FINAL COMPLETION REPORT

REMEDIAL ACTION

AREA OF CONCERN 4 SEWAGE TREATMENT PLANT

SLUDGE DRYING BEDS AND SAND FILTER BEDS/BERMS

AREA OF CONCERN 21 ABANDONED FORMER SEWER LINES

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AOC 4 AND 21 CLOSEOUT REPORT

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ACRONYMS

AOC	Area of Concern
BNL	Brookhaven National Laboratory
CY	Cubic Yards
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DMA	Direct Mercury Analyzer
EMD	Environmental Management Directorate
ESD	Environmental Services Division
FE	Field Engineer
Ft.	feet
GEL	General Engineering Laboratories, LLC
HEPA	High Efficiency Particulate Air
IAG	Interagency Agreement
KCPM	Thousand Counts Per Minute
LLW	Low-Level Radiological Waste
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Technology
MDC	Minimum Detectable Concentration
mg/kg	Milligrams Per Kilogram
NaI	Sodium Iodide
ND	Non Detect
NPC	National Priority List
NYSDEC	New York State Department of Environmental Conservation
OU	Operable Unit
OU V	Operable Unit V
ORISE	Oak Ridge Institute for Science and Education
PPM	Parts Per Million
pCi/g	pico Curies per gram
PPE	Personal Protective Equipment
RI	Remedial Investigation
RCRA	Resource Conservation and Recovery Act
RCT	Radiological Control Technician
RESRAD	Residual Radioactive Material Guidelines
ROD	Record of Decision
RWCF	Radiological Waste Control Form
SBMS	Standards Based Management System
sq ft	square feet
STP	Sewage Treatment Plant
TCLP	Toxicity Characteristic Leaching Procedure
USDOE	United States Department of Energy
USDOT	United States Department of Transportation
USEPA	Unites States Environmental Protection Agency

1.0 Introduction

1.1 Purpose

The purpose of this closeout report is to document the characterization, excavation, closeout surveys, sampling results, and disposal of contaminated soils from a portion of the U.S. Department of Energy's (DOE) Brookhaven National Laboratory (BNL). The area known as Area of Concern (AOC) 4 (the Sewage Treatment Plant sludge drying beds [sub-AOC 4A], and sand filter beds and berms, firing range berms [sub-AOC 4B]) and AOC 21 (the sewer lines within Operable Unit [OU] V), were cleaned up in accordance with the remedial actions specified in the *Operable Unit V Record of Decision (ROD)* (DOE 2001a). The remedial actions included the excavation and disposal of radiological and mercury-contaminated soils to meet prescribed cleanup goals, and the removal and disposal of radiological contaminated sludge from the ten manholes along the retired sewer lines. These areas are shown in Figures 1 and 2.

The scope of the remedial work was outlined in detail in the final *Operable Unit V - Areas of Concern 4 and 21, Remedial Action Work Plan* (BNL 2002).

The overall project objectives for the chemically and radiologically contaminated soil at BNL were to meet remedial action objectives in accordance with the OU V ROD as defined below:

- Reduce the levels of contamination in the sludge drying beds, sand filter beds and berms, firing range berms, and adjacent areas
- Prevent or minimize the migration of contaminants present in the surface soil via surface runoff and windblown dusts
- Prevent or minimize human and environmental exposure to contaminants in the surface and subsurface soil. This includes site workers, construction workers, trespassers, and future residents
- Prevent or minimize the potential for uptake of contaminants present in the soil by ecological receptors
- Prevent or minimize the potential for migration of contaminants (chemical and radiological) from the soil to groundwater.

1.2 Regulatory Framework

On December 21, 1989, the BNL site was included on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priority List (NPL). In May 1992, the DOE entered into an Interagency Agreement (IAG) with the United States Environmental Protection Agency (EPA) and the 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 the requirements of CERCLA, and the Resource Conservation and Recovery Act (RCRA). Operable Unit V is one of six operable units at the BNL site. This closeout report references the remedial action for AOCs 4 and 21 within OU V.

The nature and extent of the contaminated soil in AOCs 4 and 21 have been addressed in the *Final Operable Unit V Remedial Investigation Report* (IT Corporation 1998a). An evaluation and recommendation of remedial alternatives for this soil was presented in the *Final OU V Feasibility Study Report* (IT Corporation 1998b). The *OU V Record of Decision* (DOE, 2001a) selected excavation and offsite disposal for the contaminated soil and removal of the sludge from the manholes along the retired sewer line as the remedial alternatives.

1.3 Site Cleanup Criteria

Soil in the sand filter beds and adjacent berms at the Sewage Treatment Plant (STP) contained elevated levels of mercury, silver, chromium, lead and radionuclides (primarily cesium-137). Mercury and cesium-137 were selected as the contaminants of concern for which cleanup levels for the sand filter beds and berms were established. These contaminants were selected because of the frequency of occurrence of these contaminants exceeding the soil screening criteria established for the remedial investigation. In addition, the radiological risk assessments demonstrated that cesium-137 was the major contributor to the risks posed to human health by the radionuclides. The following site cleanup criteria were established in the ROD (DOE, 2001a).

The mercury cleanup goal -- two milligrams per kilogram (mg/k) or two parts per million (ppm) -- for localized removal of soil in the sand filter beds and adjacent berms was chosen based on the EPA action level for the protection of groundwater for mercury.

The cleanup goal for cesium-137 at the sewage treatment plant was calculated using the DOE Residual Radioactive Material Guidelines (RESRAD) computer code and was based on the following assumptions:

- a total dose limit of 15 mrem/yr above background (EPA 1997),
- a future residential land use, and
- 50 years of institutional control of the area.

Based on this information, the cleanup goal within the affected areas of the sewage treatment plant is such that the remaining average concentration for cesium-137 is less than 23 pico Curies per gram (pCi/g). A hot spot criterion of three times the cleanup goal of 23 pCi/g (i.e., 69 pCi/g) was also applied. Contaminant concentrations above this criterion were removed even if the average concentration were less than the 23 pCi/g. This cleanup goal allows current industrial use without controls and future residential land use after the assumed 50-year period of institutional control. In the event the property is transferred out of Federal control, specific requirements outlined in section 120 (h) of CERCLA will be met. These requirements ensure that future users of the property are not exposed to unacceptable levels of contamination. Post remediation sampling and analysis was conducted and dose assessments were performed to ensure that the limit of 15 mrem/yr above background was met for all nuclides that remain.

1.4 Historic Description

OU V is located in the northeastern quadrant of the property along the eastern property border.

The IAG designated the following AOCs and sub-AOCs for OU V:

AOC 4: Sewage Treatment Plant (STP)
- Sub-AOC 4A: Sludge Drying Beds
- Sub-AOC 4B: Sand Filter Beds and Firing Range Berms
- Sub-AOC 4C: Imhoff Tank
- Sub-AOC 4D: Hold-up Ponds
- Sub-AOC 4E: Satellite Disposal Area

AOC 21: Sewer Lines within OU V
AOC 23: Eastern Off-site Tritium Plume
AOC 30: Peconic River

The STP is located adjacent to a portion of the Peconic River as shown in Figure 1. Adjacent areas in sub-AOC 4B include two areas immediately north and south of the sand filter beds and the BNL firing range berms north of the STP sand filter beds. The sewer line shown in Figure 2 runs from East Fifth Avenue to the STP (approximately 3,400 feet) and is retired and capped.

The sewage treatment plant now used by BNL was built in stages by the U.S. Army between 1940 and 1944, and was upgraded by BNL in 1967. An additional upgrade in 1997 converted the plant from primary to tertiary treatment. It is an active facility used to process sanitary sewage for BNL operations.

The Sewage Treatment Plant contained several sub-areas of concern: Sludge Drying Beds, Sand Filter Beds/Berms, Imhoff Tanks, Hold-up Ponds, and a Satellite Disposal Area. The Imhoff Tanks were addressed by a removal action in 1995. The remaining concrete structure was demolished, backfilled with clean fill and capped with concrete. Both soil and groundwater samples were collected during the OU V Remedial Investigation at the Hold-up Ponds and Satellite Disposal Area. No evidence of contamination warranting further action was found in any of these areas. Concentrations of heavy metals at the Sludge Drying Beds and heavy metals and radionuclides within the sand filter beds and surrounding berms do not pose risks to public health above levels acceptable to EPA. However, in order to minimize any potential sources that may possibly leach into the groundwater and the Peconic River, a localized removal of elevated levels of mercury and cesium-137 was recommended for these areas. Excavated wastes will be disposed at a licensed off-site facility.

In the 1940s, approximately 3,400 feet of thirty-inch diameter vitreous clay sewer pipes were installed in the section of the sewer line within OU V between Fifth Avenue and the STP. These sewer lines carried various laboratory and sanitary wastes from research and support facilities to the STP. The now retired sewer line in Operable Unit V was replaced in January 1993, and all wastewater flow has been diverted to the newly installed sewer lines.

Soil sampling was conducted during the Remedial Investigation in areas surrounding the retired sewer line that were suspected to have leaks. The results of the investigation identified only a few areas with low concentrations of inorganic constituents. As part of a more recent investigation (IT Corporation 2000), sludge was collected from the bottom of manholes along the retired and capped sewer line and analyzed for radionuclides. The results of this investigation identified elevated activities of a few radionuclides. The current status of the sewer line (retired and capped at both ends) is such that no exposure pathway exists which could presently pose a risk to workers and the public. This remedial action removed sludge from 10 manholes along the retired sewer line that lead to the STP. Institutional controls will prevent future excavation or damage to the buried sewer lines.

1.4.1 Historical Data Summary

The extent of contaminants within AOCs 4 and 21 that are addressed in the ROD are presented in Table 1. The contaminants found most frequently and at the highest concentrations in the sand filter beds and berms relative to screening levels were mercury and cesium-137. Levels of both were highest in the sand filter berms and areas adjacent to the sand filter beds. The Remedial Investigation (RI) found a maximum concentration for mercury of 19.1 mg/kg. Cesium-137 was present at a maximum concentration of 98.8 pCi/g. Mercury and cesium-137 are the only constituents present that require remedial action. While contamination was concentrated in the top one foot of soil; several locations had elevated concentrations at depths to six feet.

Table 1. Operable Unit V AOCs and Extent of Contamination as Presented in the ROD

AOC	Media	Primary Contaminants	Maximum Concentration[1]	Cleanup Criteria	Reference
4A Sludge Drying Beds	Soil	Mercury	8.4 mg/kg	2.0 mg/kg	(IT 1998a)
4B Sand Filter Beds/Berms	Soil	Mercury	19.1 mg/kg	2.0 mg/kg	(IT 1998a)
		Silver	112 mg/kg		(IT 1998a)
		Copper	80.7 mg/kg		(IT 1998a)
		Chromium	157 mg/kg		(IT 1998a)
		Lead	95.5 mg/kg		(IT 1998a)
		Zinc	60.7 mg/kg		(IT 1998a)
		Thallium	1.2 mg/kg		(IT 1998a)
		Cesium-137	98.8 pCi/g	23.0 pCi/g (ave)	(IT 1998a)
		Americium-241	5.41 pCi/g		(IT 1998a)
		Plutonium-239/240	7.31 pCi/g		(IT 2000)
21 Sewer Lines	Soil	None			(IT 1998a)
	Sludge	Americium-241	22 pCi/g		(IT 2000)
		Cesium-137	12.85 pCi/g	23.0 pCi/g (ave)	(IT 2000)
		Plutonium-239/240	3.42 pCi/g		(IT 2000)

[1] Maximum concentration for each Area of Concern found during the Operable Unit V RI. The RI also found other inorganic constituents (silver, chromium, and lead) and radionuclides (americium-241, plutonium-239/240, and uranium 233/234 and 238) above screening levels in surface and subsurface soil at the sand filter beds and sand filter berms, although not at concentrations requiring cleanup.

BNL sampled the soil surrounding the areas where leaks were identified along the sewer line (AOC 21) during the Operable Unit V RI. The results of the investigation identified only eight inorganic analytes at concentrations that exceeded the screening concentrations. With the exception of nickel and thallium (maximum concentrations of 215 mg/kg and 1.8 mg/kg, respectively), the elevated concentrations of inorganics were detected at a low frequency (i.e., less than twice) or at relatively low concentrations.

As part of the Operable Unit V, *Plutonium Contamination Characterization and Radiological Dose and Risk Assessment Report* (IT Corporation 2000), sludge was collected from the bottom of manholes along the retired and capped sewer line and analyzed for radionuclides. The results identified elevated activities of a few radionuclides. Americium-241 (maximum 22 pCi/g) and cesium-137 (12.85 pCi/g) were found at the highest activities relative to screening levels. Plutonium was also detected, generally at low levels (plutonium-238 maximum 0.63 pCi/g; plutonium-239/240 maximum 3.42 pCi/g). The current status of the sewer line (retired and capped at both ends) is such that no exposure pathway presently exists which could pose a risk to workers or the public (IT Corporation 2000).

Supplemental sampling in the vicinity of the Sewage Treatment Plant in September 2000 identified an area at BNL's Firing Range (located in the eastern portion of the property directly north of the STP sand filter beds – Figure 1) with elevated levels of mercury and cesium-137. The results are presented in the *Operable Unit V Sewage Treatment Plant Supplemental Geoprobe® Soil Sampling Letter Report* (BNL 2001). The maximum concentrations were 13.9 mg/kg for mercury and 35.1 pCi/g for cesium-137. Based on this information, the BNL Firing Range was included in the overall remedy for the sewage treatment plant.

More recently, additional Geoprobe® sampling was conducted along the berms at locations previously sampled only at the surface, but with levels of either mercury or cesium-137 elevated as compared to the cleanup criteria. Results of these samples are found within the *Operable Unit V Sewage Treatment Plant Analytical Results from the Supplementary Geoprobe® Soil Sampling Program Letter Report* (BNL 2003a). Based on these results three additional areas were identified for excavation of soil with elevated levels of mercury. Figure 3 indicates all pre-excavation areas and their maximum contaminant values prior to excavation that are elevated as compared to the soil cleanup goals identified in the ROD. The areas excavated within the STP AOC 4 are shown in Figure 4.

2.0 Remediation Activities

A total of 15 areas were excavated within the STP area beginning in June 2002, and extending to February 2003. Table 2 lists all the areas, the contaminants removed, and the estimated volumes of material excavated. Each of the excavations is presented separately in Attachment 1 with

TABLE 2 - STP EXCAVATION AREAS - SLUDGE DRYING BED AND SAND FILTER BEDS AND BERMS

Excavation ID No.	Contaminants	Initial Depth of Excavation (ft)	Maximum Depth of Excavation (ft)	Initial Estimated Surface Area (ft^2)	Actual Surface Area (ft^2)	Initial Volume Estimate of Excavation (yds^3)	Survey Volume of Excavation (yds^3)	Bulk Volume for Loading (yds^3)
AOC4A-GP01	Mercury	0.5	2.5	300	3575	6.0	198.2	257.7
AOC4B-GP13	Mercury	0.5	0.5	10450	5848.7	194.0	143.0	185.9
AOC4B1-GP02	Mercury	0.5	0.8	300	315.2	6.0	4.9	6.4
AOC4B1-GP14	Mercury	1.0 (from 1'-2')	2.0	36	98.6	1.3	3.2	4.2
AOC4B1-GP15 / AOC4B1-SB11	Mercury	1.0	1.5	90	277.6	3.3	8.8	11.4
AOC4B1-GP01 / AOC4B1-SB01	Cesium-137; Mercury	2.0	4.0	600	849.3	11.0	77.5	100.7
AOC4B1-GP05 / AOC4B1-SB02	Cesium-137; Mercury	2.0	4.5	1500	1601.4	111.0	148.2	192.7
AOC4B1-GP06 / AOC4B1-SB03	Cesium-137; Mercury	0.5	1.5	300	338.8	6.0	12.0	15.6
AOC4B1-GP08 / AOC4B1-SB07	Cesium-137; Mercury	3.0	4.5	1500	2403.6	167.0	279.7	363.6
AOC4B1-GP12 / AOC4B1-SB09	Cesium-137; Mercury	1.0	2.0	300	367.2	11.0	20.3	26.4
AOC4B1-GP13 / AOC4B1-SB13	Cesium-137; Mercury	6.0	6.5	300	417.1	67.0	83.0	107.9
AOC4B1-GP16	Cesium-137; Mercury	6.0	7.0	300	300	67.0	59.0	76.7
AOC4B1-SB05	Cesium-137	0.5	0.8	300	260.2	6.0	4.8	6.2
AOC4B1-SB06	Cesium-137	0.5	2.0	300	444.5	6.0	29.8	38.7
AOC4B1-SB08	Cesium-137; Mercury	1.0	2.0	36	174.6	1.3	9.7	12.6

figures that depict the initial radiological walkover results and/or the analytical results of pre-excavation samples.

The clearing of vegetation and construction of the excavated waste soil laydown area commenced on June 16, 2002. Six laydown areas (SP1 – SP6) were constructed along the southern boundary of the STP as temporary storage for excavated soil waste (Figure 4). The laydown area consisted of 20-mil thick plastic sheeting used as a ground liner and 10-mil thick plastic sheeting used as covers. Sandbags were used to weigh down the sheeting covers. Two additional laydown areas (SP7 and SP8) for mercury waste soil were constructed adjacent to AOC4A-GP01. The laydown areas were segregated such that the piles received soil either from mercury only excavations, or from combined cesium-137 and mercury contaminated soil. The combined chemical and radiological soil waste was planned for disposal at Envirocare in Utah, a low-level waste facility, while the soil contaminated with mercury only was planned for disposal at a Subtitle D landfill facility.

Excavation began in June 2002 and was completed in March 2003. The associated activities are outlined chronologically in Table 3. Excavation of soil and debris was performed using a track excavator (Dynamic Acera Model SK 210 LC – IV) with a 1.5-cubic yard (CY) bucket. Dust generation was minimized during loading, hauling, and dumping by the application of water spray.

No free-liquids were generated from the application of water spray, as there was no over-application of water. Work was restricted or suspended if the Field Engineer (FE) and/or Radiological Control Technician (RCT) determined that visible dust was being generated. All loading, hauling, and dumping was suspended when sustained wind speed reached 25 mph or gusts exceeded 30 mph as reported by the local BNL weather station. As determined by the FE/RCT, work was restricted or suspended if there was precipitation or excessive ground moisture, because moisture interferes with proper operation of radiation detection equipment. The FE also made determinations regarding work restrictions/suspensions due to rain when working in chemically contaminated areas or working with chemically contaminated materials.

Contaminated soil was transported in accordance with BNL and United States Department of Transportation (DOT) requirements and guidelines. Each 15-CY capacity transport dump truck had a locking tailgate with a gasket to prevent loss of soil during transport. The driver inspected the tailgate prior to and after each load to ensure it latched properly. Each transport dump truck had a bed cover to control/prevent dust dispersion during vehicle operation. After loading, the driver visually inspected the vehicle, and an RCT performed a radiological survey to ensure that the exterior of the truck was not contaminated prior to leaving the area. Soil was placed in designated stockpile locations and covered. Each stockpile area was posted according to the waste categorization information available regarding waste contaminants. Specific attention was made to separate low level radioactive waste (LLW) from chemically contaminated soils, as each may go to a separate disposal facility. In November, soil designated for shipment to Envirocare was transported to the designated BNL railcar loading area.

Table 3: Chronology of Excavation at AOC 4 Sludge Drying Bed and Sand Filter Beds and Berms (quantities are approximate)

June 18, 2002	AOC4B1-GP06	Initiate and complete excavation. 12 CY removed, stored in SP1.
June 28, 2002	AOC4A-GP01	Initiate and complete excavation. 6 CY removed, stored in SP1.
	AOC4B1-GP01	Initiate and complete excavation. 11 CY removed, stored in SP1.
	AOC4B1-GP02	Initiate and complete excavation. 6 CY removed, stored in SP1.
July 2-3, 2002	AOC4B-GP13	Initiate and complete excavation. 143 CY removed, stored in SP1/SP2.
July 11, 2002	AOC4B1-SB05	Initiate and complete excavation. 6 CY removed, stored in SP3.
July 12-16, 2002	AOC4B1-GP05	Initiate excavation. 75 CY removed, stored in SP3.
July 16, 2002	AOC4B1-GP12	Initiate and complete excavation. 10 CY removed, stored in SP3.
July 24-25, 2002	AOC4B1-GP13	Initiate and complete excavation. 60 CY removed, stored in SP3.
July 24-25, 2002	AOC4B1-GP08	Remove two sections of aboveground transit pipe. Remove cinderblock structure.
July 29-31, 2002	AOC4B1-GP08	Remove two additional asbestos transit pipe sections. Initiate and complete excavation. 80 CY removed, stored in SP4.
August 12-13, 2002	AOC4B1-GP16	Initiate and complete excavation. 60 CY removed, stored in SP5.
September 9, 2002	AOC4B1-SB06	Initiate and complete excavation. 10 CY removed, stored in SP5.

Table 4. Additional excavations based on results of walkover surveys and confirmation sampling

August 14, 2002	AOC4B1-GP12	Initiate and complete excavation. 15 CY removed, stored in SP5.
September 10-13, 2002	AOC4B1-GP08	Initiate and complete excavation. 70 CY removed, stored in SP5.
September 18, 2002	AOC4B1-GP12	Initiate and complete excavation. 8 CY removed, stored in SP5.
September 18-19, 2002	AOC4B1-GP05	Complete excavation. 35 CY removed, stored in SP5.
October 30-31, 2002	AOC4B1-GP01	Complete excavation. 25 CY removed, stored in SP3.
October 31, 2002	AOC4A-GP01	Initiate and complete excavation. 6 CY removed, stored in SP1.
October 31 - November 1, 2002	AOC4B1-GP08	Initiate and complete excavation. 60 CY, stored in SP6.
January 10, 2003	AOC4B1-GP01	Initiate and complete excavation. 16 CY, stored in SP3.
	AOC4B1-GP08	Initiate excavation, task incomplete. 20 CY, transported to Glass Holes.
January 13, 2003	AOC4B1-SB06	Initiate and complete excavation. 20 CY, transported to Glass Holes.
January 13-14, 2003	AOC4B1-GP08	Initiate and complete excavation. 42 CY, transported to Glass Holes.
January 14, 2003	AOC4B1-SB08	Initiate and complete excavation. 8 CY, transported to Glass Holes.
	AOC4B1-GP14	Initiate and complete excavation. 3 CY, stored in SP3.
	AOC4B1-GP15	Initiate and complete excavation. 9 CY, stored in SP3.
January 22, 2003	AOC4B1-SB08	Initiate and complete excavation. 2 CY, stored in SP3.
	AOC4B1-GP14	Initiate and complete excavation. 2 CY, stored in SP3.
February 3, 2003	AOC4A-GP01	Initiate and complete excavation. 28 CY, stored in SP3.
	AOC4B1-GP01	Initiate and complete excavation. 16 CY, stored in SP3.
	AOC4B1-GP05	Initiate and complete excavation. 16 CY, stored in SP3.
	AOC4B1-GP12	Initiate and complete excavation. 3 CY, stored in SP3.
February 5, 2003	AOC4B1-GP08	Initiate and complete excavation. 8 CY, transported to Glass Holes.
February 13-14, 2003	AOC4B1-GP13	Complete excavation. 23 CY, transported to Glass Holes.
February 21, 2003	AOC4A-GP01	Initiate and complete excavation. 70 CY, stored in SP7.
February 24-25, 2003	AOC4A-GP01	Initiate and complete excavation. 82 CY, stored in SP7.
February 26, 2003	AOC4B1-GP05	Initiate and complete excavation. 10 CY, stored in SP8.
February 28, 2003	AOC4A-GP01	Initiate and complete excavation. 12 CY, stored in SP8.
	AOC4B1-GP05	Initiate and complete excavation. 10 CY, stored in SP8.
March 4, 2003	AOC4A-GP01	Initiate and complete excavation. 2 CY, stored in SP8.
	AOC4B1-GP01	Initiate and complete excavation. 10 CY, stored in SP8.
	AOC4B1-GP05	Initiate and complete excavation. 3 CY, stored in SP8.

Photograph : Track excavator removing soil from STP sand filter bed/berm and loading a dump truck for transport to the soil pile storage area (in background).

Approximately 1320 CY of soil and debris (e.g., plastic liner, concrete, brick, clay tile pipe) were excavated as waste. Approximately 845 CY is considered LLW and was shipped to Envirocare of Utah, Inc ?by June 5, 2003. Approximately 475 CY were shipped to Envirocare by October 2003. Approximately 600 gallons of water collected from the bottom of the excavation at AOC4B1-GP16 was containerized in eleven 55-gallon drums. This water was a combination of groundwater and precipitation (rain and snow melt) that had to be removed for the final walkover survey. The water was tested, filtered, and on meeting New York State SPDES release limits was discharged to the upstream main of the STP. Table 2 provides a summary of estimated waste volumes following excavation. (See Sections 2.4 and 3.0 regarding

management of these wastes.) Details of the excavations including depths are discussed in following sections. Details on the radiological walkover survey results prior to, during, and following excavation activities are provided in Sections 2.4 and 2.5.

2.1 AOC 4 Sewage Treatment Plant (STP)

This section discusses the activities involved with each excavation including the location, type of contaminants removed, preliminary sampling and/or sodium iodide (NaI) detector walkover surveys as appropriate, and the quantity and temporary disposition of the excavated soil. Separate figures and tables are presented to support the discussion. Note that for ease of reviewing the information, the figures and data tables are tabbed in Attachment 1 according to the respective excavation area discussed below.

2.1.1 Sludge Drying Beds

The excavation at the sludge drying bed AOC4A-GP01 was conducted only for the removal of mercury contamination as determined during the RI and from confirmation sampling. As noted in Table 2, the initial surface area of the excavation increased significantly. The excavation increased in surface area to 3575 ft^2 with a maximum depth of 2.5 feet and a volume of almost 200 CY of soil. The distribution of samples with mercury in excess of the 2 ppm criteria is noted in AOC4A-GP01 Figure A. The maximum concentration of mercury identified was 10.6 ppm (see AOC4A-GP01 Table). After several interim excavations and sampling events, mercury levels less than 2 ppm were achieved. AOC4A-GP01 Figure B represents the location of final confirmatory samples following exacvation. Mercury concentration was less than 2 ppm in all of the confirmation samples. The excavated soil from the sludge drying bed was placed in stockpiles designated as SP1, SP7, and SP8.

2.1.2 Sand Filter Beds and Berms

The excavations conducted in the sand filterbeds, berms and surrounding areas within the STP were segregated based on the clean up criteria of radiological or mercury contamination (See Table 2). This allowed for separation of waste and activities requiring additional radiation control support and oversight. Excavations based on mercury only included areas AOC4B-GP13, AOC4B1-GP02, AOC4B1-GP14, AOC4B1-GP15. Excavations based on cesium-137 only included AOC4B1-SB05 and AOC4B1-SB06. Excavations based on elevated levels of both cesium-137 and mercury included AOC4B1-GP01, AOC4B1-GP05, AOC4B1-GP06, AOC4B1-GP08, AOC4B1-GP12, AOC4B1-GP13, AOC4B1-GP16, and AOC4B1-SB08.

The locations of previous samples that exceeded the mercury or cesium-137 goals were staked. The cleanup process involved successive excavations of the area surrounding each staked area of exceedance or the cleanup goals followed by repeated rounds of sampling, staking of sample points, survey by GPS, with an approximate 8-10 foot precision, to obtain rapid location information, analysis and excavation until the cleanup goals were met. Once the cleanup goals were met, each area cleaned up was surveyed with conventional high precison survey techniques.

AOC4B-GP13

AOC4B-GP13 is located in the southwest section of inactive sand filter bed No.7. The top six inches of soil were removed based on the elevated mercury value of 5.8 identified during the RI. The results of preliminary sampling (AOC4B-GP13 Figure A, Table) reduced the original surface area and volume by 40 percent. Results of the confirmation samples indicate that mercury concentration was below 2 ppm (AOC4B-GP13 Figure B, Table). Approximately 143 CY of material was placed in waste storage piles SP1 and SP2.

AOC4B1-GP02

AOC4B1-GP02 is located on the eastern part of the berm that separates active sand filter beds No.1 and No.2, respectively (Figure 4). Based on the results of previous and preliminary sampling (AOC4B1-GP02 Figure A, Table), the top six inches of soil contained mercury at concentrations of 3.8. ppm. Following excavation the results of confirmatory sampling after excavation indicated that mercury was below the 2 ppm criteria (AOC4B1-GP02 Figure B, Table). Approximately 5 CY of material was removed and placed in stockpile SP1 for temporary storage until shipment for offsite disposal.

AOC4B1-GP14

AOC4B1-GP14 is located within the sand filter bed midway along the edge of the western berm of active filter bed No.1 (Figure 4). This excavation was based on the findings of elevated mercury during the Geoprobe® investigation in July 2002. Preliminary sampling identified the extent of the elevated mercury, with the maximum concentration of 12.04 ppm (AOC4B1-GP14 Figure A, Table). Results of the confirmatory sampling after excavation indicated that elevated mercury was removed, since the concentrations were less than 1 ppm (AOC4B1-GP14 Figure B, Table). Approximately 3.2 CY of material was excavated and placed in stockpile SP3.

AOC4B1-GP15

AOC4B1-GP15 is located within the sand filter bed along the edge of the berm at the southwest corner of active filter bed No.3 (Figure 4). This excavation was based on the findings of elevated mercury during the Geoprobe® investigation in July 2002. Preliminary sampling identified the extent of the elevated mercury, with the maximum concentration of 8.04 ppm at the surface (AOC4B1-GP15 Figure A, Table). The results of confirmation sampling indicated that the remaining mercury concentration did not exceed 1.81 ppm (AOC4B1-GP15 Figure B, Table). Approximately 8.8 CY of soil was excavated and placed at stockpile SP3.

AOC4B1-GP01

AOC4B1-GP01 is located north of active sand filter bed No.2 and across the road that bounds the north portion of the STP (Figure 4). This excavation was based on findings of elevated mercury during the RI. During the preliminary sampling, mercury was found at the southwest corner of the site (AOC4B1-GP01 Figure A , Table). Elevated mercury was found as high as 12.1 ppm during the excavation process. During a preliminary NaI walkover survey, elevated surface activity readings of 35 thousand counts per minute (kcpm) suggested radiological

contamination (AOC4B1-GP01 Figure C). Additional soil borings confirmed cesium-137 at 26.4 pCi/g at depths of one to two feet within the northeast section of the excavation (AOC4B1-GP01 Figure D, Table). Excavation then focused on the removal of soil from each of the two sections followed by additional confirmation sampling. The results of the confirmation sampling indicated that mercury values were less than 1.5 ppm (AOC4B1-GP01 Figure B, Table) and the highest value for cesium-137 was 18 pCi/g . During the excavation process, it was necessary to remove a 20-inch diameter pine tree adjacent to the north boundary road because the exposure of the root mass affected the stability of the tree, which could result in a potential safety hazard. Over the duration of the excavation approximately 77 CY of soil was removed and placed in stockpiles SP1, SP3, and SP8.

AOC4B1-GP05

AOC4B1-GP05 is located north of active sand filter bed No.4 and across the north STP boundary road (Figure 4). This excavation was based on the presence of both elevated mercury and cesium-137 at a depth of two feet. During the preliminary sampling, elevated mercury was identified at the surface at the south and east corners of the excavation boundary (AOC4B1-GP05 Figure A; Table). The preliminary NaI walkover survey detected elevated surface activity readings of 30kcpm in the north corner of the excavation site (AOC4B1-GP05 Figure 11). The results of additional soil borings collected to a depth of four feet outside the excavated area confirmed that elevated cesium-137 levels were bounded (AOC4B1-GP05 Figure D, Table). Following each of four excavations, confirmation sampling was conducted to verify that mercury and/or cesium-137 cleanup goals were met (AOC4B1-GP05 Figure B, Table). Excavation to a depth of approximately 3.5 feet was required to remove the pocket of elevated mercury found primarily in the northwest corner of the area. The highest concentration detected and removed was 6.4 ppm. The highest level of cesium-137 left in place was 21.3 pCi/g. Approximately 140 CY was excavated from this area and placed in stockpiles SP3 and SP5.

AOC4B1-GP06

AOC4B1-GP06 is located south and east of active sand filter bed No.1 and across the south STP boundary road (Figure 4). This excavation was based on the presence of both elevated mercury and cesium-137 at the surface. During preliminary sampling, elevated mercury (5.08 ppm) was found at the southeast corner of the area (AOC4B1-GP06 Figure A). The preliminary NaI walkover survey detected elevated surface activity readings of 20 to 25 kcpm in the northwest and southeast sections of the site (AOC4B1-GP06 Figure C). Following the excavation of approximately 12 CY of soil, confirmatory samples for mercury (AOC4B1-GP06 Figure B) and cesium-137 (AOC4B1-GP06 Figure D) indicated that mercury was less than 1 ppm and the highest cesium-137 was 12.3 pCi/g (AOC4B1-GP06 Table). The soil was placed in SP1.

AOC4B1-GP08

AOC4B1-GP08 is located along the east berm of inactive sand filter bed No.5 and adjacent to the aboveground piping structure that distributed the water to the treatment bed. This excavation was based on the presence of both elevated mercury at the surface and cesium-137 at a depth of 3 feet. The preliminary sampling for mercury, including the results of the supplemental Geoprobe® sampling in July 2002, identified elevated mercury from the surface to a depth of 2.5 feet (AOC4B1-GP08 Figures A and B, Table). The preliminary NaI walkover survey detected elevated surface activity readings of 25 to 30 kcpm at the extreme ends of the proposed excavation area (AOC4B1-GP08 Figure C). Since 2.5 feet diameter transit pipes ran parallel with the berm at the edge of the bed and laid directly on the ground, there was a possibility that fine material could accumulate beneath them, some of which may be contaminated. Approximately 20 feet of distribution pipe was disassembled and moved alongside the excavation area. In addition a 6 feet by 4 feet by 3 feet distribution box was removed along with 25 feet of 4-inch diameter vitrified clay tile pipe. Following the initial excavation, an interim NaI walkover survey indicated elevated activity (20 to30 kcpm) at the surface approximately 40 feet along the remaining pipe to the south of the excavation (AOC4B1-GP08 Figure D). The excavation contained a strip of elevated activity (18 to30 kcpm) that was upgradient, but parallel with the area of the removed pipe. Additional soil boring samples were collected upgradient of the remaining pipe (AOC4B1-GP08 Figure E). The *In Situ* Object Counting System™ (ISOCS™) results indicated cesium-137 was present at several locations as high as 24.4 pCi/g. Based on these results an additional 20 feet of pipe was removed and the area immediately upgradient was excavated. A post excavation walkover survey identified three isolated pockets of elevated activity (AOC4B1-GP08 Figure F). The results of confirmatory sampling after excavation indicated mercury values were less than 1 ppm and that the highest value for cesium-137 was 13.3 pCi/g (AOC4B1-GP08 Figure B, Table). Approximately 280 CY of soil was excavated and placed in stockpiles SP4, SP5, and SP6.

AOC4B1-GP12

AOC4B1-GP12 is located along the south side of inactive sand filter bed No.6 (Figure 4). This excavation was based on the presence of both elevated mercury and cesium-137 at one-foot depth. The location of elevated mercury (3.38 ppm) from the Geoprobe® soil sampling of 2000 is noted in AOC4B1-GP08 Figure A. The preliminary NaI detector walkover survey detected elevated surface activity readings of 20 kcpm in the west section of the area (AOC4B1-GP08 Figure C). Following the excavation of approximately 12 CY of soil, confirmatory samples for mercury (AOC4B1-GP08 Figure B) and cesium-137 (AOC4B1-GP08 Figure D) indicated that mercury was less than 1 ppm and the highest cesium-137 was 10.5 pCi/g (AOC4B1-GP08 Table). The excavated soil was placed in stockpiles SP3 and SP5.

AOC4B1-GP13

AOC4B1-GP13 is located at the southeast corner of inactive sand filter bed No.6 and includes both the berm and bed within the excavation (Figure 4). This excavation was based on the presence of both elevated mercury at depths of 4 to 6 feet and cesium-137 from the surface to a depth of four feet. The location of elevated mercury from the Geoprobe® soil sampling events of 2000 (10.2 ppm) and 2002 (9.59 ppm) is noted in AOC4B1-GP13 Figure A, Table.

Approximately 20 feet of distribution pipe was disassembled and moved alongside the excavation area. In addition 12 feet of 4-inch diameter vitrified clay tile pipe and a cinder block distribution box was removed before excavation was completed. Since the depth of the excavation was greater than four feet, three sides were benched to allow entrance into the excavation for sampling. The excess clean material was placed aside to be backfilled when authorized. Following the excavation of approximately 83 CY of soil, confirmatory samples for mercury (AOC4B1-GP13 Figure B) and cesium-137 (AOC4B1-GP13 Figure D) indicated that mercury was 1 ppm and the highest cesium-137 was 6.5 pCi/g (AOC4B1-GP13 Table). The excavated soil was placed for temporary storage in stockpile SP3.

AOC4B1-GP16

AOC4B1-GP16 is located north of active sand filter bed No.4 and is on the west portion of the firing range berm north of the STP boundary road (Figure 4). This excavation was based on the presence of both elevated mercury at a depth of six feet and cesium-137 at a depth of one to two feet. The locations of elevated mercury (9.82 ppm) from the Geoprobe® soil sampling of 2000 and preliminary sampling (3.17 ppm) are shown in AOC4B1-GP16 Figure A, Table. Twenty feet of galvanized security fencing was removed from the top of the berm and the security guard house was moved approximately 15 feet to allow access by the excavator. Since the depth of the excavation was greater than four feet, three sides were benched to allow entrance into the excavation for sampling. The excess clean material was placed aside to be backfilled when authorized. Due to recent precipitation events (i.e., over 24 inches of snow and freezing conditions), the bottom of the excavation contained water that had to be removed prior to collection of confirmation samples. Eleven drums of melted snow and surface water runoff was collected, contained, and analyzed before release to the STP intake stream. Analytical results of soil samples indicate that mercury did not exceed 1.1 ppm (AOC4B1-GP16 Figure B) and that cesium-137 did not exceed 1 pCi/g (AOC4B1-GP16 Figure C, Table). Approximately 59 CY of soil was excavated and placed in temporary storage in stockpile SP5.

AOC4B1-SB05

AOC4B1-SB05 is located along the south side of active sand filter bed No.2 (Figure 4). This excavation was based on the presence of elevated cesium-137 at the surface. The location of elevated cesium-137 (67 pCi/g) from the RI soil sampling is noted in AOC4B1-SB05 Figure A. The preliminary NaI walkover survey did not detect elevated surface activity readings in excess of 10 kcpm (AOC4B1-SB05 Figure B). Pre-excavation samples collected and analyzed for mercury had concentrations less than 1.44 ppm. Because elevated levels of cesium-137 and mercury were not found during the screening process, only a minimum volume of soil (5 CY) was removed. Confirmatory samples for both mercury (AOC4B1-SB05 Figure C) and cesium-137 (AOC4B1-SB05 Figure D) were less than 1 ppm for mercury and less than 2 pCi/g for cesium-137 (AOC4B1-SB05 Table). The excavated soil was placed in stockpile SP3 for temporary storage.

AOC4B1-SB06

AOC4B1-SB06 is located south of active sand filter bed No.3 and the southern STP boundary road (Figure 4). This excavation was based on the presence of elevated cesium-137 at the surface. The location of elevated cesium-137 (30.8 pCi/g) from the RI soil sampling is noted in AOC4B1-SB06 Figure A. The preliminary NaI walkover survey indicated elevated surface activity readings of 25 to 30 kcpm along the north edge of the pre-excavation boundary (AOC4B1-SB06 Figure B). A NaI survey conducted following the excavation indicated elevated surface activity readings of 19 to 37 kcpm along the north and south edges of the excavation. Results of additional soil borings at this location indicated cesium-137 at a maximum value of 14.7 pCi/g (AOC4B1-SB06 Table). Confirmation samples were collected for both mercury (AOC4B1-SB06 Figure C) and cesium-137 (AOC4B1-SB06 Figure D) following final excavation. Results were less than 1 ppm for mercury and a maximum of 10.4 pCi/g for cesium-137 (AOC4B1-SB06 Table). Approximately 30 CY of soil was excavated and placed for temporary storage in stockpile SP5.

AOC4B1-SB08

AOC4B1-SB08 is located at the north edge of the inactive sand filter bed No.5 (Figure 4). This excavation was based on the presence of both elevated mercury (7.2 ppm) and cesium-137 (26.9 pCi/g) at the surface during the Geoprobe® soil sampling in July 2002 (AOC4B1-SB08 Table). The excavation boundary was initially determined during pre-excavation sampling for mercury. Based on elevated mercury at four sample points (AOC4B1-SB08 Figure A, Table), the initial excavation removed approximately 4 CY of soil. Confirmation sampling identified three samples greater than 2 ppm that were bounded by additional samples and later excavated. The final confirmation sampling (AOC4B1-SB08 Figure B, Table) indicates that the remaining soil contains mercury at concentrations less than 2 ppm. The confirmation sampling for cesium-137 (AOC4B1-SB08 Figure C, Table) following final excavation indicated the maximum value for cesium-137 was 10.2 pCi/g. Approximately 6 CY of soil was excavated and placed for temporary storage in SP3.

2.2 AOC 21 Abandoned Sewer Lines

Waste material from each manhole (See Figure 2) was vacuumed via a 40-ft length of 4-inch diameter corrugated flexible hose. The vacuum hose was connected to an 85-gallon salvage drum to serve as the primary intercept container. This container was modified with a lid that had inlet and outlet connections and an interior baffle assembly. A length of 4-inch diameter corrugated flexible hose connected the primary intercept container to a secondary intercept container, which also was an 85-gallon salvage drum. The secondary intercept container was modified using a lid having inlet and outlet connections and an interior fixed piping manifold to which was attached three five-micron filter bags in parallel. The secondary intercept container was connected to a stand-alone high efficiency particulate air (HEPA) filter assembly by a 4-inch diameter corrugated flexible hose. The HEPA filter assembly contained a single replaceable/disposable HEPA filter element. The stand-alone HEPA filter assembly was connected to a trailer-mounted vacuum unit by a 4-inch diameter corrugated flexible hose. The trailer-mounted vacuum unit discharged to the atmosphere. The HEPA filter efficiency was

tested and approved by BNL Environmental Services Division (ESD) prior to system operation. As defined by the BNL Work Permit/Radiation Work Permit, a work exclusion zone was established at each manhole location. Actual waste handling activities took place under the direct guidance of an RCT. The following activites were performed as part of the scoped AOC 21 removal action:

Date	Location	Activities
October 8, 2002	Bldg. 484 parking lot	Perform HEPA filter system test
	MH-201	Initate and complete soil removal
October 11, 2002	MH-192 thru MH-200	Initiate and complete soil removal

A total of 15 cubic feet of soil waste material was collected from the sewer manholes. The waste material was characterized (Table 4) and part of the disposal shipment to Envirocare.

2.3 Waste Volume Summary

A total of approximately 1320 cubic yards of soil and debris and approximately 10 CY of personal protective equipment (PPE) and miscellaneous secondary wastes were generated for shipment to Envirocare, Utah (see Table 2 above and Table 5 below). A summary of the waste generated, associated Radiological Waste Control Form (RWCF) numbers, estimated weights, volumes, and temporary storage areas are summarized in Table 5. All LLW soil associated with the STP were shipped by rail to Envirocare by June 5, 2003. Non-radiological wastes (mercury contaminated soil) separated for possible shipment anddisposal at a subtitle D facility will be shipped to Envirocare by the end of August 2003. See Section 3.0 regarding management of these wastes.

2.4 Field Screening Methods Prior to and During Excavation

Gamma walkover surveys with either a Ludlam Model 19 or Eberline Model E600 Ratemeter with a two-inch-by-two-inch NaI detector were performed prior to and during remediation activities to identify localized as well as distributed sources of contamination. During the as-found surveys, the in-situ response of the NaI detector was found not to correlate linearly with biased soil sample results from the ISOCS™, perhaps due to the variability of the background levels found in the area. Thus, remediation efforts were focused on the areas with the greatest surface contamination. Once the surrounding gamma background levels were reduced, the walkover surveys were compared directly to biased soil sample results from the ISOCS™ to ascertain the relative response of the NaI detector to a projected cesium-137 contamination level. Any areas found exceeding 4 kcpm above reference background were evaluated for sampling and analysis for radionuclide identification and/or excavation. The basis for the investigation level (4 kcpm above reference background) and a derivation of the use of the cesium-137 gamma-emission was given in the *Final Status Survey Plan* (BNL 2003b) and *Field Sampling Plan* (BNL 2002).

The *Operable Unit V Remedial Investigation/Feasibility Study* (IT 1998) and *Supplemental Geoprobe® Soil Sampling Investigations* (BNL 2001, 2003a) were used to define the areas that

required excavation and to define and map the primary areas (Class 1) and secondary areas (Class 2). The primary areas (Class 1) designated for excavation indicated concentrations of radionuclides, specifically, cesium-137, above the remediation goal as identified in the ROD. Secondary areas (Class 2) contained concentrations of radionuclides at or above background levels but below the cleanup level.

Table 5: Waste Characterization Results of Material from STP Retired Sewer Manholes

Analysis	Result	Units	Lab. Qual.
Electrode Analysis Federal			
pH at Temp 21.4C	5.77		H
Hazardous Waste Federal			
Flashpoint-140	>140	degrees F	
Rad Alpha Spec			
Americium-241	2.45	pCi/g	
Curium-242	0.00	pCi/g	U
Curium-243/244	0.00709	pCi/g	U
Neptunium-237	-0.0277	pCi/g	U
Plutonium-238	-0.00473	pCi/g	U
Plutonium-239/240	0.425	pCi/g	J
Rad Gamma Spec			
Iodine-129	0.116	pCi/g	U
Nickel-59	5.10	pCi/g	U
Actinium-228	0.616	pCi/g	J
Americium-241	2.91	pCi/g	
Antimony-124	0.0267	pCi/g	U
Antimony-125	0.0365	pCi/g	U
Barium-133	-0.149	pCi/g	U
Barium-140	0.096	pCi/g	U
Beryllium-7	-0.109	pCi/g	U
Bismuth-212	0.890	pCi/g	
Bismuth-214	0.484	pCi/g	
Cerium-139	-0.00269	pCi/g	U
Cerium-141	0.0277	pCi/g	U
Cerium-144	0.0154	pCi/g	U
Cesium-134	0.00261	pCi/g	U
Cesium-136	-0.0119	pCi/g	U
Cesium-137	3.87	pCi/g	
Chromium-51	-0.048	pCi/g	U
Cobalt-56	-0.00273	pCi/g	U
Cobalt-57	0.013	pCi/g	U
Cobalt-58	-0.00726	pCi/g	U
Cobalt-60	0.699	pCi/g	
Europium-152	0.534	pCi/g	
Europium-154	0.264	pCi/g	J-UI
Europium-155	0.132	pCi/g	J-UI
Iridium-192	0.0075	pCi/g	U
Iron-59	-0.058	pCi/g	U
Lead-210	1.11	pCi/g	J
Lead-212	0.624	pCi/g	
Lead-214	0.470	pCi/g	
Manganese-54	0.00853	pCi/g	U
Mercury-203	0.0213	pCi/g	U
Neodymium-147	0.284	pCi/g	U

Analysis	Result	Units	Lab. Qual.
Rad Gamma Spec			
Silver-110m	0.0405	pCi/g	U
Sodium-22	0.094	pCi/g	UI
Thallium-208	0.186	pCi/g	
Thorium-230	0.484	pCi/g	J
Thorium-234	0.499	pCi/g	U
Tin-113	-0.00135	pCi/g	U
Uranium-235	0.128	pCi/g	U
Uranium-238	0.499	pCi/g	U
Yttrium-88	-0.00173	pCi/g	U
Zinc-65	-0.0418	pCi/g	U
Zirconium-95	0.0275	pCi/g	U
Rad Gas Flow			
Alpha	12.8	pCi/g	
Beta	14.4	pCi/g	
Strontium-90	1.67	pCi/g	J
Rad Liquid Scint			
Tritium	1.12	pCi/g	U
Carbon-14	0.169	pCi/g	U
Iron-55	-0.809	pCi/g	U
Nickel-63	0.808	pCi/g	U
Rapid Flow Analysis Federal			
Reactive Releaseable Cyanide	-11.1	pCi/g	U
Titration Analysis Federal			
Reactive Releaseable Sulfide	6.49	pCi/g	U
TCLP Inorganics			
Mercury	0.004	mg/L	
Arsenic	0.0337	mg/L	J
Barium	0.350	mg/L	
Cadmium	0.0191	mg/L	J
Chromium	0.0188	mg/L	J
Lead	0.618	mg/L	
Selenium	-0.0207	mg/L	U
Silver	0.014	mg/L	J
Zinc	1.09	mg/L	
Pesticides			
2,4,5-TP	0.00	mg/L	U
2,4-D	0.00	mg/L	U
Chlordane (tech.)	0.00	mg/L	U
Endrin	0.00	mg/L	U
Heptachlor	0.00	mg/L	U
Heptachlor expoxide	0.00	mg/L	U
Methoxychlor	0.00	mg/L	U
Toxaphene	0.00	mg/L	U
gamma-BHC (Lindane)	0.00	mg/L	U

Table 6: Sewage Treatment Plant Detailed Waste Summary

Waste Type	Storage Area	Package	Weight (pounds)	Volume (CY)	Contents
Debris / Soil (LLW)	BNL Soil Staging Area	Stockpile	2,535,000	845	Soil, Concrete Plastic sheeting,
Debris / Soil (Non-hazard)	STP SP1, SP2, SP3, SP7, SP8	Stockpile	1,425,000	475	Soil, Plastic sheeting
Soil Sewerline (LLW)	STP Sediment Drying Pens	55 gallon drum	300	less than 1	Soil
Surface water	STP Firing Range Berm	55 gallon drum	4800	less than 10	Surface water
Total			**3,965,600**	**1330**	

2.5 Post Excavation Final Status Surveys

Following remediation, a final radiological status survey was performed to demonstrate that residual radioactivity in each area satisfies the clean-up criteria identified by the ROD. The final walkover survey consisted of a 100 percent surface scan of the Class 1 areas and a 25 percent surface scan of Class 2 areas using an Eberline Model E600 Ratemeter with two-inch-by-two-inch NaI detector. In addition, the Oak Ridge Institute for Science and Education (ORISE) performed independent verification to support that clean-up goals were achieved. Results of the independent verification are provided in Attachment 2. Final status surveys for the STP are provided in Attachment 3 (AOC4B1- GP01, Figure E; AOC4B1- GP05, Figure E; AOC4B1- GP06, Figure E; AOC4B1- GP08, Figure G; AOC4B1- GP12, Figure E; AOC4B1- GP13, Figure D; AOC4B1- GP16, Figure D; AOC4B1- SB05, Figure D; and AOC4B1- SB06, Figure D).

2.5.1 Final Radiological Status Survey Design

The design of the final status survey was based on guidance provided in the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) (DOE 2001b). Details of the survey design are provided in the *OU V STP Field Sampling Plan* (BNL 2002) and the *OU V STP Final Status Survey Plan* (BNL 2002). The survey was an integrated design, combining:

- A surface scanning meter survey (walkover survey) to identify localized areas of elevated activity (100 percent of Class 1 and 25 percent of Class 2 areas);

- Analysis of soil samples from systematic positions on a triangular grid to determine the average concentration of activity distributions in relatively large areas (Class 1, Class 2 and Reference areas); and
- Analysis of soil samples to confirm instrument readings (100 percent of high readings) or to verify on-site analysis (10 percent of samples analyzed on site were sent to General Engineering Laboratories (GEL)). All samples analyzed for plutonium were sent to GEL for isotopic analysis by alpha spectroscopy.

Decision criteria and survey components are discussed further in the following sections.

a. Classifying survey units

- Areas of the STP, the sand filter beds and berms and the adjacent areas were categorized using MARSSIM methods to define the survey design. Class 1 areas were those areas with contamination levels greater than the clean-up goal. The berms surrounding the eight sand filter beds are designated Class 1 areas. For classification purposes, the berms were defined as being the 30-feet wide strip between and around the beds. These were divided into nine similar-size sections, approximately 18,000 square feet ($ft^{2)}$ (1,650 square meters [m^2]) each. Areas adjacent to excavations outside of the berms were extended to include those excavated areas.

- Class 2 areas were those which had been found to be contaminated, but at levels below the clean-up goals. The sand filter beds and area around the berm perimeter were considered the Class 2 survey units. The eight sand filter beds were paired to form four Class 2 survey areas. A 30-foot wide perimeter around the beds and berm region was divided into two Class 2 areas.

- The BNL Helipad was identified as the site radiological reference area, from which representative reference measurements were compared to measurements performed in survey units. Data from measurements in the Helipad area were available from prior remedial efforts.

This classification resulted in nine Class 1 survey units, six Class 2 survey units, and one reference area as summarized in Table 6. Areas within the AOCs were categorized using MARSSIM methods to define the survey design. Class 1 areas were those areas with contamination levels greater than the clean-up goals. Class 2 areas were those which had been found to be contaminated, but at levels below the clean-up goals. The areas are described in Table 6.

b. Determining sampling grid size and number of samples

Using the methods recommended in MARSSIM, Chapter 5, a calculation of number and spacing for a systematic triangular sampling grid pattern was performed. This number of systematic samples, and the corresponding grid spacing between the samples, assures a statistically sufficient database for determining whether the average radioactivity concentration in each of the

survey units meets or exceeds the cleanup goal. The number and spacing of the samples planned before excavation and those performed for the actual excavated areas are listed in Table 6. The calculation of the grid separation distance and of the number of sample points is detailed in *Final Status Survey Plan, Area of Concern 4 Sewage Treatment Plant Sand Filter Beds and Berms* (BNL 2003).

Table 7. Description of Survey Units

Designator	Description	Area	Number of Samples for Each Designation	Grid Interval Length
Class 1 Areas				
STP1-1	South and West sides of Cell #1	1,650 m^2	13	12 m (40 ft)
STP1-2	South and West sides of Cell #2			
STP1-3	East and North sides of Cell #2, including the excavated area west of the firing range			
STP1-4	East, South and West sides of Cell #3			
STP1-5	South and East Sides of Cell #4, South Side of Cell #6			
STP1-6	North Side of Cell #4, North side of Cell #6 and West portion of Firing Range Berm			
STP1-7	South and East sides of Cell #5, South side Cell # 7			
STP1-8	East, North and West sides of Cell #7			
STP1-9	East, South and North sides of Cell #8			
Class 2 Areas				
STP2-1	Beds #1 and #2	7,600 m^2	13	26 m (85 ft)
STP2-2	Beds #3 and #4			
STP2-3	Beds #5 and #6			
STP2-4	Beds #7 and #8			
STP2-5	Western Perimeter	9,000 m^2	13	28 m (92 ft)
STP2-6	Eastern Perimeter			
Reference	Helipad Area	previously sampled		

2.5.2 Final Status Survey Results

A summary of the radiological surveys conducted and the survey dates are given in Table 7. The results of the final walkover surveys (net counts per minute) as shown in Attachment 3 (AOC4B1- GP01, Figure E; AOC4B1- GP05, Figure E; AOC4B1- GP06, Figure E; AOC4B1- GP08, Figure G; AOC4B1- GP12, Figure E; AOC4B1- GP13, Figure D; AOC4B1- GP16, Figure D; AOC4B1- SB05, Figure D; and AOC4B1- SB06, Figure D) and the analysis of discrete surface soil samples were used with the MARSSIM statistical methods to demonstrate that clean-up criteria have been achieved successfully in each survey unit.

a. Final Radiological Walkover Survey

During the remediation, walkover surveys were performed following excavation to identify any localized areas of activity above the cleanup goal remaining in the soil. The locally elevated areas were re-excavated and another walkover survey of the re-excavated areas was performed to verify final compliance with the cleanup goal. (See Table 7 for the survey descriptions and dates.) In a few instances where single readings were near the screening levels for cleanup, readings were averaged with adjacent locations. In all cases, these average values were below the screening criteria.

Table 8: Summary of STP Sand Filter Beds and Berms Radiological Surveys

Figure Number	Description	Survey Date(s)
10C	Radiological Survey Prior to Excavation at AOC4B1-GP01	08/28/02
11C	Radiological Survey Prior to Excavation at AOC4B1-GP05	07/31/02
12C	Radiological Surveys Prior to Excavation at AOC4B1-GP06	07/31/02
13D	Radiological Surveys Prior to Excavation at AOC4B1-GP08	08/06/02
14C	Radiological Surveys Prior to Excavation at AOC4B1-GP12	07/30/02
17B	Radiological Surveys Prior to Excavation at AOC4B1-SB05	07/30/02
18	Radiological Surveys Prior to Excavation at AOC4B1-SB06	07/31/02
13C / 13F	Interim Radiological Survey (after 1st remediation) at AOC4B1-GP08	08/28/02 & 12/17/02
10E	Final Radiological Survey at AOC4B1-GP01	02/08/03
11E	Final Radiological Survey at AOC4B1-GP05	02/08/03
12E	Final Radiological Surveys at AOC4B1-GP06	02/08/03
13G	Final Radiological Surveys at AOC4B1-GP08	02/08/03
14E	Final Radiological Surveys at AOC4B1-GP12	02/08/03
15D	Final Radiological Surveys at AOC4B1-GP13	02/10/03 & 02/28/03
16D	Final Radiological Surveys at AOC4B1-GP16	02/10/03
17D	Final Radiological Survey at AOC4B1-SB05	02/08/03
20	Final Radiological Status Survey for the Class 1 & Class 2 Areas	01/13/03 thru 01/15/03

The final walkover survey consisted of a 100 percent surface scan of the Class 1 areas and a minimum 25 percent surface scan of the Class 2 areas using an Eberline E600 Ratemeter with two-inch-by-two-inch NaI detector. The survey results were recorded and graphically depicted or plotted on a site photograph. A composite of the Class 1 and Class 2 areas confirmation walkover survey is presented in Figure 5. BNL's Radiological Controls Division conducted a radiological survey of the excavation and stockpile areas on February 8-10 and February 28, 2003 to verify the final status of the remediation and to identify any institutional control issues related to the area prior to release for backfilling.

b. Sample Analysis

Final status survey surface soil samples were obtained at positions in accordance with MARSSIM guidelines as depicted in Figure 6 for Class 1 areas and Figure 7 for Class 2 areas. The samples were submitted for radiological analyses onsite by ISOCS™ (gamma spectroscopy) and offsite at GEL for gamma (cesium-137) and alpha (plutonium isotopic analysis). Mercury analysis was determined onsite by the use of a direct mercury analyzer (DMA) and offsite at GEL using standard EPA methodology.

c. Data Usability

Radiological data

Differences in reporting by the two analytical services (i.e., onsite and offsite) were reconciled before the data was used for site evaluation.

- In reporting the onsite analytical results, the ISOCS™ instruments incorporate a non-detect algorithm, so that when the upper bound of the 95 percent confidence interval for the sample result is below the minimum detectable concentration (MDC), the sample result is reported as "Non Detect" (ND).

- GEL, however, reported a numerical concentration value for all sample analyses, including when the results were below the MDC and even reporting negative values, which can be expected due to the statistical nature of decay events at these very low concentrations.

Therefore, for the GEL results, to provide comparable data for use in site evaluation, if the upper bound of the 95 percent confidence interval for the sample result was below the MDC, the sample result was coded ND for non-detect.

d. Analysis Results

The analytical results of the surface soil samples are provided in Tables 8, 9, and 10 for the Class 1, Class 2 and Reference areas, respectively. The tables provide values in pCi/g for concentration (Conc.), for the statistical counting uncertainty (Uncert), and for the minimum detectable concentration (MDC). The results for Class 1 and Class 2 cesium-137 are also presented in Figure 8.

The results of the analyses are summarized below:

- For the Class 1 Area, cesium-137 was detected in 78 of 130 ISOCS™ samples with a mean value of 1.7±3.1 pCi/g. Plutonium-238, plutonium-239/240, and amercium-241 were detected in 1, 15, and 10 samples, respectively. The average values of these radionuclides were 0.0028±.0028, 0.026±.026, and 0.30±0.28 pCi/g, respectively. The highest observed concentration of cesium-137 by ISOCS™ was 3.8 pCi/g, while the highest observed concentration of cesium-137 by gamma spectroscopy was 4.02 pCi/g. The highest concentrations observed for americium-241, plutonium-238, and plutonium 239/240 were 0.799 pCi/g, 0.007 pCi/g, and 0.108 pCi/g, respectively. (See Table 8.)
- For the Class 2 Area, cesium-137 was detected in 50 of 78 ISOCS™ samples with a mean concentration of 0.71±0.91 pCi/g. Plutonium-238, plutonium-239/240, and americium-241 were detected in samples with mean concentrations of 0.0012±0.0011, 0.037±0.037, and 1.1±1.6 pCi/g, respectively. The highest observed concentration of cesium-137 by ISOCS™ was 6.7 pCi/g. Of the 32 samples collected for offsite gamma and alpha spectroscopy, the highest observed concentration of cesium-137 was 2.83 pCi/g. The

Table 9. Post Remediation Soil Radiological Concentrations (pCi/gm) for the AOC 4 Class 1 Areas

Location	Cesium-137 (ISOCS)			Cesium- 137 (GEL)			Americium-241			Plutonium-238			Plutonium 239/240		
Site ID	Conc	Uncert	MDC	Conc	Uncert	MDC	Conc	Uncert	MDC	Conc	Uncert	MDC	Conc	Uncert	MDC
STP1-1-1	0.2	0.1	0.2							0.0005	+/-0.00241	0.0068	0.0091	+/-0.00759	0.0112
STP1-1-2	0.3	0.0	0.3												
STP1-1-3	0.3	0.0	0.3	0.2260	+/-0.0416	0.0195	0.7990	+/-0.134	0.0837						
STP1-1-4	0.4	0.2	0.1												
STP1-1-5	0.2	0.0	0.2												
STP1-1-6	0.2	0.0	0.2												
STP1-1-7	0.3	0.2	0.3												
STP1-1-8	1.8	0.4	0.3	2.0900	+/-0.258	0.0222	0.0562	+/-0.0297	0.0284						
STP1-1-9	0.2	0.2	0.2												
STP1-1-10	0.4	0.2	0.2							0.0037	+/-0.0107	0.0187	0.0112	+/-0.00734	0.0101
STP1-1-11	0.3	0.0	0.3												
STP1-1-12	0.6	0.2	0.2												
STP1-1-13	0.6	0.2	0.3												
STP1-2-1	0.3	0.1	0.2							0.0022	+/-0.00721	0.0129	0.0060	+/-0.00626	0.0100
STP1-2-2	0.6	0.2	0.2												
STP1-2-3	0.2	0.2	0.2												
STP1-2-4	0.3	0.0	0.3												
STP1-2-5	0.4	0.2	0.2												
STP1-2-6	0.6	0.2	0.3												
STP1-2-7	0.3	0.0	0.3												
STP1-2-8	0.6	0.2	0.1												
STP1-2-9	0.2	0.0	0.2	0.2370	+/-0.049	0.0320	0.0575	+/-0.0463	0.0377						
STP1-2-10	0.7	0.2	0.2												
STP1-2-11	0.5	0.2	0.2												
STP1-2-12	0.6	0.2	0.3							-0.0011	+/-0.00846	0.0159	0.0396	+/-0.0107	0.0070
STP1-2-13	0.3	0.2	0.3	0.3570	+/-0.057	0.0291	0.0063	+/-0.124	0.2070						
STP1-3-1	0.9	0.3	0.3							0.0031	+/-0.00511	0.0088	0.0281	+/-0.0085	0.0058
STP1-3-2	1.0	0.3	0.2							-0.0005	+/-0.00498	0.0100	0.0315	+/-0.0097	0.0200
STP1-3-3	3.8	0.5	0.2												
STP1-3-4	1.5	0.3	0.3												
STP1-3-5	0.2	0.1	0.1	0.2300	+/-0.040	0.0298	-0.0138	+/-0.0578	0.1060						
STP1-3-6	0.5	0.2	0.3	0.2850	+/-0.043	0.0232	0.0040	+/-0.0526	0.0910						
STP1-3-7	0.2	0.2	0.2												
STP1-3-8	0.4	0.0	0.4												
STP1-3-9	1.1	0.3	0.2												
STP1-3-10	0.6	0.2	0.2												
STP1-3-11	1.1	0.3	0.2												
STP1-3-12	0.7	0.2	0.2												
STP1-3-13	3.7	0.5	0.3	4.0200	+/-0.405	0.0313	0.0604	+/-0.0748	0.1340						
STP1-3R-1	0.7	0.3	0.3												
STP1-3R-2	1.0	0.3	0.2												
STP1-3R-3	3.5	0.5	0.4												
STP1-3R-4	2.6	0.4	0.2							-0.0029	+/-0.00641	0.0127	0.1080	+/-0.0184	0.0095
STP1-3R-5	0.6	0.2	0.1												

Table 9. Post Remediation Soil Radiological Concentrations (pCi/gm) for the AOC 4 Class 1 Areas (cont.)

Location	Cesium-137 (ISOCS)			Cesium- 137 (GEL)			Americium-241			Plutonium-238			Plutonium 239/240		
Site ID	Conc	Uncert	MDC	Conc	Uncert	MDC	Conc	Uncert	MDC	Conc	Uncert	MDC	Conc	Uncert	MDC
STP1-3R-6	0.3	0.2	0.2												
STP1-3R-7	0.4	0.2	0.2												
STP1-3R-8	0.3	0.2	0.2							-0.0045	+/-0.00506	0.0115	0.0158	+/-0.00779	0.0096
STP1-3R-9	1.4	0.3	0.3												
10	0.4	0.0	0.4												
11	0.6	0.2	0.2												
12	0.6	0.2	0.2												
13	0.7	0.2	0.3												
STP1-4-1	0.1	0.0	0.1												
STP1-4-2	0.3	0.0	0.3												
STP1-4-3	0.5	0.2	0.2												
STP1-4-4	0.5	0.2	0.1												
STP1-4-5	1.0	0.3	0.3	1.1300	+/-0.124	0.0244	0.1260	+/-0.0827	0.0865						
STP1-4-6	0.8	0.3	0.3	0.6050	+/-0.0794	0.0223	0.0077	+/-0.0632	0.1050						
STP1-4-7	0.8	0.2	0.2	0.7510	+/-0.097	0.0189	-0.0076	+/-0.0311	0.0572						
STP1-4-8	1.1	0.3	0.3												
STP1-4-9	1.3	0.4	0.4							-0.0005	+/-0.00555	0.0109	0.0443	+/-0.0116	0.0095
STP1-4-10	0.5	0.2	0.3	0.5010	+/-0.0679	0.0282	0.4250	+/-0.222	0.2000						
STP1-4-11	0.7	0.2	0.2	0.8020	+/-0.0949	0.0265	0.2400	+/-0.151	0.1330						
STP1-4-12	0.7	0.3	0.4							0.0071	+/-0.00586	0.0036	0.0403	+/-0.0145	0.0036
STP1-4-13	0.5	0.2	0.2	0.4340	+/-0.0646	0.0277	0.0097	+/-0.0617	0.1180						
STP1-5-1	0.7	0.2	0.2												
STP1-5-2	3.8	0.5	0.3												
STP1-5-3	0.5	0.2	0.2												
STP1-5-4	1.0	0.3	0.2												
STP1-5-5	0.6	0.3	0.3												
STP1-5-6	0.3	0.0	0.3							0.0006	+/-0.00261	0.0074	0.0035	+/-0.00496	0.0089
STP1-5-7	0.3	0.0	0.3												
STP1-5-8	1.3	0.3	0.3												
STP1-5-9	0.4	0.0	0.4												
STP1-5-10	0.9	0.3	0.3							-0.0012	+/-0.0032	0.0108	0.0129	+/-0.00889	0.0117
STP1-5-11	0.9	0.3	0.2												
STP1-5-12	0.3	0.2	0.2												
STP1-5-13	0.7	0.3	0.3												
STP1-6-1	0.7	0.2	0.2							-0.0007	+/-0.00348	0.0114	0.0216	+/-0.012	0.0136
STP1-6-2	0.6	0.3	0.3												
STP1-6-3	0.6	0.2	0.3												
STP1-6-4	1.4	0.4	0.4	1.4600	+/-0.168	0.2750	0.0919	+/-0.0811	0.1180						
STP1-6-5	0.2	0.0	0.2												
STP1-6-6	0.4	0.0	0.4												
STP1-6-7	0.6	0.2	0.3												
STP1-6-8	0.5	0.2	0.3												
STP1-6-9	0.3	0.0	0.3												

Table 9. Post Remediation Soil Radiological Concentrations (pCi/gm) for the AOC 4 Class 1 Areas (cont.)

