

Ground Penetrating Radar Survey

The ground penetrating radar (GPR) survey was conducted using a Geophysical Survey Systems, Sir System 2 test instrument for the investigation of potential subsurface anomalies. The sensitivity of this instrument under site-specific soil conditions was sufficient to define anomalies to a depth of 10 feet. Survey findings were evaluated for valid positive anomalies and trending. Backhoe excavation and hand digging were then used to investigate the locations of positive indication. Coarse vegetation (small trees and brush) and sharp elevation changes due to rough terrain precluded GPR survey in some areas. Where these conditions were present, investigations were performed by exploratory excavation and the direct movement of soil by hand digging or heavy earth moving equipment.

All unearthed construction materials were removed and evaluated under existing procedures for materials release. Gamma spectroscopy was judgmentally performed on samples of soil found in direct contact with excavated debris at suspect locations. Radioactivity resulting from plant operational activities was not identified at any survey location in this investigation. The findings of this evaluation are detailed below by individual area survey.

Survey Unit 12

Survey unit 12 is a flat, grassy strip of level terrain located directly north of the plant between the Protected Area fence and Lake Michigan. Historical photographs identify this area as the location used for concrete batch production and material staging during plant construction. The investigation of GPR anomalies in this area resulted in the retrieval of large pieces of concrete and wooden scaffold planking. Additional miscellaneous unearthed debris included nails, rebar, metal bands, and an empty crushed burn barrel. All of this material was excavated from the original construction level elevation. This elevation is presently located approximately 3 to 6 feet below current grade. Based on historical data and the unique properties of soil layers identified in this survey unit, the elevation change is believed to result from the contour grading of lake bottom dredge sediment that was deposited in this area. The sediment fill originated from the initial excavation and construction of the discharge canal.

It was common practice in the construction industry to dispose of unwanted building debris by onsite burial during final site grading. The construction rubble excavated during the GPR survey is typical of the building materials used during plant construction. In addition to construction debris, the GPR survey identified two separate systems of undefined piping in this survey unit:

1. A piping segment was identified in the eastern portion of the survey unit extending from the Protected Area to the beach. This section of piping is an alternate branch of the storm drain system that was abandoned as a result of reoccurring sand blockage along the lakeshore.

2. The GPR survey also identified a trend of north/south anomalies in the central portion of the survey unit. Follow-up excavations led to the discovery of a run of clay tile set in drain stone. This line is suspected to have been used for water drainage during placement of the lake bottom dredging sediment that had been removed for construction of the discharge canal. Proximity to system piping still in use precluded removal of the drain tile at this time of discovery.

Survey Unit 15(2)

The staging and storage of materials in this area during plan construction is clearly identified in historical photographic records. This location is an undisturbed beach ridge comprised of a covering of cobbles over hard clay. No subsurface anomalies were identified; however, a small volume of scrap metal and miscellaneous construction material were found on the beach surface. This material was removed from the area for disposal.

Survey Unit 16

An evaluation of a beach area near the tree line in the southwest section of Survey Unit 16 was conducted. Soils at this location are comprised of shallow gravelly sand typical of the soil layers found in survey unit 12. The soil layer covers a base of cobbles and clay. It is obvious from the topography and vegetation that this region has been graded. Vehicle barricades bisect the survey area approximately 75 feet east of the security fence. The GPR survey and follow-up anomaly investigation revealed only naturally occurring rock formations west of the vehicle barricades. An investigation of suspect anomalies east of the barricades is planned prior to Final Status survey.

Sections of tile, asphalt, concrete, and crane cable were visible near the ordinary waterline. These materials were likely placed on the beach as riprap for shoreline protection against wave action and high water levels. All construction debris has been removed from the area for disposal.

Dredge spoils from the Canal were placed in this area on several occasions. The spoils originate from the discharge canal dredging that was conducted to remove sand build-up created by wind and wave action. The shallow gravelly sand, and grading visible in this area are believed to result from the dredging projects.

Survey Unit 17 – Paved Drive

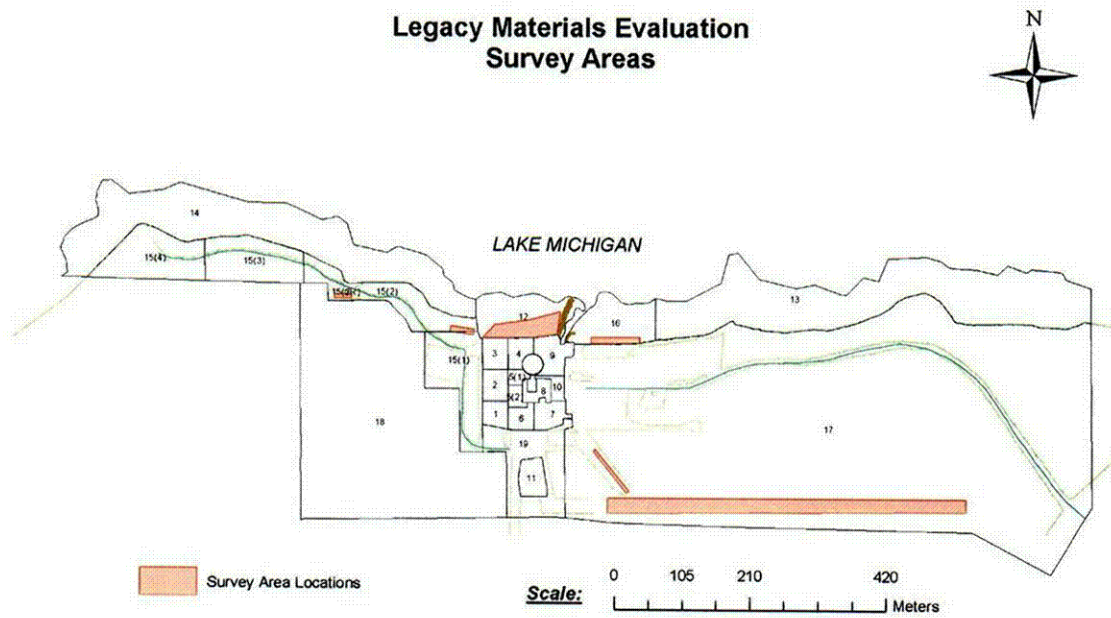
The survey area in unit 17 is the paved transport route to the Swamp Warehouse and former 138kV power line easement. This 300-foot section of roadway was developed prior to power operations at the time of original site construction.

Individual soil layers in the survey area were clearly defined by GPR as fill material, native soil, and water table strata. Power cable and/or storm drain crossings were identified at 2 locations. The soil below the roadway fill material appears undisturbed. No significant anomalies were identified in the survey and exploratory excavation was unnecessary. All cable, piping, and road surface materials have been scheduled for removal prior to Final Status Survey.

Survey Unit 17 – 138 kV Power Line Easement

During site preparation for original plant construction, an easement supporting 138 kV power distribution was created to supply electrical service to the Emmet County Substation near Petoskey, Michigan. The easement begins near the former plant substation in the Industrial area and traverses the owner-controlled property eastward approximately 400 meters to highway US Highway 31. This area, originally heavily wooded, was logged and smooth graded for power line construction. Area grading resulted in mounded embankments of excess soil spaced against the tree line on either side of the easement. These mounded areas contain large pieces of concrete, asphalt rubble, and other miscellaneous debris as documented by historical information and physical inspection.

A GPR survey could not be conducted in this area due to coarse vegetation and uneven terrain; however, investigation was performed by a thorough excavation of all suspect areas. Using a backhoe and front loader, all mounds were graded to an approximate 5-inch thickness and inspected for the presence of man-made materials. Construction debris and miscellaneous scrap materials were only found on mound surfaces. The mounds all appear to have been created by deposition of soil from the original easement grading. Soil layers beneath the mounds appear to have remained undisturbed. All materials retrieved were removed from the area.



Nal Scanning For Open Land Survey

Big Rock Point is required to perform the survey and analysis of all area soils to ensure that potential residual radioactivity levels meet the regulatory requirements for license termination and unrestricted site release. Site history and characterization activities to date have identified Cs-137 and Co-60 as the predominant potential contaminants associated with Big Rock Point. Other radioactive contaminants of plant origin, including the HTD (hard-to-detect) radionuclides, are present at levels much lower than those of Cs-137 and Co-60. Soil sampling analyses have demonstrated that measurements of Cs-137 and Co-60 can be used as surrogates for estimating levels of other radionuclides with the potential to be present in soils at Big Rock Point.

The evaluation of open land areas for unrestricted release must include a detection methodology of sufficient sensitivity for the identification of small areas of potentially elevated activity within a survey unit. This engineering analysis considers the following two survey methods:

1. Surface Scan (continuous monitoring), or
2. Static Measurement (discrete measurement)

This study establishes the detector, counting geometry, and minimum detectable concentration (MDC) values for scanning and defines the methods used to identify small areas of potentially elevated levels of radioactivity in land area surveys. Measurement methodologies follow the guidance provided in NUREG-1507 and NUREG-1575 [References 2 and 3].

ANALYSIS INPUTS:

1. Bicron Nal scintillation probe specifications
2. MicroShield radioactive source modeling [Reference 1]

ANALYSIS:

Surface Scan

Surface Scanning measurements for Big Rock Point open land areas are performed by passing a 2" x 2" Nal (Sodium Iodide) gamma scintillation detector across the land surface under investigation. The centerline of the detector is maintained 10 cm above the surface and moved from side to side in a 1 meter wide pattern at a rate of 0.5 m/sec, while advancing forward approximately 0.125 m/sec. The resulting serpentine scan pattern crosses each square meter area 4 times in 8 seconds with a maximum separation of less than 50 cm between any path. The audible signal is monitored for detectable increases in count rate. An observed count rate increase results in further investigation to verify findings and define the level and extent of contamination. This method represents the Stage 1 and Stage 2 scanning process defined in NUREG-1507 and is the basis for calculations of the scanning detection sensitivity (Scan MDC).

