-

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

See		8.	Attached	15.	Survey
Results		9.	Batch #	16.	N/A
		10.		17.	
		11.		18.	
		12.		19.	
		13.		20.	
		14.		21.	

Surveyed By: Zamora Date: 12/07/09 Reviewed by: Date: 12/9/09

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

0 62.5 125 250

Feet

Legend

Gamma Count Rate (cpm)

- < 15,000
- 15,000 - 21,499
- > or = 21,500

GPS-Based Radiological Survey
Brookhaven National Laboratory
Phase 1 Trench Wall Survey
December 7, 2009

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ ROUTINE ☐ SPECIAL
☑ RWP # 2009-ERP-019 ☐ WP #

LOCATION & EQUIPT. 801-811 waste line trench

DATE: 12-07-09 TIME: 13:30

INSTRUMENT

Model #	Serial #	CAL DUE
Lud-12	115687	9-8-10
N/A	N/A	N/A
N/A	N/A	N/A
N/A	N/A	N/A

Performed 100% direct frisk of the first 3 ft. on the north and south ends of the culvert. All alpha readings were = background (background = 0 cpm).

LEGEND

○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION

☐ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCATION

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.	N/A	6.	N/A
3.	N/A	7.	N/A
4.	N/A	8.	N/A

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

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

Surveyed By Determan Date: 12-7-09 Reviewed By: Date: 12/9/09

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ ROUTINE ☐ SPECIAL
☐ RWP # 2009-019 ☐ WP #

LOCATION & EQUIPT. 811 Culvert

DATE: 12-8-09 TIME: 0800

INSTRUMENT

Model #	Serial #	CAL DUE
Ludlum 3	74781	8.28.10
N/A	N/A	N/A
N/A	N/A	N/A

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

AIRBORNE ACTIVITY SURVEY

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

DOSE RATE (HIGHEST)

CONTACT READING	N/A
GENERAL AREA READING	

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

NOTE: Direct Monitored Duct Bank Between Phase I & Phase II Culvert

NOTE: Used an Fabricated Extension Pole w/ the Probe attached to the end. Approximate length of Pole w/ Probe was 14'

Scanned 14' on South Side & then 14' on the North End.

All Results were < 1000-0 DPM/Probe

NOTE: (2) Marinelli soil samples were taken on each sides, Marinelli's were Frisked out of Area w/ no Elevated Activity Detected

Surveyed By: [signature] Date: 12/8/09 Reviewed By: [signature] Date: 12/9/09

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ ROUTINE ☐ SPECIAL
☐ RWP # 2009-erp-019 ☐ WP #

LOCATION & EQUIPT. 801-811 trench
DATE: 12/08/09 **TIME:** 14:00

Culvert under electrical duct bank

Smear survey performed inside culvert.

1-10 on south side
11-20 in middle
21-30 on north end

INSTRUMENT

Model #	Serial #	CAL DUE
LB5100s4	32487	7/17/10
N/A	N/A	N/A

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

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis pCi/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.	See	8.	Attached	15.	Results
2.	Batch	9.	Number	16.	890
3.		10.		17.	
4.		11.		18.	
5.		12.		19.	
6.		13.		20.	
7.		14.		21.	

Surveyed By Hollander **Date:** 12/08/09 **Reviewed By:** **Date:** 12-9-09

Sample Report

Batch ID:	1min. Smear - 200912091306	**Count Date:**	12/9/2009
Group:	E	**Count Minutes:**	1.0
Device:	HFBR	**Count Mode:**	Simultaneous
Batch Key:	890	**Operating Volts:**	1350
Selected Geometry:	1/8" Stainless Steel		

Background (cpm)			Efficiency (%)			Spillover (%)		
Alpha Rate:	0.23 ± 0.09		**Alpha:**	28.24 ± 0.08		**Alpha to**	6.01 ± 0.00	
Beta Rate:	3.07 ± 0.32		**Beta:**	19.50 ± 0.12		**Beta to**	0.07 ± 0.09	

Sample ID	Sample Type	Alpha (dpm)	Unc	Alpha MDA (dpm)	Beta (dpm)	Unc	Beta MDA (dpm)
20091209130630-E1	Unknown	-0.82	0.31	15.30	-5.40	7.43	43.90
20091209130800-E2	Unknown	2.72	3.55	15.30	-10.83	5.39	43.90
20091209130920-E3	Unknown	-0.83	0.31	15.30	9.98	11.58	43.90
20091209131040-E4	Unknown	-0.82	0.31	15.30	-5.40	7.43	43.90
20091209131150-E5	Unknown	-0.83	0.31	15.30	-0.27	9.03	43.90
20091209131310-E6	Unknown	-0.85	0.31	15.30	56.13	19.26	43.90
20091209131420-E7	Unknown	2.72	3.55	15.30	-5.71	7.44	43.90
20091209131540-E7	Unknown	-0.83	0.31	15.30	9.98	11.58	43.90
20091209131650-E8	Unknown	-0.83	0.31	15.30	-0.27	9.03	43.90
20091209131810-E9	Unknown	2.71	3.55	15.30	9.68	11.59	43.90
20091209131930-E10	Unknown	-0.84	0.31	15.30	25.37	14.60	43.90
20091209132040-E11	Unknown	-0.83	0.31	15.30	15.11	12.67	43.90
20091209132200-E12	Unknown	-0.83	0.31	15.30	4.86	10.38	43.90
20091209132310-E13	Unknown	-0.84	0.31	15.30	20.24	13.66	43.90
20091209132430-E14	Unknown	2.71	3.55	15.30	9.68	11.59	43.90
20091209132550-E15	Unknown	-0.83	0.31	15.30	9.98	11.58	43.90
20091209132700-E16	Unknown	-0.85	0.31	15.30	56.13	19.26	43.90
20091209132820-E17	Unknown	-0.83	0.31	15.30	4.86	10.38	43.90
20091209132930-E18	Unknown	-0.85	0.31	15.30	51.00	18.56	43.90
20091209133050-E19	Unknown	-0.82	0.31	15.30	-5.40	7.43	43.90
20091209133210-E20	Unknown	-0.83	0.31	15.30	4.86	10.38	43.90
20091209133320-E21	Unknown	-0.83	0.31	15.30	9.98	11.58	43.90
20091209133440-E22	Unknown	6.26	5.02	15.30	-11.14	5.40	43.90
20091209133550-E23	Unknown	2.71	3.55	15.30	9.68	11.59	43.90
20091209133710-E24	Unknown	-0.82	0.31	15.30	-5.40	7.43	43.90
20091209133830-E25	Unknown	-0.84	0.31	15.30	35.62	16.30	43.90
20091209133940-E26	Unknown	-0.83	0.31	15.30	-0.27	9.03	43.90
20091209134100-E27	Unknown	2.65	3.55	15.30	142.99	28.61	43.90
20091209134210-E28	Unknown	-0.83	0.31	15.30	-0.27	9.03	43.90
20091209134330-E29	Unknown	-0.83	0.31	15.30	4.86	10.38	43.90
20091209134450-E30	Unknown	2.70	3.55	15.30	25.06	14.60	43.90

Reviewed by:

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ ROUTINE ☐ SPECIAL
☐ RWP # 2009-erp-019 ☐ WP #

LOCATION & EQUIPT. 801-811 waste transfer lines
DATE: 12/08/09 **TIME:** 12:00

Covered culvert under electrical duct bank

Surveyed covered culvert using NAI probe attached to long handled pole. Performed two passes up and back and reading's were 6500-7500 cpm.

Background just outside culvert was 7500-8500 cpm.

Masslined sleeving of pole on way back out of culvert(2 masslin's obtained).

Prior to this survey ORISE'S NAI was used and read ~5000cpm throughout culvert.

All area's of culvert were covered during survey.

INSTRUMENT

Model #	Serial #	CAL DUE
L-2221	211780	12/08/10
N/A	N/A	N/A

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

AIRBORNE ACTIVITY SURVEY

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

DOSE RATE (HIGHEST)

CONTACT READING	N/A
GENERAL AREA READING	N/A

MASSLINN SURVEY RESULTS (in dpm)

1.	< 1k dpm/las	5.	N/A
2.	< 1k dpm/las	6.	
3.	N/A	7.	
4.	N/A	8.	

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

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

Surveyed By Hollander Date: 12/08/09 Reviewed By: Date: 12/11/09

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ ☐
■ 2009-crp-019 ☐

LOCATION / EQUIPMENT: 801-811 waste lines | DATE: 12/06/09 | TIME: 1600

Phase 1 trench concrete

Final status Survey of 300 feet of concrete culvert

A 100% scan of all exposed concrete was performed with a Lud-3 and trimble unit. All NAI readings were <21,500 cpm and approximately 30 ft2 was reading 1-3k dpm/100 cm2 fixed w/ lud-3. All other surfaces were <1k dpm/frisk with most at bkgd. levels(40-60 cpm).

These 1-3k area's will have the tar removed and resurveyed and documented.

Smears and masslin's performed were all at bkgd. levels.

Approximately 20% of concrete was surveyed by direct frisk for alpha with all area's showing no detectable alpha; in addition to these spots all of the 1-3k area's were surveyed w/ alpha meter and also showed no detectable alpha.

INSTRUMENT

Model #	Serial #	CAL DUE
S5-xlb	67705	5/1/10
L-2221	284757	5/4/10
Lud-3	92741	5/12/10
Lud-12	115687	9/8/10

LEGEND

○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCA-
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 dpm/las	5.	< 1k dpm/las
2.		6.	
3.		7.	
4.		8-25	

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

See	8. Attached	15.	Survey
Results	9. Batch #	16.	22429
	10.	17.	22431
	11.	18.	
	12.	19.	
	13.	20.	
	14.	21.	

Calash
Determan
Stafford
Hollander

Lud-3's (add'l) 50662 7/21/10
72518 7/21/10
44137 11/4/10

Surveyed By: Zamora Date: 12/06/09

Reviewed by: Date: 12/9/09

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

0 62.5 125 250

Feet

Legend

Gamma Count Rate (cpm)

- < 15,000
- 15,000 - 21,499
- > or = 21,500

GPS-Based Radiological Survey
Brookhaven National Laboratory
Phase 1 Trench Floor Survey
December 7, 2009

Activity Report

12/6/09
10:59:50AM

FSS 811 phase 1 culvert smears

Batch Name:	22,429	**Acquisition Date:**	12/6/09
Batch ID:	1 Minute Smear Analysis - 200912061008	**Acquisition Time: (minutes)**	1.0
Group:	E		
Device:	S5 XLB	**Operating Voltage: (volts)**	1,350.0
Selected Geometry:	1/8" Stainless Steel		

Efficiency Factors

Alpha Efficiency: (%)	0.28	±	0.00	**Beta Efficiency: (%)**	0.20	±	0.00

Sample ID	Quantity	Alpha (DPM)	2σ	Alpha MDA (DPM)	Beta Activity (DPM)	2σ	Beta MDA (DPM)
20091206100850-E1	0.00	0.00	0.00	9.81	1.27	14.69	36.42
20091206101020-E2	0.00	3.62	7.25	9.81	6.21	17.87	36.42
20091206101140-E3	0.00	0.00	0.01	9.81	16.52	22.93	36.42
20091206101250-E4	0.00	0.00	0.00	9.81	1.27	14.69	36.42
20091206101410-E5	0.00	0.00	0.00	9.81	6.35	17.86	36.42
20091206101530-E6	0.00	0.00	0.00	9.81	-3.81	10.60	36.42
20091206101640-E7	0.00	0.00	0.00	9.81	6.35	17.86	36.42
20091206101801-E8	0.00	0.00	0.00	9.81	-3.81	10.60	36.42
20091206101911-E9	0.00	0.00	0.00	9.81	1.27	14.69	36.42
20091206102031-E10	0.00	0.00	0.01	9.81	11.44	20.55	36.42
20091206102141-E11	0.00	0.00	0.00	9.81	-3.81	10.60	36.42
20091206102301-E12	0.00	0.00	0.00	9.81	-3.81	10.60	36.42
20091206102421-E13	0.00	0.00	0.00	9.81	-8.90	3.01	36.42
20091206102531-E14	0.00	3.62	7.25	9.81	11.29	20.56	36.42
20091206102651-E15	0.00	0.00	0.00	9.81	-3.81	10.60	36.42
20091206102801-E16	0.00	0.00	0.00	9.81	1.27	14.69	36.42
20091206102921-E17	0.00	0.00	0.00	9.81	6.35	17.86	36.42
20091206103031-E18	0.00	0.00	0.00	9.81	-3.81	10.60	36.42
20091206103151-E19	0.00	0.00	0.00	9.81	-3.81	10.60	36.42
20091206103311-E20	0.00	3.63	7.25	9.81	-3.96	10.61	36.42
20091206103421-E21	0.00	0.00	0.00	9.81	1.27	14.69	36.42
20091206103541-E22	0.00	0.00	0.01	9.81	16.52	22.93	36.42
20091206103651-E25	0.00	0.00	0.00	9.81	1.27	14.69	36.42
20091206103812-E24	0.00	0.00	0.00	9.81	6.35	17.86	36.42
20091206103932-E23	0.00	0.00	0.01	9.81	16.52	22.93	36.42
20091206104042-E26	0.00	-0.01	0.01	9.81	26.69	27.07	36.42
20091206104202-E27	0.00	0.00	0.01	9.81	11.44	20.55	36.42
20091206104322-E28	0.00	7.25	10.25	9.81	0.98	14.70	36.42
20091206104432-E29	0.00	-0.01	0.01	9.81	31.77	28.91	36.42
20091206104552-E30	0.00	3.62	7.25	9.81	11.29	20.56	36.42
20091206104702-E31	0.00	-0.01	0.01	9.81	21.60	25.08	36.42
20091206104822-E32	0.00	0.00	0.00	9.81	6.35	17.86	36.42
20091206104942-E33	0.00	0.00	0.00	9.81	-3.81	10.60	36.42
20091206105052-E34	0.00	0.00	0.00	9.81	1.27	14.69	36.42
20091206105212-E35	0.00	0.00	0.00	9.81	-3.81	10.60	36.42

Activity Report

Efficiency Factors

Alpha Efficiency: (%)	0.28	±	0.00	**Beta Efficiency: (%)**	0.20	±	0.00

Sample ID	Quantity	Alpha (DPM)	2σ	Alpha MDA (DPM)	Beta Activity (DPM)	2σ	Beta MDA (DPM)
20091206105332-E36	0.00	0.00	0.00	9.81	1.27	14.69	36.42
20091206105442-E37	0.00	0.00	0.00	9.81	1.27	14.69	36.42
20091206105603-E38	0.00	0.00	0.01	9.81	16.52	22.93	36.42
20091206105713-E39	0.00	0.00	0.00	9.81	-3.81	10.60	36.42
20091206105833-E40	0.00	0.00	0.00	9.81	-8.90	3.01	36.42

Reviewed by: _____

Activity Report

FSS 811 phase 1 culvert smears

Batch Name:	22,431	**Acquisition Date:**	12/6/09
Batch ID:	1 Minute Smear Analysis - 200912061255	**Acquisition Time: (minutes)**	1.0
Group:	E		
Device:	S5 XLB	**Operating Voltage: (volts)**	1,350.0
Selected Geometry:	1/8" Stainless Steel		

Efficiency Factors

Alpha Efficiency: (%)	0.28	±	0.00	**Beta Efficiency: (%)**	0.20	±	0.00

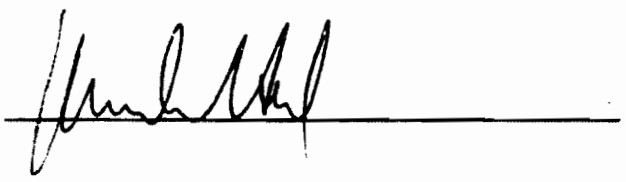
Sample ID	Quantity	Alpha (DPM)	2σ	Alpha MDA (DPM)	Beta Activity (DPM)	2σ	Beta MDA (DPM)
20091206125603-E1	0.00	-0.01	0.01	9.81	21.60	25.08	36.42
20091206125833-E2	0.00	0.00	0.00	9.81	6.35	17.86	36.42
20091206125953-E3	0.00	-0.02	0.02	9.81	72.43	40.78	36.42
20091206130113-E4	0.00	0.00	0.00	9.81	6.35	17.86	36.42
20091206130223-E5	0.00	0.00	0.00	9.81	6.35	17.86	36.42
20091206130343-E6	0.00	-0.01	0.01	9.81	21.60	25.08	36.42
20091206130453-E7	0.00	0.00	0.00	9.81	6.35	17.86	36.42
20091206130614-E8	0.00	0.00	0.01	9.81	11.44	20.55	36.42
20091206130734-E9	0.00	0.00	0.00	9.81	1.27	14.69	36.42
091206130844-E10	0.00	0.00	0.00	9.81	-3.81	10.60	36.42
20091206131004-E11	0.00	0.00	0.01	9.81	11.44	20.55	36.42
20091206131124-E12	0.00	0.00	0.00	9.81	1.27	14.69	36.42
20091206131234-E13	0.00	0.00	0.01	9.81	16.52	22.93	36.42
20091206131354-E14	0.00	0.00	0.00	9.81	6.35	17.86	36.42
20091206131514-E15	0.00	0.00	0.00	9.81	-3.81	10.60	36.42
20091206131624-E16	0.00	0.00	0.00	9.81	1.27	14.69	36.42
20091206131744-E17	0.00	0.00	0.00	9.81	-3.81	10.60	36.42
20091206131904-E18	0.00	0.00	0.00	9.81	-3.81	10.60	36.42
20091206132014-E19	0.00	0.00	0.00	9.81	6.35	17.86	36.42
20091206132134-E20	0.00	0.00	0.00	9.81	6.35	17.86	36.42
20091206132244-E21	0.00	0.00	0.00	9.81	1.27	14.69	36.42
20091206132404-E22	0.00	3.62	7.25	9.81	6.21	17.87	36.42
20091206132514-E23	0.00	0.00	0.01	9.81	16.52	22.93	36.42
20091206132635-E24	0.00	3.62	7.25	9.81	11.29	20.56	36.42
20091206132755-E25	0.00	0.00	0.00	9.81	-8.90	3.01	36.42
20091206132905-E26	0.00	0.00	0.00	9.81	1.27	14.69	36.42
20091206133025-E27	0.00	0.00	0.00	9.81	1.27	14.69	36.42
20091206133145-E28	0.00	0.00	0.00	9.81	-3.81	10.60	36.42
20091206133255-E29	0.00	0.00	0.00	9.81	-3.81	10.60	36.42
20091206133415-E30	0.00	0.00	0.00	9.81	6.35	17.86	36.42
20091206133535-E31	0.00	0.00	0.00	9.81	6.35	17.86	36.42
20091206133645-E32	0.00	0.00	0.00	9.81	6.35	17.86	36.42
20091206133805-E33	0.00	0.00	0.00	9.81	-3.81	10.60	36.42
20091206133925-E34	0.00	0.00	0.00	9.81	6.35	17.86	36.42
20091206134035-E35	0.00	0.00	0.00	9.81	-3.81	10.60	36.42