Location	Cesium-137 (ISOCS)			Cesium- 137 (GEL)			Americium-241			Plutonium-238			Plutonium 239/240		
Site ID	Conc	Uncert	MDC	Conc	Uncert	MDC	Conc	Uncert	MDC	Conc	Uncert	MDC	Conc	Uncert	MDC
STP1-6-10	0.3	0.2	0.3												
STP1-6-11	0.2	0.0	0.2												
STP1-6-12	0.8	0.3	0.3							0.0096	+/-0.00658	0.0074	0.0441	+/-0.014	0.0074
STP1-6-13	0.5	0.2	0.2												
STP1-7-1	0.5	0.0	0.5	0.6090	+/-0.0777	0.0289	0.0318	+/-0.0593	0.1040						
STP1-7-2	0.8	0.2	0.2												
STP1-7-3	2.0	0.4	0.2												
STP1-7-4	0.2	0.2	0.3	0.3930	+/-0.0604	0.0273	-0.0114	+/-0.0668	0.1240						
STP1-7-5	0.3	0.0	0.3												
STP1-7-6	0.5	0.2	0.2												
STP1-7-7	3.6	0.5	0.3												
STP1-7-8	0.9	0.3	0.3							0.0029	+/-0.0041	0.0074	0.0602	+/-0.0165	0.0061
STP1-7-9	1.6	0.3	0.2												
STP1-7-10	0.4	0.2	0.3	0.3930	+/-0.0589	0.0280	0.0128	+/-0.104	0.1670						
STP1-7-11	0.2	0.2	0.3	0.3630	+/-0.0555	0.0251	-0.0150	+/-0.0574	0.1010						
STP1-7-12	0.5	0.2	0.1												
STP1-7-13	0.3	0.0	0.3							0.0001	+/-0.00178	0.0050	0.0063	+/-0.00564	0.0086
STP1-8-1	2.2	0.4	0.3												
STP1-8-2	0.4	0.3	0.4												
STP1-8-3	1.0	0.3	0.2												
STP1-8-4	0.7	0.2	0.2												
STP1-8-5	0.3	0.1	0.2												
STP1-8-6	0.7	0.2	0.2												
STP1-8-7	0.4	0.0	0.4							0.0005	+/-0.00245	0.0069	0.0092	+/-0.00861	0.0141
STP1-8-8	0.2	0.0	0.2												
STP1-8-9	0.3	0.2	0.2												
STP1-8-10	0.4	0.0	0.4							0.0034	+/-0.00396	0.0034	0.0045	+/-0.00667	0.0126
STP1-8-11	0.2	0.1	0.2												
STP1-8-12	0.3	0.0	0.3												
STP1-8-13	0.2	0.1	0.2												
STP1-9-1	0.3	0.0	0.3												
STP1-9-2	0.3	0.0	0.3												
STP1-9-3	0.5	0.2	0.2												
STP1-9-4	0.3	0.2	0.2	0.3010	+/-0.0534	0.0311	0.0062	+/-0.0207	0.0367						
STP1-9-5	0.5	0.2	0.2	0.3810	+/-0.0707	0.0446	0.0100	+/-0.0271	0.0495						
STP1-9-6	0.4	0.2	0.3												
STP1-9-7	0.4	0.2	0.2							0.0006	+/-0.00112	0.0017	0.0073	+/-0.00624	0.0095
STP1-9-8	0.4	0.0	0.4												
STP1-9-9	0.4	0.2	0.3												
STP1-9-10	0.7	0.2	0.2												
STP1-9-11	0.5	0.2	0.2							0.0021	+/-0.00325	0.0057	0.0067	+/-0.00627	0.0098
STP1-9-12	0.2	0.1	0.2												
STP1-9-13	0.6	0.2	0.2												

The table provides values in pCi/g for concentration (Conc.), statistical counting uncertainty (Uncert), and minimum detectable concentration (MDC).

highest concentrations observed for americium-241, plutonium-238, and plutonium 239/240 were 2.77 pCi/g, 0.003 pCi/g, and 0.117 pCi/g, respectively. (See Table 9.)

- Five radionuclides were detected in the reference area samples. Cesium-137, was identified in all 16 samples with a mean of 0.34 ± .06 pCi/g, respectively. For the reference area, plutonium-238, Plutonium-239/240 were not analyzed for and were assigned "0" concentration, since these radionuclides were not found in background soils.

Table 11 lists the results of the 64 mercury samples collected in conjunction with the Class 1 and Class 2 sites random samples for offsite analysis of gamma and alpha spectroscopy. These results are also presented in Figure 9. The average concentration of mercury was 0.38 ppm. None of the samples had concentrations greater than 2 ppm and only two were greater than 1.0 ppm.

2.5.3 Final Status Survey Conclusions

It was expected that the Sign Test would be used to demonstrate that the excavated site meets the clean-up criteria. However, all sample results were less than the clean-up goal of 23 pCi/g. Since all values are below the derived concentration guideline level (DCGL), the site meets the clean-up criteria in accordance with MARSSIM Table 8-2 (DOE 2000).

2.5.4 Independent Verification

The Oak Ridge Institute for Science and Education (ORISE) served as an independent authority to verify that remediation efforts and analysis procedures at the STP sand filter beds and berms and firing range berm were sufficient to support the conclusion that the radiological clean-up goals were achieved. ORISE, under contract to DOE, prepared a separate survey plan, reviewed project surveys and analysis results, and performed an independent field verification sampling and walkover survey to evaluate the final status after remediation.

Following the excavation and remediation activities, ORISE conducted their independent survey on March 18 and 19, 2003. ORISE was originally scheduled to conduct their survey during the week of February 4, 2003. However, due to snow conditions that week and blizzard conditions on February 17 that resulted in 22 inches of snow, ORISE waited to reschedule their survey until ground conditions improved. Results of the sampling and walkover surveys are provided in the survey report in Attachment 2 and described below.

(1) Summary of ORISE Results

The objectives of the verification survey were to confirm that remedial actions were effective in meeting the established release criteria and that documentation accurately and adequately described the final radiological conditions of the areas associated with the OU V remedial action.

Table 10. Post Remediation Soil Radiological Concentrations (pCi/gm) for the AOC 4 Class 2 Areas

Location	Cesium-137 (ISOCS)			Cesium-137 (GEL)			Americium-241			Plutonium-238			Plutonium 239/240		
Site ID	Conc	Uncert	MDC	Conc	Uncert	MDC	Conc	Uncert	MDC	Conc	Uncert	MDC	Conc	Uncert	MDC
STP2-1-1	0.3	0.2	0.2	0.272	+/-0.049	0.0255	0.600	+/-0.145	0.105						
STP2-1-2	0.4	0.2	0.1												
STP2-1-3	0.2	0.1	0.1												
STP2-1-4	0.4	0.0	0.4												
STP2-1-5	0.7	0.2	0.2												
STP2-1-6	0.4	0.2	0.2												
STP2-1-7	0.3	0.0	0.3							0.00	+/-2.00	0.00464	0.016	+/-0.00747	0.00926
STP2-1-8	0.3	0.1	0.1												
STP2-1-9	0.2	0.1	0.2												
STP2-1-10	0.2	0.1	0.2	0.184	+/-0.042	0.0244	1.32	+/-0.254	0.110						
STP2-1-11	0.6	0.2	0.2							0.00061	+/-0.00123	0.00184	0.0422	+/-0.0115	0.00753
STP2-1-12	0.2	0.1	0.2	0.170	+/-0.0351	0.0246	0.375	+/-0.125	0.112						
STP2-1-13	0.5	0.2	0.2												
STP2-2-1	0.4	0.1	0.2							0.00118	+/-0.00168	0.00177	0.0219	+/-0.00256	0.00548
STP2-2-2	0.3	0.2	0.3												
STP2-2-3	0.9	0.2	0.1												
STP2-2-4	4.6	0.6	0.3												
STP2-2-5	1.5	0.3	0.3												
STP2-2-6	1.1	0.2	0.2												
STP2-2-7	1.6	0.3	0.3												
STP2-2-8	0.3	0.1	0.2												
STP2-2-9	0.4	0.2	0.2												
STP2-2-10	0.2	0.1	0.2												
STP2-2-11	0.2	0.1	0.1												
STP2-2-12	0.9	0.2	0.1							0.00057	+/-0.00257	0.00548	0.0492	+/-0.0122	0.00703
STP2-2-13	0.2	0.2	0.2												
STP2-3-1	0.4	0.2	0.2												
STP2-3-2	0.3	0.1	0.2												
STP2-3-3	0.9	0.2	0.2												
STP2-3-4	0.5	0.2	0.2							0.00169	+/-0.00298	0.00539	0.0287	+/-0.00907	0.00692
STP2-3-5	0.4	0.0	0.4	0.278	+/-0.0437	0.0204	0.983	+/-0.229	0.125						
STP2-3-6	0.5	0.3	0.4												
STP2-3-7	0.7	0.2	0.1	0.746	+/-0.0969	0.0222	2.77	+/-0.375	0.109						
STP2-3-8	1.6	0.3	0.3							0.00323	+/-0.00265	0.00161	0.117	+/-0.0203	0.0113
STP2-3-9	1.5	0.3	0.1												
STP2-3-10	1.1	0.3	0.2												
STP2-3-11	1.2	0.3	0.2												
STP2-3-12	0.8	0.2	0.2												
STP2-3-13	0.7	0.2	0.2	0.645	+/-0.0893	0.0248	0.801	+/-0.0963	0.0344						
STP2-4-1	0.3	0.2	0.2												

Table 10. Post Remediation Soil Radiological Concentrations (pCi/gm) for the AOC 4 Class 2 Areas (cont.)

Location	Cesium-137 (ISOCS)			Cesium- 137 (GEL)			Americium-241			Plutonium-238			Plutonium 239/240		
Site ID	Conc	Uncert	MDC	Conc	Uncert	MDC	Conc	Uncert	MDC	Conc	Uncert	MDC	Conc	Uncert	MDC
STP2-4-2	0.4	0.1	0.0												
STP2-4-3	0.3	0.0	0.3												
STP2-4-4	0.6	0.2	0.2							0.0005	+/-0.00107	0.0016	0.0357	+/-0.00973	0.0059
STP2-4-5	0.2	0.2	0.2	0.349	+/-0.0586	0.034	0.0012	+/-0.0227	0.0426						
STP2-4-6	0.6	0.2	0.2												
STP2-4-7	0.3	0.2	0.4												
STP2-4-8	0.3	0.0	0.3							0.00	+/-2.00	0.00149	0.00348	+/-0.00457	0.00762
STP2-4-9	0.2	0.2	0.2												
STP2-4-10	0.5	0.2	0.1												
STP2-4-11	0.2	0.2	0.2												
STP2-4-12	0.3	0.2	0.3												
STP2-4-13	0.5	0.2	0.3												
STP2-5-1	0.3	0.0	0.3							0.0005	+/-0.00109	0.00163	0.00218	+/-0.00309	0.00522
STP2-5-2	2.3	0.4	0.2	2.54	+/-0.271	0.0203	0.0259	+/-0.0764	0.127						
STP2-5-3	0.5	0.2	0.3												
STP2-5-4	6.7	0.8	0.3												
STP2-5-5	0.2	0.1	0.2												
STP2-5-6	2.4	0.4	0.2	2.83	+/-0.350	0.0196	0.0108	+/-0.0368	0.0704						
STP2-5-7	0.3	0.2	0.2	0.607	+/-0.089	0.0324	1.92	+/-0.232	0.0513						
STP2-5-8	0.3	0.2	0.3												
STP2-5-9	2.5	0.4	0.2												
STP2-5-10	0.3	0.0	0.3							0.0013	0.00263	0.00502	0.00066	0.00347	0.00725
STP2-5-11	0.2	0.2	0.2												
STP2-5-12	0.3	0.1	0.2												
STP2-5-13	1.2	0.3	0.2												
STP2-6-1	0.1	0.1	0.1												
STP2-6-2	0.4	0.2	0.2	0.399	+/-0.065	0.0315	0.00163	+/-0.125	0.214						
STP2-6-3	0.2	0.0	0.2							-0.0012	0.0023	0.00636	-0.00058	0.00199	0.00551
STP2-6-4	0.4	0.2	0.2							-0.0006	0.00259	0.00639	0.0306	0.00964	0.00775
STP2-6-5	0.3	0.0	0.3												
STP2-6-6	0.3	0.0	0.3												
STP2-6-7	0.5	0.2	0.2												
STP2-6-8	0.3	0.0	0.3												
STP2-6-9	0.1	0.1	0.2	0.0632	+/-0.0337	0.0261	-0.0026	+/-0.0827	0.112						
STP2-6-10	0.7	0.2	0.3												
STP2-6-11	0.1	0.1	0.2												
STP2-6-12	0.5	0.2	0.2												
STP2-6-13	0.2	0.1	0.2												

The table provides values in pCi/g for concentration (Conc.), statistical counting uncertainty (Uncert), and minimum detectable concentration (MDC).

Table 11: Soil Radiological Concentrations (pCi/gm) for the AOC 4 Reference Area

Sample ID*	Cs-137			Am-241			Pu- 238 [a]			Pu-239/240 [a]		
	Conc.	Un-cert	MDC	Conc.	Un-cert	MDC	Conc.	Un-cert	MDC	Conc.	Un-cert	MDC
H1	0.3	0.07	0.09	ND		0.10	0			0		
H2	0.3	0.05	0.07	ND		0.10	0			0		
H3	0.3	0.05	0.06	ND		0.10	0			0		
H4	0.4	0.07	0.08	ND		0.10	0			0		
H5	0.4	0.08	0.1	ND		0.07	0			0		
H6	0.4	0.08	0.1	ND		0.07	0			0		
H7	0.4	0.07	0.09	ND		0.08	0			0		
H8	0.3	0.07	0.08	ND		0.07	0			0		
H9	0.3	0.05	0.05	ND		0.06	0			0		
H10	0.4	0.07	0.09	ND		0.07	0			0		
H11	0.2	0.05	0.06	ND		0.06	0			0		
H12	0.4	0.08	0.1	ND		0.06	0			0		
H13	0.3	0.08	0.1	ND		0.08	0			0		
H14	0.3	0.06	0.08	ND		0.07	0			0		
H15	0.4	0.07	0.08	ND		0.07	0			0		
H16	0.3	0.06	0.08	ND		0.07	0			0		

a. For the reference area, Pu-238, Pu-239/240 and Sr-90 were not analyzed for and are assigned "0" concentration, since these radionuclides are not found in background soils.

The tables provide values in pCi/g for concentration (Conc.), for the statistical counting uncertainty (Uncert), and for the minimum detectable concentration (MDC).

*****Sample locations are provided in Figure 1B.

Gamma scans were conducted over 100% of the berms with particular attention to the excavated areas in the OU V survey units (Figure 3, Attachment 2). Approximately 25% of the Class 2 filter beds were scanned. All gamma radiation scans were performed using NaI scintillation detectors coupled to rate meters with audible indication. Locations for possible soil sampling were flagged where elevated radiation was at least two times background or greater. Twenty-five soil samples were collected along the berms and in the Class 1 excavations (Figure 4, Attachment 2). The focus was primarily to sample those locations with the highest gamma radiation levels. Samples were collected at depths of 0-15 cm and 15-30 cm.

Soil samples were analyzed by gamma spectroscopy for the radionuclide of interest, Cs-137. As part of the verification process, the spectra were reviewed for additional identifiable photo peaks. Specific analyses for Sr-90 and Pu-239-240 by alpha spectroscopy were performed on six randomly selected soil samples. Concentrations for Cs-137 ranged from 4.8 to 77.3 pCi/g (see Table 1, Attachment 2). Results for additional analyses for Sr-90 and alpha spectroscopy for Pu-239/240 indicated that concentrations ranged from 0.01 to 0.84 pCi/g for Sr-90 and from –0.01 to 2.80 pCi/g for Pu-239/240.

Thirteen soil samples were collected from elevated locations along the tops and the side edges of the berms. The Cs-137 activity ranged from 12.2 to 55.8 pCi/g. Individually, nine of the soil samples exceeded the 23 pCi/g guideline; however, these appear to be primarily small point sources and did not exceed the hot spot criterion.

The results of the ORISE verification survey identified three areas of residual contamination that should be investigated further by BNL; in particular, those areas that bound or extend from the areas of excavation AOC4B1-GP08, AOC4BA-GP12 and AOC4B2-GP13.

Sample 1 collected from the excavated area AOC4B1-GP13 from a depth of 15-30 cm contained cesium-137 at a concentration that exceeded the 69 pCi/g hot spot criterion with a total activity of 77.3 pCi/g. The cesium-137 concentration in surface soil samples (0-15 cm) 5 and 6 collected from elevated activity areas in survey unit AOC4B1-GP08, were 48 and 42.5 pCi/g, respectively. Sample 17, which contained cesium-137 at a concentration of 53.7 pCi/g, was collected from an area of elevated radioactivity that was adjacent to the excavated AOC4B1-GP12 area (Figure 4, Attachment 2). This area of elevated radiation extends beyond the boundaries of AOC4B1-GP12. Although the samples did not exceed the hot spot guideline, additional investigation into the elevated activity in this area is suggested due to the close proximity of the sample location to the Class 1 excavations.

(2) BNL Response to ORISE findings

Based on the results of the independent verification survey conducted by ORISE, it was suggested that additional investigation of three areas be conducted to confirm the extent of the elevated levels of cesium-137 reported by ORISE. In response, BNL collected samples at locations sampled by ORISE as well as from three locations associated with AOC4B1- GP08, AOC4B1- GP12, and AOC4B1- GP13.

With the aid of NaI detector, the three areas were scanned at the surface. Where elevated readings (above area background) were noted, a hand auger was used to remove soil at 6-inch depth intervals for additional scanning with the detector. In each area, a layer of soil approximately 24 to 36 inches wide and 6 to12 inches thick at depths of 12 to18 inches was encountered with gamma readings greater than background. The material had a darker coloration and was finer in texture than the surrounding sand substrate. Within each area a hand auger sample was collected at the depth where maximum gamma readings were recorded and sent for analysis. The areas measured approximately 50 square feet (20 feet x 2.5 feet) at AOC4B1-GP08, 75 square feet (30 feet x 2.5 feet) at AOC4B1- GP12, and 150 square feet (75 feet x 2 feet) at AOC4B1- GP13.

Additional sampling was conducted at the hot spot location at AOC4B1-GP13 where ORISE had a sample result of 77.3 +/- 3.2 pCi/g; laboratory confirmation by GEL of this sample yielded a result of 80 +/- 8.01 pCi/g. These sample results exceeded the 69 pCi/g hot spot criterion, however additional sampling yielded a maximum concentration of 60.4 pCi/g, indicating that the hot spot was removed through sampling; therefore additional removal was not required. The maximum concentration found at 1.0-foot depth within the 150 square foot boundary area was 28 +/- 3.12 pCi/g.

Additional sampling was conducted in association with the north boundary of AOC4B1-GP08 that included sampling near the ORISE sample S019. The maximum value measured from the 50 square foot bounded area at 1.5-foot depth was 23.2 +/- 2.47 pCi/g. Additional removal of soil was not necessary.

Additional sampling associate with the ORISE sample S017 located east of AOC4B1- GP12, indicated a maximum concentration found from the 75 square foot boundary area at 1.0-foot depth was 52.1 +/- 5.19 pCi/g. Additional removal of soil was not necessary.

Additional excavation was not deemed necessary since the concentrations of the remaining soil did not exceed the hot spot criterion. The activity in these three slightly elevated areas, comprising no more than 275 square feet, does not significantly alter the site wide average that is based on 63,000 square feet.

(3) ORISE Response to BNL Additional Investigation

After review of the BNL and ORISE results, it was ORISE Environmental Survey and Site Assessment Program's opinion that residual radioactivity in the AOC4B survey units, when averaged over the site, meets the established 23 pCi/g criteria.

Table 12. Post Remediation Soil Mercury Concentrations (mg/kg) for AOC 4B – Sewage Treatment Plant

	Mercury		
Location	Result	Units	DL
STP1-1-1	0.125	mg/kg	0.0010
STP1-1-3	0.319	mg/kg	0.0103
STP1-1-8	0.501	mg/kg	0.0095
STP1-1-10	0.135	mg/kg	0.0010
STP1-2-1	0.051	mg/kg	0.0010
STP-1-2-9	0.174	mg/kg	0.0010
STP1-2-12	0.244	mg/kg	0.0011
STP1-2-13	0.101	mg/kg	0.0010
STP1-3-1	0.113	mg/kg	0.0010
STP1-3-2	0.352	mg/kg	0.0100
STP1-3-5	0.047	mg/kg	0.0011
STP1-3-6	0.105	mg/kg	0.0010
STP1-3-13	0.702	mg/kg	0.0116
STP1-3R-4	0.645	mg/kg	0.0104
STP1-3R-8	0.173	mg/kg	0.0010
STP1-4-5	0.268	mg/kg	0.0097
STP1-4-6	0.157	mg/kg	0.0011
STP1-4-7	0.269	mg/kg	0.0104
STP1-4-9	0.433	mg/kg	0.0087
STP-1-4-10	0.667	mg/kg	0.0104
STP1-4-11	0.325	mg/kg	0.0092
STP1-4-12	0.722	mg/kg	0.0093
STP1-4-13	0.247	mg/kg	0.0011
STP1-5-6	0.044	mg/kg	0.0010
STP1-5-10	0.163	mg/kg	0.0010
STP1-6-1	0.099	mg/kg	0.0010
STP1-6-4	0.466	mg/kg	0.0095
STP1-6-12	0.402	mg/kg	0.0094
STP1-7-1	0.985	mg/kg	0.0103
STP1-7-4	0.195	mg/kg	0.0009
STP1-7-8	0.281	mg/kg	0.0104
STP1-7-10	0.237	mg/kg	0.0011

	Mercury		
Location	Result	Units	DL
STP1-7-11	0.154	mg/kg	0.0010
STP1-7-13	0.202	mg/kg	0.0010
STP1-8-7	0.100	mg/kg	0.0010
STP1-8-10	0.139	mg/kg	0.0010
STP1-9-4	0.154	mg/kg	0.0010
STP1-9-5	0.323	mg/kg	0.0109
STP1-9-7	0.160	mg/kg	0.0011
STP1-9-11	0.694	mg/kg	0.0099
STP2-1-1	0.720	mg/kg	0.0095
STP2-1-7	0.465	mg/kg	0.0095
STP2-1-10	0.395	mg/kg	0.0096
STP2-1-11	0.439	mg/kg	0.0098
STP2-1-12	0.597	mg/kg	0.0113
STP2-2-1	0.467	mg/kg	0.0106
STP2-2-12	0.718	mg/kg	0.0097
STP2-3-4	0.378	mg/kg	0.0097
STP2-3-5	0.431	mg/kg	0.0088
STP2-3-7	0.553	mg/kg	0.0101
STP2-3-8	0.985	mg/kg	0.0099
STP2-3-13	0.670	mg/kg	0.0092
STP2-4-4	0.450	mg/kg	0.0102
STP2-4-5	0.174	mg/kg	0.0010
STP2-4-8	0.133	mg/kg	0.0009
STP2-5-1	1.490	mg/kg	0.0098
STP2-5-2	0.462	mg/kg	0.0093
STP2-5-6	1.180	mg/kg	0.0088
STP2-5-7	0.951	mg/kg	0.0107
STP2-5-10	0.016	mg/kg	0.0011
STP2-6-2	0.242	mg/kg	0.0013
STP2-6-3	0.013	mg/kg	0.0010
STP2-6-4	0.558	mg/kg	0.0090
STP2-6-9	0.618	mg/kg	0.0128

3.0 Waste Management

3.1 Waste Characterization and Handling

The waste management strategy, waste characterization, packaging, handling, and storage were in accordance with the *OU V Sewage Treatment Plant Waste Management Plan* (BNL 2002b) and the *BNL Standard Based Management System* (SBMS). The waste from the excavations that included both radiological and chemical contaminants was designated as LLW and was temporarily staged at the Former Chemical/Animal Holes site. The soil and debris were temporarily stockpiled for loading into railcars and shipped to Envirocare of Utah. The last rail shipment to Envirocare departed BNL on June 5, 2003. The waste from the excavations that included only mercury contamination was temporarily staged at the Sewage Treatment Plant awaiting evaluation for disposal at a Subtitle D landfill. However, it was decided that the material would be shipped to Envirocare by the end of August 2003.

Characterization of the waste stream was completed in accordance with the Final Bulk Waste Characterization for Off-site Disposal Sampling Guidance (BNL 2000b), which provides information on requirements for the handling and characterization of bulk waste streams. Based on this guidance, sampling was conducted for Toxicity Characteristic Leaching Procedure (TCLP) metals and results confirmed that the excavated soil was not hazardous (see STP Waste Management Plan).

3.2 Waste Shipment and Disposal

Low-level radioactive waste will be shipped to Envirocare by rail. The contaminated soil and debris was placed into liners on rail cars for transportation. Waste loading and shipping was initiated in November 2002 and was completed on June 5, 2003. The types and volume of wastes excavated were discussed in Section 2.3 and listed in Table 4.

A LLW Exemption Request to DOE Order 435.1 was prepared to obtain permission from DOE to dispose of LLW at a non-DOE commercial disposal facility prior to the transport and disposal of the waste. The LLW Exemption Request showed that there are cost benefits to the transport and disposal of the waste at Envirocare of Utah utilizing the DOE Ohio contract.

Waste determined not to be radioactive was stored separately, however, this too will be disposed at Envirocare.

3.3 Pollution Prevention and Waste Minimization Opportunities

The overall objectives of the BNL Pollution Prevention and Waste Minimization Program include the following:

- Reduction of environmental impacts as low as reasonably achievable
- Elimination or reduction of wastes, effluents and emissions

- Reduction of waste management costs
- Conservation of natural resources and reuse of materials
- Recycling and procurement of environmentally preferable products.

The pollution prevention and waste minimization opportunities that resulted in cost avoidances during the STP remediation include the following:

- The use of radiological walkover surveys for the removal of clean overburden to minimize the co-mingling of clean and contaminated soils, especially for the benching of slopes at excavations greater than 5-foot depth, thereby reducing the volume of waste generated.

- Controlling rainfall runoff and wind dispersion of stockpiled material by maintaining covers prior to loading onto rail cars for offsite shipment.

- Using excavation methods that minimize quantities of excavated soil (i.e., hand and small equipment excavation), which are above treatment standards.

- Ensuring that the required radiological surveys are performed to prevent accidental spread of contamination.

Because of the heterogeneity of the contaminants within the soil, there was a possibility that the material excavated could be separated into either LLW and/or non-radiological waste. By incorporating the radiological field surveying and rapid laboratory screening for mercury, approximately 475 CY of soil was segregated as potential waste that does not have to be handled as LLW. However, this material will be included to supplement debris shipments to Envirocare, thereby reducing the cost of shipping debris only.
Also, the RI data characterized the soil material in the sewer manholes as possibly being mixed waste. However, the waste profile of the material removed characterized the waste as LLW and not mixed. This further reduces the cost and complexity of waste handling at the STP.

4.0 Post Closure Dose Assessment

A post closure dose assessment was performed to estimate post cleanup dose exposures and to verify that the total annual dose was less than 15 mrem for the remediated areas.

4.1 Risk Assessment Methods

An assessment of radiation risk and dose using the RESRAD code was performed for residually contaminated soils following the remediation efforts. RESRAD is a computer code developed by Argonne National Laboratory that calculates radiation dose from residual radioactivity in the ground (ANL 2001). The RESRAD model allows the inclusion of site-specific characteristics and exposure pathway assumptions. The version of the RESRAD code used in this risk assessment is *RESRAD 6.21*, issued in September 2002.

The RESRAD code calculates radiation doses, soil guidelines, and media concentrations over user-specified time intervals. The radiation source is adjusted by the code over the time interval to account for radioactive decay and in-growth, leaching, erosion, and mixing. Assumptions on use and occupancy of the site in the future are used to quantify exposures to individuals through multiple environmental pathways and land use scenarios. RESRAD uses a one-dimensional groundwater model that accounts for differential transport of parent and progeny radionuclides with different distribution coefficients. In this risk assessment, doses estimated through RESRAD are compared to the dose limit of 15 mrem/y.

4.2 Site Conditions

Following the final status survey and verification that cleanup goals had been attained, the excavations were backfilled with clean soil in volume sufficient to restore surface contour as defined below. Concentration of measured contaminants in the remediation zone and in the backfill materials is provided in Table 12.

4.2.1 Backfill Materials

Backfill material consists of:

- Clean topsoil in a volume sufficient to restore surface contour was obtained from the construction of a recharge basin in the vicinity of the RHIC facility.
- Sand and clay to be placed within the sand filter beds as needed to replace the comparable functional substrate.

The approved sampling strategy that allowed excavated material (i.e., overburden) to be used as backfill is provided in the *Final Bulk Waste Characterization Sampling Guidance* (BNL 2000b). The guidance provides information on the requirements for handling and characterization of bulk waste streams. In addition to field screening data, analytical data for the backfill material is provided in Table 12.

All areas excavated for the removal of cesium-137 contamination were backfilled and/or graded to enhance the existing topography for proper runoff control. With the exception of areas AOC4A-GP01 and AOC4B-GP13, all areas excavated for the removal of mercury were backfilled and/or graded and seeded with native grass as appropriate for stabilization and dust control. AOC4A-GP01 was graded to stabilize the slope along the existing temporary road and regarded and seeded with native grass for control of runoff and dust. Since AOC4B-GP13 is within an inactive filter bed, it would only be seeded with a native grass.

4.2.2 Reconstruction of Filter Bed Drainage Collection

The excavations along the eastern berms of sand filter beds Nos. 5 and 6 required the disassembly and removal of a portion of the filter bed drainage structure in order to attain access for removal of contaminated soil. After backfilling the excavated areas, the drainage collection system will be reconstructed. The following activities are noted for each excavation.

Table 13: Contamination Concentration Summary

Radionuclide	Cleanup Goal (pCi/g)	Activity Concentration (pCi/g)			
		Reference Area*	Class 1	Class 2	Backfill
Cesium-137	23	0.34±0.06	1.7±3.1	0.71±0.91	0.21±0.22
Americium-241	NA	ND [0.08±0.01]	0.30±0.28	1.1±1.6	0.029±0.021
Plutonium-238	NA	NM	0.0028±.0028	0.0012±0.0011	ND [0.25±0.17]
Plutonium-239/240	NA	NM	0.026±.026	0.037±0.037	0.011± 0.012

*Data for the Reference Area is not used in this evaluation, but provided for comparison purposes
NA = Not applicable, no cleanup goal for this radionuclide
ND = Not detected; minimum detectable concentration in [ ]
NM = Not measured
1.7 ± 3.1= Mean and standard deviation of multiple measurements

AOC4B1-GP08

1) Place 4-inch thick clay layer within filter bed portion of excavation at four foot depth

2) Place 6-inch thick pebble/stone/gravel layer within filter bed portion of excavation on top of clay layer and drainage pipe sections

3) Place clean sand within filter bed portion of excavation to a thickness equivalent to the original grade

AOC4B1-GP13

1) Place 4-inch thick clay layer within filter bed portion of excavation at four foot depth

2) Place 6- inch thick pebble/stone/gravel layer within filter bed portion of excavation on top of clay layer and drainage pipe sections

3) Place clean sand within filter bed portion of excavation to a thickness equivalent to original grade

4.2.3 Reconstruct Tertiary Treatment Distribution Piping

As required for the filter bed collection system listed above, section of the distribution piping system will be reconstructed as discussed below.

AOC4B1-GP08

1) Emplace and align four 12 ft long sections of approximately 2.5-ft diameter distribution pipe
2) Replace rubber seals connecting distribution pipe sections
3) Rebuild concrete (cinder) block distribution box (6 ft long by 4 ft wide by 3 ft high)

AOC4B1-GP13

1) Emplace and align two 12 ft long sections and one 3 ft long angle section of approximately 2.5-ft diameter distribution pipe
2) Replace rubber seals connecting distribution pipe sections
3) Rebuild concrete (cinder) block distribution box (5 ft long by 3 ft wide by 3 ft high)

4.2.4 Reconstruct Firing Range Berm and Fence; Relocate Security Building

During excavation of the berm at the western end of the firing range, the security building had to be moved approximately 20 feet, including the electrical service, and a portion of the chain-link fence was removed for access. After backfilling the excavated area, the building and fence were repositioned as noted below.

AOC4B1-GP16

1) Backfill the berm with clean material to original grade
2) Rebuild/replace approximately 20 linear feet of 6-ft high galvanized chain-link fence, including concrete fence post footings
3) Relocate security building and reconnect electricity

4.3 Post Remediation Exposure Assessment

In applying the RESRAD code to radiological risk analysis at BNL, certain assumptions are necessary so consistent site parameters are developed. These parameters describe the site characteristics that influence potential radiological doses to individuals on the site. The OU V ROD adopted the cleanup levels developed in the OU I reports and, hence, it is appropriate to use the assumptions.

4.3.1 Land Use and Institutional Control (LU/IC)

A draft Land Use Controls Management Plan has been prepared for BNL. Part of BNL's environmental stewardship responsibility is to maintain land use control and institutional control (LU/IC) of remediation sites to ensure that workers and the public are not exposed to unacceptable levels of contamination. For the purposes of this plan, LU/ICs are defined as legal or administrative measures that limit human exposure by restricting activity, use and access to properties with residual contamination and certain engineered restrictions or controls that limit

use of and/or exposure to any portion of the real property or associated resources, including water resources, together with mechanisms to monitor and enforce those restrictions.

The two primary purposes of LU/ICs are to:

- minimize the potential for exposure to contaminants and
- protect the integrity of the remedy

Specific to the AOC4, the following measures will be implemented:

Institutional controls at BNL, which ensure that workers and the public are not exposed to unacceptable levels of contamination, include existing DOE orders and site-specific procedures. DOE Orders such as 5400.1 (General Environmental Protection Program) and 5400.5 (Radiation Protection of the Public and Environment) govern the management of radioactive waste and other waste types not regulated under RCRA or CERCLA at DOE facilities. Site-specific procedures such as BNL ESH 1.3.6 (Work Planning and Control for Operations) ensure that all work at BNL is planned and implemented properly, hazards and risks are identified and controlled, resources are scheduled and coordinated, and appropriate feedback mechanisms are in place. In addition, BNL ESH 1.1.18 (Excavation Safety) ensures that, prior to conducting excavation work, the Project Manager will check site maps and investigate, as appropriate, the potential for soil/pavement/floor contamination (radioactive or chemical). A background check that includes the history of activities in the vicinity is also required as part of this procedure.

In addition, any sale or transfer of BNL properties will also meet the requirements of 120 (h) of CERCLA to ensure future users are not exposed to unacceptable levels of contamination.

4.3.2 Exposure Pathways

In this post remediation exposure assessment, two exposure scenarios were evaluated. The first was an industrial/commercial use scenario where present day workers were exposed to radiation from residual soil contamination within the STP. The second scenario was a future resident scenario where exposure begins fifty years in the future to an individual who constructs and lives in a home over the affected areas.

Given the land use scenario, there are exposure pathways in the RESRAD model that are inappropriate, due to site specific characteristics that make it improbable that the pathway applies. Table 13 indicates the pathways that are active in the RESRAD analysis of the indicated land use scenario.

4.3.3 Detail of Model Parameters

The RESRAD code uses over 200 parameters to describe the site exposure scenario in the mathematical model. Default and BNL site-specific parameter values are provided in RESRAD reports in the appendix. Specific parameter values of interest are described here. The demographic and hydrogeological parameters used for modeling the exposures were the same as

those used in a previous analysis conducted for OU I. The differences consisted of the size of the areas of exposure and the levels of radioactivity within the area.

During 1 year, the on-site worker spends 1,500 hours (17 percent) outdoors at the site, 500 hours (6 percent) indoors at the site, and 6,760 hours (77 percent) away from the site. The future resident spends 4,380 hours (50 percent) indoors, 2,190 hours (25 percent) outdoors in the

Table 14: Summary of Pathway Selections for Risk Assessment

Pathway	Residential Scenario	Industrial Scenario	Comment
external gamma	active	active	Time on site differs between scenarios
inhalation (w/o radon)	active	active	Time on site differs between scenarios
plant ingestion	active	suppressed	On site garden to supplement diet for resident
meat ingestion	active	suppressed	On-site meat production supplements diet
milk ingestion	active	suppressed	On-site milk production supplements diet
aquatic foods	active	suppressed	Fishing supports diet of residents
drinking water	active	suppressed	Alternate water source available for industrial use
soil ingestion	active	active	Incidental through ground contact
Radon	suppressed	suppressed	No source on site

decontaminated area, and 2,190 hours (25 percent) away from the site. While indoors, the walls, floors, and foundation of the house or office building will reduce external direct gamma exposure by 20 percent.

The indoor dust level in the house or office building is 40 percent of the outdoor dust level. The annual intake of soil is 36.5 grams per year (g/y) for on-site worker and for the future resident. For the future resident scenario, an individual's annual intake of leafy vegetables and other produce is 14 and 160 kilograms per year (kg/y), respectively. Of the diet consumed by the resident, 50 percent of the plants are grown in the remediated area and 10 percent of the meat and dairy products. RESRAD calculates the percentage of foodstuff raised by the resident based on the size of the property. The on-site worker does not consume these food products.

The precipitation and irrigation rates are 120 centimeters per year (cm/y) and 20 cm/y, respectively. Approximately 20 percent of the precipitation is lost by runoff and 46 percent of the remainder is lost by evapo-transpiration, resulting in a net infiltration rate of 63 cm/y.

The sandy soils in the remediation area have a density of 1.66 grams per cubic centimeter (g/cm^3) and a total and effective porosity of 0.33 and 0.24, respectively. The vertical hydraulic conductivity in the unsaturated zone is 5,000 meters per year (m/y). The hydraulic conductivity and hydraulic gradient in the saturated zone are 20,000 m/y and 0.001, respectively. The "b" parameter used by RESRAD to calculate the saturation ratio in the unsaturated zones is 4.9.

The distribution coefficient (Kd) is used to calculate radionuclide leaching and transport in groundwater. The Kd value is specific to the chemical species of the radionuclide as well as the site-specific characteristics of the media. Site-specific distribution coefficients have been measured in BNL soil for several contaminants of concern. These values were substituted for RESRAD default values. The americium distribution coefficient of 1900 ml/g was used instead of the default value of 20, and the cesium value of 190 was used instead of the default value of 1000. The distribution coefficient for plutonium was set to 550 instead of 2000. A smaller value indicates that more radionuclide is in the water phase, and mobilizes more readily.

The future resident drinks 700 liters per year (l/y) (two liters per day for 350 days per year) of water drawn from an on-site well. For the on-site worker it was assumed that an uncontaminated, potable water supply was available for consumption.

The soil radioactivity measurements and other principal parameters used in the model are summarized in Table 14. Cs-137 is the major contaminant of concern. The contributions of other radionuclides to any current or future exposures are negligible, but americium-241, plutonium-238, and plutonium-239/240 were included for completeness. For the future residential scenario, radionuclide concentrations at year "0" are adjusted to account for decay, erosion, and transport during the 50-year period of institutional control. Printouts of each RESRAD analysis are provided in Attachment 3.

Table 15: Parameter Values Used in the RESRAD Code

Parameter of Interest	**Units**	**Values**
Radionuclide activity at year 0		
Amercium-241	pCi/g	0.58
Cesium-137	pCi/g	1.4
Plutonium-238	pCi/g	0.035
Plutonium-239*	pCi/g	0.043
Area	m^2	63,000
Layer thickness	m	0.15
Depth to ground water	m	2.5
Cover thickness	m	0
Length Parallel to Aquifer	m	365
*Plutonium-239/240 was assumed to be Plutonium-239 for conservatism		

4.4 Results of Radiological Risk and Dose Assessment

Following remediation residual contaminated soil are present at the levels and distributions indicated in Table 12. The consequences for each of the modeled scenarios as estimated by the RESRAD code are listed in Table 15.

(a) For the site worker, there is a slight increase in risk with a corresponding increase in radiological dose due to the cesium-137 remaining in the soil. The maximum dose occurs in the first year after remediation.

(b) The dose and risk for the future resident occurs from direct exposure due to the cesium-137 remaining in the soil. The maximum dose occurs in the first year after the assumed period of institutional control.

Graphs of estimated radionuclide concentration in the soil, total dose, and excess risk from remaining contaminated materials are shown in Attachment 3.

Table 16: Consequences of Residual Radioactive Materials in the STP

Consequence	**Worker**	**Future Resident (1)**
Excess Risk	1.2E-05 in year 0	1.8E-05 in year 50
Total Dose	0.90 mrem in year 0	1.4 mrem in year 50
(1)Time of occurrence of the consequence is measured from the end of remediation. Thus, Year 50 is 50 years after remediation or the first year following the end of a 50-year institutional control period.		

4.5 Conclusions of Post Closure Dose Assessment

The post-closure dose assessment has quantified the estimated dose and excess risk associated with each land use alternative.

- The remediated site is protective of the future site resident under the dose criterion of 15 mrem/y total effective dose equivalent through all exposure pathways.
- The remediated site is protective of the future site resident under the excess risk criterion of 1E-04 to 1E-06 through all exposure pathways.
- The remediated site is protective of the site worker under dose criteria of Title 10 CFR Part 835.

5.0 Summary and Conclusions

The remedial action at OU V, Areas of Concern 4 and 21 successfully completed the objectives addressed in the ROD and stated in Section 1.1. Specifically, the levels of contamination in the sludge drying beds, sand filter beds and berms, firing range berms, and sewer lines were reduced to the prescribed concentrations addressed in the ROD (less than 2 ppm for mercury and an average of 23 pCi/g with no hot spot areas greater than 69 pCi/g for cesium-137). Based on 210 confirmation samples from excavation areas, mercury concentrations were reduced to an average of 0.58 ppm. Random sampling for mercury within the Class 1 and Class 2 areas for resulted in an average concentration of 0.39 ppm.

Cesium-137 was reduced to an average of 1.7±3.1 in Class 1 areas, below the criterion of an average of 23 pCi/g for the sand filterbeds and berms, with no hot spots exceeding 69 pCi/g. Also, 15 cu ft of contaminated soil was removed from the ten manholes along the retired STP sewer line.

- Assuring that beds of dump trucks were covered during transport of the excavated soil to the stockpile areas and that these stockpiles remained covered minimized any migration of contaminants from the excavated soil.

- To prevent or minimize human (i.e., site workers, construction workers) and environmental exposure to contaminants in the surface and subsurface soil, work was restricted or suspended if visible dust was being generated and all loading, hauling, and dumping of soil was suspended if sustained wind speeds reached 25 mph or gusts exceeded 30 mph. This occurred six times during the remedial action period. In addition, areas were sprayed with water to reduce the potential for generating dust during the excavation activities. The backfilling of clean material further reduces the potential for exposure to site workers, trespassers, and future residents as determined in the dose assessment.

- The removal of elevated levels of mercury and cesium-137 minimizes the potential for uptake of these contaminants in the soil by ecological receptors. The backfilling of clean material further reduces the potential for exposure to ecological receptors.

Again, the removal of mercury and cesium-137 to prescribed levels in the ROD, and the addition of clean backfill material minimizes the potential for migration of contaminants (chemical and radiological) from the surface soil to groundwater as addressed by the dose assessment.

6.0 Lessons Learned

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

1. The planning phase of this project should be evaluated to take a look at the compression of the schedule toward the end of the project that resulted in more overtime than originally estimated.

2. Separation of chemical and radiological wastes during excavation can reduce the volume of material to be sent to LLW facility. Planning the excavation with sufficient data and continually monitoring the contaminant concentrations in the soil during the excavation should aid in the separation of LLW and in the reduction of waste when clean overburden is significant.

3. Avoid winter months for conducting final walkover surveys as the inclement weather (i.e., snow) can impact scheduling.

4. Avoid excavation into, or immediately above, the groundwater table since the presence of water can cause NaI surveying problems as well as potential extraction and testing of the water for contamination.

A formal documented review of these lessons learned and an evaluation of their root causes will be conducted. Recommendations will be prepared and any corrective actions will be documented in the Standards Based Management System (SBMS) subject area "Lessons Learned" through the Environmental Management Directorate (EMD) Lessons Learned Coordinator. In addition, Operations Procedures will be modified to incorporate these corrective actions where applicable.

7.0 References

ANL 2001 - *User's Manual for RESRAD Version 6*, ANL/EAD-4, Argonne National Laboratory, Argonne, Illinois, July 2001.

BNL 2000 - *Final Bulk Waste Characterization for Off-site Disposal Sampling Guidance*, Brookhaven National Laboratory, Upton NY, 2000

BNL 2001 - *Operable Unit V – Sewage Treatment Plant; Supplemental Geoprobe® Soil Sampling Letter Report,* Brookhaven National Laboratory, Upton NY, March 2001.

BNL 2002 - *OU V - Areas of Concern 4 and 21, Remedial Action Work Plan,* Brookhaven National Laboratory, Upton NY, June 14, 2002)

BNL 2003a - *Operable Unit V – Sewage Treatment Plant; Analytical Results from the Supplementary Geoprobe® Soil Sampling Program,* Letter Report, Brookhaven National Laboratory, Upton NY, January 2003.

BNL 2003b - *Final Status Survey Plan, Area of Concern 4 Sewage Treatment Plant Sand Filter Beds and Berms*, Brookhaven National Laboratory, Upton NY, February 2003.

DOE 2001a - *Operable Unit V - Record of Decision AOC 4 (Sewage Treatment Plant); AOC 21(Sewer Lines); AOC 23 (Eastern Offsite Tritium Plume)* July 24,2001.

DOE 2001b - *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) DOE/EH-0624, Rev 1, DOE, October 2000 (corrections issued June 2001) [also published as NUREG-1575, Rev 1 and EPA 402-R-97-016, Rev 1]

EPA 1997 - *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination.* Directive OSWER-9200.4-18, August 1997.

IT Corp 1998a - *Final Operable Unit V Remedial Investigation Report,* prepared for Brookhaven National Laboratory, Upton, New York, May 1998

IT Corp 1998b - *Final OU V Feasibility Study Report,* prepared for Brookhaven National Laboratory, Upton, New York, September 1998

IT Corp 2000 - *Operable Unit V Plutonium Contamination Characterization and Radiological Dose and Risk Assessment Report,* prepared for Brookhaven National Laboratory, Upton, New York, 2000.

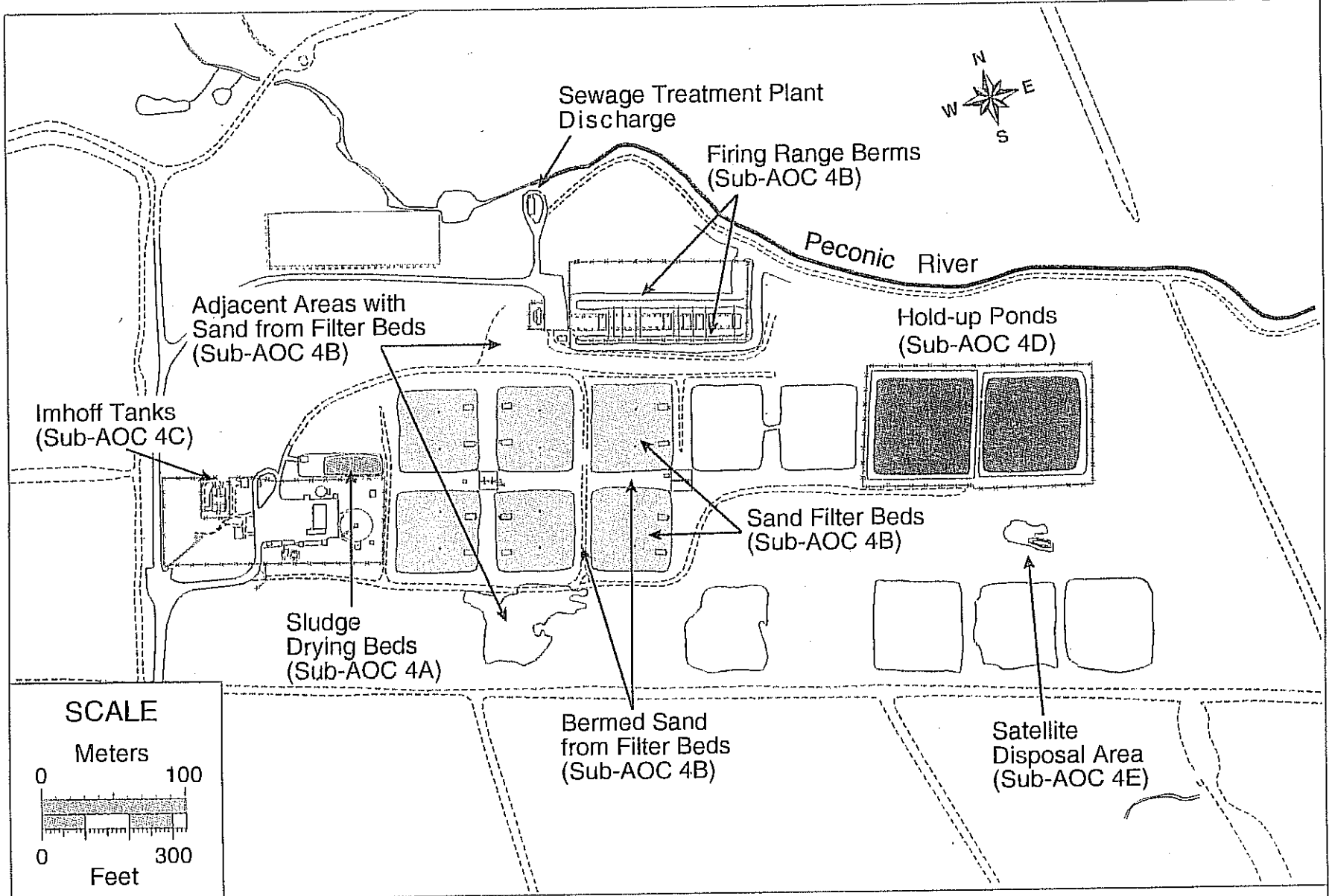
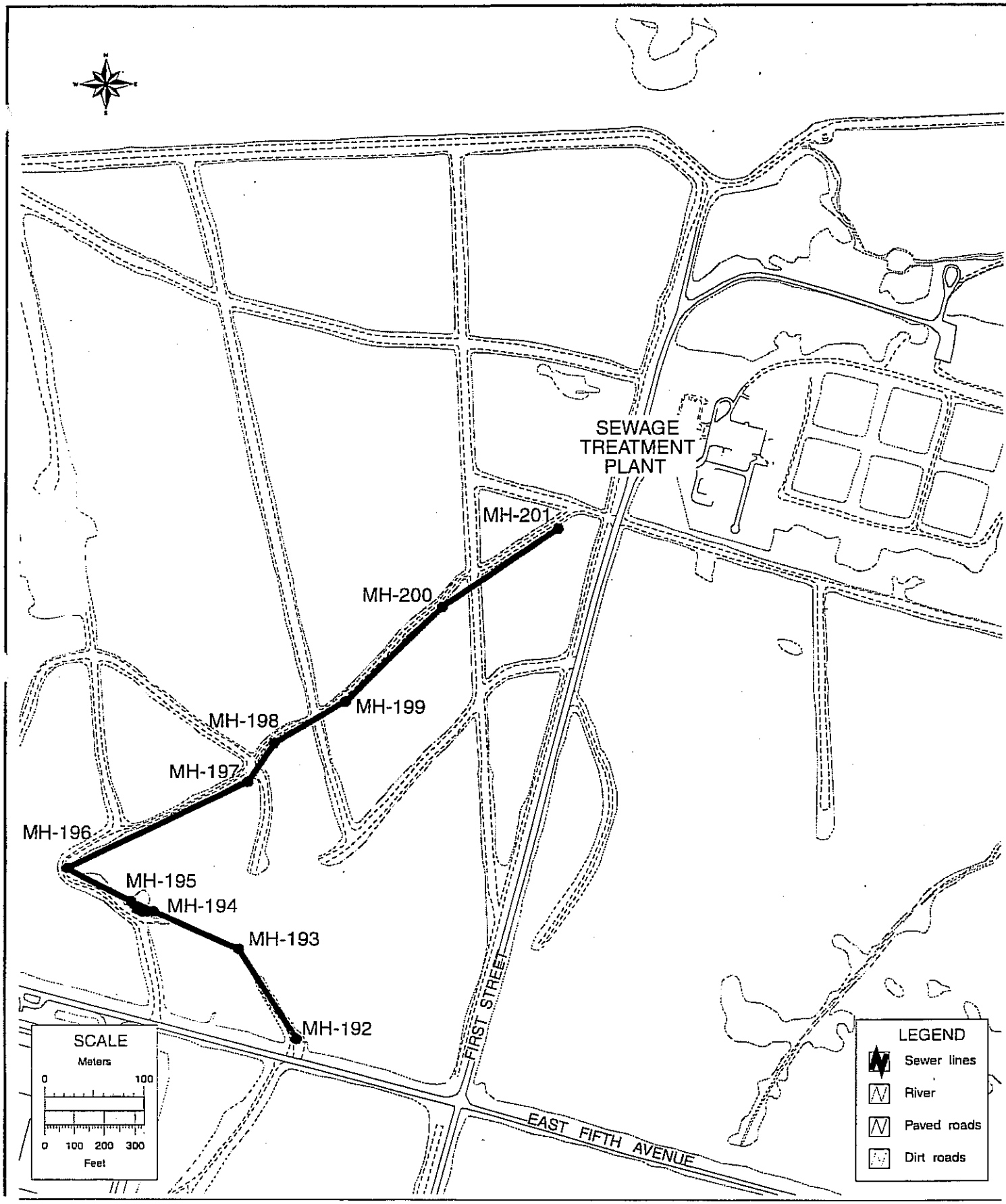


Figure 1

Sewage Treatment Plant (AOC 4)



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Environmental Restoration Division

Figure 2. Area of Concern 21
Former Leaking Sewer Pipes in OU V

ALR - 03/18/03
ou5/rod/fig5_r1.aml
Graphics/OU V/rod/fig5_r2.ai

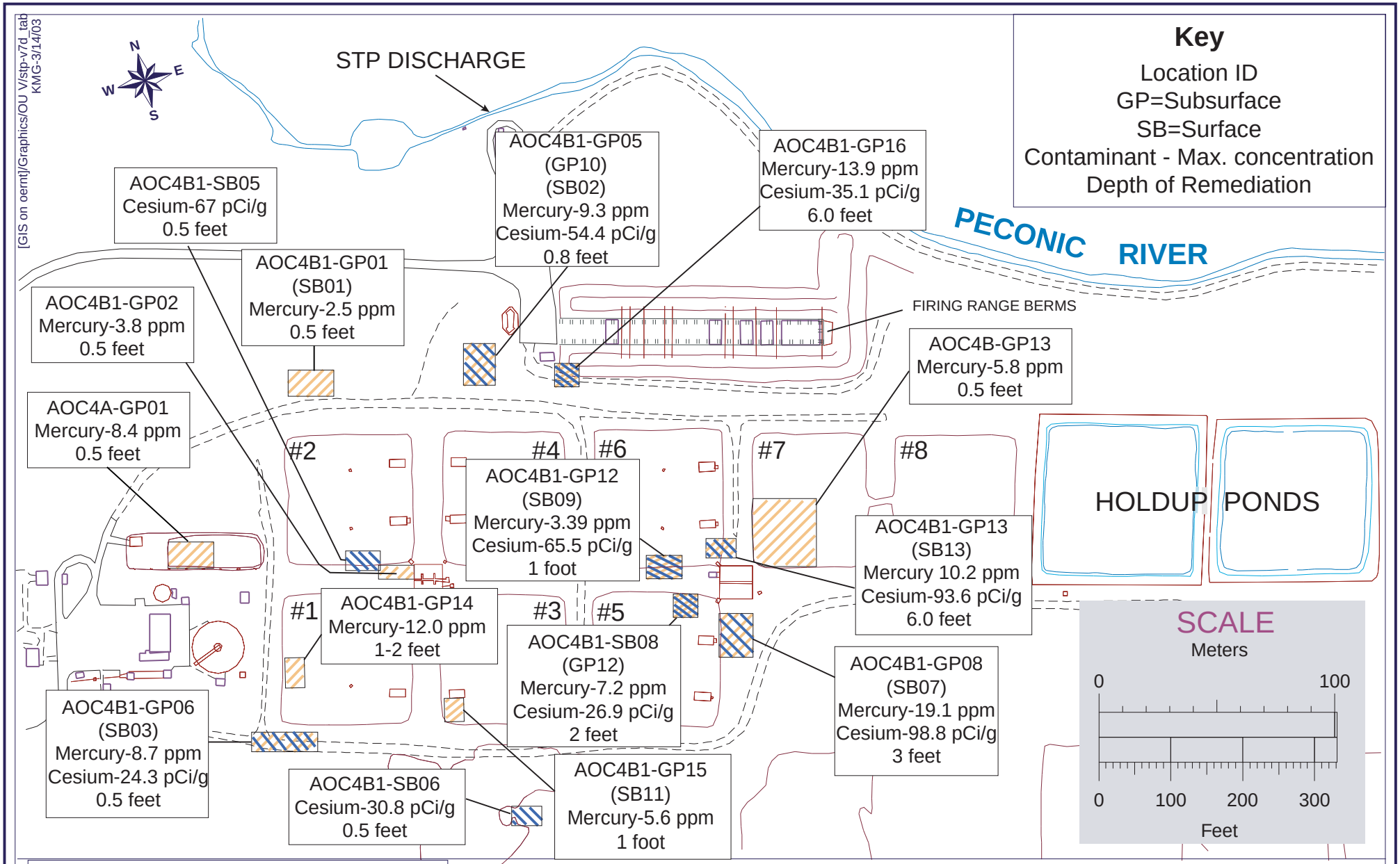

Figure 3: Excavation Areas Based on Soil Cleanup Goals

- Clean up Hg at areas greater than 2 ppm.
- Clean up Cs-137 to an area average less than or equal to 23 pCi/g; hot spots not to exceed three times the cleanup goal

N
W E
S

Legend

- Fence
- Dirt Roads
- Paved Roads
- Recharge Basins
- Active Sand Filter Bed
- Inactive Sand Filter Bed
- Buildings

Excavation Criteria

- Cesium and Mercury
- Mercury Only
- Waste Storage Areas (Not to Scale)

0 50 100 200 Feet

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Location of STP Excavation Sites

Figure # 4

Environmental Information Management System

JLH - 09/18/07
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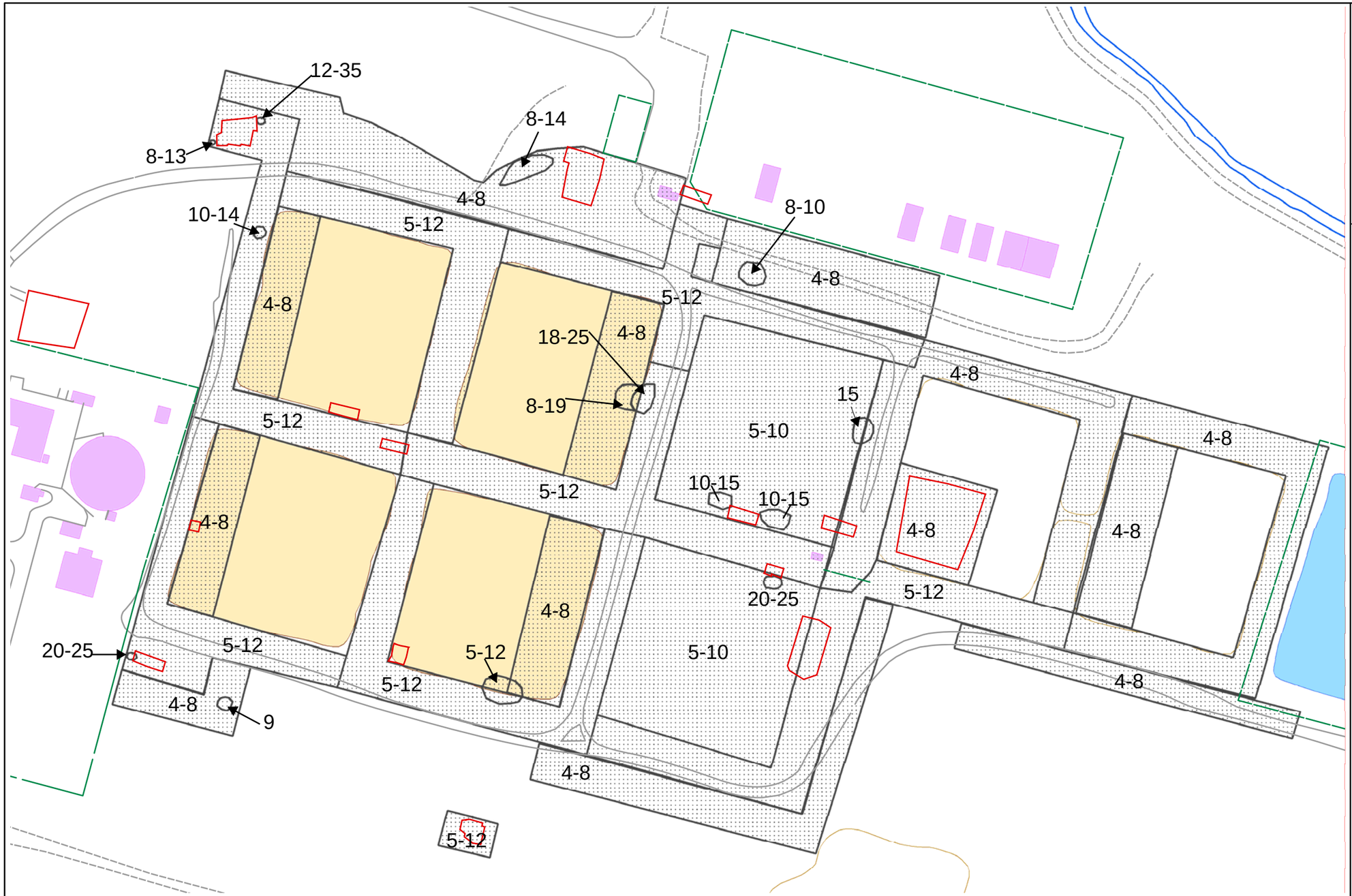
r:/graphics/out5/stp_cs/excavation.pdf



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Confirmation Walkover Survey

Figure # 5

Environmental Information Management System

JLH - 09/18/07
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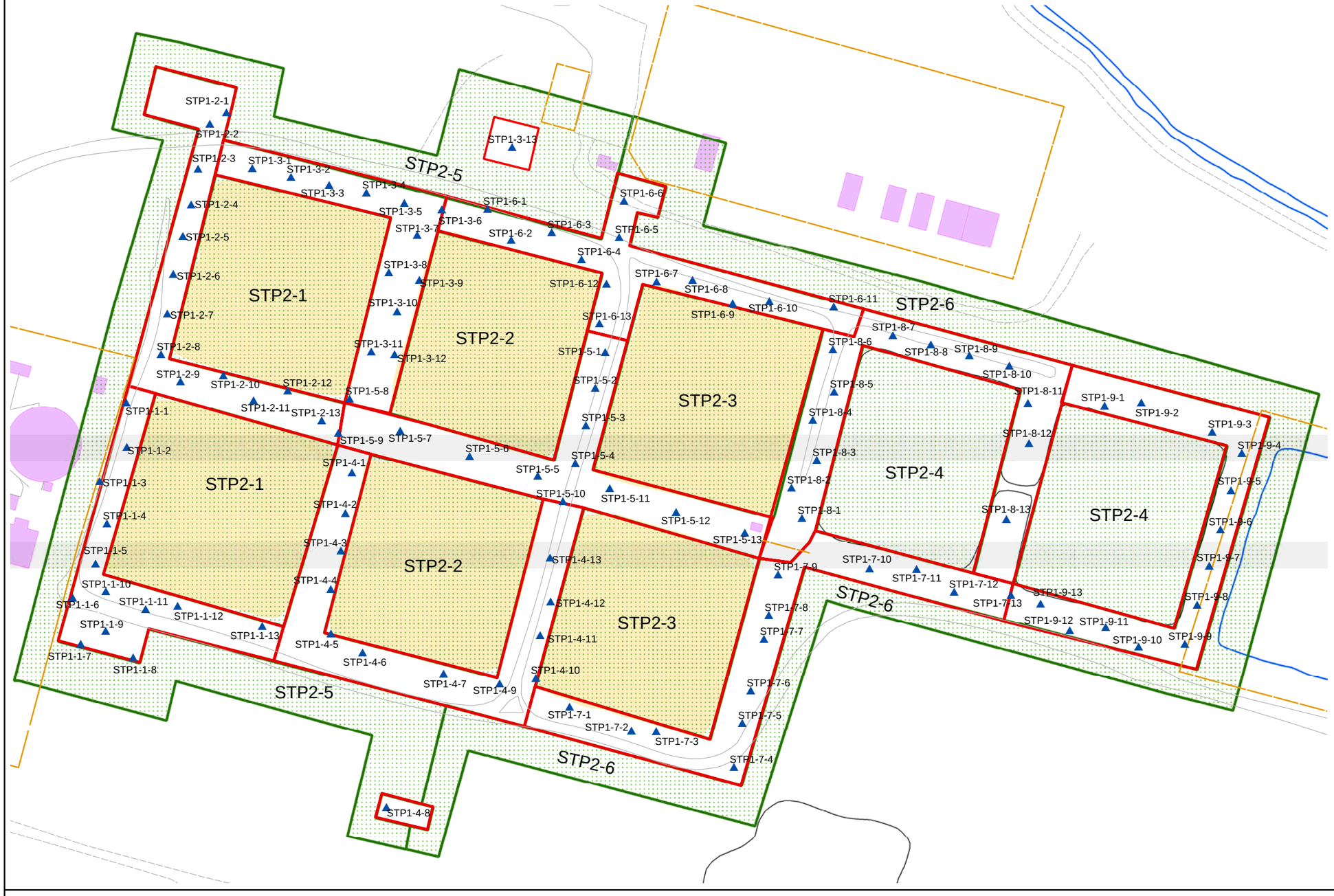
r:/graphics/ou5/stp_cs/walkover.pdf



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Sewage Treatment Plant - Class 1 Sample Locations

Figure 6

Environmental Information Management System

JLH - 03/05/03
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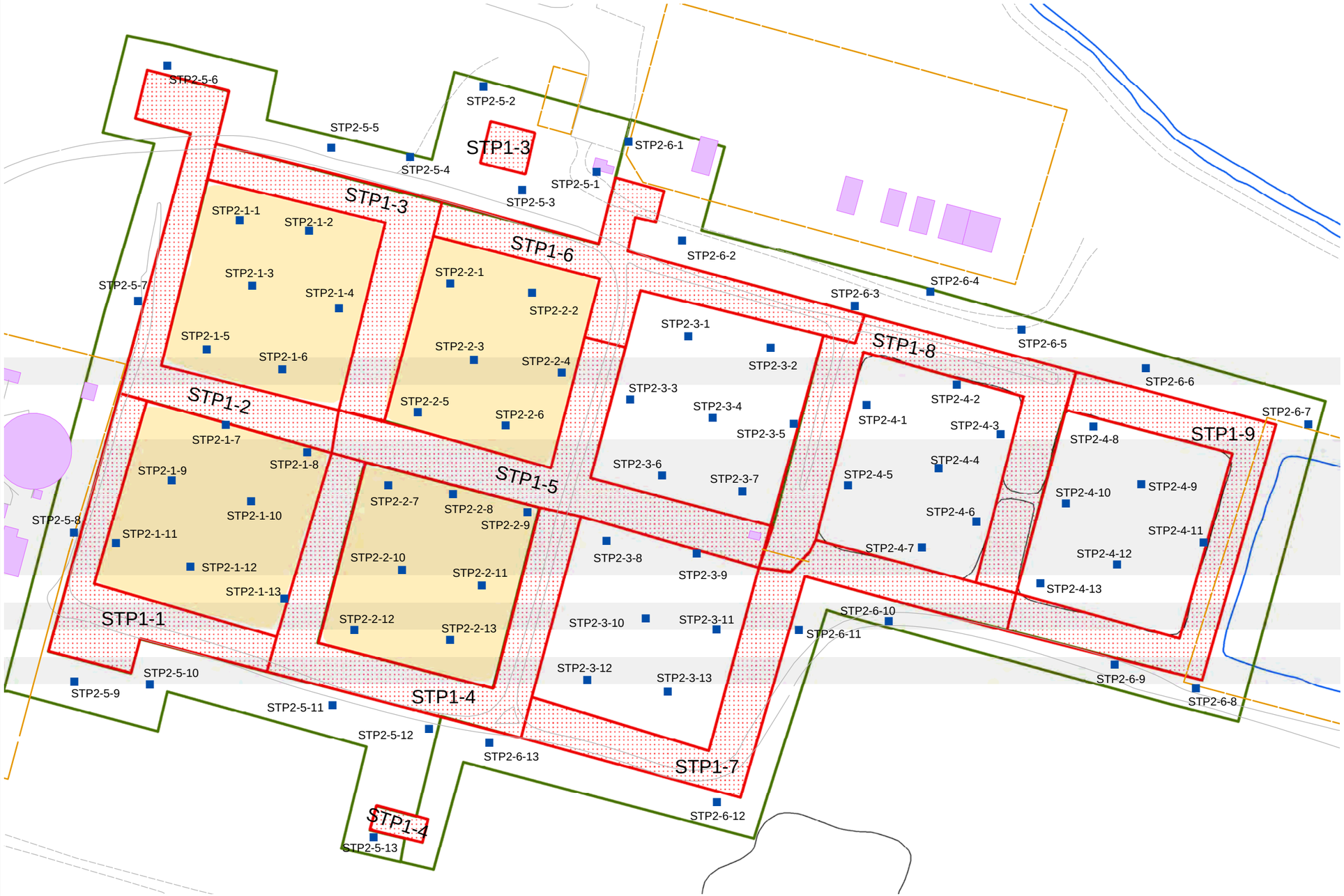
r:/graphics/ou5/stp_cs/class1.pdf



Legend

- Class 2 Sample Locations
- Fence
- Dirt Roads
- Paved Roads
- Buildings
- Class 1 Areas
- Class 2 Areas
- Onsite Surface Water
- Active Sand Filter Bed
- Inactive Sand Filter Bed

0 100 200 Feet

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Sewage Treatment Plant - Class 2 Sample Locations

Figure 7

Environmental Information Management System

JLH - 09/18/07
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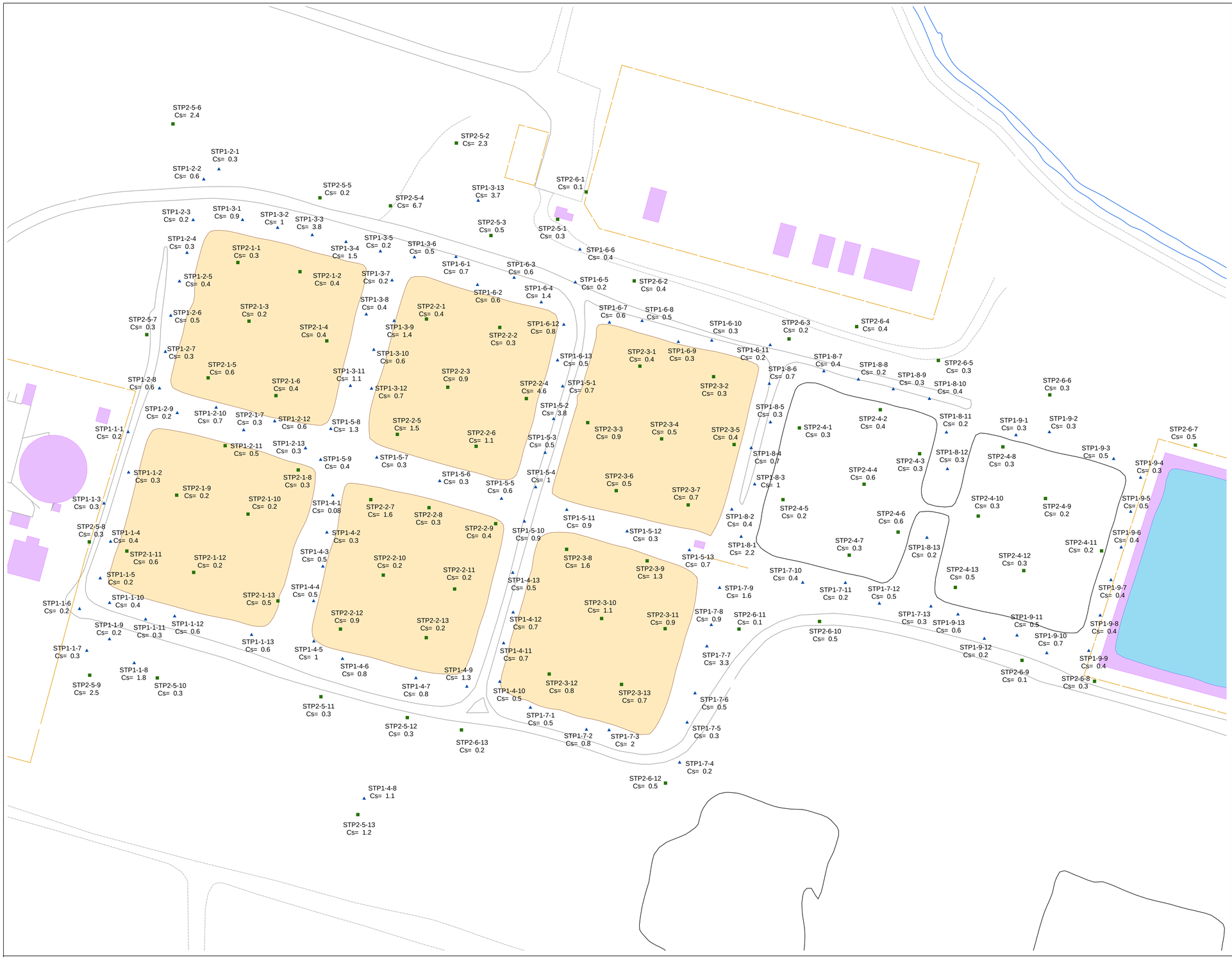
r:/graphics/ou5/stp_cs/class2_r1.pdf.