Measurement sensitivity

An *a priori* determination of scanning sensitivity is performed to ensure that the measurement system is able to detect concentrations of radioactivity at levels below the regulatory release limit. Expressed in terms of Scan MDC, this sensitivity is the lowest concentration of radioactivity for a given background that the measurement system is able to detect at a specified performance level. The MDC value for Surface Scanning is developed in the following steps:

1. Minimum Detectable Count Rate surveyor (MDCR_s)

The MDCR_s is the minimum detectable count rate above a given background that the scanning instrument and measurement technique are expected to identify at a specified level of performance. Scanning is conducted by the following two stages of measurement technique:

- Stage 1 scanning
The detector is in motion for initial identification of potential areas of elevated activity. Based on the scanning progression of 1 square meter per 8 seconds, an observation interval of 2 seconds exists for measurement evaluation. The specified performance level for Stage 1 scanning defines the count rate above a given background that results in a 95% probability of being correctly identified when present and a 60% probability of being falsely identified when not present ($\alpha = 0.6$, $\beta = 0.05$).
- Stage 2 Scanning
Following identification of a potential area of elevated activity in the Stage 1 scanning process; further investigation is conducted by increasing the observation interval for measurement of the suspect area to 4 seconds. The specified performance level for Stage 2 scanning defines the count rate above a given background that results in a 95% probability of being correctly identified when present and a 20% probability of being falsely identified when not present ($\alpha = 0.2$, $\beta = 0.05$).

The MDCR_s is determined for Stage 1 and Stage 2 scanning based on the following relationship:

$$\text{MDCR}_s = d' \cdot \frac{\sqrt{B_i}}{\sqrt{p}} \cdot \frac{60}{i}$$

Where : d' = Index of sensitivity: Stage1 $d' = 1.38$ ($\alpha = 0.6$, $\beta = 0.05$)
Stage2 $d' = 2.48$ ($\alpha = 0.2$, $\beta = 0.05$)

i = Observation interval: Stage 1 (2 seconds)
Stage 2 (4 seconds)

B_i = Background count rate in the interval i

p = Surveyor efficiency of 0.05

The longer observation interval of Stage 2 scanning increases measurement sensitivity and permits an improvement in the level of specified performance. Stage 2 scanning provides more conservative (higher) values of MDCR_s as detailed in Tables 1 and 2. The Stage 2 scanning MDCR_s is the basis value used for development of the Scan MDC.

2. Detector Rating

The detector rating is the manufacturer rated value of detector cpm response to delivered $\mu\text{R/hr}$ exposure. The detector used in this counting system has a Cs-137 rated value of 1200cpm/ $\mu\text{R/hr}$. To determine the rating value for other nuclides of interest, a calculation of the relative detector response is required. This value is the product of the fluence rate and the probability of interaction for each nuclide. The detector rating for the additional nuclide of interest (cpm/ $\mu\text{R/hr}$) is the product of the manufacturer Cs-137 rated value and the relative detector response ratio at each energy. The rating values for additional nuclides of interest are defined by the following:

$$\text{Fluence Rate } F = \frac{\mu\text{R/hr}}{(E\gamma)(\mu_{en}/\rho)_{\text{air}}}$$

Where: $E\gamma$ = nuclide of interest energy (keV)

μ_{en}/ρ = mass energy absorption coefficient for air at $E\gamma$

$$\text{Probability of Interaction } P = 1 - e^{-(\mu/\rho)_{\text{NaI}}(x)(\rho)_{\text{NaI}}}$$

Where: $(\mu/\rho)_{\text{NaI}}$ = mass attenuation coefficient for NaI at the nuclide energy

(x) = thickness of the NaI crystal (cm)

ρ_{NaI} = density of NaI g/cm³

Relative Detector Response = Fluence Rate • Probability of Interaction

Detector Rating For Additional Nuclides

$$\text{cpm / } \mu\text{R/hr}_{\text{new energy}} = \text{Cs-137}_{\text{rated}} \cdot \frac{\text{RDR}_{\text{@ new energy}}}{\text{RDR}_{\text{@ rated energy}}}$$

Where: Cs-137_{rated} = 1200cpm/ $\mu\text{R/hr}$

RDR = Relative Detector Response

Detector rating values for Big Rock Point nuclides of interest are detailed in Table 2-D1.

Table 2-D1 Detector Rating						
Energy keV	$\mu_{en}/\rho_{\text{air}}$	μ/ρ_{NaI}	Fluence (F)	Probability (P)	F • P	Det. Rating
661.6	2.93E-02	7.77E-02	5.16E-02	7.65E-01	3.95E-02	1200
1173.2	2.70E-02	5.38E-02	3.15E-02	6.33E-01	2.00E-02	607
1332.5	2.63E-02	5.01E-02	2.86E-02	6.07E-01	1.73E-02	527
Detector Rating cpm/ $\mu\text{R/hr}$						
			Cs-137	Co-60*		
			1200	565		

* Weighted sum based on exposure rate_{model} contribution at energies of 1173.2 and 1332.5 keV

3. Minimum Detector Exposure Rate (MDER)

The MDER is the minimum level of exposure rate delivered to the detector in a given background that the counting system is able to identify at the specified level of performance. This value is a ratio of the MDCR_s and the detector rating for the nuclide of interest.

$$\text{MDER} = \frac{\text{MDCR}_s}{\text{Detector Rating cpm} / \mu\text{R} / \text{hr}}$$

4. Scan MDC

Finally, the Scan MDC is the product of the minimum detectable exposure rate and the modeled exposure/activity.

$$\text{Scan MDC} = \text{MDER} \cdot \frac{\text{pCi} / \text{g}}{\mu\text{R} / \text{hr}} \text{Exposure/Activity model}$$

Final derivation of the Scan MDC is developed using the Microshield modeling code (ref. 1) to define the exposure/activity model. The source of potential elevated activity for identification by the scanning process is considered to be distributed for an area of approximately 0.25 square meters (0.28 meter radius). A given concentration of the source nuclide of interest is modeled to the measurement system geometry resulting in a known delivered exposure rate to the detector. Modeled exposure to source concentration values are provided later in this Appendix.

Results

For a distributed source geometry of 0.15 meters depth and 0.28 meters radius in typical Big Rock Point background levels of 4000 cpm to 6500 cpm, Scan MDC values range from 2.91 to 3.71 pCi/g for Cs-137 and 1.51 to 1.93 pCi/g for Co-60. Stage 1 and Stage 2 MDCR_s, MDER, and Scan MDC values are detailed for various background activity levels in Tables 2-D2 and 2-D3.

Table 2-D2
Stage 1 Scan MDC In Varying Backgrounds

Background	d'	I	S _i	CPM	MDER μ R/hr		Scan MDC pCi/g	
				MDCR _{surveyor}	Cs-137	Co-60	Cs-137	Co-60
2000	1.38	2	11.27	478.05	0.40	0.85	1.62	0.84
2500	1.38	2	12.60	534.47	0.45	0.95	1.81	0.94
3000	1.38	2	13.80	585.48	0.49	1.04	1.98	1.03
3500	1.38	2	14.91	632.40	0.53	1.12	2.14	1.11
4000	1.38	2	15.93	676.06	0.56	1.20	2.29	1.19
4500	1.38	2	16.90	717.07	0.60	1.27	2.43	1.26
5000	1.38	2	17.82	755.86	0.63	1.34	2.56	1.33
5500	1.38	2	18.69	792.75	0.66	1.40	2.69	1.40
6000	1.38	2	19.52	828.00	0.69	1.47	2.81	1.46
6500	1.38	2	20.31	861.81	0.72	1.53	2.92	1.52
7000	1.38	2	21.08	894.34	0.75	1.58	3.03	1.57
7500	1.38	2	21.82	925.73	0.77	1.64	3.14	1.63
8000	1.38	2	22.54	956.09	0.80	1.69	3.24	1.68
8500	1.38	2	23.23	985.52	0.82	1.74	3.34	1.73
9000	1.38	2	23.90	1,014.09	0.85	1.79	3.44	1.78
10000	1.38	2	25.20	1,068.94	0.89	1.89	3.62	1.88
10000	1.38	2	25.20	1,068.94	0.89	1.89	3.62	1.88
10500	1.38	2	25.82	1,095.34	0.91	1.94	3.71	1.93
11000	1.38	2	26.42	1,121.12	0.93	1.98	3.80	1.97
11500	1.38	2	27.02	1,146.31	0.96	2.03	3.89	2.02
12000	1.38	2	27.60	1,170.97	0.98	2.07	3.97	2.06
12500	1.38	2	28.17	1,195.12	1.00	2.12	4.05	2.10
13000	1.38	2	28.73	1,218.78	1.02	2.16	4.13	2.14
13500	1.38	2	29.27	1,242.00	1.04	2.20	4.21	2.19
14000	1.38	2	29.81	1,264.79	1.05	2.24	4.29	2.23
14500	1.38	2	30.34	1,287.18	1.07	2.28	4.36	2.27
15000	1.38	2	30.86	1,309.18	1.09	2.32	4.44	2.30
Modeled Exposure (μ R/hr) @ 5 pCi/g								
	Cs-137	1.23E+00						
	Co-60	5.03E+00						

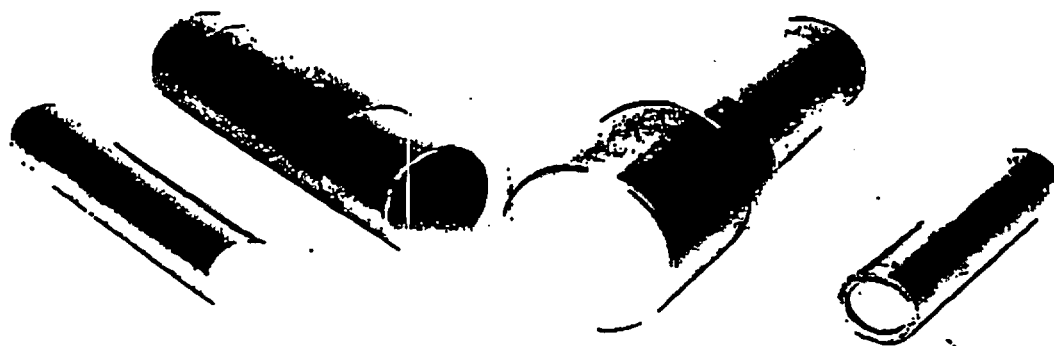
Table 2-D3
Stage 2 Scan MDC In Varying Backgrounds