Activity Report

Efficiency Factors

Alpha Efficiency: (%)	0.28	±	0.00	**Beta Efficiency: (%)**	0.20	±	0.00

Sample ID	Quantity	Alpha (DPM)	2σ	Alpha MDA (DPM)	Beta Activity (DPM)	2σ	Beta MDA (DPM)
20091206134155-E36	0.00	0.00	0.00	9.81	-3.81	10.60	36.42
20091206134305-E37	0.00	0.00	0.00	9.81	6.35	17.86	36.42
20091206134426-E38	0.00	0.00	0.01	9.81	16.52	22.93	36.42
20091206134546-E39	0.00	0.00	0.00	9.81	1.27	14.69	36.42
20091206134656-E40	0.00	0.00	0.00	9.81	1.27	14.69	36.42
20091206134816-E41	0.00	3.62	7.25	9.81	6.21	17.87	36.42
20091206134936-E42	0.00	0.00	0.01	9.81	11.44	20.55	36.42
20091206135046-E43	0.00	0.00	0.00	9.81	1.27	14.69	36.42
20091206135206-E44	0.00	0.00	0.00	9.81	-8.90	3.01	36.42
20091206135316-E45	0.00	0.00	0.00	9.81	-3.81	10.60	36.42
20091206135436-E46	0.00	0.00	0.00	9.81	1.27	14.69	36.42
20091206135556-E47	0.00	0.00	0.00	9.81	6.35	17.86	36.42
20091206135706-E48	0.00	0.00	0.01	9.81	11.44	20.55	36.42
20091206135826-E49	0.00	0.00	0.00	9.81	1.27	14.69	36.42
20091206135946-E50	0.00	0.00	0.00	9.81	1.27	14.69	36.42
20091206140056-E51	0.00	0.00	0.00	9.81	-8.90	3.01	36.42
20091206140216-E52	0.00	0.00	0.00	9.81	-8.90	3.01	36.42
20091206140336-E53	0.00	3.63	7.25	9.81	1.12	14.69	36.42
20091206140447-E54	0.00	0.00	0.00	9.81	-3.81	10.60	36.42
20091206140607-E55	0.00	0.00	0.00	9.81	-8.90	3.01	36.42
20091206140727-E56	0.00	0.00	0.00	9.81	1.27	14.69	36.42
20091206140837-E57	0.00	0.00	0.00	9.81	6.35	17.86	36.42
20091206140957-E58	0.00	0.00	0.00	9.81	-3.81	10.60	36.42
20091206141117-E59	0.00	3.63	7.25	9.81	1.12	14.69	36.42
20091206141227-E60	0.00	0.00	0.00	9.81	1.27	14.69	36.42
20091206141347-E61	0.00	0.00	0.01	9.81	11.44	20.55	36.42
20091206141457-E62	0.00	-0.01	0.01	9.81	21.60	25.08	36.42
20091206141617-E63	0.00	0.00	0.01	9.81	16.52	22.93	36.42
20091206141737-E64	0.00	-0.01	0.01	9.81	21.60	25.08	36.42
20091206141847-E65	0.00	0.00	0.00	9.81	-8.90	3.01	36.42
20091206142007-E66	0.00	0.00	0.00	9.81	1.27	14.69	36.42
20091206142127-E67	0.00	3.63	7.25	9.81	-9.04	3.02	36.42
20091206142237-E68	0.00	0.00	0.00	9.81	6.35	17.86	36.42
20091206142358-E69	0.00	0.00	0.00	9.81	-8.90	3.01	36.42
20091206142508-E70	0.00	0.00	0.01	9.81	11.44	20.55	36.42

Reviewed by: 

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ ROUTINE ☐ SPECIAL
☐ RWP # 2009-019 ☐ WP #

LOCATION & EQUIPT. 811 CULVERT

DATE: 12/7/09 TIME: 1330

INSTRUMENT

Model #	Serial #	CAL DUE
Ludlum 3	70090	10/21/10
N/A	N/A	N/A
N/A	N/A	N/A
N/A	N/A	N/A

NOTE: SURVEY PERFORMED ON APPROXIMATED 30' SQ. THAT WAS FOUND TO HAVE FIXED CONTAMINATION DURING FINAL STATUS SURVEY OF THE PHASE I CULVERT. ON 12/6/09

NOTE: POST REMEDIATION SURVEY FOUND ALL AREAS TO BE < 1000.0 DPM/PROBE (βγ) SJS 12/7/09

NOTE: REMEDIATION SPOILS WERE BAGGED & TAGGED AS RAD WASTE & PLACED IN A POSTED RMA (BLDG 811) AWAITING DISPOSAL.

LEGEND
○ SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCATION
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	

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

Surveyed By: [signature] Date: 12/7/09 Reviewed By: [signature] Date: 12/9/09

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ ROUTINE ☐ SPECIAL
☐ RWP # 019 ☐ WP #

LOCATION & EQUIPT. 801-811 yard
DATE: 12/06/09 TIME: 10:45

Zone #1 801—811 Excavation

This survey was done in support of 801/811 excavation of the FSS of zone #1.

Approximately 300 feet of culvert was measured and marked every 30 ft. A smear and direct frisk of the area was performed prior to the chipping of the concrete. A direct frisk showed no activity above background and the smear results are on the attached sheet. A sample was taken at all 10 areas they were chipped up and a composite sample was made of samples 1-4 and 5-8 and 9&10.

INSTRUMENT

Model #	Serial #	CAL DUE
S5-xlb	67705	5/1/10
Lud-3	39854	12/16/09
N/A		
N/A		

LEGEND
○ SMEAR SURVEY LOCATION △ AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCA-
C̄ CONTAMINATION ✱ CONTACT
XXXX / 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.	
2	n/a	6.	
3	n/a	7.	
4.	n/a	8.	

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

1.	See	8.	Attached	15.	Results
2	Batch	9.	Number	16.	22430
3.		10.		17.	
4.		11.		18.	
5.		12.		19.	
6.		13.		20	
7.		14		21.	

Surveyed By William Calash Date: 12/06/09 Reviewed By: Date: 12/7/09

Activity Report

chipping locations zone #1

Batch Name:	22,430	**Acquisition Date:**	12/6/09
Batch ID:	1 Minute Smear Analysis - 200912061141	**Acquisition Time: (minutes)**	1.0
Group:	E		
Device:	S5 XLB	**Operating Voltage: (volts)**	1,350.0
Selected Geometry:	1/8" Stainless Steel		

Efficiency Factors

Alpha Efficiency: (%)	0.28	±	0.00	**Beta Efficiency: (%)**	0.20	±	0.00

Sample ID	Quantity	Alpha (DPM)	2σ	Alpha MDA (DPM)	Beta Activity (DPM)	2σ	Beta MDA (DPM)
20091206114137-E1	0.00	0.00	0.01	9.81	11.44	20.55	36.42
20091206114407-E2	0.00	0.00	0.01	9.81	16.52	22.93	36.42
20091206114527-E3	0.00	-0.01	0.01	9.81	31.77	28.91	36.42
20091206114647-E4	0.00	-0.01	0.01	9.81	21.60	25.08	36.42
20091206114757-E5	0.00	-0.01	0.01	9.81	26.69	27.07	36.42
20091206114917-E6	0.00	0.00	0.00	9.81	-3.81	10.60	36.42
20091206115028-E7	0.00	-0.01	0.01	9.81	47.02	33.85	36.42
20091206115148-E8	0.00	-0.01	0.01	9.81	36.85	30.65	36.42
20091206115308-E9	0.00	0.00	0.01	9.81	11.44	20.55	36.42
20091206115418-E10	0.00	0.00	0.00	9.81	-3.81	10.60	36.42

Reviewed by:

ASL Prefix No. 239230

Page 1 of 1

BROOKHAVEN NATIONAL LABORATORY

Carrier/Waybill # ______

P.O. # ______

Chain of Custody No. 30035

Requires EDD [X] DQL ___

SAMPLING CHAIN OF CUSTODY

Name: Adrian Stronhauff	Name: HPs	Name: General Engineering Labs
Life No: 07065 Ext.	Contact: Mike Hollander	Address: 2040 Savage Road
Acct. No: Dept: FAP	Phone:	City: Charleston St: SC Zip: 29417
Email Reports To:	Email/Fax: hollander@bnl.gov	Contact: Ann Skrudski
1 M. Pizzulli	Sampler: hollander	Phone: 843-556-8171
2 hollander@bnl.gov		Email/Fax: ann.skradski@gel.com
811 Waste Transfer Lines	M. Pizzulli	Adrian Stronhauff

Comments: "E" (and) 10/14/09. "C" = Concrete. cell: 516-807-1656.

LBD	Inp	Col	Site ID/Bldg/Life #	Depth/RWP	Date	Time	Matrix	Name/Description		Cont. Vol./Units	Cont. Type	# of Cont.	Preservative	Ni-63	Tritium (10-14-09)	Gamma Spec	Plutonium isotopes	Curium isotopes	Uranium isotopes	Nuclide-specific Alpha	PCBs	Metals	Tritium
001	E	C	811 WTL	0-0.5	9/22/09	0000	C	Samples (1-4)	C-001	500ml	P	1	/	X	X	X	X	X	X				X
002	E	C	811 WTL	0-0.5	↓	0000	C	Samples (5-8)	C-002	↓	↓	↓	/	X	X	X	X	X	X				X
003	E	C	811 WTL	0-0.5	↓	0000	C	Samples (9-12)	C-003	↓	↓	↓	/	X		X	X	X	X				X
004	E	C	811 WTL	0-0.5	↓	0010	C	Samples (13-16)	C-004	↓	↓	↓	/	X		X	X	X	X				X

(Ann)

1 Relinquished By/Date/Time	2 Relinquished By/Date/Time	3 Relinquished By/Date/Time
Print: Adrian Stronhauff 10/14/09 [illegible]	Print	Print
Signature: [signature]	Signature	Signature
1 Received By/Date/Time	2 Received By/Date/Time	3 Received By/Date/Time
Print: Mike Kinslow 10-17-09	Print	Print
Signature: [signature] 0920	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 ( )

GEL Laboratories LLC

SAMPLE RECEIPT & REVIEW FORM

Client: BRKL	**SDG/ARCOC/Work Order:** 239236
Received By: MK	**Date Received:** 10/7/09

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?		✓	Maximum Counts Observed*: Cpm 20
Classified Radioactive II or III by RSO?		✓	
COC/Samples marked containing PCBs?		✓	
Shipped as a DOT Hazardous?		✓	Hazard Class Shipped: UN#:
Samples identified as Foreign Soil?		✓	

	Sample Receipt Criteria	Yes	NA	No	Comments/Qualifiers (Required for Non-Conforming Items)
1	Shipping containers received intact and sealed?	✓			Circle Applicable: seals broken / damaged container / leaking container / other (describe)
2	Samples requiring cold preservation within 0 ≤ 6 deg. C?		✓		Preservation Method: ice bags / blue ice / dry ice / (none) / other (describe) 17°
3	Chain of custody documents included with shipment?	✓			
4	Sample containers intact and sealed?	✓			Circle Applicable: seals broken / damaged container / leaking container / other (describe)
5	Samples requiring chemical preservation at proper pH?		✓		Sample ID's, containers affected and observed pH: If Preservation added, Lot#:
6	VOA vials free of headspace (defined as < 6mm bubble)?		✓		Sample ID's and containers affected:
7	Are Encore containers present?			✓	(If yes, immediately deliver to Volatiles laboratory)
8	Samples received within holding time?	✓			Id's and tests affected:
9	Sample ID's on COC match ID's on bottles?	✓			Sample ID's and containers affected:
10	Date & time on COC match date & time on bottles?			✓	Sample ID's affected: NO TIME ON CONTAINERS
11	Number of containers received match number indicated on COC?	✓			Sample ID's affected:
12	COC form is properly signed in relinquished/received sections?	✓			

Comments:

FX 9800 5392 7360

PM (or PMA) review: Initials MMS Date 10/19/09

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: October 23, 2009

Contact: Mr. John Burke
Project: **Hazardous & Radiochemical Analytical Services—Summary**

Client Sample ID:	30035-001	Project:	BRKL00501
Sample ID:	239236001	Client ID:	BRKL005
Matrix:	R	COC:	30035
Collect Date:	22-SEP-09 00:00	Samp Recv.:	
Receive Date:	17-OCT-09 09:20	Client Desc:	811 WTL
Collector:	Client	Vol. Recv:	

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Alpha Spec Analysis											
Alphaspec Am241, Cm, Solid "Dry Weight Corrected"											
Americium-241	U	0.0717	+/-0.247	0.555	1.00	pCi/g		AXD2 10/21/09	2047	913993	1
Curium-242	U	0.143	+/-0.229	0.390	1.00	pCi/g					
Curium-243/244	U	0.00575	+/-0.221	0.580	1.00	pCi/g					
Curium-245/246	U	0.313	+/-0.328	0.399	1.00	pCi/g					
Alphaspec Pu, Solid "Dry Weight Corrected"											
Plutonium-239/240	U	0.0764	+/-0.173	0.365	1.00	pCi/g		AXD2 10/22/09	2141	913994	2
Alphaspec U, Solid "Dry Weight Corrected"											
Uranium-233/234	U	-0.0889	+/-0.169	0.577	0.900	pCi/g		AXD2 10/21/09	2045	913997	3
Uranium-235/236	U	0.134	+/-0.252	0.489	0.900	pCi/g					
Uranium-238	J	0.286	+/-0.280	0.214	0.900	pCi/g					
Rad Gamma Spec Analysis											
Gammaspec, Gamma, Solid "Dry Weight Corrected"											
Beryllium-7	DL	0.0471	+/-0.161	0.268	0.074	pCi/g		MXR1 10/21/09	1528	914045	4
Cesium-137		0.472	+/-0.0544	0.0233	0.010	pCi/g					
Cobalt-57	DL	0.00968	+/-0.00911	0.0151	0.007	pCi/g					
Cobalt-60	DL	0.0095	+/-0.0146	0.026	0.011	pCi/g					
Manganese-54	DL	-0.0364	+/-0.0244	0.0241	0.008	pCi/g					
Potassium-40		3.14	+/-0.498	0.232	0.180	pCi/g					
Radium-226		0.231	+/-0.074	0.0464	0.026	pCi/g					
Sodium-22	DL	0.0163	+/-0.015	0.0273	0.010	pCi/g					
Thorium-228		0.323	+/-0.0638	0.036	0.021	pCi/g					
Rad Liquid Scintillation Analysis											
LSC, Tritium Dist, Solid "As Received"											
Tritium	U	-45.7	+/-159	282	300	pCi/g		KXK2 10/20/09	1853	913613	5
Liquid Scint Ni63, Solid "Dry Weight Corrected"											
Nickel-63	U	0.137	+/-2.02	3.51	4.00	pCi/g		DXM 10/21/09 2025 914020 2			6

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	KXG3	10/19/09	1902	913840

The following Analytical Methods were performed

Method	Description	Analyst Comments

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Certificate of Analysis

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

Report Date: October 23, 2009

Contact: Mr. John Burke
Project: **Hazardous & Radiochemical Analytical Services—Summary**

Client Sample ID: 30035-001
Sample ID: 23923600l

Project: BRKL00501
Client ID: BRKL005

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	DOE EML HASL-300, Am-05-RC Modified	
2	DOE EML HASL-300, Pu-11-RC Modified	
3	DOE EML HASL-300, U-02-RC Modified	
4	DOE HASL 300, 4 5.2.3/Ga-01-R	
5	EPA 906.0 Modified	
6	DOE RESL Ni-1, Modified	

Surrogate/Tracer recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
Americium-243 Tracer	Alphaspec Am241, Cm, Solid "Dry Weight Corrected"			86.3	(15%-125%)
Plutonium-242 Tracer	Alphaspec Pu, Solid "Dry Weight Corrected"			98.6	(15%-125%)
Uranium-232 Tracer	Alphaspec U, Solid "Dry Weight Corrected"			69.2	(15%-125%)
Nickel Carrier	Liquid Scint Ni63, Solid "Dry Weight Corrected"			67.6	(25%-125%)

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Certificate of Analysis

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

Report Date: October 23, 2009

Contact: Mr. John Burke
Project: **Hazardous & Radiochemical Analytical Services—Summary**

Client Sample ID:	30035-002	Project:	BRKL00501
Sample ID:	239236002	Client ID:	BRKL005
Matrix:	R	COC:	30035
Collect Date:	22-SEP-09 00:00	Samp Recv.:	
Receive Date:	17-OCT-09 09:20	Client Desc.:	811 WTL
Collector:	Client	Vol. Recv.:	

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Alpha Spec Analysis											
Alphaspec Am241, Cm, Solid "Dry Weight Corrected"											
Americium-241	U	-0.0966	+/-0.167	0.506	1.00	pCi/g		AXD2 10/21/09	2047	913993	1
Curium-242	U	-0.0209	+/-0.176	0.418	1.00	pCi/g					
Curium-243/244	U	-0.0185	+/-0.155	0.369	1.00	pCi/g					
Curium-245,246	U	0.00	+/-0.175	0.267	1.00	pCi/g					
Alphaspec Pu, Solid "Dry Weight Corrected"											
Plutonium-239/240	U	-0.0554	+/-0.125	0.380	1.00	pCi/g		AXD2 10/22/09	2141	913994	2
Alphaspec U, Solid "Dry Weight Corrected"											
Uranium-233/234	J	0.561	+/-0.332	0.238	0.900	pCi/g		AXD2 10/21/09	2045	913997	3
Uranium-235/236	U	-0.0148	+/-0.124	0.295	0.900	pCi/g					
Uranium-238	J	0.348	+/-0.258	0.149	0.900	pCi/g					
Rad Gamma Spec Analysis											
Gammaspec, Gamma, Solid "Dry Weight Corrected"											
Beryllium-7	DL	-0.0108	+/-0.0665	0.115	0.074	pCi/g		MXR1 10/20/09	2020	914045	4
Cesium-137		0.209	+/-0.0206	0.011	0.010	pCi/g					
Cobalt-57	DL	0.000458	+/-0.00464	0.00812	0.007	pCi/g					
Cobalt-60	U	-0.000248	+/-0.00625	0.0105	0.011	pCi/g					
Manganese-54	DL	-0.00108	+/-0.00638	0.0109	0.008	pCi/g					
Potassium-40		2.91	+/-0.295	0.0935	0.180	pCi/g					
Radium-226		0.238	+/-0.036	0.021	0.026	pCi/g					
Sodium-22	DL	-0.00823	+/-0.00644	0.0102	0.010	pCi/g					
Thorium-228		0.354	+/-0.0315	0.0164	0.021	pCi/g					
Rad Liquid Scintillation Analysis											
LSC, Tritium Dist, Solid "As Received"											
Tritium	U	-81.5	+/-155	277	300	pCi/g		KXK2 10/20/09	1940	913613	5
Liquid Scint Ni63, Solid "Dry Weight Corrected"											
Nickel-63	U	0.406	+/-2.01	3.48	4.00	pCi/g		DXM 10/21/09 2	2047	914020	6