Legend

- Class 1 Sample Locations
- Class 2 Sample Locations
- Fence
- Dirt Roads
- Paved Roads
- Recharge Basins
- Active Sand Filter Bed
- Inactive Sand Filter Bed
- Buildings
- Surface Water

*ISOCS Values for Cs-137 given in pCi/g.

0 100 200 Feet

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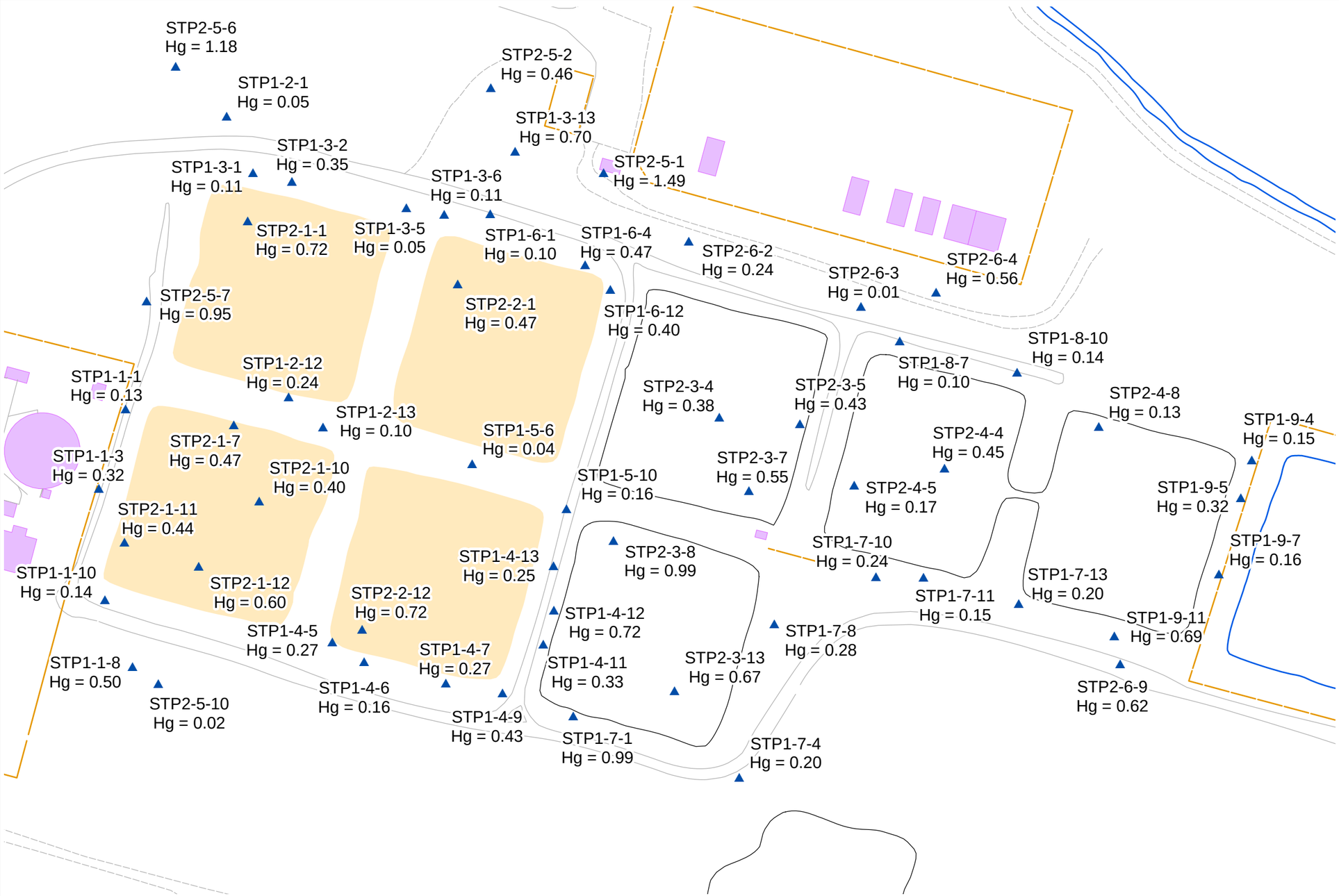
STP Final Survey Confirmation Sampling for Cesium-137

Figure # 8

Environmental Information Management System

JLH - 03/06/03
r:/arcmap_projects/ou5
/stp_cs/cs_vaule.mxd



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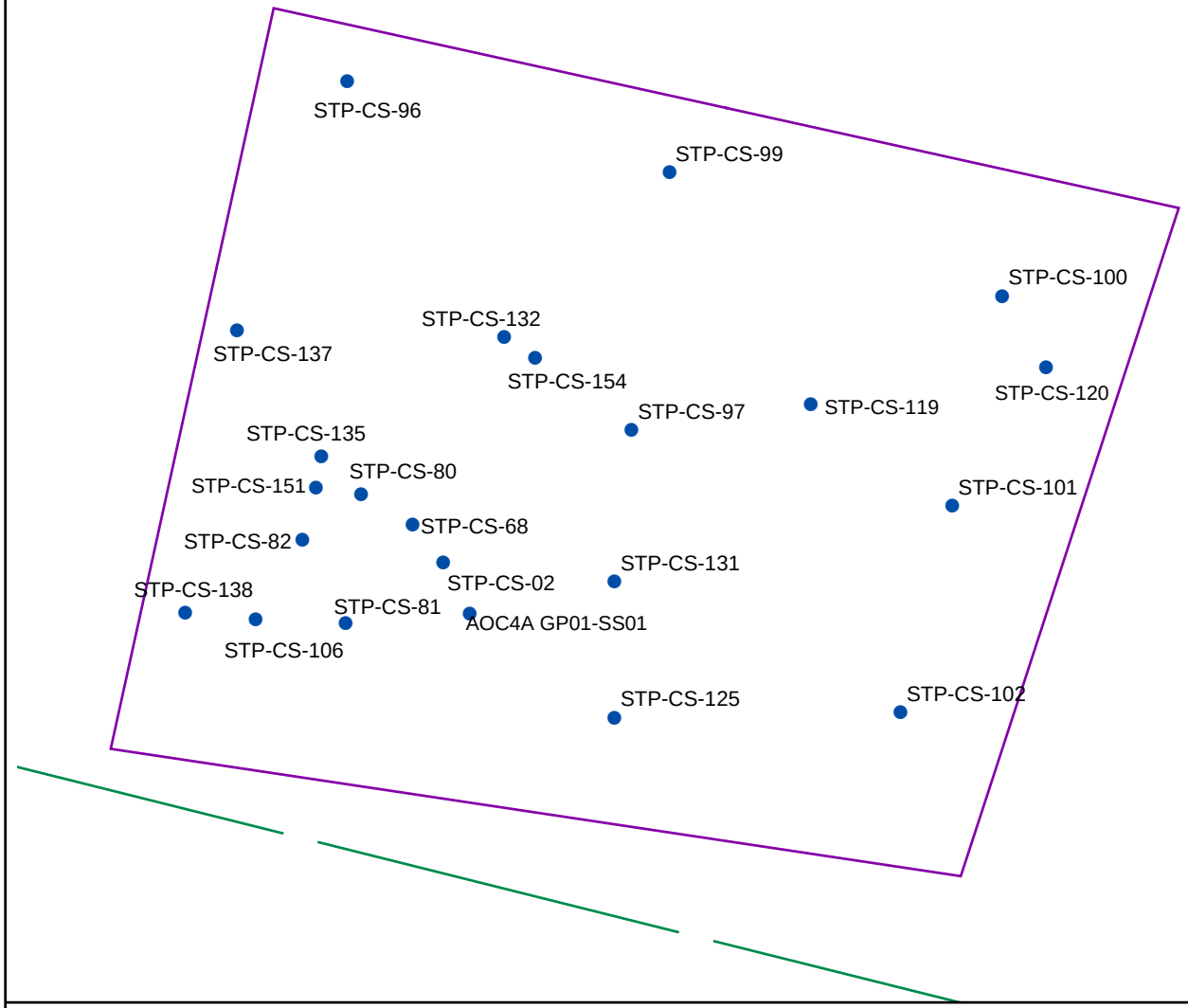
Sewage Treatment Plant - Mercury Results (mg/Kg) of Random Surface Soil Samples Collected Outside of Excavated Areas

Figure 9

Environmental Information Management System

JLH - 03/26/03
r:/arcmap_projects/ou5/stp_cs/mercury.mxd
r:/graphics/ou5/stp_cs/mercury.mxd



N
W
E
S

Legend

- Fence
- Excavation Area
- Sample Locations

0 5 10
Feet

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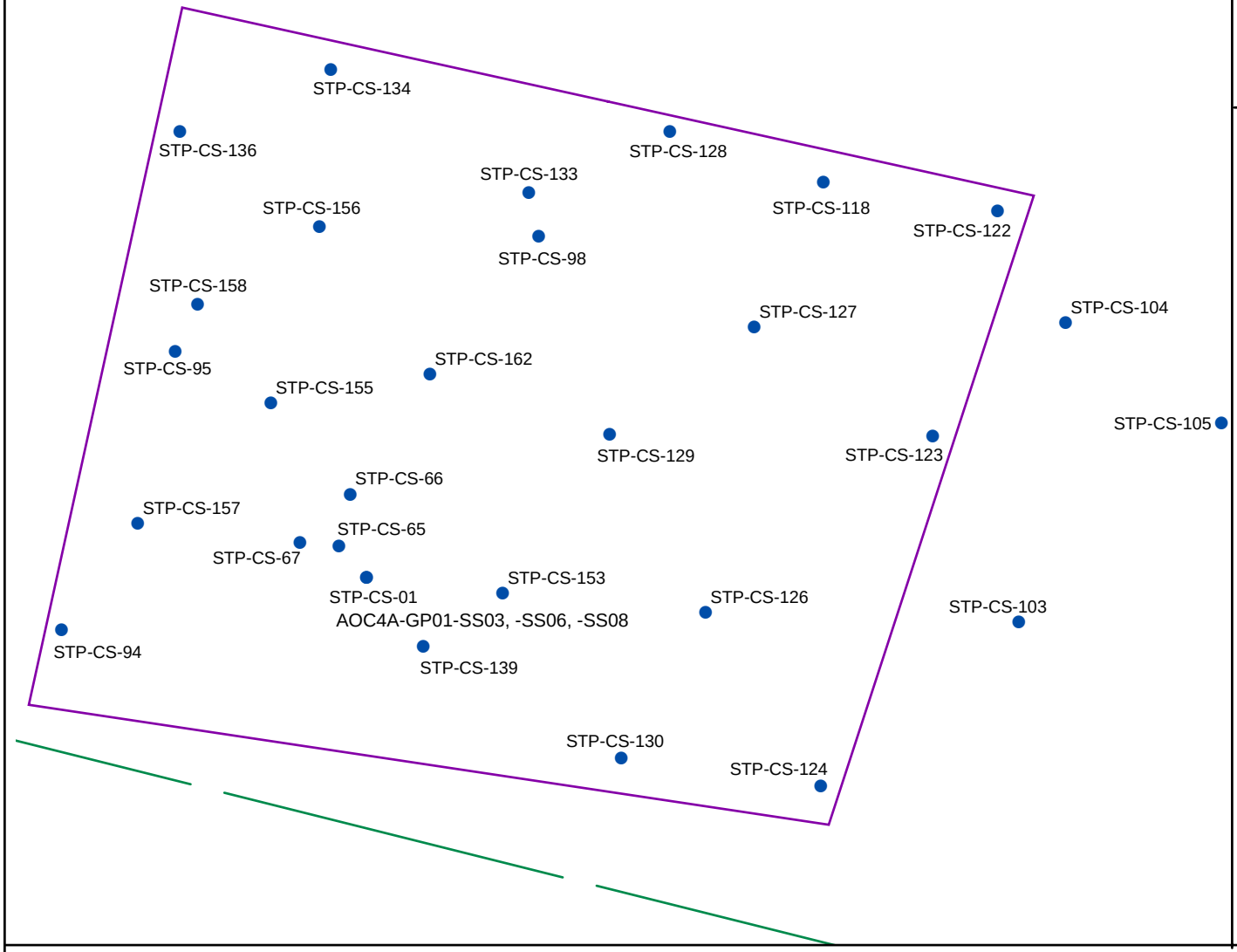
Location of Elevated Mercury Samples (Hg > 2 ppm) Prior to Completion of Excavation AOC4A-GP01

Figure A

Environmental Information Management System

JLH - 02/24/03
ALR - 10/17/03
r:/arcmap_projects/ou5/stp-cs/aoc4A-gp01b.mxd
r:/graphics/ou5/stp-cs/aoc4A-gp01b.mxd



N
W
E
S

Legend

- Fence
- Excavation Area
- Sample Locations

0 5 10
Feet

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Environmental Information Management System

Location of Final Confirmatory Samples for Mercury (Hg < 2 ppm) AOC4A-GP01

Figure B

JLH - 02/24/03
ALR - 10/21/03
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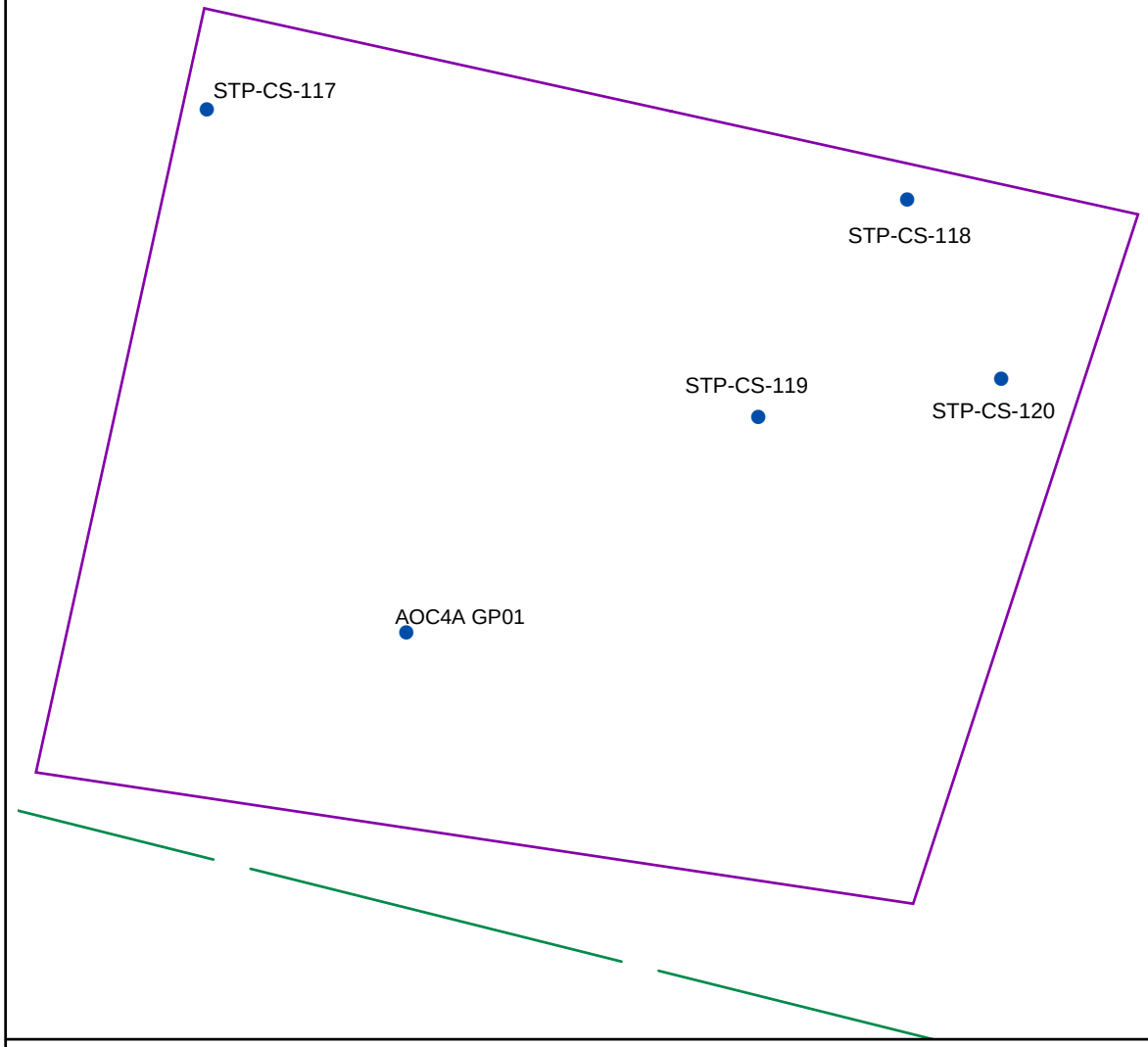

N
W
E
S

Legend

- Fence
- Excavation Area
- Sample Locations

0 5 10
Feet

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Location of ISOCS Samples Collected for Cesium-137 During Excavation and Confirmation Sampling AOC4A-GP01

Figure C

Environmental Information Management System

ALR - 10/17/03
r:/arcmap_projects/ou5/stp-cs/aoc4A-gp01isocs.mxd
r:/graphics/ou5/stp-cs/aoc4A-gp01isocs.mxd

ANALYTICAL DATA FOR EXCAVATION AREA
AOC 4A GP01

Mercury Results > 2 ppm

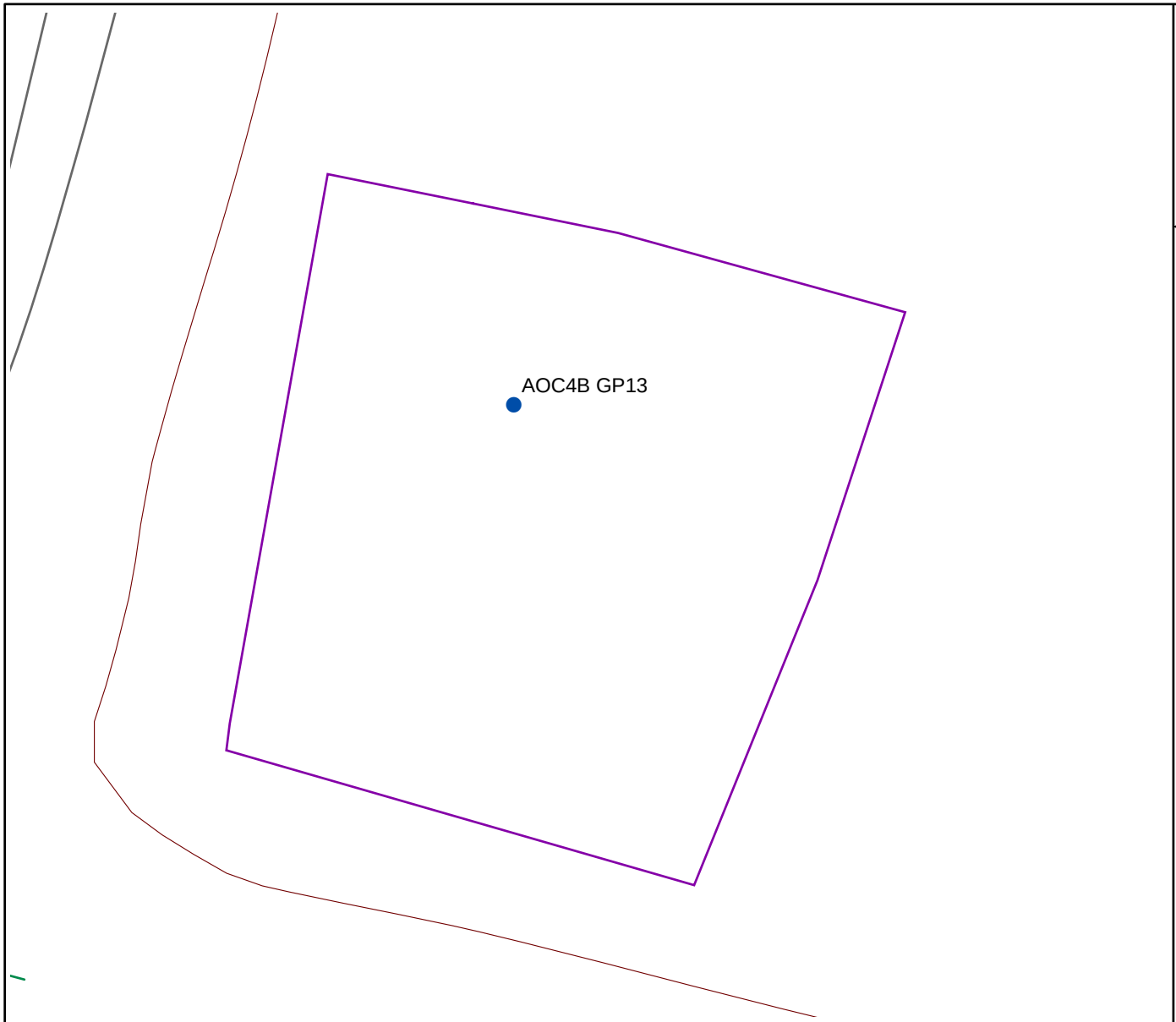
Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
AOC4A-GP01-SS01	2/1/1995	8.4			mg/kg	0.5	NA		S
STP-CS-02	1/22/2003	2.35	0.025	0	mg/kg	0.25	1	B	S
STP-CS-68	2/5/2003	4.14	0.001	0	mg/kg	0.25	0.5		S
STP-CS-80	2/5/2003	6.17	0.001	0	mg/kg	0.25	0.5		S
STP-CS-81	2/5/2003	6.76	0.001	0	mg/kg	0.25	0.5		S
STP-CS-82	2/5/2003	8.33	0.001	0	mg/kg	0.25	0.5		S
STP-CS-96	2/7/2003	2.61	0.001	0	mg/kg	0.5	0.5		S
STP-CS-97	2/7/2003	4.67	0.001	0	mg/kg	0.5	0.5		S
STP-CS-99	2/7/2003	2.54	0.001	0	mg/kg	0.5	0.5		S
STP-CS-100	2/7/2003	9.53	0.001	0	mg/kg	0.5	0.5		S
STP-CS-101	2/7/2003	7.40	0.001	0	mg/kg	0.5	0.5		S
STP-CS-102	2/7/2003	5.57	0.001	0	mg/kg	0.5	0.5		S
STP-CS-106	2/7/2003	10.62	0.001	0	mg/kg	0.5	0.5		S
STP-CS-106	2/7/2003	6.00	0.001	0	mg/kg	1.5	1.5		S
STP-CS-119	2/11/2003	4.69	0.001	0	mg/kg	0.25	0.5		S
STP-CS-120	2/11/2003	4.25	0.001	0	mg/kg	0.25	0.5		S
STP-CS-125	2/24/2003	2.18	0.001	0	mg/kg	0.25	1.5		S
STP-CS-131	2/24/2003	5.71	0.001	0	mg/kg	0.25	1.5		S
STP-CS-132	2/24/2003	4.55	0.001	0	mg/kg	0.25	1.5		S
STP-CS-135	2/24/2003	4.43	0.001	0	mg/kg	0.25	1.5		S
STP-CS-137	2/25/2003	6.84	0.001	0	mg/kg	0.25	1.5		S
STP-CS-138	2/25/2003	3.33	0.001	0	mg/kg	0.25	1.5		S
STP-CS-154	3/3/2003	2.72	0.001	0	mg/kg	0.25	2.5		S

Mercury Results < 2 ppm

Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
AOC4A-GP01-SS03	2/1/1995	8.4			mg/kg	1- 3	NA		S
AOC4A-GP01-SS06	2/1/1995	8.4			mg/kg	4- 6	NA		S
AOC4A-GP01-SS08	2/1/1995	8.4			mg/kg	6- 8	NA		S
STP-CS-01	1/22/2003	0.10	0.001	0	mg/kg	0.25	1	B	S
STP-CS-65	2/5/2003	0.60	0.001	0	mg/kg	0.25	0.5		S
STP-CS-66	2/5/2003	1.03	0.001	0	mg/kg	0.25	0.5		S
STP-CS-67	2/5/2003	1.19	0.001	0	mg/kg	0.25	0.5		S
STP-CS-94	2/7/2003	0.48	0.001	0	mg/kg	0.5	0.5		S
STP-CS-94	2/7/2003	0.08	0.001	0	mg/kg	2.5	2.5		S
STP-CS-94	2/7/2003	0.09	0.001	0	mg/kg	1.5	1.5		S
STP-CS-95	2/7/2003	0.08	0.001	0	mg/kg	0.5	0.5		S
STP-CS-95	2/7/2003	1.01	0.001	0	mg/kg	1.5	1.5		S
STP-CS-95	2/7/2003	0.29	0.001	0	mg/kg	2.5	2.5		S
STP-CS-98	2/7/2003	1.75	0.001	0	mg/kg	0.5	0.5		S
STP-CS-103	2/7/2003	0.98	0.001	0	mg/kg	0.5	0.5		S
STP-CS-104	2/7/2003	1.54	0.001	0	mg/kg	0.5	0.5		S
STP-CS-105	2/7/2003	0.26	0.001	0	mg/kg	0.5	0.5		S
STP-CS-118	2/11/2003	0.55	0.001	0	mg/kg	0.25	0.5		S
STP-CS-122	2/24/2003	0.31	0.001	0	mg/kg	0.25	1.5		S
STP-CS-123	2/24/2003	0.27	0.001	0	mg/kg	0.25	1.5		S
STP-CS-124	2/24/2003	0.18	0.001	0	mg/kg	0.25	1.5		S
STP-CS-126	2/24/2003	0.55	0.001	0	mg/kg	0.25	1.5		S
STP-CS-127	2/24/2003	0.40	0.001	0	mg/kg	0.25	1.5		S
STP-CS-128	2/24/2003	0.21	0.001	0	mg/kg	0.25	1.5		S
STP-CS-129	2/24/2003	1.08	0.001	0	mg/kg	0.25	1.5		S
STP-CS-130	2/24/2003	1.13	0.001	0	mg/kg	0.25	1.5		S
STP-CS-133	2/24/2003	1.49	0.001	0	mg/kg	0.25	1.5		S
STP-CS-134	2/24/2003	0.46	0.001	0	mg/kg	0.25	1.5		S
STP-CS-136	2/25/2003	0.68	0.001	0	mg/kg	0.25	1.5		S
STP-CS-153	3/3/2003	0.23	0.001	0	mg/kg	0.25	2.5		S
STP-CS-155	3/3/2003	1.17	0.001	0	mg/kg	0.25	2.5		S
STP-CS-156	3/3/2003	0.33	0.001	0	mg/kg	0.25	2.5		S
STP-CS-157	3/3/2003	0.16	0.001	0	mg/kg	0.25	2.5		S
STP-CS-158	3/3/2003	0.28	0.001	0	mg/kg	0.25	2.5		S
STP-CS-162	3/4/2003	0.32	0.001	0	mg/kg	0.25	3		S

Cesium-137

Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Method
AOC 4A GP01	12/11/2001	1.36	0.07	0.21	pCi/g	0.5	NA		ISOCS
STP CS-117	2/11/2003	0.3	0.2	0.2	pCi/g	0.25	0.5		ISOCS
STP CS-118	2/11/2003	0.2	0.2	0.1	pCi/g	0.25	0.5		ISOCS
STP CS-119	2/11/2003	2.7	0.3	0.4	pCi/g	0.25	0.5		ISOCS
STP CS-120	2/11/2003	2.5	0.04	0.4	pCi/g	0.25	0.5		ISOCS



N
W
E
S

Legend

- Fence
- Dirt Roads
- Paved Roads
- Excavation Area
- Sample Locations

0 5 10 15 20
Feet

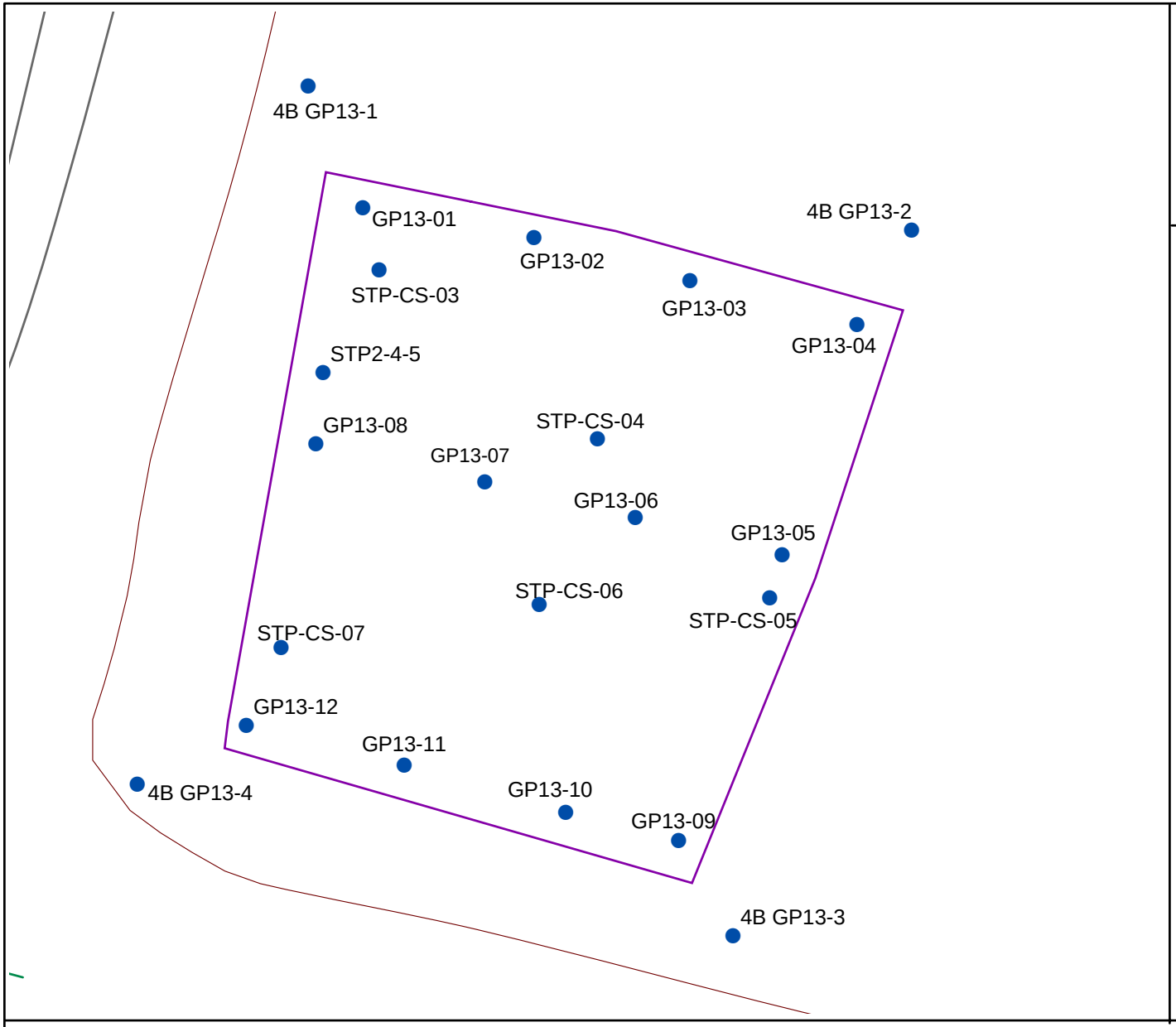
BROOKHAVEN NATIONAL LABORATORY

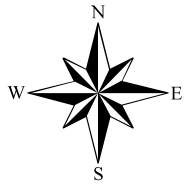
Locations of Elevated Mercury Samples (Hg > 2ppm) Prior to Completion of Excavation AOC4B-GP13

Figure A

Environmental Information Management System

ALR - 10/17/03
r:/arcmap_projects/ou5/stp-cs/aoc4b-gp13b.mxd
r:/graphics/ou5/stp-cs/aoc4b-gp13b.mxd





Legend

- Fence
- Dirt Roads
- Paved Roads
- Excavation Area
- Sample Locations

0 5 10 15 20
Feet

BROOKHAVEN NATIONAL LABORATORY

Locations of Final Confirmatory Samples for Mercury (Hg < 2ppm) AOC4B-GP13

Figure B

Environmental Information Management System

JLH - 02/24/03
r:/arcmap_projects/ou5/stp-cs/aoc4b-gp13.mxd
r:/graphics/ou5/stp-cs/aoc4b-gp13.mxd

ANALYTICAL DATA FOR EXCAVATION AREA
AOC 4B GP13

Mercury Results > 2 ppm

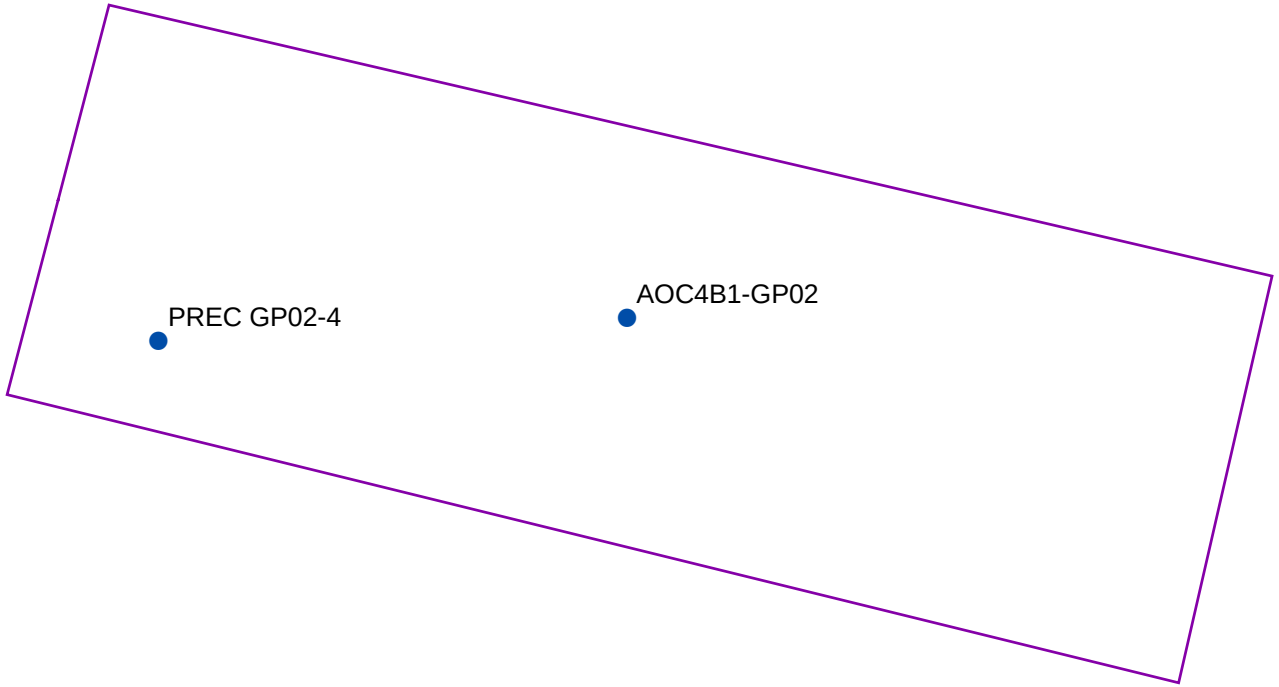
Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
AOC4B GP13	1/25/1995	5.8		0	mg/kg	0.5	NA		S

Mercury Results < 2 ppm

Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
4B GP13-1	6/5/2002	0.36	0.001	0	mg/kg	0.5	NA		S
4B GP13-2	6/5/2002	0.28	0.001	0	mg/kg	0.5	NA		S
4B GP13-3	6/5/2002	0.53	0.001	0	mg/kg	0.5	NA		S
4B GP13-4	6/5/2002	0.42	0.001	0	mg/kg	0.5	NA		S
GP13-1	10/9/2002	1.29	0.001	0	mg/kg	0.25	0.5		S
GP13-2	10/9/2002	0.22	0.001	0	mg/kg	0.25	0.5		S
GP13-3	10/9/2002	0.15	0.001	0	mg/kg	0.25	0.5		S
GP13-4	10/9/2002	0.07	0.001	0	mg/kg	0.25	0.5		S
GP13-5	10/9/2002	0.08	0.001	0	mg/kg	0.25	0.5		S
GP13-6	10/9/2002	0.18	0.001	0	mg/kg	0.25	0.5		S
GP13-7	10/9/2002	0.23	0.001	0	mg/kg	0.25	0.5		S
GP13-8	10/9/2002	0.16	0.001	0	mg/kg	0.25	0.5		S
GP13-9	10/9/2002	0.11	0.001	0	mg/kg	0.25	0.5		S
GP13-10	10/9/2002	0.11	0.001	0	mg/kg	0.25	0.5		S
GP13-11	10/9/2002	0.89	0.001	0	mg/kg	0.25	0.5		S
GP13-12	10/9/2002	0.27	0.001	0	mg/kg	0.25	0.5		S
STP-CS-03	1/22/2003	0.39	0.001	0	mg/kg	0.25	0.5		S
STP-CS-04	1/22/2003	0.31	0.001	0	mg/kg	0.25	0.5		S
STP-CS-05	1/22/2003	0.15	0.001	0	mg/kg	0.25	0.5	B	S
STP-CS-06	1/22/2003	0.37	0.001	0	mg/kg	0.25	0.5		S
STP-CS-07	1/22/2003	0.36	0.001	0	mg/kg	0.25	0.5		S

Cesium 137 Results

Sample ID	Sample Date	Value	MDA	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
4B GP13-1	6/5/2002	0.377			pCi/g	0.5	NA		gamma
4B GP13-2	6/5/2002	0.138			pCi/g	0.5	NA		gamma
4B GP13-3	6/5/2002	0.501			pCi/g	0.5	NA		gamma
4B GP13-4	6/5/2002	0.18			pCi/g	0.5	NA		gamma



N
W
E
S

Legend

- Sample Locations
- Fence
- Dirt Roads
- Paved Roads
- Excavation Area

0 4 8
Feet

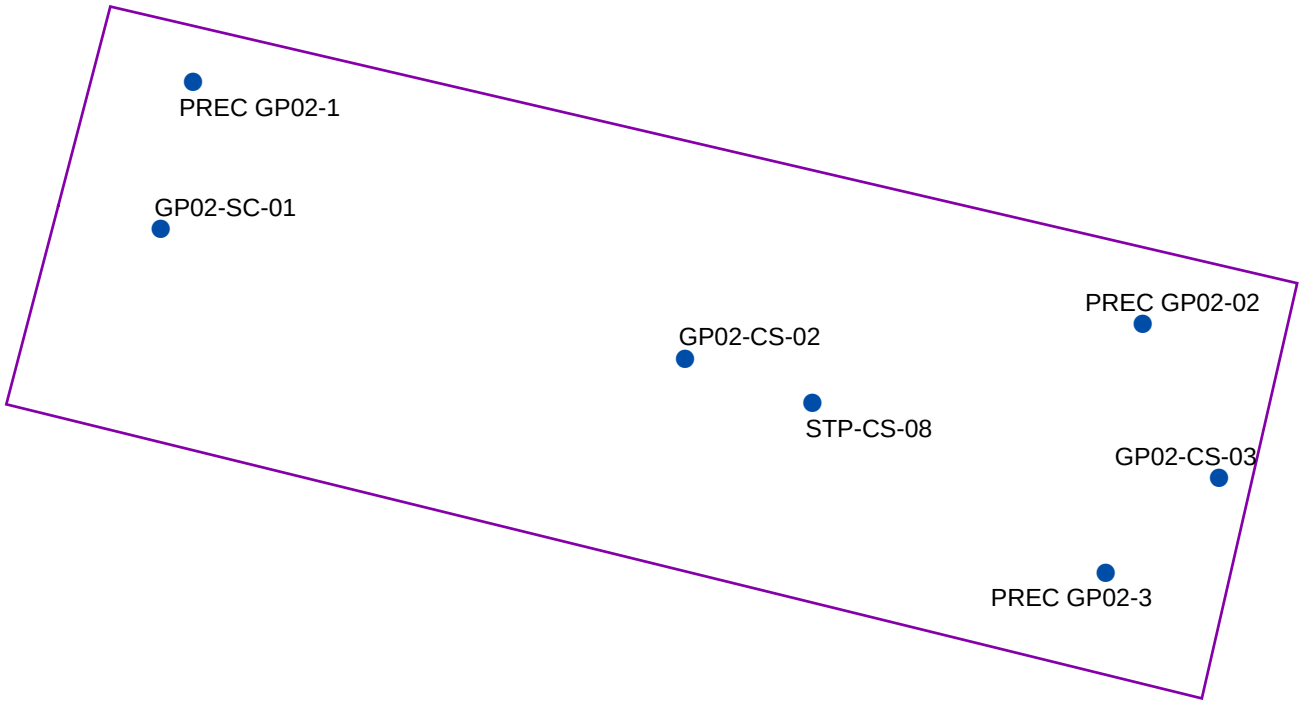
BROOKHAVEN NATIONAL LABORATORY

Location of Elevated Mercury Samples (Hg > 2ppm) Prior to Completion of Excavation AOC4B1-GP02

Figure A

ALR - 10/17/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp02b.mxd
r:/graphics/ou5/stp-cs/aoc4b1-gp02b.mxd

Environmental Information Management System



N
W
E
S

Legend

- Sample Location
- Fence
- Dirt Roads
- Paved Roads
- Excavation Area

0 4 8
Feet

BROOKHAVEN NATIONAL LABORATORY

Environmental Information Management System

Location of Final Confirmatory Samples for Mercury (Hg < 2ppm) AOC4B1-GP02

Figure B

JLH - 02/24/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp02.mxd
r:/graphics/ou5/stp-cs/aoc4b1-gp02.mxd

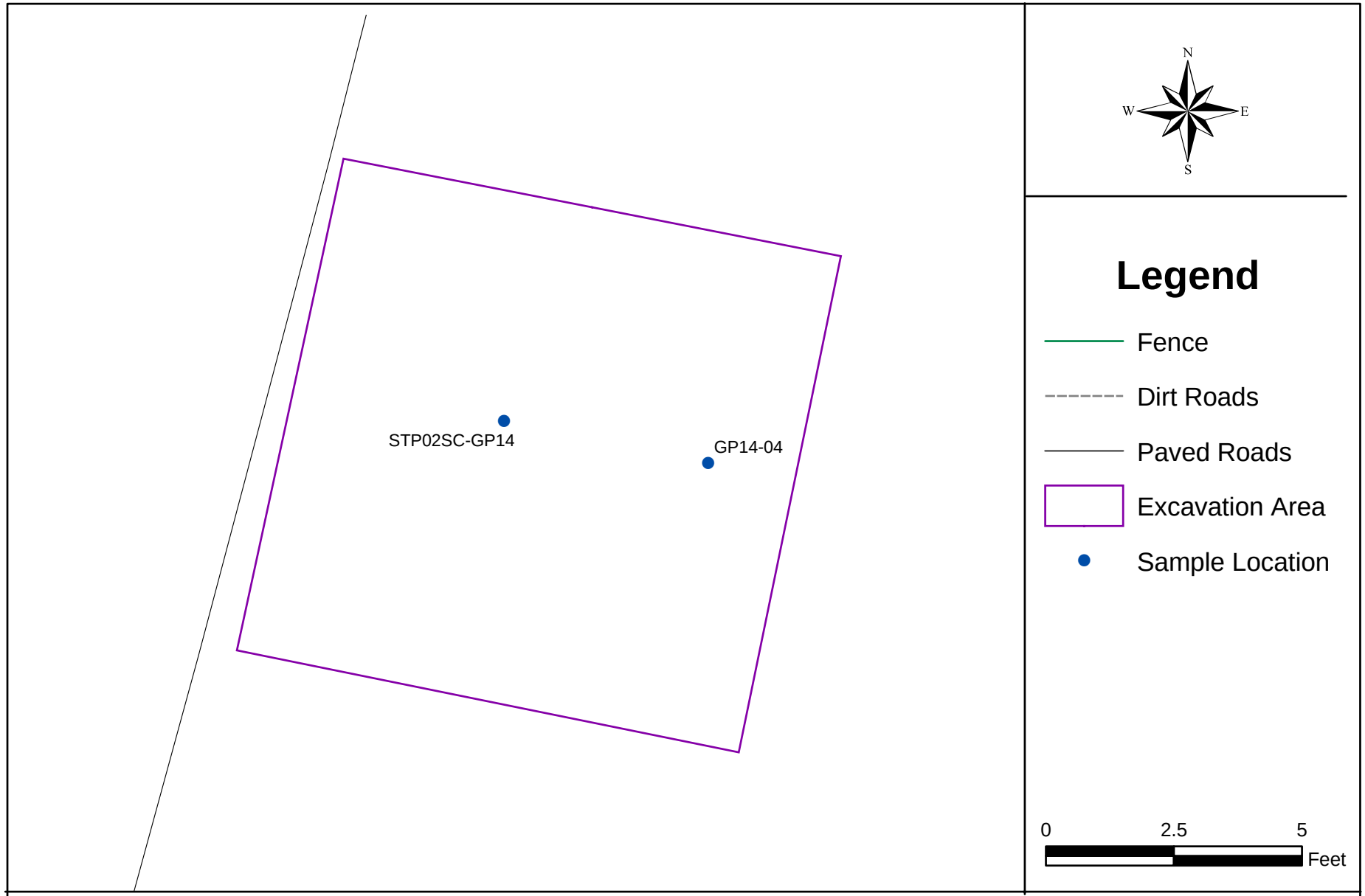
ANALYTICAL DATA FOR EXCAVATION AREA
AOC 4B1 GP02

Mercury Results > 2 ppm

Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
AOC4B1 GP02	2/2/1995	3.80		0	mg/kg	0.5	NA	J	S
PREC GP02-04	6/5/2002	3.77	0.001	0	mg/kg	0.5	NA		S

Mercury Results < 2 ppm

Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
PREC GP02-01	6/5/2002	0.43	0.001	0	mg/kg	0.25	NA		S
PREC GP02-02	6/5/2002	0.28	0.001	0	mg/kg	0.25	NA		S
PREC GP02-03	6/5/2002	1.67	0.001	0	mg/kg	0.25	NA		S
GP02-CS-01	10/9/2002	0.19	0.001	0	mg/kg	0.25	1		S
GP02-CS-02	10/9/2002	1.62	0.001	0	mg/kg	0.25	1		S
GP02-CS-03	10/9/2002	0.08	0.001	0	mg/kg	0.25	1		S
STP-CS-08	1/22/2003	1.50	0.013	0	mg/kg	0.25	1	B	S



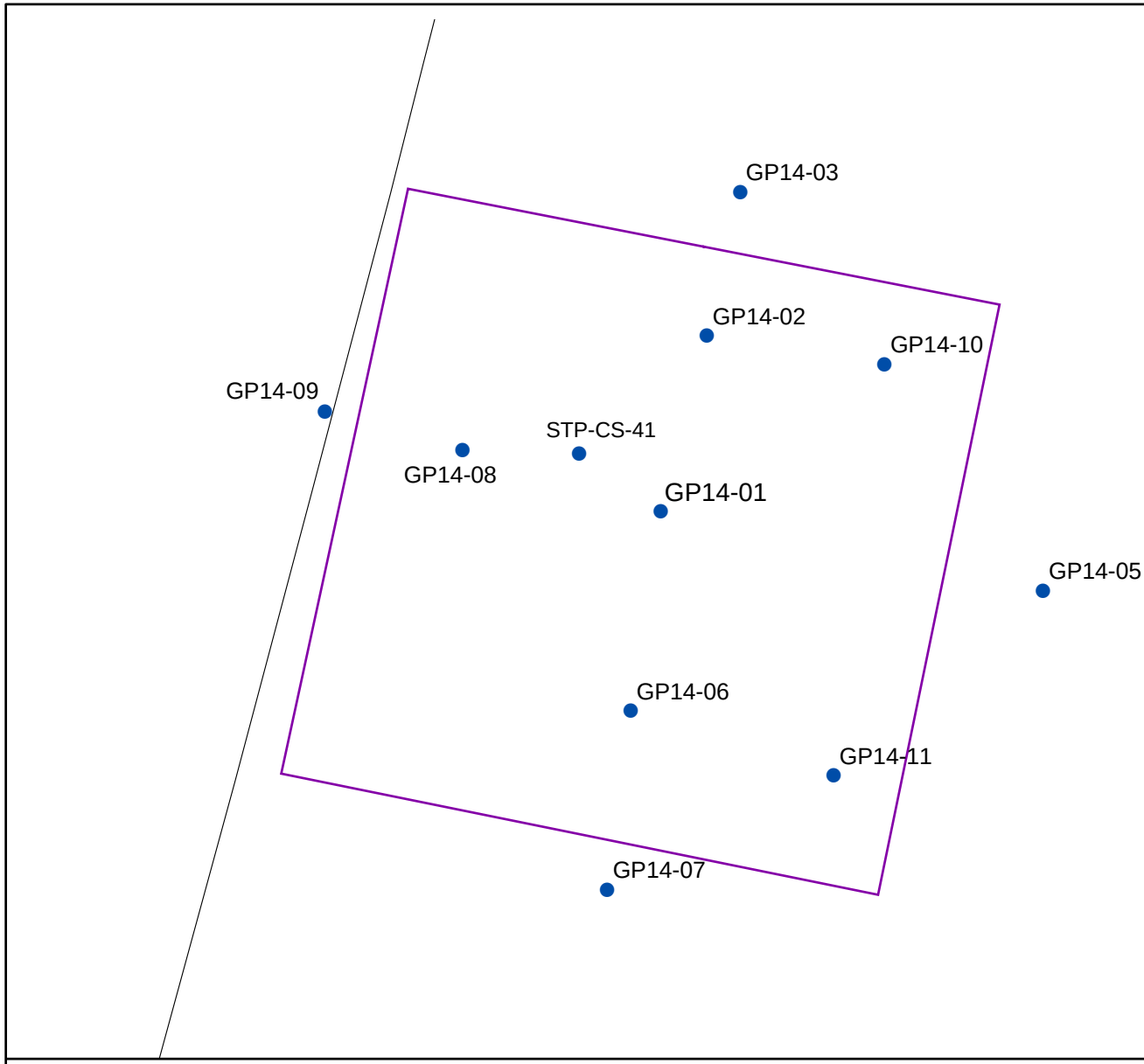
BROOKHAVEN NATIONAL LABORATORY

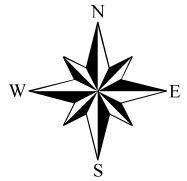
Environmental Information Management System

Location of Elevated Mercury Samples (Hg > 2ppm) Prior to Completion of Excavation AOC4B1-GP14

Figure A

JLH - 02/24/03
ALR - 10/17/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp14b.mxd





Legend

- Sample Location
- Fence
- Dirt Roads
- Paved Roads
- Excavation Area

0 2.5 5 Feet

BROOKHAVEN NATIONAL LABORATORY

Environmental Information Management System

Location of Final Confirmatory Samples for Mercury (Hg < 2ppm) AOC4B1-GP14

Figure B

JLH - 02/24/03
ALR - 10/17/03
r:/arcmap_projects/ou5/
stp-cs/aoc4b1-gp14.mxd

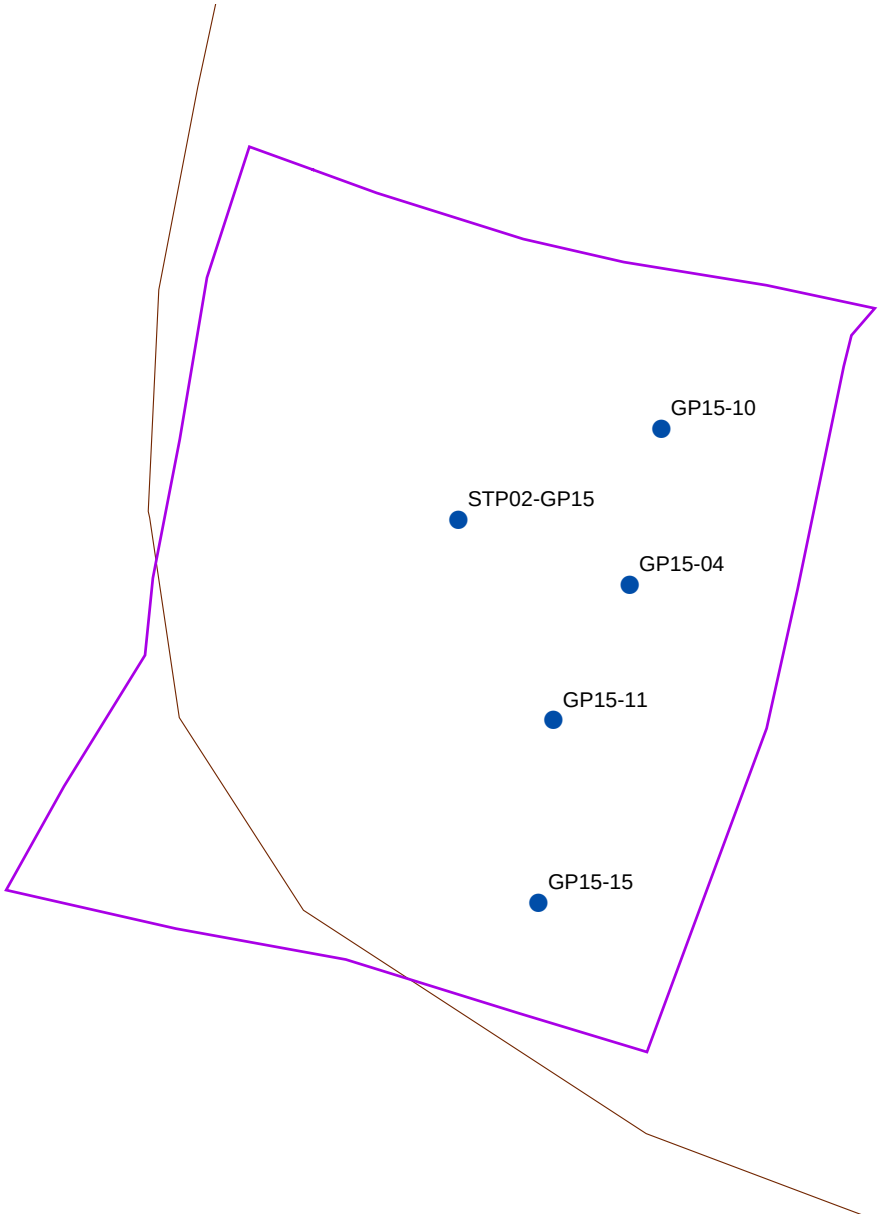
ANALYTICAL DATA FOR EXCAVATION AREA
AOC 4B1 GP14

Mercury Results > 2 ppm

Location	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
STP02 -SC-GP14	7/18/2002	5.69	0.298	0	mg/kg	1.5	NA		S
GP14-04	11/5/2002	12.04	0.05154	0	mg/kg	0.25	0.5		S

Mercury Results < 2 ppm

Location	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
GP14-01	11/5/2002	0.24		0	mg/kg	0.25	0.5		S
GP14-02	11/5/2002	0.99		0	mg/kg	0.25	0.5		S
GP14-03	11/5/2002	0.22		0	mg/kg	0.25	0.5		S
GP14-05	11/5/2002	0.12		0	mg/kg	0.25	0.5		S
GP14-06	11/5/2002	0.24		0	mg/kg	0.25	0.5		S
GP14-07	11/5/2002	0.18		0	mg/kg	0.25	0.5		S
GP14-08	11/5/2002	0.10		0	mg/kg	0.25	0.5		S
GP14-09	11/5/2002	0.09		0	mg/kg	0.25	0.5		S
GP14-10	11/5/2002	0.23		0	mg/kg	0.25	0.5		S
GP14-11	11/5/2002	0.22		0	mg/kg	0.25	0.5		S
STP-CS-41	1/22/2003	0.11		0	mg/kg	0.25	2		S



N
W
E
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Legend

- Sample Location
- Fence
- Dirt Roads
- Paved Roads
- Excavation Area

0 4 8
Feet

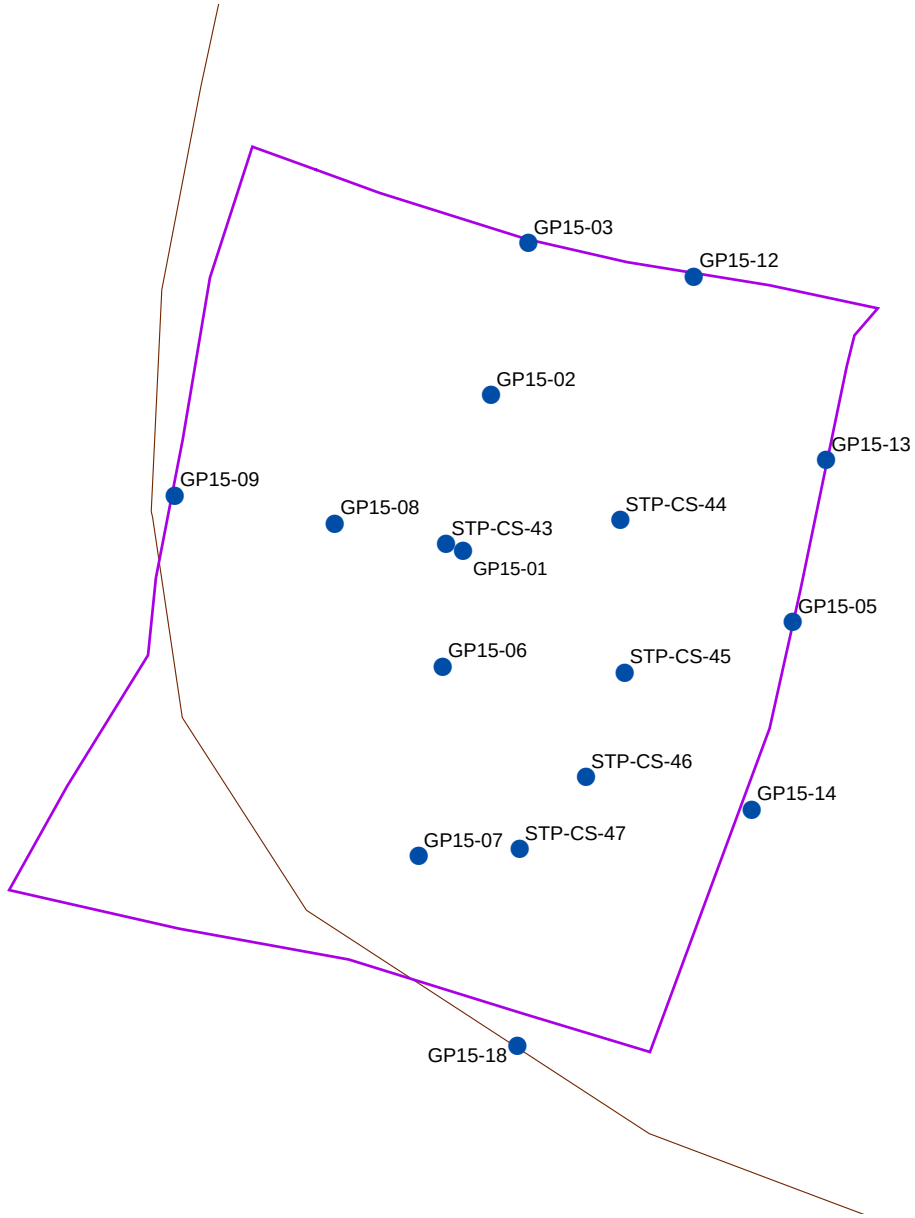
BROOKHAVEN NATIONAL LABORATORY

Location of Elevated Mercury Samples (Hg > 2ppm) Prior to Completion of Excavation AOC4B1-GP15

Figure A

JLH - 02/24/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp15b.mxd
r:/graphics/ou5/stp-cs/aoc4b1-gp15b.mxd

Environmental Information Management System



N
W
E
S

Legend

- Sample Location
- Fence
- Dirt Roads
- Paved Roads
- Excavation Area

0 4 8
Feet

BROOKHAVEN NATIONAL LABORATORY

Environmental Information Management System

Location of Final Confirmatory Samples for Mercury (Hg < 2ppm) AOC4B1-GP15

Figure B

JLH - 02/24/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp15.mxd
r:/graphics/ou5/stp-cs/aoc4b1-gp15.mxd

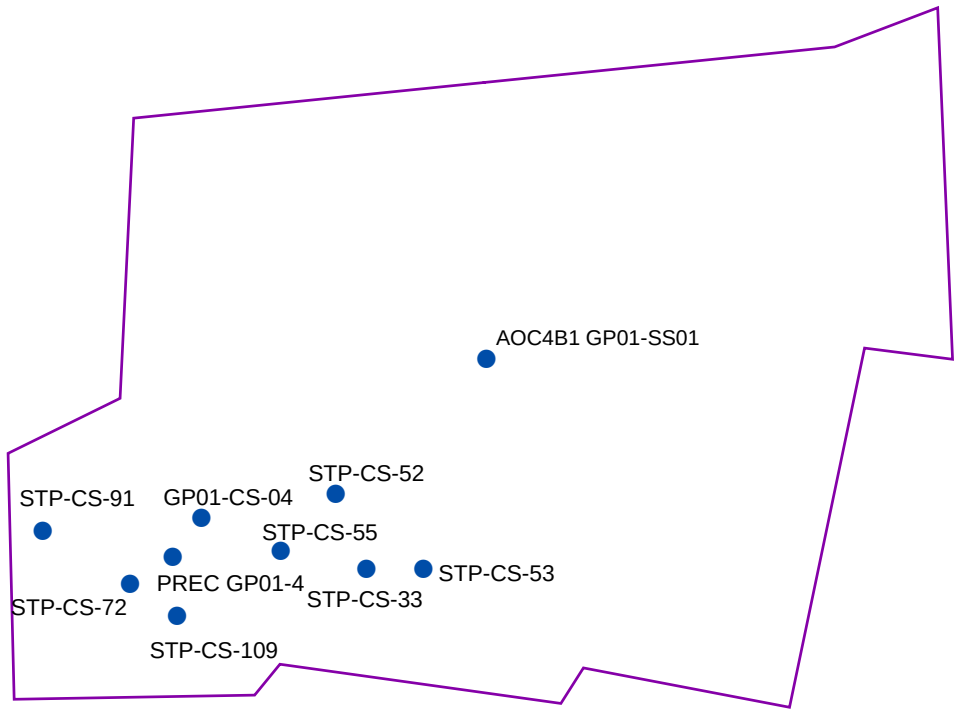
ANALYTICAL DATA FOR EXCAVATION AREA
AOC 4B1 GP15

Mercury Results > 2 ppm

Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
STP02-GP15	7/18/2002	5.65	0.061	0	mg/kg	0.5	NA		S
GP15-04	11/5/2002	6.05		0	mg/kg	0.5	NA		S
GP15-10	11/5/2002	2.98		0	mg/kg	0.5	NA		S
GP15-11	11/5/2002	6.48		0	mg/kg	0.5	NA	H	S
GP15-15	11/5/2002	8.04		0	mg/kg	0.5	NA		S

Mercury Results < 2 ppm

Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
GP15-01	11/5/2002	0.25		0	mg/kg	0.5	NA		S
GP15-02	11/5/2002	0.90		0	mg/kg	0.5	NA		S
GP15-03	11/5/2002	0.58		0	mg/kg	0.5	NA		S
GP15-05	11/5/2002	0.63		0	mg/kg	0.5	NA		S
GP15-06	11/5/2002	0.37		0	mg/kg	0.5	NA		S
GP15-07	11/5/2002	0.51		0	mg/kg	0.5	NA		S
GP15-08	11/5/2002	1.12		0	mg/kg	0.5	NA		S
GP15-09	11/5/2002	0.39		0	mg/kg	0.5	NA		S
GP15-12	11/5/2002	0.76		0	mg/kg	0.5	NA		S
GP15-13	11/5/2002	0.74		0	mg/kg	0.5	NA		S
GP15-14	11/5/2002	1.81		0	mg/kg	0.5	NA		S
GP15-18	11/5/2002	0.64		0	mg/kg	0.5	NA		S
STP-CS-43	1/22/2003	0.17	0.001	0	mg/kg	0.25	1.5	B	S
STP-CS-44	1/22/2003	0.20	0.001	0	mg/kg	0.25	1.5	B	S
STP-CS-45	1/22/2003	0.07	0.001	0	mg/kg	0.25	1.5	B	S
STP-CS-46	1/22/2003	0.09	0.001	0	mg/kg	0.25	1.5	B	S
STP-CS-47	1/22/2003	0.09	0.001	0	mg/kg	0.25	1.5	B	S



N
W
E
S

Legend

- Fence
- Dirt Roads
- Paved Roads
- Excavation Area
- Sample Locations

0 7 14
Feet

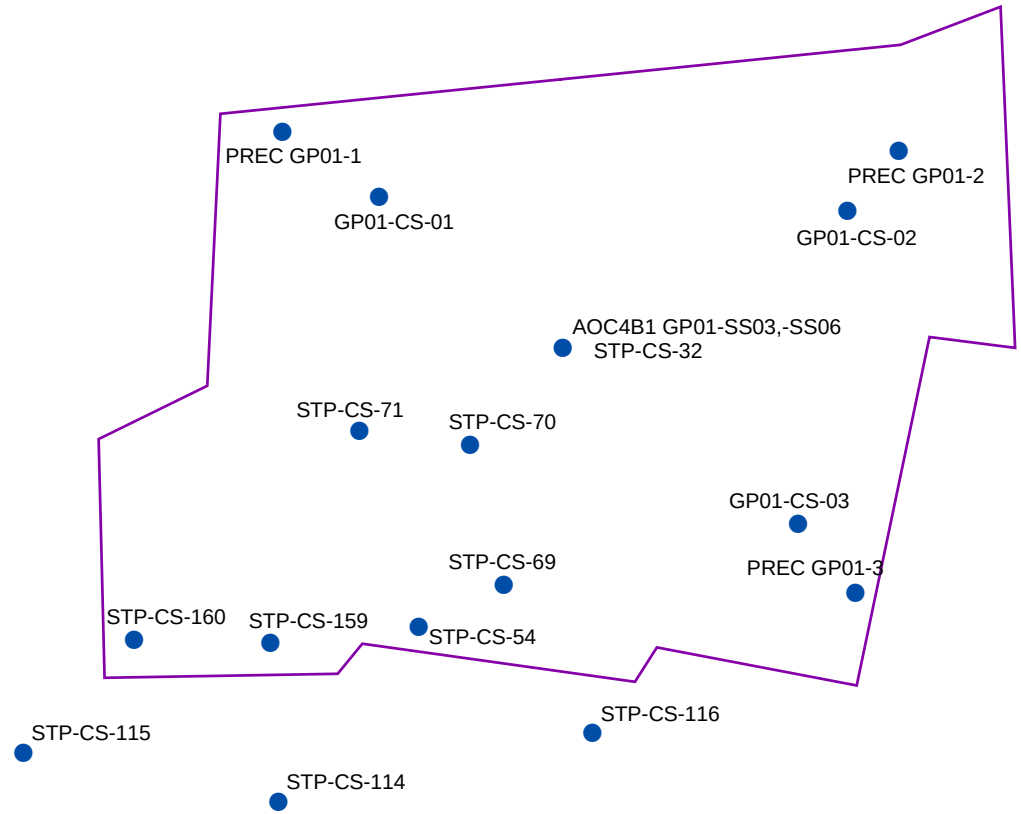
BROOKHAVEN NATIONAL LABORATORY

Location of Elevated Mercury Samples (Hg > 2ppm) Prior to Completion of Excavation AOC4B1-GP01

Figure A

Environmental Information Management System

ALR - 10/21/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp01b.mxd
r:/graphics/ou5/stp-cs/aoc4b1-gp01b.mxd



N
W
E
S

Legend

- Fence
- Dirt Roads
- Paved Roads
- Excavation Area
- Sample Locations

0 7 14
Feet

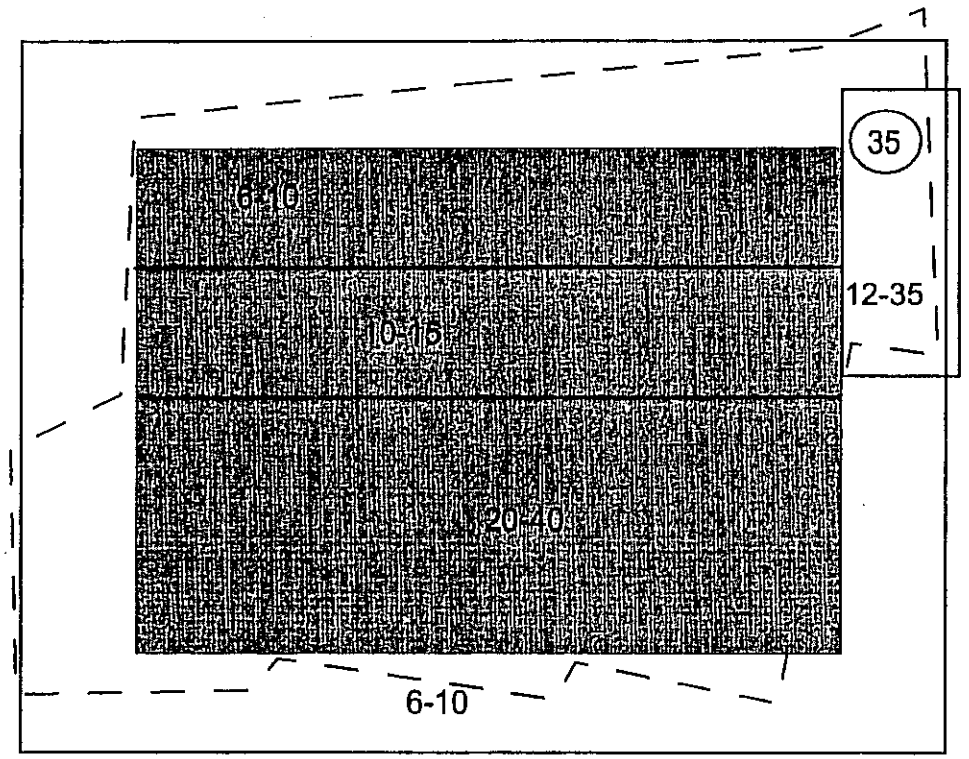
BROOKHAVEN NATIONAL LABORATORY

Environmental Information Management System

Location of Final Confirmatory Samples for Mercury (Hg < 2ppm) AOC4B1-GP01

Figure B

ALR - 10/21/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp01.mxd
r:/graphics/ou5/stp-cs/aoc4b1-gp01.mxd



N
W
E
S

Legend

Excavation Area

Pre-Excavation Boundary

0 7 14 Feet

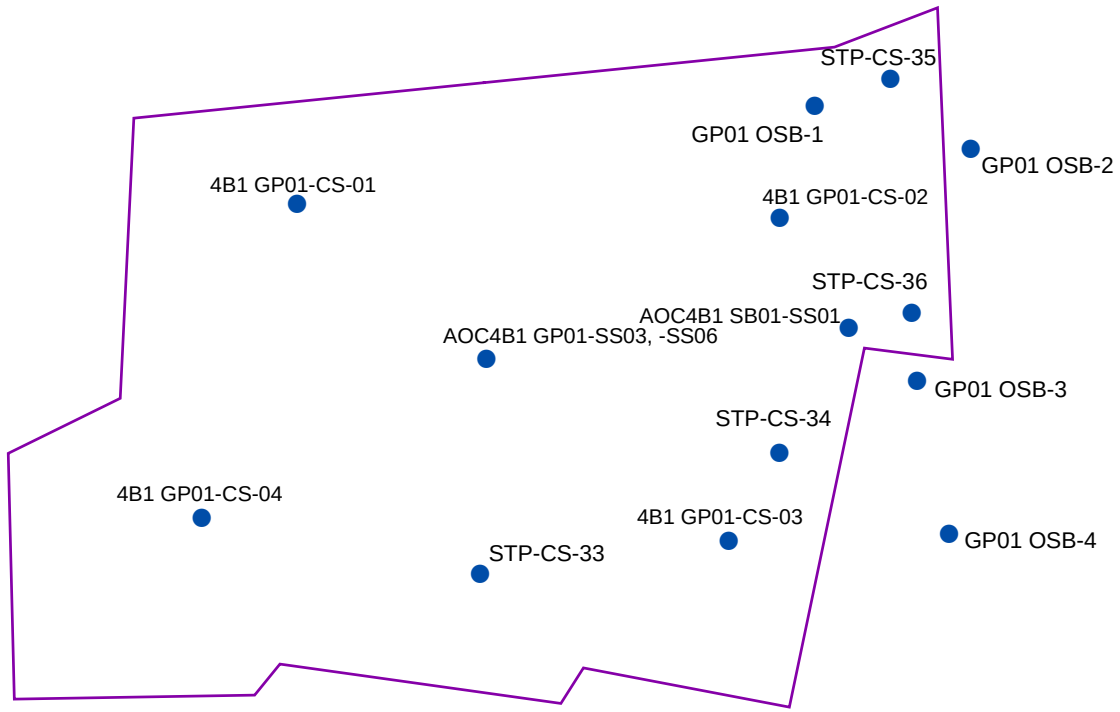
BROOKHAVEN NATIONAL LABORATORY

Environmental Information Management System

Preliminary Nal Walkover Survey (8-28-02) (Values Expressed as Gross x1000 cpm) AOC4B1-GP01

Figure C

KMG - 03/20/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp01.mxd



N
W
E
S

Legend

- Fence
- Dirt Roads
- Paved Roads
- Excavation Area
- Sample Locations

0 7.5 15
Feet

BROOKHAVEN NATIONAL LABORATORY

Location of ISOCS Samples Collected for Cesium-137 During Excavation and Confirmation Sampling AOC4B1-GP01

Figure D

Environmental Information Management System

ALR - 10/21/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp01isocs.mxd
r:/graphics/ou5/stp-cs/aoc4b1-gp01isocs.mxd

AOC 4B1-GP01 Figure E Final Walkover Survey

☐ ROUTINE _____

☒ SPECIAL WALKOVER

☐ RWP# _____

☐ WP# _____

BLDG.#: N/A LOCATION: SEWAGE TREATMENT PLANT OUT #11 DATE/TIME: ~~1-30-03~~ 2-3-03 1400

MODEL	E600	NaI PROBE				
SERIAL#	00739	4001				
Cal Due Date	3-7-03	3-7-03				
Source Check OK (Yes or No)	Y	Y				

DOSE RATES (HIGHEST)		AIRBORNE CONTAMINATION		
		TIME	uCi/cc	%DAC
CONTACT	N/A		N/A	
GENERAL AREA				

LEGEND: O SMEAR SURVEY LOCATION ☐ MASSLINN SURVEY LOCATION

XXX Y — XXX = CONTACT READING

ZZZ — ZZZ = READING @ 30 Cm

Δ AIR SAMPLE LOCATION

Y = RADIATION TYPE

SMEAR SURVEY RESULTS
(DPM/100 cm²)
³H B-γ α

☐ All Dose Rates are in mR/Hr and taken at waist level unless otherwise noted.
☐ All masslinn wipes are <1,000 dpm/LAS
☐ Frisked various areas – all were less than 100cpm
☐ See Attachment for smear survey results

1.		8.		15.		22.	
2.		9.		16.		23.	
3.		10.	N	17.		24.	
4.		11.		18.	A	25.	
5.		12.		19.		26.	
6.		13.		20.		27.	
7.		14.		21.		28.	