Background	d'	I	S _I	CPM	MDER μ R/hr		Scan MDC pCi/g	
				MDCR _{surveyor}	Cs-137	Co-60	Cs-137	Co-60
2000	2.48	4	28.64	607.47	0.51	1.08	2.06	1.07
2500	2.48	4	32.02	679.18	0.57	1.20	2.30	1.20
3000	2.48	4	35.07	744.00	0.62	1.32	2.52	1.31
3500	2.48	4	37.88	803.61	0.67	1.42	2.72	1.41
4000	2.48	4	40.50	859.10	0.72	1.52	2.91	1.51
4500	2.48	4	42.95	911.21	0.76	1.61	3.09	1.60
5000	2.48	4	45.28	960.50	0.80	1.70	3.26	1.69
5500	2.48	4	47.49	1,007.38	0.84	1.78	3.42	1.77
6000	2.48	4	49.60	1,052.17	0.88	1.86	3.57	1.85
6500	2.48	4	51.63	1,095.14	0.91	1.94	3.71	1.93
7000	2.48	4	53.57	1,136.48	0.95	2.01	3.85	2.00
7500	2.48	4	55.45	1,176.37	0.98	2.08	3.99	2.07
8000	2.48	4	57.27	1,214.95	1.01	2.15	4.12	2.14
8500	2.48	4	59.04	1,252.34	1.04	2.22	4.25	2.20
9000	2.48	4	60.75	1,288.65	1.07	2.28	4.37	2.27
10000	2.48	4	64.03	1,358.35	1.13	2.40	4.61	2.39
10000	2.48	4	64.03	1,358.35	1.13	2.40	4.61	2.39
10500	2.48	4	65.61	1,391.90	1.16	2.46	4.72	2.45
11000	2.48	4	67.16	1,424.65	1.19	2.52	4.83	2.51
11500	2.48	4	68.67	1,456.67	1.21	2.58	4.94	2.56
12000	2.48	4	70.14	1,488.00	1.24	2.63	5.04	2.62
12500	2.48	4	71.59	1,518.68	1.27	2.69	5.15	2.67
13000	2.48	4	73.01	1,548.76	1.29	2.74	5.25	2.73
13500	2.48	4	74.40	1,578.26	1.32	2.79	5.35	2.78
14000	2.48	4	75.77	1,607.22	1.34	2.84	5.45	2.83
14500	2.48	4	77.11	1,635.67	1.36	2.89	5.55	2.88
15000	2.48	4	78.42	1,663.63	1.39	2.94	5.64	2.93
Modeled Exposure (μ R/hr) @ 5 pCi/g								
	Cs-137	1.23E+00						

Bicron Detector Specifications

002

Models: G1/G1LE/G2/G3 NaI(Tl) Scintillation Probes



G1 Features

- 1" x 1" CRYSTAL
- HIGH GAMMA SENSITIVITY

G1LE Features

- LOW ENERGY GAMMA
- DETECTION
- ¹²⁵I EFFICIENCY >90%

GENERAL: The probes described on this data sheet use NaI(Tl) scintillators to detect gamma and x-ray energies. The energy range and the count rate (efficiency/sensitivity) desired determine which probe to use in a given application.

G2/G3 Features

- 2" x 2" CRYSTAL (G2)
- 3" x 3" CRYSTAL (G3)
- RUGGED CONSTRUCTION
- SINGLE MHV CONNECTOR
- HIGH GAMMA SENSITIVITY

When matched with the single channel analyzers of the ANALYST or LABTECH, these probes can discriminate between low and high energy sources or detect low energy radiation while reducing background counting rate.

The G1 is a compact, lightweight, general purpose probe useful for detecting small changes in background.

The G1LE has a thin crystal and entrance window (aluminum or beryllium) for enhanced detection of ¹²⁵I and other low energy sources.

The G2 is a ruggedly built probe with a larger scintillation crystal than the G1 for greater sensitivity. In turn, the G3 has a still larger volume for sensitivity greater than the G2.

The G1, G1LE, G2 and G3 are compatible with portable survey meters, analyzers, and scalars which accept scintillation probes. These include the Bicron ANALYST, SURVEYOR M, SURVEYOR MS, LABTECH and FRISK-TECH.



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Bicron Detector Specifications

Models: G1/G1LE/G2/G3 Specifications

	G1 Probe	G1LE Probe	G2 Probe	G3 Probe
Radiation Detected	Gamma >60 keV	Gamma, 10-60 keV	Gamma >60 keV	Gamma >60 keV
	NaI(Tl)	NaI(Tl)	NaI(Tl)	
Crystal Dimensions	1" x 0.97"	1" x 0.04"	2" x 2"	
Housing Material	Aluminum	Aluminum	Aluminum	
Housing Thickness	0.13" side wall 0.07" end	0.13" side wall	0.02"	
Window Density	N/A	6.9 mg/cm ² Al 23 mg/cm ² Be	N/A	N/A
Photomultiplier Tube	1.125" dia., 11 stage, selected, bi-alkali cathode	1.125" dia., 11 stage, selected, bi-alkali cathode	2.0" dia., 10 stage, selected, bi-alkali cathode	3.0" dia., 10 stage, selected, bi-alkali cathode
Magnetic Shield	Conetic foil	Conetic foil	Mu-metal	
Operating Voltage	Variable	Variable	Variable	
Maximum Voltage	1500 V	1500 V	1500 V	
Voltage Divider Termination	Single MHV	Single MHV	Single MHV (others available)	
Total Impedance	110 meg	110 meg	110 meg (other ratings available)	
Pulse Height Resolution	8.5% or better for ¹³⁷ Cs (663 keV)	20% or better for ¹²⁵ I (35 keV)	8.5% or better for ¹³⁷ Cs (663 keV)	
Relative Sensitivity	300 kcpm/mR/h for ¹³⁷ Cs	375 kcpm/mR/h for ¹²⁵ I	1200 kcpm/mR/h for ¹³⁷ Cs	
Efficiency	46% for ¹³⁷ Cs	99% for ¹²⁵ I	74% for ¹³⁷ Cs	
	-40° to +50°C	-40° to +50°C	-40° to +50°C	
	10°C per hour	10°C per hour	10°C per hour	
	7.9" x 1.37" 20 x 3.5 cm	7.1" x 1.37" 18 x 3.5 cm	8.37" x 2.3" 21.3 x 5.8 cm	9.87" x 3.25" (max) 25.1 x 8.3 cm
Weight	9.8 oz 278 g	7.5 oz 213 g	1.79 lb 0.81 kg	4.0 lb 1.81 kg

* Efficiency is defined as that percentage of a well collimated beam incident on the center face of the detector which is counted by the detector.

APPLICATION NOTES:

G1.5 and G2LE model probes are also available. The G1.5 uses a 1.5" diameter by 1" thick crystal to provide a larger sensitive area and more efficiency than the G1.

Manufacturer reserves right to alter specifications.

The G2LE is a 2" diameter version of the G1LE, and, like the G1LE, is optimized for ¹²⁵I detection. The optional beryllium window for the G1LE and G2LE provides greater low energy efficiency.

Bicron's capabilities in NaI(Tl) and organic scintillators enable us to offer a wide variety of scintillation probes. Versatile detection systems result from combining these probes with Bicron's ANALYST, LABTECH, FRISK-TECH, or SURVEYOR M & MS instruments.



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MicroShield Model

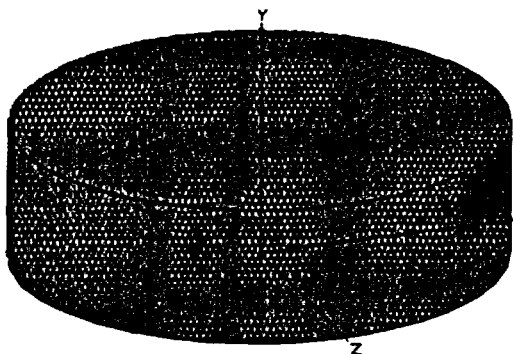
Cs-137

MicroShield v5.03 (5.03-00060)
Consumers Energy

Page : 1
DOS File: CS137@28.MS5
Run Date: October 15, 2002
Run Time: 11:45:47 AM
Duration: 00:00:00

File Ref:
Date:
By:
Checked:

Case Title: Scan MDC
Description: Cs-137 uniform concentration, 28 cm radius
Geometry: 8 - Cylinder Volume - End Shields



Source Dimensions
Height 15.0 cm 5.9 in
Radius 28.0 cm 11.0 in

Dose Points
1 X 0 cm 25 cm 0 cm
0.0 in 9.8 in 0.0 in

Shields
Shield Name Dimension Material Density
Source 3.69e+04 cm³ Concrete 1.6
Air Gap Air 0.00122

Source Input
Grouping Method : Actual Photon Energies
Nuclide curies becquerels $\mu\text{Ci/cm}^3$ Bq/cm³
Ba-137m 2.7960e-007 1.0345e+004 7.5680e-006 2.8002e-001
Cs-137 2.9556e-007 1.0936e+004 8.0000e-006 2.9600e-001

Buildup
The material reference is : Source

Integration Parameters
Radial 20
Circumferential 10
Y Direction (axial) 10

Results					
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm ² /sec No Buildup	Fluence Rate MeV/cm ² /sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0318	2.142e+02	3.852e-05	4.667e-05	3.209e-07	3.888e-07
0.0322	3.952e+02	7.408e-05	9.030e-05	5.962e-07	7.267e-07
0.0364	1.438e+02	4.101e-05	5.350e-05	2.330e-07	3.040e-07
0.6616	9.309e+03	3.553e-01	6.330e-01	6.889e-04	1.227e-03
TOTALS:	1.006e+04	3.555e-01	6.332e-01	6.900e-04	1.229e-03