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	KXG3	10/19/09	1902	913840

The following Analytical Methods were performed

Method	Description	Analyst Comments

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Certificate of Analysis

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

Report Date: October 23, 2009

Contact: Mr. John Burke
Project: **Hazardous & Radiochemical Analytical Services--Summary**

Client Sample ID: 30035-002
Sample ID: 239236002

Project: BRKL00501
Client ID: BRKL005

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	DOE EML HASL-300, Am-05-RC Modified	
2	DOE EML HASL-300, Pu-11-RC Modified	
3	DOE EML HASL-300, U-02-RC Modified	
4	DOE HASL 300, 4 5.2.3/Ga-01-R	
5	EPA 906 0 Modified	
6	DOE RESL Ni-1, Modified	

Surrogate/Tracer recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
Americium-243 Tracer	Alphaspec Am241, Cm, Solid "Dry Weight Corrected"			82.9	(15%-125%)
Plutonium-242 Tracer	Alphaspec Pu, Solid "Dry Weight Corrected"			102	(15%-125%)
Uranium-232 Tracer	Alphaspec U, Solid "Dry Weight Corrected"			101	(15%-125%)
Nickel Carrier	Liquid Scint Ni63, Solid "Dry Weight Corrected"			68 4	(25%-125%)

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Certificate of Analysis

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

Report Date: October 23, 2009

Contact: Mr. John Burke
Project: **Hazardous & Radiochemical Analytical Services—Summary**

Client Sample ID:	30035-003	Project:	BRKL00501
Sample ID:	239236003	Client ID:	BRKL005
Matrix:	R	COC:	30035
Collect Date:	22-SEP-09 00:00	Samp Recv.:	
Receive Date:	17-OCT-09 09 20	Client Desc.:	811 WTL
Collector:	Client	Vol Recv:	

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Alpha Spec Analysis												
Alphaspec Am241, Cm, Solid "Dry Weight Corrected"												
Americium-241	U	0.0278	+/-0.132	0.314	1.00	pCi/g		AXD2	10/21/09	2047	913993	1
Curium-242	U	-0.0357	+/-0.154	0.412	1.00	pCi/g						
Curium-243/244	U	-0.0158	+/-0.132	0.315	1.00	pCi/g						
Curium-245/246	U	0.152	+/-0.211	0.228	1.00	pCi/g						
Alphaspec Pu, Solid "Dry Weight Corrected"												
Plutonium-239/240	U	-0.0408	+/-0.120	0.346	1.00	pCi/g		AXD2	10/22/09	2141	913994	2
Alphaspec U, Solid "Dry Weight Corrected"												
Uranium-233/234	U	0.133	+/-0.226	0.417	0.900	pCi/g		AXD2	10/21/09	2045	913997	3
Uranium-235/236	U	0.145	+/-0.199	0.319	0.900	pCi/g						
Uranium-238	U	0.235	+/-0.228	0.307	0.900	pCi/g						
Rad Gamma Spec Analysis												
Gammaspec, Gamma, Solid "Dry Weight Corrected"												
Beryllium-7	DL	0.0754	+/-0.200	0.339	0.074	pCi/g		MXR1	10/21/09	1528	914045	4
Cesium-137		0.428	+/-0.055	0.0319	0.010	pCi/g						
Cobalt-57	DL	0.00233	+/-0.0115	0.0193	0.007	pCi/g						
Cobalt-60	DL	-0.00912	+/-0.0185	0.0294	0.011	pCi/g						
Manganese-54	DL	-0.00633	+/-0.0171	0.0285	0.008	pCi/g						
Potassium-40		4.04	+/-0.666	0.281	0.180	pCi/g						
Radium-226		0.271	+/-0.0827	0.0554	0.026	pCi/g						
Sodium-22	DL	-0.0137	+/-0.0185	0.0289	0.010	pCi/g						
Thorium-228		0.309	+/-0.0745	0.0442	0.021	pCi/g						
Rad Liquid Scintillation Analysis												
LSC Tritium Dist, Solid "As Received"												
Tritium	U	-143	+/-160	291	300	pCi/g		KXK2	10/20/09	2027	913613	5
Liquid Scint Ni63, Solid "Dry Weight Corrected"												
Nickel-63	U	0.184	+/- 2.04	3.56	4.00	pCi/g		DXM 2	10/21/09	2108	914020	6

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	KXG3	10/19/09	1902	913840

The following Analytical Methods were performed

Method	Description	Analyst Comments

GEL LABORATORIES LLC
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Certificate of Analysis

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

Report Date: October 23, 2009

Contact: Mr. John Burke
Project **Hazardous & Radiochemical Analytical Services—Summary**

Client Sample ID: 30035-003
Sample ID: 239236003

Project: BRKL00501
Client ID: BRKL005

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	DOE EML HASL-300, Am-05-RC Modified	
2	DOE EML HASL-300, Pu-11-RC Modified	
3	DOE EML HASL-300, U-02-RC Modified	
4	DOE HASL 300, 4.5.2.3/Ga-01-R	
5	EPA 906.0 Modified	
6	DOE RESL Ni-1, Modified	

Surrogate/Tracer recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
Americium-243 Tracer	Alphaspec Am241, Cm, Solid "Dry Weight Corrected"			84.9	(15%-125%)
Plutonium-242 Tracer	Alphaspec Pu, Solid "Dry Weight Corrected"			96.3	(15%-125%)
Uranium-232 Tracer	Alphaspec U, Solid "Dry Weight Corrected"			102	(15%-125%)
Nickel Carrier	Liquid Scint Ni63, Solid "Dry Weight Corrected"			67.6	(25%-125%)

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Company: Brookhaven National Laboratory
Address: Building 51
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Report Date: October 23, 2009

Contact: Mr. John Burke
Project: **Hazardous & Radiochemical Analytical Services—Summary**

Client Sample ID:	30035-004	Project:	BRKL00501
Sample ID:	239236004	Client ID:	BRKL005
Matrix:	R	COC	30035
Collect Date:	22-SEP-09 00:00	Samp Recv:	
Receive Date:	17-OCT-09 09:20	Client Desc:	811 WTL
Collector:	Client	Vol Recv:	

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Alpha Spec Analysis											
Alphaspec Am241, Cm, Solid "Dry Weight Corrected"											
Americium-241	U	0.037	+/-0.114	0.175	1.00	pCi/g		AXD2 10/21/09	2047	913993	1
Curium-242	U	0.00	+/-0.130	0.199	1.00	pCi/g					
Curium-243/244	U	0.00	+/-0.115	0.176	1.00	pCi/g					
Curium-245/246	U	0.136	+/-0.188	0.203	1.00	pCi/g					
Alphaspec Pu, Solid "Dry Weight Corrected"											
Plutonium-239/240	U	-0.0122	+/-0.135	0.427	1.00	pCi/g		AXD2 10/22/09	2141	913994	2
Alphaspec U, Solid "Dry Weight Corrected"											
Uranium-233/234	U	0.289	+/-0.295	0.455	0.900	pCi/g		AXD2 10/21/09	2045	913997	3
Uranium-235/236	U	0.0742	+/-0.167	0.354	0.900	pCi/g					
Uranium-238	U	0.146	+/-0.238	0.432	0.900	pCi/g					
Rad Gamma Spec Analysis											
Gammaspec, Gamma, Solid "Dry Weight Corrected"											
Beryllium-7	DL	-0.00738	+/-0.0896	0.153	0.074	pCi/g		MXR1 10/21/09	1554	914045	4
Cesium-137		0.470	+/-0.0577	0.0143	0.010	pCi/g					
Cobalt-57	DL	-0.000914	+/-0.00396	0.00715	0.007	pCi/g					
Cobalt-60	DL	0.0144	+/-0.00953	0.0172	0.011	pCi/g					
Manganese-54	DL	-0.000457	+/-0.00842	0.0143	0.008	pCi/g					
Potassium-40		4.80	+/-0.495	0.114	0.180	pCi/g					
Radium-226		0.184	+/-0.0409	0.0258	0.026	pCi/g					
Sodium-22	DL	-0.00117	+/-0.00919	0.0154	0.010	pCi/g					
Thorium-228		0.343	+/-0.0445	0.0184	0.021	pCi/g					
Rad Liquid Scintillation Analysis											
LSC, Tritium Dist, Solid "As Received"											
Tritium	U	22.6	+/-166	289	300	pCi/g		KXK2 10/20/09	2114	913613	5
Liquid Scint Ni63, Solid "Dry Weight Corrected"											
Nickel-63	U	-1.48	+/-1.86	3.36	4.00	pCi/g		DXM 10/21/09 2	2129	914020	6

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	KXG3	10/19/09	1902	913840

The following Analytical Methods were performed

Method	Description	Analyst Comments

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Certificate of Analysis

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

Report Date: October 23, 2009

Contact: Mr John Burke
Project: **Hazardous & Radiochemical Analytical Services---Summary**

Client Sample ID: 30035-004
Sample ID: 239236004

Project: BRKL00501
Client ID: BRKL005

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	DOE EML HASL-300, Am-05-RC Modified	
2	DOE EML HASL-300, Pu-11-RC Modified	
3	DOE EML HASL-300, U-02-RC Modified	
4	DOE HASL 300, 4.5 2 3/Ga-01-R	
5	EPA 906 0 Modified	
6	DOE RESL Ni-1, Modified	

Surrogate/Tracer recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
Americium-243 Tracer	Alphaspec Am241, Cm, Solid "Dry Weight Corrected"			87 2	(15%-125%)
Plutonium-242 Tracer	Alphaspec Pu, Solid "Dry Weight Corrected"			91.1	(15%-125%)
Uranium-232 Tracer	Alphaspec U, Solid "Dry Weight Corrected"			97.8	(15%-125%)
Nickel Carrier	Liquid Scint Ni63, Solid "Dry Weight Corrected"			70.1	(25%-125%)

Appendix C

RESRAD Dose Assessment Summary Reports

1. **Resrad Run – BNL Soil Samples Only – Residential Scenario**
2. **Resrad Run – BNL Soil Samples Only – Industrial Scenario**
3. **Resrad Run – BNL and ORISE Soil Samples – Residential Scenario**
4. **Resrad Run – BNL and ORISE Soil Samples – Industrial Scenario**

Summary : WasteTransLines-Ind-Bkg-subtract-3
File : F:\RESRAD_FAMILY\RESRAD\WASTETRANSFERLINES-INDUST-BKG-SUBTRACT-3.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)	2.000E+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	1.500E-01	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Ra-226	1.000E-03	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Sr-90	6.000E-02	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 : WasteTransLines-Ind-Bkg-subtract-3
File : F:\RESRAD_FAMILY\RESRAD\WASTETRANSFERLINES-INDUST-BKG-SUBTRACT-3.RAD

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	2000.00 square meters	Cs-137	1.500E-01
Thickness:	5.00 meters	Ra-226	1.000E-03
Cover Depth:	0.00 meters	Sr-90	6.000E-02

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):	1.018E-01	9.955E-02	9.116E-02	8.169E-02	3.460E-02	1.308E-02	2.583E-03	1.324E-03
M(t):	6.785E-03	6.637E-03	6.078E-03	5.446E-03	2.307E-03	8.719E-04	1.722E-04	8.829E-05

Maximum TDOSE(t): 1.018E-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	9.908E-02	0.9736	1.105E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.223E-05	0.0006
Ra-226	2.210E-03	0.0217	2.090E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.202E-05	0.0001
Sr-90	2.875E-04	0.0028	1.810E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.598E-05	0.0007
Total	1.016E-01	0.9981	2.130E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.502E-04	0.0015

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	1.443E-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	9.914E-02	0.9[illegible]
Ra-226	1.021E-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	2.223E-03	0.0218
Sr-90	3.927E-05	0.0004	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	4.046E-04	0.0040
Total	4.044E-05	0.0004	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	1.018E-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	9.679E-02	0.9723	1.079E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.080E-05	0.0006
Ra-226	2.207E-03	0.0222	2.250E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.384E-05	0.0001
Sr-90	2.801E-04	0.0028	1.764E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.403E-05	0.0007
Total	9.928E-02	0.9973	2.097E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.487E-04	0.0015

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	4.280E-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	9.685E-02	0.9729
Ra-226	3.318E-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	2.224E-03	0.0223
Sr-90	1.156E-04	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	4.716E-04	0.0047
Total	1.194E-04	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	9.955E-02	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	8.817E-02	0.9672	9.833E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.538E-05	0.0006
Ra-226	2.195E-03	0.0241	2.840E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.055E-05	0.0002
Sr-90	2.525E-04	0.0028	1.590E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.674E-05	0.0007
Total	9.062E-02	0.9940	1.973E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.427E-04	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 = 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	1.437E-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	8.823E-02	0.
Ra-226	1.587E-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	2.232E-03	0.0245
Sr-90	3.848E-04	0.0042	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	7.057E-04	0.0077
Total	4.021E-04	0.0044	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	9.116E-02	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	7.846E-02	0.9605	8.750E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.928E-05	0.0006
Ra-226	2.180E-03	0.0267	3.473E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.776E-05	0.0003
Sr-90	2.218E-04	0.0027	1.397E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.862E-05	0.0007
Total	8.086E-02	0.9899	1.832E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.357E-04	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 = 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	2.445E-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	7.851E-02	0.9611
Ra-226	3.807E-05	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	2.247E-03	0.0275
Sr-90	6.489E-04	0.0079	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	9.308E-04	0.0114
Total	6.894E-04	0.0084	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	8.169E-02	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	3.085E-02	0.8918	3.441E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.938E-05	0.0006
Ra-226	2.067E-03	0.0597	5.939E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.616E-05	0.0016
Sr-90	7.864E-05	0.0023	4.952E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.078E-05	0.0006
Total	3.300E-02	0.9538	1.124E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.633E-05	0.0028

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	4.655E-06	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	3.088E-02	0.9
Ra-226	3.425E-04	0.0099	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	2.466E-03	0.0
Sr-90	1.154E-03	0.0334	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	1.254E-03	0.0363
Total	1.502E-03	0.0434	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	3.460E-02	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	9.608E-03	0.7346	1.071E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.035E-06	0.0005
Ra-226	1.932E-03	0.1478	6.369E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.171E-05	0.0047
Sr-90	2.151E-05	0.0016	1.355E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.684E-06	0.0004
Total	1.156E-02	0.8840	7.830E-07	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.343E-05	0.0056

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	2.907E-06	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	9.617E-03	0.7353
Ra-226	7.766E-04	0.0594	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	2.771E-03	0.2119
Sr-90	6.630E-04	0.0507	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	6.903E-04	0.0528
Total	1.442E-03	0.1103	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	1.308E-02	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	8.496E-07	0.0003	9.474E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.336E-10	0.0000
Ra-226	1.128E-03	0.4366	3.851E-07	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.752E-05	0.0145
Sr-90	6.741E-10	0.0000	4.245E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.781E-10	0.0000
Total	1.129E-03	0.4370	3.851E-07	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.752E-05	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	1.360E-09	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	8.514E-07	0.0
Ra-226	1.417E-03	0.5483	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	2.582E-03	0.9
Sr-90	2.068E-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	2.154E-08	0.0000
Total	1.417E-03	0.5484	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	2.583E-03	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	7.285E-12	0.0000	8.124E-18	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.576E-15	0.0000
Ra-226	5.755E-04	0.4345	1.965E-07	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.914E-05	0.0145
Sr-90	1.580E-15	0.0000	9.952E-18	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.176E-16	0.0000
Total	5.755E-04	0.4345	1.965E-07	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.914E-05	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 = 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	2.513E-14	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	7.314E-12	0.0000
Ra-226	7.296E-04	0.5509	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	1.324E-03	1.0000
Sr-90	4.685E-14	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	4.886E-14	0.0000
Total	7.296E-04	0.5509	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	1.324E-03	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	6.609E-01	6.457E-01	5.882E-01	5.234E-01	2.058E-01	6.411E-02	5.676E-06	4.876E-11
Ra-226+D	Ra-226+D	1.000E+00	2.222E+00	2.221E+00	2.217E+00	2.211E+00	2.170E+00	2.118E+00	1.422E+00	7.224E-01
Ra-226+D	Pb-210+D	1.000E+00	1.029E-03	3.290E-03	1.514E-02	3.531E-02	2.965E-01	6.529E-01	1.160E+00	6.020E-01
Ra-226+D	äDSR(j)		2.223E+00	2.224E+00	2.232E+00	2.247E+00	2.466E+00	2.771E+00	2.582E+00	1.324E+00
Sr-90+D	Sr-90+D	1.000E+00	6.743E-03	7.860E-03	1.176E-02	1.551E-02	2.091E-02	1.150E-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	2.269E+01	2.323E+01	2.550E+01	2.866E+01	7.287E+01	2.340E+02	2.643E+06	3.076E+11
Ra-226	6.748E+00	6.744E+00	6.721E+00	6.677E+00	6.083E+00	5.412E+00	5.808E+00	1.133E+01
Sr-90	2.225E+03	1.908E+03	1.275E+03	9.669E+02	7.175E+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	1.500E-01	0.000E+00	6.609E-01	2.269E+01	6.609E-01	2.269E+01
Ra-226	1.000E-03	262.3 ñ 0.5	3.514E+00	4.269E+00	2.223E+00	6.748E+00
Sr-90	6.000E-02	35.06 ñ 0.07	2.210E-02	6.788E+02	6.743E-03	2.225E+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	9.914E-02	9.685E-02	8.823E-02	7.851E-02	3.088E-02	9.617E-03	8.514E-07	7.314E-12
Ra-226	Ra-226	1.000E+00	2.222E-03	2.221E-03	2.217E-03	2.211E-03	2.170E-03	2.118E-03	1.422E-03	7.224E-04
Pb-210	Ra-226	1.000E+00	1.029E-06	3.290E-06	1.514E-05	3.531E-05	2.965E-04	6.529E-04	1.160E-03	6.020E-04
Sr-90	Sr-90	1.000E+00	4.046E-04	4.716E-04	7.057E-04	9.308E-04	1.254E-03	6.903E-04	2.154E-08	4.886E-14

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	1.500E-01	1.465E-01	1.335E-01	1.188E-01	4.671E-02	1.455E-02	1.286E-06	1.103E-11
Ra-226	Ra-226	1.000E+00	1.000E-03	9.987E-04	9.933E-04	9.866E-04	9.349E-04	8.741E-04	5.102E-04	2.603E-04
Pb-210	Ra-226	1.000E+00	0.000E+00	3.057E-05	1.432E-04	2.645E-04	7.472E-04	8.515E-04	5.221E-04	2.664E-04
Sr-90	Sr-90	1.000E+00	6.000E-02	5.846E-02	5.270E-02	4.630E-02	1.641E-02	4.489E-03	1.407E-07	3.298E-13

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

RESCALC.EXE execution time = 1.86 seconds

Summary : WasteTransLines-Ind-NO-Bkg-subtract-4
File : F:\RESRAD_FAMILY\RESRAD\WASTETRANSFERLINES-INDUST-NO-BKG-SUBTRACT-4.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.