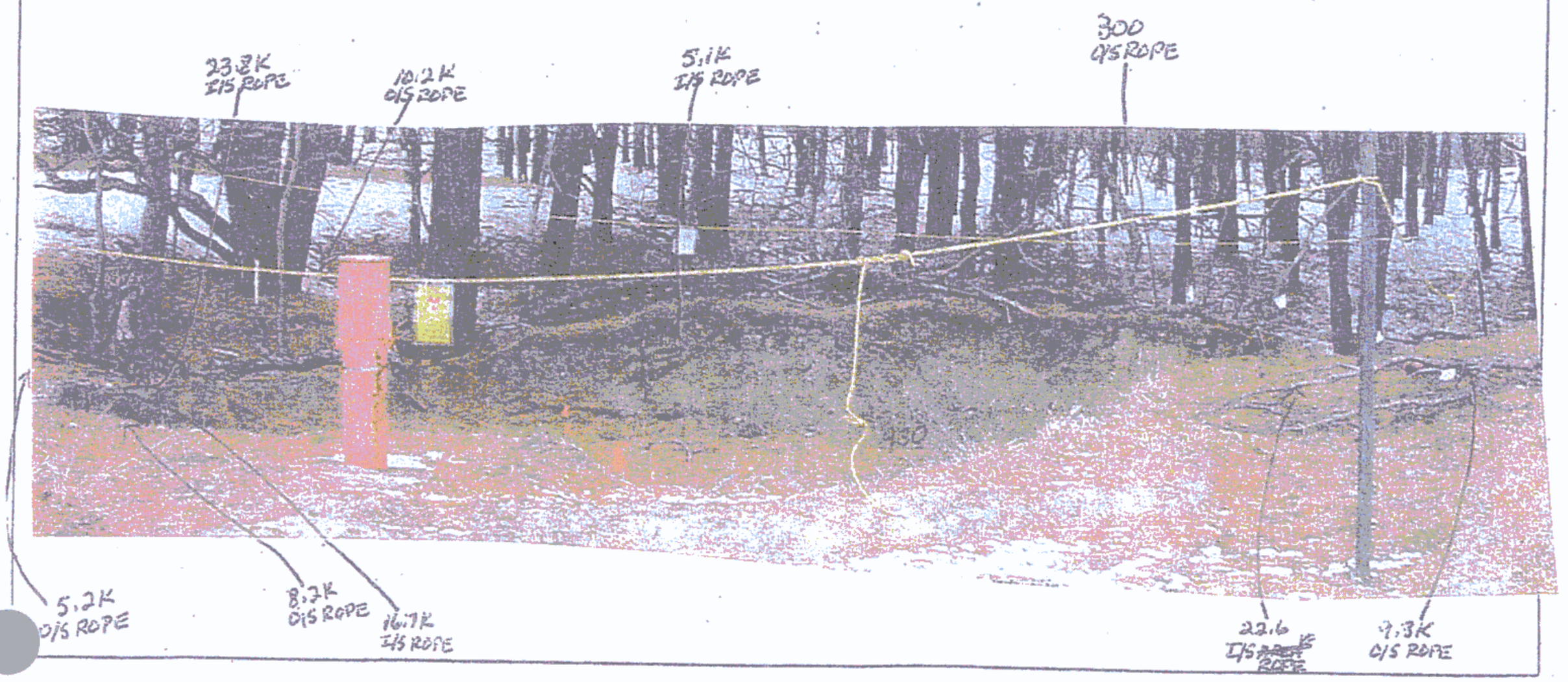
MASSLINN SURVEY RESULTS
(DPM/LAS)

1.		8.	
2.		9.	
3.		10.	
4.	N	11.	A
5.		12.	
6.		13.	
7.		14.	

WALK OVER SURVEY OF SOIL CONTAMINATION AREA AOC4B1-GP01 AT SEWAGE TREATMENT PLANT USING AN E-600 W/NAI PROBE

E600 BKG - 6.42K cpm
MDCR - 1211 ncpm

ALL READINGS IN NET COUNTS/MINUTE



SURVEYED BY: Ken Ratt 2-8-03
Signature/date

REVIEWED BY: Donald M Dan 2-10-03
Signature/date

ANALYTICAL DATA FOR EXCAVATION AREA
AOC 4B1 GP01

Mercury Results > 2 ppm

Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
AOC4B1-GP01-SS01	2/2/1995	2.5			mg/kg	0.5	NA	J	S
PREC GP01-4	6/5/2002	2.23	0.001	0	mg/kg	0.5	NA		S
GP01-CS-04	10/9/2002	4.20	0.001	0	mg/kg	0.25	2		S
STP-CS-33	1/22/2003	8.89	0.001	0	mg/kg	0.5	2.5		S
STP-CS-52	1/30/2003	2.07	0.001	0	mg/kg	0.5	2.5		S
STP-CS-53	1/30/2003	6.51	0.001	0	mg/kg	0.5	2.5		S
STP-CS-55	1/30/2003	12.10	0.001	0	mg/kg	0.5	2.5		S
STP-CS-72	2/5/2003	10.58	0.001	0	mg/kg	0.5	3		S
STP-CS-91	2/7/2003	2.16	0.001	0	mg/kg	0.5	3		S
STP-CS-109	2/8/2003	7.82	0.001	0	mg/kg	0.5	3		S
STP-CS-109	2/8/2003	3.96	0.001	0	mg/kg	1.5	3		S

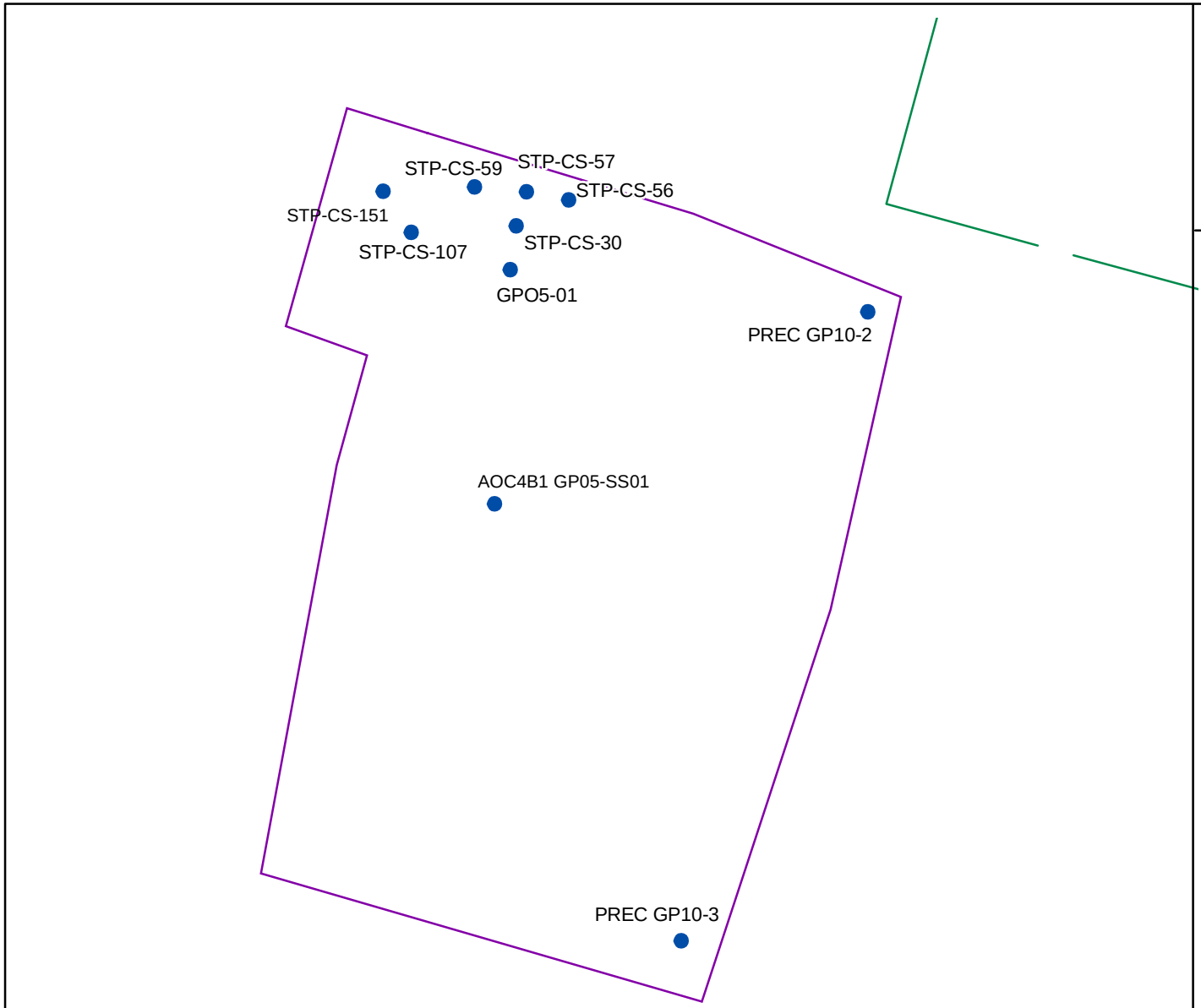
Mercury Results < 2 ppm

Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
AOC4B1-GP01-SS03	2/2/1995	0.88			mg/kg	1-3	NA	J	S
AOC4B1-GP01-SS06	2/2/1995	1.5			mg/kg	4-6	NA	J	S
PREC GP01-01	6/5/2002	0.92	0.001	0	mg/kg	0.5	NA		S
PREC GP01-02	6/5/2002	0.94	0.001	0	mg/kg	0.5	NA		S
PREC GP01-03	6/5/2002	0.18	0.001	0	mg/kg	0.5	NA		S
GP01-CS-01	10/9/2002	0.17	0.001	0	mg/kg	0.25	2		S
GP01-CS-02	10/9/2002	1.02	0.001	0	mg/kg	0.25	2		S
GP01-CS-03	10/9/2002	0.18	0.001	0	mg/kg	0.25	2		S
STP-CS-32	1/22/2003	0.43	0.001	0	mg/kg	0.5	2.5		S
STP-CS-54	1/30/2003	1.29	0.001	0	mg/kg	0.5	2.5		S
STP-CS-69	2/5/2003	0.22	0.001	0	mg/kg	0.5	3		S
STP-CS-70	2/5/2003	1.48	0.001	0	mg/kg	0.5	3		S
STP-CS-71	2/5/2003	1.11	0.001	0	mg/kg	0.5	3		S
STP-CS-114A	2/11/2003	0.16	0.001	0	mg/kg	0.5	0.5		S
STP-CS-114B	2/11/2003	0.03	0.001	0	mg/kg	1.5	1.5		S
STP-CS-115	2/11/2003	0.76	0.001	0	mg/kg	0.25	0.25		S
STP-CS-116	2/11/2003	0.34	0.001	0	mg/kg	0.25	0.25		S
STP-CS-159	3/4/2003	0.61	0.001	0	mg/kg	0.25	4		S
STP-CS-160	3/4/2003	0.44	0.001	0	mg/kg	0.25	4		S

Cesium-137

Sample ID	Sample Date	Value	MDA	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Lab Qual	Method
AOC4B1-SB01-SS01	1/31/1995	20.2			pCi/g	0.5	NA		gamma
AOC4B1-GP01-SS03	2/1/1995	16.8			pCi/g	1-3	NA		gamma
AOC4B1-GP01-SS06	2/2/1995	3.12			pCi/g	4-6	NA		gamma
PREC GP01-1	6/5/2002	1.69			pCi/g	0.5	NA		gamma
PREC GP01-2	6/5/2002	3.58			pCi/g	0.5	NA		gamma
PREC GP01-3	6/5/2002	1.11			pCi/g	0.5	NA		gamma
PREC GP01-4	6/5/2002	3.48			pCi/g	0.5	NA		gamma
4B1-GP01-CS1	8/27/2002	18.3	0.4	1.8	pCi/g	0.5	1		ISOCS
4B1-GP01-CS2	8/27/2002	28.4	0.4	2.8	pCi/g	0.5	1		ISOCS
4B1-GP01-CS3	8/27/2002	25	0.3	2.5	pCi/g	0.5	1		ISOCS
4B1-GP01-CS4	8/27/2002	8.8	0.7	1.2	pCi/g	0.5	1		ISOCS
GP01 OSB1-1	11/14/2002	26.40	0.2	2.6	pCi/g	0-1	1		ISOCS
GP01 OSB1-2	11/14/2002	22.00	0.2	1.9	pCi/g	1-2	1		ISOCS
GP01 OSB1-3	11/14/2002	0.40	0.2	0.2	pCi/g	2-3	1		ISOCS
GP01 OSB2-1	11/14/2002	0.70	0.2	0.4	pCi/g	0-1	1		ISOCS
GP01 OSB2-2	11/14/2002	0.50	0.2	0.2	pCi/g	1-2	1		ISOCS
GP01 OSB2-3	11/14/2002	1.40	0.3	0.3	pCi/g	2-3	1		ISOCS
GP01 OSB3-1	11/14/2002	1.40	0.3	0.3	pCi/g	0-1	1		ISOCS
GP01 OSB3-2	11/14/2002	2.10	0.2	0.4	pCi/g	1-2	1		ISOCS
GP01 OSB3-3	11/14/2002	0.20	0.2	0.1	pCi/g	2-3	1		ISOCS
GP01 OSB4-1	11/14/2002	0.50	0.2	0.2	pCi/g	0-1	1		ISOCS
GP01 OSB4-2	11/14/2002	ND	0.2	ND	pCi/g	1-2	1		ISOCS
GP01 OSB4-3	11/14/2002	0.10	0.2	0.1	pCi/g	2-3	1		ISOCS
STP-CS-33	1/22/2003	18.00	0.4	1.5	pCi/g	0.25	1.5		ISOCS
STP-CS-34	1/22/2003	0.30	0.2	0.1	pCi/g	0.25	1.8		ISOCS
STP-CS-35	1/22/2003	0.50	0.3	0.2	pCi/g	0.25	1.8		ISOCS

STP-CS-36	1/22/2003	13.90	0.5	1.3	pCi/g	0.25	1.8		ISOCS



N
W
E
S

Legend

- Fence
- Dirt Roads
- Paved Roads
- Excavation Area
- Sample Locations

0 8 16
Feet

BROOKHAVEN NATIONAL LABORATORY

Location of Elevated Mercury Samples (Hg > 2ppm) Prior to Completion of Excavation AOC4B1-GP05

Figure A

Environmental Information Management System

ALR - 10/21/03
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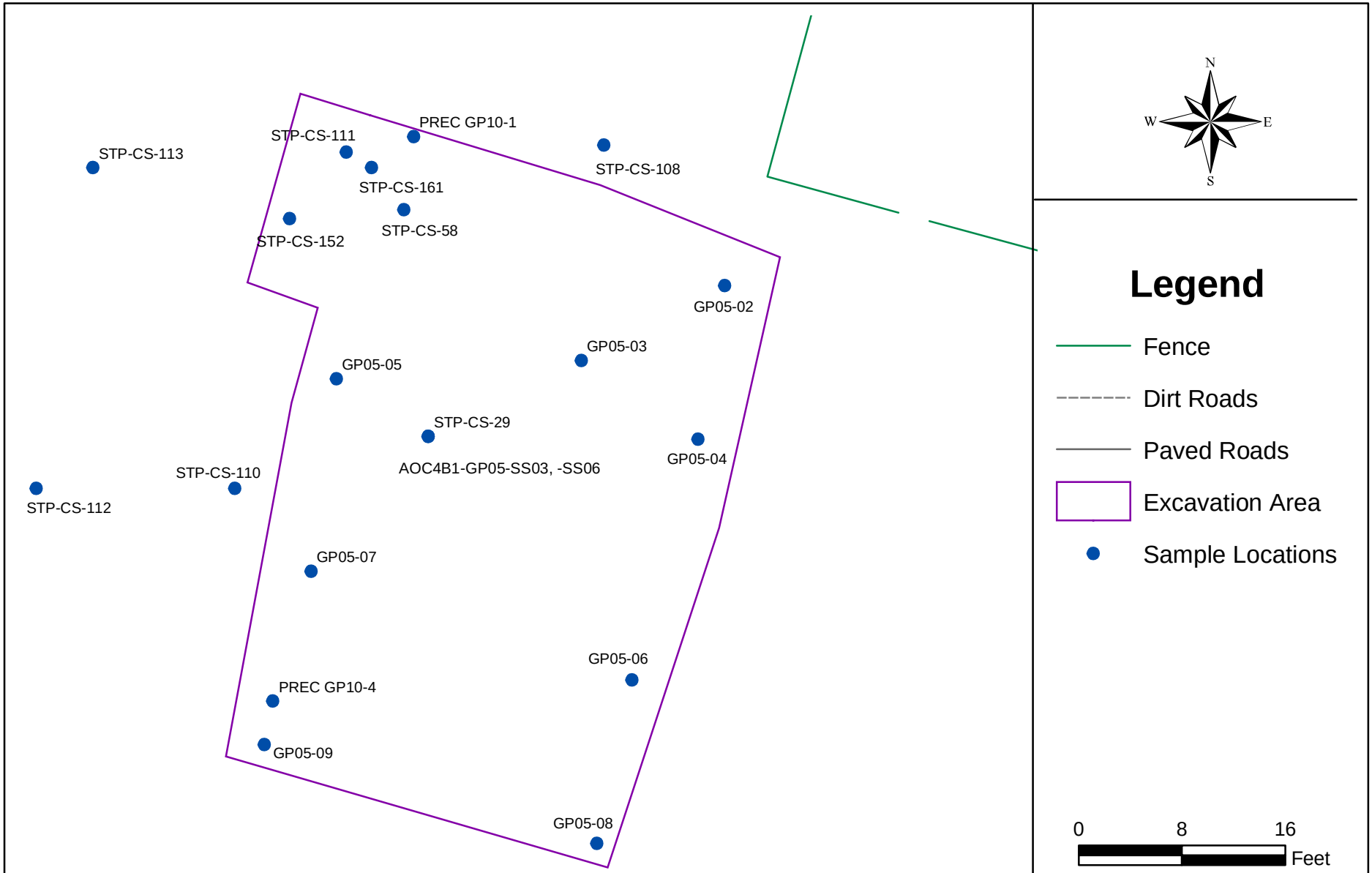
r:/graphics/ou5/stp-cs/aoc4b1-gp05b.mxd



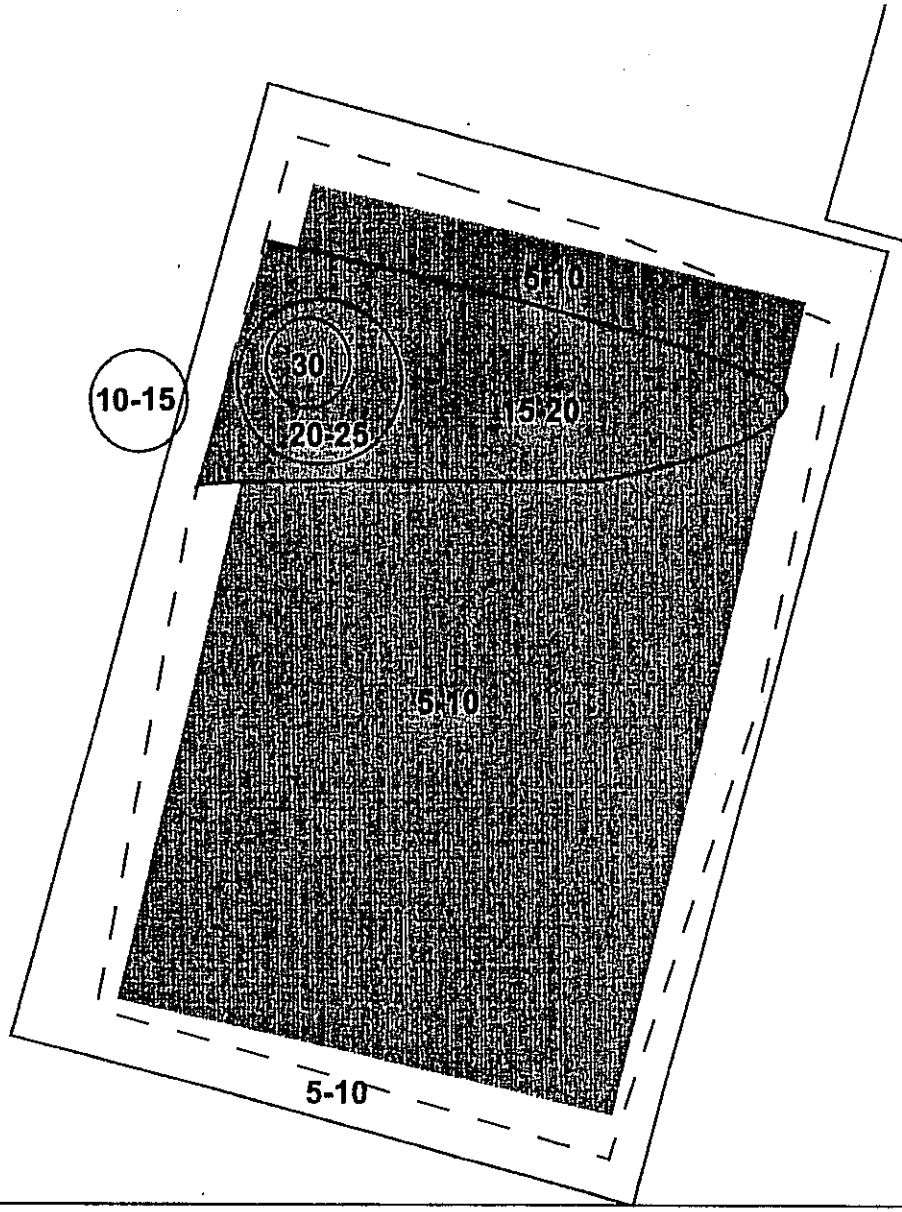
BROOKHAVEN NATIONAL LABORATORY

Environmental Information Management System

Location of Final Confirmatory Samples for Mercury (Hg < 2ppm) AOC4B1-GP05

Figure B

ALR - 10/21/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp05a.mxd
r:/graphics/ou5/stp-cs/aoc4b1-gp05a.mxd



N
W
E
S

Legend

- Fence
- Excavation Area
- Pre-Excavation Boundary

0 8 16 Feet

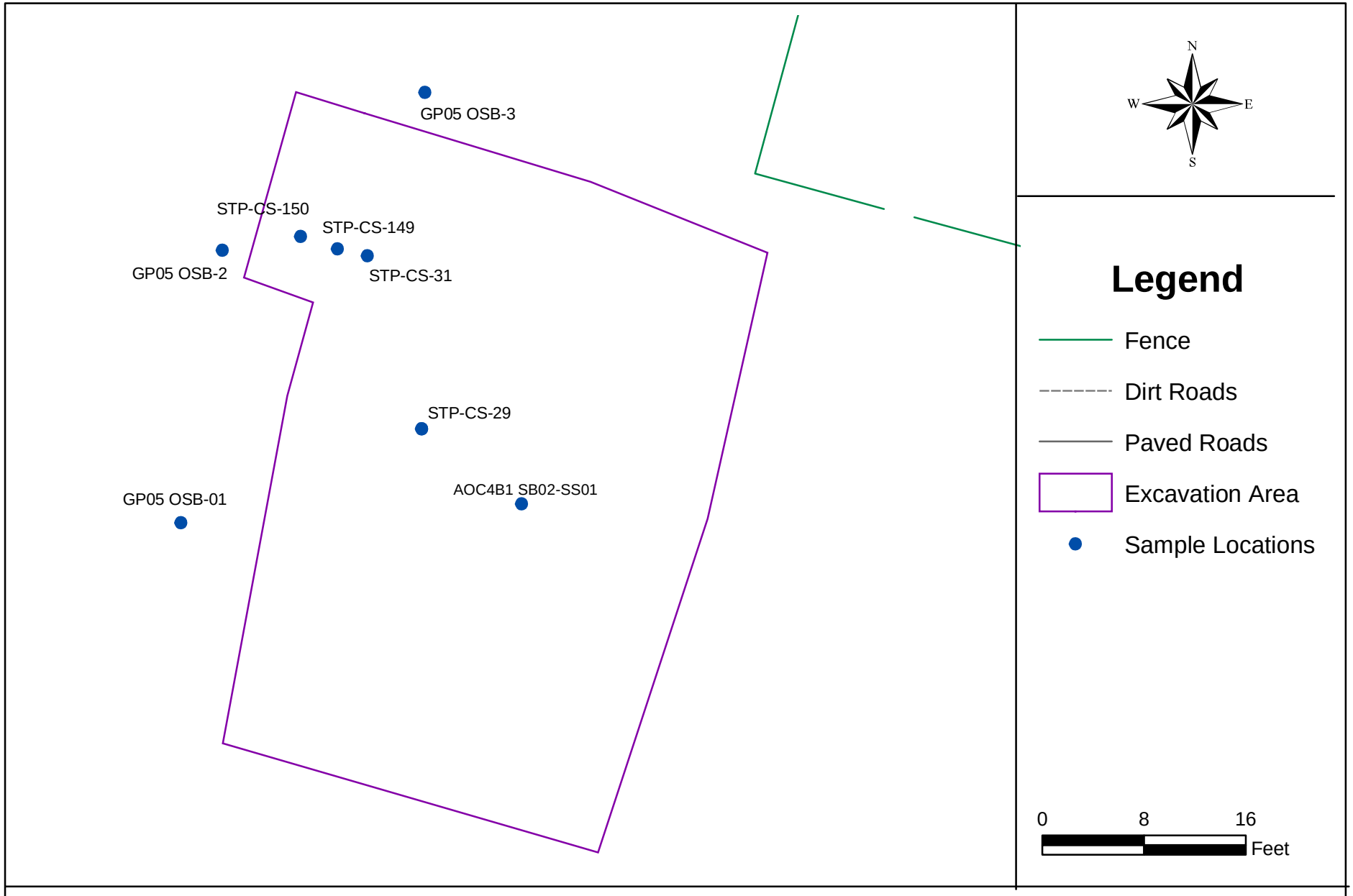
BROOKHAVEN NATIONAL LABORATORY

Environmental Information Management System

Preliminary NaI Walkover Survey (7-31-02)
(Values Expressed as Gross x1000 cpm)
AOC4B1-GP05

Figure C

KMG - 03/20/03
r:/arcmap_projects/ou5/
stp-cs/aoc4b1-gp05a.mxd



BROOKHAVEN NATIONAL LABORATORY

Location of ISOCS Samples Collected for Cesium-137 During Excavation and Confirmation Sampling AOC4B1-GP05

Figure D

Environmental Information Management System

ALR - 10/21/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp05aisocs.mxd
r:/graphics/ou5/stp-cs/aoc4b1-gp05aisocs.mxd

AOC 4B1-GP05 Figure E Final Walkover Survey

☐ ROUTINE ☒ SPECIAL WALKOVER ☐ RWP#: ☐ WP#:

BLDG.#: N/A LOCATION: SEWAGE TREATMENT PLANT DATE/TIME: ~~1-30-03~~ 2-3-03 / 1445

OU2 #HF #72

MODEL	E600	NaI PROBE				
SERIAL#	00739	H001				
Cal Due Date	3-7-03	3-7-03				
Source Check OK (Yes or No)	Y	Y				

DOSE RATES (HIGHEST)		AIRBORNE CONTAMINATION		
		TIME	uCi/cc	%DAC
CONTACT	N/A		N/A	
GENERAL AREA				

LEGEND: O SMEAR SURVEY LOCATION ☐ MASSLINN SURVEY LOCATION

XXX Y / ZZZ — XXX = CONTACT READING; ZZZ = READING @ 30 Cm; Y = RADIATION TYPE

Δ AIR SAMPLE LOCATION

SMEAR SURVEY RESULTS (DPM/100 cm²) ³H B-γ α

- ☐ All Dose Rates are in mR/Hr and taken at waist level unless otherwise noted.
- ☐ All masslinn wipes are <1,000 dpm/LAS
- ☐ Frisked various areas – all were less than 100cpm
- ☐ See Attachment for smear survey results

1.		8.		15.		22.			
2.		9.		16.		23.			
3.		10.	N/A	17.		24.			
4.		11.		18.		25.			
5.		12.		19.		26.			
6.		13.		20.		27.			
7.		14.		21.		28.			

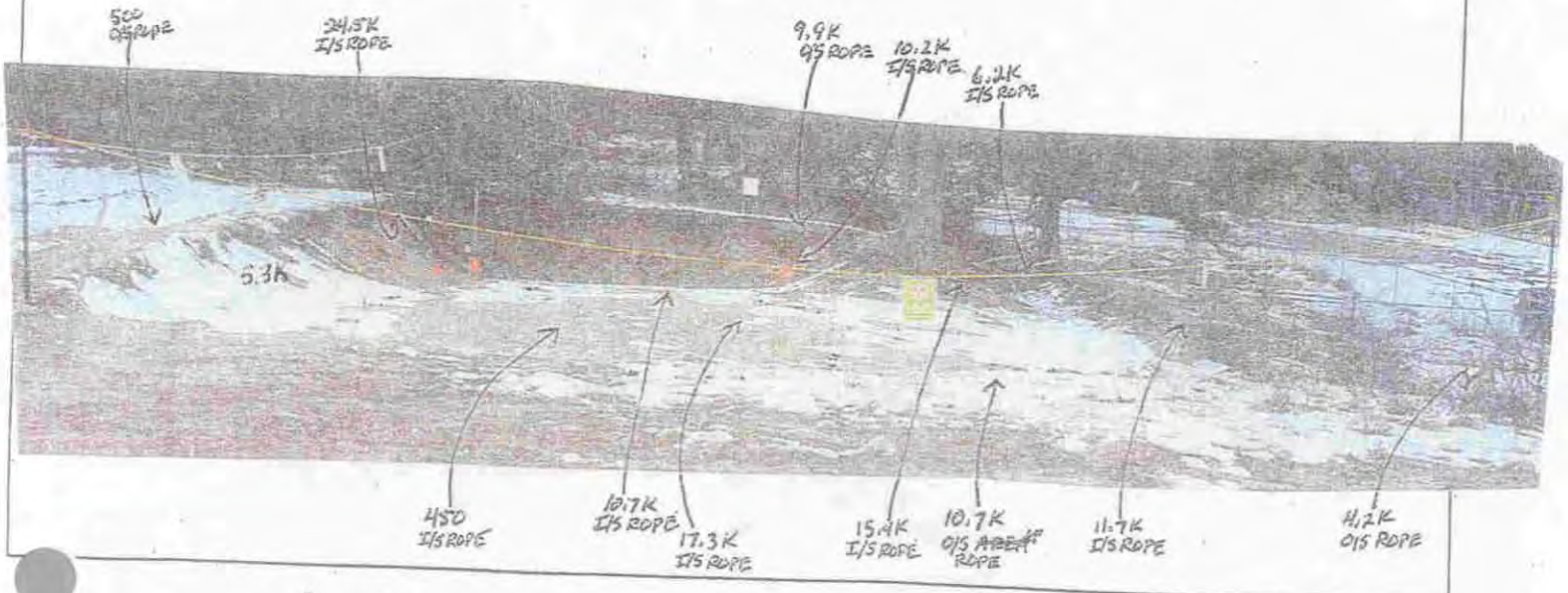
MASSLINN SURVEY RESULTS (DPM/LAS)

1.		8.	
2.		9.	
3.		10.	
4.	N/A	11.	
5.		12.	
6.		13.	
7.		14.	

WALKOVER SURVEY OF SOIL CONTAMINATION AREA AOC4B1-GP05 AT SEWAGE TREATMENT PLANT USING AN E-600 W/NAI PROBE

E600 BKG - 5.63K cpm
MDCR - 1135 cpm

ALL READINGS IN NET COUNTS/MINUTE



SURVEYED BY: Ken Zint 2-8-03 (Signature/date) REVIEWED BY: [signature] 2-10-03 (Signature/date)

Figure E (cont)

BNL RADIOLOGICAL SURVEY FORM

☐ ROUTINE ____

☐ SPECIAL ____

☒ RWP # 02 ERD 27

☐ WP# ____

BLDG.#: N/A LOCATION: SEWAGE TREATMENT PLANT OU II GP-05 DATE/TIME: 2-28-03 / 1045

MODEL	E600	NAI PROBE				
SERIAL#	00739	04001				
Cal Due Date	2-24-04	2-24-04				
Source Check OK (Yes or No)	Y	Y				

DOSE RATES (HIGHEST)	
CONTACT	N/A
GENERAL AREA	

AIRBORNE CONTAMINATION		
TIME	uCi/cc	%DAC
	N/A	

LEGEND: O SMEAR SURVEY LOCATION ☐ MASSLINN SURVEY LOCATION

XXX Y = XXX = CONTACT READING

ZZZ = ZZZ = READING @ 30 Cm

Δ AIR SAMPLE LOCATION

Y = RADIATION TYPE

SMEAR SURVEY RESULTS (DPM/100 cm²)

^3H B-γ α

- ☐ All Dose Rates are in mR/Hr and taken at waist level unless otherwise noted.
- ☐ All masslinn wipes are <1,000 dpm/LAS
- ☐ Frisked various areas – all were less than 100cpm
- ☐ See Attachment for smear survey results

1.		8.		15.		22.	
2.		9.		16.		23.	
3.		10.	N	17.		24.	
4.		11.		18.		25.	
5.		12.		19.	A	26.	
6.		13.		20.		27.	
7.		14.		21.		28.	

MASSLINN SURVEY RESULTS (DPM/LAS)

1.		8.	
2.		9.	
3.	N	10.	
4.		11.	A
5.		12.	
6.		13.	
7.		14.	

WALK OVER SURVEY OF NEW EXCAVATION IN GP-05 USING E600 W/NAI PROBE

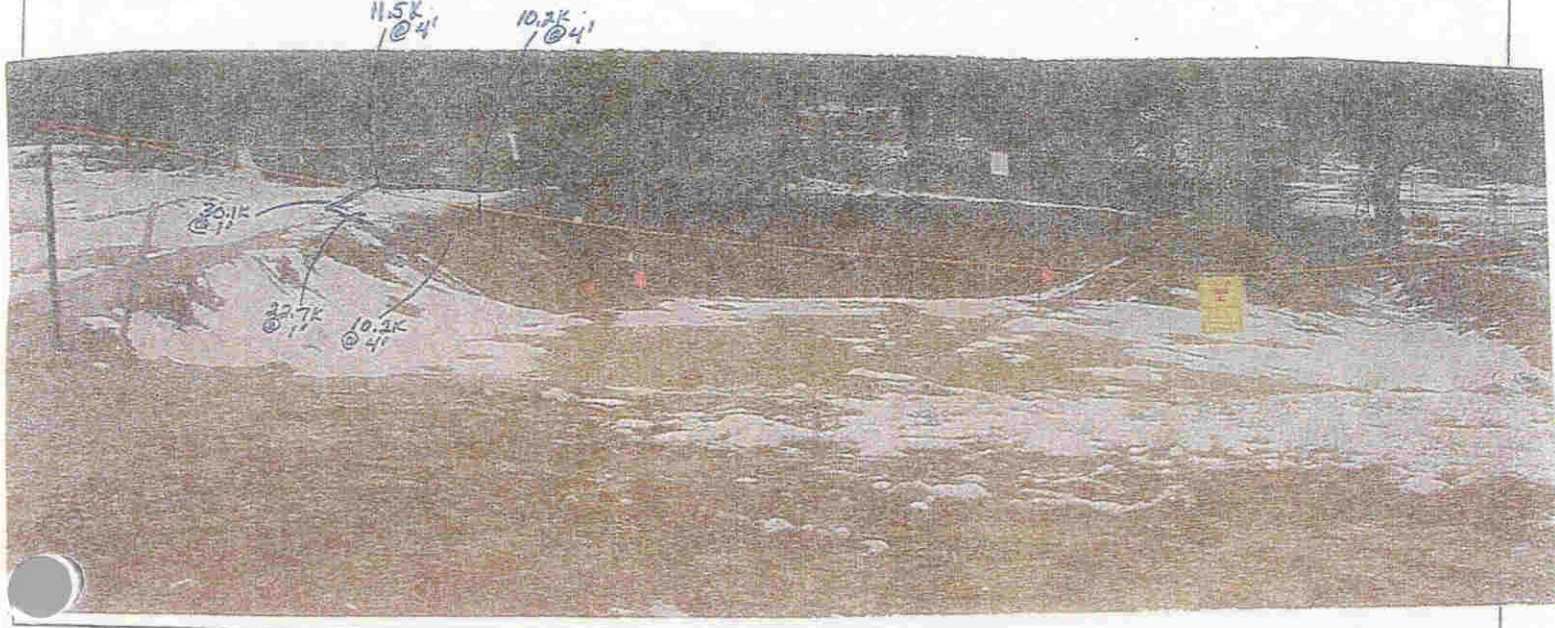
E600 BKG - 5.7Kcpm

MDCR - 1142ncpm

All READINGS IN net counts per minute.

AREA WAS EXCAVATE DUE TO HIGH MERCURY READINGS.

NEWLY EXCAVATED AREA IS INCLUDED IN SOIL CONTAM. AREA



SURVEYED BY: Ken Foot 2-28-03 (Signature/date)

REVIEWED BY: [signature] 2-28-03 (Signature/date)

ANALYTICAL DATA FOR EXCAVATION AREA
AOC 4B1 GP05

Mercury Results > 2 ppm

Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
AOC4B1-GP 10									
AOC4B1-GP05-SS01	2/2/1995	3.50			mg/kg	1-3	NA	J	S
AOC4B1-GP10	9/21/2000	9.33	0.082	**0**	mg/kg	0.5-1	NA		S
PREC GP10-2	6/5/2002	3.04	0.001	0	mg/kg	0.5	NA		S
PREC GP10-3	6/5/2002	2.47	0.001	0	mg/kg	0.5	NA		S
GP05-01	10/9/2002	2.12	0.001	0	mg/kg	0.5	2		S
STP-CS-30	1/22/2003	6.40	0.026	0	mg/kg	0.25	2.5		S
STP-CS-56	1/30/2003	2.68	0.001	0	mg/kg	0.25	3		S
STP-CS-57	1/30/2003	3.19	0.001	0	mg/kg	0.25	3		S
STP-CS-59	1/30/2003	2.65	0.001	0	mg/kg	0.25	3		S
STP-CS-107	2/8/2003	2.82	0.001	0	mg/kg	0.5	0.5		S
STP-CS-107	2/8/2003	3.01	0.001	0	mg/kg	1.5	1.5		S
STP-CS-107	2/8/2003	2.39	0.001	0	mg/kg	2.5	2.5		S
STP-CS-151	3/2/2003	2.55	0.001	0	mg/kg	0.25	3.5		S

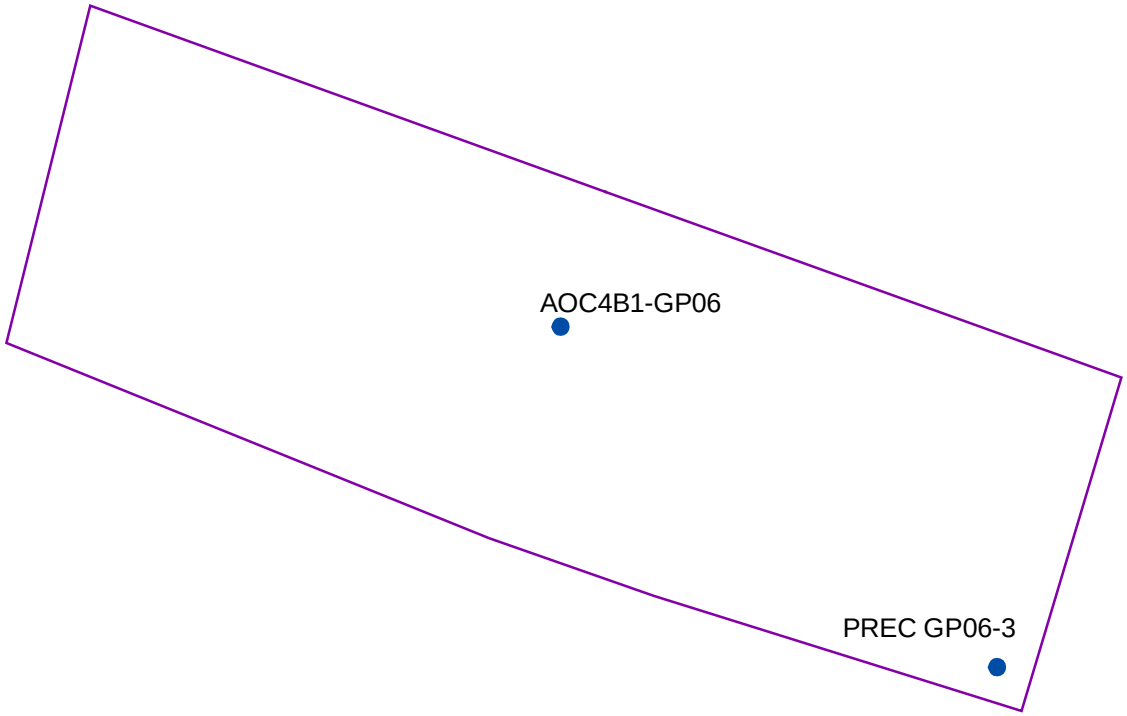
Mercury Results < 2 ppm

Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
AOC4B1-GP05-SS03	2/2/1995	1.50			mg/kg	1-3	NA	J	S
AOC4B1-GP05-SS06	2/2/1995	2.00			mg/kg	4-6	NA	J	S
PREC GP10-1	6/5/2002	0.27	0.001	0	mg/kg	0.5	NA		S
PREC GP10-4	6/5/2002	0.27	0.001	0	mg/kg	0.5	NA		S
GP05-02	10/9/2002	0.64	0.001	0	mg/kg	0.5	2		S
GP05-03	10/9/2002	0.07	0.001	0	mg/kg	0.5	2		S
GP05-04	10/9/2002	0.16	0.001	0	mg/kg	0.5	2		S
GP05-05	10/9/2002	1.45	0.001	0	mg/kg	0.5	2		S
GP05-06	10/9/2002	1.33	0.001	0	mg/kg	0.5	2		S
GP05-07	10/9/2002	0.10	0.001	0	mg/kg	0.5	2		S
GP05-08	10/9/2002	0.08	0.001	0	mg/kg	0.5	2		S
GP05-09	10/9/2002	0.09	0.001	0	mg/kg	0.5	2		S
STP-CS-29	1/22/2003	0.49	0.003	0	mg/kg	0.25	2.5		S
STP-CS-58	1/30/2003	0.36	0.001	0	mg/kg	0.25	3		S
STP-CS-108	2/8/2003	1.60	0.001	0	mg/kg	0.5	0.5		S
STP-CS-108	2/8/2003	1.72	0.001	0	mg/kg	1.5	1.5		S
STP-CS-108	2/8/2003	1.83	0.001	0	mg/kg	2.5	2.5		S
STP-CS-110	2/11/2003	1.66	0.001	0	mg/kg	0.5	0.5		S
STP-CS-110	2/11/2003	1.89	0.001	0	mg/kg	1.5	1.5		S
STP-CS-110	2/11/2003	0.23	0.001	0	mg/kg	2.5	2.5		S
STP-CS-111	2/11/2003	0.69	0.001	0	mg/kg	0.5	0.5		S
STP-CS-111	2/11/2003	0.67	0.001	0	mg/kg	1.5	1.5		S
STP-CS-111	2/11/2003	0.21	0.001	0	mg/kg	2.5	2.5		S
STP-CS-112	2/11/2003	1.27	0.001	0	mg/kg	0.25	0.5		S
STP-CS-113	2/11/2003	0.91	0.001	0	mg/kg	0.25	0.5		S
STP-CS-152	3/2/2003	1.11	0.001	0	mg/kg	0.25	3.5		S
STP-CS-161	3/4/2003	0.34	0.001	0	mg/kg	0.25	4.5		S

ANALYTICAL DATA FOR EXCAVATION AREA
AOC 4B1 GP05

Cesium-137

Sample ID	Sample Date	Value	MDA	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Lab Qual	Method
AOC4B1-SB02-SS01	1/31/1995	45.40			pCi/g	0.5	NA		Gamma
AOC4B1 SB02	3/29/1999	47.60	0.057	4.91	pCi/g	0.2	NA		Gamma
AOC4B1 SB02	3/29/1999	38.94	0.097	5.002	pCi/g	0.5	NA		Gamma
AOC4B1-GP10	9/21/2000	54.40	0.059	0.422	pCi/g	0.5-1	NA		S
PREC GP10-1	6/5/2002	2.47	0.001	0	pCi/g	0.5	NA		Gamma
PREC GP10-2	6/5/2002	2.47	0.001	0	pCi/g	0.5	NA		Gamma
PREC GP10-3	6/5/2002	2.47	0.001	0	pCi/g	0.5	NA		Gamma
PREC GP10-4	6/5/2002	2.47	0.001	0	pCi/g	0.5	NA		Gamma
GP05 OSB1-1	11/15/2002	4.30	0.2	0.6	pCi/g	0-1	NA		ISOCS
GP05 OSB1-2	11/15/2002	4.70	0.2	0.6	pCi/g	1-2	NA		ISOCS
GP05 OSB1-3	11/15/2002	5.60	0.2	0.6	pCi/g	2-3	NA		ISOCS
GP05 OSB1-4	11/15/2002	5.90	0.2	0.7	pCi/g	3-4	NA		ISOCS
GP05 OSB2-1	11/15/2002	3.20	0.2	0.4	pCi/g	0-1	NA		ISOCS
GP05 OSB2-2	11/15/2002	2.30	0.2	0.4	pCi/g	1-2	NA		ISOCS
GP05 OSB2-3	11/15/2002	2.80	0.2	0.4	pCi/g	2-3	NA		ISOCS
GP05 OSB2-4	11/15/2002	1.30	0.2	0.3	pCi/g	3-4	NA		ISOCS
GP05 OSB3-1	11/15/2002	7.80	0.2	0.8	pCi/g	0-1	NA		ISOCS
GP05 OSB3-2	11/15/2002	9.90	0.2	1.0	pCi/g	1-2	NA		ISOCS
GP05 OSB3-3	11/15/2002	4.70	0.2	0.6	pCi/g	2-3	NA		ISOCS
GP05 OSB3-4	11/15/2002	2.00	0.2	0.3	pCi/g	3-4	NA		ISOCS
STP-CS-29	1/22/2003	3.10	0.3	0.5	pCi/g	0.25	2.5		ISOCS
STP-CS-31	1/22/2003	11.10	0.4	1.1	pCi/g	0.25	2.5		ISOCS
STP CS-149	3/3/2003	16.60	0.4	1.4	pCi/g	0.25	3.5		ISOCS
STP CS-150	3/3/2003	21.30	0.5	1.7	pCi/g	0.25	3.5		ISOCS



N
W
E
S

Legend

- Fence
- Dirt Roads
- Paved Roads
- Excavation Area
- Sample Locations

0 5 10
Feet

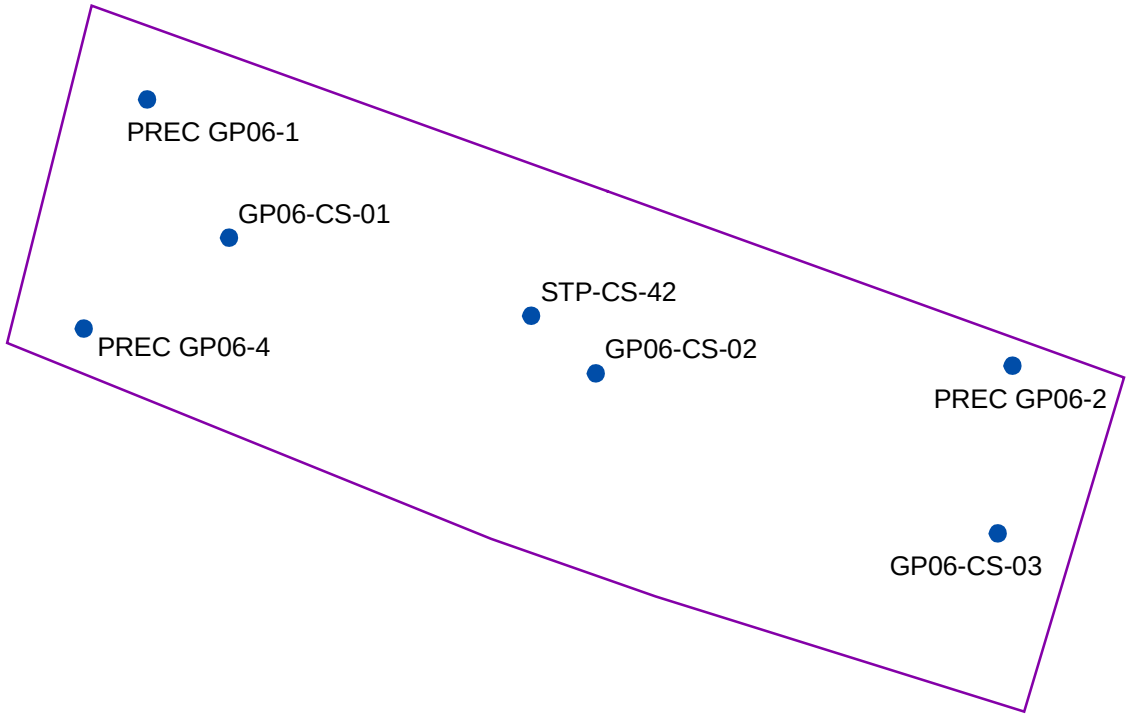
BROOKHAVEN NATIONAL LABORATORY

Location of Mercury Samples (Hg > 2ppm) Prior to Completion of Excavation AOC4B1-GP06

Figure A

Environmental Information Management System

ALR - 10/21/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp06b.mxd
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp06b.mxd



N
W
E
S

Legend

- Sample Location
- Fence
- Dirt Roads
- Paved Roads
- Excavation Area

0 5 10
Feet

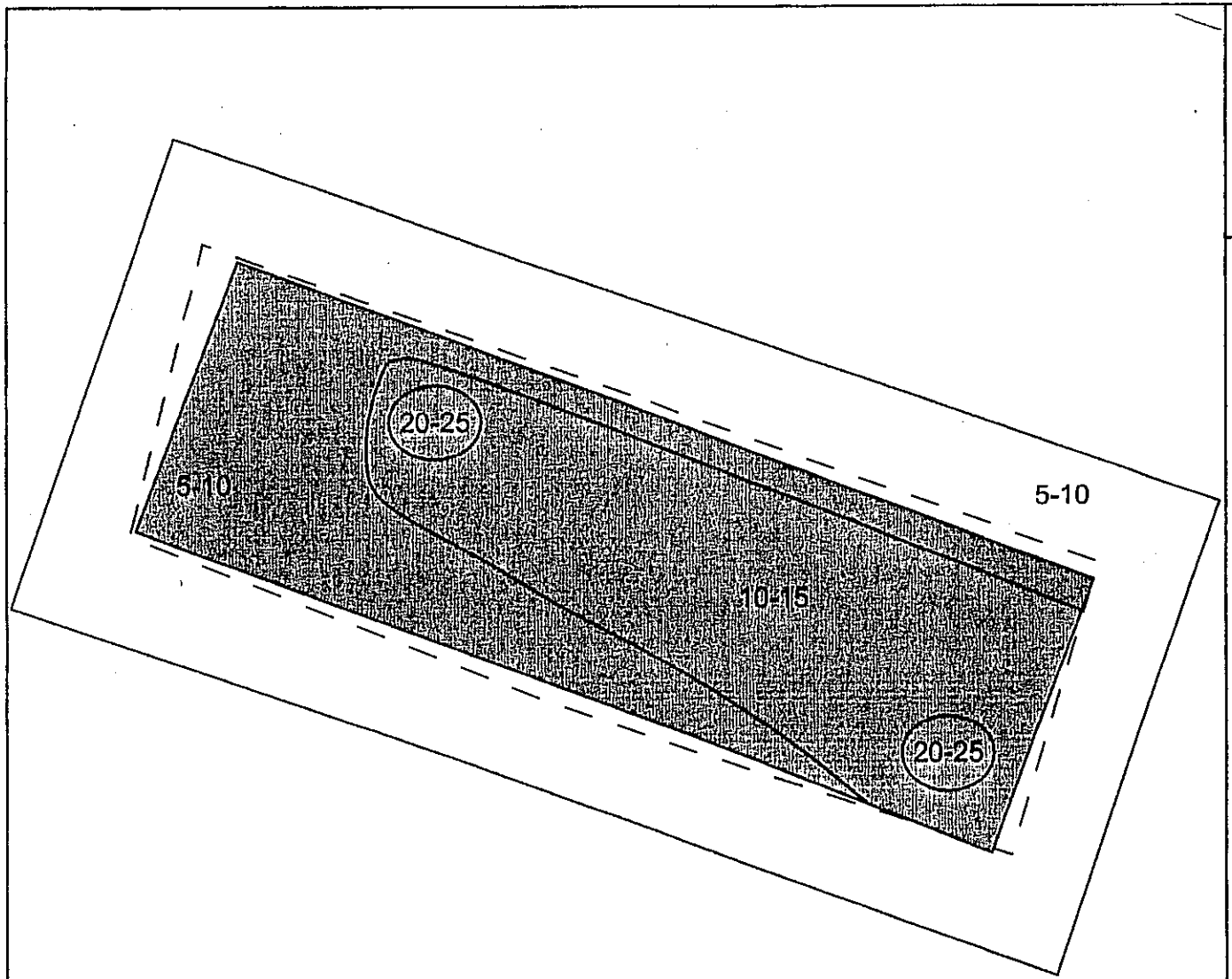
BROOKHAVEN NATIONAL LABORATORY

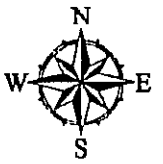
Environmental Information Management System

Location of Final Confirmatory Samples for Mercury (Hg < 2ppm) AOC4B1-GP06

Figure # 12

JLH - 02/24/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp06.mxd
r:/graphics/ou5/stp-cs/aoc4b1-gp06.mxd





Legend

Excavation Area

Pre-Excavation Boundary

0 5 10 Feet

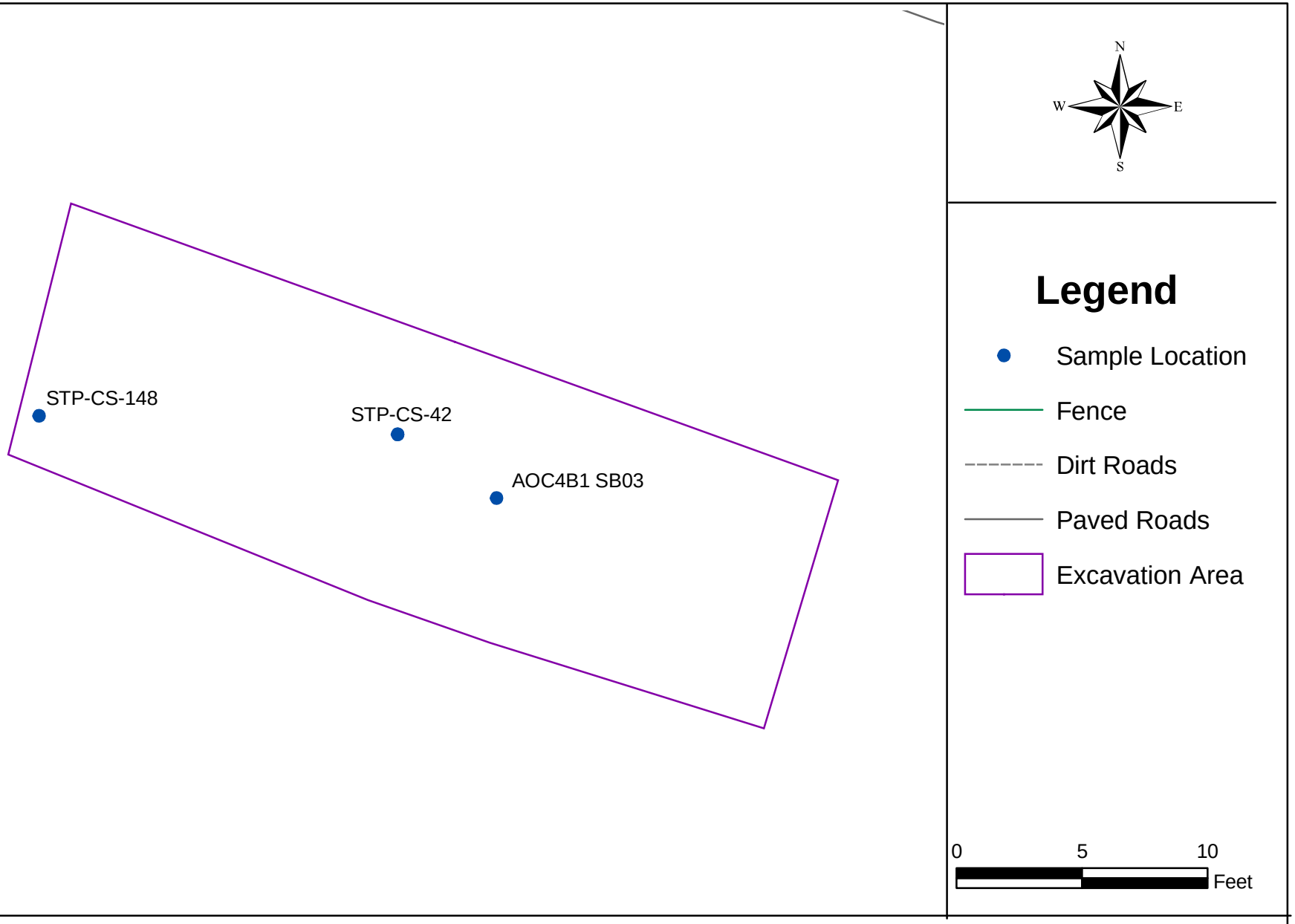
BROOKHAVEN NATIONAL LABORATORY

Environmental Information Management System

Preliminary Nal Walkover Survey (7-31-02) (Values Expressed as Gross x1000 cpm) AOC4B1-GP06

Figure C

KMG - 03/20/03
r:/arcmap_projects/ou5/
stp-cs/aoc4b1-gp06.mxd



BROOKHAVEN NATIONAL LABORATORY

Location of ISOCS Samples Collected for Cesium-137 During Excavation and Confirmation Sampling AOC4B1-GP06

Figure D

Environmental Information Management System

ALR - 10/21/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp06isocs.mxd
r:/graphics/ou5/stp-cs/aoc4b1-gp06isocs.mxd

AOC 4B1-GP06 Figure E Final Walkover Survey

☐ ROUTINE _____
☒ SPECIAL WALKOVER
☐ RWP # _____
☐ WP# _____

BLDG.#: N/A LOCATION: SEWAGE TREATMENT PLANT DATE/TIME: 1-30-03/0900
OU IV SS #13

MODEL	E600	NAI PROBE				
SERIAL#	00739	4001				
Cal Due Date	3-7-03	3-7-03				
Source Check OK (Yes or No)	Y	Y				

DOSE RATES (HIGHEST)		AIRBORNE CONTAMINATION		
		TIME	uCi/cc	%DAC
CONTACT	N/A		N/A	
GENERAL AREA				

LEGEND: O SMEAR SURVEY LOCATION ☐ MASSLINN SURVEY LOCATION
XXX Y = XXX = CONTACT READING; ZZZ = READING @ 30 Cm; Y = RADIATION TYPE
Δ AIR SAMPLE LOCATION

SMEAR SURVEY RESULTS (DPM/100 cm²)
^{3}H B-γ α

- ☐ All Dose Rates are in mR/Hr and taken at waist level unless otherwise noted.
- ☐ All masslinn wipes are <1,000 dpm/LAS
- ☐ Frisked various areas – all were less than 100ccpm
- ☐ See Attachment for smear survey results

1.		8.		15.		22	
2.		9.		16.		23.	
3.		10.	N/A	17.		24.	
4.		11.		18.		25.	
5.		12.		19.	A	26.	
6.		13.		20.		27.	
7.		14.		21.		28.	

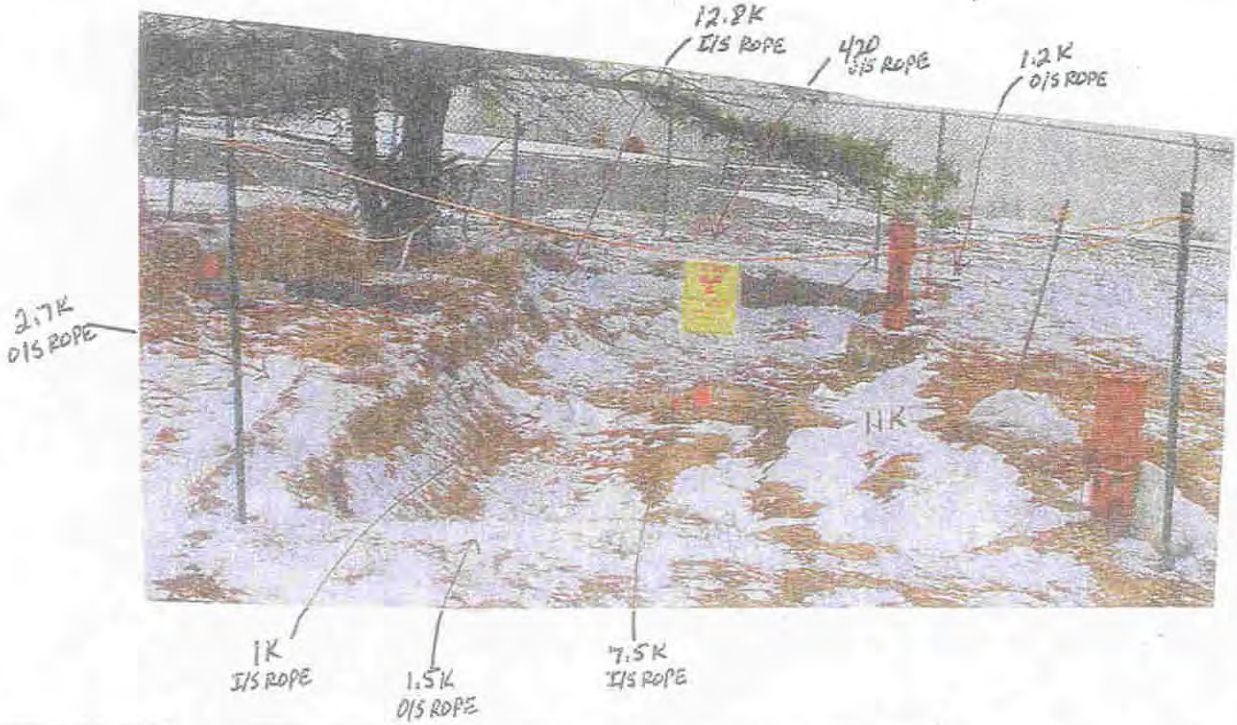
MASSLINN SURVEY RESULTS (DPM/LAS)

1.		8.	
2.		9.	
3.		10.	
4.	N/A	11.	
5.		12.	A
6.		13.	
7.		14.	

WALKOVER SURVEY OF SOIL CONTAMINATION AREA AOC 4B1-GP06 AT SEWAGE TREATMENT PLANT USING AN E600 & NaI PROBE.

E600 BKG - 5.79K cpm
MDCR - 1149 ncpm

All READINGS ARE IN NET COUNTS PER MINUTE.