MicroShield Model

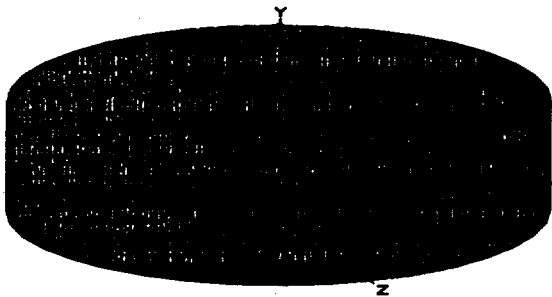
Scan Co-60

MicroShield v5.03 (5.03-00060)
Consumers Energy

File : 1
File: CO60@28.MS5
Date: October 15, 2002
Time: 12:10:15 PM
ation: 00:00:00

File Ref:
Date:
By:
Checked:

Case Title: Scan MDC
Description: CO-60 uniform concentration, 28 cm radius
Geometry: 8 - Cylinder Volume - End Shields



Source Dimensions
Height 15.0 cm 5.9 in
Radius 28.0 cm 11.0 in

Dose Points
1 X Y Z
0 cm 25 cm 0 cm
0.0 in 9.8 in 0.0 in

Shields
Shield Name Dimension Material Density
Source 3.69e+04 cm³ Concrete 1.6
Air Gap Air 0.0012

Source Input
Grouping Method : Actual Photon Energies
Nuclide curies becquerels $\mu\text{Ci/cm}^3$ Bq/cm³
Co-60 2.9556e-007 1.0936e+004 8.0000e-006 2.9600e-001

Buildup
The material reference is : Source

Integration Parameters
Radial 20
Circumferential 10
Y Direction (axial) 10

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		No Buildup	With Buildup	No Buildup	With Buildup
.6938	1.784e+00	7.244e-05	1.272e-04	1.399e-07	2.456e-07
.1732	1.094e+04	8.782e-01	1.335e+00	1.569e-03	2.386e-03
.3325	1.094e+04	1.035e+00	1.523e+00	1.795e-03	2.643e-03
TALS:	2.187e+04	1.913e+00	2.858e+00	3.364e-03	5.029e-03

References

1. MicroShield v5.03
Grove Engineering
15215 Shady Grove Road
Rockville, Maryland 20850
2. NUREG-1507, Minimum Detectable Concentrations With Typical Radiation Survey
Instruments for Various Contaminants and Field Conditions
U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001
Office of Nuclear Regulatory Research
3. NUREG-1575, Multi-Agency Radiation Survey And Site Investigation Manual U. S. Nuclear
Regulatory Commission Washington, DC 20555-0001
4. Harshaw Bicron Radiation Measurement Products
6081 Cochran Road Solon, OH 44139

Characterization Summary

Radiological surveys conducted in support of site characterization are designed by directives established through the Data Quality Objective (DQO) process and follow the guidance provided in NUREG-1575. Survey design information contained in this Appendix follows the applicable guidance provided in NUREG-1575. The Big Rock Point Impacted Area is 0.540 km² (133.3 acres) in size and currently consists of 27 survey units. The characterization survey process has identified less than 1% of this area to contain residual radioactivity of plant origin. Four survey units (Discharge Canal, 5(1), 5(2), and 8) qualify as complex locations containing one or more of the following:

- Identified contaminant levels requiring remediation,
- Previous soil remediation and backfill within the survey unit,
- Subsurface contamination,
- Subsurface components currently supporting containment ventilation or continued operation of the fuel pool, or
- Geomorphologic conditions requiring complex sampling techniques (Discharge Canal).

Measurement instrumentation and methods used for the performance of characterization surveys are detailed in Sections 2.3.4. and 2.4.4.1. This appendix defines the radiological status of Impacted area soils and provides the characterization survey findings of individual survey units to include:

- Physical description and brief history of the survey unit,
- Current radiological status,
- Data summary,
- The primary survey design and summary of all supporting surveys,
- Maps defining the survey unit and identifying sample point locations, and
- Survey results.

Survey Unit 1

Description

Survey Unit 1 is an area of approximately 1,600 m² that occupies the southwest corner of the Protected Area. The Butler Building, Contaminated Warehouse, Calibration Shack, and the QA/QC Warehouse are located in this area. Subsurface structures and equipment in Survey Unit 1 include building foundations, plumbing connections, fiber optics, and electrical conduit.

History

The HSA identifies this survey as potentially containing residual radioactivity. This location is adjacent to the transport route that was used to move spent resin and filter material from the Protected Area to the Radwaste Compound. Buildings located in this area have been used for the storage of contaminated materials. The Butler Building and the QA/QC Warehouse have undergone remediation following the discovery of fixed structural contamination.

Radiological Status

Radioactivity of potential plant origin was not identified in Survey Unit 1 above Initial Derived Concentration Guideline Levels (IDCGLs). Subsurface soil contamination is not indicated by the HSA or process knowledge and was not identified in soil analyses. The radiological status of this survey unit is Class 1 based on proximity to the following area locations:

- Contaminated materials transport pathways,
- Areas of known soil contamination scheduled for excavation and subsurface component removal,
- Locations scheduled for soil remediation, and
- Buildings and foundations scheduled for demolition and removal of contaminated equipment and materials.

Primary Survey Design

1. Sample Data Points Required

The scoping survey resulted in the following data:

Nuclide identification	Cs-137
Mean value (pCi/g)	0.038
Standard Deviation (σ)	0.076

The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL.

$$\text{Relative Shift} = \frac{\text{DCGL} - \text{LBGR}}{\sigma} = \frac{5.11 - 2.5}{0.076} = 34$$

With α and β error levels set at 0.05 and an assumed relative shift of 3, the Sign Test requirements specify a sample size of 14 data points.

2. Sample Locations

Sample data point locations were selected in a random start, square grid pattern with the southwest corner of the survey unit as origin.

Survey unit dimensions 40 x 50 meters

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Random Numbers 0.82, 0.31

$$X = (0.82)(40 \text{ m}) = 32.8 \text{ m}$$

$$Y = (0.31)(50 \text{ m}) = 15.5 \text{ m}$$

$$\text{Sample Spacing } L = \sqrt{\text{Area}/N} = \sqrt{1600/14} = 10.7 \text{ m spacing}$$

As a conservative measure 20 samples were collected using 10 meter spacing. For data points falling outside the survey unit or where obstructions prohibited sample collection, alternate sample locations were identified by the random selection process.

Supporting Surveys

One deep-core profile was obtained in survey grid 363 as shown on the following page. Sampling was performed to a depth of 2.4 m by a mechanically driven 3-inch diameter split-spoon hollow stem auger. The sample data point was judgmentally selected based on location availability due to subsurface piping, fiber optics, and electrical power supply.

Data Summary

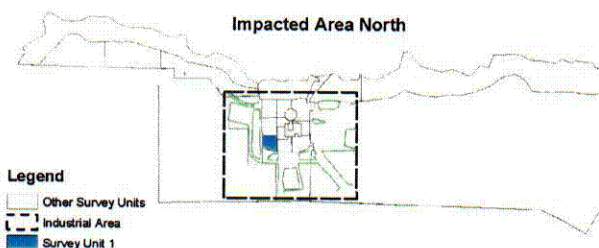
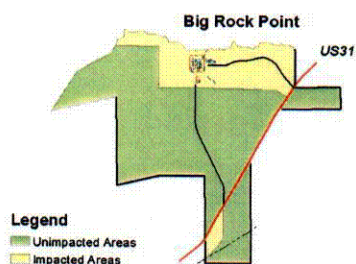
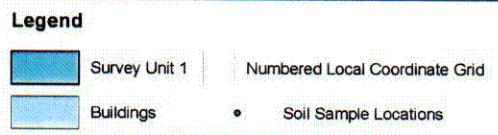
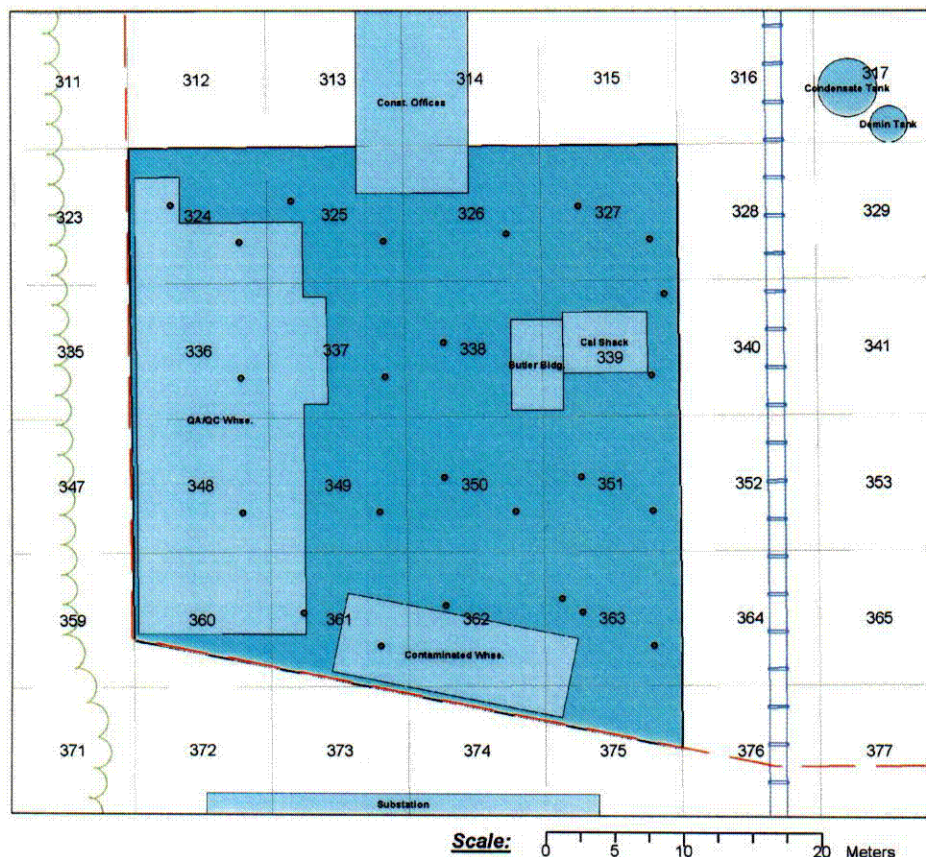
Survey Unit 1