Summary : WasteTransLines-Ind-NO-Bkg-subtract-4
File : F:\RESRAD_FAMILY\RESRAD\WASTETRANSFERLINES-INDUST-NO-BKG-SUBTRACT-4.RAD

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)	2.000E+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	1.500E-01	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Ra-226	3.900E-01	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Sr-90	6.000E-02	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

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	2000.00 square meters	Cs-137	1.500E-01
Thickness:	5.00 meters	Ra-226	3.900E-01
Cover Depth:	0.00 meters	Sr-90	6.000E-02

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):	9.665E-01	9.647E-01	9.593E-01	9.556E-01	9.939E-01	1.091E+00	1.007E+00	5.165E-01
M(t):	6.443E-02	6.432E-02	6.395E-02	6.371E-02	6.626E-02	7.274E-02	6.714E-02	3.443E-02

Maximum TDOSE(t): 1.371E+00 mrem/yr at t = 262.2 ñ 0.5 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 = 2.622E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
uclide														
Cs-137	2.181E-04	0.0002	2.432E-10	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.370E-07	0.0000
Ra-226	6.058E-01	0.4420	2.068E-04	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.015E-02	0.0147
Sr-90	3.206E-07	0.0000	2.019E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.472E-08	0.0000
Total	6.061E-01	0.4422	2.068E-04	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.015E-02	0.0147

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 2.622E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Nuclide														
Cs-137	1.768E-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	2.184E-04	0.0002
Ra-226	7.442E-01	0.5430	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	1.370E+00	0.9998
Sr-90	9.963E-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	1.037E-05	0.0000
Total	7.442E-01	0.5430	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	1.371E+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 = 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	9.908E-02	0.1025	1.105E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.223E-05	0.0001
Ra-226	8.618E-01	0.8917	8.150E-05	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.688E-03	0.0049
Sr-90	2.875E-04	0.0003	1.810E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.598E-05	0.0001
Total	9.611E-01	0.9945	8.342E-05	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.826E-03	0.0050

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	1.443E-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	9.914E-02	0.1
Ra-226	3.983E-04	0.0004	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	8.669E-01	0.
Sr-90	3.927E-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	4.046E-04	0.0004
Total	4.377E-04	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	9.665E-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	9.679E-02	0.1003	1.079E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.080E-05	0.0001
Ra-226	8.606E-01	0.8921	8.775E-05	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.399E-03	0.0056
Sr-90	2.801E-04	0.0003	1.764E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.403E-05	0.0001
Total	9.577E-01	0.9927	8.962E-05	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.533E-03	0.0057

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	4.280E-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	9.685E-02	0.1004
Ra-226	1.294E-03	0.0013	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	8.674E-01	0.8991
Sr-90	1.156E-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	4.716E-04	0.0005
Total	1.410E-03	0.0015	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	9.647E-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	8.817E-02	0.0919	9.833E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.538E-05	0.0001
Ra-226	8.561E-01	0.8924	1.107E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.015E-03	0.0084
Sr-90	2.525E-04	0.0003	1.590E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.674E-05	0.0001
Total	9.445E-01	0.9845	1.124E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.137E-03	0.0085

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	1.437E-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	8.823E-02	0.0
Ra-226	6.190E-03	0.0065	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	8.704E-01	0.9075
Sr-90	3.848E-04	0.0004	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	7.057E-04	0.0007
Total	6.577E-03	0.0069	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	9.593E-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	7.846E-02	0.0821	8.750E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.928E-05	0.0001
Ra-226	8.504E-01	0.8899	1.354E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.083E-02	0.0113
Sr-90	2.218E-04	0.0002	1.397E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.862E-05	0.0001
Total	9.291E-01	0.9722	1.369E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.093E-02	0.0114

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.
s-137	2.445E-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	7.851E-02	0.0822
a-226	1.485E-02	0.0155	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	8.762E-01	0.9169
Sr-90	6.489E-04	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	9.308E-04	0.0010
Total	1.550E-02	0.0162	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	9.556E-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	3.085E-02	0.0310	3.441E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.938E-05	0.0000
Ra-226	8.060E-01	0.8110	2.316E-04	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.190E-02	0.0220
Sr-90	7.864E-05	0.0001	4.952E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.078E-05	0.0000
Total	8.370E-01	0.8421	2.322E-04	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.194E-02	0.0221

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	4.655E-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	3.088E-02	0.0
Ra-226	1.336E-01	0.1344	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	9.617E-01	0.9
Sr-90	1.154E-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	1.254E-03	0.0013
Total	1.347E-01	0.1355	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	9.939E-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+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	9.608E-03	0.0088	1.071E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.035E-06	0.0000
Ra-226	7.536E-01	0.6907	2.484E-04	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.407E-02	0.0221
Sr-90	2.151E-05	0.0000	1.355E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.684E-06	0.0000
Total	7.633E-01	0.6995	2.485E-04	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.408E-02	0.0221

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	2.907E-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	9.617E-03	0.0088
Ra-226	3.029E-01	0.2776	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	1.081E+00	0.9906
Sr-90	6.630E-04	0.0006	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	6.903E-04	0.0006
Total	3.035E-01	0.2782	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	1.091E+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	8.496E-07	0.0000	9.474E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.336E-10	0.0000
Ra-226	4.399E-01	0.4368	1.502E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.463E-02	0.0145
Sr-90	6.741E-10	0.0000	4.245E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.781E-10	0.0000
Total	4.399E-01	0.4368	1.502E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.463E-02	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	1.360E-09	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	8.514E-07	0.0
Ra-226	5.525E-01	0.5485	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	1.007E+00	1.00
Sr-90	2.068E-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	2.154E-08	0.0000
Total	5.525E-01	0.5485	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	1.007E+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	7.285E-12	0.0000	8.124E-18	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.576E-15	0.0000
Ra-226	2.244E-01	0.4345	7.663E-05	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.466E-03	0.0145
Sr-90	1.580E-15	0.0000	9.952E-18	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.176E-16	0.0000
Total	2.244E-01	0.4345	7.663E-05	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.466E-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 = 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	2.513E-14	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	7.314E-12	0.0000
Ra-226	2.845E-01	0.5509	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	5.165E-01	1.0000
Sr-90	4.685E-14	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	4.886E-14	0.0000
Total	2.845E-01	0.5509	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	5.165E-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	6.609E-01	6.457E-01	5.882E-01	5.234E-01	2.058E-01	6.411E-02	5.676E-06	4.876E-11
Ra-226+D	Ra-226+D	1.000E+00	2.222E+00	2.221E+00	2.217E+00	2.211E+00	2.170E+00	2.118E+00	1.422E+00	7.224E-01
Ra-226+D	Pb-210+D	1.000E+00	1.029E-03	3.290E-03	1.514E-02	3.531E-02	2.965E-01	6.529E-01	1.160E+00	6.020E-01
Ra-226+D	äDSR(j)		2.223E+00	2.224E+00	2.232E+00	2.247E+00	2.466E+00	2.771E+00	2.582E+00	1.324E+00
Sr-90+D	Sr-90+D	1.000E+00	6.743E-03	7.860E-03	1.176E-02	1.551E-02	2.091E-02	1.150E-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	2.269E+01	2.323E+01	2.550E+01	2.866E+01	7.287E+01	2.340E+02	2.643E+06	3.076E+11
Ra-226	6.748E+00	6.744E+00	6.721E+00	6.677E+00	6.083E+00	5.412E+00	5.808E+00	1.133E+01
Sr-90	2.225E+03	1.908E+03	1.275E+03	9.669E+02	7.175E+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 = 262.2 ñ 0.5 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	1.500E-01	0.000E+00	6.609E-01	2.269E+01	1.456E-03	1.030E+04
Ra-226	3.900E-01	262.3 ñ 0.5	3.514E+00	4.269E+00	3.514E+00	4.269E+00
Sr-90	6.000E-02	35.06 ñ 0.07	2.210E-02	6.788E+02	1.728E-04	8.679E+04

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	9.914E-02	9.685E-02	8.823E-02	7.851E-02	3.088E-02	9.617E-03	8.514E-07	7.314E-12
Ra-226	Ra-226	1.000E+00	8.665E-01	8.661E-01	8.645E-01	8.624E-01	8.461E-01	8.262E-01	5.546E-01	2.818E-01
Pb-210	Ra-226	1.000E+00	4.012E-04	1.283E-03	5.904E-03	1.377E-02	1.156E-01	2.546E-01	4.526E-01	2.348E-01
Sr-90	Sr-90	1.000E+00	4.046E-04	4.716E-04	7.057E-04	9.308E-04	1.254E-03	6.903E-04	2.154E-08	4.886E-14

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	1.500E-01	1.465E-01	1.335E-01	1.188E-01	4.671E-02	1.455E-02	1.286E-06	1.103E-11
Ra-226	Ra-226	1.000E+00	3.900E-01	3.895E-01	3.874E-01	3.848E-01	3.646E-01	3.409E-01	1.990E-01	1.015E-01
Pb-210	Ra-226	1.000E+00	0.000E+00	1.192E-02	5.586E-02	1.031E-01	2.914E-01	3.321E-01	2.036E-01	1.039E-01
Sr-90	Sr-90	1.000E+00	6.000E-02	5.846E-02	5.270E-02	4.630E-02	1.641E-02	4.489E-03	1.407E-07	3.298E-13

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

RESCALC.EXE execution time = 2.08 seconds

Summary : Waste Transfer Lines-Res-Non-Farm-BKG-subtract-1
File : F:\RESRAD_FAMILY\RESRAD\WASTETRANSFERLINESRES-NON-FARM-BKG-SUBTRACT-1.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)	2.000E+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	1.500E-01	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Ra-226	1.000E-03	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Sr-90	6.000E-02	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 : Waste Transfer Lines-Res-Non-Farm-BKG-subtract-1
File : F:\RESRAD_FAMILY\RESRAD\WASTETRANSFERLINESRES-NON-FARM-BKG-SUBTRACT-1.RAD

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	2000.00 square meters	Cs-137	1.500E-01
Thickness:	5.00 meters	Ra-226	1.000E-03
Cover Depth:	0.00 meters	Sr-90	6.000E-02

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):	5.702E-01	5.570E-01	5.071E-01	4.513E-01	1.823E-01	6.681E-02	1.161E-02	5.233E-03
M(t):	3.802E-02	3.713E-02	3.381E-02	3.009E-02	1.215E-02	4.454E-03	7.740E-04	3.489E-04

Maximum TDOSE(t): 5.702E-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	2.954E-01	0.5181	2.227E-07	0.0000	0.000E+00	0.0000	2.580E-02	0.0452	0.000E+00	0.0000	0.000E+00	0.0000	2.435E-04	0.0004
Ra-226	6.588E-03	0.0116	4.212E-07	0.0000	0.000E+00	0.0000	4.708E-03	0.0083	0.000E+00	0.0000	0.000E+00	0.0000	4.703E-05	0.0001
Sr-90	8.570E-04	0.0015	3.649E-06	0.0000	0.000E+00	0.0000	2.362E-01	0.4142	0.000E+00	0.0000	0.000E+00	0.0000	2.972E-04	0.0005
Total	3.029E-01	0.5311	4.293E-06	0.0000	0.000E+00	0.0000	2.667E-01	0.4677	0.000E+00	0.0000	0.000E+00	0.0000	5.878E-04	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 = 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	5.007E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.326E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.215E-01	0.
Ra-226	2.688E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.872E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.135E-02	0.0199
Sr-90	1.008E-04	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	7.511E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.374E-01	0.4164
Total	1.040E-04	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	7.731E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.702E-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	2.886E-01	0.5181	2.176E-07	0.0000	0.000E+00	0.0000	2.520E-02	0.0452	0.000E+00	0.0000	0.000E+00	0.0000	2.379E-04	0.0004
Ra-226	6.577E-03	0.0118	4.534E-07	0.0000	0.000E+00	0.0000	4.895E-03	0.0088	0.000E+00	0.0000	0.000E+00	0.0000	5.415E-05	0.0001
Sr-90	8.346E-04	0.0015	3.553E-06	0.0000	0.000E+00	0.0000	2.300E-01	0.4129	0.000E+00	0.0000	0.000E+00	0.0000	2.894E-04	0.0005
Total	2.960E-01	0.5314	4.224E-06	0.0000	0.000E+00	0.0000	2.601E-01	0.4669	0.000E+00	0.0000	0.000E+00	0.0000	5.815E-04	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	1.480E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.048E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.140E-01	0.5638
Ra-226	8.731E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.292E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.154E-02	0.0207
Sr-90	2.968E-04	0.0005	0.000E+00	0.0000	0.000E+00	0.0000	2.283E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.314E-01	0.4155
Total	3.070E-04	0.0006	0.000E+00	0.0000	0.000E+00	0.0000	2.357E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.570E-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	2.628E-01	0.5182	1.981E-07	0.0000	0.000E+00	0.0000	2.295E-02	0.0453	0.000E+00	0.0000	0.000E+00	0.0000	2.166E-04	0.0004
Ra-226	6.536E-03	0.0129	5.717E-07	0.0000	0.000E+00	0.0000	5.566E-03	0.0110	0.000E+00	0.0000	0.000E+00	0.0000	8.032E-05	0.0002
Sr-90	7.507E-04	0.0015	3.196E-06	0.0000	0.000E+00	0.0000	2.069E-01	0.4079	0.000E+00	0.0000	0.000E+00	0.0000	2.603E-04	0.0005
Total	2.701E-01	0.5326	3.966E-06	0.0000	0.000E+00	0.0000	2.354E-01	0.4641	0.000E+00	0.0000	0.000E+00	0.0000	5.573E-04	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	4.963E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.614E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.860E-01	0.5
Ra-226	4.183E-05	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	3.056E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.223E-02	0.0241
Sr-90	9.863E-04	0.0019	0.000E+00	0.0000	0.000E+00	0.0000	7.702E-05	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	2.089E-01	0.4120
Total	1.033E-03	0.0020	0.000E+00	0.0000	0.000E+00	0.0000	8.043E-05	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	5.071E-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	2.338E-01	0.5181	1.763E-07	0.0000	0.000E+00	0.0000	2.042E-02	0.0452	0.000E+00	0.0000	0.000E+00	0.0000	1.927E-04	0.0004
Ra-226	6.485E-03	0.0144	6.983E-07	0.0000	0.000E+00	0.0000	6.282E-03	0.0139	0.000E+00	0.0000	0.000E+00	0.0000	1.084E-04	0.0002
Sr-90	6.576E-04	0.0015	2.800E-06	0.0000	0.000E+00	0.0000	1.812E-01	0.4015	0.000E+00	0.0000	0.000E+00	0.0000	2.281E-04	0.0005
Total	2.409E-01	0.5339	3.674E-06	0.0000	0.000E+00	0.0000	2.079E-01	0.4607	0.000E+00	0.0000	0.000E+00	0.0000	5.292E-04	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	8.441E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.177E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.544E-01	0.5637
Ra-226	1.004E-04	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	7.344E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.298E-02	0.0288
Sr-90	1.661E-03	0.0037	0.000E+00	0.0000	0.000E+00	0.0000	1.300E-04	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	1.839E-01	0.4075
Total	1.770E-03	0.0039	0.000E+00	0.0000	0.000E+00	0.0000	1.380E-04	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	4.513E-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	9.171E-02	0.5030	6.915E-08	0.0000	0.000E+00	0.0000	8.009E-03	0.0439	0.000E+00	0.0000	0.000E+00	0.0000	7.560E-05	0.0004
Ra-226	6.088E-03	0.0334	1.184E-06	0.0000	0.000E+00	0.0000	8.958E-03	0.0491	0.000E+00	0.0000	0.000E+00	0.0000	2.174E-04	0.0012
Sr-90	2.279E-04	0.0013	9.704E-07	0.0000	0.000E+00	0.0000	6.281E-02	0.3445	0.000E+00	0.0000	0.000E+00	0.0000	7.905E-05	0.0004
Total	9.803E-02	0.5377	2.223E-06	0.0000	0.000E+00	0.0000	7.978E-02	0.4376	0.000E+00	0.0000	0.000E+00	0.0000	3.720E-04	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 = 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	1.604E-05	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	1.179E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.982E-02	0.5
Ra-226	9.003E-04	0.0049	0.000E+00	0.0000	0.000E+00	0.0000	6.585E-05	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	1.623E-02	0.0890
Sr-90	2.923E-03	0.0160	0.000E+00	0.0000	0.000E+00	0.0000	2.293E-04	0.0013	0.000E+00	0.0000	0.000E+00	0.0000	6.627E-02	0.3635
Total	3.839E-03	0.0211	0.000E+00	0.0000	0.000E+00	0.0000	2.964E-04	0.0016	0.000E+00	0.0000	0.000E+00	0.0000	1.823E-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+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	2.847E-02	0.4262	2.147E-08	0.0000	0.000E+00	0.0000	2.487E-03	0.0372	0.000E+00	0.0000	0.000E+00	0.0000	2.347E-05	0.0004
Ra-226	5.624E-03	0.0842	1.255E-06	0.0000	0.000E+00	0.0000	9.210E-03	0.1378	0.000E+00	0.0000	0.000E+00	0.0000	2.361E-04	0.0035
Sr-90	6.062E-05	0.0009	2.581E-07	0.0000	0.000E+00	0.0000	1.671E-02	0.2500	0.000E+00	0.0000	0.000E+00	0.0000	2.102E-05	0.0003
Total	3.416E-02	0.5113	1.534E-06	0.0000	0.000E+00	0.0000	2.840E-02	0.4251	0.000E+00	0.0000	0.000E+00	0.0000	2.806E-04	0.0042