SURVEYED BY: Kenneth K. 2-8-03 REVIEWED BY: 2-10-03
Signature/date Signature/date

ANALYTICAL DATA FOR EXCAVATION AREA
AOC 4B1 GP06

Mercury Results > 2 ppm

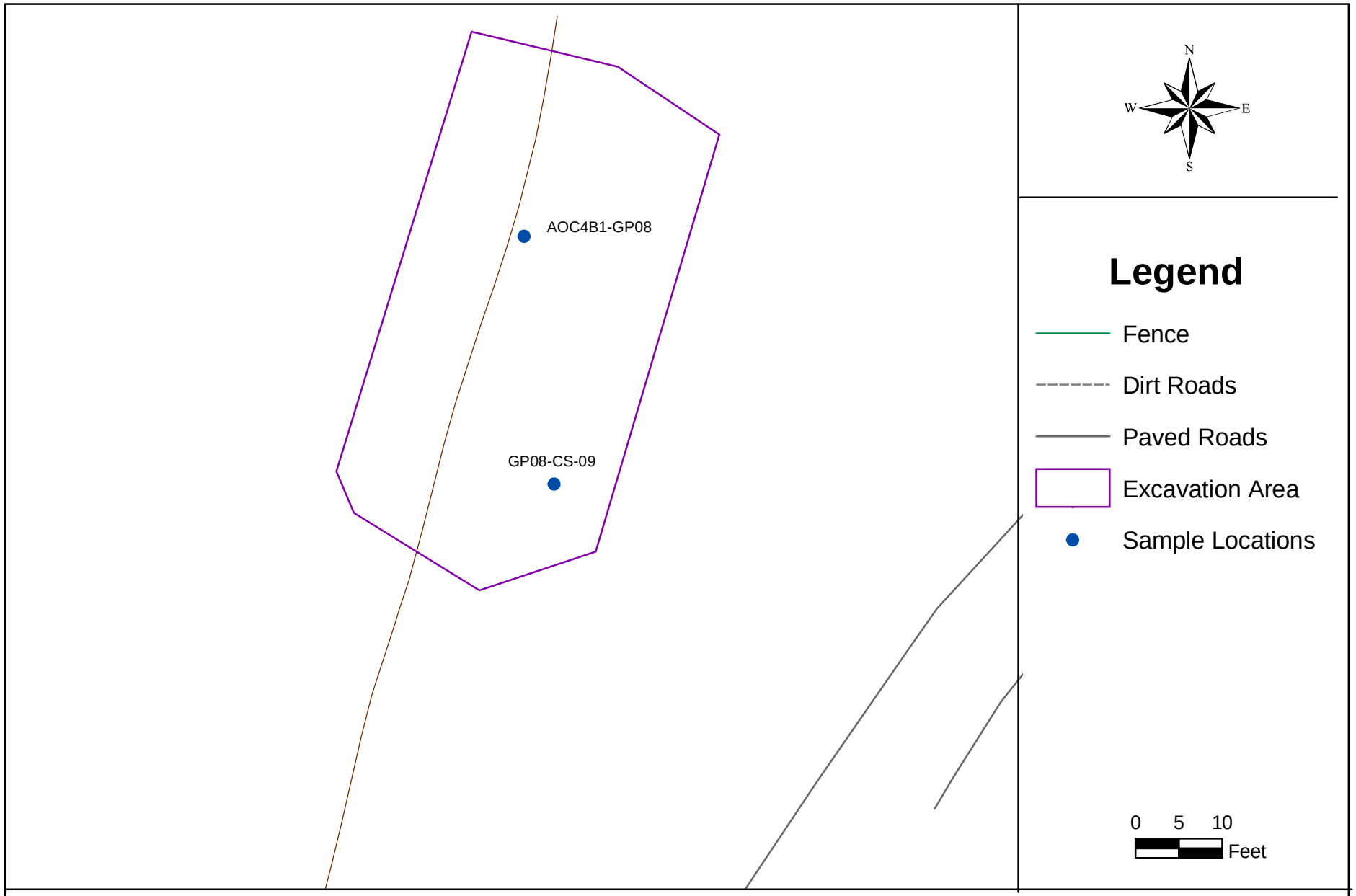
Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
AOC4B1-GP06	2/3/1995	8.70		0	mg/kg	0.5	NA	J	S
PREC GP06-3	6/5/2002	5.08	0.001	0	mg/kg	0.25	NA		S

Mercury Results < 2 ppm

Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
PREC GP06-1	6/5/2002	0.44	0.001	0	mg/kg	0.25	NA		S
PREC GP06-2	6/5/2002	0.26	0.001	0	mg/kg	0.25	NA		S
PREC GP06-4	6/5/2002	0.97	0.001	0	mg/kg	0.25	NA		S
GP06-CS-01	10/9/2002	0.64	0.001	0	mg/kg	0.25	1.5		S
GP06-CS-02	10/9/2002	0.57	0.001	0	mg/kg	0.25	1.5		S
GP06-CS-03	10/9/2002	0.06	0.001	0	mg/kg	0.25	1.5		S
STP-CS-42	1/22/2003	0.75	0.013	0	mg/kg	0.25	1.5	B	S

Cesium-137

Sample ID	Sample Date	Value	MDA	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Method
AOC4B1 GP06(SB03)	1/31/1995	24.30			pCi/g	0.25	NA		Gamma
STP-CS-42	1/22/2003	0.80	0.200	0.2	pCi/g	0.25	1.5		ISOCS
STP CS-148	2/27/2003	12.30	0.400	1.1	pCi/g	0.25	1.5		ISOCS



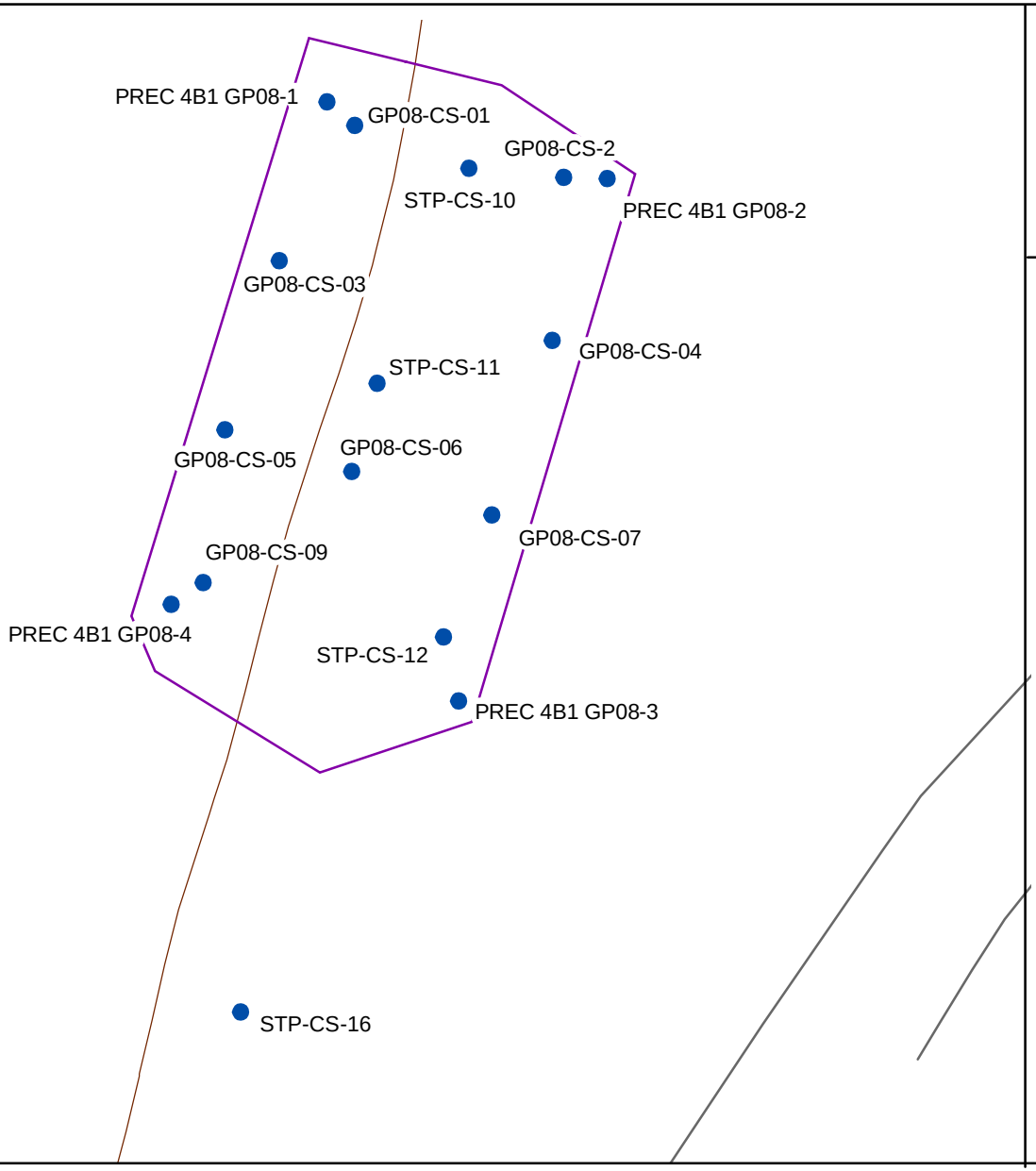
BROOKHAVEN NATIONAL LABORATORY

Environmental Information Management System

Location of Elevated Mercury Samples (Hg > 2ppm) Prior to Completion of Excavation AOC4B1-GP08

Figure A

ALR - 10/21/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp08b.mxd
r:/graphics/ou5/stp-cs/aoc4b1-gp08b.mxd



N
W
E
S

Legend

- Fence
- Dirt Roads
- Paved Roads
- Excavation Area
- Sample Locations

0 5 10
Feet

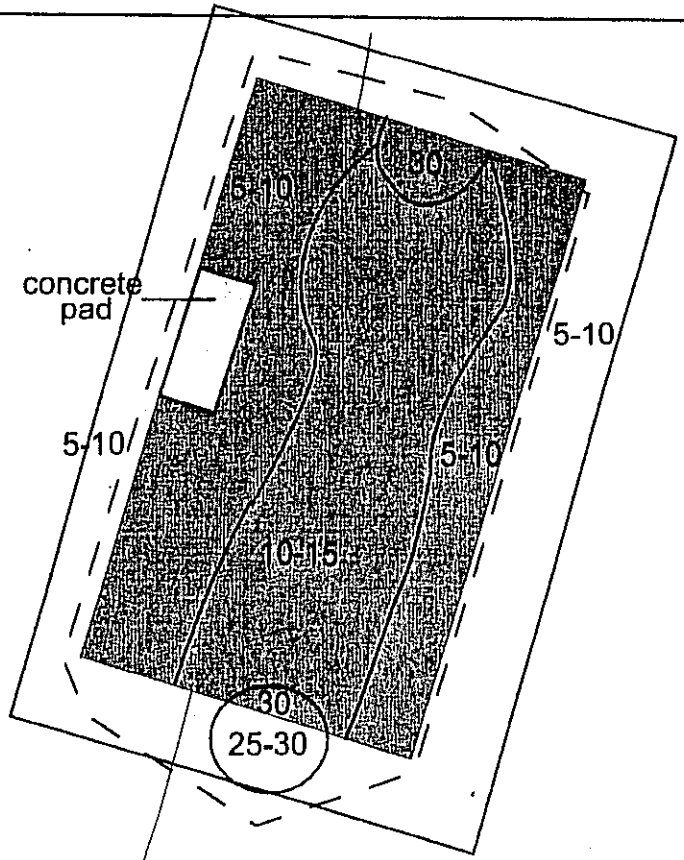
BROOKHAVEN NATIONAL LABORATORY

Environmental Information Management System

Location of Final Confirmatory Samples for Mercury (Hg < 2ppm) AOC4B1-GP08

Figure # 13

JLH - 02/24/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp08.mxd
r:/graphics/ou5/stp-cs/aoc4b1-gp08.mxd



N
W
E
S

Legend

- Dirt Roads
- Excavation Area
- Pre-Excavation Boundary

0 5 10
Feet

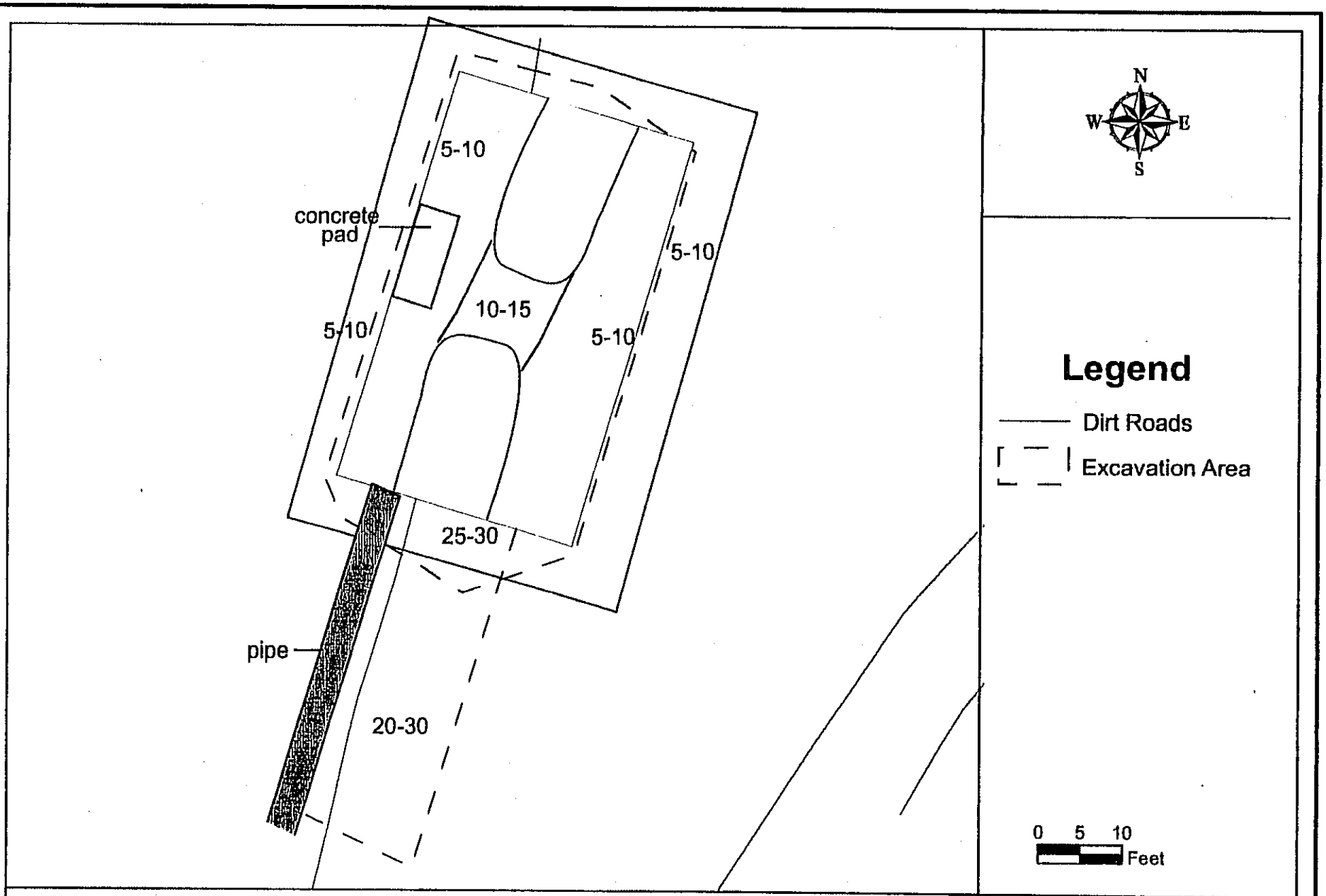
BROOKHAVEN NATIONAL LABORATORY

Preliminary Nal Walkover Survey (7-31-02) (Values Expressed as Gross x1000 cpm) AOC4B1-GP08

Figure C

Environmental Information Management System

KMG - 03/20/03
r:/arcmap_projects/ou5/slp-cs/aoc4b1-gp08.mxd



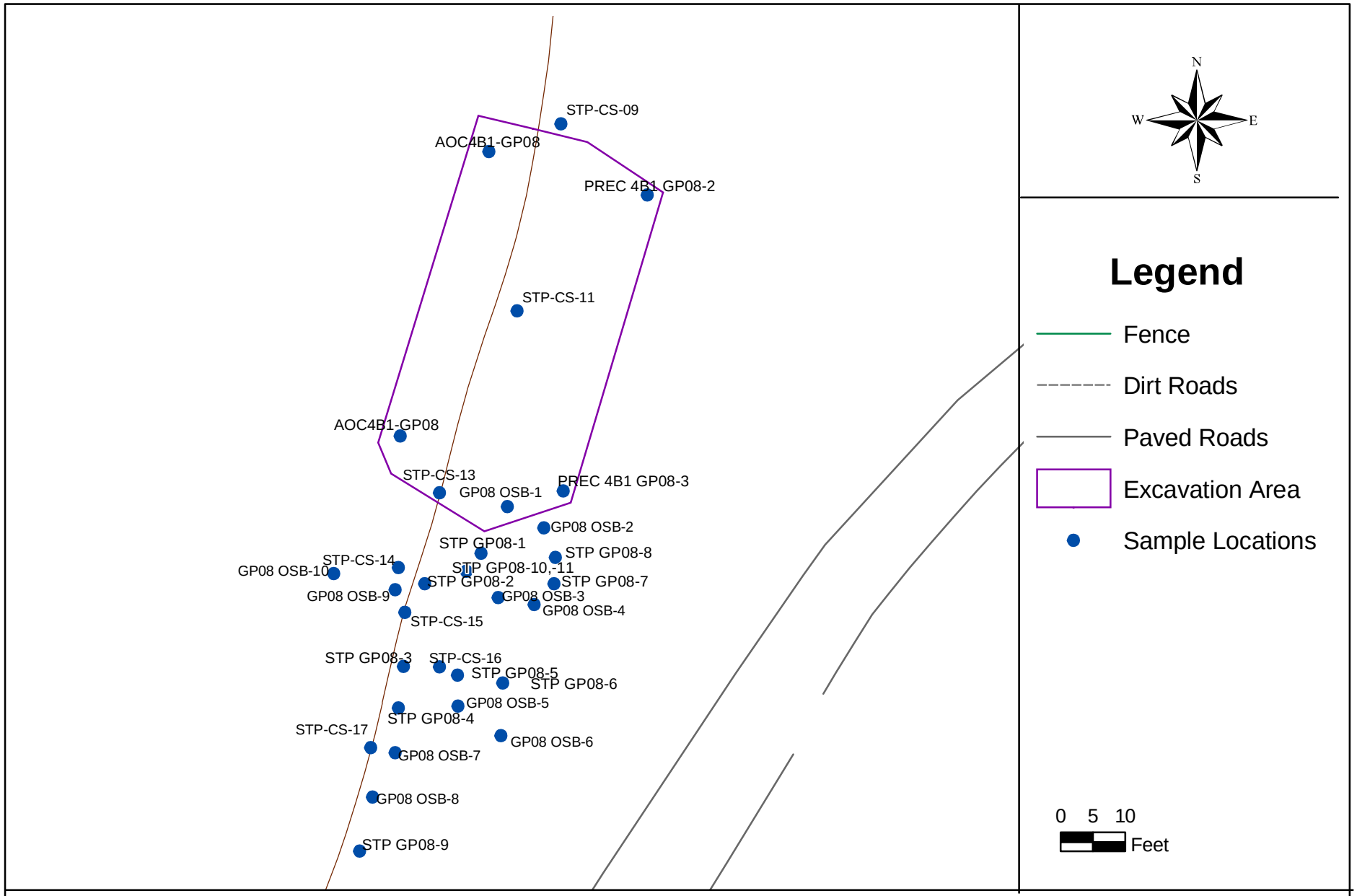
BROOKHAVEN NATIONAL LABORATORY

Environmental Information Management System

Nal Walkover Survey During Excavation (8-28-02)
(Values Expressed as Gross x1000 cpm)
AOC4B1-GP08

Figure D

KMG - 03/20/03
r:/arcmap_projects/ou5/
sip-cs/aoc4b1-gp08.mxd



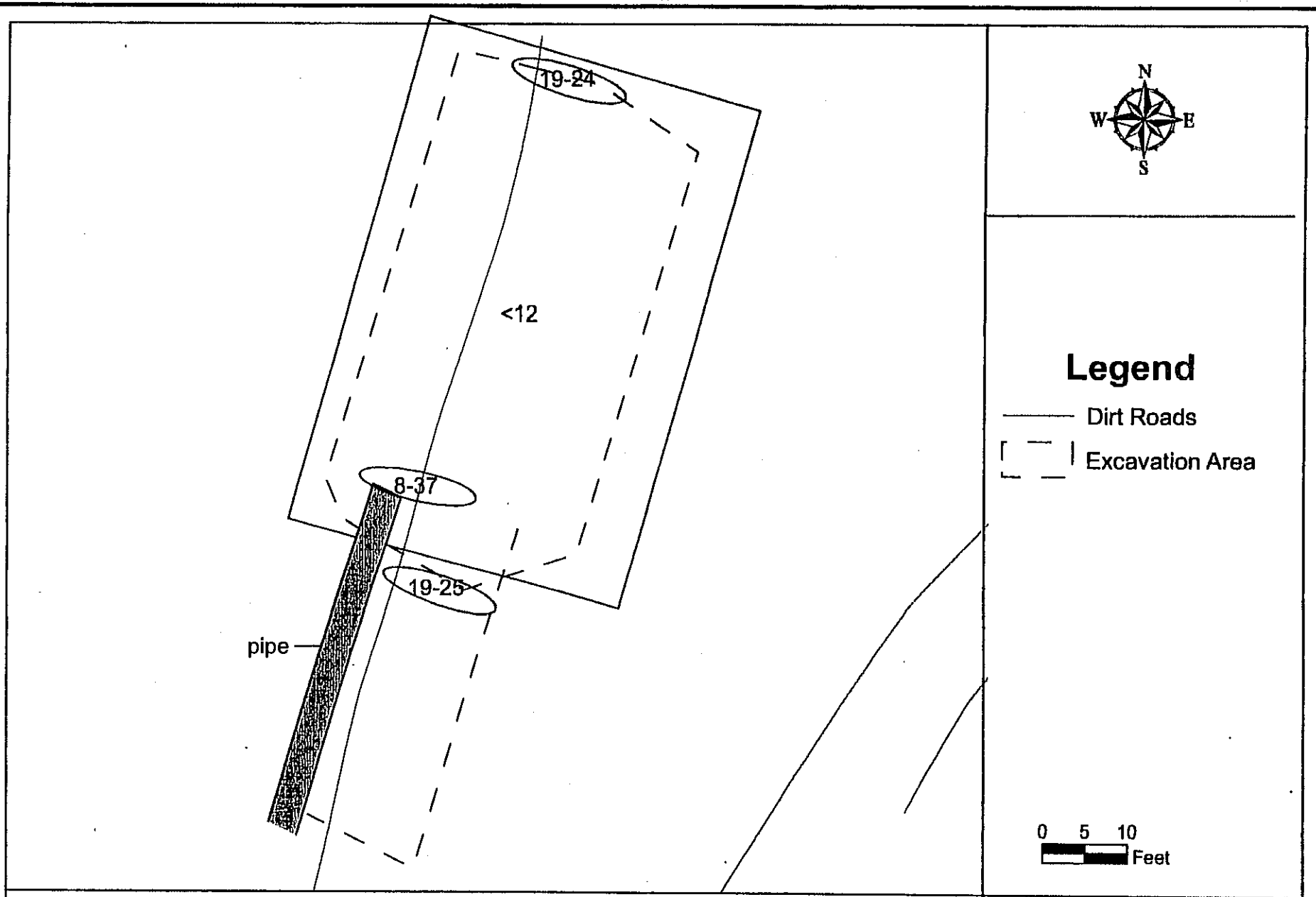
BROOKHAVEN NATIONAL LABORATORY

Location of ISOCS Samples Collected for Cesium-137 During Excavation and Confirmation Sampling AOC4B1-GP08

Figure E

Environmental Information Management System

ALR - 10/22/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp08isocs.mxd
r:/graphics/ou5/stp-cs/aoc4b1-gp08isocs.mxd



BROOKHAVEN NATIONAL LABORATORY

Nal Walkover Survey Post Excavation (12-17-02)
(Values Expressed as Gross x1000 cpm)
AOC4B1-GP08

Environmental Information Management System

Figure F

KMG - 03/20/03
r:/arcmap_projects/ou5/
stp-cs/aoc4b1-gp08.mxd

AOC 4B1-GP08 Figure G Final Walkover Survey

☐ ROUTINE ☒ SPECIAL WALKOVER ☐ RWP# ☐ WP#

BLDG.#: N/A LOCATION: SEWAGE TREATMENT PLANT OUT #5 DATE/TIME: 1-30-03/ 1545

MODEL	E600	NaI PROBE				
SERIAL#	00739	4001		N		
Cal Due Date	3-7-03	3-7-03				
Source Check OK (Yes or No)	Y	Y			A	

DOSE RATES (HIGHEST)		AIRBORNE CONTAMINATION		
CONTACT	N	TIME	uCi/cc	%DAC
GENERAL AREA	A		N	
			A	

LEGEND: O SMEAR SURVEY LOCATION ☐ MASSLINN SURVEY LOCATION

XXX Y = CONTACT READING

ZZZ = READING @ 30 Cm

Δ AIR SAMPLE LOCATION

Y = RADIATION TYPE

SMEAR SURVEY RESULTS (DPM/100 cm²)

³H B-γ α

☐ All Dose Rates are in mR/Hr and taken at waist level unless otherwise noted.
☐ All masslinn wipes are <1,000 dpm/LAS
☐ Frisked various areas – all were less than 100cpm
☐ See Attachment for smear survey results

MASSLINN SURVEY RESULTS (DPM/LAS)

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. N 11. A 12. 13. 14.

WALKOVER SURVEY OF SOIL CONTAMINATION AREA AOC4B1-GP08 AT SEWAGE TREATMENT PLANT USING E600 W/NaI PROBE

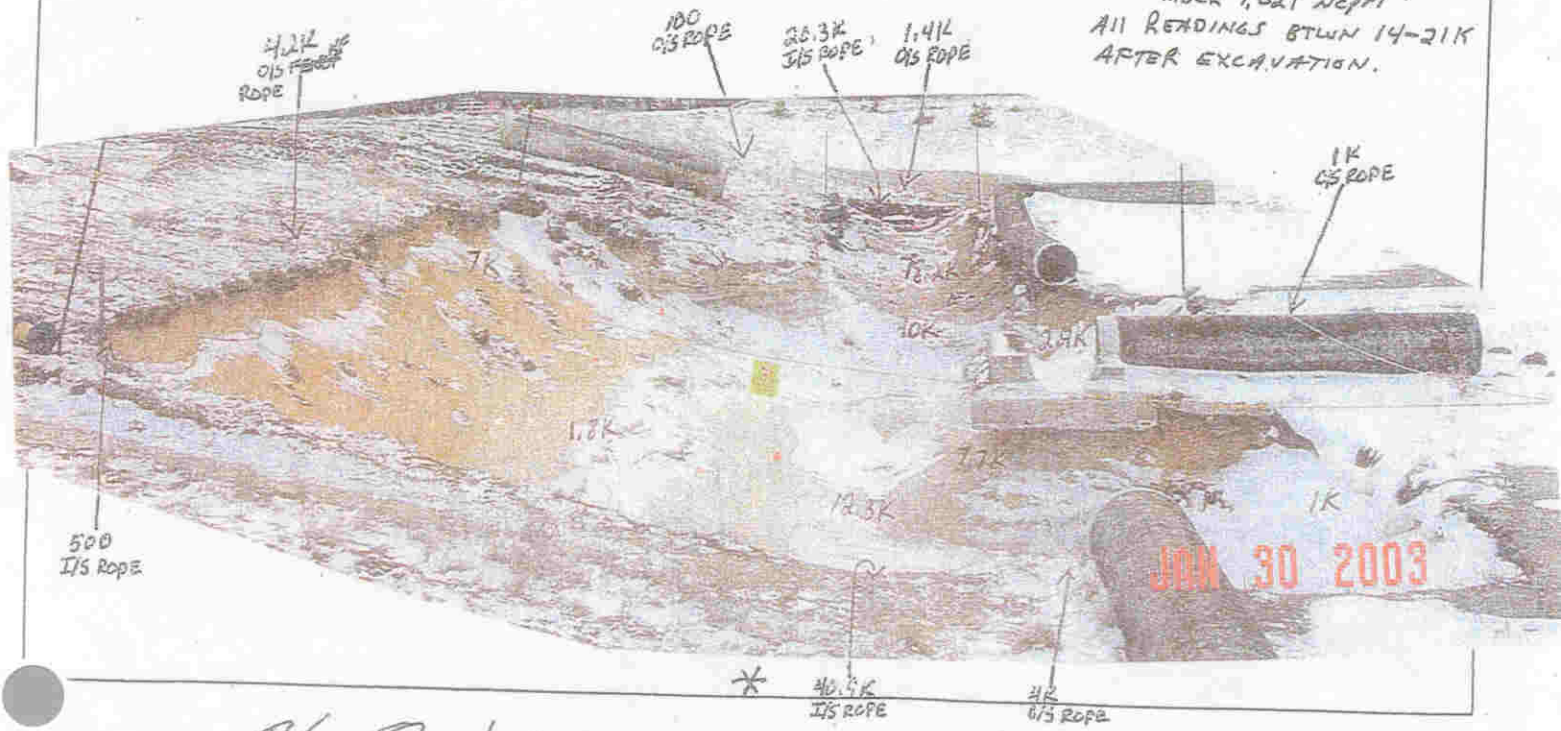
E600 BKG - 5.5Kcpm
MDCR - 1121ncpm

ALL READINGS IN NET COUNTS/MINUTE

AREA WITH ELEVATED READINGS (40.9K) WILL BE EXCAVATED AT A LATER DATE.

* AREA EXCAVATED 2.5.03 SURVEY'D WITH E600 W/NaI PROBE BKGD 1.2 Kcpm MDCR 1,021 ncpm

ALL READINGS BTWN 14-21K AFTER EXCAVATION.



SURVEYED BY: Ken Ford 2-8-03 Signature/date REVIEWED BY: [signature] 2-10-03 Signature/date

Form FS-1000.1 * R. Wilkey 2-8-03 ES&H-1000, Rev 3, attch. 8.2,

File Code: HP3120

ANALYTICAL DATA FOR EXCAVATION AREA

AOC 4B1 GP08

Mercury Results > 2 ppm

Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
4B1-GP08 SS01	2/3/1995	15.100		0.0	mg/kg	0.5	NA	J	S
4B1-GP08 SS03	2/3/1995	7.100		0.0	mg/kg	1.0	NA		S
4B1-GP08	9/21/2000	19.100	0.215	0.0	mg/kg	0.8	NA		S
4B1-GP08	7/17/2002	4.290		0.0	mg/kg	2.5	NA		S
4B1-GP08	7/17/2002	13.700	0.003	0.0	mg/kg	0.5	NA		S
GP08-CS-08	10/9/2002	3.470	0.003	0.0	mg/kg	0.25	2		S

Mercury Results < 2 ppm

Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
4B1-GP08 SS06	2/3/1995	0.270		0.0	mg/kg	4.0	NA		S
PREC 4B1 GP08-1	6/5/2002	0.875		0.0	mg/kg	0.5	NA		S
PREC 4B1 GP08-2	6/5/2002	0.977		0.0	mg/kg	0.5	NA		S
PREC 4B1 GP08-3	6/5/2002	0.462		0.0	mg/kg	0.5	NA		S
PREC 4B1 GP08-4	6/5/2002	0.065		0.0	mg/kg	0.5	NA		S
4B1-GP08	7/17/2002	0.192	0.003	0.0	mg/kg	5.5	NA		S
4B1-GP08	7/17/2002	0.003	0.003	0.0	mg/kg	11	NA		S
GP08-CS-01	10/9/2002	0.110		0.0	mg/kg	0.25	2		S
GP08-CS-02	10/9/2002	0.060		0.0	mg/kg	0.25	2		S
GP08-CS-03	10/9/2002	0.010		0.0	mg/kg	0.25	2		S
GP08-CS-04	10/9/2002	0.760		0.0	mg/kg	0.25	2		S
GP08-CS-05	10/9/2002	0.030		0.0	mg/kg	0.25	2		S
GP08-CS-06	10/9/2002	0.030		0.0	mg/kg	0.25	2		S
GP08-CS-07	10/9/2002	0.040		0.0	mg/kg	0.25	2		S
GP08-CS-09	10/9/2002	0.870		0.0	mg/kg	0.25	2		S
STP-CS-10	1/22/2003	0.096	0.001	0.0	mg/kg	0.25	3	B	S
STP-CS-11	1/22/2003	0.059	0.001	0.0	mg/kg	0.25	3	B	S
STP-CS-12	1/22/2003	0.092	0.001	0.0	mg/kg	0.25	3	B	S
STP-CS-16	1/22/2003	0.070	0.001	0.0	mg/kg	0.25	3		S

Cesium-137

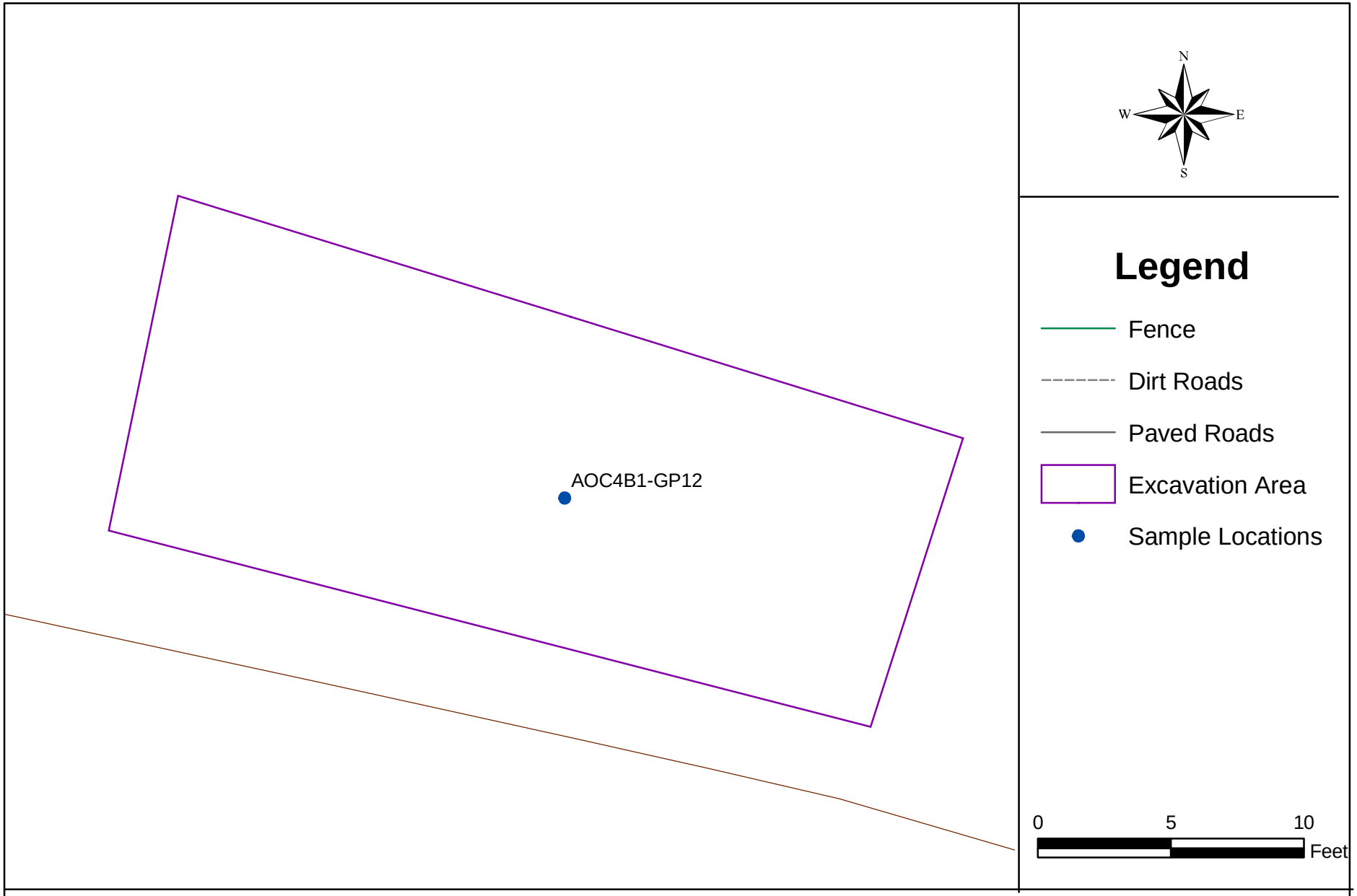
Sample ID	Sample Date	Value	MDA	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Method
AOC4B1-SB07	3/25/1999	52.350	0.09	4.7	pCi/g	0.2	NA		gamma
AOC4B1-SB07	3/25/1999	83.000	0.07	10.6	pCi/g	0.5	NA		gamma
PREC 4B1 GP08-1	6/5/2002	0.52		0.0	pCi/g	0.5	NA		gamma
PREC 4B1 GP08-2	6/5/2002	0.991		0.0	pCi/g	0.5	NA		gamma
PREC 4B1 GP08-3	6/5/2002	0.547		0.0	pCi/g	0.5	NA		gamma
PREC 4B1 GP08-4	6/5/2002	0.382		0.0	pCi/g	0.5	NA		gamma
STP GP08-1	9/6/2002	26.1	0.30	2.5	pCi/g	0.5	NA		ISOCS
STP GP08-2	9/7/2002	12.3	0.30	1.3	pCi/g	0.5	NA		ISOCS
STP GP08-3	9/8/2002	3.6	0.20	0.5	pCi/g	0.5	NA		ISOCS
STP GP08-4	9/9/2002	5.6	0.30	0.7	pCi/g	0.5	NA		ISOCS
STP GP08-5	9/10/2002	0.1	0.10	0.1	pCi/g	0.5	NA		ISOCS
STP GP08-6	9/11/2002	0.5	0.20	0.2	pCi/g	0.5	NA		ISOCS
STP GP08-7	9/12/2002	0.6	0.30	0.2	pCi/g	0.5	NA		ISOCS
STP GP08-8	9/13/2002	1.4	0.20	0.3	pCi/g	0.5	NA		ISOCS
STP GP08-9	9/14/2002	5.3	0.20	0.7	pCi/g	0.5	NA		ISOCS
STP GP08-10	9/15/2002	13.5	0.30	1.5	pCi/g	0-1	NA		ISOCS
STP GP08-11	9/16/2002	2.9	0.20	0.4	pCi/g	1-2	NA		ISOCS
GP08 OSB1-1	11/18/2002	11.300	0.30	1.1	pCi/g	0-1	NA		ISOCS
GP08 OSB1-3	11/18/2002	0.100	0.20	0.1	pCi/g	2-3	NA		ISOCS
GP08 OSB1-4	11/18/2002	0.600	0.20	0.2	pCi/g	3-4	NA		ISOCS
GP08 OSB1-5	11/18/2002	0.900	0.20	0.2	pCi/g	4-5	NA		ISOCS
GP08 OSB1-6	11/18/2002	1.900	0.30	0.3	pCi/g	5-6	NA		ISOCS
GP08 OSB2-1	11/18/2002	1.300	0.30	0.3	pCi/g	0-1	NA		ISOCS
GP08 OSB2-2	11/18/2002	ND	0.20	ND	pCi/g	1-2	NA		ISOCS
GP08 OSB2-3	11/18/2002	ND	0.20	ND	pCi/g	2-3	NA		ISOCS
GP08 OSB2-4	11/18/2002	ND	0.20	ND	pCi/g	3-4	NA		ISOCS
GP08 OSB2-5	11/18/2002	0.700	0.20	0.2	pCi/g	4-5	NA		ISOCS
GP08 OSB2-6	11/18/2002	6.100	0.30	0.7	pCi/g	5-6	NA		ISOCS
GP08 OSB3-1	11/18/2002	13.400	0.40	1.3	pCi/g	0-1	NA		ISOCS
GP08 OSB3-2	11/18/2002	4.500	0.30	0.6	pCi/g	1-2	NA		ISOCS
GP08 OSB3-3	11/18/2002	2.800	0.20	0.4	pCi/g	2-3	NA		ISOCS
GP08 OSB3-4	11/18/2002	0.600	0.20	0.2	pCi/g	3-4	NA		ISOCS
GP08 OSB3-5	11/18/2002	0.600	0.20	0.2	pCi/g	4-5	NA		ISOCS
GP08 OSB3-6	11/18/2002	8.800	0.30	0.9	pCi/g	5-6	NA		ISOCS

ANALYTICAL DATA FOR EXCAVATION AREA

AOC 4B1 GP08

Cesium-137 - Cont'd

Sample ID	Sample Date	Value	MDA	Error	Units	Depth ft	Cumulative Excavation Depth ft	Qual.	Method
GP08 OSB4-1	11/18/2002	3.000	0.30	0.4	pCi/g	0-1	NA		ISOCS
GP08 OSB4-2	11/18/2002	0.300	0.20	0.1	pCi/g	1-2	NA		ISOCS
GP08 OSB4-3	11/18/2002	0.300	0.20	0.1	pCi/g	2-3	NA		ISOCS
GP08 OSB4-4	11/18/2002	ND	0.20	ND	pCi/g	3-4	NA		ISOCS
GP08 OSB4-5	11/18/2002	ND	0.20	ND	pCi/g	4-5	NA		ISOCS
GP08 OSB4-6	11/18/2002	ND	0.30	ND	pCi/g	5-6	NA		ISOCS
GP08 OSB5-1	11/18/2002	24.400	0.40	2.1	pCi/g	0-1	NA		ISOCS
GP08 OSB5-2	11/18/2002	0.900	0.20	0.2	pCi/g	1-2	NA		ISOCS
GP08 OSB5-3	11/18/2002	0.400	0.20	0.2	pCi/g	2-3	NA		ISOCS
GP08 OSB5-4	11/18/2002	0.700	0.20	0.2	pCi/g	3-4	NA		ISOCS
GP08 OSB5-5	11/18/2002	0.800	0.20	0.2	pCi/g	4-5	NA		ISOCS
GP08 OSB5-6	11/18/2002	0.400	0.30	0.2	pCi/g	5-6	NA		ISOCS
GP08 OSB6-1	11/18/2002	ND	0.30	ND	pCi/g	0-1	NA		ISOCS
GP08 OSB6-2	11/18/2002	ND	0.20	ND	pCi/g	1-2	NA		ISOCS
GP08 OSB6-3	11/18/2002	ND	0.20	ND	pCi/g	2-3	NA		ISOCS
GP08 OSB6-4	11/18/2002	ND	0.10	ND	pCi/g	3-4	NA		ISOCS
GP08 OSB6-5	11/18/2002	ND	0.20	ND	pCi/g	4-5	NA		ISOCS
GP08 OSB6-6	11/18/2002	ND	0.20	ND	pCi/g	5-6	NA		ISOCS
GP08 OSB7-1	11/18/2002	17.600	0.20	1.6	pCi/g	0-1	NA		ISOCS
GP08 OSB7-2	11/18/2002	4.200	0.20	0.5	pCi/g	1-2	NA		ISOCS
GP08 OSB7-3	11/18/2002	1.500	0.20	0.3	pCi/g	2-3	NA		ISOCS
GP08 OSB7-4	11/18/2002	1.400	0.20	0.3	pCi/g	3-4	NA		ISOCS
GP08 OSB7-5	11/18/2002	4.700	0.30	0.6	pCi/g	4-5	NA		ISOCS
GP08 OSB7-6	11/18/2002	0.700	0.20	0.2	pCi/g	5-6	NA		ISOCS
GP08 OSB8-1	11/18/2002	22.300	0.30	1.9	pCi/g	0-1	NA		ISOCS
GP08 OSB8-2	11/18/2002	12.500	0.30	1.2	pCi/g	1-2	NA		ISOCS
GP08 OSB8-3	11/18/2002	9.300	0.30	0.9	pCi/g	2-3	NA		ISOCS
GP08 OSB8-4	11/18/2002	6.100	0.30	0.7	pCi/g	3-4	NA		ISOCS
GP08 OSB8-5	11/18/2002	5.100	0.20	0.6	pCi/g	4-5	NA		ISOCS
GP08 OSB8-6	11/18/2002	5.200	0.40	0.6	pCi/g	5-6	NA		ISOCS
GP08 OSB9-1	11/18/2002	22.600	0.40	2.0	pCi/g	0-1	NA		ISOCS
GP08 OSB9-2	11/18/2002	12.300	0.30	1.2	pCi/g	1-2	NA		ISOCS
GP08 OSB9-3	11/18/2002	18.300	0.30	1.6	pCi/g	2-3	NA		ISOCS
GP08 OSB9-4	11/18/2002	11.900	0.30	1.1	pCi/g	3-4	NA		ISOCS
GP08 OSB9-5	11/18/2002	4.500	0.20	0.5	pCi/g	4-5	NA		ISOCS
GP08 OSB9-6	11/18/2002	2.700	0.30	0.4	pCi/g	5-6	NA		ISOCS
GP08 OSB10-1	11/18/2002	0.500	0.20	0.2	pCi/g	0-1	NA		ISOCS
GP08 OSB10-2	11/18/2002	0.400	0.10	0.1	pCi/g	1-2	NA		ISOCS
GP08 OSB10-3	11/18/2002	1.100	0.20	0.2	pCi/g	2-3	NA		ISOCS
GP08 OSB10-4	11/18/2002	0.900	0.20	0.2	pCi/g	3-4	NA		ISOCS
GP08 OSB10-5	11/18/2002	0.500	0.20	0.2	pCi/g	4-5	NA		ISOCS
GP08 OSB10-6	11/18/2002	0.600	0.30	0.2	pCi/g	5-6	NA		ISOCS
STP-CS-09	1/22/2003	10.600	0.30	1.0	pCi/g	0.25	2		ISOCS
STP-CS-11	1/22/2003	0.800	0.30	0.3	pCi/g	0.25	4.5		ISOCS
STP-CS-13	1/22/2003	13.600	0.40	1.2	pCi/g	0.25	3		ISOCS
STP-CS-14	1/22/2003	7.600	0.30	0.8	pCi/g	0.25	2.5		ISOCS
STP-CS-15	1/22/2003	1.800	0.20	0.3	pCi/g	0.25	3		ISOCS
STP-CS-16	1/22/2003	4.700	0.20	0.6	pCi/g	0.25	2		ISOCS
STP-CS-17	1/22/2003	4.100	0.30	0.6	pCi/g	0.25	3		ISOCS



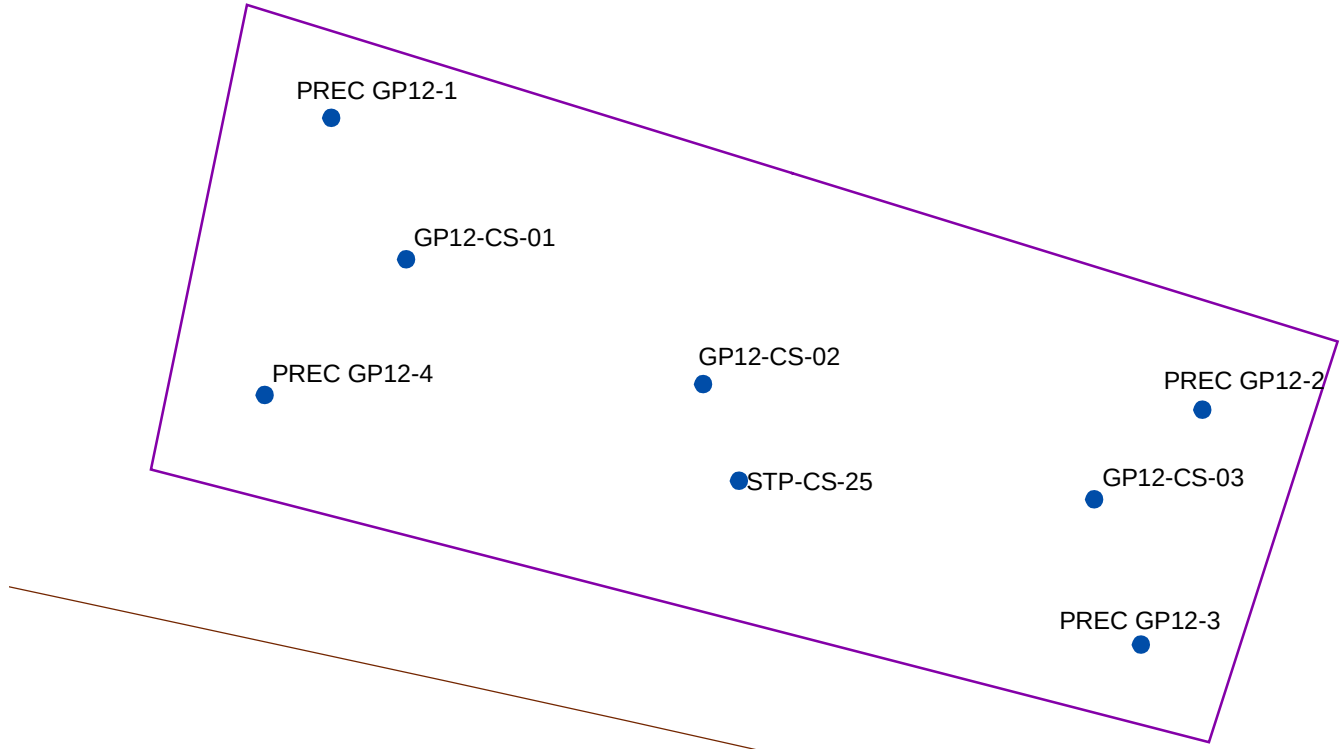
BROOKHAVEN NATIONAL LABORATORY

Environmental Information Management System

Location of Elevated Mercury Samples (Hg > 2ppm) Prior to Completion of Excavation AOC4B1-GP12

Figure A

ALR - 10/21/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp12b.mxd
r:/graphics/ou5/stp-cs/aoc4b1-gp12b.mxd



N
W
E
S

Legend

- Fence
- Dirt Roads
- Paved Roads
- Excavation Area
- Sample Locations

0 5 10
Feet

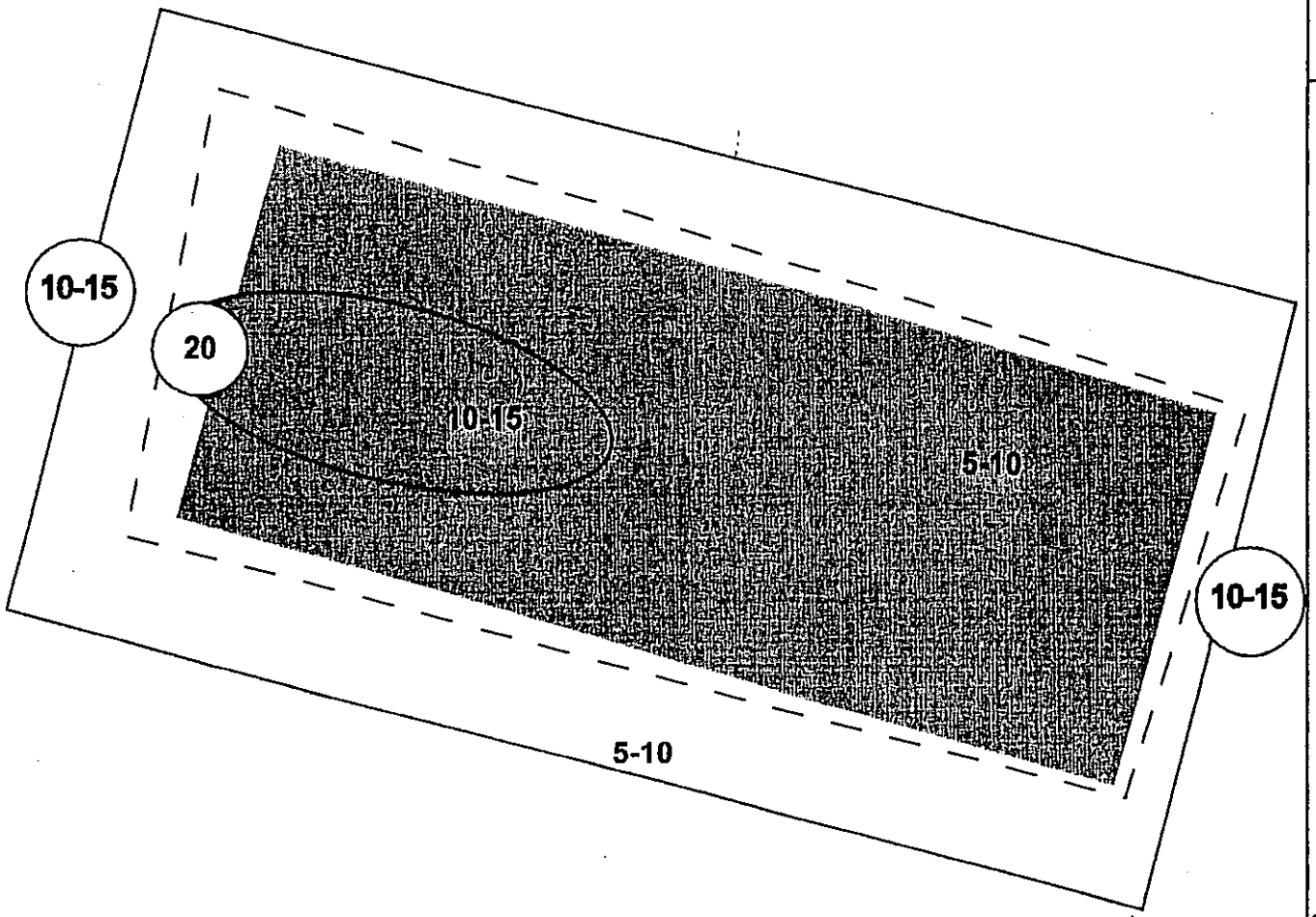
BROOKHAVEN NATIONAL LABORATORY

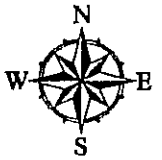
Environmental Information Management System

Location of Final Confirmatory Samples for Mercury (Hg < 2ppm) AOC4B1-GP12

Figure # 14

JLH - 02/24/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp12.mxd
r:/graphics/ou5/stp-cs/aoc4b1-gp12.mxd





Legend

Excavation Area

Pre-Excavation Boundary

0 5 10 Feet

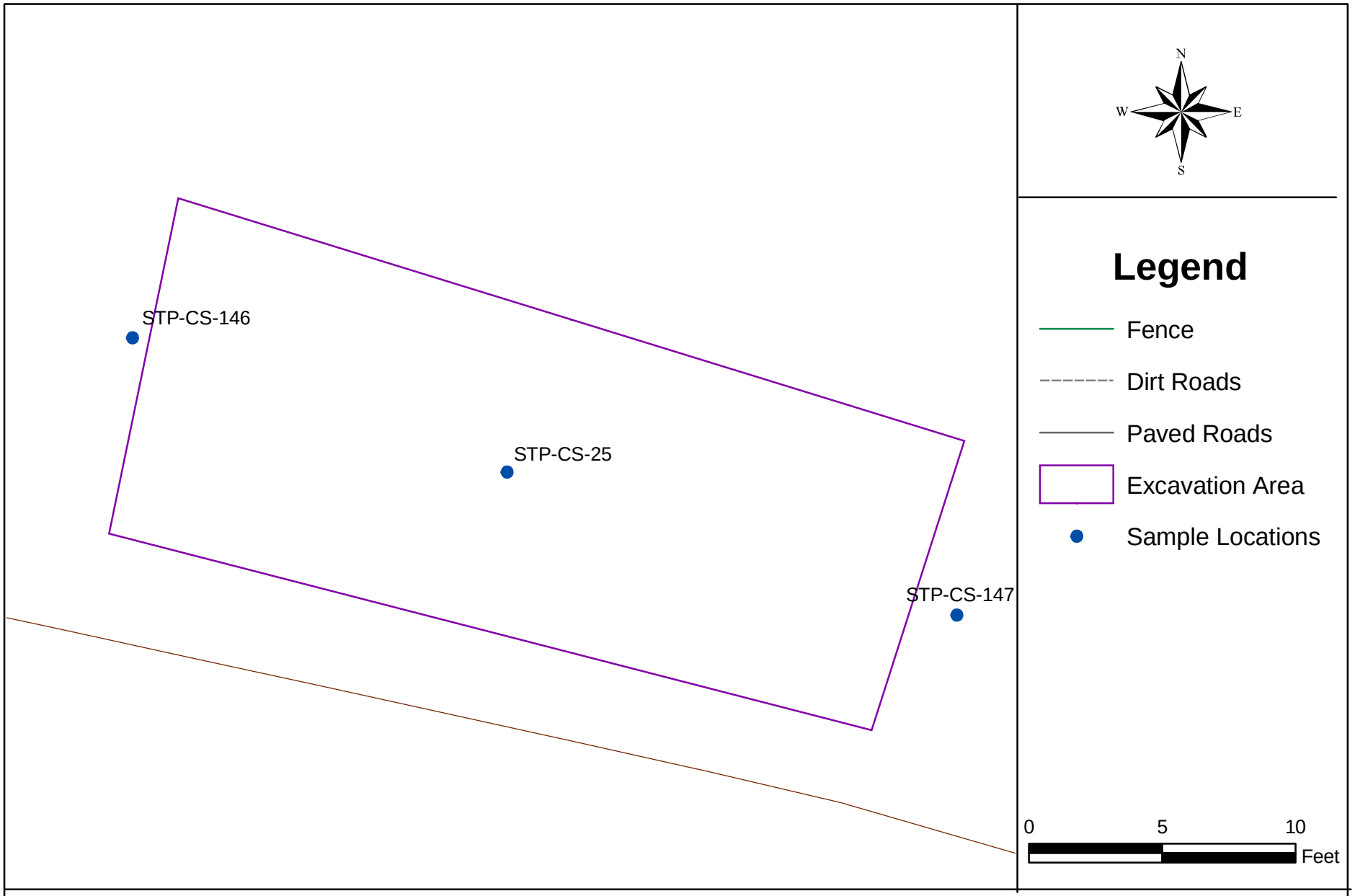
BROOKHAVEN NATIONAL LABORATORY

Environmental Information Management System

Preliminary NaI Walkover Survey (7-30-02)
(Values Expressed as Gross x1000 cpm)
AOC4B1-GP12

Figure C

KMG - 03/20/03
r:/arcmap_projects/ou5/
stp-cs/aoc4b1-gp12.mxd



BROOKHAVEN NATIONAL LABORATORY

Location of ISOCS Samples Collected for Cesium-137 During Excavation and Confirmation Sampling AOC4B1-GP12

Figure # 14

Environmental Information Management System

JLH - 02/24/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp12isocs.mxd
r:/graphics/ou5/stp-cs/aoc4b1-gp12isocs.mxd

AOC 4B1-GP12 Figure E Final Walkover Survey

☐ ROUTINE ____

☒ SPECIAL WALKOVER

☐ RWP # ____

☐ WP# ____

BLDG.#: N/A LOCATION: SEWAGE TREATMENT PLANT OUTF #6 DATE/TIME: 2-3-03/1030

MODEL	E600	NAI PROBE				
SERIAL#	00739	4001				
Cal Due Date	3-7-03	3-7-03				
Source Check OK (Yes or No)	Y	Y				

DOSE RATES (HIGHEST)		AIRBORNE CONTAMINATION		
		TIME	uCi/cc	%DAC
CONTACT	N		N	
GENERAL AREA	A		A	

LEGEND: O SMEAR SURVEY LOCATION □ MASSLINN SURVEY LOCATION

XXX Y = XXX = CONTACT READING; ZZZ = READING @ 30 Cm; Y = RADIATION TYPE

Δ AIR SAMPLE LOCATION

SMEAR SURVEY RESULTS (DPM/100 cm²)

³H B-γ α

☐ All Dose Rates are in mR/Hr and taken at waist level unless otherwise noted.
☐ All masslinn wipes are <1,000 dpm/LAS
☐ Frisked various areas – all were less than 100cpm
☐ See Attachment for smear survey results

1.		8.		15.		22	
2.		9.		16.		23.	
3.		10.		17.		24.	
4.		11.	N	18.		25.	
5.		12.		19.		26.	
6.		13.		20.	A	27.	
7.		14.		21.		28.	

MASSLINN SURVEY RESULTS (DPM/LAS)

1.		8.	
2.		9.	
3.	N	10.	
4.		11.	A
5.		12.	
6.		13.	
7.		14.	

WALKOVER SURVEY OF CONTAMINATED AREA AOC4B1-GP12 AT SEWAGE TREATMENT PLANT
USING AN E-600 W/ NAI PROBE
E600 BKG - 5.73K cpm
MDCR - 1145 ncpm

ALL READINGS IN NET COUNTS/MINUTE

SURVEYED BY: Ken Ford 2-8-03 (Signature/date) REVIEWED BY: [signature] 2-10-03 (Signature/date)

ANALYTICAL DATA FOR EXCAVATION AREA
AOC 4B1 GP12

Mercury Results > 2 ppm

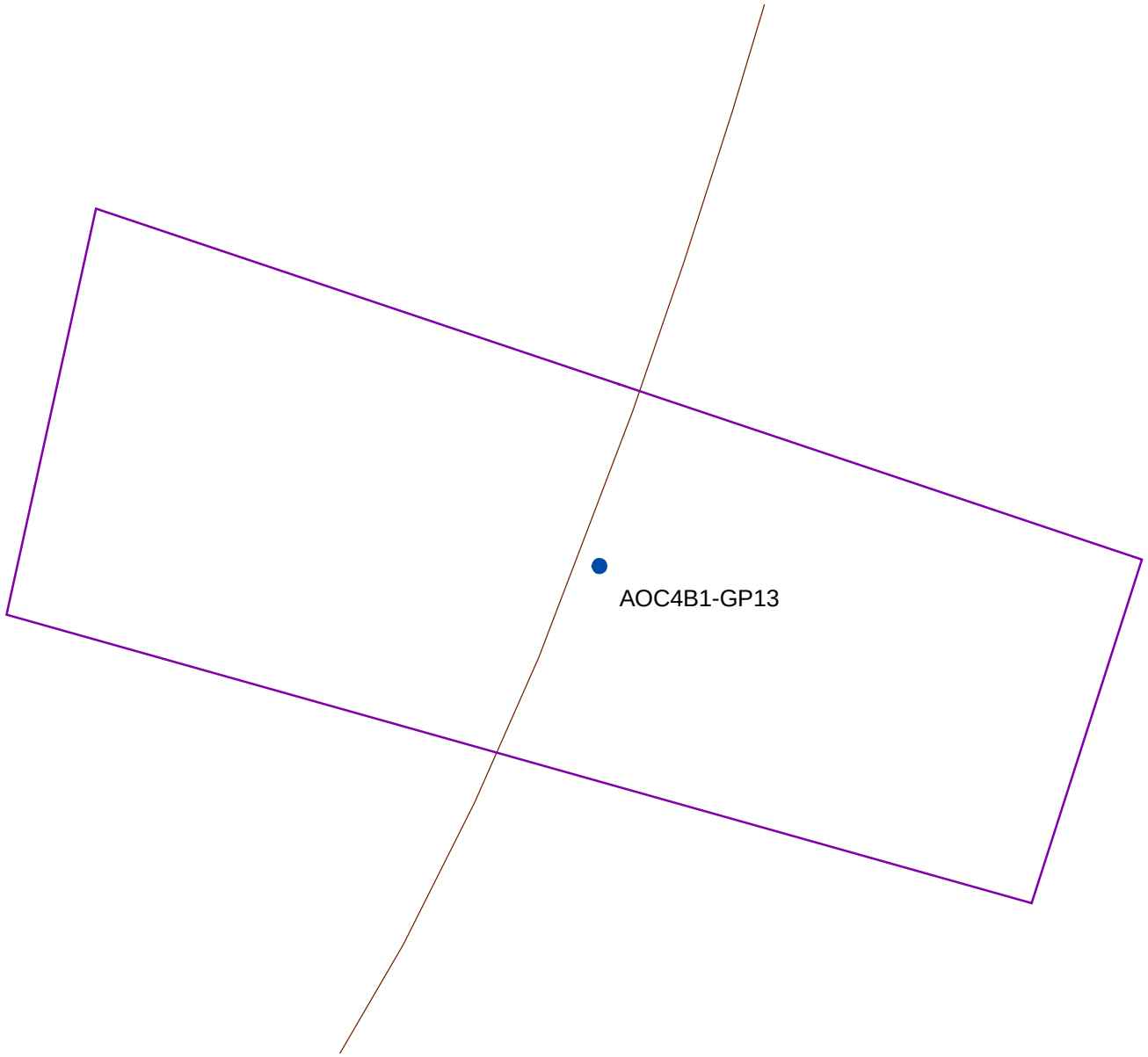
Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
AOC4B1-GP12	9/20/2000	3.38	0.042	0	ug/kg	0.75	NA		S

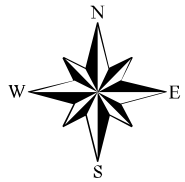
Mercury Results < 2 ppm

Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
PREC GP12-1	6/5/2002	0.66		0	ug/kg	0.5	NA		S
PREC GP12-2	6/5/2002	0.39		0	ug/kg	0.5	NA		S
PREC GP12-3	6/5/2002	0.49		0	ug/kg	0.5	NA		S
PREC GP12-4	6/5/2002	0.33		0	ug/kg	0.5	NA		S
GP12-CS-01	10/9/2002	0.14		0	ug/kg	0.25	1		S
GP12-CS-02	10/9/2002	0.43		0	ug/kg	0.25	1		S
GP12-CS-03	10/9/2002	1.60		0	ug/kg	0.25	1		S
STP-CS-25	1/22/2003	0.85	0.013	0	mg/kg	0.25	2	B	S

Cesium-137

Sample ID	Sample Date	Value	MDA	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Method
AOC4B1 GP12	3/29/1999	17.39	0.055	1.734	pCi/g	0.2	NA		ISOCS
AOC4B1 GP12	3/29/1999	65.50	0.086	7.79	pCi/g	0.5	NA		ISOCS
STP-CS-25	1/22/2003	3.00	0.3	0.5	pCi/g	0.25	2		ISOCS
STP CS-146	2/27/2003	10.50	0.3	1	pCi/g	0.25	0.5		ISOCS
STP CS-147	2/27/2003	8.60	0.4	0.9	pCi/g	0.25	0.5		ISOCS





Legend

- Fence
- Dirt Roads
- Paved Roads
- Excavation Area
- Sample Locations

0 5 10
Feet

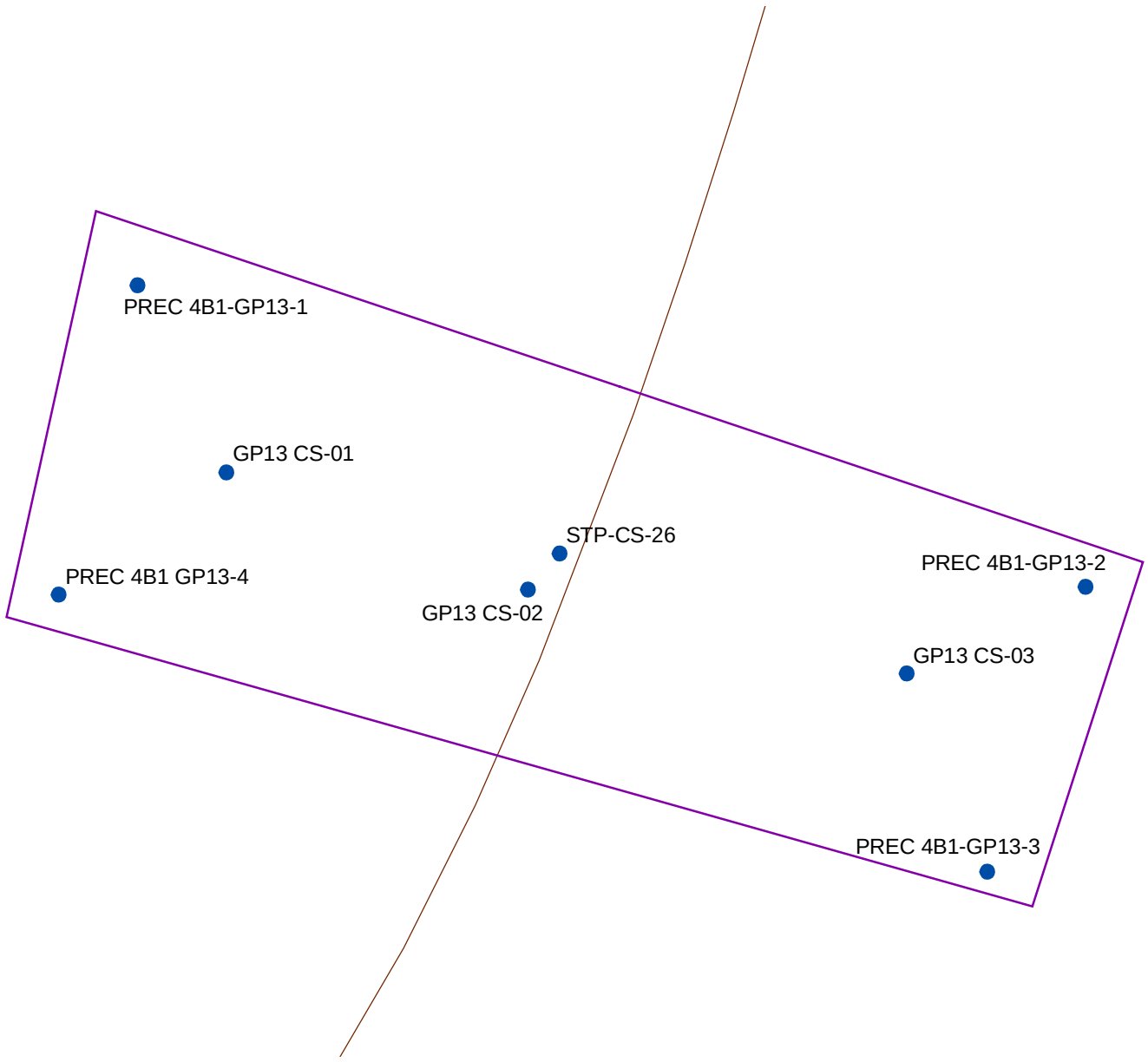
BROOKHAVEN NATIONAL LABORATORY

Environmental Information Management System

Location of Elevated Mercury Samples (Hg > 2ppm) Prior to Completion of Excavation AOC4B1-GP13

Figure # 15

ALR - 10/17/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp13b.mxd
r:/graphics/ou5/stp-cs/aoc4b1-gp13b.mxd



N
W
E
S

Legend

- Fence
- Dirt Roads
- Paved Roads
- Excavation Area
- Sample Locations

0 5 10
Feet

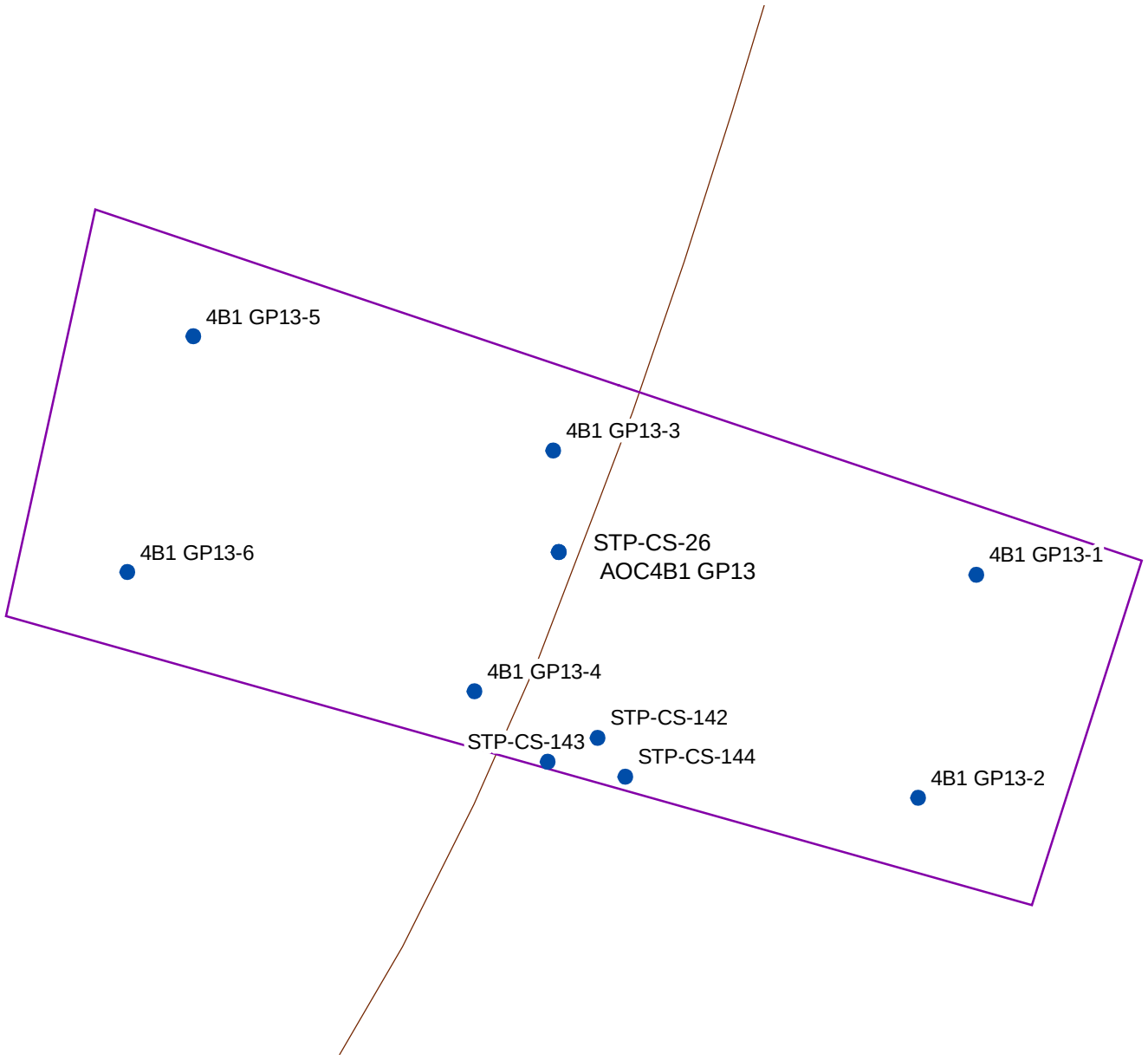
BROOKHAVEN NATIONAL LABORATORY

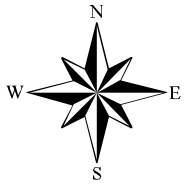
Environmental Information Management System

Location of Final Confirmatory Samples for Mercury (Hg < 2ppm) AOC4B1-GP13

Figure # 15

JLH - 02/24/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp13.mxd
r:/graphics/ou5/stp-cs/aoc4b1-gp13.mxd





Legend

- Fence
- Dirt Roads
- Paved Roads
- Excavation Area
- Sample Locations

0 5 10 Feet

BROOKHAVEN NATIONAL LABORATORY

Location of ISOCS Samples Collected for Cesium-137 During Excavation and Confirmation Sampling AOC4B1-GP13

Figure C

Environmental Information Management System

ALR - 10/22/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp13isocs.mxd
r:/graphics/ou5/stp-cs/aoc4b1-gp13isocs.mxd

AOC 4B1-GP13 Figure D Final Walkover Survey

☐ ROUTINE
☒ SPECIAL WALKOVER
☐ RWP #
☐ WP#

BLDG.#: N/A LOCATION: SEWAGE TREATMENT PLANT DUE #6 DATE/TIME: 2-10-03 / 0930

MODEL	E600	NAI PROBE				
SERIAL#	06739	4001				
Cal Due Date	3-7-03	3-7-03				
Source Check OK (Yes or No)	Y	Y				

DOSE RATES (HIGHEST)		AIRBORNE CONTAMINATION		
CONTACT	N/A	TIME	uCi/cc	%DAC
GENERAL AREA			N/A	

LEGEND: O SMEAR SURVEY LOCATION ☐ MASSLINN SURVEY LOCATION
XXX Y = XXX = CONTACT READING; ZZZ = READING @ 30 Cm; Y = RADIATION TYPE
Δ AIR SAMPLE LOCATION

SMEAR SURVEY RESULTS (DPM/100 cm²)
³H B-γ α

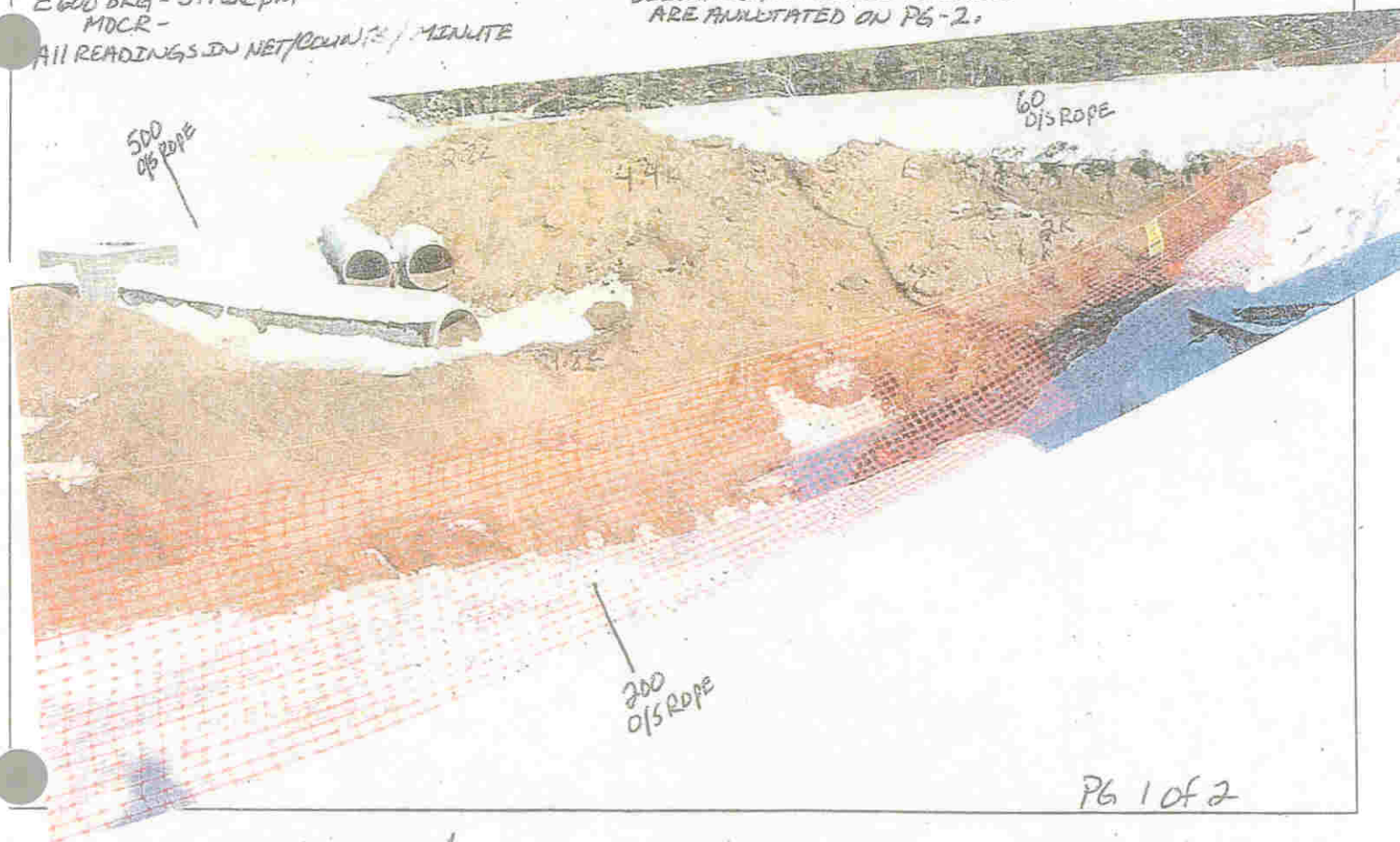
- ☐ All Dose Rates are in mR/Hr and taken at waist level unless otherwise noted.
- ☐ All masslinn wipes are <1,000 dpm/LAS
- ☐ Frisked various areas – all were less than 100ccpm
- ☐ See Attachment for smear survey results

1.		8.		15.		22.	
2.		9.		16.		23.	
3.		10.	N/A	17.		24.	
4.		11.		18.		25.	
5.		12.		19.		26.	
6.		13.		20.	N/A	27.	
7.		14.		21.		28.	