Survey	No. of Samples	Radionuclides*	Mean (pCi/g)	Max. Value (pCi/g)
1A ₁	23	Cs ₁₃₇	0.16	0.37
		Co ₆₀ **	0.11	0.11
1A ₁ deepcore1	4	nd	-	-

* nd indicates non detect

** Activity detected in one sample only

Survey Unit 1



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Survey Results

Survey	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
1A	324	(3.0,5.8)	0.00-0.15	0.07		nd	0.04	nd	0.18
1A	324	(8.0,3.0)	0.00-0.15	nd	0.04	nd	0.02	nd	0.19
1A	325	(1.8,6.0)	0.00-0.15	0.05		nd	0.04	nd	0.18
1A	325	(8.5,3.0)	0.00-0.15	0.07		nd	0.04	nd	0.18
1A	326	(7.5,3.5)	0.00-0.15	0.33		0.11		nd	0.28
1A	327	(2.8,5.5)	0.00-0.15	0.26		nd	0.03	nd	0.17
1A	327	(8.0,3.0)	0.00-0.15	0.06		nd	0.04	nd	0.19
1A	336	(8.0,3.0)	0.00-0.15	nd	0.04	nd	0.04	nd	0.17
1A	337	(8.5,3.0)	0.00-0.15	0.07		nd	0.05	nd	0.16
1A	338	(2.8,5.5)	0.00-0.15	0.28		nd	0.04	nd	0.19
1A	339	(8.0,3.0)	0.00-0.15	0.37		nd	0.08	nd	0.30
1A	339	(9.0,9.0)	0.00-0.15	nd	0.04	nd	0.04	nd	0.16
1A	348	(8.0,3.0)	0.00-0.15	nd	0.04	nd	0.04	nd	0.21
1A	349	(8.0,3.0)	0.00-0.15	nd	0.26	nd	0.05	nd	0.19
1A	350	(2.8,5.5)	0.00-0.15	0.36		nd	0.04	nd	0.18
1A	350	(8.0,3.0)	0.00-0.15	nd	0.04	nd	0.04	nd	0.23
1A	351	(2.8,5.5)	0.00-0.15	0.03		nd	0.04	nd	0.17
1A	351	(8.0,3.0)	0.00-0.15	nd	0.03	nd	0.03	nd	0.15
1A	361	(2.4,5.5)	0.00-0.15	0.05		nd	0.03	nd	0.17
1A	361	(8.0,3.0)	0.00-0.15	0.08		nd	0.04	nd	0.18
1A	362	(2.8,6.0)	0.00-0.15	0.09		nd	0.03	nd	0.17
1A	363	(2.8,5.5)	0.00-0.15	0.18		nd	0.10	nd	0.32
1A	363	(8.0,3.0)	0.00-0.15	0.18		nd	0.10	nd	0.33
1A _{deepcore1}	363	(1.3,6.5)	0.00-0.90	0.03		nd	0.07	nd	0.21
1A _{deepcore1}	363	(1.3,6.5)	0.90-1.20	nd	0.08	nd	0.09	nd	0.35
1A _{deepcore1}	363	(1.3,6.5)	1.20-180	nd	0.05	nd	0.11	nd	0.41
1A _{deepcore1}	363	(1.3,6.5)	1.80-240	nd	0.03	nd	0.05	nd	0.25

^a nd indicates non detect, MDA reported

^b No entry in MDA columns is provided when residual radioactivity is detected.

Survey Unit 2

Description

Survey Unit 2 is approximately 2000 m² and occupies the west-central section of the Protected Area. This area contains the Maintenance/Construction Complex (MCC). Subsurface structures and equipment in Survey Unit 2 include the MCC building foundation, plumbing connections, fiber optics, electrical conduit runs, and a section of the site Fire Protection System piping.

History

The HSA identifies this survey unit to potentially contain radioactive contamination in area soils. Survey Unit 2 is adjacent to the transport route used to move spent resin and filter material from the Protected Area to the Radwaste Compound. The MCC has not been used for the storage of contaminated materials and equipment.

Radiological Status

Residual radioactivity was not identified in Survey Unit 2 above established background concentrations. Subsurface soil contamination is not indicated by the HSA or process knowledge and was not identified in deep-core sample analyses. The radiological status of this survey unit is Class 1 based on proximity to the following area locations:

- Contaminated material transport pathways,
- Areas of known soil contamination scheduled for excavation and subsurface component removal,
- Locations scheduled for soil remediation, and
- Buildings and foundations scheduled for demolition and removal of contaminated equipment and materials.

Primary Survey Design

1. Sample Data Points Required

The scoping survey resulted in the following data:

Nuclide identification	Cs-137
Mean value (pCi/g)	0.014
Standard deviation (σ)	0.025

The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL.

$$\text{Relative Shift} = \frac{\text{DCGL} - \text{LBGR}}{\sigma} = \frac{5.11 - 2.5}{0.025} = 104$$

With α and β error levels set at 0.05 and an assumed relative shift of 3, the Sign Test requirements specify a sample size of 14 data points.

2. Sample Locations

Sample data point locations were selected in a random start, square grid pattern with the southwest corner of the survey unit as origin.

Survey unit dimensions 40 x 50 meters

Random Numbers 0.60, 0.13

$X = (0.60)(40 \text{ m}) = 24 \text{ m}$

$Y = (0.13)(50 \text{ m}) = 6.5 \text{ m}$

$$\text{Sample Spacing } L = \sqrt{\frac{\text{Area}}{N}} = \sqrt{\frac{2000}{14}} = 11.9 \text{ meters}$$

As a conservative measure 20 samples were collected using 10 meter spacing. For data points falling outside the survey unit or where obstructions prohibited sample collection, alternate sample locations were identified by the random selection process described above.

Supporting Surveys

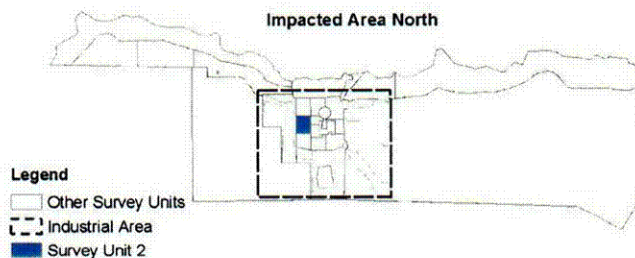
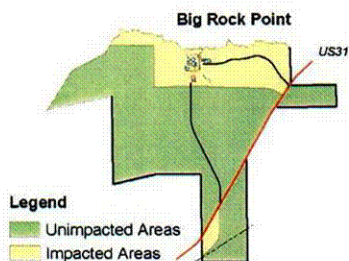
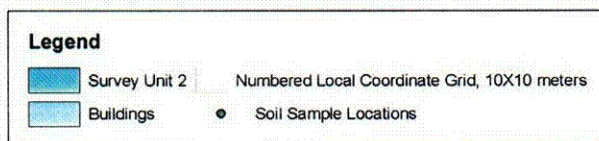
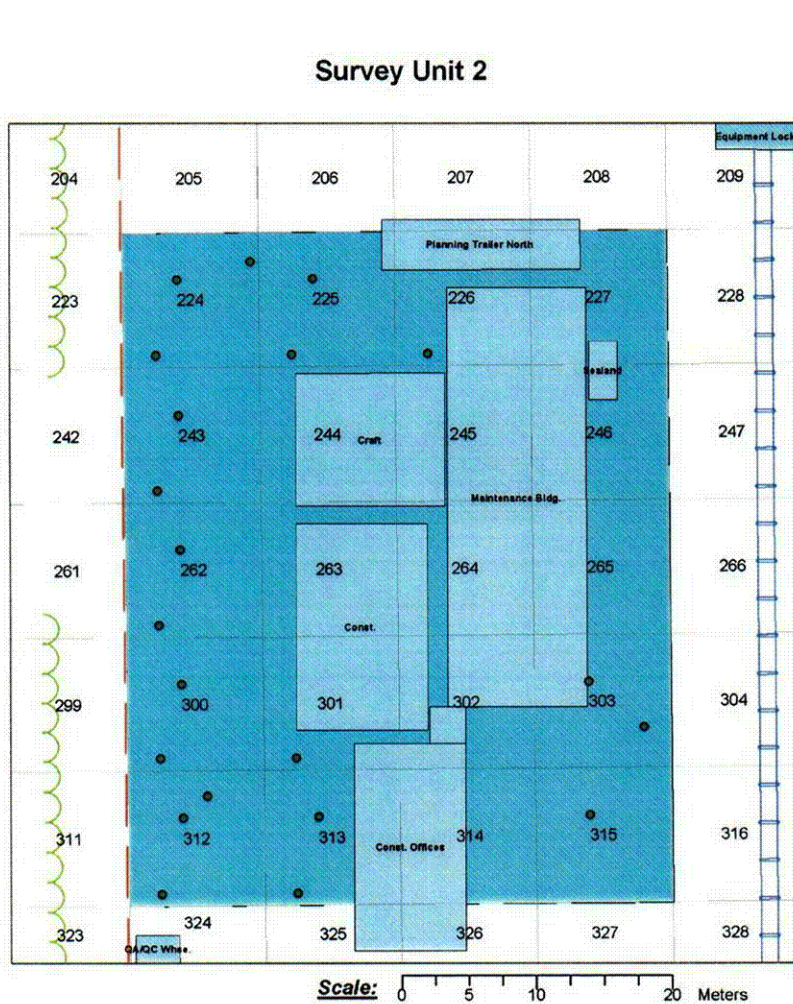
A deep-core profile survey was conducted in survey grids 224 and 3129. Sampling was performed to a maximum depth of 2.4 meters by split-spoon, hollow-stem auger. Sample point locations were judgmentally selected based on historical data, process knowledge and the potential to contain subsurface radioactivity of plant origin. Sample point locations for deep-core profiles are limited in this survey unit due to the safety concerns associated underground systems and power supplies that remain in service.