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	9.996E-06	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	7.350E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.099E-02	0.4639
Ra-226	2.028E-03	0.0304	0.000E+00	0.0000	0.000E+00	0.0000	1.483E-04	0.0022	0.000E+00	0.0000	0.000E+00	0.0000	1.725E-02	0.2582
Sr-90	1.653E-03	0.0247	0.000E+00	0.0000	0.000E+00	0.0000	1.297E-04	0.0019	0.000E+00	0.0000	0.000E+00	0.0000	1.857E-02	0.2779
Total	3.691E-03	0.0552	0.000E+00	0.0000	0.000E+00	0.0000	2.788E-04	0.0042	0.000E+00	0.0000	0.000E+00	0.0000	6.681E-02	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	2.458E-06	0.0002	1.853E-12	0.0000	0.000E+00	0.0000	2.146E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.026E-09	0.0000
Ra-226	2.981E-03	0.2567	6.892E-07	0.0001	0.000E+00	0.0000	5.021E-03	0.4325	0.000E+00	0.0000	0.000E+00	0.0000	1.304E-04	0.0112
Sr-90	1.518E-09	0.0000	6.461E-12	0.0000	0.000E+00	0.0000	4.182E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.263E-10	0.0000
Total	2.983E-03	0.2570	6.892E-07	0.0001	0.000E+00	0.0000	5.022E-03	0.4325	0.000E+00	0.0000	0.000E+00	0.0000	1.304E-04	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	fra
Cs-137	4.596E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.381E-10	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.679E-06	0.0002
Ra-226	3.238E-03	0.2788	0.000E+00	0.0000	0.000E+00	0.0000	2.368E-04	0.0204	0.000E+00	0.0000	0.000E+00	0.0000	1.161E-02	0.9997
Sr-90	4.054E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.183E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.640E-07	0.0000
Total	3.238E-03	0.2789	0.000E+00	0.0000	0.000E+00	0.0000	2.368E-04	0.0204	0.000E+00	0.0000	0.000E+00	0.0000	1.161E-02	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	2.045E-11	0.0000	1.542E-17	0.0000	0.000E+00	0.0000	1.786E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.685E-14	0.0000
Ra-226	1.348E-03	0.2576	3.117E-07	0.0001	0.000E+00	0.0000	2.271E-03	0.4340	0.000E+00	0.0000	0.000E+00	0.0000	5.897E-05	0.0113
Sr-90	2.688E-15	0.0000	1.144E-17	0.0000	0.000E+00	0.0000	7.407E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.321E-16	0.0000
Total	1.348E-03	0.2576	3.117E-07	0.0001	0.000E+00	0.0000	2.271E-03	0.4340	0.000E+00	0.0000	0.000E+00	0.0000	5.897E-05	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	8.316E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.118E-15	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.234E-11	0.0000
Ra-226	1.449E-03	0.2768	0.000E+00	0.0000	0.000E+00	0.0000	1.060E-04	0.0202	0.000E+00	0.0000	0.000E+00	0.0000	5.233E-03	1.0000
Sr-90	6.923E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.435E-15	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.189E-13	0.0000
Total	1.449E-03	0.2768	0.000E+00	0.0000	0.000E+00	0.0000	1.060E-04	0.0202	0.000E+00	0.0000	0.000E+00	0.0000	5.233E-03	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	2.143E+00	2.093E+00	1.906E+00	1.696E+00	6.654E-01	2.066E-01	1.786E-05	1.489E-10
Ra-226+D	Ra-226+D	1.000E+00	1.123E+01	1.121E+01	1.117E+01	1.110E+01	1.063E+01	1.007E+01	5.788E+00	2.610E+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)		1.135E+01	1.154E+01	1.223E+01	1.298E+01	1.623E+01	1.725E+01	1.161E+01	5.233E+00
Sr-90+D	Sr-90+D	1.000E+00	3.957E+00	3.857E+00	3.482E+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	7.000E+00	7.165E+00	7.868E+00	8.844E+00	2.254E+01	7.259E+01	8.398E+05	1.007E+11
Ra-226	1.322E+00	1.300E+00	1.227E+00	1.155E+00	9.242E-01	8.697E-01	1.292E+00	2.867E+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	1.500E-01	0.000E+00	2.143E+00	7.000E+00	2.143E+00	7.000E+00
Ra-226	1.000E-03	143.7 ñ 0.3	1.738E+01	8.632E-01	1.135E+01	1.322E+00
Sr-90	6.000E-02	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	3.215E-01	3.140E-01	2.860E-01	2.544E-01	9.982E-02	3.099E-02	2.679E-06	2.234E-11
Ra-226	Ra-226	1.000E+00	1.123E-02	1.121E-02	1.117E-02	1.110E-02	1.063E-02	1.007E-02	5.788E-03	2.610E-03
Pb-210	Ra-226	1.000E+00	1.191E-04	3.208E-04	1.062E-03	1.879E-03	5.601E-03	7.176E-03	5.819E-03	2.623E-03
Sr-90	Sr-90	1.000E+00	2.374E-01	2.314E-01	2.089E-01	1.839E-01	6.627E-02	1.857E-02	4.640E-07	8.189E-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	1.500E-01	1.465E-01	1.334E-01	1.187E-01	4.657E-02	1.446E-02	1.248E-06	1.038E-11
Ra-226	Ra-226	1.000E+00	1.000E-03	9.984E-04	9.921E-04	9.843E-04	9.237E-04	8.532E-04	4.522E-04	2.045E-04
Pb-210	Ra-226	1.000E+00	0.000E+00	3.057E-05	1.431E-04	2.639E-04	7.392E-04	8.329E-04	4.639E-04	2.098E-04
Sr-90	Sr-90	1.000E+00	6.000E-02	5.843E-02	5.256E-02	4.604E-02	1.596E-02	4.244E-03	1.063E-07	1.882E-13

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

RESCALC.EXE execution time = 3.49 seconds

Summary : Waste Transfer Lines-Res-Non-Farm-NO-BKG-subtract-2
File : F:\RESRAD_FAMILY\RESRAD\WASTETRANSFERLINESRES-NON-FARM-NO-BKG-SUBTRACT-2.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)	2.000E+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	1.500E-01	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Ra-226	3.900E-01	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Sr-90	6.000E-02	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

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	2000.00 square meters	Cs-137	1.500E-01
Thickness:	5.00 meters	Ra-226	3.900E-01
Cover Depth:	0.00 meters	Sr-90	6.000E-02

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):	4.984E+00	5.044E+00	5.264E+00	5.502E+00	6.496E+00	6.776E+00	4.527E+00	2.041E+00
M(t):	3.323E-01	3.363E-01	3.509E-01	3.668E-01	4.331E-01	4.517E-01	3.018E-01	1.361E-01

Maximum TDOSE(t): 6.797E+00 mrem/yr at t = 129.3 ñ 0.3 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 = 1.293E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.434E-02	0.0021	1.081E-08	0.0000	0.000E+00	0.0000	1.253E-03	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	1.182E-05	0.0000
Ra-226	2.094E+00	0.3080	4.771E-04	0.0001	0.000E+00	0.0000	3.486E+00	0.5129	0.000E+00	0.0000	0.000E+00	0.0000	9.006E-02	0.0133
Sr-90	2.789E-05	0.0000	1.187E-07	0.0000	0.000E+00	0.0000	7.686E-03	0.0011	0.000E+00	0.0000	0.000E+00	0.0000	9.672E-06	0.0000
Total	2.108E+00	0.3101	4.773E-04	0.0001	0.000E+00	0.0000	3.495E+00	0.5142	0.000E+00	0.0000	0.000E+00	0.0000	9.009E-02	0.0133

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.293E+02 years

Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	6.536E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.807E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.561E-02	0.0023
Ra-226	1.027E+00	0.1511	0.000E+00	0.0000	0.000E+00	0.0000	7.513E-02	0.0111	0.000E+00	0.0000	0.000E+00	0.0000	6.773E+00	0.9964
Sr-90	7.600E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	5.967E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.543E-03	0.0013
Total	1.028E+00	0.1512	0.000E+00	0.0000	0.000E+00	0.0000	7.519E-02	0.0111	0.000E+00	0.0000	0.000E+00	0.0000	6.797E+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 = 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	2.954E-01	0.0593	2.227E-07	0.0000	0.000E+00	0.0000	2.580E-02	0.0052	0.000E+00	0.0000	0.000E+00	0.0000	2.435E-04	0.0000
Ra-226	2.569E+00	0.5155	1.643E-04	0.0000	0.000E+00	0.0000	1.836E+00	0.3684	0.000E+00	0.0000	0.000E+00	0.0000	1.834E-02	0.0037
Sr-90	8.570E-04	0.0002	3.649E-06	0.0000	0.000E+00	0.0000	2.362E-01	0.0474	0.000E+00	0.0000	0.000E+00	0.0000	2.972E-04	0.0001
Total	2.865E+00	0.5749	1.681E-04	0.0000	0.000E+00	0.0000	2.098E+00	0.4210	0.000E+00	0.0000	0.000E+00	0.0000	1.888E-02	0.0038

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	5.007E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.326E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.215E-01	0.06
Ra-226	1.048E-03	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	7.302E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.425E+00	0.8879
Sr-90	1.008E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.511E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.374E-01	0.0476
Total	1.150E-03	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	8.057E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.984E+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	2.886E-01	0.0572	2.176E-07	0.0000	0.000E+00	0.0000	2.520E-02	0.0050	0.000E+00	0.0000	0.000E+00	0.0000	2.379E-04	0.0000
Ra-226	2.565E+00	0.5085	1.768E-04	0.0000	0.000E+00	0.0000	1.909E+00	0.3784	0.000E+00	0.0000	0.000E+00	0.0000	2.112E-02	0.0042
Sr-90	8.346E-04	0.0002	3.553E-06	0.0000	0.000E+00	0.0000	2.300E-01	0.0456	0.000E+00	0.0000	0.000E+00	0.0000	2.894E-04	0.0001
Total	2.855E+00	0.5659	1.806E-04	0.0000	0.000E+00	0.0000	2.164E+00	0.4290	0.000E+00	0.0000	0.000E+00	0.0000	2.165E-02	0.0043

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	1.480E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.048E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.140E-01	0.0623
Ra-226	3.405E-03	0.0007	0.000E+00	0.0000	0.000E+00	0.0000	2.454E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.499E+00	0.8919
Sr-90	2.968E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	2.283E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.314E-01	0.0459
Total	3.704E-03	0.0007	0.000E+00	0.0000	0.000E+00	0.0000	2.683E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	5.044E+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	2.628E-01	0.0499	1.981E-07	0.0000	0.000E+00	0.0000	2.295E-02	0.0044	0.000E+00	0.0000	0.000E+00	0.0000	2.166E-04	0.0000
Ra-226	2.549E+00	0.4843	2.230E-04	0.0000	0.000E+00	0.0000	2.171E+00	0.4124	0.000E+00	0.0000	0.000E+00	0.0000	3.132E-02	0.0060
Sr-90	7.507E-04	0.0001	3.196E-06	0.0000	0.000E+00	0.0000	2.069E-01	0.0393	0.000E+00	0.0000	0.000E+00	0.0000	2.603E-04	0.0000
Total	2.813E+00	0.5343	2.264E-04	0.0000	0.000E+00	0.0000	2.400E+00	0.4560	0.000E+00	0.0000	0.000E+00	0.0000	3.180E-02	0.0060

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	4.963E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.614E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.860E-01	0.05
Ra-226	1.631E-02	0.0031	0.000E+00	0.0000	0.000E+00	0.0000	1.192E-03	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	4.769E+00	0.9060
Sr-90	9.863E-04	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	7.702E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.089E-01	0.0397
Total	1.731E-02	0.0033	0.000E+00	0.0000	0.000E+00	0.0000	1.269E-03	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	5.264E+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	2.338E-01	0.0425	1.763E-07	0.0000	0.000E+00	0.0000	2.042E-02	0.0037	0.000E+00	0.0000	0.000E+00	0.0000	1.927E-04	0.0000
Ra-226	2.529E+00	0.4597	2.724E-04	0.0000	0.000E+00	0.0000	2.450E+00	0.4453	0.000E+00	0.0000	0.000E+00	0.0000	4.227E-02	0.0077
Sr-90	6.576E-04	0.0001	2.800E-06	0.0000	0.000E+00	0.0000	1.812E-01	0.0329	0.000E+00	0.0000	0.000E+00	0.0000	2.281E-04	0.0000
Total	2.764E+00	0.5023	2.753E-04	0.0001	0.000E+00	0.0000	2.652E+00	0.4819	0.000E+00	0.0000	0.000E+00	0.0000	4.269E-02	0.0078

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	8.441E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.177E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.544E-01	0.0462
Ra-226	3.915E-02	0.0071	0.000E+00	0.0000	0.000E+00	0.0000	2.864E-03	0.0005	0.000E+00	0.0000	0.000E+00	0.0000	5.064E+00	0.9203
Sr-90	1.661E-03	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	1.300E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.839E-01	0.0334
Total	4.082E-02	0.0074	0.000E+00	0.0000	0.000E+00	0.0000	2.995E-03	0.0005	0.000E+00	0.0000	0.000E+00	0.0000	5.502E+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	9.171E-02	0.0141	6.915E-08	0.0000	0.000E+00	0.0000	8.009E-03	0.0012	0.000E+00	0.0000	0.000E+00	0.0000	7.560E-05	0.0000
Ra-226	2.374E+00	0.3655	4.617E-04	0.0001	0.000E+00	0.0000	3.494E+00	0.5378	0.000E+00	0.0000	0.000E+00	0.0000	8.477E-02	0.0130
Sr-90	2.279E-04	0.0000	9.704E-07	0.0000	0.000E+00	0.0000	6.281E-02	0.0097	0.000E+00	0.0000	0.000E+00	0.0000	7.905E-05	0.0000
Total	2.466E+00	0.3796	4.627E-04	0.0001	0.000E+00	0.0000	3.565E+00	0.5487	0.000E+00	0.0000	0.000E+00	0.0000	8.492E-02	0.0131

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	1.604E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.179E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.982E-02	0.015
Ra-226	3.511E-01	0.0540	0.000E+00	0.0000	0.000E+00	0.0000	2.568E-02	0.0040	0.000E+00	0.0000	0.000E+00	0.0000	6.330E+00	0.9744
Sr-90	2.923E-03	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	2.293E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.627E-02	0.0102
Total	3.540E-01	0.0545	0.000E+00	0.0000	0.000E+00	0.0000	2.591E-02	0.0040	0.000E+00	0.0000	0.000E+00	0.0000	6.496E+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	2.847E-02	0.0042	2.147E-08	0.0000	0.000E+00	0.0000	2.487E-03	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	2.347E-05	0.0000
Ra-226	2.193E+00	0.3237	4.894E-04	0.0001	0.000E+00	0.0000	3.592E+00	0.5301	0.000E+00	0.0000	0.000E+00	0.0000	9.207E-02	0.0136
Sr-90	6.062E-05	0.0000	2.581E-07	0.0000	0.000E+00	0.0000	1.671E-02	0.0025	0.000E+00	0.0000	0.000E+00	0.0000	2.102E-05	0.0000
Total	2.222E+00	0.3279	4.897E-04	0.0001	0.000E+00	0.0000	3.611E+00	0.5329	0.000E+00	0.0000	0.000E+00	0.0000	9.212E-02	0.0136

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	9.996E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.350E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.099E-02	0.0046
Ra-226	7.910E-01	0.1167	0.000E+00	0.0000	0.000E+00	0.0000	5.785E-02	0.0085	0.000E+00	0.0000	0.000E+00	0.0000	6.727E+00	0.9927
Sr-90	1.653E-03	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	1.297E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.857E-02	0.0027
Total	7.926E-01	0.1170	0.000E+00	0.0000	0.000E+00	0.0000	5.798E-02	0.0086	0.000E+00	0.0000	0.000E+00	0.0000	6.776E+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	2.458E-06	0.0000	1.853E-12	0.0000	0.000E+00	0.0000	2.146E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.026E-09	0.0000
Ra-226	1.163E+00	0.2568	2.688E-04	0.0001	0.000E+00	0.0000	1.958E+00	0.4326	0.000E+00	0.0000	0.000E+00	0.0000	5.086E-02	0.0112
Sr-90	1.518E-09	0.0000	6.461E-12	0.0000	0.000E+00	0.0000	4.182E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.263E-10	0.0000
Total	1.163E+00	0.2568	2.688E-04	0.0001	0.000E+00	0.0000	1.958E+00	0.4326	0.000E+00	0.0000	0.000E+00	0.0000	5.086E-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	4.596E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.381E-10	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.679E-06	0.0000
Ra-226	1.263E+00	0.2789	0.000E+00	0.0000	0.000E+00	0.0000	9.235E-02	0.0204	0.000E+00	0.0000	0.000E+00	0.0000	4.527E+00	1.0000
Sr-90	4.054E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.183E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.640E-07	0.0000
Total	1.263E+00	0.2789	0.000E+00	0.0000	0.000E+00	0.0000	9.235E-02	0.0204	0.000E+00	0.0000	0.000E+00	0.0000	4.527E+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	2.045E-11	0.0000	1.542E-17	0.0000	0.000E+00	0.0000	1.786E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.685E-14	0.0000
Ra-226	5.258E-01	0.2576	1.216E-04	0.0001	0.000E+00	0.0000	8.856E-01	0.4340	0.000E+00	0.0000	0.000E+00	0.0000	2.300E-02	0.0113
Sr-90	2.688E-15	0.0000	1.144E-17	0.0000	0.000E+00	0.0000	7.407E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.321E-16	0.0000
Total	5.258E-01	0.2576	1.216E-04	0.0001	0.000E+00	0.0000	8.856E-01	0.4340	0.000E+00	0.0000	0.000E+00	0.0000	2.300E-02	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	8.316E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.118E-15	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.234E-11	0.0000
Ra-226	5.650E-01	0.2768	0.000E+00	0.0000	0.000E+00	0.0000	4.132E-02	0.0202	0.000E+00	0.0000	0.000E+00	0.0000	2.041E+00	1.0000
Sr-90	6.923E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.435E-15	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.189E-13	0.0000
Total	5.650E-01	0.2768	0.000E+00	0.0000	0.000E+00	0.0000	4.132E-02	0.0202	0.000E+00	0.0000	0.000E+00	0.0000	2.041E+00	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	2.143E+00	2.093E+00	1.906E+00	1.696E+00	6.654E-01	2.066E-01	1.786E-05	1.489E-10
Ra-226+D	Ra-226+D	1.000E+00	1.123E+01	1.121E+01	1.117E+01	1.110E+01	1.063E+01	1.007E+01	5.788E+00	2.610E+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)		1.135E+01	1.154E+01	1.223E+01	1.298E+01	1.623E+01	1.725E+01	1.161E+01	5.233E+00
Sr-90+D	Sr-90+D	1.000E+00	3.957E+00	3.857E+00	3.482E+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	7.000E+00	7.165E+00	7.868E+00	8.844E+00	2.254E+01	7.259E+01	8.398E+05	1.007E+11
Ra-226	1.322E+00	1.300E+00	1.227E+00	1.155E+00	9.242E-01	8.697E-01	1.292E+00	2.867E+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 = 129.3 ñ 0.3 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	1.500E-01	0.000E+00	2.143E+00	7.000E+00	1.041E-01	1.441E+02
Ra-226	3.900E-01	143.7 ñ 0.3	1.738E+01	8.632E-01	1.737E+01	8.637E-01
Sr-90	6.000E-02	0.000E+00	3.957E+00	3.791E+00	1.424E-01	1.054E+02

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	3.215E-01	3.140E-01	2.860E-01	2.544E-01	9.982E-02	3.099E-02	2.679E-06	2.234E-11
Ra-226	Ra-226	1.000E+00	4.379E+00	4.374E+00	4.355E+00	4.331E+00	4.146E+00	3.928E+00	2.258E+00	1.018E+00
Pb-210	Ra-226	1.000E+00	4.644E-02	1.251E-01	4.141E-01	7.328E-01	2.184E+00	2.799E+00	2.269E+00	1.023E+00
Sr-90	Sr-90	1.000E+00	2.374E-01	2.314E-01	2.089E-01	1.839E-01	6.627E-02	1.857E-02	4.640E-07	8.189E-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	1.500E-01	1.465E-01	1.334E-01	1.187E-01	4.657E-02	1.446E-02	1.248E-06	1.038E-11
Ra-226	Ra-226	1.000E+00	3.900E-01	3.894E-01	3.869E-01	3.839E-01	3.602E-01	3.328E-01	1.764E-01	7.977E-02
Pb-210	Ra-226	1.000E+00	0.000E+00	1.192E-02	5.580E-02	1.029E-01	2.883E-01	3.248E-01	1.809E-01	8.182E-02
Sr-90	Sr-90	1.000E+00	6.000E-02	5.843E-02	5.256E-02	4.604E-02	1.596E-02	4.244E-03	1.063E-07	1.882E-13

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

RESCALC.EXE execution time = 2.07 seconds

Appendix D

ORISE IVS Report

ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

February 10, 2010

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

SUBJECT: DOE CONTRACT NO. DE-AC05-06OR23100
REVISED FINAL REPORT - INDEPENDENT VERIFICATION SURVEY OF THE A AND B RADIOACTIVE WASTE TRANSFER LINES TRENCH, BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
DCN: 5062-SR-01-1

Dear Ms. Kneitel:

The Oak Ridge Institute for Science and Education (ORISE), Independent Environmental Assessment and Verification (IEAV) Program has enclosed the revised final verification survey report for the A and B Radioactive Waste Transfer Line Trench at Brookhaven National Laboratory revision 1. This revision was prepared to include additional data that was not available at the time of the first release. Please contact me at 865.576.5321 or Tim Vitkus at 865.576.5073 should you have any questions.