MASSLINN SURVEY RESULTS (DPM/LAS)

1.		8.	
2.		9.	
3.	N/A	10.	
4.		11.	
5.		12.	
6.		13.	
7.		14.	

WALKOVER SURVEY OF SOIL CONTAMINATION AREA AT SEWAGE TREATMENT PLANT USING E600 W/ NAI PROBE
E600 BKG - 5.1 kCPM
MDCR -
All READINGS IN NET/COUNTS / MINUTE
ELEVATED READINGS LOCATED ARE ANNOTATED ON PG-2.



PG 1 of 2

SURVEYED BY: Ken Ford 2-10-03 (Signature/date) REVIEWED BY: Donald Chan 2-11-03 (Signature/date)

OLV #126

Donald Chan 2-11-

Figure D (cont)

BNL RADIOLOGICAL SURVEY FORM

☐ ROUTINE ____
☐ SPECIAL ____
☒ RWP # 02ERD27
☐ WP# ____

BLDG.#: N/A LOCATION: SEWAGE TREATMENT PLANT OU V #6 DATE/TIME: 2-25-03 / 1100

MODEL	E600	NAI PROBE				
SERIAL#	0746	2108				
Cal Due Date	1-20-04	1-20-04				
Source Check OK (Yes or No)	Y	Y				

DOSE RATES (HIGHEST)		AIRBORNE CONTAMINATION		
		TIME	uCi/cc	%DAC
CONTACT	N/A		N/A	
GENERAL AREA				

LEGEND: ○ SMEAR SURVEY LOCATION ☐ MASSLINN SURVEY LOCATION
XXX Y = CONTACT READING
ZZZ = READING @ 30 Cm
△ AIR SAMPLE LOCATION
Y = RADIATION TYPE

SMEAR SURVEY RESULTS (DPM/100 cm²)
³H B-γ α

☐ All Dose Rates are in mR/Hr and taken at waist level unless otherwise noted.
☐ All masslinn wipes are <1,000 dpm/LAS
☐ Frisked various areas – all were less than 100ccpm
☐ See Attachment for smear survey results

1.		8.		15.		22			
2.		9.		16.		23.			
3.		10.	N	17.		24.			
4.		11.		18.		25.			
5.		12.		19.	A	26.			
6.		13.		20.		27.			
7.		14.		21.		28.			

MASSLINN SURVEY RESULTS (DPM/LAS)

1.		8.	
2.		9.	
3.		10.	
4.	N	11.	
5.		12.	A
6.		13.	
7.		14.	

WALKOVER SURVEY OF NEW EXCAVATION IN AREA #6 USING E-600 W/ NAI PROBE
E600 BKG - 4.5 Kcpm
MDCR - 1014 ncpm
ALL READINGS IN ncpm.

SURVEYED BY: [signature] 2-28-03
Signature/date

REVIEWED BY: [signature] 02-28-03
Signature/date

ANALYTICAL DATA FOR EXCAVATION AREA
AOC 4B1 GP13

Mercury Results > 2 ppm

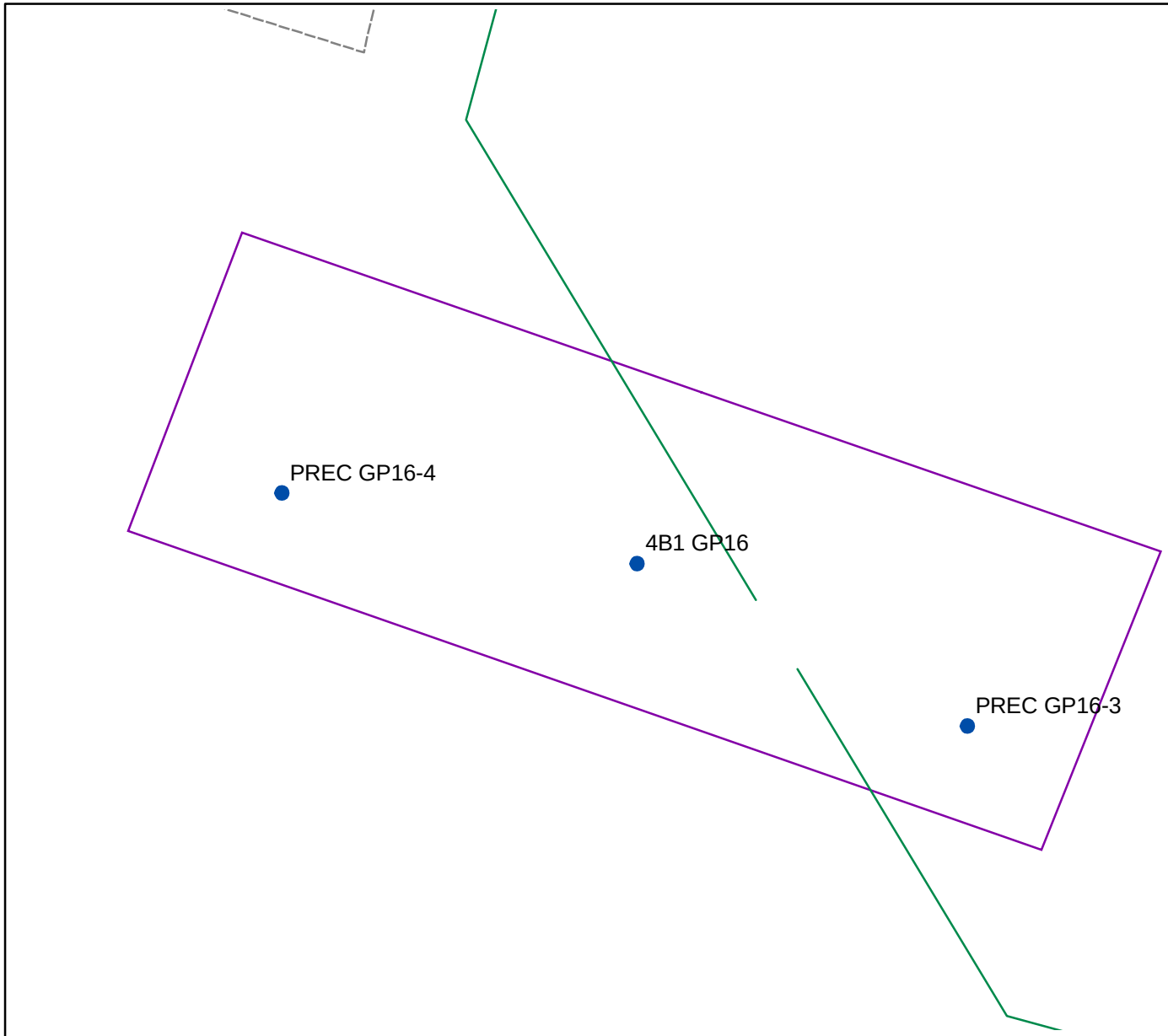
Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
4B1-GP13	9/20/2000	10.20	0.001	0	mg/kg	0.75	NA		S
4B1-GP13	9/20/2000	4.05	0.001	0	mg/kg	1.5	NA		S
4B1-GP13	9/20/2000	2.95	0.001	0	mg/kg	5.5	NA		S
4B1-GP13	9/20/2000	4.09	0.001	0	mg/kg	4.5	NA		S
4B1-GP13	7/17/2002	9.59	0.316	0	mg/kg	0.5	NA	N	S
4B1-GP13	7/17/2002	3.53	0.065	0	mg/kg	1.5	NA	N	S

Mercury Results < 2 ppm

Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
PREC 4B1-GP13-1	6/5/2002	0.99		0	mg/kg	0.5	NA		S
PREC 4B1-GP13-2	6/5/2002	0.59		0	mg/kg	0.5	NA		S
PREC 4B1-GP13-3	6/5/2002	0.57		0	mg/kg	0.5	NA		S
PREC 4B1-GP13-4	6/5/2002	0.24		0	mg/kg	0.5	NA		S
GP13 CS-01	10/9/2002	0.41	0.001	0	mg/kg	0.25	5		S
GP13 CS-02	10/9/2002	1.01	0.001	0	mg/kg	0.25	6.5		S
GP13 CS-03	10/9/2002	0.06	0.001	0	mg/kg	0.25	5		S
STP-CS-26	1/22/2003	0.26	0.001	0	mg/kg	0.25	6.5		S

Cesium-137

Sample ID	Sample Date	Value	MDA	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Method
AOC4B1 GP13	3/29/1999	76.24	0.094	7.511	pCi/g	0.2	NA		Gamma
AOC4B1 GP13	3/29/1999	93.60	0.104	11.38	pCi/g	0.5	NA		Gamma
AOC4B1 GP13-1	8/28/2002	2.40	0.4	0.5	pCi/g	0.5	2.5		ISOCS
AOC4B1 GP13-2	8/28/2002	4.60	0.4	0.7	pCi/g	0.5	2.5		ISOCS
AOC4B1 GP13-3	8/28/2002	ND	0.5	ND	pCi/g	0.5	2		ISOCS
AOC4B1 GP13-4	8/28/2002	ND	0.5	ND	pCi/g	0.5	2		ISOCS
AOC4B1 GP13-5	8/28/2002	4.90	0.4	0.7	pCi/g	0.5	3		ISOCS
AOC4B1 GP13-6	8/28/2002	2.20	0.4	0.4	pCi/g	0.5	2.5		ISOCS
STP-CS-26	1/22/2003	1.30	0.1	0.3	pCi/g	0.25	6.5		ISOCS
STP CS-142	2/25/2003	6.00	0.5	0.7	pCi/g	0.25	4.5		ISOCS
STP CS-143	2/25/2003	6.50	0.4	0.7	pCi/g	0.25	4.5		ISOCS
STP CS-144	2/25/2003	3.20	0.4	0.5	pCi/g	0.25	4.5		ISOCS



N
W
E
S

Legend

- Fence
- Dirt Roads
- Paved Roads
- Buildings
- Excavation Area
- Sample Locations

0 4 8
Feet

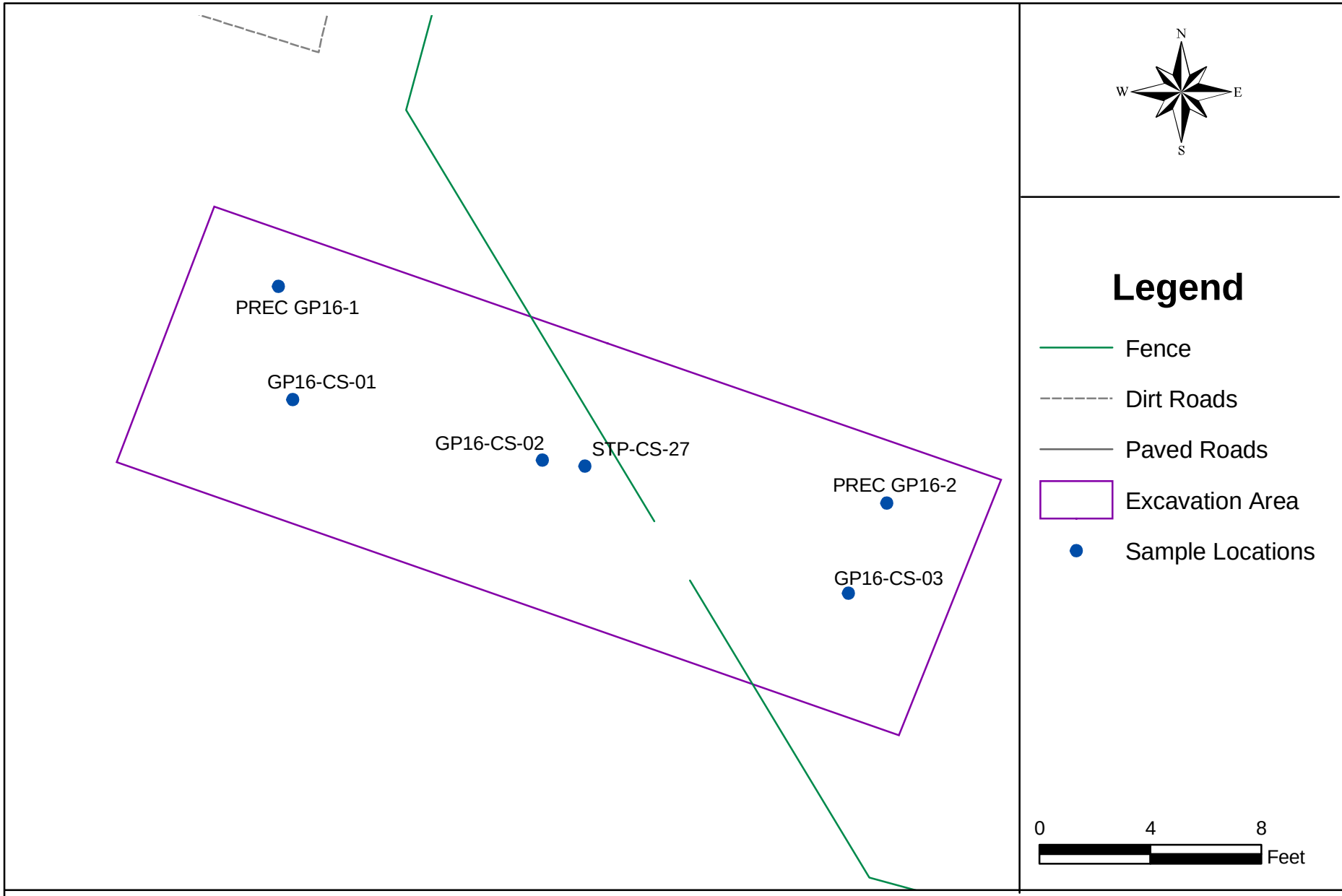
BROOKHAVEN NATIONAL LABORATORY

Environmental Information Management Systems

Location of Elevated Mercury Samples (Hg > 2ppm) Prior to Completion of Excavation AOC4B1-GP16

Figure A

JLH - 02/24/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp16b.mxd
r:/graphics/ou5/stp-cs/aoc4b1-gp16b.mxd



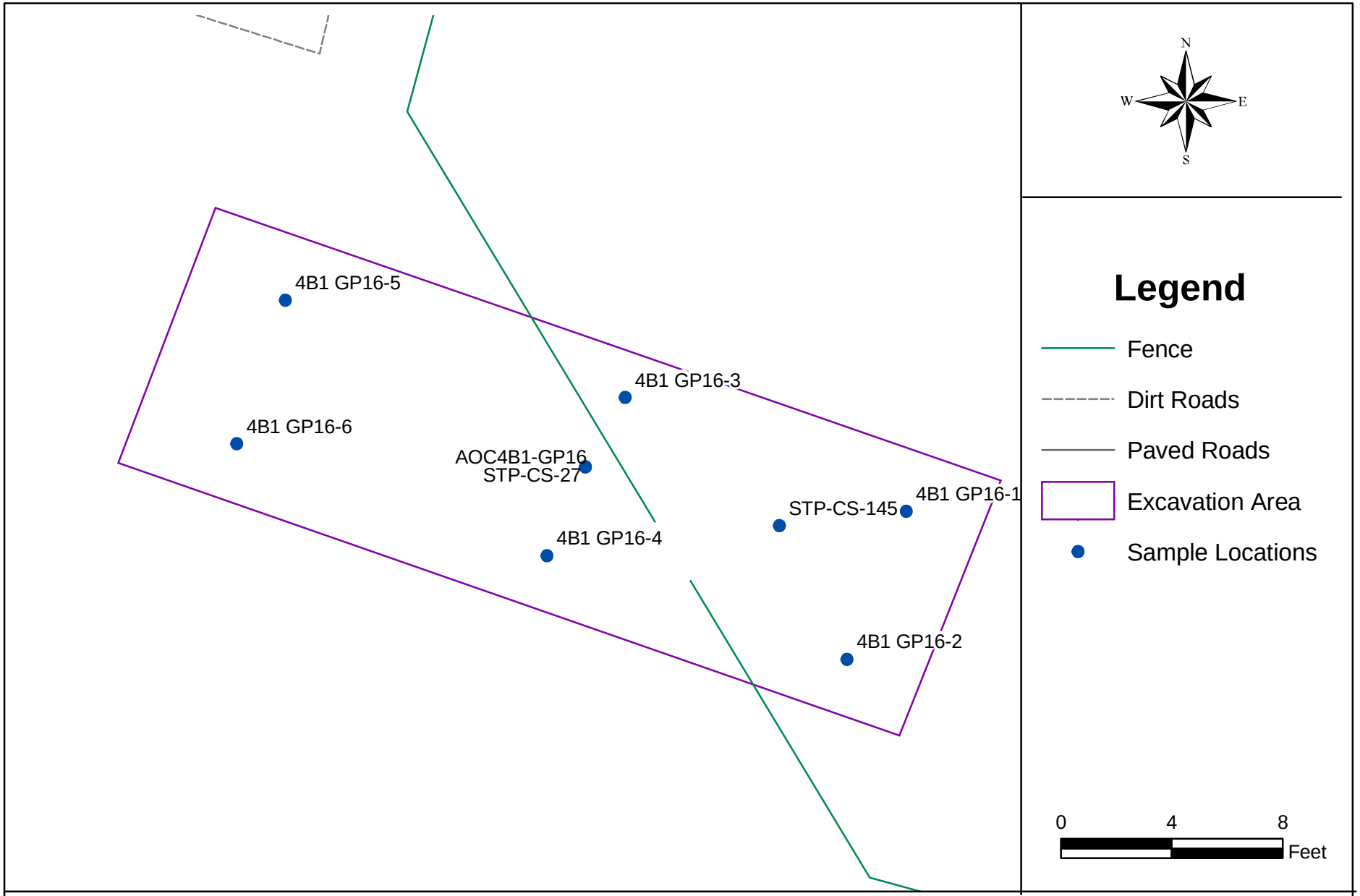
BROOKHAVEN NATIONAL LABORATORY

Environmental Information Management System

Location of Final Confirmatory Samples for Mercury (Hg < 2ppm) AOC4B1-GP16

Figure B

JLH - 02/24/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp16.mxd
r:/graphics/ou5/stp-cs/aoc4b1-gp16.mxd



BROOKHAVEN NATIONAL LABORATORY

Location of ISOCS Samples Collected for Cesium-137 During Excavation and Confirmation Sampling AOC4B1-GP16

Figure C

Environmental Information Management System

ALR - 10/22/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-gp16isocs.mxd
r:/graphics/ou5/stp-cs/aoc4b1-gp16isocs.mxd

AOC 4B1-GP16 Figure D Final Walkover Survey

☐ ROUTINE
☒ SPECIAL WALKOVER
☐ RWP #
☐ WP#

BLDG.#: NA LOCATION: SEWAGE TREATMENT PLANT DATE/TIME: 2-03-03/1030
EXIT #12

MODEL	E600	NaI Probe				
SERIAL#	00739	4001		N		
Cal Due Date	3-7-03	3-7-03		A		
Source Check OK (Yes or No)	Y	Y				

DOSE RATES (HIGHEST)		AIRBORNE CONTAMINATION			LEGEND: O SMEAR SURVEY LOCATION	☐ MASSLINN SURVEY LOCATION
CONTACT	N/A	TIME	uCi/cc	%DAC	XXX Y	XXX = CONTACT READING
					ZZZ	ZZZ = READING @ 30 Cm
GENERAL AREA			N/A			Δ AIR SAMPLE LOCATION
				A		Y = RADIATION TYPE

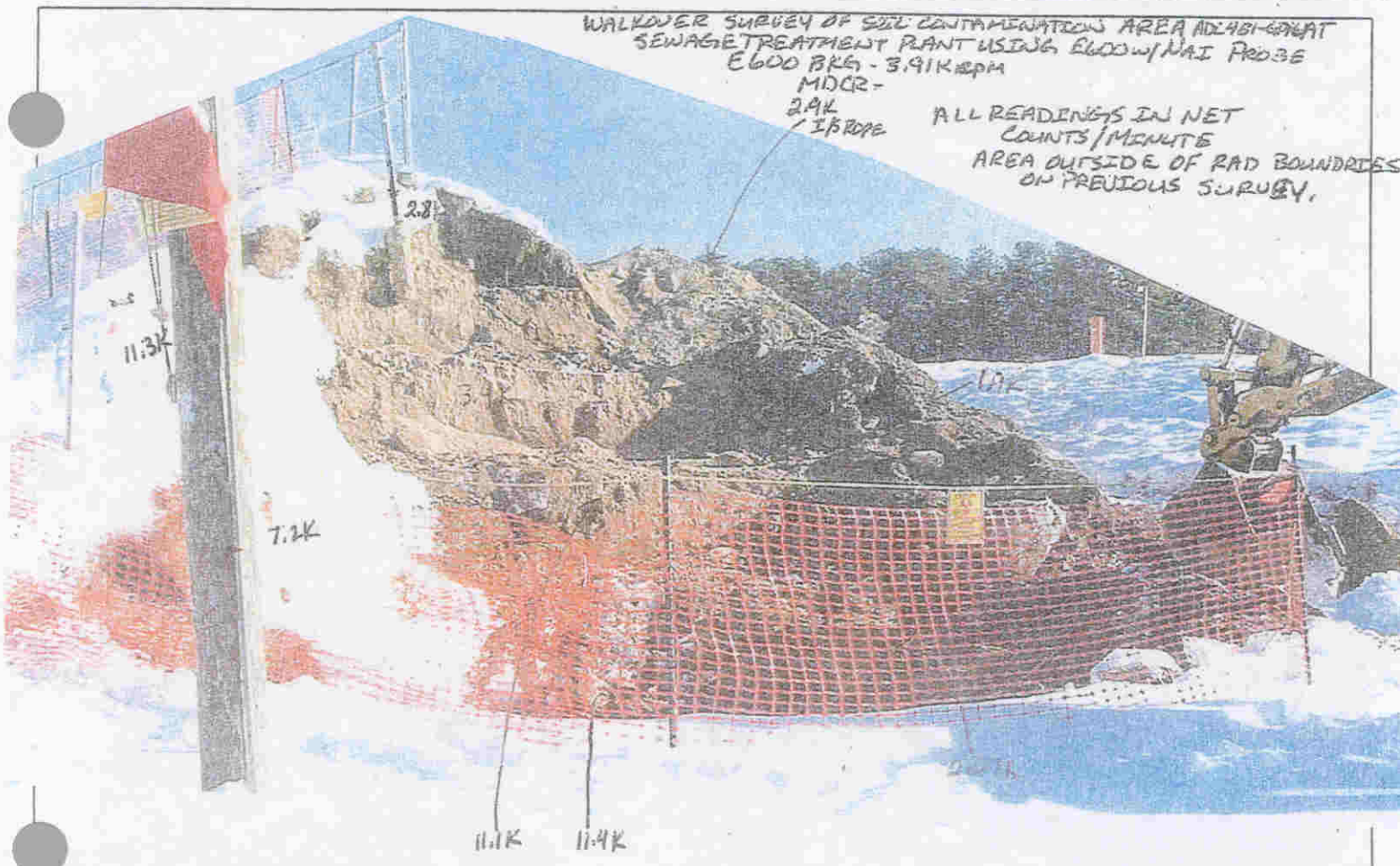
SMEAR SURVEY RESULTS (DPM/100 cm²)
³H B-γ α

☐ All Dose Rates are in mR/Hr and taken at waist level unless otherwise noted.
☐ All masslinn wipes are <1,000 dpm/LAS
☐ Frisked various areas – all were less than 100cpm
☐ See Attachment for smear survey results

1.	8.	15.	22.
2.	9.	16.	23.
3.	10. N	17.	24.
4.	11.	18.	25.
5.	12.	19.	26.
6.	13.	20. A	27.
7.	14.	21.	28.

MASSLINN SURVEY RESULTS (DPM/LAS)

1.	8.		
2.	9.		
3.	10. N		
4.	11. A		
5.	12.		
6.	13.		
7.	14.		



SURVEYED BY: Ken Ford 2-10-03 REVIEWED BY: [signature] 2-11-03
Signature/date Signature/date

ANALYTICAL DATA FOR EXCAVATION AREA
AOC 4B1 GP16

Mercury Results > 2 ppm

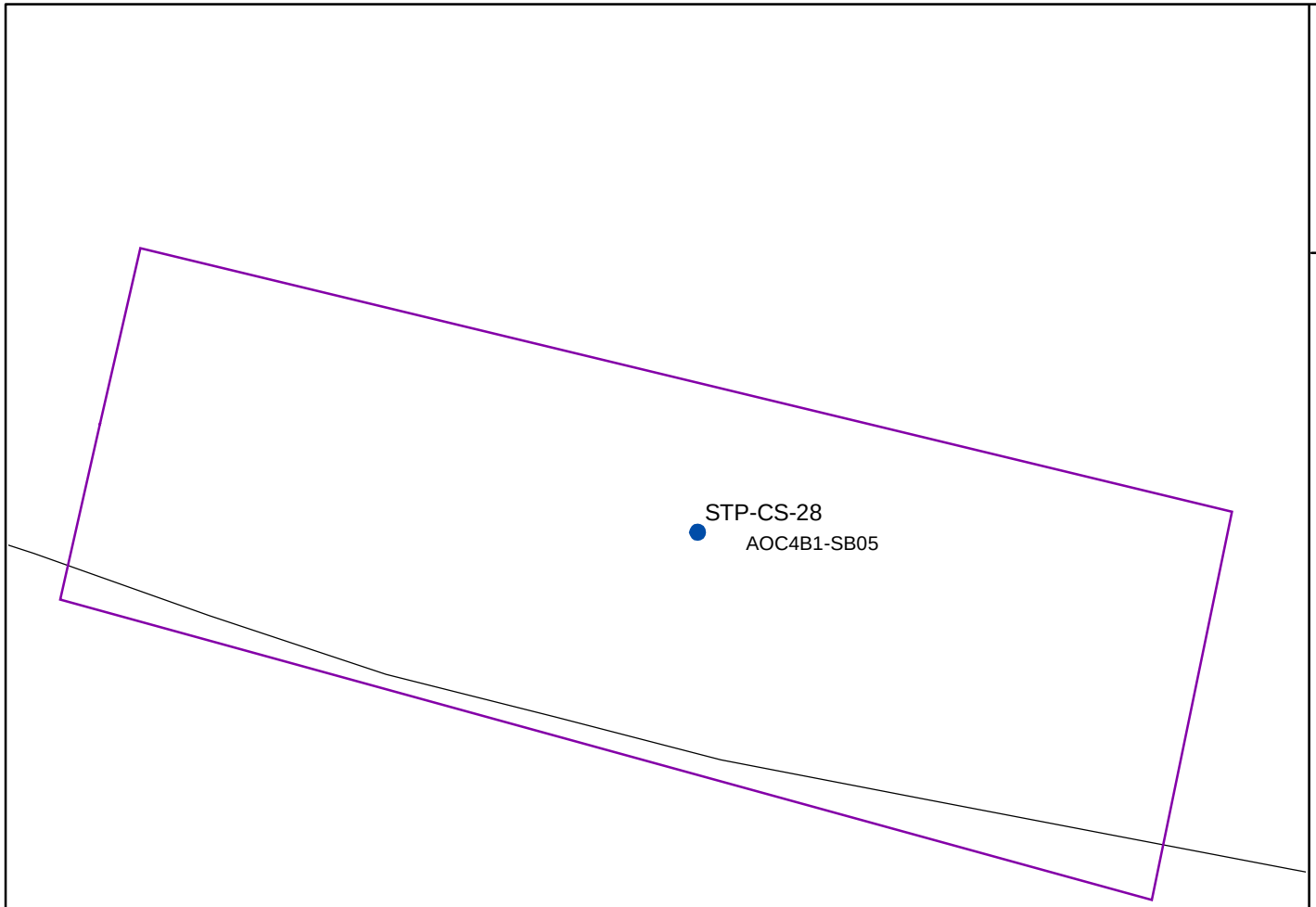
Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
4B1 GP16	9/20/2000	9.82		0	mg/kg	0.1	NA		S
4B1 GP16	9/20/2000	13.50		0	mg/kg	0.35	NA		S
4B1 GP16	9/20/2000	13.90		0	mg/kg	0.75	NA		S
4B1 GP16	9/20/2000	8.27	0.089	0	mg/kg	1.5	NA		S
4B1 GP16	9/20/2000	5.02	0.086	0	mg/kg	4.5	NA		S
4B1 GP16	9/20/2000	3.39	0.048	0	mg/kg	5.5	NA		S
PREC GP16-03	6/5/2002	2.07		0	mg/kg	0.25	NA		S
PREC GP16-04	6/5/2002	3.33		0	mg/kg	0.25	NA		S
4B1 GP16	7/16/2002	3.17		0	mg/kg	0.5	NA		S

Mercury Results < 2 ppm

Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
PREC GP16-01	6/5/2002	1.54		0	mg/kg	0.25	NA		S
PREC GP16-02	6/5/2002	0.096		0	mg/kg	0.25	NA		S
GP16-CS-01	10/9/2002	0.04		0	mg/kg	0.25	5		S
GP16-CS-02	10/9/2002	0.34		0	mg/kg	0.25	6		S
GP16-CS-03	10/9/2002	0.67		0	mg/kg	0.25	4.5		S
STP-CS-27	1/22/2003	1.09	0.015	0	mg/kg	0.25	6	B	S

Cesium-137

Sample ID	Sample Date	Value	MDA	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Method
AOC4B1 GP16	9/20/2000	35.10	0.074	0.502	pCi/g	0.5	NA		Gamma
4B1 GP16-1	8/27/2002	ND	0.2	ND	pCi/g	0.5	3.5		ISOCS
4B1 GP16-2	8/27/2002	1.60	0.4	0.4	pCi/g	0.5	3.5		ISOCS
4B1 GP16-3	8/27/2002	1.10	0.3	0.3	pCi/g	0.5	5		ISOCS
4B1 GP16-4	8/27/2002	ND	0.4	ND	pCi/g	0.5	5		ISOCS
4B1 GP16-5	8/27/2002	ND	0.4	ND	pCi/g	0.5	4.5		ISOCS
4B1 GP16-6	8/27/2002	ND	0.3	ND	pCi/g	0.5	4.5		ISOCS
STP-CS-27	1/22/2003	0.70	0.2	0.2	pCi/g	0.25	6		ISOCS
STP CS-145	2/27/2003	0.60	0.1	0.2	pCi/g	0.25	4.5		ISOCS



N
W
E
S

Legend

- Fence
- Dirt Roads
- Paved Roads
- Excavation Area

0 4 8
Feet

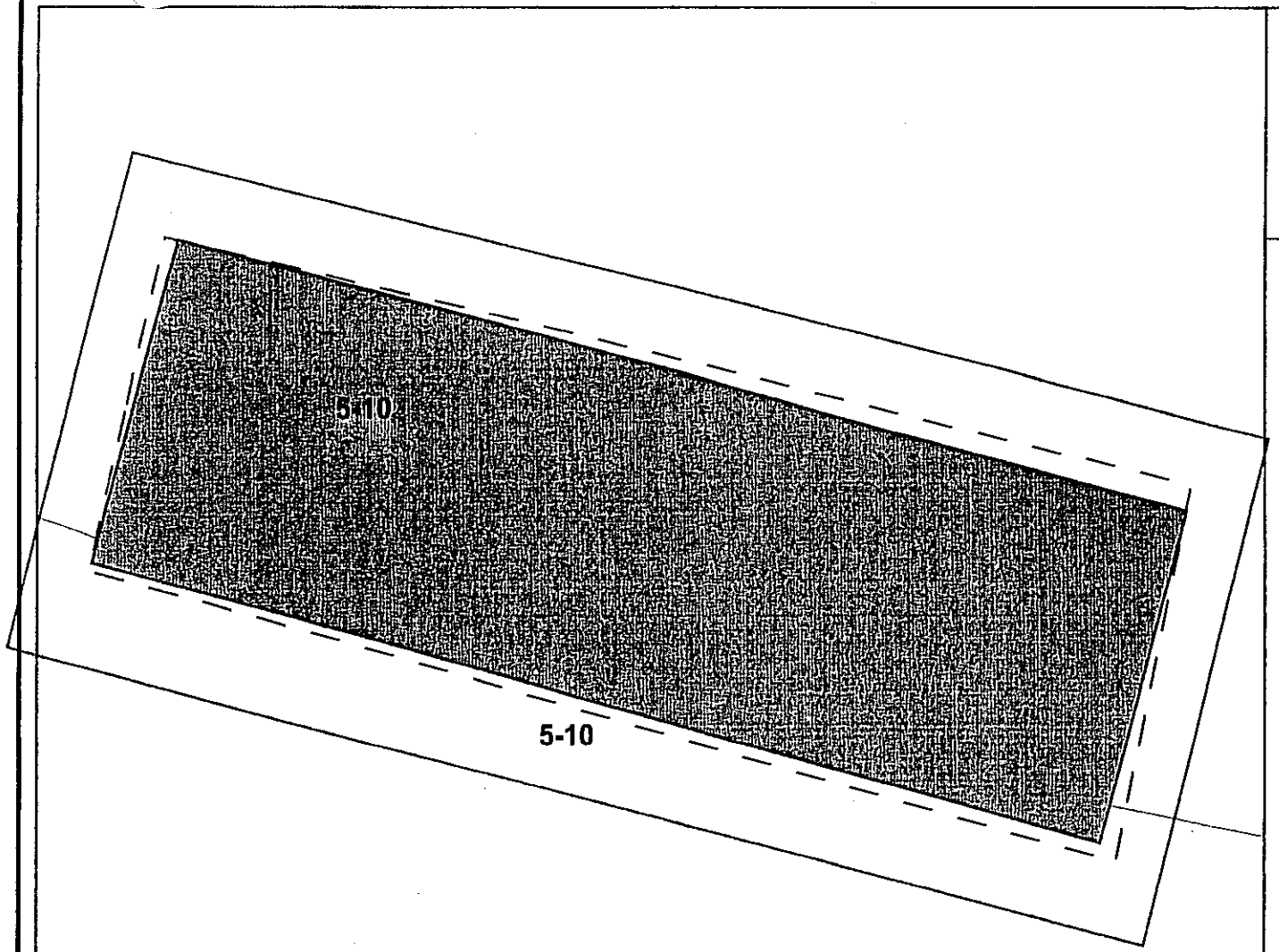
BROOKHAVEN NATIONAL LABORATORY

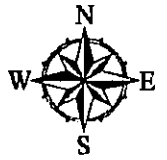
Location of ISOCS Samples Collected for Cesium-137 During Excavation and Confirmation Sampling AOC4B1-SB05

Figure A

Environmental Information Management System

ALR - 10/21/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-sb05isocs.mxd
r:/graphics/ou5/stp-cs/aoc4b1-sb05isocs.mxd





Legend

Excavation Area

Pre-Excavation Boundary

0 4 8 Feet

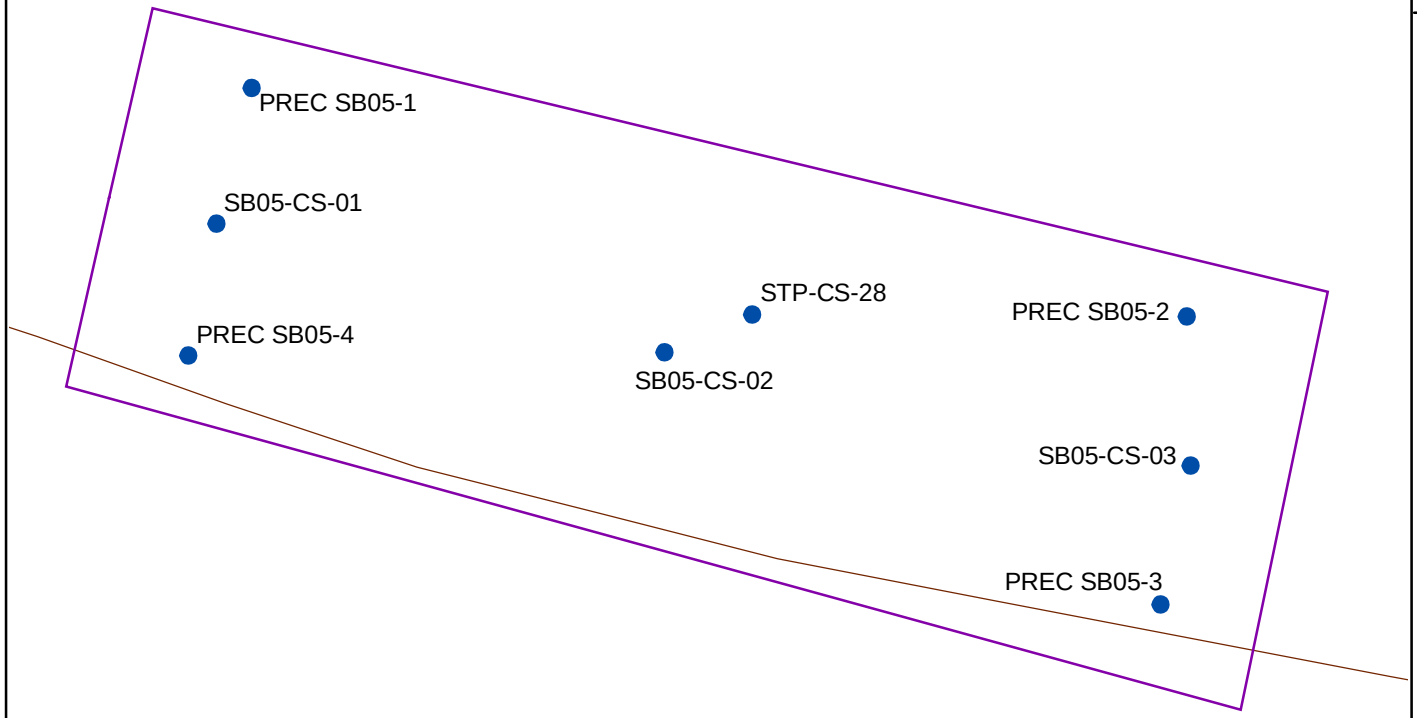
BROOKHAVEN NATIONAL LABORATORY

Environmental Information Management System

Preliminary Nal Walkover Survey (7-30-02)
(Values Expressed as Gross x1000 cpm)
AOC4B1-SB05

Figure B

KMG - 03/20/03
r:/arcmap_projects/ou5/
stp-cs/aoc4b1-sb05.mxd



N
W
E
S

Legend

- Fence
- Dirt Roads
- Paved Roads
- Excavation Area
- Sample Locations

0 4 8
Feet

BROOKHAVEN NATIONAL LABORATORY

Location of Final Confirmatory Samples for Mercury (Hg < 2ppm) AOC4B1-SB05

Figure C

Environmental Information Management System

JLH - 02/24/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-sb05.mxd
r:/graphics/ou5/stp-cs/aoc4b1-sb05.mxd

AOC 4B1-SB05 Figure D Final Walkover Survey

BLDG.#: N/A LOCATION: SEWAGE TREATMENT PLANT OUTF #4 DATE/TIME: 2-3-03/ 0400

☐ ROUTINE
☒ SPECIAL WALKOVER
☐ RWP#
☐ WP#

MODEL	E600	NAI PROBE				
SERIAL#	00139	4001				
Cal Due Date	3-7-03	3-7-03				
Source Check OK (Yes or No)	Y	Y				

DOSE RATES (HIGHEST)		AIRBORNE CONTAMINATION		
CONTACT	N/A	TIME	uCi/cc	%DAC
GENERAL AREA			N/A	

LEGEND: O SMEAR SURVEY LOCATION ☐ MASSLINN SURVEY LOCATION
XXX Y = CONTACT READING
ZZZ = READING @ 30 Cm
Δ AIR SAMPLE LOCATION
Y = RADIATION TYPE

SMEAR SURVEY RESULTS
(DPM/100 cm²)
³H B-γ α

☐ All Dose Rates are in mR/Hr and taken at waist level unless otherwise noted.
☐ All masslinn wipes are <1,000 dpm/LAS
☐ Frisked various areas – all were less than 100cpm
☐ See Attachment for smear survey results

1.	8.	15.	22.		
2.	9.	16.	23.		
3.	10. N	17.	24.		
4.	11.	18.	25.		
5.	12. Δ	19.	26.		
6.	13.	20.	27.		
7.	14.	21.	28.		

MASSLINN SURVEY RESULTS
(DPM/LAS)

1.	8.
2.	9.
3.	10.
4. N	11. Δ
5.	12.
6.	13.
7.	14.

WALKOVER SURVEY OF SOIL CONTAMINATION AREA AOC4B1-~~SB07~~ SB05 AT SEWAGE TREATMENT PLANT
USING AN E-600 w/NAI PROBE
E600 BKG- 5.57Kcpm
MDCR- 1128ncpm
ALL READINGS IN NET COUNTS/MINUTE

SURVEYED BY: Kenneth C Gant 2803 REVIEWED BY: [signature] 2-10-03
Signature/date Signature/date

Form FS-1000.1 FS-SOP-1000, rev 3, attch. 8.2, File Code: HP3120

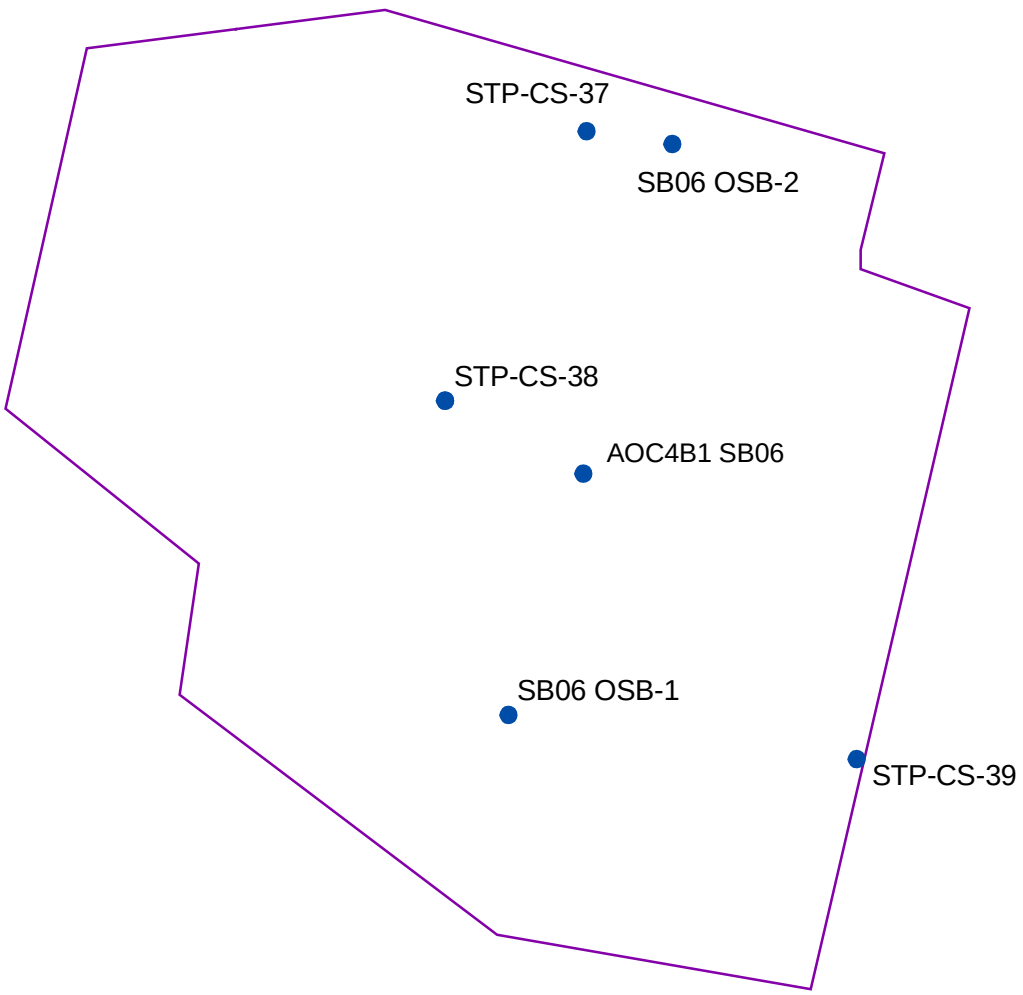
ANALYTICAL DATA FOR EXCAVATION AREA
AOC 4B1 SB05

Mercury Results < 2 ppm

Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
PREC SB05-1	6/5/2002	0.09	0.00203	0	mg/kg	0.25	NA		S
PREC SB05-2	6/5/2002	0.24	0.00203	0	mg/kg	0.25	NA		S
PREC SB05-3	6/5/2002	0.47	0.00203	0	mg/kg	0.25	NA		S
PREC SB05-4	6/5/2002	0.47	0.00203	0	mg/kg	0.25	NA		S
SB05-CS-01	10/9/2002	0.30		0	mg/kg	0.5	0.8		S
SB05-CS-02	10/9/2002	1.44		0	mg/kg	0.5	0.8		S
SB05-CS-03	10/9/2002	0.12		0	mg/kg	0.5	0.8		S
STP-CS-28	1/22/2003	0.80	0.013	0	mg/kg	0.25	0.8	B	S

Cesium-137

Sample ID	Sample Date	Value	MDA	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Lab Qual	Method
AOC4B1 SB05	1/31/1995	67.00			pCi/g	0.25	NA		ISOCS
STP-CS-28	1/22/2003	1.80	0.3	0.4	pCi/g	0.25	0.8		ISOCS



N
W
E
S

Legend

- Fence
- Dirt Roads
- Paved Roads
- Excavation Area
- Sample Locations

0 4 8
Feet

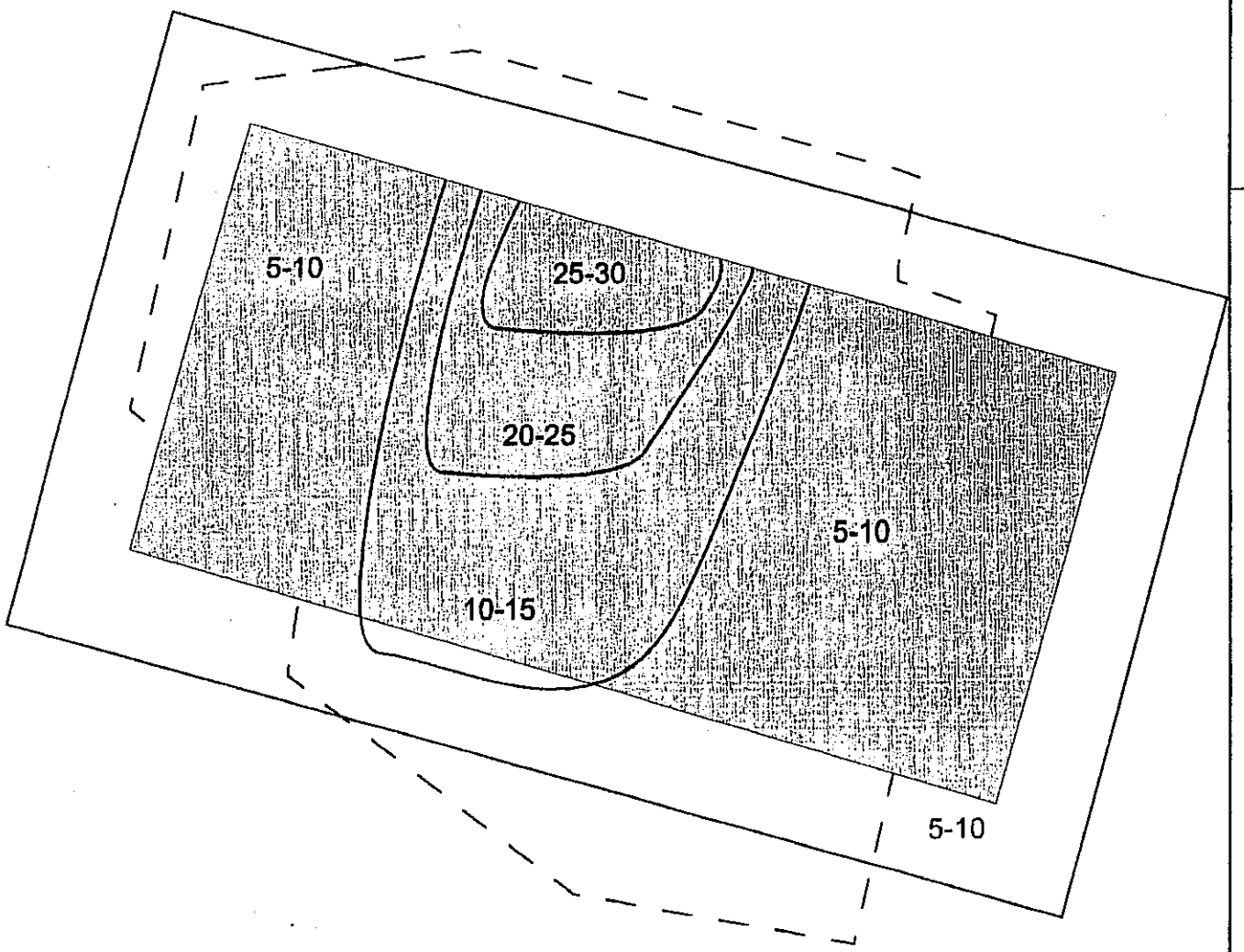
BROOKHAVEN NATIONAL LABORATORY

Location of ISOCS Samples Collected for Cesium-137 During Excavation and Confirmation Sampling AOC4B1-SB06

Figure A

Environmental Information Management System

ALR - 10/22/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-sb06isocs.mxd
r:/graphics/ou5/stp-cs/aoc4b1-sb06isocs.mxd



N
W E
S

Legend

Excavation Area

Pre-Excavation Boundary

0 4 8 Feet

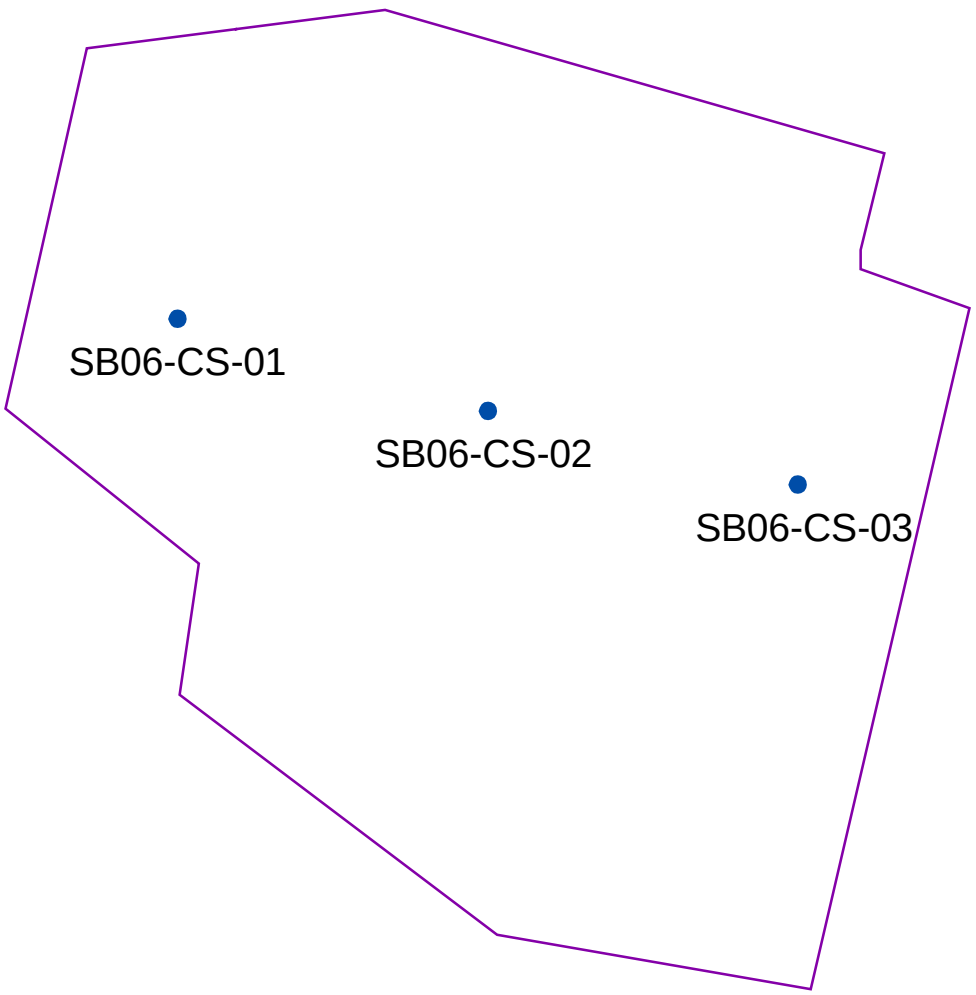
BROOKHAVEN NATIONAL LABORATORY

Environmental Information Management System

Preliminary Nal Walkover Survey (7-31-02) (Values Expressed as Gross x1000 cpm) AOC4B1-SB06

Figure B

KMG - 03/21/03
r:/arcmap_projects/ou5/
stp-cs/aoc4b1-sb06.mxd



N
W
E
S

Legend

- Fence
- Dirt Roads
- Paved Roads
- Excavation Area
- Sample Locations

0 4 8
Feet

BROOKHAVEN NATIONAL LABORATORY

Environmental Information Management System

Location of Final Confirmatory Samples for Mercury (Hg < 2ppm) AOC4B1-SB06

Figure C

ALR - 10/22/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-sb06.mxd
r:/graphics/ou5/stp-cs/aoc4b1-sb06.mxd

AOC 4B1-SB06 Figure D Final Walkover Survey

☐ ROUTINE ☒ SPECIAL WALKOVER ☐ RWP#: ☐ WPR#:

BLDG.#: N/A LOCATION: SEWAGE TREATMENT PLANT OUT #9 DATE/TIME: 1-30-03/1400

MODEL	E600	NAI PROBE				
SERIAL#	00739	4001				
Cal Due Date	3-7-03	3-7-03				
Source Check OK (Yes or No)	Y	Y				

DOSE RATES (HIGHEST)		AIRBORNE CONTAMINATION		
CONTACT	N/A	TIME	uCi/cc	%DAC
GENERAL AREA			N/A	

LEGEND: O SMEAR SURVEY LOCATION ☐ MASSLINN SURVEY LOCATION

XXX Y / ZZZ — XXX = CONTACT READING, ZZZ = READING @ 30 Cm — Δ AIR SAMPLE LOCATION

Y = RADIATION TYPE

SMEAR SURVEY RESULTS (DPM/100 cm²)

³H B-γ α

- ☐ All Dose Rates are in mR/Hr and taken at waist level unless otherwise noted.
- ☐ All masslinn wipes are <1,000 dpm/LAS
- ☐ Frisked various areas – all were less than 100cpm
- ☐ See Attachment for smear survey results

1.		8.		15.		22.	
2.		9.		16.		23.	
3.		10.		17.		24.	
4.		11.		18.		25.	
5.		12.		19.		26.	
6.		13.		20.		27.	
7.		14.		21.		28.	

MASSLINN SURVEY RESULTS (DPM/LAS)

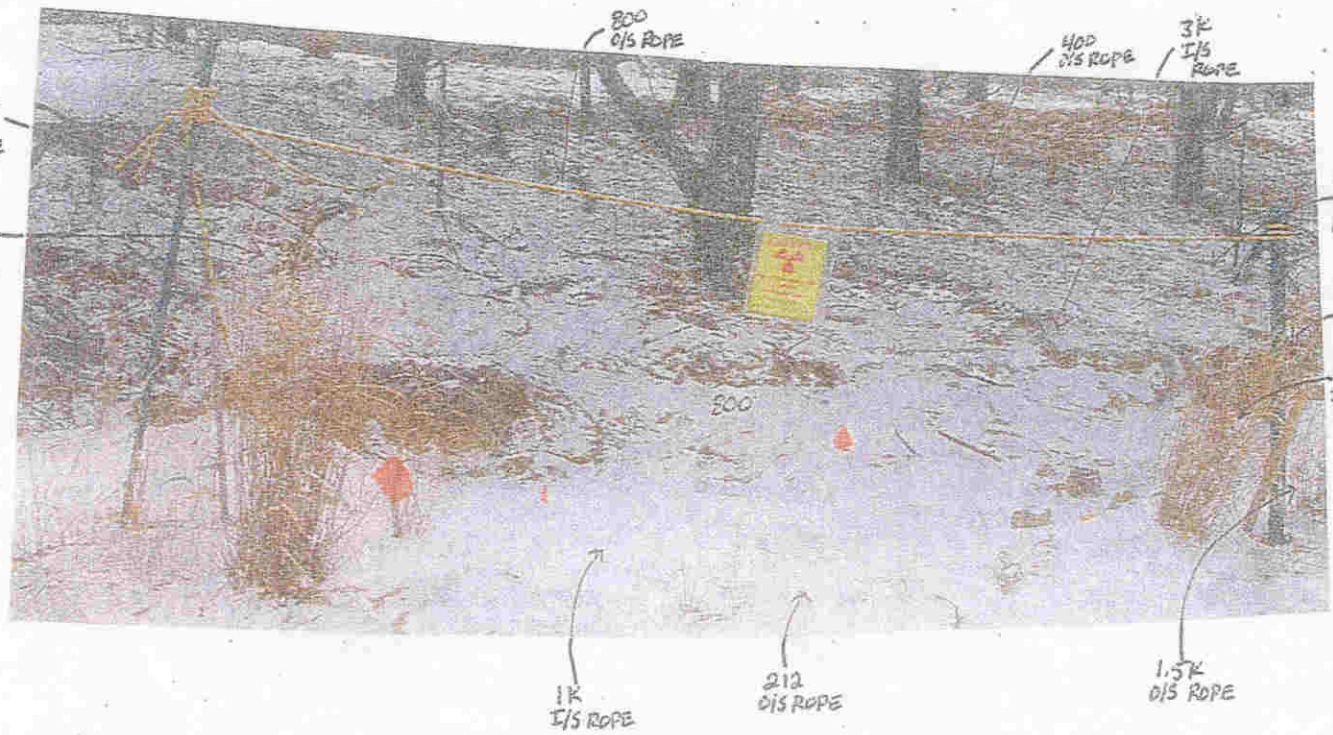
1.		8.	
2.		9.	
3.		10.	
4.	N	11.	A
5.		12.	
6.		13.	
7.		14.	

WALKOVER SURVEY OF CONTAMINATED AREA AOC4B1-SB06 AT SEWAGE TREATMENT PLANT USING AN E-600 W/ NAI PROBE.