Data Summary

Survey Unit 2

Survey	No. of Samples	Radionuclides*	Mean (pCi/g)	Max. Value (pCi/g)
2A ₁	20	Cs ₁₃₇	0.24	0.92
2A ₁ deepcore1	11	nd	-	-

* nd indicates non detect



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Survey Results

Survey	Grid	Coordinate (x,y) (m)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
2A	224	(2.4,0.9)	0.00-0.15	0.92		nd	0.08	nd	0.27
2A	224	(4.0,6.5)	0.00-0.15	0.18		nd	0.13	nd	0.26
2A	225	(2.4,0.9)	0.00-0.15	0.14		nd	0.08	nd	0.28
2A	225	(4.0,6.5)	0.00-0.15	nd	0.13	nd	0.13	nd	0.23
2A	226	(2.4,0.9)	0.00-0.15	0.10		nd	0.11	nd	0.16
2A	243	(2.4,0.9)	0.00-0.15	0.33		nd	0.13	nd	0.22
2A	243	(4.0,6.5)	0.00-0.15	0.08		nd	0.10	nd	0.17
2A	262	(2.4,0.9)	0.00-0.15	nd	0.03	nd	0.03	nd	0.17
2A	262)	(4.0,6.5)	0.00-0.15	0.29		nd	0.09	nd	0.33
2A	300	(2.4,0.9)	0.00-0.15	nd	0.03	nd	0.03	nd	0.15
2A	300	(4.0,6.5)	0.00-0.15	0.06		nd	0.04	nd	0.18
2A	301	(2.4,0.9)	0.00-0.15	0.39		nd	0.11	nd	0.21
2A	303	(4.0,6.5)	0.00-0.15	0.04		nd	0.11	nd	0.27
2A	303	(8.0,3.0)	0.00-0.15	0.15		nd	0.10	nd	0.24
2A	312	(2.4,0.9)	0.00-0.15	0.03		nd	0.04	nd	0.20
2A	312	(4.0,6.5)	0.00-0.15	0.03		nd	0.04	nd	0.19
2A	313	(2.4,0.9)	0.00-0.15	0.15		nd	0.05	nd	0.20
2A	313	(4.0,6.5)	0.00-0.15	0.83		nd	0.06	nd	0.26
2A	315	(4.0,6.5)	0.00-0.15	0.19		nd	0.04	nd	0.18
2A	315	(4.0,6.5)	0.00-0.15	nd		nd	0.06	nd	0.24
2A _{deep core1}	224	(9.4,7.8)	0.00-0.15	nd	.08	nd	0.08	nd	0.27
2A _{deep core1}	224	(9.4,7.8)	0.60-1.20	nd	0.08	nd	0.07	nd	0.38
2A _{deep core1}	224	(9.4,7.8)	1.20-1.80	nd	0.04	nd	0.04	nd	0.18
2A _{deep core1}	224	(9.4,7.8)	1.80-2.40	nd	0.07	nd	0.08	nd	0.37
2A _{deep core1}	224	(9.4,7.8)	2.40-3.00	nd	0.05	nd	0.07	nd	0.35
2A _{deep core1}	224	(9.4,7.8)	3.00-3.60	nd	0.07	nd	0.09	nd	0.38
2A _{deep core1}	312	(2.4,0.9)	0.00-0.15	nd	0.09	nd	0.10	nd	0.28
2A _{deep core1}	312	(2.4,0.9)	0.60-1.20	nd	0.06	nd	0.13	nd	0.34
2A _{deep core1}	312	(2.4,0.9)	1.20-1.80	nd	0.03	nd	0.04	nd	0.15
2A _{deep core1}	312	(2.4,0.9)	1.80-2.40	nd	0.08	nd	0.11	nd	0.38
2A _{deep core1}	312	(2.4,0.9)	240 - 300	nd	0.04	nd	0.05	nd	0.27

^a nd indicates non detect, MDA reported

^b No entry in MDA columns is provided when residual radioactivity is detected.

Survey Unit 3

Description

Survey Unit 3 is approximately 2000 m² and occupies the northwestern section of the Protected Area. Subsurface structures and equipment located in this area include electrical conduit, storm drains, Fire Protection System piping and Post Incident System piping.

History

The HSA identifies this survey unit to potentially contain radioactive contamination in area soils. Survey Unit 3 is adjacent to the transport route used to move spent resin and filter material from the Protected Area to the Radwaste Compound. A trash incineration site for the burning of radiologically clean refuse was formerly located in this area. Radioactivity identified in incinerator ash has been documented by the HSA.

The Alternate Shutdown Building was dismantled and removed from this area in 2001 to prepare for construction of the transport pathway that will be used to move spent fuel to the ISFSI storage pad. Characterization surveys supporting this construction effort (3A₂ and 3A₃) were conducted prior to road surfacing and have been included in the Survey Results table.

Radiological Status

Residual radioactivity was not identified in Survey Unit 3 above the IDCGL values. Subsurface soil contamination is not indicated by the HSA or process knowledge and was not identified above trace values in deep-core sampling analyses. The radiological status of this survey unit is Class 1 based on proximity to the following area locations:

- Contaminated material transport pathways,
- Areas of known soil contamination scheduled for excavation and subsurface component removal,
- Locations scheduled for soil remediation, and
- Buildings and foundations scheduled for demolition and removal of contaminated equipment and materials.

Primary Survey Design

1. Sample Data Points Required

The scoping survey resulted in the following data:

Nuclide identification	Cs-137	Co-60
Mean value (pCi/g)	0.086	0.013
Standard deviation (σ)	0.177	0.038

Applying the Unity Rule,

$$\sigma = \sqrt{\left(\frac{\sigma_{Cs}}{DCGL_{Cs}}\right)^2 + \left(\frac{\sigma_{Co}}{DCGL_{Co}}\right)^2} = \sqrt{\left(\frac{0.177_{Cs}}{5.11_{Cs}}\right)^2 + \left(\frac{0.0379_{Co}}{4.99_{Co}}\right)^2}$$

$$\sigma = 0.036$$

Using the Unity Rule, the DCGL weighted sum is 1.0. The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL.

$$\text{Relative Shift} = \frac{DCGL - LBGR}{\sigma} = \frac{1 - 0.5}{0.036} = 13.8$$

With α and β error levels set at 0.05 and an assumed relative shift of 3, the Sign Test requirements specify a sample size of 14 data points.

2. Sample Locations

Sample data point locations were selected in a random start, square grid pattern with the southwest corner of the survey unit as origin.

Survey unit dimensions 40 x 50 meters

Random Numbers 0.69, 0.47

$X = (0.69)(40 \text{ m}) = 27.6 \text{ m}$

$Y = (0.47)(50 \text{ m}) = 23.5 \text{ m}$

$$\text{Sample Spacing } L = \sqrt{\text{Area}/N} = \sqrt{2000/14} = 11.9 \text{ meters}$$

As a conservative measure 17 samples were collected using 10 meter spacing. Sampling was prohibited in grids 206 and 207 due to subsurface obstruction.

Supporting Surveys

Supporting surveys include those conducted in support of ASD Building removal (3A_{deepcore3}, 3A_{deepcore2}), and ISFSI road construction (3A₂, 3A_{deepcore1}). Deep core sampling was performed to a maximum depth of 6.6 meters. Sample point locations were judgmentally selected based on historical data, process knowledge and the potential to contain subsurface radioactivity of plant origin. Sample point locations for deep-core profiles are limited in this survey unit due to the safety concerns associated underground systems and power supplies that remain in service.