Sincerely,

Phyllis C. Weaver
Health Physics Project Leader

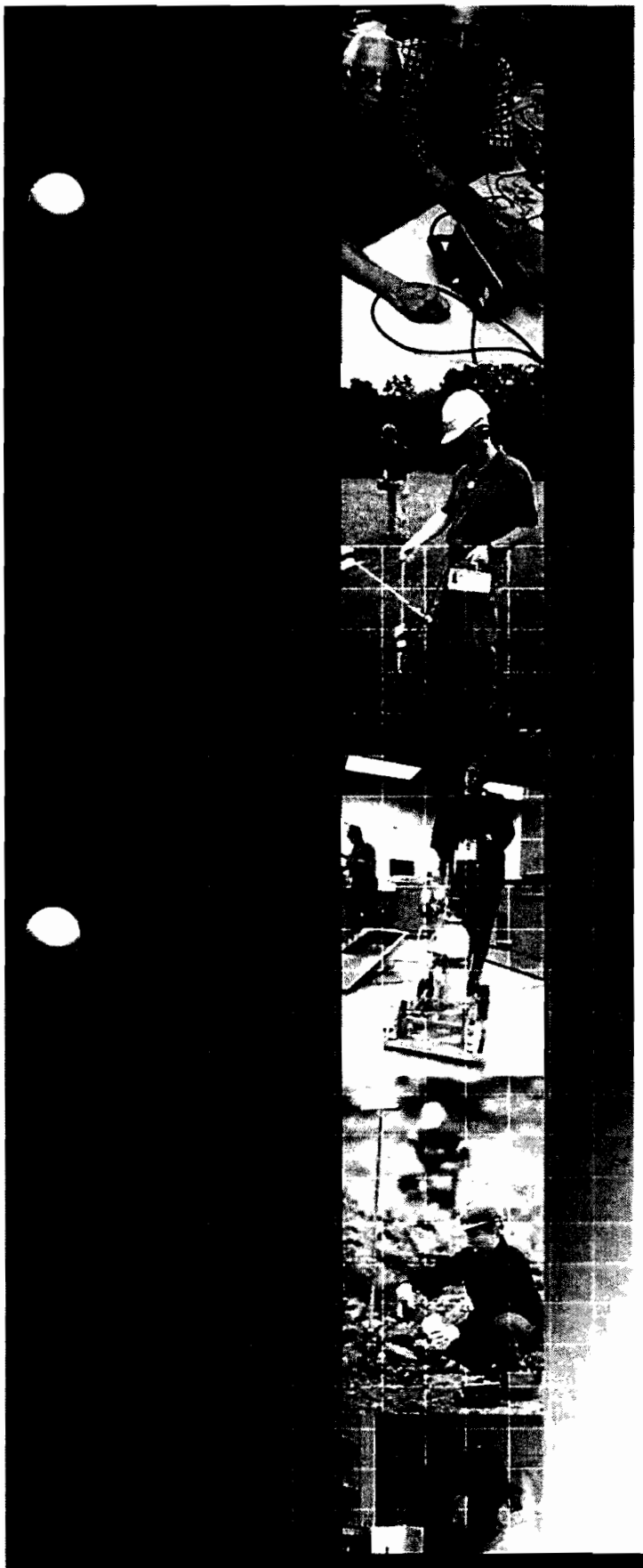
PCW:bf

Enclosure:

c:
S. Roberts, ORISE
T. Vitkus, ORISE
B. Estes, ORISE
File/5062

Box 117
Oak Ridge, TN 37831

Voice: 865.576.5321 Fax: 865.241.3497 Email: Phyllis.Weaver@orau.org



REVISED INDEPENDENT VERIFICATION SURVEY OF THE A AND B RADIOACTIVE WASTE TRANSFER LINES TRENCH 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

REVISED INDEPENDENT VERIFICATION SURVEY OF THE A AND B RADIOACTIVE WASTE TRANSFER LINES TRENCH BROOKHAVEN NATIONAL LABORATORY UPTON, NEW YORK

Prepared by

P. C. Weaver

Oak Ridge Institute for Science and Education
Oak Ridge, Tennessee 37831-0017

Prepared for the
U.S. Department of Energy

REVISED
FINAL REPORT

ORISE

February 2010

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.

REVISED
INDEPENDENT VERIFICATION SURVEY
OF THE
A AND B RADIOACTIVE WASTE TRANSFER LINES TRENCH
BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK

Prepared by: _____ Date: 2/10/10
P. C. Weaver, Project Leader

Reviewed by: _____ Date: 2/10/10
T. J. Vitkus, Survey Projects Manager

Reviewed by: _____ Date: 2/10/10
R. D. Condra, Laboratory Manager

Reviewed by: _____ for Date: 2/10/10
F. A. Templon, Quality Manager

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The author would like to acknowledge the significant contributions of the following staff members:

PROJECT STAFF

B. D. Estes
T. D. Herrera
E. Montalvo
J. A. Viars

LABORATORY STAFF

R. D. Condra
J. S. Cox
W. P. Ivey
W. F. Smith

CLERICAL STAFF

J. L. Clary
R. M. Fink
K. M. Moore
A. Ramsey

ILLUSTRATORS

A. M. Hood
J. A. Viars

TABLE OF CONTENTS

PAGE

LIST OF FIGURES

PAGE

LIST OF TABLES

PAGE

ABBREVIATIONS AND ACRONYMS

AEC	Atomic Energy Commission
BAO	Brookhaven Area Office
BKG	background
BNL	Brookhaven National Laboratory
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	centimeter
cm^2	square centimeter
cpm	counts per minute
Cs-137	cesium-137
DCGL	derived concentration guideline level
DOE	U.S. Department of Energy
EPA	Environmental Protection Agency
FIPS	Federal Information Processing Standard
FSP	Field Sampling Plan
g	gram
GPS	global positioning system
HFBR	High Flux Beam Reactor
IAG	interagency agreement
ISM	Integrated Safety Management
ITP	Intercomparison Testing Program
JHA	job hazard analysis
keV	kiloelectron volts
kg	kilogram
MAPEP	Mixed Analyte Performance Evaluation Program
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
NaI	sodium iodide
NIST	National Institute of Standards and Technology
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
Ra-226	radium-226
RCRA	Resource Conservation and Recovery Act
ROD	record of decision
sec	second
SOR	sum-of-ratio
SPCS	State Plane Coordinate System
Sr-90	strontium-90
TAP	total absorption peak

REVISED INDEPENDENT VERIFICATION SURVEY OF THE A AND B RADIOACTIVE WASTE TRANSFER LINES TRENCH BROOKHAVEN NATIONAL LABORATORY UPTON, NEW YORK

INTRODUCTION

The Brookhaven Nation 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). The DOE's Brookhaven Area Office (BAO) oversees the site.

Research operations and processes conducted at the site have produced a variety of radioactive and hazardous wastes. As a result, the BNL site was included on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priority List on December 21, 1989. 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. The IAG established the framework and schedule for characterizing, assessing, and remediating the site in accordance with requirements of CERCLA and the Resource Conservation and Recovery Act (EPA 1997). In April 2009, the *Record of Decision – Area of Concern 31, High Flux Beam Reactor* (HFBR ROD), was finalized. The HFBR ROD includes the removal of the A &B waste transfer lines and associated contaminated soil (BNL 2009).

The A-waste line, B-waste line, original D-waste line, steam line, and Non-Acid Off-Gas Pipe were installed in 1949 in an underground concrete culvert. The A- and B-waste lines operated from 1952 until they were abandoned-in-place in 1961. The original 4 inch D-waste line operated briefly in 1952, but was abandoned-in-place after the pipe developed leaks. The steam line operated until it was abandoned in 2001.

The transfer lines carried radioactive liquid wastes to Building 811 from Building 801. BNL has recently performed remediation of a portion of the A and B Radioactive Waste Transfer Line

(A/B Trench) working from Building 811 towards Building 801. BNL divided work on the A&B Trench into four phases.

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. At the request of the DOE-BAO, the Oak Ridge Institute for Science and Education (ORISE) performed IV of the A/B Trench. By using an independent third party, DOE can provide a level of assurance to the stakeholders that the as-left radiological concentration in the A/B Trench is accurately documented. This report has been revised to reflect additional surveys performed by ORISE at the southern end of the trench (Zone 1 and Zone 2) and report the results of soil samples that were collected during this activity.

OBJECTIVES

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 and again on December 9 and 10, 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 2008, and ORAU 2009). The A/B Trench has been excavated from Building 811 to Building 801. The A/B Trench is a designated Class 1 survey unit due to its inherent operational purpose and the contaminants associated with the process activities.

REFERENCE SYSTEM

ORISE used a global positioning system (GPS) for documenting survey area boundaries and tracking data for accessible areas within the trench. The specific geological reference system used was the State Plane Coordinate System (SPCS) New York Long Island Federal Information Processing Standard (FIPS) 3104. 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 of the remediated A/B Trench (Figure A-2 and A-3). 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 for further investigation.

During the December verification effort of the trench excavation, the condition of most of the trench was such that it was considered a significant safety hazard for physical access. Therefore, in order to adequately verify the as-left condition of the trench, the team requested the excavation of soil along the bottom and sidewalls of the trench. This soil was laid down adjacent to the excavation, scanned, and then sampled. Scans were performed as previously detailed. Potential areas that may have required additional evaluation were re-excavated and scanned. Any contaminated soils identified would have been segregated for disposal.

SOIL SAMPLING

Surface soil samples were collected from judgmental locations based on surveyor observation of gamma radiation measurements and process knowledge. An additional six samples were collected for completion of Zone 1 and Zone 2 portions of the trench during the December survey effort, for a total of 10 judgmental samples (Figure A-4 and A-5).

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 2009b). 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 counted 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 Operational Unit (OU) I ROD (BNL1999). Because 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 AND A&B WASTE LINES INDUSTRIAL LAND USE CLEAN-UP GOALS BROOKHAVEN NATIONAL LABORATORY

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

FINDINGS AND RESULTS

The results of the two verification surveys of the A/B Trench remediation activities are discussed below.

SURFACE SCANS

The background count rate averaged just slightly greater than 2,300 counts per minute (cpm) during the first verification survey and approximately 4,300 cpm during the second verification survey that were performed in order to complete the Zone 1 and 2 phases of the trench excavation. The difference in backgrounds between the two surveys is the result of using different sized NaI detectors. A 1.5 inch by 1.25 inch NaI detector was used initially and a 2 inch by 2 inch (SPA-3) was used for the final verification survey effort.

Gamma area scan count rates during the initial survey generally ranged from 3,500 to approximately 7,300 cpm with a mean of 4,600 cpm. Gamma area scan count rates during the second verification survey effort generally ranged from 4,200 to approximately 72,000 cpm with a median of 8,300 cpm with the SPA-3. The count rate frequency distributions of the gamma scans are illustrated in Figures A-6 and A-7. Counts that were typically 30,000 cpm and greater were primarily detected when the detector was above the level of the trench as a result of the gamma radiation shine from a nearby building.

During the second verification survey effort of the trench, the ambient gamma radiation levels were higher in the area nearest to Building 801. The significant increase in activity was due to high activity sources inside Building 801. Once inside the trench, the radioactivity levels were significantly lower. No background reference area was defined by ORISE prior to the survey; therefore, measurement data provided in this report are the gross gamma count rate data.

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES

The summary radionuclide soil concentration data for the A/B Trench are presented in Table B-1. The data for the radionuclide concentrations in individual soil samples and the sum-of-ratios are provided in Table B-2. The concentration of Ra-226 ranged from 0.25 to 0.51 pCi/g, Cs-137 ranged from 0.00 to 0.18 pCi/g, and Sr-90 ranged from -0.24 to 0.27 pCi/g.

COMPARISON OF RESULTS WITH GUIDELINES

The final radionuclide concentration for the A/B Trench must meet the guidance per the BNL Field Sampling Plan (FSP) for each individual soil sample and the SOR for the average concentration of each radionuclide of interest must be less than one. The SOR for individual samples are included in Table B-2. All radionuclides were below the cleanup goals and the SOR limit.

SUMMARY

During the period between September 28 and 29, 2009 and December 9 and 10, 2009 an independent verification team with the Oak Ridge Institute for Science and Education conducted measurements and sampling of the A and B Radioactive Waste Transfer Line Trench at the Brookhaven National Laboratory site. Gamma walkover scans did not identify radiation levels that warranted additional investigation. ORISE collected ten judgmental soil samples. All individual samples and the corresponding mean concentration were determined to be below the established cleanup goals. Therefore, it is the opinion of ORISE that the remedial actions implemented by BNL sufficiently meet the established clean-up goals.

REFERENCES

Brookhaven National Laboratory (BNL). Record of Decision Operable Unit I and Radiologically Contaminated Soils (including areas of concern 6, 8, 10, 16, 17, and 18). Upton, NY; August 25, 1999.

Brookhaven National Laboratory. High Flux Beam Reactor Decommissioning Project Field Sampling Plan Removal of the Building 801 – 811 Waste Transfer Lines. Upton, New York; August 14, 2009.

Oak Ridge Associated Universities (ORAU). Quality Program for the Independent Environmental Assessment and Verification Program. Oak Ridge, TN; June 30, 2009.

Oak Ridge Institute for Science and Education (ORISE). Survey Procedures Manual for the Independent Environmental Assessment and Verification Program. Oak Ridge, TN; May 1, 2008.

Oak Ridge Institute for Science and Education. Project-Specific Verification Plan for the Former Hazardous Waste Management Facility Waste Loading Area Perimeter Area, Upton, New York. Oak Ridge, Tennessee; September 10, 2009a.

Oak Ridge Institute for Science and Education. Laboratory Procedures Manual for the Independent Environmental Assessment and Verification Program. Oak Ridge, TN; June 30, 2009b.

Oak Ridge Institute for Science and Education. Interim Letter Report–Independent Verification Survey Report for the Former Hazardous Waste Management Facility Perimeter Soils Area and A/B Waste Line Trench, Brookhaven National Laboratory. Oak Ridge, TN; November 13, 2009c.

U.S. Department of Energy (DOE). Environment, Safety and Health Bulletin: A Guide to Good Practices for the Control and Release of Property. DOE/EH-0697. Washington, DC. July 2006.

U.S. Environmental Protection Agency (EPA). Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination (OSWER Directive 9200.14-18), US Environmental Protection Agency, August, 1997.