E600 BKG - 5.61K BKG cpm

MDCR - 1132 nCpm

ALL READINGS IN NET COUNTS/MINUTE



SURVEYED BY: Ken Ford 2-8-03 (Signature/date) REVIEWED BY: [signature] 2-10-03 (Signature/date)

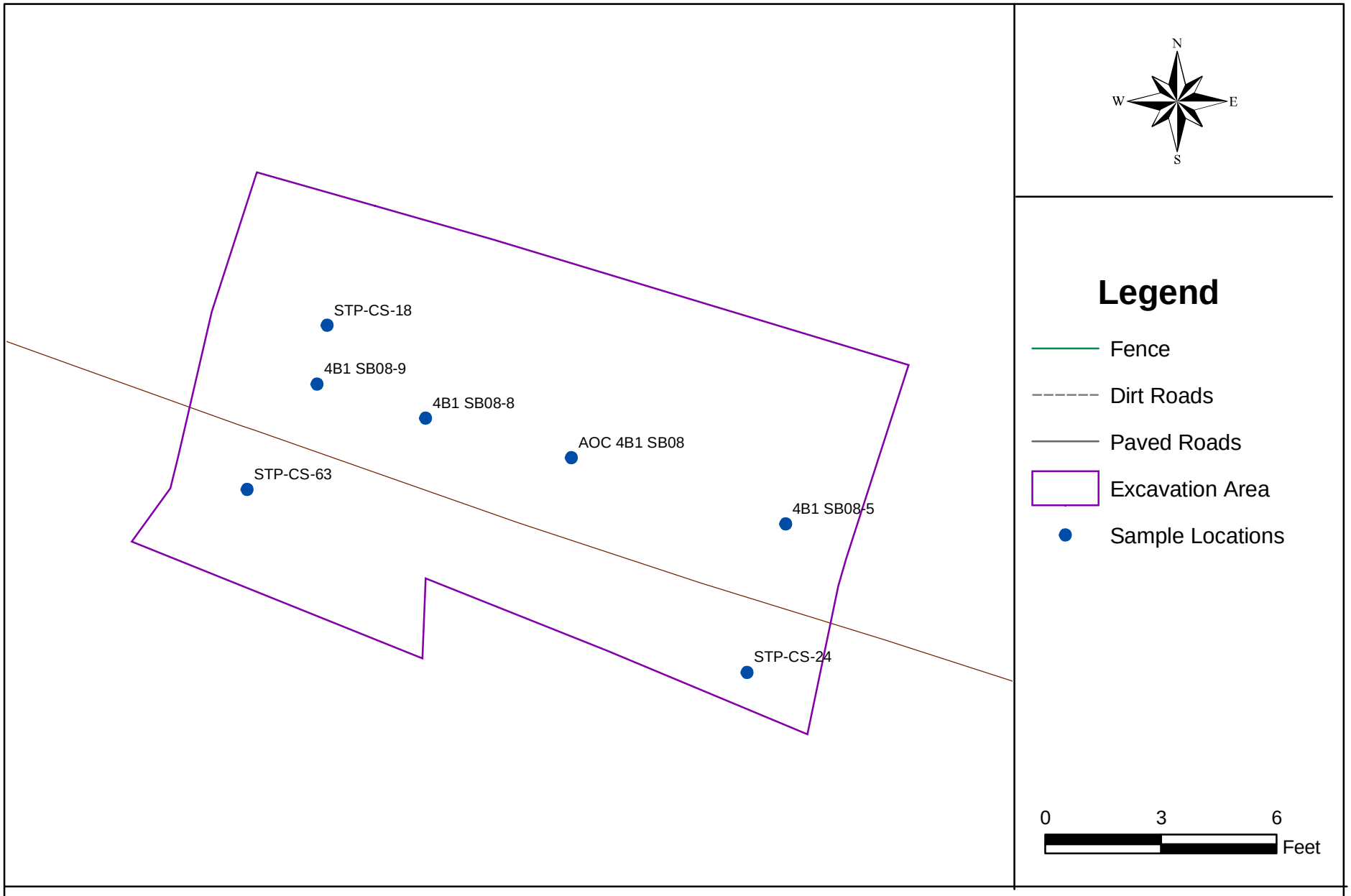
ANALYTICAL DATA FOR EXCAVATION AREA
AOC 4B1 SB06

Mercury Results < 2 ppm

Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.	Matrix
SB06-CS-01	1/22/2003	0.64		0	mg/kg	0.5	2		S
SB06-CS-02	1/22/2003	0.57		0	mg/kg	0.5	2		S
SB06-CS-03	1/22/2003	0.06		0	mg/kg	0.5	2		S

Cesium-137

Sample ID	Sample Date	Value	MDA	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Lab Qual	Method
AOC4B1 SB06	2/1/1995	30.80			pCi/g	0.25	NA		Gamma
4B1 SB06	3/26/1999	41.33	0.053	4.159	pCi/g	0.2	NA		Gamma
4B1 SB06	3/26/1999	47.91	0.046	4.659	pCi/g	0.5	NA		Gamma
SB06 OSB1-1	11/15/2002	0.80	0.2	0.2	pCi/g	0-1	1		ISOCS
SB06 OSB1-2	11/15/2002	1.30	0.2	0.3	pCi/g	1-2	1		ISOCS
SB06 OSB1-3	11/15/2002	ND	0.1		pCi/g	2-3	1		ISOCS
SB06 OSB2-1	11/15/2002	14.70	0.1	1.4	pCi/g	0-1	1		ISOCS
SB06 OSB2-2	11/15/2002	5.10	0.2	0.6	pCi/g	1-2	1		ISOCS
SB06 OSB2-3	11/15/2002	2.80	0.2	0.4	pCi/g	2-3	1		ISOCS
STP-CS-37	1/22/2003	8.10	0.3	0.9	pCi/g	0.25	2		ISOCS
STP-CS-38	1/22/2003	2.00	0.2	0.4	pCi/g	0.25	2		ISOCS
STP-CS-39	1/22/2003	10.40	0.4	1	pCi/g	0.25	2		ISOCS



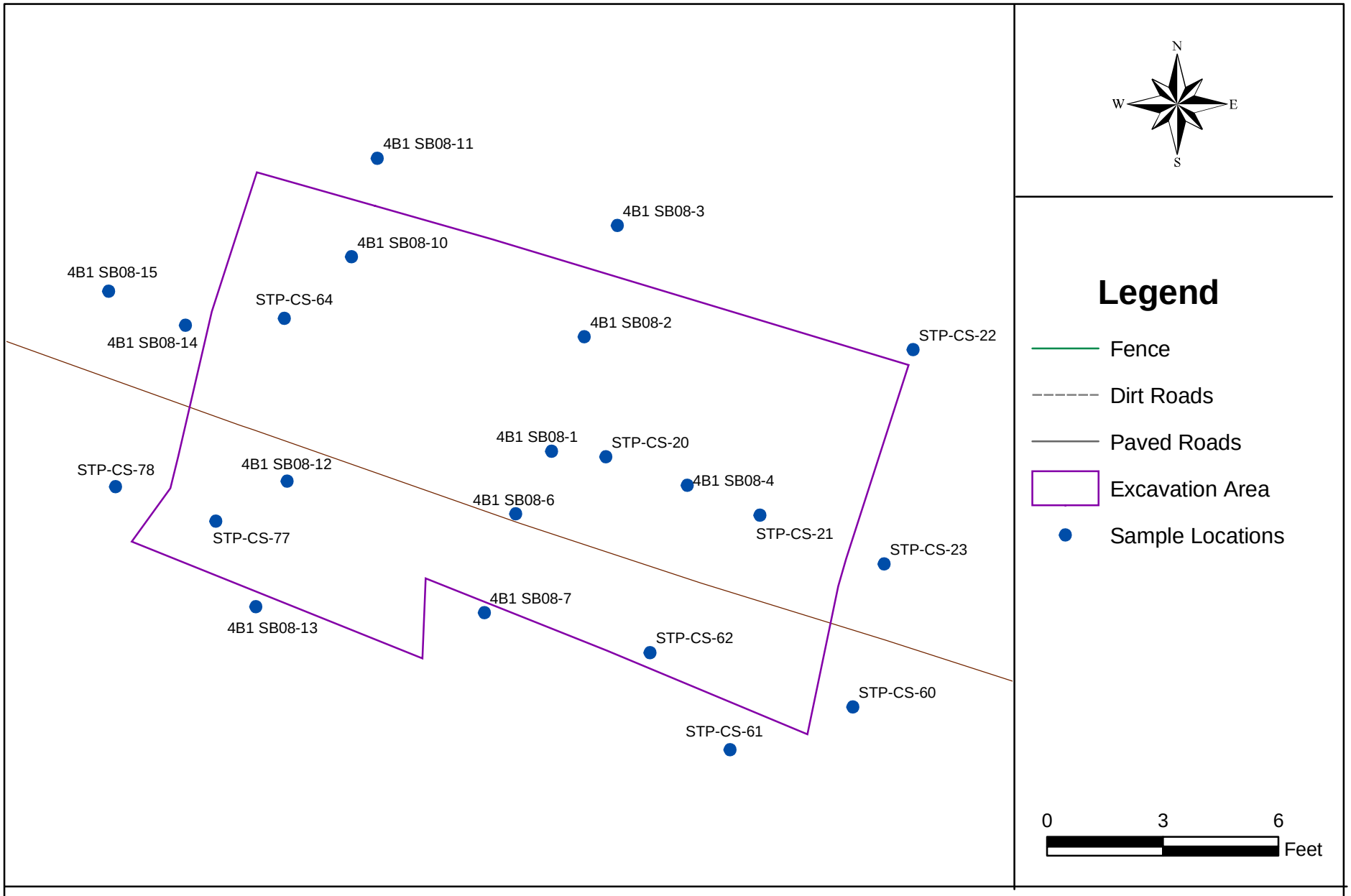
BROOKHAVEN NATIONAL LABORATORY

Location of Elevated Mercury Samples (Hg > 2ppm) Prior to Completion of Excavation AOC4B1-SB08

Figure A

Environmental Information Management System

ALR - 10/22/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-sb08b.mxd
r:/graphics/ou5/stp-cs/aoc4b1-sb08b.mxd



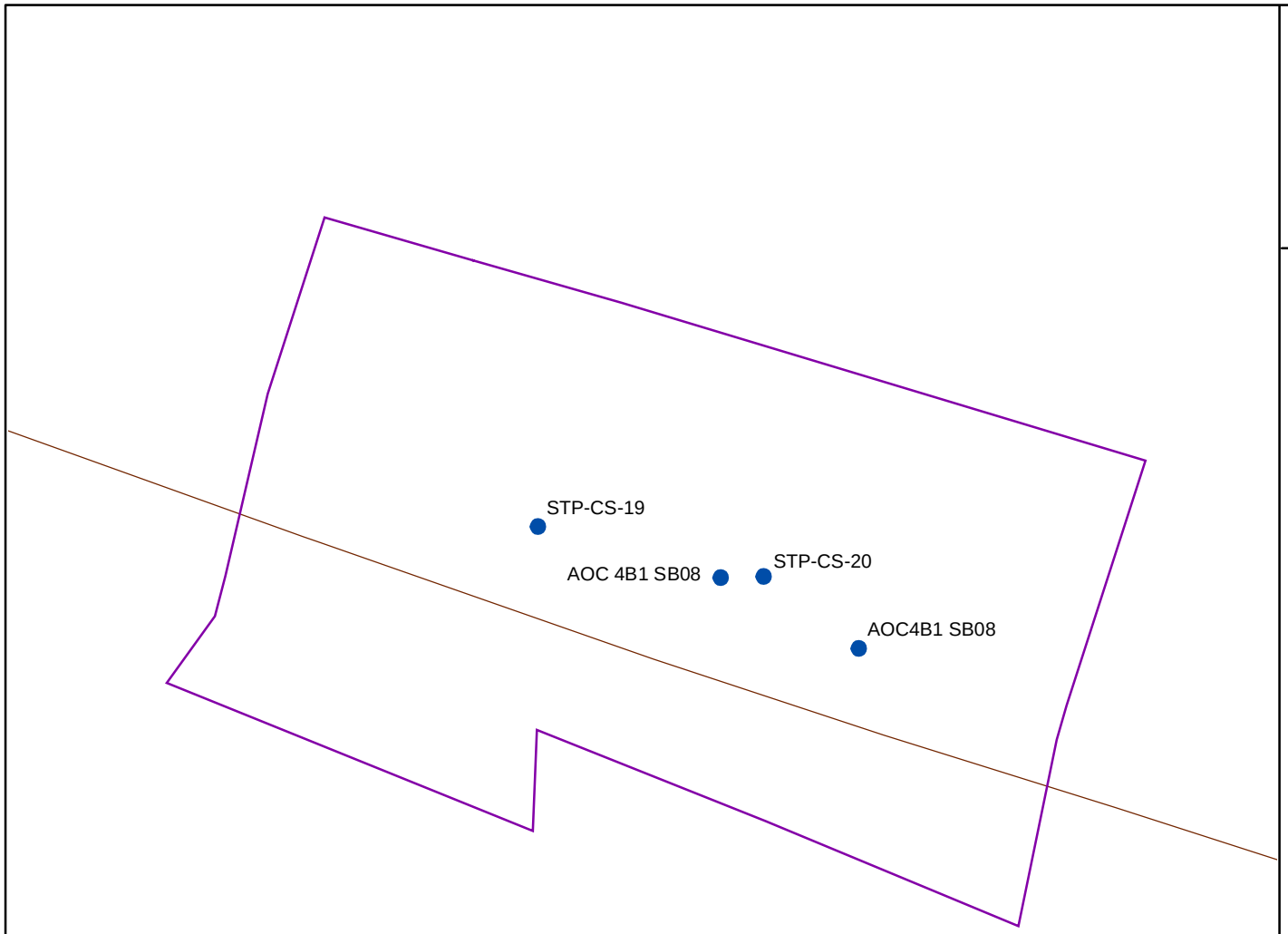
BROOKHAVEN NATIONAL LABORATORY

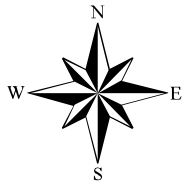
Environmental Information Management System

Location of Final Confirmatory Samples for Mercury (Hg < 2ppm) AOC4B1-SB08

Figure B

ALR - 10/22/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-sb08.mxd
r:/graphics/ou5/stp-cs/aoc4b1-sb08.mxd





Legend

- Fence
- Dirt Roads
- Paved Roads
- Excavation Area
- Sample Locations

0 3 6 Feet

BROOKHAVEN NATIONAL LABORATORY

Location of ISOCS Samples Collected for Cesium-137 During Excavation and Confirmation Sampling AOC4B1-SB08

Figure C

Environmental Information Management System

ALR - 10/22/03
r:/arcmap_projects/ou5/stp-cs/aoc4b1-sb08isocs.mxd
r:/graphics/ou5/stp-cs/aoc4b1-sb08isocs.mxd

ANALYTICAL DATA FOR EXCAVATION AREA
AOC 4B1 SB08

Mercury Results > 2 ppm

Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.
AOC4B1 SB08	7/18/2002	7.2	0.32	0	MG/KG	0.5	NA	
4B1 SB08-5	11/5/2002	2.31		0	MG/KG	0.5	NA	
4B1 SB08-8	11/5/2002	2.90		0	MG/KG	0.5	NA	
4B1 SB08-9	11/5/2002	5.51		0	MG/KG	0.5	NA	H
STP-CS-18	1/22/2003	3.17	0.027	0	MG/KG	0.25	1	B
STP-CS-24	1/22/2003	3.17		0	MG/KG	0.25	1	
STP-CS-63	1/30/2003	3.17		0	MG/KG	0.25	1.5	

Mercury Results < 2 ppm

Sample ID	Sample Date	Value	Det. Limit	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.
4B1 SB08-1	11/5/2002	1.205		0	MG/KG	0.5	NA	
4B1 SB08-2	11/5/2002	0.795		0	MG/KG	0.5	NA	
4B1 SB08-3	11/5/2002	0.110		0	MG/KG	0.5	NA	
4B1 SB08-4	11/5/2002	0.333		0	MG/KG	0.5	NA	
4B1 SB08-6	11/5/2002	0.656		0	MG/KG	0.5	NA	
4B1 SB08-7	11/5/2002	1.251		0	MG/KG	0.5	NA	
4B1 SB08-10	11/18/2002	0.76		0	MG/KG	0.5	NA	
4B1 SB08-11	11/18/2002	0.48		0	MG/KG	0.5	NA	
4B1 SB08-12	11/18/2002	1.280		0	MG/KG	0.5	NA	
4B1 SB08-13	11/18/2002	0.330		0	MG/KG	0.5	NA	
4B1 SB08-14	11/18/2002	1.430	0.014	0	MG/KG	0.5	NA	
4B1 SB08-15	11/18/2002	1.440	0.014	0	MG/KG	0.5	NA	
STP-CS-20	1/22/2003	1.37	0.013	0	MG/KG	0.25	1	
STP-CS-21	1/22/2003	1.83	0.013	0	MG/KG	0.25	1	
STP-CS-22	1/22/2003	0.402	0.001	0	MG/KG	0.25	1	
STP-CS-23	1/22/2003	0.945	0.012	0	MG/KG	0.25	1	
STP-CS-60	1/30/2003	0.90		0	MG/KG	0.25	1	
STP-CS-61	1/30/2003	0.47		0	MG/KG	0.25	1	
STP-CS-62	1/30/2003	0.32		0	MG/KG	0.25	1.5	
STP-CS-64	1/30/2003	1.9		0	MG/KG	0.25	1.5	
STP-CS-77	2/5/2003	0.6		0	MG/KG	0.25	2	
STP-CS-78	2/5/2003	1.22		0	MG/KG	0.25	0.5	

Cesium-137

Sample ID	Sample Date	Value	MDA	Error	Units	Sample Depth ft	Cumulative Excavation Depth ft	Qual.
4B1 SB08	3/29/1999	6.345	0.034	0.61	pCi/g	0.2	NA	
4B1 SB08	3/29/1999	8.635	0.037	0.828	pCi/g	0.5	NA	
4B1 SB08	3/29/1999	63.46	0.083	7.364	pCi/g	1	NA	
4B1 SB08	3/29/1999	15.04	0.039	1.435	pCi/g	1.5	NA	
4B1 SB08	3/29/1999	10.37	0.046	1.018	pCi/g	2	NA	
4B1 SB08	3/29/1999	13.31	0.041	1.327	pCi/g	2.5	NA	
4B1 SB08	3/29/1999	5.363	0.034	0.525	pCi/g	3	NA	
4B1 SB08	3/29/1999	9.586	0.054	0.919	pCi/g	3.5	NA	
4B1 SB08	3/29/1999	5.848	0.034	0.6	pCi/g	4	NA	
4B1 SB08	3/29/1999	7.661	0.044	0.765	pCi/g	4.5	NA	
4B1 SB08	3/29/1999	12.52	0.097	1.628	pCi/g	5	NA	
4B1 SB08	3/29/1999	9.697	0.052	1.019	pCi/g	5.5	NA	
4B1 SB08	3/29/1999	4.636	0.05	0.062	pCi/g	6	NA	
AOC4B1 SB08	7/18/2002	26.9	0.0422	2.75	pCi/g	0.5	NA	
AOC4B1 SB08	7/18/2002	23.5	0.0391	2.39	pCi/g	1.5	NA	
STP-CS-19	1/22/2003	10.2	0.3	1	pCi/g	0.25	1	
STP-CS-20	1/22/2003	8.8	0.4	0.9	pCi/g	0.25	1	

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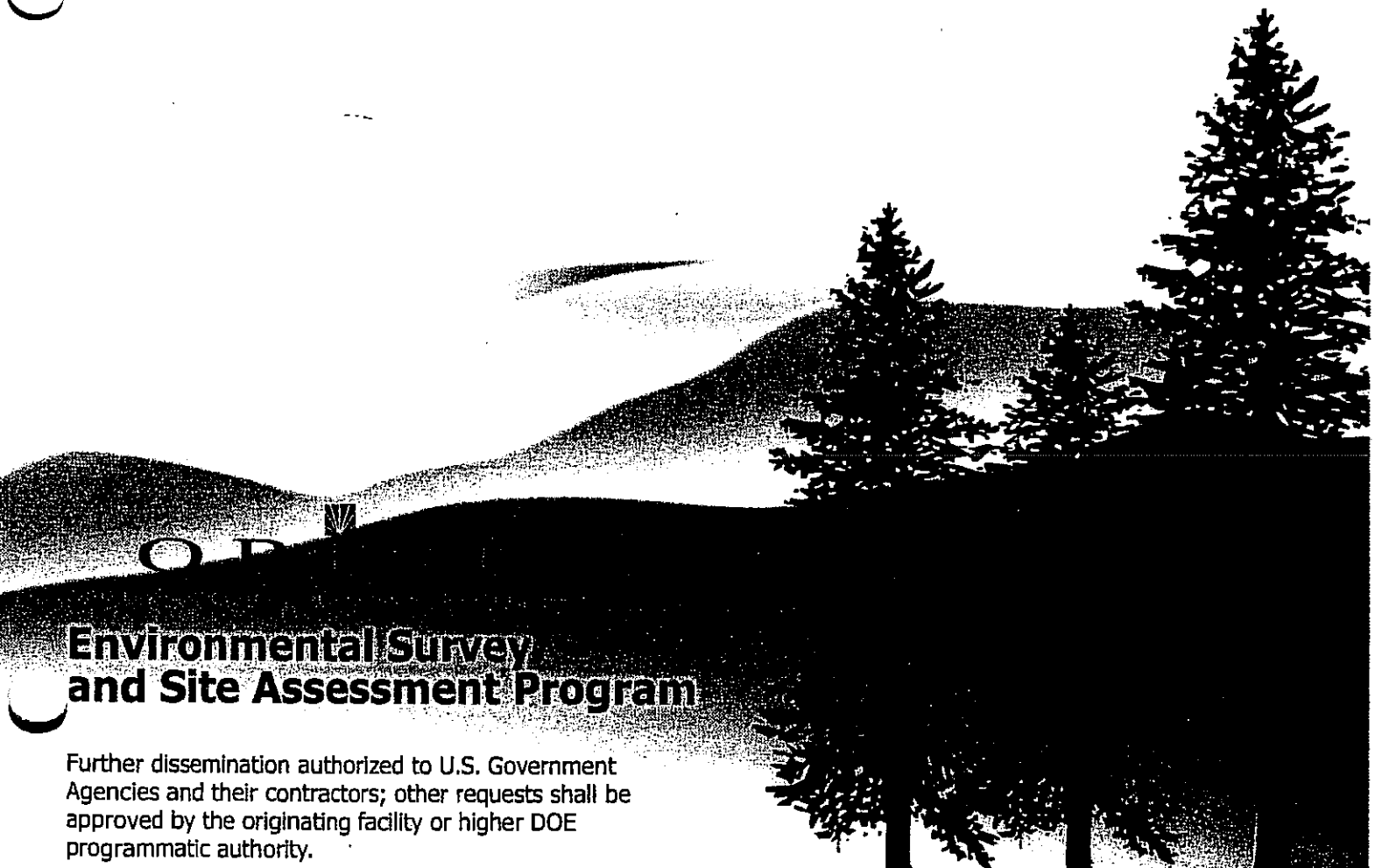
VERIFICATION SURVEY OF THE OPERABLE UNIT V (OU V) AREA OF CONCERN 4B SEWAGE TREATMENT PLANT BROOKHAVEN NATIONAL LABORATORY UPTON, NEW YORK

P. C. WEAVER

Prepared for the
Department of Energy
Brookhaven Area Office



Environmental Survey and Site Assessment Program

VERIFICATION SURVEY OF THE OPERABLE UNIT V (OU V) AREA OF CONCERN 4B SEWAGE TREATMENT PLANT BROOKHAVEN NATIONAL LABORATORY UPTON, NEW YORK

Prepared by

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Department of Energy
Brookhaven Area Office

FINAL REPORT

June 2003

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VERIFICATION SURVEY
OF THE OPERABLE UNIT V (OU V)
AREA OF CONCERN 4B
SEWAGE TREATMENT PLANT
BROOKHAVEN NATIONAL LABORATORY
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ABBREVIATIONS AND ACRONYMS

AEC	Atomic Energy Commission
AOC	Area of Concern
BAO	Brookhaven Area Office
BNL	Brookhaven National Laboratory
DCGL	derived concentration guideline level
DOE	Department of Energy
DQOs	data quality objectives
DTPA	diethylenetriaminepentaacetic acid
EDTA	ethylenediaminetetraacetic acid
EML	Environmental Measurements Laboratory
ERDA	Energy Research and Development Administration
ESSAP	Environmental Survey and Site Assessment Program
FSS	final status survey
ITP	Intercomparison Testing Program
kg	kilogram
m	meter
m^2	square meter
MAPEP	Mixed Analyte Performance Evaluation Program
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
NEPA	National Environmental Policy Act
NIST	National Institute of Science and Technology
NRC	Nuclear Regulatory Commission
NRIP	NIST Radiochemistry Intercomparison Program
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
OU V	Operable Unit V
pCi/g	picocuries per gram
STP	Sewage Treatment Plant

VERIFICATION SURVEY
OF THE OPERABLE UNIT V (OU V)
AREA OF CONCERN 4B
SEWAGE TREATMENT PLANT
BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK

INTRODUCTION AND SITE HISTORY

Established in 1947, Brookhaven National Laboratory (BNL) has designed, built, and operated many research facilities for the scientific community. Formerly operated by the U.S. Army as Camp Upton during World Wars I and II and between the wars by the Civilian Conservation Corps, the site was transferred to the Atomic Energy Commission (AEC) in 1947, to the Energy Research and Development Administration (ERDA) in 1975, and to the U.S. Department of Energy (DOE) in 1977. While the site continues to carry out their DOE mission, legacy environmental restoration activities are also being conducted.

BNL has recently conducted remediation of contaminated soils from the BNL Sewage Treatment Plant (STP), designated as Operable Unit V (OU V). This facility was built by the U.S. Army between the period of 1940 and 1944, upgraded in 1967, and upgraded again in 1997 to convert the plant from a primary to a tertiary treatment facility. The original sewer line to the STP, which was installed in 1917, has since been replaced. The STP is an active facility that is used to process sanitary sewage only from BNL operations. There are several areas of concern (AOC) associated with the STP, which include the AOC 4 (sewage treatment plant), the AOC 21 (associated sewer lines), and the AOC 23 (eastern off-site tritium plume) (BNL 2001). Sub-areas associated with AOC 4 include the sludge drying beds, sand filter beds and firing range berms, Imhoff Tanks, hold-up ponds, and satellite disposal area.

Initial soil sampling in OU V by BNL indicated significant levels of Cs-137 contamination. The highest levels were identified in the sand filter beds and berms. BNL initiated cleanup activities in AOC 4 and AOC 21 in 2002; however, only the AOC 4 area filter beds and berms were addressed during this phase of BNL's final status survey (BNL 2003a).

DOE's Brookhaven Area Office (BAO) is responsible for the oversight of the OU V remedial action activities. It is the policy of the DOE to perform independent (third party) verification of remedial action activities conducted within the Office of Site Closure programs. The purpose of this independent verification was to confirm that remedial actions were effective in meeting established and site-specific guidelines and that the documentation accurately describes the radiological conditions at the site. The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) was designated by the DOE as the organization responsible for this task at BNL, and was requested to verify the current radiological status of the cleanup activities associated with the BNL OU V AOC 4.

SITE DESCRIPTION

The Brookhaven National Laboratory is situated on 5,265 acres of land owned by the DOE, located in Suffolk County, New York (Figure 1). Approximately 25 percent of this area is developed for laboratory and support facilities, while the remainder is wooded and undeveloped. OU V is located adjacent to the Peconic River in the northeastern quadrant of the BNL property along its eastern border (Figure 2). The OU V AOC 4 includes the sewage treatment plant, Sub-AOC 4A (sludge drying beds), Sub-AOC 4B (sand filter beds and firing range berms), Sub-AOC 4C (Imhoff Tanks), Sub-AOC 4D (hold-up ponds), and Sub-AOC 4E (satellite disposal area) (BNL 2003a). However, only the AOC 4A and AOC 4B survey units were surveyed during this phase of the project; with much of the focus on AOC 4B. The AOC 4B consists of nine Class 1 survey units of approximately 1,700 square meters (m^2) each. There are six Class 2 survey units, four that are approximately 7,600 m^2 each and two units that total 9,000 m^2 (Figure 3). Survey unit classification by BNL was based on the guiding principles in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NRC 2000).

OBJECTIVES

The objectives of the verification survey were to confirm that remedial actions were effective in meeting the established release criteria and that documentation accurately and adequately described the final radiological conditions of the areas associated with the OU V remedial action.

DOCUMENT REVIEW

ESSAP reviewed the OU V record of decision and remedial action work and sampling plan in preparation for the verification effort (BNL 2001 and 2002a). ESSAP also reviewed the BNL final status soil sample data collected from the OU V, prior to initiating verification activities.

SURVEY PROCEDURES

A survey team from ESSAP performed visual inspections and independent measurements and sampling of the berms and 6 of 8 filter beds at the OU V during the period of March 18 to 20, 2003. Verification survey activities were conducted in accordance with the approved verification survey plan, and the ORISE/ESSAP Survey Procedures and Quality Assurance Manuals (ORISE 2002 and 2003a, b, and c).

REFERENCE SYSTEM

ESSAP used the grid system established by the contractor and prominent site features for referencing measurement and sample locations.

SURFACE SCANS

Gamma scans were conducted over 100% of the berms with particular attention given to excavated areas in the OU V survey units (Figure 3). Where water was present, scans could not be performed. Filter beds 1 and 2 contained water, rendering them inaccessible for scanning. Approximately 20% of the total area of filter beds 3 through 6 were scanned. Scans were performed over greater than 50% of the total area in filter beds 7 and 8. Again, particular attention was given to open excavated areas that extended from the berms into the filter beds. All gamma radiation scans were performed using NaI scintillation detectors coupled to ratemeters with audible indication. Locations of elevated gamma radiation were marked and identified for further investigation.

SOIL SAMPLING

ESSAP collected 25 soil samples along the berms and in the Class 1 excavations. Sample locations were selected based on gamma surface scan results (Figure 4). Flags were placed to identify areas that exceeded at least twice background. Not all of the flagged locations that were identified by ESSAP were sampled. The team focused on the flagged locations with the highest gamma radiation levels. Sample numbers 1 through 12 were from the Class 1 excavated areas and sample numbers 13 through 25 were collected along the sides of the berms at locations where elevated radiation was at least three times background or greater. Samples were collected at depths of 0-15 cm and 15-30 cm.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Soil samples were returned to ESSAP's Oak Ridge, Tennessee laboratory for analysis and interpretation. Sample analyses were performed in accordance with the ORISE/ESSAP Laboratory Procedures Manual (ORISE 2003d). Soil samples were analyzed by gamma spectroscopy for the radionuclide of interest, Cs-137 and spectra were reviewed for other identifiable photopeaks. Specific analyses for Sr-90 by wet chemistry and for Pu-239/240 by alpha spectroscopy were performed on six randomly selected soil samples. Analytical results were reported in units of pCi/g.

FINDINGS AND RESULTS

DOCUMENT REVIEW

ESSAP reviewed the licensee's work plan, sampling plan, and soil analysis results for the AOC 4B areas. The review indicated that there were basic issues concerning radiological survey procedures. Comments were provided to DOE, after which BNL provided an appropriate response to identified issues in a revised sampling plan (ORISE 2003e, BNL 2002b).

The BNL final status soil sample results did not indicate any activity that exceeded the guidelines in any of the survey units.

SURFACE SCANS

Surface scans of the berms and excavations identified several areas of elevated gamma radiation that were significantly greater than background measurements for the site. Scans of the excavated areas identified elevated gamma radiation on the side wall of several excavations. Elevated locations were marked but not all locations were sampled. For example, in AOC4B1-GP01, five elevated locations were marked along the walls of the excavation; however, only two were sampled. In the AOC4B1-GP13 survey unit, six elevated locations were identified in the excavated area and in an area extending beyond its boundaries. Only two soil samples were collected from this survey unit.

There were no significant locations of elevated radiation noted in the accessible filter bed areas.

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES

The primary gamma-emitting radionuclide of concern was Cs-137; however, additional analyses were performed to ensure that Cs-137 was the only radionuclide contaminant present. Table 1 provides the radionuclide concentrations in soil samples as determined by gamma spectroscopy. Concentrations for Cs-137 ranged from 4.8 to 77.3 pCi/g. Gamma spectroscopy data were also reviewed for the presence of other radionuclides that had previously been used and identified at the BNL site. Radionuclide concentrations reported were as follows: Co-60 ranged from -0.01 to 0.10 pCi/g; Eu-152 ranged from -0.11 to 0.10 pCi/g; Am-241 ranged from 0.01 to 1.76 pCi/g; and U-238 concentrations ranged from 0.25 to 2.90 pCi/g.

The six samples selected for additional analyses for Sr-90 and Pu-239/240 were from locations 1, 3, 5, 12, 16, and 23. Sr-90 concentrations ranged from 0.01 to 0.84 pCi/g and Pu-239/240 concentrations ranged from -0.01 to 2.80 pCi/g.

COMPARISON OF RESULTS WITH GUIDELINES

The site release criterion for the primary radionuclide of concern, Cs-137, was 23 pCi/g (BNL 2002b). This site-specific DCGL was applicable for the average concentrations that may be

uniformly distributed within a survey unit. However, allowances for areas of residual contamination of approximately three times the average concentration, or 67 pCi/g, for Cs-137 can remain when averaged over the site (BNL 2003b). Other radionuclides that were identified, typically by gamma spectroscopy, were compared to the DCGLs that were previously established for BNL (2002a).

The first 12 samples were obtained where elevated radiation levels were detected in areas that had been excavated by BNL. Sample 1 was collected from the excavated area AOC4B1-GP13 from a depth of 15-30 cm. The concentration of Cs-137 in sample 1, exceeded the 67 pCi/g hot spot criterion with a total activity of 77 pCi/g. The Cs-137 concentration in surface soil samples (0-15 cm) 5 and 6—collected from elevated radiation areas in survey unit AOC4B1-GP08—were 48 and 42.5 pCi/g, respectively. Although these numbers were not above the hot spot limit, the additional gamma measurements obtained after the samples had been collected identified a notable increase in the level of activity which would be indicative of additional subsurface contamination. Samples 2 through 4 and samples 7 through 12 were also collected from open excavations in Class 1 survey units (Figure 4). The Cs-137 concentrations in these samples ranged from 4.8 to 37.1 pCi/g. Although the activity reported in seven samples collected from these areas was above the 23 pCi/g guideline, each of these locations were smaller than 1 m^2 in area and therefore would probably meet the hot spot criterion.

Thirteen soil samples were collected from elevated locations along the tops and the side edges of the berms. The Cs-137 activity ranged from 12.2 to 55.8 pCi/g. Individually, nine of the soil samples exceeded the 23 pCi/g guideline; however, these appeared to be primarily small point sources that would not exceed the hot spot criterion. The Cs-137 concentrations measured in samples 16 and 17 were 55.8 and 53.7 pCi/g, respectively. These samples were collected along the wall of the berms near the filter bed STP2-3 and both were obtained at a depth of 15-30 cm (Figure 4). Sample 17 was collected from an area of elevated radioactivity that was adjacent to the excavated AOC4B1-GP12 area (Figure 4). This area of elevated radiation extended beyond the boundaries of AOC4B1-GP12. Although the samples did not exceed the hot spot guideline, additional investigation into the elevated activity in this area was suggested due to the close proximity of the sample location to the Class 1 excavations.

The additional analyses for Sr-90 and Pu-239/240 did not identify concentrations of any significance. Sr-90 concentrations ranged from 0.01 to 0.84 pCi/g well below the 15 pCi/g DCGL. Pu-239/240 concentrations ranged from -0.01 to 2.80 pCi/g much less than the 40 pCi/g DCGL. Based on current guidance these small concentrations of radionuclides were well within the established unrestricted release criteria.

SUMMARY

During the period of March 18 through 20, 2003, the Environmental Survey and Site Assessment Program of the Oak Ridge Institute for Science and Education, performed verification survey activities at the Operable Unit V, Area of Concern 4B, Sewage Treatment Plant filter beds and berms at Brookhaven National Laboratory. Survey activities consisted of gamma surface scans and soil sampling. ESSAP collected 25 soil samples to verify BNL remediation results. Several of the samples collected by ESSAP were located near or at previous BNL sample locations. In comparing the post remediation soil data provided by BNL (prior to the verification survey) with that collected by ESSAP during the verification survey, there was a significant difference in reported soil concentrations. A review of these BNL data did not indicate the presence of any residual Cs-137 concentrations above the 23 pCi/g guideline while seventeen of the ESSAP samples collected exceeded the guideline limit.

The results of the ESSAP verification survey identified three areas of residual contamination that were close to or exceeded the hot spot limit in AOC4B1-GP08, AOC4B1-GP12, and AOC4B1-GP13. ESSAP suggested that BNL conduct additional investigations in those areas that bounded or extended through the areas. ESSAP did not collect samples to determine the approximate areas or boundary of the elevated activity. However, ESSAP attempted to identify each location of elevated radiation detected during the scans to provide a visual reference for BNL follow-up.

Concurrent with ESSAP verification sampling, BNL also collected samples at the same locations. Concentrations determined by BNL's ISOCS system were much lower than those reported by ESSAP. In addition, BNL also selected samples for additional analysis by their contract laboratory, General Engineering Laboratory (GEL). Values reported by GEL were similar to results reported

by ESSAP. In addition, ESSAP provided to GEL, five soil samples from ESSAP in an effort to provide confirmation of ESSAP results to BNL. GEL results were comparable to those reported by ESSAP (BNL 2003c).

BNL conducted additional investigations of AOC4B1-GP08, AOC4B-GP12, and AOC4B-GP13 based upon the recommendation of ESSAP findings. BNL's investigation did not result in the removal of additional soils. Surface scans performed by BNL were conducted to bound the area of elevated activity. An additional sample from each of the three areas was collected and analyzed. Based on sample results, BNL concluded that initial sampling removed the highest level of activity.

After careful review of the BNL and ESSAP results, it is ESSAP's opinion that residual radioactivity in the AOC 4B survey units of the OU V, when averaged over the site, meets the established 23 pCi/g criteria. However, ESSAP is concerned that BNL's initial soil data did not adequately represent the radiological conditions in AOC 4B; specifically, BNL soil sample results did not indicate the presence of any activity greater than the DCGL, while ESSAP identified numerous (17 of 25 soil samples) areas that exceeded the DCGL.

FIGURES

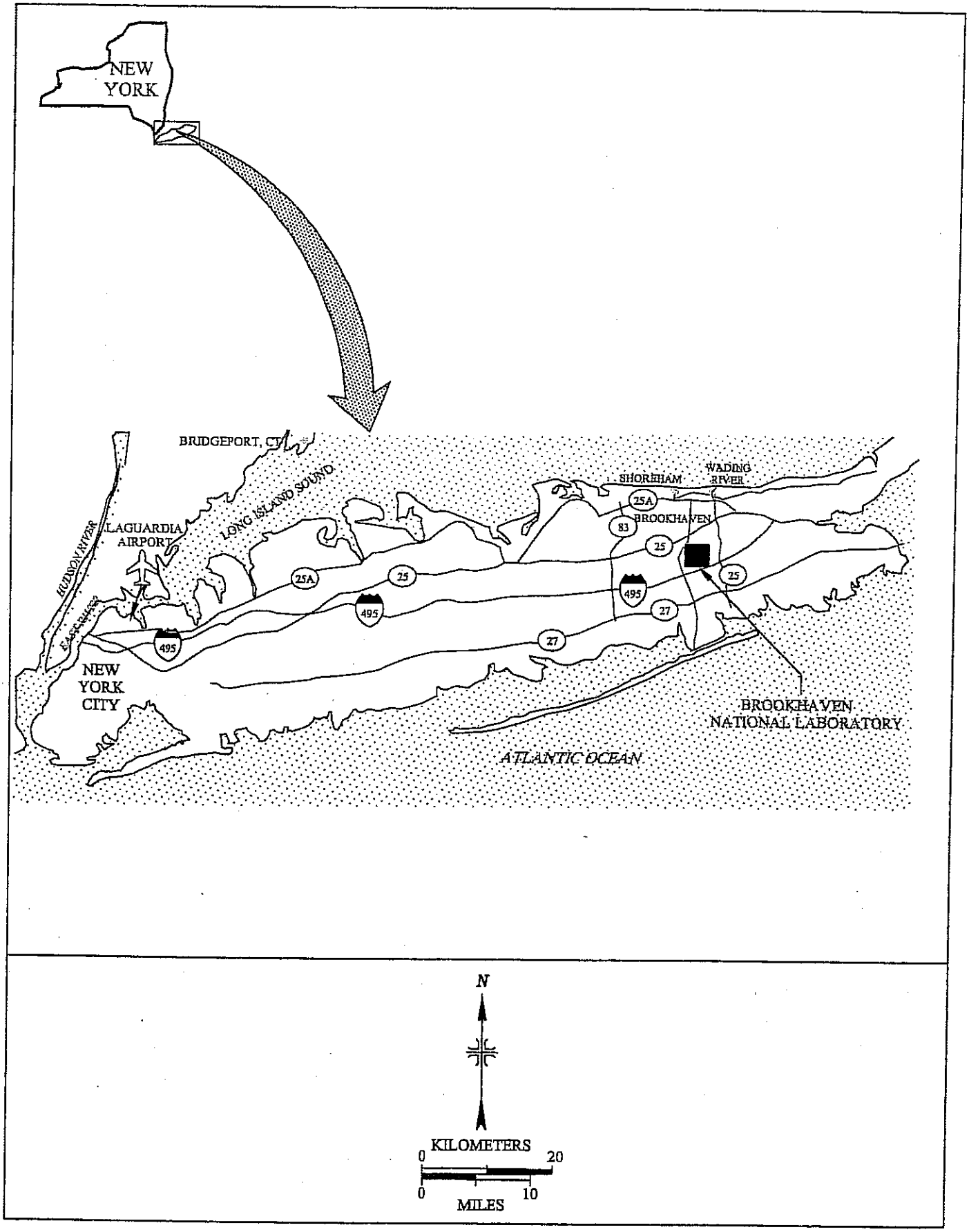

FIGURE 1: Location of Brookhaven National Laboratory, Upton, New York

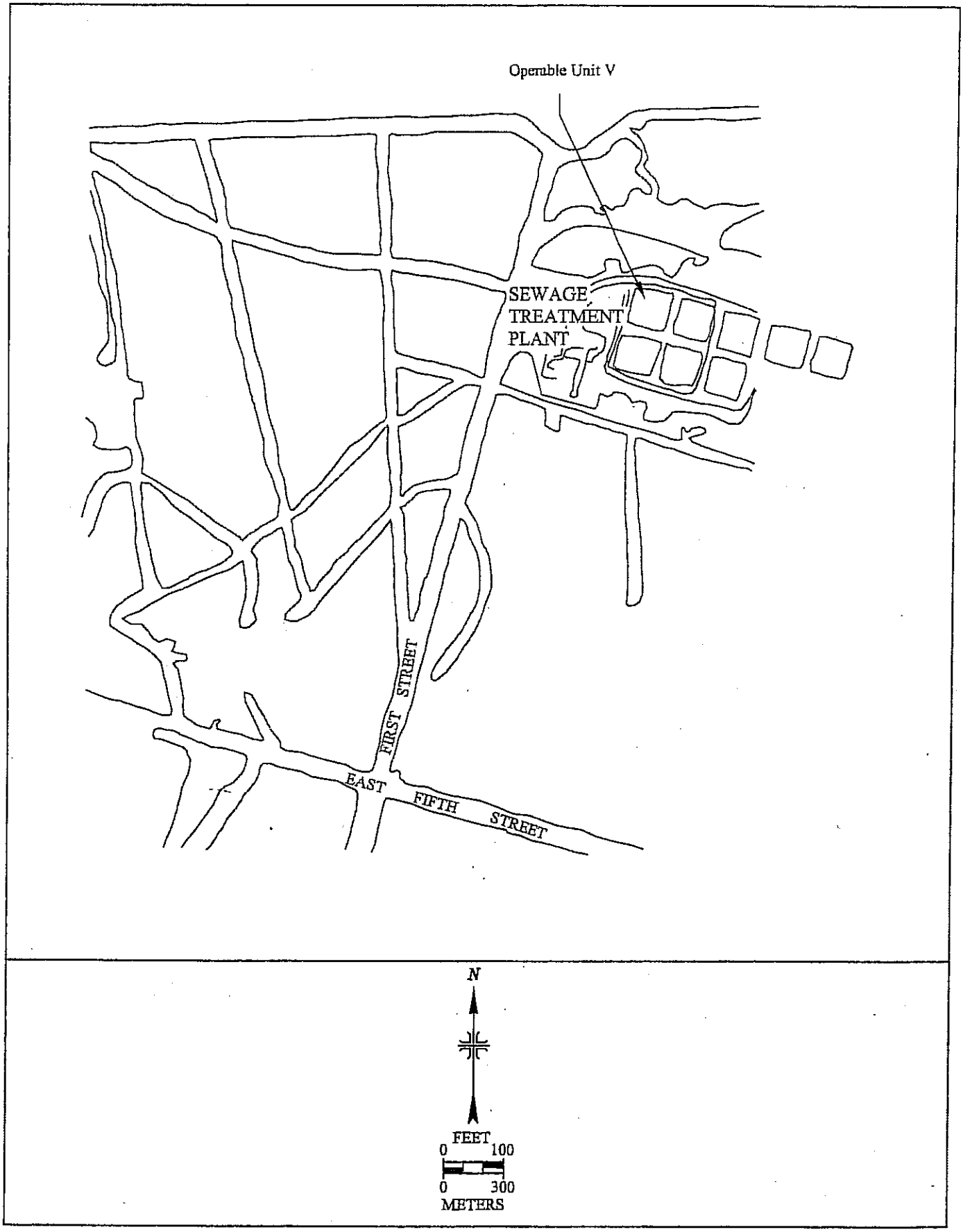

FIGURE 2: Plot Plan of the Brookhaven National Laboratory, Sewage Treatment Plant - Operable Unit V

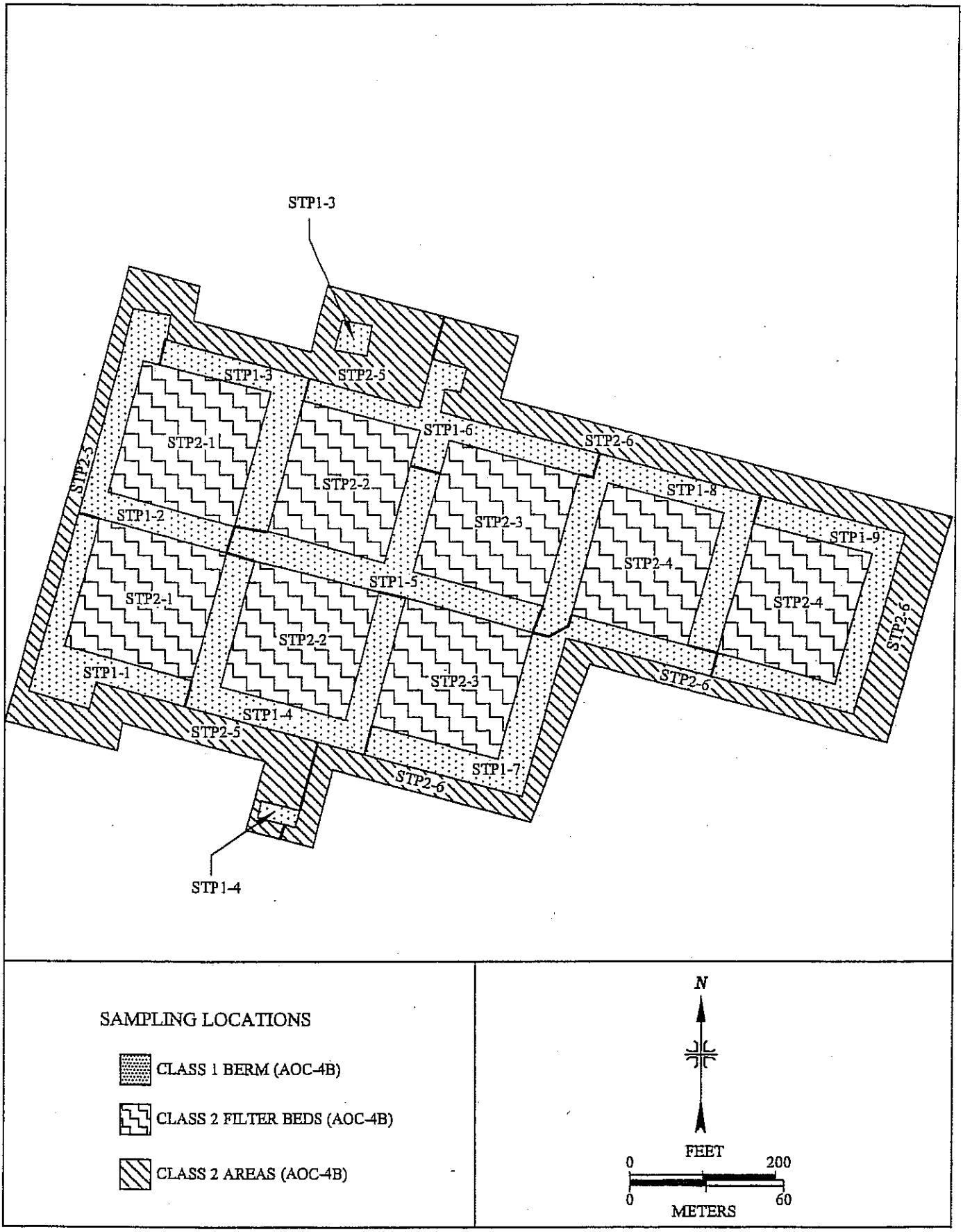

FIGURE 3: Class 1 and Class 2 Survey Units - Operable Unit V, Area of Concern 4B

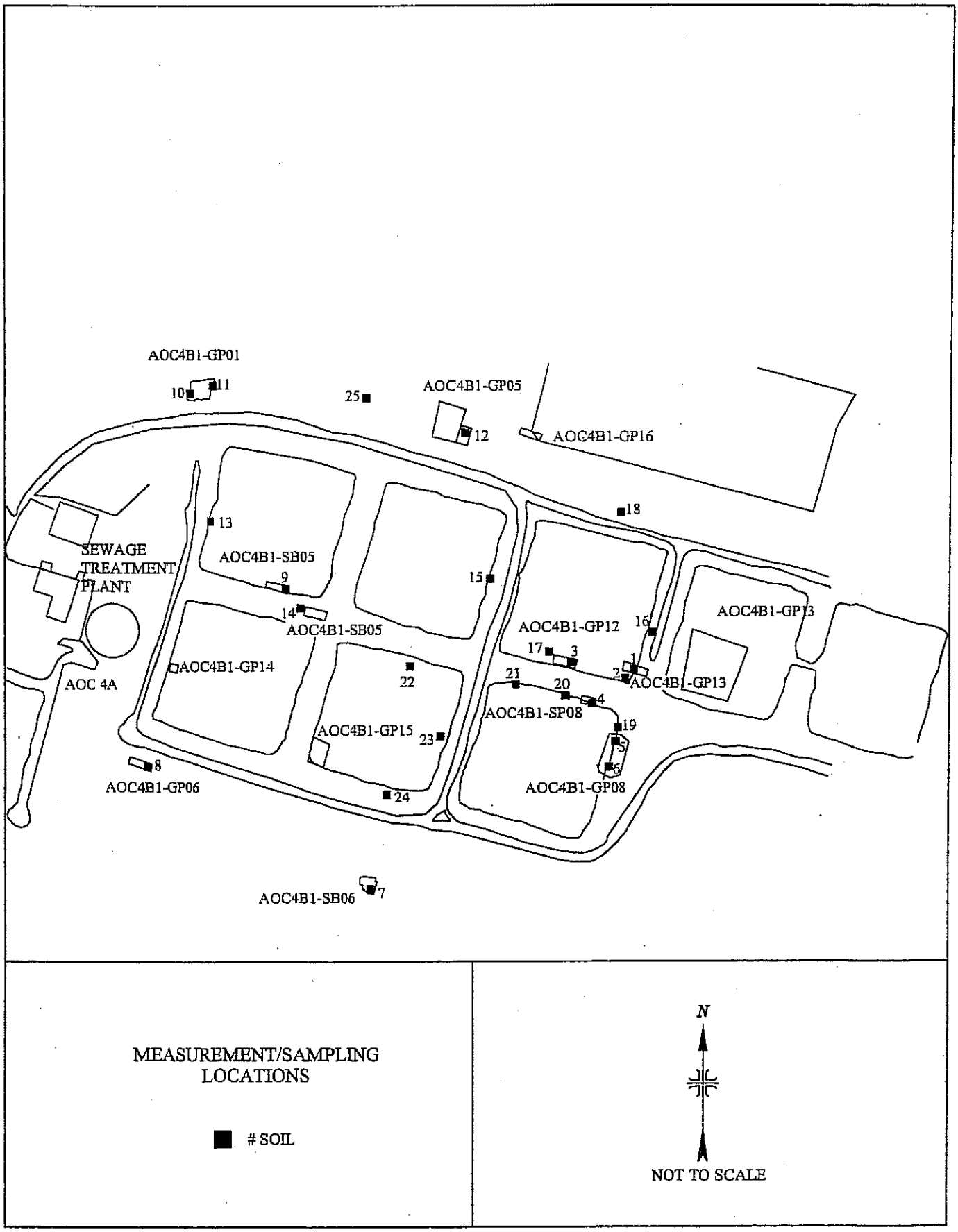

FIGURE 4: Area of Concern 4B, Filter Beds and Berms - Soil Sampling Locations

TABLES

ORISE TABLE 1

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES
AREA OF CONCERN 4B
SEWAGE TREATMENT PLANT
BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK

Location[a]	Depth	Radionuclide Concentration (pCi/g)						
		Cs-137	Co-60	U-238 by Th-234	Am-241	Eu-152	Pu-239/240[c]	Sr-90[d]
1	15-30 cm	77.3 ± 3.2[b]	0.08 ± 0.02	1.6 ± 1.1	0.26 ± 0.11	-0.05 ± 0.19	1.54 ± 0.16	0.37 ± 0.38
2	15-30 cm	28.0 ± 1.2	0.03 ± 0.02	1.62 ± 0.62	0.15 ± 0.06	0.00 ± 0.10[e]	---[f]	---
3	0-15 cm	28.7 ± 1.2	0.00 ± 0.01	0.73 ± 0.63	0.05 ± 0.06	-0.11 ± 0.12	0.13 ± 0.04	0.01 ± 0.37
4	0-15 cm	24.6 ± 1.0	0.02 ± 0.01	1.37 ± 0.51	0.18 ± 0.06	0.02 ± 0.09	---	---
5	0-15 cm	48.0 ± 2.0	0.03 ± 0.03	2.90 ± 1.26	0.01 ± 0.09	0.04 ± 0.17	-0.01 ± 0.01	0.84 ± 0.41
6	0-15 cm	42.5 ± 1.8	0.02 ± 0.01	2.04 ± 0.85	0.32 ± 0.08	0.10 ± 0.14	---	--
7	0-15 cm	19.36 ± 0.81	0.01 ± 0.01	0.25 ± 0.36	0.47 ± 0.07	-0.01 ± 0.08	---	---
8	0-15 cm	4.76 ± 0.23	0.01 ± 0.01	0.49 ± 0.41	0.05 ± 0.04	0.03 ± 0.06	---	---
9	15-30 cm	8.45 ± 0.36	0.05 ± 0.02	0.30 ± 0.29	0.05 ± 0.04	-0.02 ± 0.06	---	---
10	0-15 cm	16.77 ± 0.70	0.01 ± 0.01	0.71 ± 0.44	0.23 ± 0.05	0.02 ± 0.08	---	---
11	0-15 cm	37.1 ± 1.5	0.00 ± 0.01	1.01 ± 0.59	0.55 ± 0.09	-0.02 ± 0.11	---	---
12	0-15 cm	34.1 ± 1.4	0.02 ± 0.01	1.30 ± 0.76	0.21 ± 0.08	0.03 ± 0.13	2.80 ± 0.27	0.55 ± 0.42
13	15-30 cm	25.5 ± 1.1	0.01 ± 0.01	0.71 ± 0.63	0.39 ± 0.09	-0.02 ± 0.12	---	---
14	15-30 cm	20.90 ± 0.89	0.10 ± 0.04	0.53 ± 0.49	0.30 ± 0.08	-0.02 ± 0.10	---	---

ORISE TABLE 1 (CONTINUED)

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES
AREA OF CONCERN 4
SEWAGE TREATMENT PLANT
BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK

Location[a]	Depth	Radionuclide Concentration (pCi/g)						
		Cs-137	Co-60	U-238	Am-241	Eu-152	Pu-239/240[c]	Sr-90[d]
15	15-30 cm	36.2 ± 1.5 [b]	0.01 ± 0.01	0.35 ± 0.47	0.25 ± 0.07	-0.03 ± 0.11	---	---
16	15-30 cm	55.8 ± 2.3	0.01 ± 0.01	2.06 ± 0.74	0.32 ± 0.09	0.07 ± 0.16	1.91 ± 0.20	0.48 ± 0.35
17	15-30 cm	53.7 ± 2.2	-0.01 ± 0.01	1.53 ± 0.76	0.24 ± 0.08	-0.01 ± 0.13	---	---
18	15-30 cm	25.7 ± 1.1	0.01 ± 0.02	0.52 ± 0.55	0.24 ± 0.09	0.05 ± 0.12	---	---
19	15-30 cm	18.41 ± 0.77	0.03 ± 0.02	0.65 ± 0.48	0.62 ± 0.08	-0.02 ± 0.08	---	---
20	15-30 cm	36.2 ± 1.5	0.02 ± 0.01	1.48 ± 0.78	1.76 ± 0.15	-0.04 ± 0.13	---	---
21	15-30 cm	40.3 ± 1.7	0.01 ± 0.01	1.37 ± 0.63	0.37 ± 0.07	0.07 ± 0.11	---	---
22	15-30 cm	12.15 ± 0.53	0.03 ± 0.02	0.33 ± 0.44	0.11 ± 0.05	0.05 ± 0.08	---	---
23	15-30 cm	29.8 ± 1.2	0.05 ± 0.01	1.54 ± 0.60	0.46 ± 0.06	-0.04 ± 0.10	0.24 ± 0.05	0.71 ± 0.43
24	15-30 cm	26.6 ± 1.1	0.08 ± 0.02	1.11 ± 0.62	0.39 ± 0.08	-0.07 ± 0.11	---	---
25	0-15 cm	21.19 ± 0.88	0.06 ± 0.02	0.88 ± 0.45	0.37 ± 0.07	0.03 ± 0.08	---	---

[a] Refer to Figure 4.
[b] Uncertainties represent the 95% confidence level, based on total propagated uncertainty.
[c] Analysis by alpha spectroscopy.
[d] Sr-90 analysis by wet chemistry.
[e] Zero due to rounding.
[f] --- Analyses were not performed.

REFERENCES

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Brookhaven National Laboratory. E-mail from J. K. Shaw (BNL) to P. C. Weaver (ORISE), Reference: Response: Hot Spot Criteria. Upton, NY; April 29, 2003b.

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Oak Ridge Institute for Science and Education. Survey Procedures Manual for the Environmental Survey and Site Assessment Program. Oak Ridge, TN; February 28, 2003b.

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U.S. Nuclear Regulatory Commission (NRC). Multiagency Radiation Survey and Site Investigation Manual (MARSSIM) NUREG-1575 Revision 1. Washington D.C.; August 2000.

APPENDIX A
MAJOR INSTRUMENTATION

APPENDIX A
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 by the author's employer.

SCANNING INSTRUMENT/DETECTOR COMBINATIONS

Gamma

Eberline Pulse Ratemeter Model PRM-6
(Eberline, Santa Fe, NM)
coupled to
Victoreen NaI Scintillation Detector Model 489-55, Crystal: 3.2 cm x 3.8 cm
(Victoreen, Cleveland, OH)

LABORATORY ANALYTICAL INSTRUMENTATION

Alpha Spectrometry System
Tennelec Model 256
(Canberra, Meriden, CT)
Used in conjunction with:
Ion Implanted Detectors
(Canberra, Meriden, CT) and
Multichannel Analyzer
DEC ALPHA Workstation
(Canberra, Meriden,CT)

Alpha Spectrometry System
Canberra Model 7401VR
(Canberra, Meriden, CT)
Used in conjunction with:
Ion Implanted Detectors and
Multichannel Analyzer
DEC ALPH Workstation
(Canberra, Meriden, CT)

High Purity Extended Range Intrinsic Detector
CANBERRA/Tennelec Model No: ERVDS30-25195
(Canberra, Meriden, CT)
Used in conjunction with:
Lead Shield Model G-11

(Nuclear Lead, Oak Ridge, TN) and
Multichannel Analyzer DEC ALPHA Workstation
(Canberra, Meriden, CT)

High Purity Extended Range Intrinsic Detector
Model No. GMX-45200-5
(EG&g ORTEC, Oak Ridge, TN)
used in conjunction with:
Lead Shield Model SPG-16-K8
(Nuclear Data)
Multichannel Analyzer 3100 Vax Workstation
(Canberra, Meriden, CT)

Low Background Gas Proportional Counter
Model LB-5100-W
(Tennelec/Canberra, Meriden, CT)

Tri-Carb Liquid Scintillation Analyzer
Model 3100
(Packard Instrument Co., Meriden, CT)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX B
SURVEY AND ANALYTICAL PROCEDURES

PROJECT HEALTH AND SAFETY

All survey and laboratory activities were conducted in accordance with ORISE health and safety and radiation protection programs.

CALIBRATION AND QUALITY ASSURANCE

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

Analytical and field survey activities were conducted in accordance with procedures from the following documents of the Environmental Survey and Site Assessment Program:

- Survey Procedures Manual (February 2003)
- Laboratory Procedures Manual (February 2003)
- Quality Assurance Manual (April 2002 and April 2003)

The procedures contained in these manuals were developed to meet the requirements of DOE Order 414.1A 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, ITP, and EML Laboratory Quality Assurance Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

SURVEY PROCEDURES

Surface Scans

Surface scans were performed by passing the detector slowly over the surface; the distance between the detectors and the surface was maintained at a minimum nominally about 4 cm. The scan MDC for the NaI scintillation detector for Cs-137 was obtained directly from NUREG-1507. The scan MDC was 10 pCi/g.

Soil Sampling

Approximately 1 kg of soil was collected at each sample location. Collected samples were placed in a plastic bag, sealed, and labeled in accordance with ESSAP survey procedures.

ANALYTICAL PROCEDURES

Gamma Spectroscopy

Soil samples were dried, mixed, crushed, and/or homogenized as necessary. A portion of a sample was sealed in a 0.5-liter Marinelli beaker or other appropriate container. The quantity of soil placed in the beaker was chosen to reproduce the calibrated counting geometry. Net material weights were determined and the samples counted using intrinsic germanium detectors coupled to a pulse height analyzer system. Background and Compton stripping, peak search, peak identification, and concentration calculations were performed using the computer capabilities inherent in the analyzer system. All photopeaks associated with the radionuclides of concern were reviewed for consistency of activity. Spectra were also reviewed for other identifiable photopeaks. Photopeaks reviewed to determine activities of radionuclides of concern and the typical associated MDCs for a 1 hour count were:

Radionuclide	Photopeak	MDC soil (pCi/g)
Am-241	0.059 MeV	0.06
Co-60	1.173 MeV	0.05
Cs-137	0.662 MeV	0.05

U-238	0.063 MeV from Th-234*	0.21
	(or 1.001 MeV from Pa-234 m)*	1.74
Eu-152	0.344 MeV	0.11

*Secular equilibrium assumed.

Alpha Spectroscopy

Soil samples were crushed and homogenized. Soil samples were dissolved by potassium fluoride and pyrosulfate fusion and the elements of interest were precipitated with barium sulfate. Barium sulfate precipitate was redissolved and the specific elements of interest—isotopic plutonium—were individually separated by extraction chromotography and re-precipitated with a cerium fluoride carrier. The precipitate was then analyzed using ion implanted detectors (Canberra), alpha spectrometers (Tennelec and Canberra), and a multichannel analyzer (Canberra). The typical MDC of the procedure for a 1000 minute count time is 0.02 pCi/g (solids).

Strontium-90

Soil samples were dissolved by a combination of potassium hydrogen fluoride and pyrosulfate fusions. 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 for 60 minutes on a low-background gas proportional counter. The typical MDC of the procedure is 0.8 pCi/g.

Uncertainties and Detection Limits

The uncertainties associated with the analytical data presented in the tables of this report represent the 95% confidence level for that data. These uncertainties were calculated based on both the gross sample count levels and the associated background count levels.

Detection limits, referred to as minimum detectable concentration (MDC), were based on 3 plus 4.65 times the standard deviation of the background count [$3 + (4.65\sqrt{\text{BKG}})$]. When the activity was determined to be less than the MDC. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclide in samples, the detection limits differ from sample to sample and instrument to instrument.