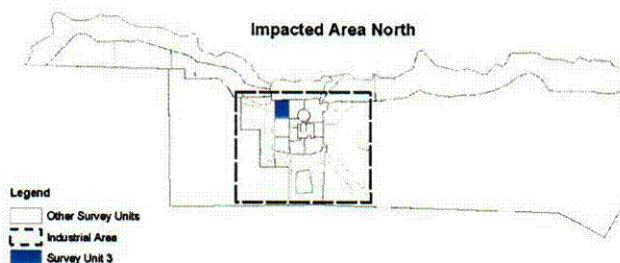
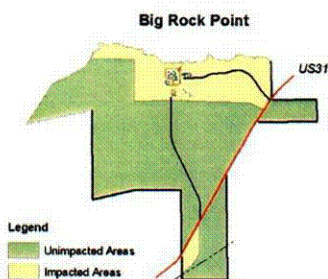
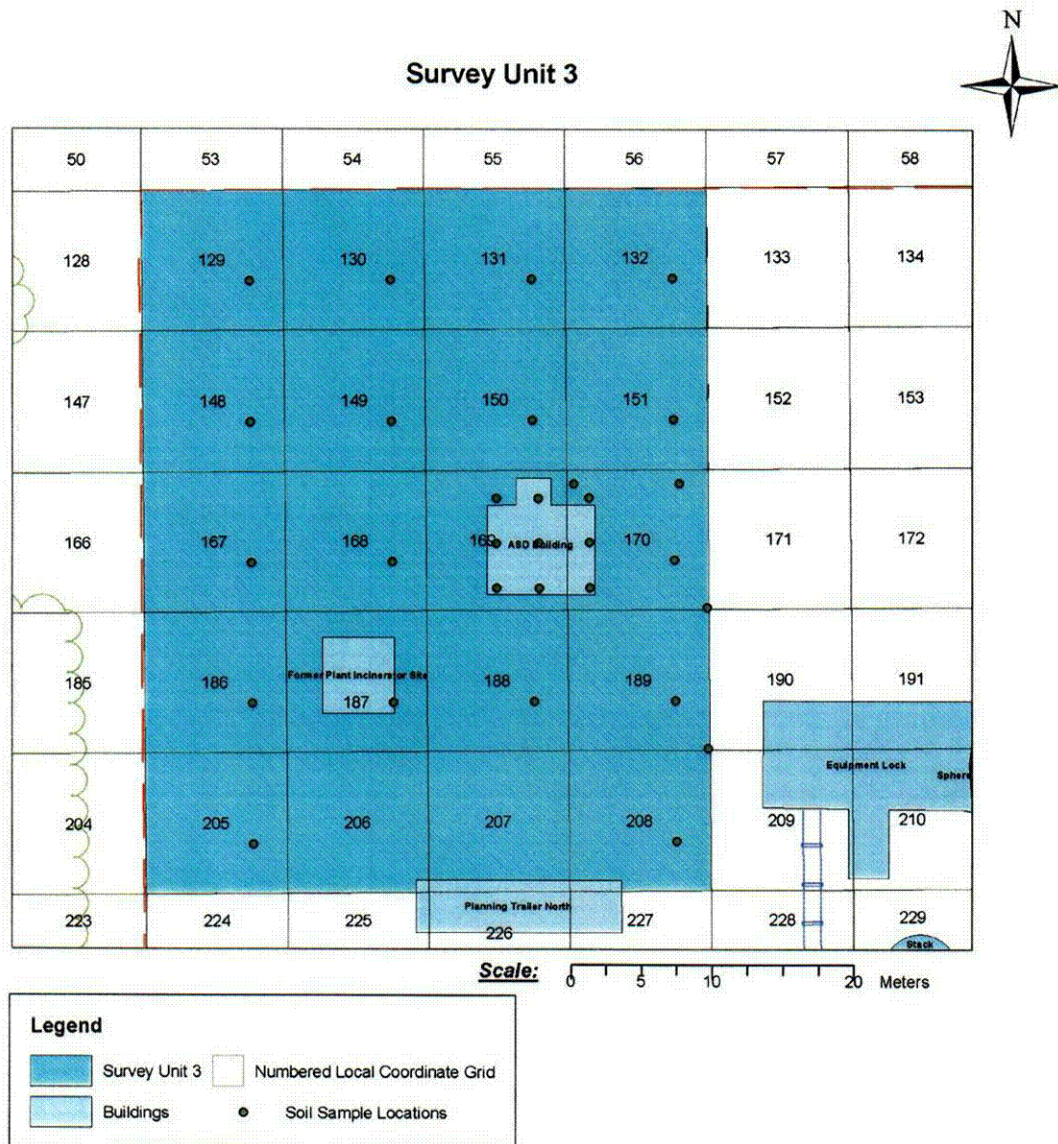
Data Summary

Survey Unit 3

Survey	No. of Samples	Radionuclides*	Mean (pCi/g)	Max. Value (pCi/g)
3A ₁	17	Cs ₁₃₇	0.34	2.13
		Co ₆₀ **	0.28	0.28
3A ₂	2	nd	-	-
3A _{deepcore1}	9	Cs-137	-	0.17
3A _{deepcore2}	3	nd	-	-
3A _{deepcore3}	9	Cs-137	-	0.06

* nd indicates non detect

** Activity identified in one sample only



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Survey Results

Survey	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
3A ₁	129	(7.6,3.5)	0.00-0.15	nd	0.15	nd	0.04	nd	0.26
3A ₁	130	(7.6,3.5)	0.00-0.15	0.21		nd	0.09	nd	0.31
3A ₁	131	(7.6,3.5)	0.00-0.15	0.32		nd	0.12	nd	0.22
3A ₁	132	(7.6,3.5)	0.00-0.15	0.30		nd	0.06	nd	0.31
3A ₁	148	(7.6,3.5)	0.00-0.15	0.08		nd	0.08	nd	0.27
3A ₁	149	(7.6,3.5)	0.00-0.15	0.18		nd	0.07	nd	0.31
3A ₁	150	(7.6,3.5)	0.00-0.15	nd	0.08	nd	0.09	nd	0.15
3A ₁	151	(7.6,3.5)	0.00-0.15	0.07		nd	0.06	nd	0.30
3A ₁	167	(7.6,3.5)	0.00-0.15	0.11		nd	0.08	nd	0.31
3A ₁	168	(7.6,3.5)	0.00-0.15	nd	0.09	nd	0.12	nd	0.24
3A ₁	170	(7.6,3.5)	0.00-0.15	0.16		nd	0.08	nd	0.32
3A ₁	186	(7.6,3.5)	0.00-0.15	nd	0.14	nd	0.13	nd	0.25
3A ₁	187	(7.6,3.5)	0.00-0.15	0.08		nd	0.07	nd	0.28
3A ₁	188	(7.6,3.5)	0.00-0.15	nd	0.07	nd	0.11	nd	0.19
3A ₁	189	(7.6,3.5)	0.00-0.15	0.31		nd	0.13	nd	0.18
3A ₁	205	(7.6,3.5)	0.00-0.15	0.11		nd	0.06	nd	0.16
3A ₁	208	(7.6,3.5)	0.00-0.15	2.13		0.28		nd	0.41
3A ₂ ^c	189	(9.9,0.1)	0.00-0.15	nd	0.04	nd	0.05	nd	0.26
3A ₂ ^c	170	(9.9,0.1)	0.00-0.15	nd	0.05	nd	0.05	nd	0.21
3A _{deepcore1}	170	(0.5,9.0)	0.00-0.20	0.06		nd	0.05	nd	0.22
3A _{deepcore1}	170	(0.5,9.0)	0.30-0.75	0.06		nd	0.05	nd	0.25
3A _{deepcore1}	170	(0.5,9.0)	1.05-1.50	nd	0.04	nd	0.06	nd	0.25
3A _{deepcore1}	170	(0.5,9.0)	1.80-2.25	nd	0.05	nd	0.06	nd	0.26
3A _{deepcore1}	170	(0.5,9.0)	2.55-2.70	0.17		nd	0.04	nd	0.21
3A _{deepcore1}	170	(0.5,9.0)	2.55-2.70	0.12		nd	0.05	nd	0.21
3A _{deepcore1}	170	(0.5,9.0)	3.3-4.5	nd	0.04	nd	0.02	nd	0.15
3A _{deepcore1}	170	(0.5,9.0)	4.5-5.1	nd	0.04	nd	0.04	nd	0.17
3A _{deepcore1}	170	(0.5,9.0)	5.4-6.6	nd	0.03	nd	0.04	nd	0.17
3A _{deepcore2}	189	(9.9,0.1)	0.15-30	nd	0.04	nd	0.05	nd	0.24
3A _{deepcore2}	189	(9.9,0.1)	0.30-0.45	nd	0.04	nd	0.06	nd	0.28
3A _{deepcore2}	189	(9.9,0.1)	0.45-0.60	nd	0.05	nd	0.07	nd	0.32
3A _{deepcore3}	169/170	°	0.00-0.60	nd	0.05	nd	0.05	nd	0.20
3A _{deepcore3}	169/170	°	0.00-0.60	nd	0.05	nd	0.05	nd	0.21
3A _{deepcore3}	169/170	°	0.00-0.60	nd	0.05	nd	0.05	nd	0.25
3A _{deepcore3}	169/170	°	0.00-0.60	nd	0.06	nd	0.04	nd	0.23
3A _{deepcore3}	169/170	°	0.00-0.60	nd	0.05	nd	0.05	nd	0.21
3A _{deepcore3}	169/170	°	0.00-0.60	0.03		nd	0.05	nd	0.23
3A _{deepcore3}	170	(1.6,1.6) ^d	0.60-0.75	nd	0.06	nd	0.06	nd	0.28
3A _{deepcore3}	169	(8.0,1.6) ^e	0.60-0.75	0.06		nd	0.05	nd	0.29
3A _{deepcore3}	169	(5.0,1.6) ^e	0.60-0.75	nd	0.05	nd	0.06	nd	0.22
3A _{deepcore3}	169	(5.0,4.8) ^e	0.60-0.75	nd	0.04	nd	0.04	nd	0.23
3A _{deepcore3}	169	(8.0,4.8) ^e	0.60-0.75	nd	0.03	nd	0.05	nd	0.18
3A _{deepcore3}	170	(1.6,4.8) ^e	0.60-0.75	0.06		nd	0.05	nd	0.25
3A _{deepcore3}	170	(1.6,8.0) ^e	0.60-0.75	nd	0.04	nd	0.05	nd	0.22
3A _{deepcore3}	169	(8.0,8.0) ^e	0.60-0.75	nd	0.04	nd	0.04	nd	0.26
3A _{deepcore3}	169	(5.0,8.0) ^e	0.60-0.75	nd	0.05	nd	0.06	nd	0.25

^a nd Indicated non detect, MDA reported

No entry in MDA columns is provided when residual radioactivity is detected

Survey Unit 3, portion of road construction survey

^d Excavation Soil Fill For ASD Building Removal

^e Base Elevation Survey During ASD Building Removal

Survey Unit 4

Description

Survey Unit 4 is approximately 1600 m² in size and occupies the north-central section of the Protected Area. Subsurface structures located in this area include electrical conduit, Fire Protection System piping, Post Incident System piping, and footings and foundations of the Equipment Lock and Containment Building.

History

The HSA identifies this survey unit to residual radioactivity in area soils. The Equipment Lock is the point of transfer for radiologically contaminated equipment and materials from the Containment Sphere. Survey Unit 4 is also adjacent to the transport route used for movement of spent resin and filter material from the Protected Area to the Radwaste Compound.

Radiological Status

Radioactivity of potential plant origin was not identified in Survey Unit 4 above the IDCGL value. Subsurface soil contamination is not indicated by the HSA or process knowledge and was not identified above trace values in deep-core sampling analyses. The radiological status of this survey unit is Class 1 based on proximity to the following area locations:

- Contaminated material transport pathways,
- Areas of known soil contamination scheduled for excavation and subsurface component removal,
- Locations scheduled for soil remediation, and
- Buildings and foundations scheduled for demolition and removal of contaminated equipment and materials.