APPENDIX A

FIGURES

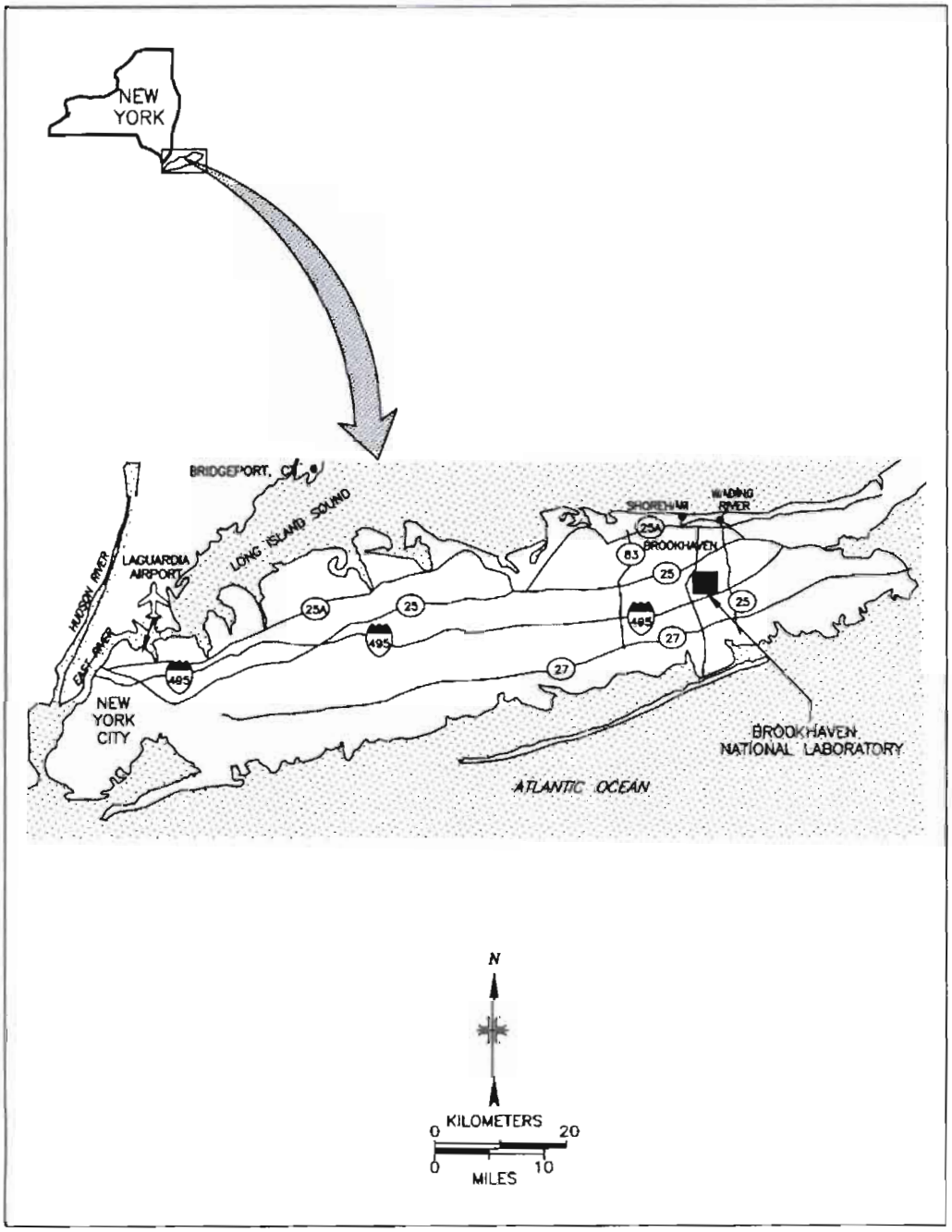

Figure A - 1: Location of Brookhaven National Laboratory, Upton, New York

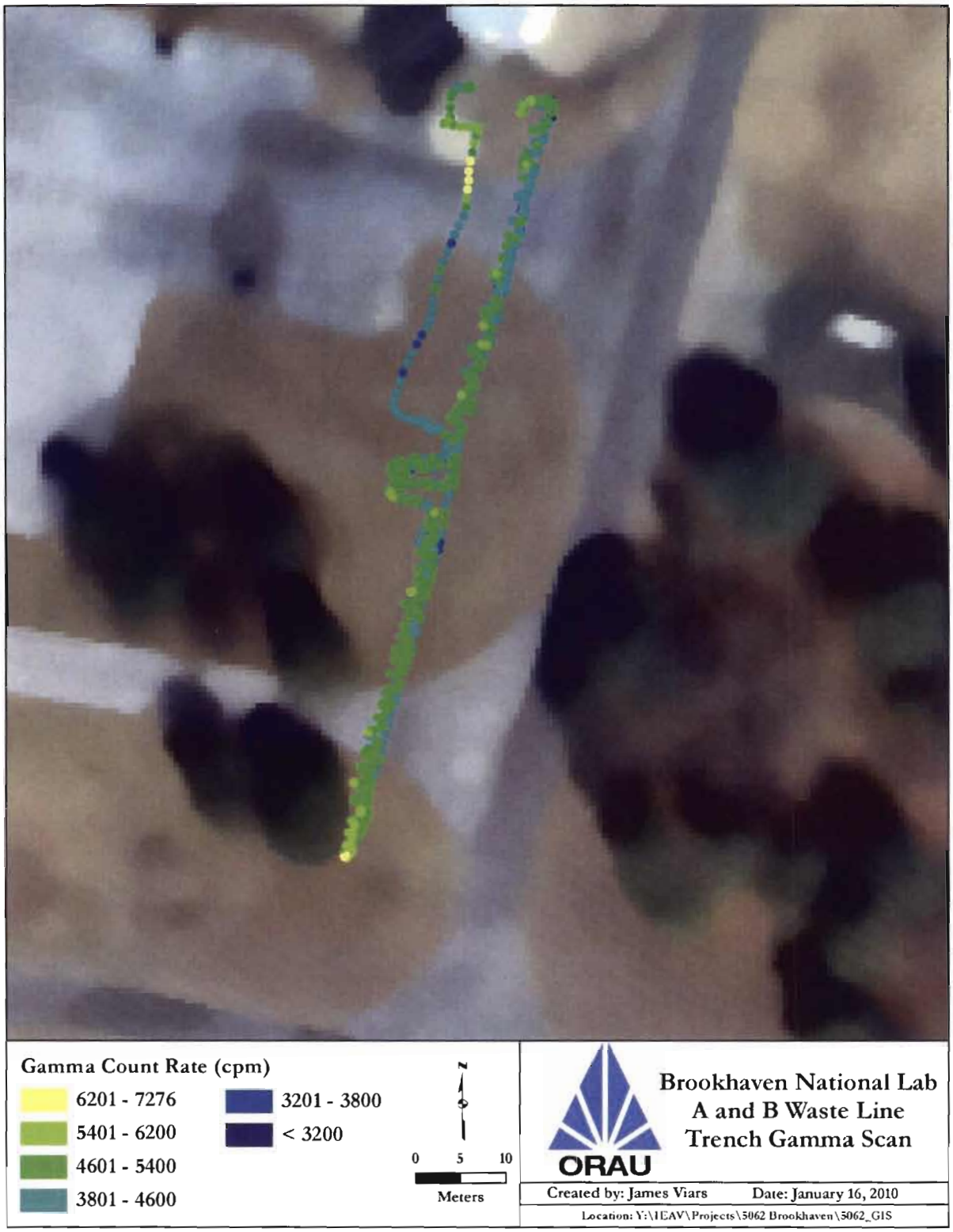

Figure A - 2: A and B Radioactive Waste Line Trench Gamma Activity Scan Pattern

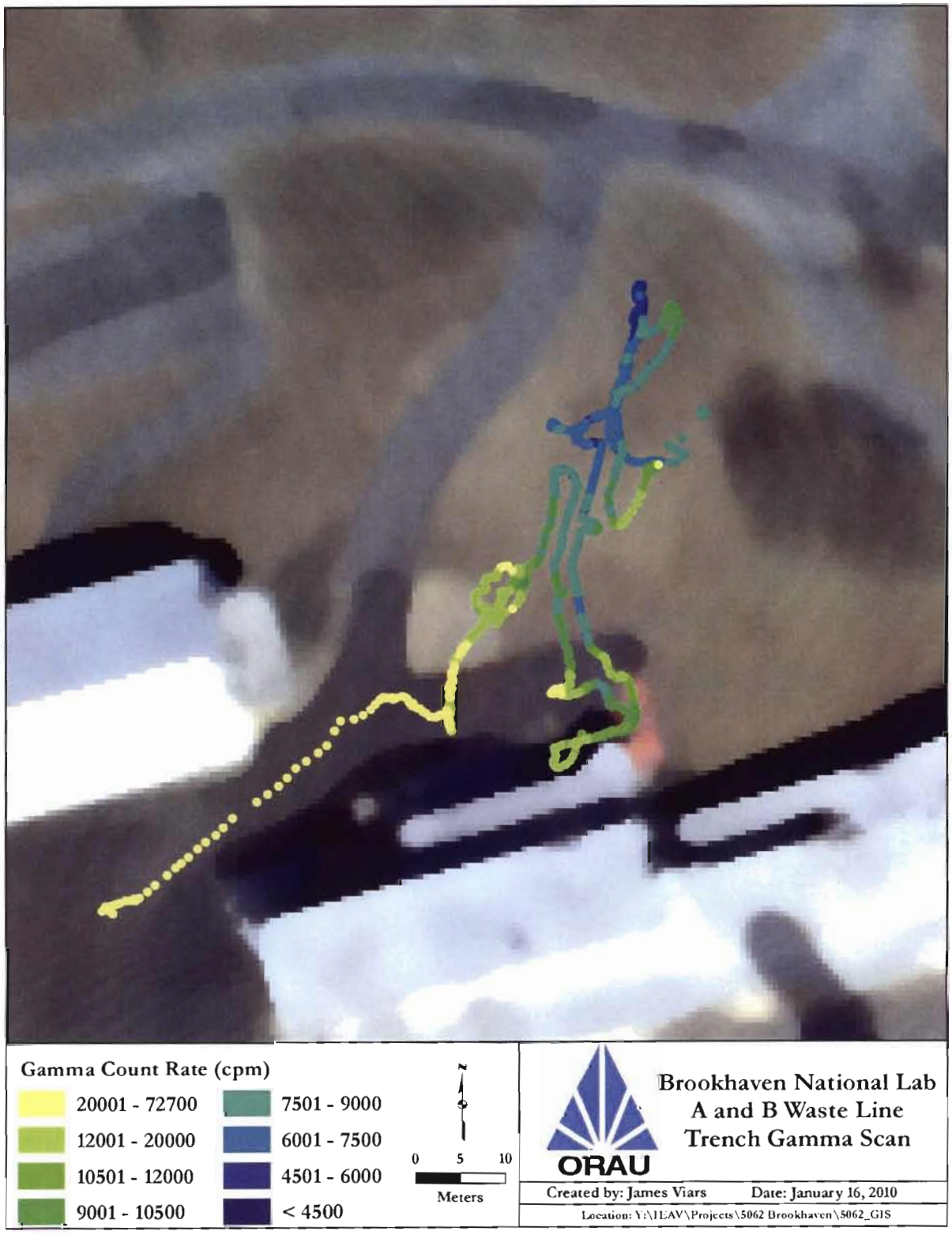

Figure A - 3: A and B Radioactive Waste Line Trench Gamma Activity Scan Pattern

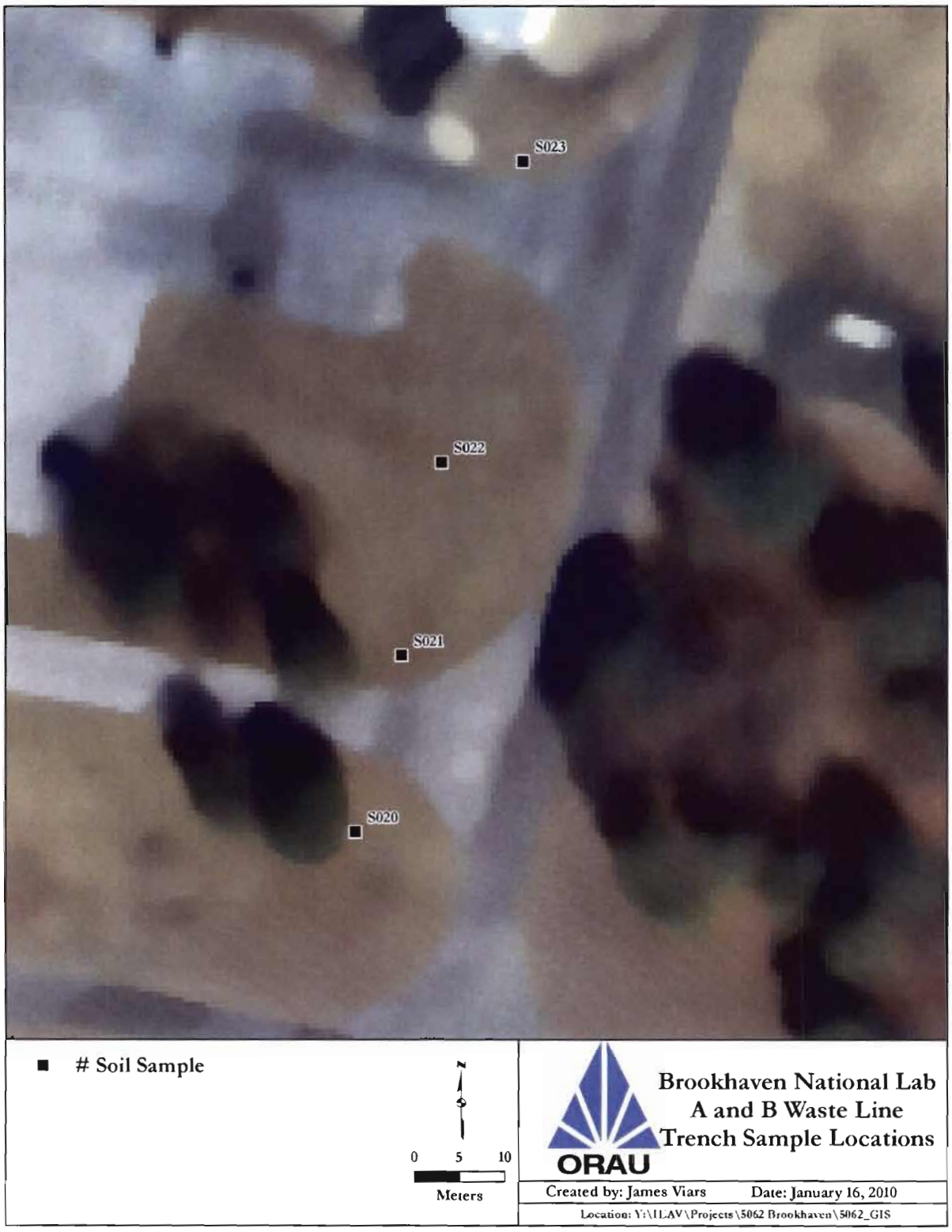

Figure A - 4: A and B Radioactive Waste Line Trench (North) Sample Locations

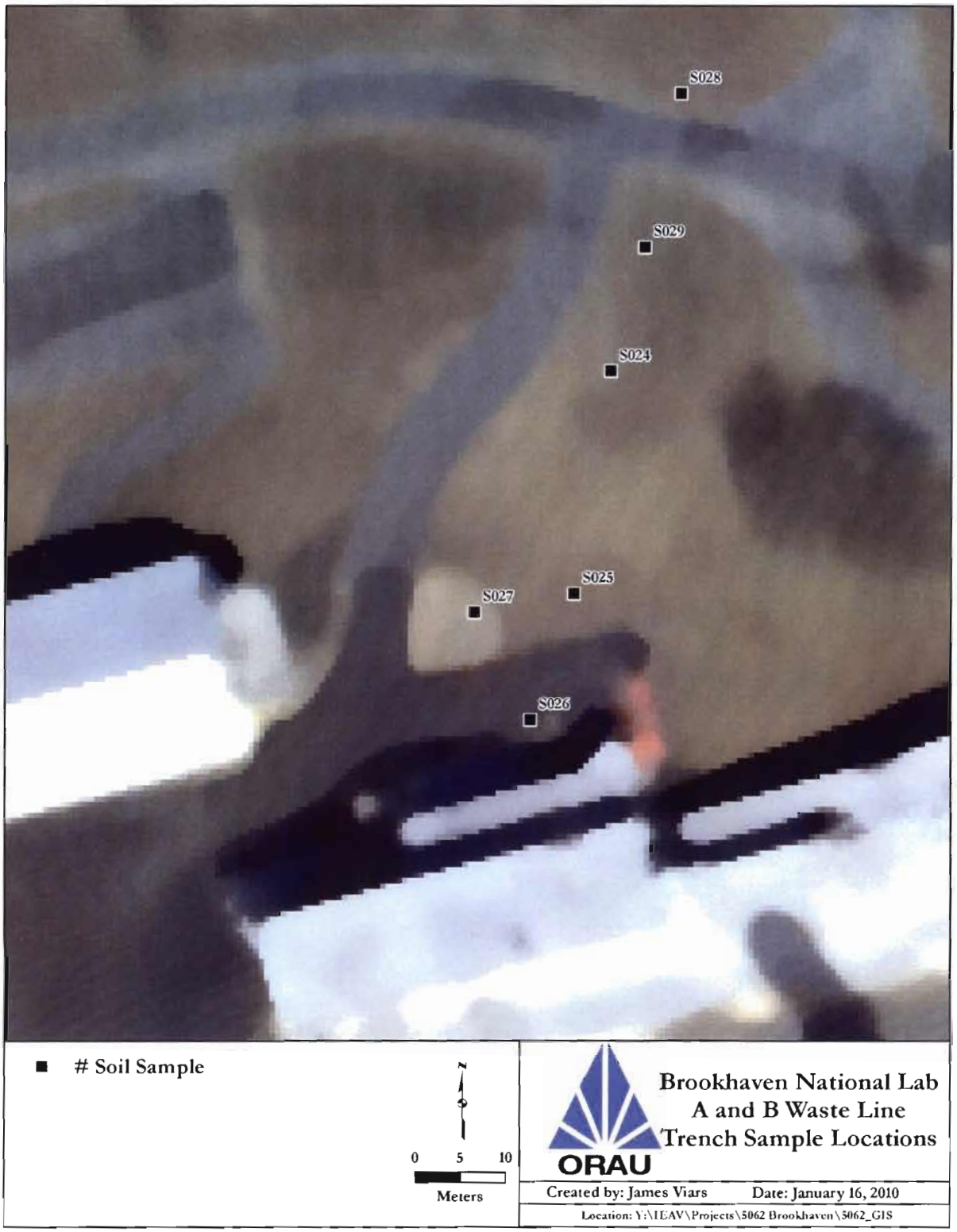

Figure A - 5: A and B Radioactive Waste Line Trench (South) Sample Locations

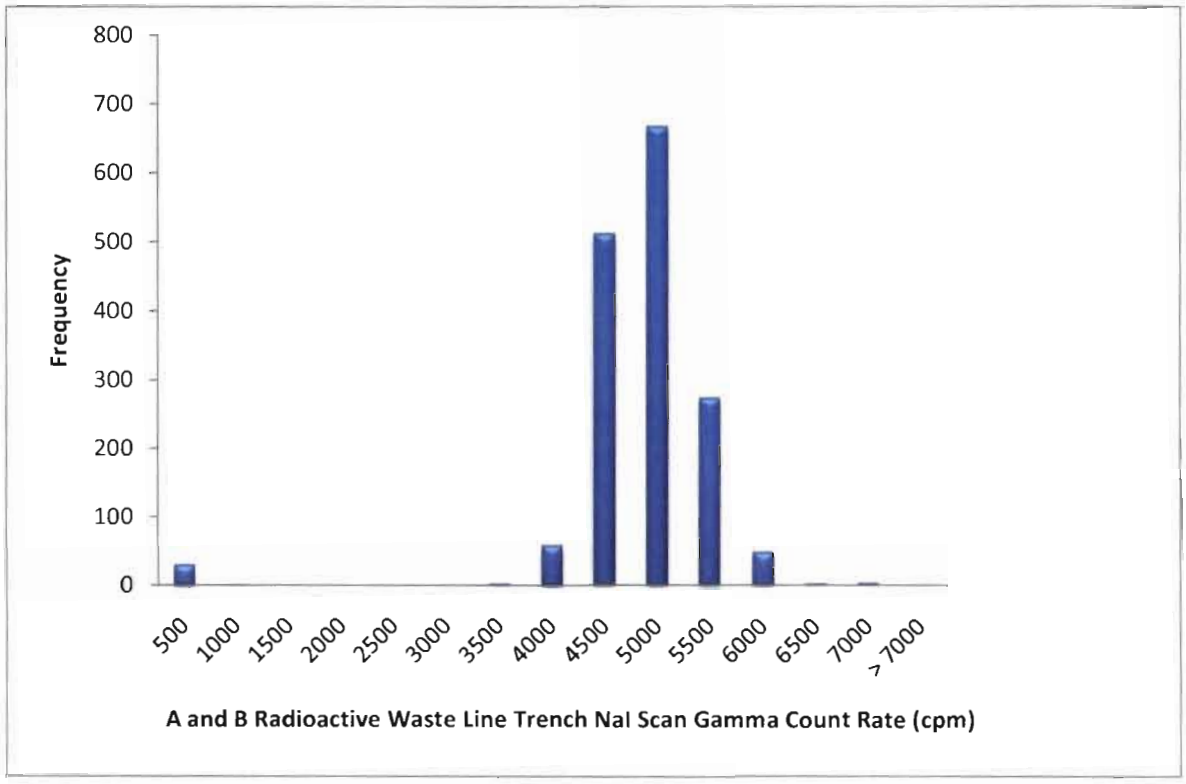

Figure A - 6: A and B Radioactive Waste Line Trench (North) Gamma Scan Count Rate Histogram