Attachment 3

RESRAD OUTPUT

Occupational Scenario

Summary : STP Dose Assessment Post Clean-up Occupational
File : Ocuupational.RAD

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary
File: FGR 13 Morbidity

Parameter Menu	Parameter	Current Value	Default	Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.720E+00	6.720E+00	DCF2(1)
B-1	Am-241	4.440E-01	4.440E-01	DCF2(2)
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(3)
B-1	Np-237+D	5.400E-01	5.400E-01	DCF2(4)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(5)
B-1	Pb-210+D	2.320E-02	2.320E-02	DCF2(6)
B-1	Pu-238	3.920E-01	3.920E-01	DCF2(7)
B-1	Pu-239	4.290E-01	4.290E-01	DCF2(8)
B-1	Ra-226+D	8.600E-03	8.600E-03	DCF2(9)
B-1	Th-229+D	2.160E+00	2.160E+00	DCF2(10)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(11)
B-1	U-233	1.350E-01	1.350E-01	DCF2(12)
B-1	U-234	1.320E-01	1.320E-01	DCF2(13)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2(14)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.480E-02	DCF3(1)
D-1	Am-241	3.640E-03	3.640E-03	DCF3(2)
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(3)
D-1	Np-237+D	4.440E-03	4.440E-03	DCF3(4)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(5)
D-1	Pb-210+D	7.270E-03	7.270E-03	DCF3(6)
D-1	Pu-238	3.200E-03	3.200E-03	DCF3(7)
D-1	Pu-239	3.540E-03	3.540E-03	DCF3(8)
D-1	Ra-226+D	1.330E-03	1.330E-03	DCF3(9)
D-1	Th-229+D	4.030E-03	4.030E-03	DCF3(10)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(11)
D-1	U-233	2.890E-04	2.890E-04	DCF3(12)
D-1	U-234	2.830E-04	2.830E-04	DCF3(13)
D-1	U-235+D	2.670E-04	2.670E-04	DCF3(14)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34	Am-241 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(2,1)
D-34	Am-241 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-05	5.000E-05	RTF(2,2)
D-34	Am-241 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-06	2.000E-06	RTF(2,3)
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(3,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(3,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(3,3)
D-34	Np-237+D , plant/soil concentration ratio, dimensionless	2.000E-02	2.000E-02	RTF(4,1)
D-34	Np-237+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,2)
D-34	Np-237+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(4,3)

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: FGR 13 Morbidity

Parameter Menu	Parameter	Current Value	Default	Name
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(5,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(5,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(5,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(6,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(6,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(6,3)
D-34				
D-34	Pu-238 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(7,1)
D-34	Pu-238 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(7,2)
D-34	Pu-238 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(7,3)
D-34				
D-34	Pu-239 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(8,1)
D-34	Pu-239 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(8,2)
D-34	Pu-239 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(8,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(9,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(9,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(9,3)
D-34				
D-34	Th-229+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(10,1)
D-34	Th-229+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(10,2)
D-34	Th-229+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(10,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(11,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(11,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(11,3)
D-34				
D-34	U-233 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(12,1)
D-34	U-233 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(12,2)
D-34	U-233 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(12,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(13,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(13,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(13,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(14,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(14,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(14,3)

```
      3                                                                3           3           3
 D-5  3 Bioaccumulation factors, fresh water, L/kg:                    3           3           3
 D-5  3 Ac-227+D , fish                                                3 1.500E+01 3 1.500E+01 3 BIOFAC(
1,1)
 D-5  3 Ac-227+D , crustacea and mollusks                              3 1.000E+03 3 1.000E+03 3 BIOFAC(
1,2)
 D-5  3                                                                3           3           3
 D-5  3 Am-241   , fish                                                3 3.000E+01 3 3.000E+01 3 BIOFAC(
2,1)
 D-5  3 Am-241   , crustacea and mollusks                              3 1.000E+03 3 1.000E+03 3 BIOFAC(
2,2)
 D-5  3                                                                3           3           3
 D-5  3 Cs-137+D , fish                                                3 2.000E+03 3 2.000E+03 3 BIOFAC(
3,1)
 D-5  3 Cs-137+D , crustacea and mollusks                              3 1.000E+02 3 1.000E+02 3 BIOFAC(
3,2)
 D-5  3                                                                3           3           3
```

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: FGR 13 Morbidity

Parameter Menu	Parameter	Current Value	Default	Name
D-5	Np-237+D , fish	3.000E+01	3.000E+01	BIOFAC(4,1)
D-5	Np-237+D , crustacea and mollusks	4.000E+02	4.000E+02	BIOFAC(4,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(5,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(5,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(6,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(6,2)
D-5				
D-5	Pu-238 , fish	3.000E+01	3.000E+01	BIOFAC(7,1)
D-5	Pu-238 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(7,2)
D-5				
D-5	Pu-239 , fish	3.000E+01	3.000E+01	BIOFAC(8,1)
D-5	Pu-239 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(8,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(9,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(9,2)
D-5				
D-5	Th-229+D , fish	1.000E+02	1.000E+02	BIOFAC(10,1)
D-5	Th-229+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(10,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(11,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(11,2)
D-5				
D-5	U-233 , fish	1.000E+01	1.000E+01	BIOFAC(12,1)
D-5	U-233 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(12,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(13,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(13,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(14,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(14,2)

Site-Specific Parameter Summary

RESRAD Menu	Parameter		User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)		6.325E+04	1.000E+04		AREA
R011	Thickness of contaminated zone (m)		1.500E-01	2.000E+00		THICK0
R011	Length parallel to aquifer flow (m)		not used	1.000E+02		LCZPAQ
R011	Basic radiation dose limit (mrem/yr)		1.500E+01	2.500E+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)		3.000E+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)		3.000E+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):	Am-241	5.827E-01	0.000E+00		S1(2)
R012	Initial principal radionuclide (pCi/g):	Cs-137	1.361E+00	0.000E+00		S1(3)
R012	Initial principal radionuclide (pCi/g):	Pu-238	3.537E-02	0.000E+00		S1(7)
R012	Initial principal radionuclide (pCi/g):	Pu-239	4.334E-02	0.000E+00		S1(8)
R012	Concentration in groundwater (pCi/L):	Am-241	not used	0.000E+00		W1(2)
R012	Concentration in groundwater (pCi/L):	Cs-137	not used	0.000E+00		W1(3)
R012	Concentration in groundwater (pCi/L):	Pu-238	not used	0.000E+00		W1(7)
R012	Concentration in groundwater (pCi/L):	Pu-239	not used	0.000E+00		W1(8)
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		2.000E-01	2.000E-01		FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)		2.000E+04	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)	not used	1.000E+06	---
WAREA				
R013	Accuracy for water/soil computations	not used	1.000E-03	---
EPS				
R014	Density of saturated zone (g/cm**3)	not used	1.500E+00	---
DENSAQ				
R014	Saturated zone total porosity	not used	4.000E-01	---
TPSZ				
R014	Saturated zone effective porosity	not used	2.000E-01	---
EPSZ				
R014	Saturated zone field capacity	not used	2.000E-01	---
FCSZ				
R014	Saturated zone hydraulic conductivity (m/yr)	not used	1.000E+02	---
HCSZ				
R014	Saturated zone hydraulic gradient	not used	2.000E-02	---
HGWT				
R014	Saturated zone b parameter	not used	5.300E+00	---
BSZ				

Site-Specific Parameter Summary (continued)

RESRAD Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Water table drop rate (m/yr)	not used	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	not used	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	not used	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	not used	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	not used	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Am-241				
R016	Contaminated zone (cm**3/g)	1.900E+03	2.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.420E-03	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	1.900E+02	1.000E+03	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	not used	1.000E+03	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	not used	1.000E+03	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.419E-02	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Pu-238				
R016	Contaminated zone (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+03	---	DCNUCU(7,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+03	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.904E-03	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)

```
      ³                                                  ³           ³           ³
³
 R016 ³ Distribution coefficients for Pu-239             ³           ³           ³
³
 R016 ³   Contaminated zone (cm**3/g)                    ³ 5.500E+02 ³ 2.000E+03 ³              ---
³ DCNUCC( 8)
 R016 ³   Unsaturated zone 1 (cm**3/g)                  ³ not used  ³ 2.000E+03 ³              ---
³ DCNUCU( 8,1)
 R016 ³   Saturated zone (cm**3/g)                      ³ not used  ³ 2.000E+03 ³              ---
³ DCNUCS( 8)
 R016 ³   Leach rate (/yr)                              ³ 0.000E+00 ³ 0.000E+00 ³           4.904E-03
³ ALEACH( 8)
 R016 ³   Solubility constant                          ³ 0.000E+00 ³ 0.000E+00 ³           not used
³ SOLUBK( 8)
      ³                                                  ³           ³           ³
³
 R016 ³ Distribution coefficients for daughter Ac-227    ³           ³           ³
³
 R016 ³   Contaminated zone (cm**3/g)                    ³ 2.000E+01 ³ 2.000E+01 ³              ---
³ DCNUCC( 1)
 R016 ³   Unsaturated zone 1 (cm**3/g)                  ³ not used  ³ 2.000E+01 ³              ---
³ DCNUCU( 1,1)
 R016 ³   Saturated zone (cm**3/g)                      ³ not used  ³ 2.000E+01 ³              ---
³ DCNUCS( 1)
 R016 ³   Leach rate (/yr)                              ³ 0.000E+00 ³ 0.000E+00 ³           1.341E-01
³ ALEACH( 1)
 R016 ³   Solubility constant                          ³ 0.000E+00 ³ 0.000E+00 ³           not used
³ SOLUBK( 1)
```

Site-Specific Parameter Summary (continued)

RESRAD Menu	Parameter	User Input	Default	Used by (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Np-237				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	2.574E+02	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	not used	-1.000E+00	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	not used	-1.000E+00	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.048E-02	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.383E-02	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	not used	1.000E+02	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	not used	1.000E+02	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.695E-02	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for daughter Ra-226				
R016	Contaminated zone (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCC(9)
R016	Unsaturated zone 1 (cm**3/g)	not used	7.000E+01	---	DCNUCU(9,1)
R016	Saturated zone (cm**3/g)	not used	7.000E+01	---	DCNUCS(9)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.394E-03	ALEACH(9)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(9)
R016	Distribution coefficients for daughter Th-229				
R016	Contaminated zone (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCC(10)
R016	Unsaturated zone 1 (cm**3/g)	not used	6.000E+04	---	DCNUCU(10,1)
R016	Saturated zone (cm**3/g)	not used	6.000E+04	---	DCNUCS(10)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.430E-04	ALEACH(10)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(10)

```
      ³                                                  ³           ³           ³
³
 R016 ³ Distribution coefficients for daughter Th-230    ³           ³           ³
³
 R016 ³   Contaminated zone (cm**3/g)                    ³ 3.200E+03 ³ 6.000E+04 ³              ---
³ DCNUCC(11)
 R016 ³   Unsaturated zone 1 (cm**3/g)                  ³ not used  ³ 6.000E+04 ³              ---
³ DCNUCU(11,1)
 R016 ³   Saturated zone (cm**3/g)                      ³ not used  ³ 6.000E+04 ³              ---
³ DCNUCS(11)
 R016 ³   Leach rate (/yr)                              ³ 0.000E+00 ³ 0.000E+00 ³           8.430E-04
³ ALEACH(11)
 R016 ³   Solubility constant                          ³ 0.000E+00 ³ 0.000E+00 ³           not used
³ SOLUBK(11)
      ³                                                  ³           ³           ³
³
 R016 ³ Distribution coefficients for daughter U-233     ³           ³           ³
³
 R016 ³   Contaminated zone (cm**3/g)                    ³ 1.700E+01 ³ 5.000E+01 ³              ---
³ DCNUCC(12)
 R016 ³   Unsaturated zone 1 (cm**3/g)                  ³ not used  ³ 5.000E+01 ³              ---
³ DCNUCU(12,1)
 R016 ³   Saturated zone (cm**3/g)                      ³ not used  ³ 5.000E+01 ³              ---
³ DCNUCS(12)
 R016 ³   Leach rate (/yr)                              ³ 0.000E+00 ³ 0.000E+00 ³           1.576E-01
³ ALEACH(12)
 R016 ³   Solubility constant                          ³ 0.000E+00 ³ 0.000E+00 ³           not used
³ SOLUBK(12)
```

Site-Specific Parameter Summary (continued)

RESRAD Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter U-234				
R016	Contaminated zone (cm**3/g)	1.700E+01	5.000E+01	---	DCNUCC(13)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(13,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(13)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.576E-01	ALEACH(13)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(13)
R016	Distribution coefficients for daughter U-235				
R016	Contaminated zone (cm**3/g)	1.700E+01	5.000E+01	---	DCNUCC(14)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(14,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(14)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.576E-01	ALEACH(14)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(14)
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	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	5.710E-02	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	1.712E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
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 ³   Outer annular radius (m), ring 12:            ³ not used  ³ 0.000E+00 ³             ---
³ RAD_SHAPE(12)
      ³                                                 ³           ³           ³
³
 R017 ³ Fractions of annular areas within AREA:         ³           ³           ³
³
 R017 ³   Ring  1                                       ³ not used  ³ 1.000E+00 ³             ---
³ FRACA( 1)
 R017 ³   Ring  2                                       ³ not used  ³ 2.732E-01 ³             ---
³ FRACA( 2)
 R017 ³   Ring  3                                       ³ not used  ³ 0.000E+00 ³             ---
³ FRACA( 3)
 R017 ³   Ring  4                                       ³ not used  ³ 0.000E+00 ³             ---
³ FRACA( 4)
 R017 ³   Ring  5                                       ³ not used  ³ 0.000E+00 ³             ---
³ FRACA( 5)
 R017 ³   Ring  6                                       ³ not used  ³ 0.000E+00 ³             ---
³ FRACA( 6)
 R017 ³   Ring  7                                       ³ not used  ³ 0.000E+00 ³             ---
³ FRACA( 7)
 R017 ³   Ring  8                                       ³ not used  ³ 0.000E+00 ³             ---
³ FRACA( 8)
 R017 ³   Ring  9                                       ³ not used  ³ 0.000E+00 ³             ---
³ FRACA( 9)
 R017 ³   Ring 10                                       ³ not used  ³ 0.000E+00 ³             ---
³ FRACA(10)
 R017 ³   Ring 11                                       ³ not used  ³ 0.000E+00 ³             ---
³ FRACA(11)
 R017 ³   Ring 12                                       ³ not used  ³ 0.000E+00 ³             ---
³ FRACA(12)
      ³                                                 ³           ³           ³
³
```

Site-Specific Parameter Summary (continued)

RESRAD Menu	Parameter	User Input	Default	Used by (If different from user input)	Name
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)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	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
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	not used	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 ³ Growing Season for  Leafy     (years)            ³ not used  ³ 2.500E-01 ³              ---
³ TE(2)
 R19B ³ Growing Season for  Fodder    (years)            ³ not used  ³ 8.000E-02 ³              ---
³ TE(3)
 R19B ³ Translocation Factor for  Non-Leafy              ³ not used  ³ 1.000E-01 ³              ---
³ TIV(1)
 R19B ³ Translocation Factor for  Leafy                  ³ not used  ³ 1.000E+00 ³              ---
³ TIV(2)
 R19B ³ Translocation Factor for  Fodder                 ³ not used  ³ 1.000E+00 ³              ---
³ TIV(3)
 R19B ³ Dry Foliar Interception Fraction for  Non-Leafy  ³ not used  ³ 2.500E-01 ³              ---
³ RDRY(1)
 R19B ³ Dry Foliar Interception Fraction for  Leafy      ³ not used  ³ 2.500E-01 ³              ---
³ RDRY(2)
 R19B ³ Dry Foliar Interception Fraction for  Fodder     ³ not used  ³ 2.500E-01 ³              ---
³ RDRY(3)
 R19B ³ Wet Foliar Interception Fraction for  Non-Leafy  ³ not used  ³ 2.500E-01 ³              ---
³ RWET(1)
 R19B ³ Wet Foliar Interception Fraction for  Leafy      ³ not used  ³ 2.500E-01 ³              ---
³ RWET(2)
 R19B ³ Wet Foliar Interception Fraction for  Fodder     ³ not used  ³ 2.500E-01 ³              ---
³ RWET(3)
 R19B ³ Weathering Removal Constant for Vegetation       ³ not used  ³ 2.000E+01 ³              ---
³ WLAM
      ³                                                  ³           ³           ³
³
 C14  ³ C-12 concentration in water (g/cm**3)            ³ not used  ³ 2.000E-05 ³              ---
³ C12WTR
 C14  ³ C-12 concentration in contaminated soil (g/g)    ³ not used  ³ 3.000E-02 ³              ---
³ C12CZ
 C14  ³ Fraction of vegetation carbon from soil          ³ not used  ³ 2.000E-02 ³              ---
³ CSOIL
```

Site-Specific Parameter Summary (continued)

RESRAD Menu	Parameter	User Input	Default	Used by (If different from user input)	Name
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
C14	DCF correction factor for gaseous forms of C14	not used	8.894E+01	---	CO2F
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
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	suppressed
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

Summary : STP Dose Assessment Post Clean-up Occupational
File : Ocuupational.RAD

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	63250.00 square meters	Am-241	5.827E-01
Thickness:	0.15 meters	Cs-137	1.361E+00
Cover Depth:	0.00 meters	Pu-238	3.537E-02
		Pu-239	4.334E-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	3.000E+00	1.000E+01	5.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	9.251E-01	8.909E-01	8.263E-01	6.350E-01	1.434E-01	2.423E-02	0.000E+00	0.000E+00
M(t):	6.167E-02	5.939E-02	5.509E-02	4.234E-02	9.557E-03	1.615E-03	0.000E+00	0.000E+00

Maximum TDOSE(t): 9.251E-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)

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.
Am-241	5.460E-03	0.0059	8.564E-03	0.0093	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.759E-02	0.0190
Cs-137	8.897E-01	0.9617	1.413E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.547E-04	0.0006
Pu-238	1.145E-06	0.0000	4.567E-04	0.0005	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.340E-04	0.0010
Pu-239	2.664E-06	0.0000	6.149E-04	0.0007	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.271E-03	0.0014
Total	8.951E-01	0.9676	9.637E-03	0.0104	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.035E-02	0.0220

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

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.
Am-241	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	0.000E+00	0.0000	3.161E-02	0.0342
Cs-137	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	0.000E+00	0.0000	8.902E-01	0.9623
Pu-238	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	0.000E+00	0.0000	1.392E-03	0.0015
Pu-239	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	0.000E+00	0.0000	1.889E-03	0.0020
Total	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	0.000E+00	0.0000	9.251E-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)

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.
Am-241	5.443E-03	0.0061	8.481E-03	0.0095	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.742E-02	0.0196
Cs-137	8.558E-01	0.9606	1.352E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.308E-04	0.0006
Pu-238	1.130E-06	0.0000	4.479E-04	0.0005	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.160E-04	0.0010
Pu-239	2.649E-06	0.0000	6.078E-04	0.0007	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.256E-03	0.0014
Total	8.613E-01	0.9667	9.538E-03	0.0107	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.012E-02	0.0226

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

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.
Am-241	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	0.000E+00	0.0000	3.134E-02	0.0352
Cs-137	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	0.000E+00	0.0000	8.563E-01	0.9612
Pu-238	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	0.000E+00	0.0000	1.365E-03	0.0015
Pu-239	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	0.000E+00	0.0000	1.867E-03	0.0021
Total	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	0.000E+00	0.0000	8.909E-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 = 3.000E+00 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.
Am-241	5.411E-03	0.0065	8.316E-03	0.0101	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.708E-02	0.0207
Cs-137	7.919E-01	0.9583	1.238E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.861E-04	0.0006
Pu-238	1.101E-06	0.0000	4.307E-04	0.0005	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.808E-04	0.0011
Pu-239	2.620E-06	0.0000	5.937E-04	0.0007	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.227E-03	0.0015
Total	7.973E-01	0.9649	9.342E-03	0.0113	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.967E-02	0.0238

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 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.
Am-241	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	0.000E+00	0.0000	3.081E-02	0.0373
Cs-137	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	0.000E+00	0.0000	7.924E-01	0.9589
Pu-238	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	0.000E+00	0.0000	1.313E-03	0.0016
Pu-239	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	0.000E+00	0.0000	1.824E-03	0.0022
Total	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	0.000E+00	0.0000	8.263E-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)

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.
Am-241	5.299E-03	0.0083	7.753E-03	0.0122	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.592E-02	0.0251
Cs-137	6.029E-01	0.9494	9.079E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.565E-04	0.0006
Pu-238	1.006E-06	0.0000	3.750E-04	0.0006	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.668E-04	0.0012
Pu-239	2.518E-06	0.0000	5.461E-04	0.0009	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.129E-03	0.0018
Total	6.082E-01	0.9577	8.675E-03	0.0137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.818E-02	0.0286

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

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.
Am-241	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	0.000E+00	0.0000	2.897E-02	0.0456
Cs-137	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	0.000E+00	0.0000	6.033E-01	0.9499
Pu-238	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	0.000E+00	0.0000	1.143E-03	0.0018
Pu-239	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	0.000E+00	0.0000	1.678E-03	0.0026
Total	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	0.000E+00	0.0000	6.350E-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)

Radio- Nuclide	Ground Soil mrem/yr	fract.	Inhalation mrem/yr	fract.	Radon mrem/yr	fract.	Plant mrem/yr	fract.	Meat mrem/yr	fract.	Milk mrem/yr	fract.
Am-241	4.687E-03	0.0327	4.900E-03	0.0342	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	1.222E-01	0.8523	1.457E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.720E-05	0.0004
Pu-238	5.984E-07	0.0000	1.603E-04	0.0011	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.277E-04	0.0023
Pu-239	1.962E-06	0.0000	3.198E-04	0.0022	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.611E-04	0.0046
Total	1.269E-01	0.8850	5.380E-03	0.0375	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.111E-02	0.0775

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

Radio- Nuclide	Water mrem/yr	fract.	Fish mrem/yr	fract.	Radon mrem/yr	fract.	Plant mrem/yr	fract.	Meat mrem/yr	fract.	Milk mrem/yr	fract.	All Pathways* mrem/yr	fract.
Am-241	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	0.000E+00	0.0000	1.965E-02	0.1371
Cs-137	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	0.000E+00	0.0000	1.222E-01	0.8527
Pu-238	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	0.000E+00	0.0000	4.886E-04	0.0034
Pu-239	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	0.000E+00	0.0000	9.828E-04	0.0069
Total	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	0.000E+00	0.0000	1.434E-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)

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.
Am-241	3.801E-03	0.1569	2.096E-03	0.0865	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.304E-03	0.1776
Cs-137	1.352E-02	0.5578	1.123E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.409E-06	0.0002
Pu-238	3.006E-07	0.0000	4.203E-05	0.0017	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.595E-05	0.0035
Pu-239	1.237E-06	0.0001	1.243E-04	0.0051	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.570E-04	0.0106
Total	1.732E-02	0.7147	2.262E-03	0.0933	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.651E-03	0.1920

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

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.
Am-241	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	0.000E+00	0.0000	1.020E-02	0.4210
Cs-137	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	0.000E+00	0.0000	1.352E-02	0.5580
Pu-238	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	0.000E+00	0.0000	1.283E-04	0.0053
Pu-239	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	0.000E+00	0.0000	3.825E-04	0.0158
Total	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	0.000E+00	0.0000	2.423E-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 = 3.000E+02 years
Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground Soil		Inhalation		Radon		Plant		Meat		Milk	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	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	0.000E+00	0.0000
Cs-137	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	0.000E+00	0.0000
Pu-238	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	0.000E+00	0.0000
Pu-239	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	0.000E+00	0.0000
Total	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	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
Water Dependent Pathways

Radio-	Water All Pathways*		Fish		Radon		Plant		Meat		Milk	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	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	0.000E+00	0.0000
Cs-137	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	0.000E+00	0.0000
Pu-238	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	0.000E+00	0.0000
Pu-239	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	0.000E+00	0.0000
Total	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	0.000E+00	0.0000

*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)

Radio-	Ground Soil		Inhalation		Radon		Plant		Meat		Milk	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	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	0.000E+00	0.0000
Cs-137	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	0.000E+00	0.0000
Pu-238	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	0.000E+00	0.0000
Pu-239	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	0.000E+00	0.0000
Total	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	0.000E+00	0.0000

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

Radio-	Water All Pathways*		Fish		Radon		Plant		Meat		Milk	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	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	0.000E+00	0.0000
Cs-137	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	0.000E+00	0.0000
Pu-238	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	0.000E+00	0.0000
Pu-239	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	0.000E+00	0.0000
Total	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	0.000E+00	0.0000

*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)	Branch Fraction*	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	5.000E+01	1.000E+02	3.000E+02	1.000E+03
Am-241	Am-241	1.000E+00	5.425E-02	5.379E-02	5.287E-02	4.973E-02	3.372E-02	1.750E-02	0.000E+00	0.000E+00
Am-241	Np-237	1.000E+00	4.519E-08	1.345E-07	3.085E-07	8.699E-07	2.858E-06	2.964E-06	0.000E+00	0.000E+00
Am-241	U-233	1.000E+00	1.619E-15	1.075E-14	5.054E-14	3.069E-13	1.428E-12	1.138E-12	0.000E+00	0.000E+00
Am-241	Th-229	1.000E+00	2.310E-18	3.336E-17	3.583E-16	7.195E-15	2.487E-13	6.220E-13	0.000E+00	0.000E+00
Am-241	äDSR(j)		5.425E-02	5.379E-02	5.287E-02	4.973E-02	3.373E-02	1.751E-02	0.000E+00	0.000E+00
Cs-137	Cs-137	1.000E+00	6.541E-01	6.293E-01	5.822E-01	4.433E-01	8.982E-02	9.935E-03	0.000E+00	0.000E+00
Pu-238	Pu-238	1.000E+00	3.935E-02	3.859E-02	3.711E-02	3.231E-02	1.381E-02	3.627E-03	0.000E+00	0.000E+00
Pu-238	U-234	1.000E+00	9.119E-09	2.526E-08	4.962E-08	8.507E-08	4.675E-08	1.244E-08	0.000E+00	0.000E+00
Pu-238	Th-230	1.000E+00	6.356E-14	4.219E-13	1.983E-12	1.203E-11	5.576E-11	4.468E-11	0.000E+00	0.000E+00
Pu-238	Ra-226	1.000E+00	9.453E-16	1.364E-14	1.463E-13	2.922E-12	9.636E-11	2.222E-10	0.000E+00	0.000E+00
Pu-238	Pb-210	1.000E+00	1.717E-19	5.085E-18	1.160E-16	6.407E-15	6.264E-13	1.491E-12	0.000E+00	0.000E+00
Pu-238	äDSR(j)		3.935E-02	3.859E-02	3.711E-02	3.231E-02	1.381E-02	3.627E-03	0.000E+00	0.000E+00
Pu-239	Pu-239	1.000E+00	4.358E-02	4.307E-02	4.208E-02	3.871E-02	2.268E-02	8.826E-03	0.000E+00	0.000E+00
Pu-239	U-235	1.000E+00	7.643E-11	2.136E-10	4.280E-10	7.932E-10	7.615E-10	4.577E-10	0.000E+00	0.000E+00
Pu-239	Pa-231	1.000E+00	5.565E-16	3.649E-15	1.668E-14	9.100E-14	2.330E-13	1.170E-13	0.000E+00	0.000E+00
Pu-239	Ac-227	1.000E+00	1.932E-17	2.666E-16	2.584E-15	3.598E-14	2.140E-13	1.306E-13	0.000E+00	0.000E+00
Pu-239	äDSR(j)		4.358E-02	4.307E-02	4.208E-02	3.871E-02	2.268E-02	8.826E-03	0.000E+00	0.000E+00

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ó 0.5 yr) 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	3.000E+00	1.000E+01	5.000E+01	1.000E+02	3.000E+02	1.000E+03
Am-241	2.765E+02	2.789E+02	2.837E+02	3.016E+02	4.448E+02	8.568E+02	*3.430E+12	*3.430E+12
Cs-137	2.293E+01	2.384E+01	2.576E+01	3.384E+01	1.670E+02	1.510E+03	*8.701E+13	*8.701E+13
Pu-238	3.812E+02	3.887E+02	4.042E+02	4.643E+02	1.086E+03	4.136E+03	*1.711E+13	*1.711E+13
Pu-239	3.442E+02	3.482E+02	3.565E+02	3.875E+02	6.615E+02	1.699E+03	*6.212E+10	*6.212E+10

*At specific activity limit

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)
Am-241	5.827E-01	0.000E+00	5.425E-02	2.765E+02	5.425E-02	2.765E+02
Cs-137	1.361E+00	0.000E+00	6.541E-01	2.293E+01	6.541E-01	2.293E+01
Pu-238	3.537E-02	0.000E+00	3.935E-02	3.812E+02	3.935E-02	3.812E+02
Pu-239	4.334E-02	0.000E+00	4.358E-02	3.442E+02	4.358E-02	3.442E+02

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

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	5.000E+01	1.000E+02	3.000E+02	1.000E+03
Am-241	Am-241	1.000E+00	3.161E-02	3.134E-02	3.081E-02	2.897E-02	1.965E-02	1.020E-02	0.000E+00	0.000E+00
Np-237	Am-241	1.000E+00	2.633E-08	7.838E-08	1.798E-07	5.069E-07	1.665E-06	1.727E-06	0.000E+00	0.000E+00
U-233	Am-241	1.000E+00	9.436E-16	6.264E-15	2.945E-14	1.788E-13	8.320E-13	6.633E-13	0.000E+00	0.000E+00
Th-229	Am-241	1.000E+00	1.346E-18	1.944E-17	2.087E-16	4.192E-15	1.449E-13	3.624E-13	0.000E+00	0.000E+00
Cs-137	Cs-137	1.000E+00	8.902E-01	8.563E-01	7.924E-01	6.033E-01	1.222E-01	1.352E-02	0.000E+00	0.000E+00
Pu-238	Pu-238	1.000E+00	1.392E-03	1.365E-03	1.313E-03	1.143E-03	4.886E-04	1.283E-04	0.000E+00	0.000E+00
U-234	Pu-238	1.000E+00	3.225E-10	8.934E-10	1.755E-09	3.009E-09	1.654E-09	4.401E-10	0.000E+00	0.000E+00
Th-230	Pu-238	1.000E+00	2.248E-15	1.492E-14	7.013E-14	4.253E-13	1.972E-12	1.580E-12	0.000E+00	0.000E+00
Ra-226	Pu-238	1.000E+00	3.343E-17	4.826E-16	5.175E-15	1.033E-13	3.408E-12	7.860E-12	0.000E+00	0.000E+00
Pb-210	Pu-238	1.000E+00	6.072E-21	1.799E-19	4.104E-18	2.266E-16	2.215E-14	5.275E-14	0.000E+00	0.000E+00
Pu-239	Pu-239	1.000E+00	1.889E-03	1.867E-03	1.824E-03	1.678E-03	9.828E-04	3.825E-04	0.000E+00	0.000E+00
U-235	Pu-239	1.000E+00	3.312E-12	9.256E-12	1.855E-11	3.438E-11	3.300E-11	1.984E-11	0.000E+00	0.000E+00
Pa-231	Pu-239	1.000E+00	2.412E-17	1.582E-16	7.228E-16	3.944E-15	1.010E-14	5.073E-15	0.000E+00	0.000E+00
Ac-227	Pu-239	1.000E+00	8.374E-19	1.155E-17	1.120E-16	1.559E-15	9.274E-15	5.661E-15	0.000E+00	0.000E+00

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	5.000E+01	1.000E+02	3.000E+02	1.000E+03
Am-241	Am-241	1.000E+00	5.827E-01	5.809E-01	5.774E-01	5.653E-01	5.009E-01	4.306E-01	2.352E-01	2.833E-02
Np-237	Am-241	1.000E+00	0.000E+00	1.875E-07	5.548E-07	1.765E-06	6.773E-06	9.833E-06	9.131E-06	1.231E-06
U-233	Am-241	1.000E+00	0.000E+00	3.900E-13	3.148E-12	2.474E-11	1.701E-10	2.655E-10	2.568E-10	3.482E-11
Th-229	Am-241	1.000E+00	0.000E+00	1.245E-17	3.095E-16	8.797E-15	3.889E-13	1.409E-12	6.102E-12	8.216E-12
Cs-137	Cs-137	1.000E+00	1.361E+00	1.311E+00	1.217E+00	9.373E-01	2.109E-01	3.267E-02	1.882E-05	8.646E-17
Pu-238	Pu-238	1.000E+00	3.537E-02	3.492E-02	3.404E-02	3.112E-02	1.865E-02	9.830E-03	7.593E-04	9.725E-08
U-234	Pu-238	1.000E+00	0.000E+00	9.216E-08	2.348E-07	4.661E-07	3.649E-07	1.925E-07	1.487E-08	1.904E-12
Th-230	Pu-238	1.000E+00	0.000E+00	4.266E-13	3.442E-12	2.705E-11	1.868E-10	2.975E-10	3.620E-10	2.055E-10
Ra-226	Pu-238	1.000E+00	0.000E+00	6.238E-17	1.547E-15	4.355E-14	1.812E-12	6.082E-12	2.027E-11	1.768E-11
Pb-210	Pu-238	1.000E+00	0.000E+00	4.833E-19	3.572E-17	3.252E-15	5.146E-13	2.449E-12	1.045E-11	9.599E-12
Pu-239	Pu-239	1.000E+00	4.334E-02	4.313E-02	4.270E-02	4.125E-02	3.387E-02	2.646E-02	9.867E-03	3.123E-04
U-235	Pu-239	1.000E+00	0.000E+00	3.939E-11	1.012E-10	2.083E-10	2.184E-10	1.707E-10	6.366E-11	2.015E-12
Pa-231	Pu-239	1.000E+00	0.000E+00	4.204E-16	3.288E-15	2.305E-14	8.248E-14	7.304E-14	2.754E-14	8.716E-16
Ac-227	Pu-239	1.000E+00	0.000E+00	4.357E-18	9.754E-17	1.932E-15	1.530E-14	1.437E-14	5.446E-15	1.724E-16

BRF(i) is the branch fraction of the parent nuclide.
RESCALC.EXE execution time = 5.22 seconds

Residential Scenario

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary
File: FGR 13 Morbidity

Parameter Menu	Parameter	Current Value	Default	Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.720E+00	6.720E+00	DCF2(1)
B-1	Am-241	4.440E-01	4.440E-01	DCF2(2)
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(3)
B-1	Np-237+D	5.400E-01	5.400E-01	DCF2(4)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(5)
B-1	Pb-210+D	2.320E-02	2.320E-02	DCF2(6)
B-1	Pu-238	3.920E-01	3.920E-01	DCF2(7)
B-1	Pu-239	4.290E-01	4.290E-01	DCF2(8)
B-1	Ra-226+D	8.600E-03	8.600E-03	DCF2(9)
B-1	Th-229+D	2.160E+00	2.160E+00	DCF2(10)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(11)
B-1	U-233	1.350E-01	1.350E-01	DCF2(12)
B-1	U-234	1.320E-01	1.320E-01	DCF2(13)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2(14)
B-1	U-238+D	1.180E-01	1.180E-01	DCF2(15)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.480E-02	DCF3(1)
D-1	Am-241	3.640E-03	3.640E-03	DCF3(2)
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(3)
D-1	Np-237+D	4.440E-03	4.440E-03	DCF3(4)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(5)
D-1	Pb-210+D	7.270E-03	7.270E-03	DCF3(6)
D-1	Pu-238	3.200E-03	3.200E-03	DCF3(7)
D-1	Pu-239	3.540E-03	3.540E-03	DCF3(8)
D-1	Ra-226+D	1.330E-03	1.330E-03	DCF3(9)
D-1	Th-229+D	4.030E-03	4.030E-03	DCF3(10)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(11)
D-1	U-233	2.890E-04	2.890E-04	DCF3(12)
D-1	U-234	2.830E-04	2.830E-04	DCF3(13)
D-1	U-235+D	2.670E-04	2.670E-04	DCF3(14)
D-1	U-238+D	2.690E-04	2.690E-04	DCF3(15)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Am-241 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(2,1)
D-34	Am-241 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-05	5.000E-05	RTF(2,2)
D-34	Am-241 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-06	2.000E-06	RTF(2,3)
D-34				
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(3,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(3,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(3,3)
D-34				
D-34	Np-237+D , plant/soil concentration ratio, dimensionless	2.000E-02	2.000E-02	RTF(4,1)
D-34	Np-237+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,2)
D-34	Np-237+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(4,3)
D-34				

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: FGR 13 Morbidity

Parameter Menu	Parameter	Current Value	Default	Name
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(5,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(5,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(5,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(6,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(6,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(6,3)
D-34				
D-34	Pu-238 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(7,1)
D-34	Pu-238 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(7,2)
D-34	Pu-238 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(7,3)
D-34				
D-34	Pu-239 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(8,1)
D-34	Pu-239 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(8,2)
D-34	Pu-239 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(8,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(9,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(9,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(9,3)
D-34				
D-34	Th-229+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(10,1)
D-34	Th-229+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(10,2)
D-34	Th-229+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(10,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(11,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(11,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(11,3)
D-34				
D-34	U-233 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(12,1)
D-34	U-233 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(12,2)
D-34	U-233 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(12,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(13,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(13,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(13,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(14,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(14,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(14,3)
D-34				

```
 D-34 ³ U-238+D  , plant/soil concentration ratio, dimensionless    ³ 2.500E-03 ³ 2.500E-03 ³
RTF(15,1)
 D-34 ³ U-238+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)    ³ 3.400E-04 ³ 3.400E-04 ³
RTF(15,2)
 D-34 ³ U-238+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d)     ³ 6.000E-04 ³ 6.000E-04 ³
RTF(15,3)
      ³                                                            ³           ³           ³
 D-5  ³ Bioaccumulation factors, fresh water, L/kg:                 ³           ³           ³
 D-5  ³ Ac-227+D , fish                                             ³ 1.500E+01 ³ 1.500E+01 ³ BIOFAC(
1,1)
 D-5  ³ Ac-227+D , crustacea and mollusks                           ³ 1.000E+03 ³ 1.000E+03 ³ BIOFAC(
1,2)
 D-5  ³                                                            ³           ³           ³
 D-5  ³ Am-241   , fish                                             ³ 3.000E+01 ³ 3.000E+01 ³ BIOFAC(
2,1)
 D-5  ³ Am-241   , crustacea and mollusks                           ³ 1.000E+03 ³ 1.000E+03 ³ BIOFAC(
2,2)
 D-5  ³                                                            ³           ³           ³
```

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: FGR 13 Morbidity

Parameter Menu	Parameter	Current Value	Default	Name
D-5	Cs-137+D , fish	2.000E+03	2.000E+03	BIOFAC(3,1)
D-5	Cs-137+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	Np-237+D , fish	3.000E+01	3.000E+01	BIOFAC(4,1)
D-5	Np-237+D , crustacea and mollusks	4.000E+02	4.000E+02	BIOFAC(4,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(5,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(5,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(6,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(6,2)
D-5				
D-5	Pu-238 , fish	3.000E+01	3.000E+01	BIOFAC(7,1)
D-5	Pu-238 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(7,2)
D-5				
D-5	Pu-239 , fish	3.000E+01	3.000E+01	BIOFAC(8,1)
D-5	Pu-239 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(8,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(9,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(9,2)
D-5				
D-5	Th-229+D , fish	1.000E+02	1.000E+02	BIOFAC(10,1)
D-5	Th-229+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(10,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(11,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(11,2)
D-5				
D-5	U-233 , fish	1.000E+01	1.000E+01	BIOFAC(12,1)
D-5	U-233 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(12,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(13,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(13,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(14,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(14,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(15,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(15,2)

Site-Specific Parameter Summary

RESRAD Menu	Parameter		User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)		6.325E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)		2.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)		3.650E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)		1.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)		0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)		5.000E+01	1.000E+00	---	T(2)
R011	Times for calculations (yr)		1.000E+02	3.000E+00	---	T(3)
R011	Times for calculations (yr)		3.000E+02	1.000E+01	---	T(4)
R011	Times for calculations (yr)		1.000E+03	3.000E+01	---	T(5)
R011	Times for calculations (yr)		not used	1.000E+02	---	T(6)
R011	Times for calculations (yr)		not used	3.000E+02	---	T(7)
R011	Times for calculations (yr)		not used	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):	Am-241	5.827E-01	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g):	Cs-137	1.361E+00	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g):	Pu-238	3.537E-02	0.000E+00	---	S1(7)
R012	Initial principal radionuclide (pCi/g):	Pu-239	4.334E-02	0.000E+00	---	S1(8)
R012	Concentration in groundwater (pCi/L):	Am-241	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L):	Cs-137	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L):	Pu-238	not used	0.000E+00	---	W1(7)
R012	Concentration in groundwater (pCi/L):	Pu-239	not used	0.000E+00	---	W1(8)
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		2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)		2.000E+04	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	1.000E-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				

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
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)	2.500E+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 Am-241				
R016	Contaminated zone (cm**3/g)	1.900E+03	2.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	1.900E+03	2.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	1.900E+03	2.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.065E-04	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	1.900E+02	1.000E+03	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	1.900E+02	1.000E+03	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	1.900E+02	1.000E+03	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.064E-03	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Pu-238				
R016	Contaminated zone (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCU(7,1)
R016	Saturated zone (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.678E-04	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for Pu-239				

```
 R016 ³   Contaminated zone (cm**3/g)                  ³ 5.500E+02 ³ 2.000E+03 ³              ---
³ DCNUCC( 8)
 R016 ³   Unsaturated zone 1 (cm**3/g)                ³ 5.500E+02 ³ 2.000E+03 ³              ---
³ DCNUCU( 8,1)
 R016 ³   Saturated zone (cm**3/g)                    ³ 5.500E+02 ³ 2.000E+03 ³              ---
³ DCNUCS( 8)
 R016 ³   Leach rate (/yr)                            ³ 0.000E+00 ³ 0.000E+00 ³           3.678E-04
³ ALEACH( 8)
 R016 ³   Solubility constant                         ³ 0.000E+00 ³ 0.000E+00 ³           not used
³ SOLUBK( 8)
      ³                                               ³           ³           ³
³
 R016 ³ Distribution coefficients for daughter Ac-227 ³           ³           ³
³
 R016 ³   Contaminated zone (cm**3/g)                  ³ 2.000E+01 ³ 2.000E+01 ³              ---
³ DCNUCC( 1)
 R016 ³   Unsaturated zone 1 (cm**3/g)                ³ 2.000E+01 ³ 2.000E+01 ³              ---
³ DCNUCU( 1,1)
 R016 ³   Saturated zone (cm**3/g)                    ³ 2.000E+01 ³ 2.000E+01 ³              ---
³ DCNUCS( 1)
 R016 ³   Leach rate (/yr)                            ³ 0.000E+00 ³ 0.000E+00 ³           1.006E-02
³ ALEACH( 1)
 R016 ³   Solubility constant                         ³ 0.000E+00 ³ 0.000E+00 ³           not used
³ SOLUBK( 1)
```

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Np-237				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	2.574E+02	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	-1.000E+00	-1.000E+00	2.574E+02	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	-1.000E+00	-1.000E+00	2.574E+02	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.856E-04	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.037E-03	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.021E-03	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for daughter Ra-226				
R016	Contaminated zone (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCC(9)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCU(9,1)
R016	Saturated zone (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCS(9)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.046E-04	ALEACH(9)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(9)
R016	Distribution coefficients for daughter Th-229				
R016	Contaminated zone (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCC(10)
R016	Unsaturated zone 1 (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCU(10,1)
R016	Saturated zone (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCS(10)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.323E-05	ALEACH(10)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(10)

```
R016 ³ Distribution coefficients for daughter Th-230    ³           ³           ³
³
R016 ³   Contaminated zone (cm**3/g)                    ³ 3.200E+03 ³ 6.000E+04 ³              ---
³ DCNUCC(11)
R016 ³   Unsaturated zone 1 (cm**3/g)                  ³ 3.200E+03 ³ 6.000E+04 ³              ---
³ DCNUCU(11,1)
R016 ³   Saturated zone (cm**3/g)                      ³ 3.200E+03 ³ 6.000E+04 ³              ---
³ DCNUCS(11)
R016 ³   Leach rate (/yr)                              ³ 0.000E+00 ³ 0.000E+00 ³           6.323E-05
³ ALEACH(11)
R016 ³   Solubility constant                           ³ 0.000E+00 ³ 0.000E+00 ³           not used
³ SOLUBK(11)
     ³                                                 ³           ³           ³
³
R016 ³ Distribution coefficients for daughter U-233     ³           ³           ³
³
R016 ³   Contaminated zone (cm**3/g)                    ³ 1.700E+01 ³ 5.000E+01 ³              ---
³ DCNUCC(12)
R016 ³   Unsaturated zone 1 (cm**3/g)                  ³ 1.700E+01 ³ 5.000E+01 ³              ---
³ DCNUCU(12,1)
R016 ³   Saturated zone (cm**3/g)                      ³ 1.700E+01 ³ 5.000E+01 ³              ---
³ DCNUCS(12)
R016 ³   Leach rate (/yr)                              ³ 0.000E+00 ³ 0.000E+00 ³           1.182E-02
³ ALEACH(12)
R016 ³   Solubility constant                           ³ 0.000E+00 ³ 0.000E+00 ³           not used
³ SOLUBK(12)
```

Site-Specific Parameter Summary (continued)

RESRAD Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter U-234				
R016	Contaminated zone (cm**3/g)	1.700E+01	5.000E+01	---	DCNUCC(13)
R016	Unsaturated zone 1 (cm**3/g)	1.700E+01	5.000E+01	---	DCNUCU(13,1)
R016	Saturated zone (cm**3/g)	1.700E+01	5.000E+01	---	DCNUCS(13)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.182E-02	ALEACH(13)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(13)
R016	Distribution coefficients for daughter U-235				
R016	Contaminated zone (cm**3/g)	1.700E+01	5.000E+01	---	DCNUCC(14)
R016	Unsaturated zone 1 (cm**3/g)	1.700E+01	5.000E+01	---	DCNUCU(14,1)
R016	Saturated zone (cm**3/g)	1.700E+01	5.000E+01	---	DCNUCS(14)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.182E-02	ALEACH(14)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(14)
R016	Distribution coefficients for daughter U-238				
R016	Contaminated zone (cm**3/g)	1.700E+01	5.000E+01	---	DCNUCC(15)
R016	Unsaturated zone 1 (cm**3/g)	1.700E+01	5.000E+01	---	DCNUCU(15,1)
R016	Saturated zone (cm**3/g)	1.700E+01	5.000E+01	---	DCNUCS(15)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.182E-02	ALEACH(15)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(15)
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	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
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 ³   Outer annular radius (m), ring  6:            ³ not used  ³ 0.000E+00 ³             ---
³ RAD_SHAPE( 6)
 R017 ³   Outer annular radius (m), ring  7:            ³ not used  ³ 0.000E+00 ³             ---
³ RAD_SHAPE( 7)
 R017 ³   Outer annular radius (m), ring  8:            ³ not used  ³ 0.000E+00 ³             ---
³ RAD_SHAPE( 8)
 R017 ³   Outer annular radius (m), ring  9:            ³ not used  ³ 0.000E+00 ³             ---
³ RAD_SHAPE( 9)
 R017 ³   Outer annular radius (m), ring 10:            ³ not used  ³ 0.000E+00 ³             ---
³ RAD_SHAPE(10)
 R017 ³   Outer annular radius (m), ring 11:            ³ not used  ³ 0.000E+00 ³             ---
³ RAD_SHAPE(11)
 R017 ³   Outer annular radius (m), ring 12:            ³ not used  ³ 0.000E+00 ³             ---
³ RAD_SHAPE(12)
      ³                                                 ³           ³           ³
³
```

Site-Specific Parameter Summary (continued)

RESRAD Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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)	9.200E+01	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	5.400E+00	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E+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	1.000E+00	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.100E+01	FMEAT
R018	Contamination fraction of milk	-1	-1	0.100E+01	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6

```
 R019 ³ Livestock soil intake (kg/day)                  ³ 5.000E-01 ³ 5.000E-01 ³             ---
³ LSI
 R019 ³ Mass loading for foliar deposition (g/m**3)     ³ 1.000E-04 ³ 1.000E-04 ³             ---
³ MLFD
 R019 ³ Depth of soil mixing layer (m)                  ³ 1.500E-01 ³ 1.500E-01 ³             ---
³ DM
 R019 ³ Depth of roots (m)                              ³ 9.000E-01 ³ 9.000E-01 ³             ---
³ DROOT
 R019 ³ Drinking water fraction from ground water       ³ 1.000E+00 ³ 1.000E+00 ³             ---
³ FGWDW
 R019 ³ Household water fraction from ground water      ³ 1.000E+00 ³ 1.000E+00 ³             ---
³ FGWHH
 R019 ³ Livestock water fraction from ground water      ³ 1.000E+00 ³ 1.000E+00 ³             ---
³ FGWLW
 R019 ³ Irrigation fraction from ground water           ³ 1.000E+00 ³ 1.000E+00 ³             ---
³ FGWIR
      ³                                                 ³           ³           ³
³
 R19B ³ Wet weight crop yield for Non-Leafy (kg/m**2)   ³ 7.000E-01 ³ 7.000E-01 ³             ---
³ YV(1)
 R19B ³ Wet weight crop yield for Leafy     (kg/m**2)   ³ 1.500E+00 ³ 1.500E+00 ³             ---
³ YV(2)
 R19B ³ Wet weight crop yield for Fodder    (kg/m**2)   ³ 1.100E+00 ³ 1.100E+00 ³             ---
³ YV(3)
 R19B ³ Growing Season for  Non-Leafy (years)           ³ 1.700E-01 ³ 1.700E-01 ³             ---
³ TE(1)
 R19B ³ Growing Season for  Leafy     (years)           ³ 2.500E-01 ³ 2.500E-01 ³             ---
³ TE(2)
 R19B ³ Growing Season for  Fodder    (years)           ³ 8.000E-02 ³ 8.000E-02 ³             ---
³ TE(3)
 R19B ³ Translocation Factor for  Non-Leafy             ³ 1.000E-01 ³ 1.000E-01 ³             ---
³ TIV(1)
```

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	1.000E+00	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	2.500E-01	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	2.500E-01	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
C14	DCF correction factor for gaseous forms of C14	not used	8.894E+01	---	CO2F
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)	1.500E-01	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	2.400E+00	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV

R021	Total porosity of the building foundation	1.000E-01	1.000E-01	--- TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	--- PH2OCV
R021	Volumetric water content of the foundation	3.000E-02	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	3.000E-07	3.000E-07	--- DIFFL
R021	in contaminated zone soil	2.000E-06	2.000E-06	--- DIFCZ
R021	Radon vertical dimension of mixing (m)	2.000E+00	2.000E+00	--- HMIX
R021	Average building air exchange rate (1/hr)	5.000E-01	5.000E-01	--- REXG
R021	Height of the building (room) (m)	2.500E+00	2.500E+00	--- HRM
R021	Building interior area factor	0.000E+00	0.000E+00	code computed (time dependent) FAI
R021	Building depth below ground surface (m)	-1.000E+00	-1.000E+00	code computed (time dependent) DMFL
R021	Emanating power of Rn-222 gas	2.500E-01	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

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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	active
5 -- milk ingestion	active
6 -- aquatic foods	active
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	active
Find peak pathway doses	active

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	63250.00 square meters	Am-241	5.827E-01
Thickness:	2.00 meters	Cs-137	1.361E+00
Cover Depth:	0.00 meters	Pu-238	3.537E-02
		Pu-239	4.334E-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	5.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	3.975E+00	1.381E+00	5.900E-01	1.910E-01	6.484E-02
M(t):	2.650E-01	9.207E-02	3.933E-02	1.273E-02	4.323E-03

Maximum TDOSE(t): 3.975E+00 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

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.
Am-241	1.638E-02	0.0041	1.994E-02	0.0050	0.000E+00	0.0000	1.846E-01	0.0464	3.794E-03	0.0010	2.165E-04	0.0001	5.801E-02	0.0146
Cs-137	2.879E+00	0.7244	3.309E-06	0.0000	0.000E+00	0.0000	2.340E-01	0.0589	4.093E-01	0.1030	1.336E-01	0.0336	1.840E-03	0.0005
Pu-238	3.446E-06	0.0000	1.065E-03	0.0003	1.192E-15	0.0000	9.821E-03	0.0025	4.036E-04	0.0001	5.759E-06	0.0000	3.086E-03	0.0008
Pu-239	8.163E-06	0.0000	1.434E-03	0.0004	0.000E+00	0.0000	1.336E-02	0.0034	5.493E-04	0.0001	7.837E-06	0.0000	4.199E-03	0.0011
Total	2.896E+00	0.7285	2.244E-02	0.0056	1.192E-15	0.0000	4.418E-01	0.1111	4.140E-01	0.1042	1.339E-01	0.0337	6.714E-02	0.0169

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

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.
Am-241	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	0.000E+00	0.0000	2.830E-01	0.0712
Cs-137	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	0.000E+00	0.0000	3.658E+00	0.9203
Pu-238	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	0.000E+00	0.0000	1.438E-02	0.0036
Pu-239	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	0.000E+00	0.0000	1.956E-02	0.0049
Total	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	0.000E+00	0.0000	3.975E+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)

Radio-	Ground Soil		Inhalation		Radon		Plant		Meat		Milk	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	1.504E-02	0.0109	1.831E-02	0.0133	0.000E+00	0.0000	1.696E-01	0.1228	3.488E-03	0.0025	1.988E-04	0.0001
Cs-137	8.599E-01	0.6227	9.882E-07	0.0000	0.000E+00	0.0000	6.988E-02	0.0506	1.222E-01	0.0885	3.991E-02	0.0289
Pu-238	2.280E-06	0.0000	7.045E-04	0.0005	4.750E-10	0.0000	6.496E-03	0.0047	2.670E-04	0.0002	3.839E-06	0.0000
Pu-239	8.003E-06	0.0000	1.406E-03	0.0010	0.000E+00	0.0000	1.310E-02	0.0095	5.385E-04	0.0004	7.683E-06	0.0000
Total	8.750E-01	0.6336	2.042E-02	0.0148	4.750E-10	0.0000	2.590E-01	0.1876	1.265E-01	0.0916	4.012E-02	0.0290

	Fish											
Radio-	Water				Radon		Plant		Meat		Milk	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	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	0.000E+00	0.0000
Cs-137	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	0.000E+00	0.0000
Pu-238	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	0.000E+00	0.0000
Pu-239	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	0.000E+00	0.0000
Total	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	0.000E+00	0.0000

Radio-	All Pathways*			
Nuclide	mrem/yr	fract.	mrem/yr	fract.
Am-241	2.599E-01	0.1882		
Cs-137	1.093E+00	0.7911		
Pu-238	9.514E-03	0.0069		
Pu-239	1.918E-02	0.0139		
Total	1.381E+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)

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.
Am-241	1.382E-02	0.0234	1.681E-02	0.0285	0.000E+00	0.0000	1.557E-01	0.2640	3.206E-03	0.0054	1.825E-04	0.0003	4.889E-02	0.0829
Cs-137	2.568E-01	0.4353	2.951E-07	0.0000	0.000E+00	0.0000	2.087E-02	0.0354	3.650E-02	0.0619	1.192E-02	0.0202	1.642E-04	0.0003
Pu-238	1.509E-06	0.0000	4.660E-04	0.0008	2.929E-09	0.0000	4.296E-03	0.0073	1.766E-04	0.0003	2.556E-06	0.0000	1.350E-03	0.0023
Pu-239	7.847E-06	0.0000	1.378E-03	0.0023	0.000E+00	0.0000	1.285E-02	0.0218	5.279E-04	0.0009	7.532E-06	0.0000	4.036E-03	0.0068
Total	2.707E-01	0.4587	1.865E-02	0.0316	2.929E-09	0.0000	1.937E-01	0.3284	4.042E-02	0.0685	1.211E-02	0.0205	5.444E-02	0.0923

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

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.
Am-241	4.532E-11	0.0000	2.207E-13	0.0000	0.000E+00	0.0000	3.289E-12	0.0000	2.856E-13	0.0000	1.027E-12	0.0000	2.386E-01	0.4045
Cs-137	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	0.000E+00	0.0000	3.263E-01	0.5530
Pu-238	7.053E-07	0.0000	3.436E-09	0.0000	2.515E-15	0.0000	5.126E-08	0.0000	4.479E-09	0.0000	1.603E-08	0.0000	6.294E-03	0.0107
Pu-239	3.025E-10	0.0000	1.553E-12	0.0000	0.000E+00	0.0000	2.198E-11	0.0000	1.994E-12	0.0000	6.809E-12	0.0000	1.880E-02	0.0319
Total	7.057E-07	0.0000	3.438E-09	0.0000	2.515E-15	0.0000	5.128E-08	0.0000	4.481E-09	0.0000	1.604E-08	0.0000	5.900E-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 = 3.000E+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.
Am-241	9.832E-03	0.0515	1.194E-02	0.0625	0.000E+00	0.0000	1.108E-01	0.5804	2.292E-03	0.0120	1.298E-04	0.0007	3.473E-02	0.1819
Cs-137	2.043E-03	0.0107	2.348E-09	0.0000	0.000E+00	0.0000	1.660E-04	0.0009	2.904E-04	0.0015	9.483E-05	0.0005	1.306E-06	0.0000
Pu-238	2.921E-07	0.0000	8.918E-05	0.0005	3.284E-08	0.0000	8.222E-04	0.0043	3.380E-05	0.0002	4.977E-07	0.0000	2.583E-04	0.0014
Pu-239	7.249E-06	0.0000	1.273E-03	0.0067	0.000E+00	0.0000	1.187E-02	0.0621	4.877E-04	0.0026	6.958E-06	0.0000	3.728E-03	0.0195
Total	1.188E-02	0.0622	1.330E-02	0.0697	3.284E-08	0.0000	1.237E-01	0.6477	3.104E-03	0.0163	2.320E-04	0.0012	3.872E-02	0.2028

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+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.
Am-241	2.783E-08	0.0000	1.362E-10	0.0000	0.000E+00	0.0000	2.027E-09	0.0000	1.788E-10	0.0000	6.351E-10	0.0000	1.698E-01	0.8890
Cs-137	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	0.000E+00	0.0000	2.596E-03	0.0136
Pu-238	2.332E-05	0.0001	1.139E-07	0.0000	1.403E-11	0.0000	1.699E-06	0.0000	1.500E-07	0.0000	5.325E-07	0.0000	1.230E-03	0.0064
Pu-239	1.940E-08	0.0000	1.743E-10	0.0000	0.000E+00	0.0000	1.413E-09	0.0000	1.679E-10	0.0000	3.850E-10	0.0000	1.737E-02	0.0910
Total	2.336E-05	0.0001	1.142E-07	0.0000	1.403E-11	0.0000	1.702E-06	0.0000	1.504E-07	0.0000	5.335E-07	0.0000	1.910E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
Water Independent Pathways (Inhalation excludes radon)

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.
Am-241	3.001E-03	0.0463	3.608E-03	0.0556	0.000E+00	0.0000	3.382E-02	0.5216	7.153E-04	0.0110	3.934E-05	0.0006	1.050E-02	0.1619
Cs-137	9.178E-11	0.0000	1.055E-16	0.0000	0.000E+00	0.0000	7.458E-12	0.0000	1.305E-11	0.0000	4.260E-12	0.0000	5.866E-14	0.0000
Pu-238	1.662E-08	0.0000	2.737E-07	0.0000	1.530E-07	0.0000	2.545E-06	0.0000	1.051E-07	0.0000	2.718E-09	0.0000	7.926E-07	0.0000
Pu-239	5.492E-06	0.0001	9.645E-04	0.0149	0.000E+00	0.0000	8.989E-03	0.1386	3.695E-04	0.0057	5.271E-06	0.0001	2.824E-03	0.0436
Total	3.006E-03	0.0464	4.573E-03	0.0705	1.530E-07	0.0000	4.281E-02	0.6602	1.085E-03	0.0167	4.461E-05	0.0007	1.332E-02	0.2054

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

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.
Am-241	2.422E-07	0.0000	1.212E-09	0.0000	0.000E+00	0.0000	1.765E-08	0.0000	1.556E-09	0.0000	5.516E-09	0.0000	5.168E-02	0.7970
Cs-137	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	0.000E+00	0.0000	1.166E-10	0.0000
Pu-238	7.235E-07	0.0000	1.021E-08	0.0000	4.984E-10	0.0000	5.274E-08	0.0000	5.488E-09	0.0000	1.553E-08	0.0000	4.696E-06	0.0001
Pu-239	5.644E-08	0.0000	1.176E-09	0.0000	0.000E+00	0.0000	4.113E-09	0.0000	8.413E-10	0.0000	6.357E-10	0.0000	1.316E-02	0.2029
Total	1.022E-06	0.0000	1.260E-08	0.0000	4.984E-10	0.0000	7.450E-08	0.0000	7.885E-09	0.0000	2.168E-08	0.0000	6.484E-02	1.0000

*Sum of all water independent and dependent pathways.

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

Parent (i)	Product (j)	Branch Fraction*	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	5.000E+01	1.000E+02	3.000E+02	1.000E+03
Am-241	Am-241	1.000E+00	4.856E-01	4.458E-01	4.093E-01	2.907E-01	8.781E-02
Am-241	Np-237	1.000E+00	1.382E-06	1.398E-04	2.616E-04	6.113E-04	8.775E-04
Am-241	U-233	1.000E+00	3.501E-14	1.393E-10	5.287E-10	5.472E-08	4.622E-07
Am-241	Th-229	1.000E+00	9.991E-18	3.988E-12	2.664E-11	4.244E-10	5.090E-09
Am-241	äDSR(j)		4.856E-01	4.460E-01	4.096E-01	2.913E-01	8.869E-02
Cs-137	Cs-137	1.000E+00	2.688E+00	8.028E-01	2.398E-01	1.907E-03	8.568E-11
Pu-238	Pu-238	1.000E+00	4.067E-01	2.690E-01	1.779E-01	3.405E-02	1.044E-04
Pu-238	U-234	1.000E+00	1.279E-07	8.097E-06	3.186E-05	7.337E-04	1.968E-05
Pu-238	Th-230	1.000E+00	4.181E-13	2.123E-09	6.163E-09	2.556E-08	5.522E-08
Pu-238	Ra-226	1.000E+00	3.896E-14	1.568E-08	9.674E-08	1.089E-06	5.230E-06
Pu-238	Pb-210	1.000E+00	2.961E-17	4.031E-10	3.968E-09	1.325E-07	3.439E-06
Pu-238	äDSR(j)		4.067E-01	2.690E-01	1.779E-01	3.478E-02	1.328E-04
Pu-239	Pu-239	1.000E+00	4.514E-01	4.425E-01	4.338E-01	4.008E-01	3.036E-01
Pu-239	U-235	1.000E+00	2.780E-10	2.110E-08	3.987E-08	4.710E-07	7.232E-07
Pu-239	Pa-231	1.000E+00	4.117E-14	2.779E-10	8.838E-10	2.006E-08	1.926E-07
Pu-239	Ac-227	1.000E+00	2.065E-16	4.004E-11	2.299E-10	5.224E-08	5.815E-07
Pu-239	äDSR(j)		4.514E-01	4.425E-01	4.338E-01	4.008E-01	3.036E-01

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ó 0.5 yr) 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	5.000E+01	1.000E+02	3.000E+02	1.000E+03
Am-241	3.089E+01	3.363E+01	3.662E+01	5.149E+01	1.691E+02
Cs-137	5.580E+00	1.869E+01	6.256E+01	7.864E+03	1.751E+11
Pu-238	3.688E+01	5.576E+01	8.430E+01	4.313E+02	1.130E+05
Pu-239	3.323E+01	3.390E+01	3.458E+01	3.743E+01	4.941E+01

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) (pCi/g)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Am-241	5.827E-01	0.000E+00	4.856E-01	3.089E+01	4.856E-01	3.089E+01
Cs-137	1.361E+00	0.000E+00	2.688E+00	5.580E+00	2.688E+00	5.580E+00
Pu-238	3.537E-02	0.000E+00	4.067E-01	3.688E+01	4.067E-01	3.688E+01
Pu-239	4.334E-02	0.000E+00	4.514E-01	3.323E+01	4.514E-01	3.323E+01

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

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	5.000E+01	1.000E+02	3.000E+02	1.000E+03
Am-241	Am-241	1.000E+00	2.830E-01	2.598E-01	2.385E-01	1.694E-01	5.117E-02
Np-237	Am-241	1.000E+00	8.054E-07	8.148E-05	1.524E-04	3.562E-04	5.113E-04
U-233	Am-241	1.000E+00	2.040E-14	8.119E-11	3.081E-10	3.188E-08	2.693E-07
Th-229	Am-241	1.000E+00	5.821E-18	2.323E-12	1.552E-11	2.473E-10	2.966E-09
Cs-137	Cs-137	1.000E+00	3.658E+00	1.093E+00	3.263E-01	2.596E-03	1.166E-10
Pu-238	Pu-238	1.000E+00	1.438E-02	9.514E-03	6.293E-03	1.204E-03	3.692E-06
U-234	Pu-238	1.000E+00	4.525E-09	2.864E-07	1.127E-06	2.595E-05	6.960E-07
Th-230	Pu-238	1.000E+00	1.479E-14	7.508E-11	2.180E-10	9.040E-10	1.953E-09
Ra-226	Pu-238	1.000E+00	1.378E-15	5.547E-10	3.422E-09	3.852E-08	1.850E-07
Pb-210	Pu-238	1.000E+00	1.047E-18	1.426E-11	1.403E-10	4.687E-09	1.216E-07
Pu-239	Pu-239	1.000E+00	1.956E-02	1.918E-02	1.880E-02	1.737E-02	1.316E-02
U-235	Pu-239	1.000E+00	1.205E-11	9.146E-10	1.728E-09	2.041E-08	3.134E-08
Pa-231	Pu-239	1.000E+00	1.784E-15	1.205E-11	3.830E-11	8.695E-10	8.346E-09
Ac-227	Pu-239	1.000E+00	8.949E-18	1.735E-12	9.962E-12	2.264E-09	2.520E-08

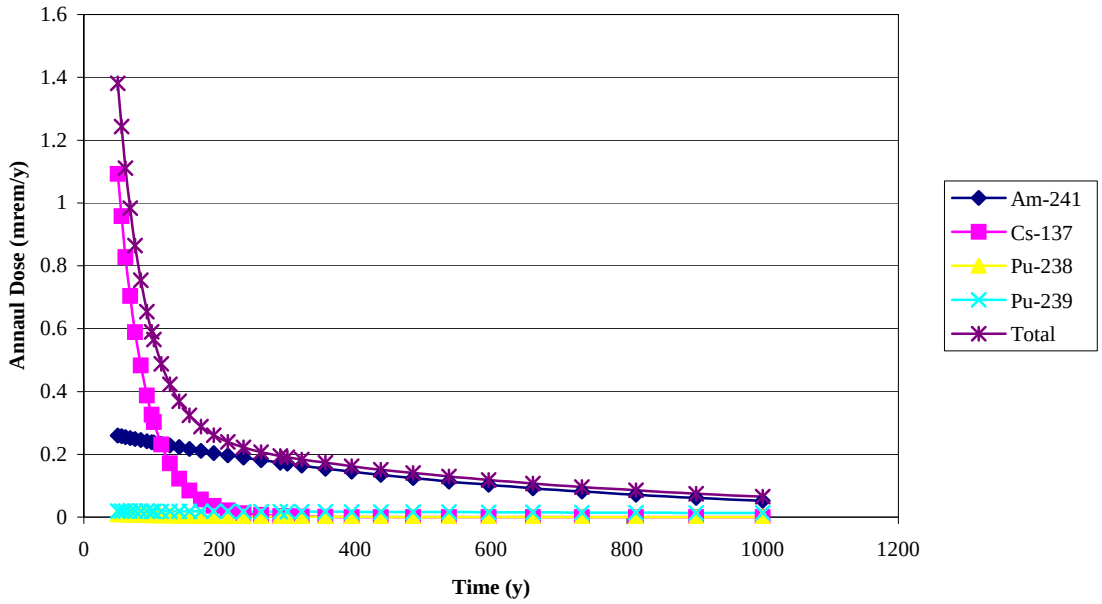
BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

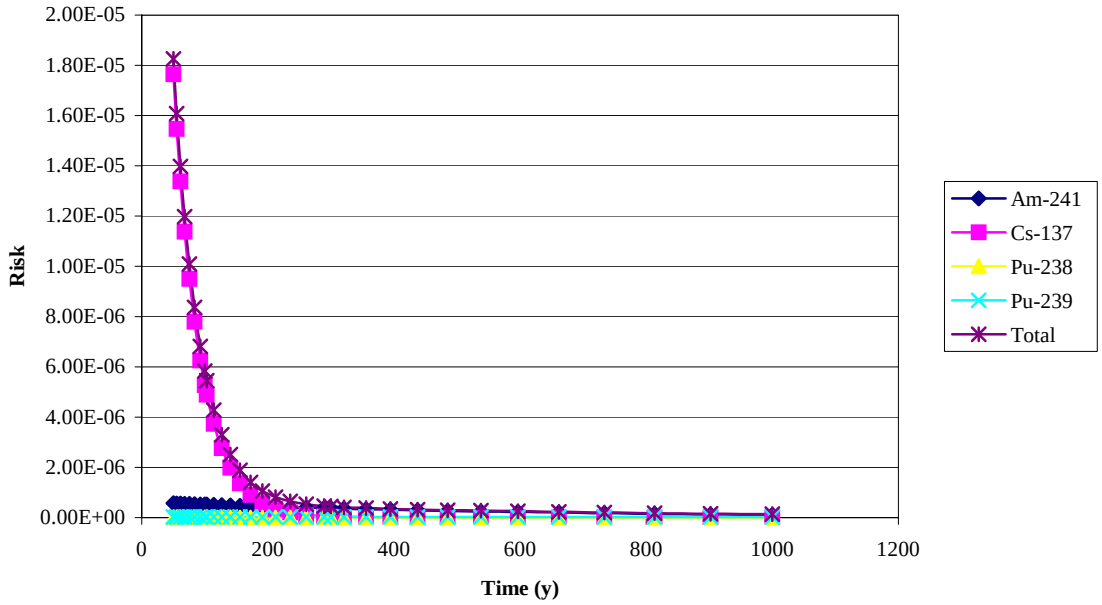
Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	5.000E+01	1.000E+02	3.000E+02	1.000E+03
Am-241	Am-241	1.000E+00	5.827E-01	5.349E-01	4.911E-01	3.488E-01	1.054E-01
Np-237	Am-241	1.000E+00	0.000E+00	8.866E-06	1.666E-05	3.906E-05	5.612E-05
U-233	Am-241	1.000E+00	0.000E+00	8.189E-10	2.638E-09	1.126E-08	2.090E-08
Th-229	Am-241	1.000E+00	0.000E+00	1.362E-12	9.241E-12	1.405E-10	1.280E-09
Cs-137	Cs-137	1.000E+00	1.361E+00	4.064E-01	1.214E-01	9.658E-04	4.338E-11
Pu-238	Pu-238	1.000E+00	3.537E-02	2.339E-02	1.547E-02	2.961E-03	9.078E-06
U-234	Pu-238	1.000E+00	0.000E+00	3.038E-06	3.692E-06	1.549E-06	7.035E-09
Th-230	Pu-238	1.000E+00	0.000E+00	8.125E-10	2.377E-09	7.202E-09	8.713E-09
Ra-226	Pu-238	1.000E+00	0.000E+00	6.304E-12	3.950E-11	4.496E-10	2.227E-09
Pb-210	Pu-238	1.000E+00	0.000E+00	1.895E-12	1.910E-11	3.486E-10	2.036E-09
Pu-239	Pu-239	1.000E+00	4.334E-02	4.249E-02	4.165E-02	3.848E-02	2.915E-02
U-235	Pu-239	1.000E+00	0.000E+00	1.594E-09	2.446E-09	3.210E-09	2.514E-09
Pa-231	Pu-239	1.000E+00	0.000E+00	8.668E-13	2.698E-12	1.006E-11	1.398E-11
Ac-227	Pu-239	1.000E+00	0.000E+00	3.077E-13	1.399E-12	7.104E-12	1.068E-11

BRF(i) is the branch fraction of the parent nuclide.
RESCALC.EXE execution time = 29.82 seconds

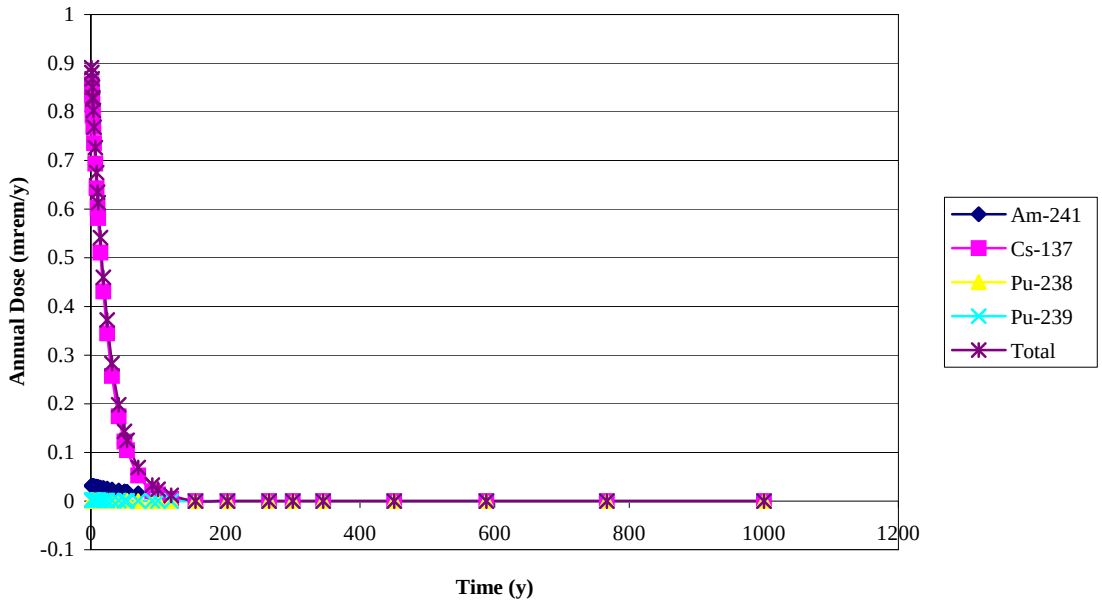
RESRAD Graphs



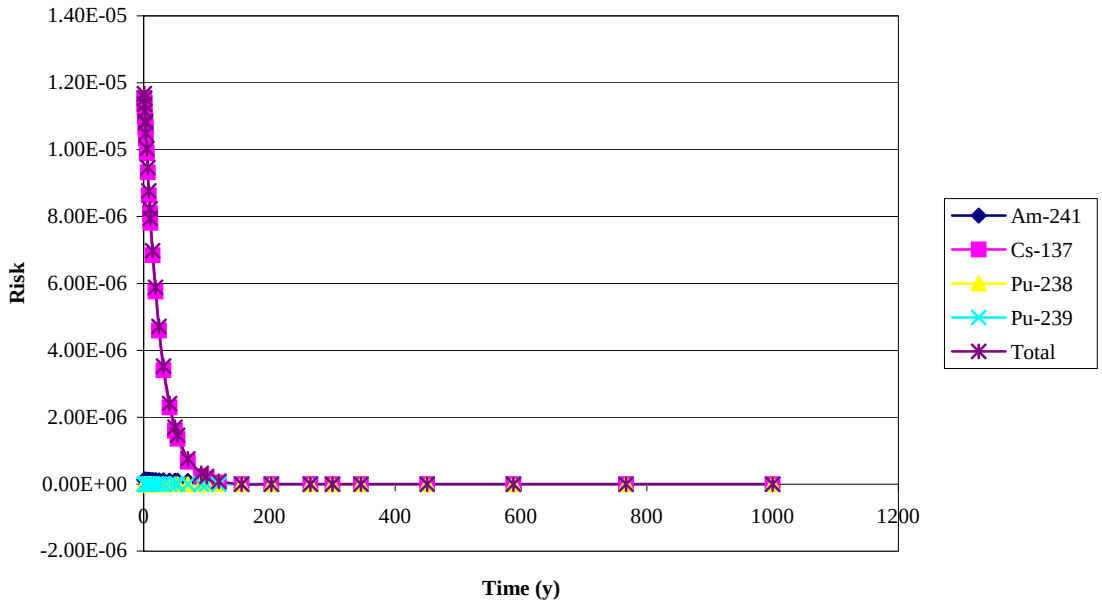
Residential Dose as a Function of Time



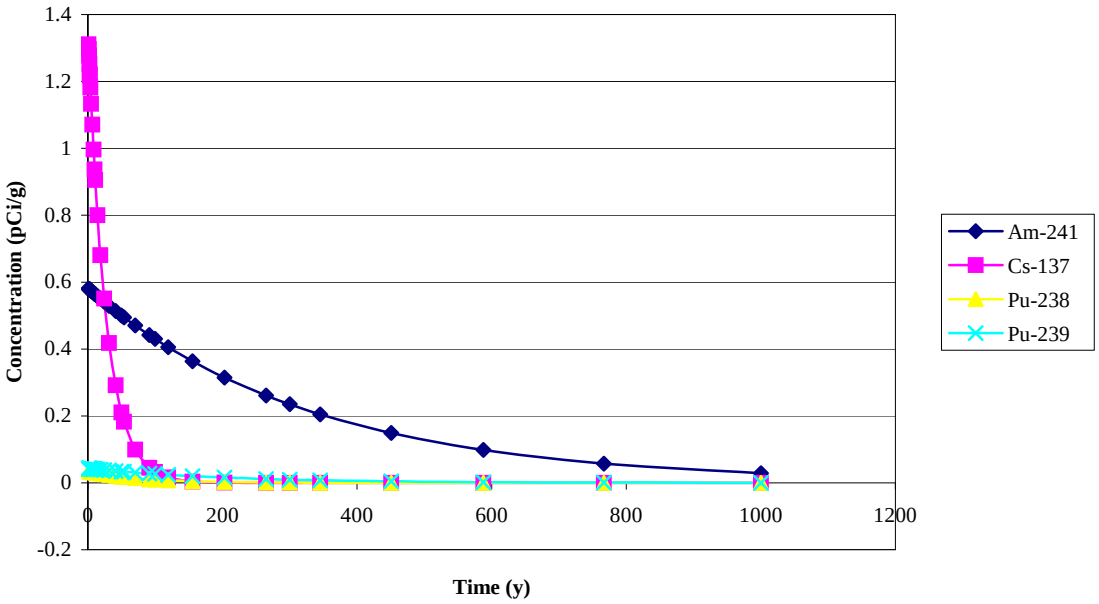
Residential Risk as a Function of Time



Occupational Dose as a Function of Time



Occupational Risk as a Function of Time



Radionuclide Concentrations in the Soil as a Function of Time