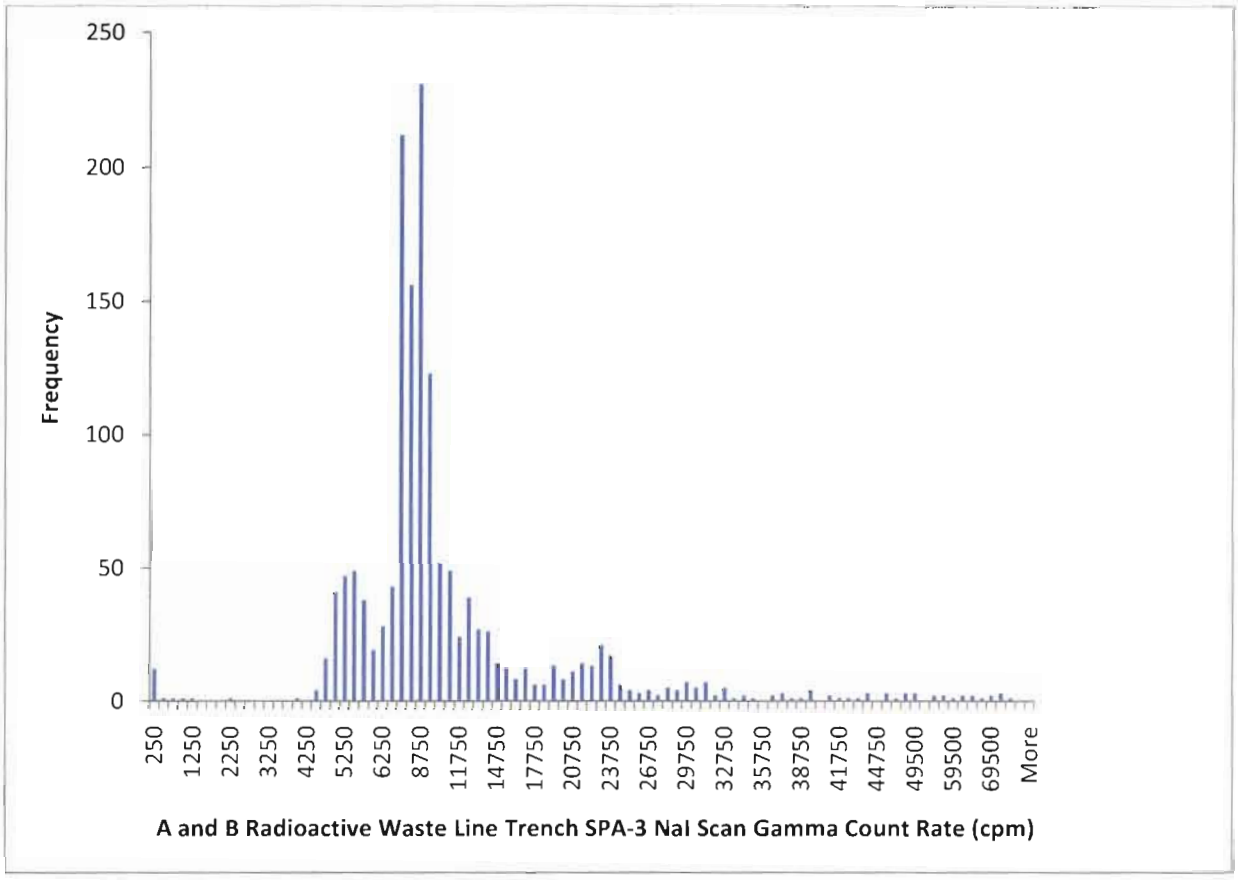

Figure A - 7: A and B Radioactive Waste Line Trench (North) Gamma Scan Count Rate Histogram

APPENDIX B

TABLES

TABLE B-1
RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES
A & B RADIOACTIVE WASTE LINE TRENCH
SUMMARY SAMPLE RANGE AND MEAN CONCENTRATION
BROOKHAVEN NATIONAL LABORATORY
UPTON, NY

Survey Unit	Ra-226 (pCi/g)	Cs-137 (pCi/g)	Sr-90 (pCi/g)
North A/B Waste Line[a]	0.25 to 0.41	0.03 to 0.18	-0.10 to 0.12
Mean Concentration	*0.33*	*0.09*	*-0.01*
South A/B Waste Line[b]	0.25 to 0.51	0.00 to 0.14	-0.24 to 0.27
Mean Concentration	*0.35*	*0.05*	*-0.12*

[a]Samples 20-23 collected during the September verification effort.
[b]Samples 24- 29 collected during the December verification effort.

TABLE B-2
RADIONUCLIDE CONCENTRATIONS IN SOIL
A & B RADIOACTIVE WASTE LINE TRENCH
FORMER HAZARDOUS WASTE MANAGEMENT FACILITY
BROOKHAVEN NATIONAL LABORATORY
UPTON, NY

Sample ID/Location[a]	Radionuclide Concentration (pCi/g)			
	Cs-137	Sr-90	Ra-226	SOR[b]
S020	0.18 ± 0.03[c]	-0.09 ± 0.22	0.41 ± 0.04	0.08
S021	0.03 ± 0.01	-0.10 ± 0.25	0.3 ± 0.04	0.05
S022	0.06 ± 0.02	0.12 ± 0.21	0.36 ±0.05	0.08
S023	0.10 ± 0.02	0.01 ± 0.20	0.25 ± 0.03	0.06
S024	0.02 ± 0.01	-0.23 ± 0.23	0.25 ± 0.04	0.04
S025	0.06 ± 0.02	-0.18 ± 0.23	0.35 ± 0.04	0.06
S026	0.07 ± 0.01	-0.18 ± 0.25	0.30 ± 0.03	0.05
S027	0.02 ± 0.01	-0.24 ± 0.23	0.43 ± 0.05	0.07
S028	0.14 ± 0.03	0.27 ± 0.26	0.51 ± 0.06	0.13
S029	0.00[d] ± 0.03	-0.19 ± 0.25	0.26 ± 0.04	0.04

[a]Refer to Figures A-4 and A-5.
[b]Sum of the ratios.
[c]Uncertainties are at the 95% confidence level based on total propagated uncertainties.
[d]"Zero" reported due to rounding.

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: 1.5 inch x 1.25 inch
(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
Dell Workstation and Canberra's Apex
Gamma Software
(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
Dell Workstation and Canberra's Apex
Gamma Software(Canberra, Meriden, CT)

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
Dell Workstation and Canberra's Apex
Gamma Software
(Canberra, Meriden, CT)

Low background alpha/beta counting system
Canberra/Tennelec LB5100W
Eclipse Software
(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 Oak Ridge Associated Universities (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 distance 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 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 Levels

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

[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.

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 E

Waste Shipment Summary

Waste Shipment Summary
Waste Transfer Lines Project

# Intermodal	Car number	waste confirmation sample #	waste weight	volume cuyds	Date shipped	cuft
1065	GCCX 200018	on site	22,600	16.00	3/6/10	432
1074	GCCX 200018	on site	32,460	16.00	3/6/10	432
1066	GCCX 200018	on site	23,000	16.00	3/6/10	432
1094	GCCX 200018	on site	37,840	16.00	3/6/10	432
1135	MHFX 516185	on site	38,400	16.00	3/6/10	432
1129	MHFX 516185	on site	38,760	16.00	3/6/10	432
1077	MHFX 516185	on site	38,200	16.00	3/6/10	432
1088	MHFX 516185	on site	29,200	16.00	3/6/10	432
1086	GCCX 200000	on site	22,860	16.00	3/6/10	432
1101	GCCX 200000	on site	39,600	16.00	3/6/10	432
1122	GCCX 200000	on site	36,000	16.00	3/6/10	432
1102	GCCX 200000	on site	22,800	16.00	3/6/10	432
1132	truck(#3)	on site	32,480	16.00	2/18/10	432
1099	truck(#4)	on site	30,600	16.00	2/9/10	432
B-12-mixed	truck (#1)	on site	1,260	1.78	12/10/09	48
B-12-mixed	truck (#1)	on site	1,500	1.78	12/10/09	48
B-12-mixed	truck (#1)	on site	1,500	1.78	12/10/09	48
B-12-mixed	truck (#2)	on site	1,750	1.78	2/2/10	48
B-6-mixed	truck (#2)	on site	1,800	0.89	2/2/10	24
55-gal drum elemental mercury	truck (#5)	on site	60	0.28	3/4/10	8
		Totals	**452,670**	**232.28**		**6,272**

Appendix F

Backfill Compaction Tests

ALL ISLAND TESTING ASSOCIATES, INC.

75B Pine Aire Drive
Bay Shore, NY 11706
Phone (631) 273-5717
Fax (631) 273-2457

Michelle Pizzulli
Brookhaven National Lab
Bldg 701
PO Box 5000
Upton, N.Y. 11973-5000

Re: Bldg #811/Density Tests taken 10/22/09

INSPECTOR: DP Quick (8-4:30)

TEST #	MAX DENSITY	OPT MOISTURE	DRY DENSITY	% MOISTURE	% COMPACTION
1	123.9	9.3	112.0	11.0	90.4*
2	123.9	9.3	112.6	11.3	90.9*

NOTES: 1) * - Test Rejected; Material Supersaturated with Insufficient Compaction.
2) Tests Valid for Top 6" Only.

LOCATION: Lawrence & 4th Street Pipe Trench
1) Lawrence: 100' North of Rutherford, 5' East of Westside, Subsoil Grade
2) 4th Avenue: 40' South of Bldg, 9' East of Existing, Subsoil Grade

Respectfully Submitted,
ALL ISLAND TESTING
Doug Quick

ALL ISLAND TESTING ASSOCIATES, INC.

75B Pine Aire Drive
Bay Shore, NY 11706
Phone (631) 273-5717
Fax (631) 273-2457

Michelle Pizzulli
Brookhaven National Lab
Bldg 701
PO Box 5000
Upton, N.Y. 11973-5000

Re: Bldg #811/RCA Density Tests taken 12/4/09

INSPECTOR: DP Quick (8-4:30)

TEST #	MAX DENSITY	OPT MOISTURE	DRY DENSITY	% MOISTURE	% COMPACTION
1	120.8	9.9	118.4	5.9	98.0
2	120.8	9.9	119.2	5.9	98.7

NOTE: Tests Valid for Top 6" Only.

LOCATION: Lawrence & 4th Street Pipe Trench, Subgrade

SIEVE SIZE	PERCENT PASSING
2	100.0
¼	44.7
40	16.1
200	4.6
MAXIMUM DENSITY (#/cu ft)	120.8
OPTIMUM MOISTURE (%)	9.9

Respectfully Submitted,
ALL ISLAND TESTING
Doug Quick

ALL ISLAND TESTING ASSOCIATES, INC.

75B Pine Aire Drive
Bay Shore, NY 11706
Phone (631) 273-5717
Fax (631) 273-2457

Michelle Pizzulli
Brookhaven National Lab
Bldg 701
PO Box 5000
Upton, N.Y. 11973-5000

Re: Bldg #811/RCA Density Tests taken 12/18/09

INSPECTOR: R Oliveri (8-4:30)

TEST #	MAX DENSITY	OPT MOISTURE	DRY DENSITY	% MOISTURE	% COMPACTION
1	120.8	9.9	118.3	6.3	97.9

NOTE: Tests Valid for Top 6" Only.

LOCATION: Rutherford & 4th Street Pipe Trench: 7'9" North of South Curbline, Subgrade

Respectfully Submitted,
ALL ISLAND TESTING
Doug Quick

(516) 273-5717

ALL ISLAND TESTING ASSOC. INC.

61G Pine Aire Drive Bay Shore, N.Y. 11706

CLIENT Brookhaven National Labs PO Box 5000 Upton, NY 11973

PROJECT Scales House **Date Cast** Nov 19, 2009

CONTRACTOR **Lab No.** pu. 11/20/09

Class Concrete 4000 **Yards Inspected** 22 4 cyls **Concrete Mfr.** Jenco

MATERIAL	BRAND or SOURCE	BATCH WEIGHTS PER CUBIC YARD	Plant Man
Cement		+ =	
Fine Agg.		+ =	Time:
C. Agg.		+ =	Field Man
Water Gal.		− =	DP Quick
Admix.			Time 8.4.30

Aggregate Gradation	Percent Passing													
Passing	1½	1	3/4	1/2	3/8	1/4	4	8	16	30	50	100	F.M.	Moisture
Fine														
Coarse														

LOCATION OF CONCRETE PLACEMENT:

Scale

REINFORCING STEEL INSP:

Cyl. No. (6"x12")	Slump	Air Content %	Temp.	Weight Per cu. ft.	7 Days	28 Days	Special
A	5	5	63°		2901		
C						3926*	
D						4068	
E						3820*	
	NOTE: * - Did Not Reach Supplied Strength.						

Respectfully submitted

Reported to:

ALL ISLAND TESTING ASSOCIATES, INC.

75B Pine Aire Drive
Bay Shore, NY 11706
Phone (631) 273-5717
Fax (631) 273-2457

October 22, 2009

Michelle Pizzulli
Brookhaven National Lab
Bldg 701
PO Box 5000
Upton, N.Y. 11973-5000

Re: Bldg #811/Sample pu 10/20/09

SIEVE SIZE	PERCENT PASSING
¾	100.0
3/8	99.5
4	96.3
10	90.9
20	79.5
40	50.3
60	29.2
100	20.8
200	14.9 (Wash)
MAXIMUM DENSITY (#/ft³)	123.9
OPTIMUM MOISTURE (%)	9.3

Respectfully Submitted,
ALL ISLAND TESTING

Doug Quick

EPA COMMENTS ON THE WASTE TRANSFER LINES CLOSEOUT REPORT

COMMENT RESOLUTION FORM

EPA -3	Appendix C: Some parameter values differ significantly from RESRAD default values, specifically, some hydrological calculations were not provided. Provide the rationale for the site parameters that were used in dose pathway analyses.	RESRAD parameters are based on the RESRAD Evaluations in the Final Remedial Investigation/ Risk Assessment Report, OU I/VI, June 14, 1996, CDM Federal Programs Corp. This work was for the Former Hazardous Waste Management Facility. Since these parameters have been used and approved in the past, the same values for the RESRAD parameters were used for the current evaluation, except where there were known differences (e.g., area of contamination).

EPA COMMENTS ON THE WASTE TRANSFER LINES CLOSEOUT REPORT

COMMENT RESOLUTION FORM

Reviewer and Organization: Doug Pocze, EPA		
Number	**EPA Comment**	**Response**
EPA-1	Provide and/or reference the information as to how institutional controls and any land use restrictions will be implemented after 50 years.	Maintaining land use and institutional control to prevent exposure of workers and the public to unacceptable levels of contamination is part of DOE's environmental stewardship responsibility. Brookhaven Science Associates (BSA), the contractor that operates the Laboratory on behalf of DOE, is responsible for managing and operating BNL and implementing the land use and institutional controls for DOE. The Land Use Controls Management Plan (LUCMP) summarizes the land use and institutional controls that are deployed at BNL. The LUCMP is a living document and is periodically updated to address evolving technology and the findings and recommendations of the CERCLA five-year review process. Revisions to the plan are reviewed and approved by the DOE, EPA and NYSDEC. Land use and institutional controls will be maintained until the hazardous substances reach levels that allow unlimited use and unrestricted exposure.
EPA -2	Section 3.2.2 Table 3-1 and Appendix C: Explain why the 0.06 pCi/g value is used for Sr-90 soil concentration in dose pathway calculations while Table 3-1 indicates 1.1 pCi/g detection limit for Sr-90 in soil.	Sr-90 values were obtained from the actual sample results as shown in Appendix B. The core samples and surface samples were averaged together to obtain an overall average for all the work phases. The Chain of Custodies 27632 and 28880 were used for this averaging. Table 3-1 is a summary table of results and for Sr-90, it only lists the fact that all samples were below the detection limit (1.1 pCi/g). Table 3-2 also only lists the detection limit as it is a conservative estimate in order to include Sr-90 in the sum of the fractions calculation.

NYSDEC COMMENTS ON THE WASTE TRANSFER LINES CLOSEOUT REPORT

COMMENT RESOLUTION FORM

DEC -5	Appendix B: The GPS Based Radiation Surveys presented are in black and white. The gray scale presented makes it impossible to assess the information that is being presented. Please provide color images.	The black and white figures were replaced with colored figures.
DEC -6	On page 33, Section 6.2, Paragraph 2 states "No worker received a measurable dose by TLD while working on the Waste Transfer Lines Project." Who is the supplier of the TLDs, and are TLDs read on or off site?	The TLDs are provided by BNL and processed on site. BNL Dosimetry Program is Department of Energy Laboratory Accredited Program (DOELAP) accredited.

NYSDEC COMMENTS ON THE WASTE TRANSFER LINES CLOSEOUT REPORT

COMMENT RESOLUTION FORM

Reviewer and Organization: Chek Beng Ng, NYSDEC		
Number	**NYSDEC Comment**	**Response**
DEC-1	Executive Summary, Page I, Bullet 3 incorrectly states that "New York State Department of Environmental Conservation ALARA goal of 10 millirem/yr..." TAGM 4003 is a cleanup guideline which is being used for ALARA purposes (see Section 2.1 paragraph 1). The Department does not have an ALARA value, but rather the Department's TAGM 4003 cleanup guideline of 10 millirem/yr is used as an ALARA value. Please clarify and revise.	The sentence was revised to read as follows: The results of the dose assessment are below the objectives established in the HFBR ROD, including the dose objective of 15 millirem/yr and the New York State Department of Environmental Conservation cleanup guideline of 10 millirem/yr from TAGM 4003, which was adopted as an ALARA goal.
DEC -2	Page 15, Bullet 1 does not state the transportation method utilized. Please correct.	Page 15, Bullet 1 was revised to read as follows: The solidified waste (approx. 2.5 CY) was shipped via closed box truck for disposal at the Nevada Test Site (NTS) Disposal Facility of Nevada.
DEC -3	Page 17, Last paragraph – Figure 3-1 is missing from the report.	This figure was attached at the end of the report.
DEC -4	Appendix B: The "Final Status Survey Building 801-811 Waste Transfer Lines" table seems to have a redundant page.	The redundant page was removed.