Primary Survey Design

1. Sample Data Points Required

The scoping survey resulted in the following data:

Nuclide identification	Cs-137	Co-60
Mean value (pCi/g)	0.720	0.043
Standard deviation (σ)	0.127	0.003

Applying the Unity Rule,

$$\sigma = \sqrt{\left(\frac{\sigma_{Cs}}{DCGL_{Cs}}\right)^2 + \left(\frac{\sigma_{Co}}{DCGL_{Co}}\right)^2} = \sqrt{\left(\frac{0.127_{Cs}}{5.11_{Cs}}\right)^2 + \left(\frac{0.003_{Co}}{4.99_{Co}}\right)^2}$$

$$\sigma = 0.025$$

For the Unity Rule the DCGL for the weighted sum is 1.0. The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL .

$$\text{Relative Shift} = \frac{DCGL - LBGR}{\sigma} = \frac{1 - 0.5}{0.025} = 20$$

With α and β error levels set at 0.05 and an assumed relative shift of 3, the Sign Test requirements specify a sample size of 14 data points.

2. Sample Locations

Sample data point locations were selected in a random start, square grid pattern with the southwest corner of the survey unit as origin.

Bounding survey unit dimensions 40 X 50 meters

Random Numbers 0.59, 0.99

$X = (0.59)(40 \text{ m}) = 23.6 \text{ m}$

$Y = (0.99)(50 \text{ m}) = 49.5 \text{ m}$

$$\text{Sample Spacing } L = \sqrt{\text{Area}/N} = \sqrt{1616/14} = 10.7 \text{ meters}$$

As a conservative measure 22 samples were collected using 8.7 meter spacing.

Supporting Surveys

Supporting surveys were conducted during soil preparation for construction of the loading dock annex to the Equipment Lock (4A₃, 4A₄). Additional surveys were also performed (4A₂) prior to construction of the ISFSI road using systematic sampling. Sample point locations for deep-core profiles are limited in this survey unit due to the safety concerns associated with underground systems and power supplies that remain in service.

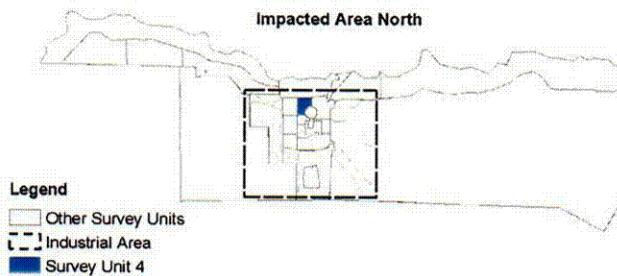
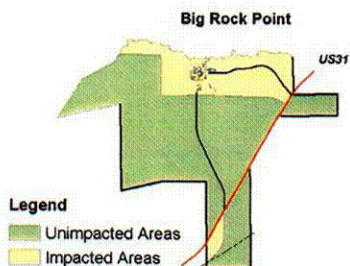
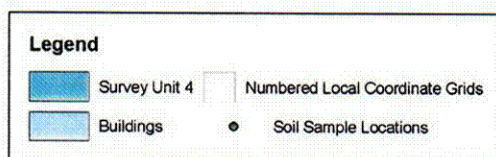
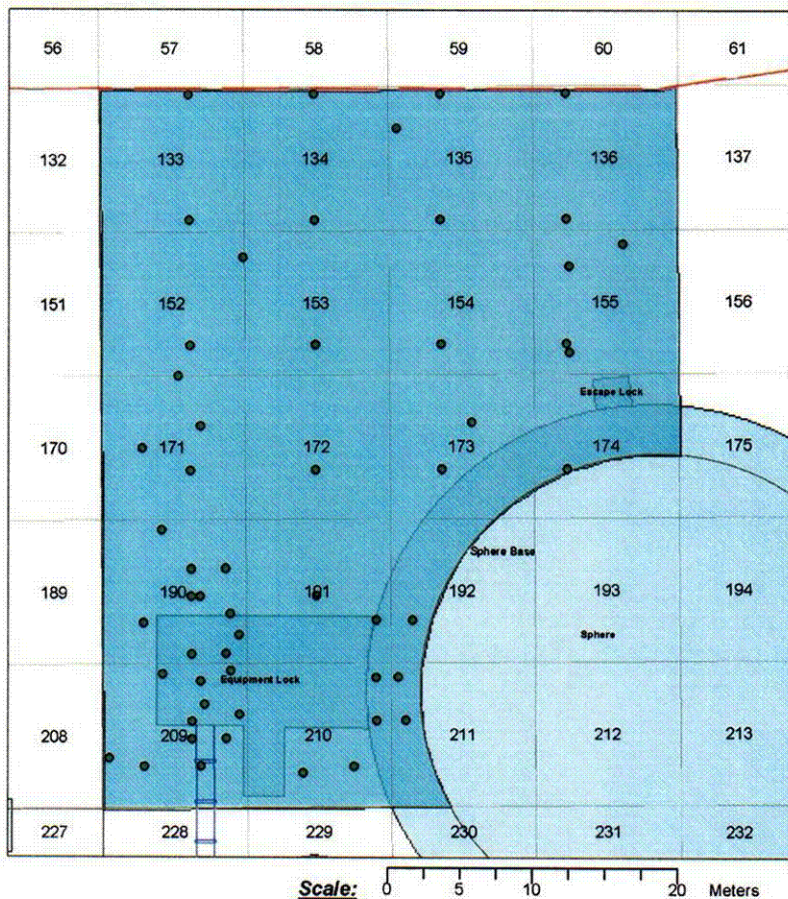
Data Summary

Survey Unit 4

Survey	No. of Samples	Radionuclides*	Mean (pCi/g)	Max. Value (pCi/g)
4A ₁	22	Cs-137	0.22	0.74
4A ₂	17	Cs ₁₃₇	0.05	0.07
		Co ₆₀	0.27	0.27
4A ₃	10	Cs ₁₃₇	0.57	1.22
		Co ₆₀	0.06	0.07
4A ₄	4	Cs-137*	0.17	0.17
4A _{deepcore 1}	22	Cs-137*	0.08	0.08
4A _{deepcore 2}	12	Cs-137*	0.10	0.10

* Activity identified in one sample only

Survey Unit 4



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Survey Results

Survey	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
4A ₁	133	(6.2,9.5)	0.00-0.15	0.15		nd	0.09	nd	0.40
4A ₁	134	(4.9,9.5)	0.00-0.15	0.28		nd	0.05	nd	0.21
4A ₁	135	(3.6,9.5)	0.00-0.15	0.18		nd	0.06	nd	0.22
4A ₁	136	(2.3,9.5)	0.00-0.15	0.20		nd	0.09	nd	0.37
4A ₁	133	(6.2,0.8)	0.00-0.15	0.27		nd	0.04	nd	0.22
4A ₁	134	(4.9,0.8)	0.00-0.15	0.34		nd	0.12	nd	0.33
4A ₁	135	(3.6,0.8)	0.00-0.15	nd	0.11	nd	0.07	nd	0.40
4A ₁	136	(2.3,0.8)	0.00-0.15	nd	0.05	nd	0.04	nd	0.19
4A ₁	152	(6.2,2.1)	0.00-0.15	nd	0.07	nd	0.10	nd	0.42
4A ₁	153	(4.9,2.1)	0.00-0.15	0.20		nd	0.04	nd	0.18
4A ₁	154	(3.6,2.1)	0.00-0.15	0.74		nd	0.13	nd	0.38
4A ₁	155	(2.3,2.1)	0.00-0.15	0.20		nd	0.10	nd	0.44
4A ₁	171	(6.2,3.4)	0.00-0.15	nd	0.04	nd	0.05	nd	0.21
4A ₁	172	(4.9,3.4)	0.00-0.15	0.08		nd	0.08	nd	0.33
4A ₁	173	(3.6,3.4)	0.00-0.15	0.13		nd	0.09	nd	0.35
4A ₁	174	(2.3,3.4)	0.00-0.15	0.10		nd	0.12	nd	0.31
4A ₁	190	(6.2,4.7)	0.00-0.15	nd	0.06	nd	0.07	nd	0.38
4A ₁	191	(4.9,4.7)	0.00-0.15	0.03		nd	0.09	nd	0.20
4A ₁	209	(6.2,6.0)	0.00-0.15	nd	0.04	nd	0.05	nd	0.21
4A ₁	210	(3.9,2.4)	0.00-0.15	nd	0.05	nd	0.04	nd	0.23
4A ₁	210	(7.4,2.8)	0.00-0.15	nd	0.07	nd	0.09	nd	0.32
4A ₁	155	(6.2,9.0)	0.00-0.15	nd	0.05	nd	0.03	nd	0.20
4A ₂	209	(2.9,2.9)	0.00-0.15	nd	0.05	nd	0.07	nd	0.29
4A ₂	209	(4.2,9.3)	0.00-0.15	nd	0.05	nd	0.07	nd	0.30
4A ₂	190	(2.9,2.9)	0.00-0.15	nd	0.05	nd	0.07	nd	0.26
4A ₂	190	(4.2,9.3)	0.00-0.15	nd	0.04	nd	0.05	nd	0.26
4A ₂	171	(2.9,5.0)	0.00-0.15	nd	0.04	nd	0.06	nd	0.29
4A ₂	171	(6.9,6.5)	0.00-0.15	nd	0.04	nd	0.06	nd	0.29
4A ₂	152	(5.4,0.0)	0.00-0.15	nd	0.05	nd	0.06	nd	0.29
4A ₂	152	(9.9,8.2)	0.00-0.15	nd	0.05	nd	0.06	nd	0.29
4A ₂	190	(6.2,6.6)	0.00-0.15	0.04		nd	0.06	nd	0.26
4A ₂	190	(8.6,6.6)	0.00-0.15	nd	0.05	nd	0.06	nd	0.31
4A ₂	190	(6.8,4.7)	0.00-0.15	nd	0.04	nd	0.06	nd	0.26
4A ₂	190	(6.2,0.7)	0.00-0.15	0.07		0.27		nd	0.33
4A ₂	190	(8.6,0.7)	0.00-0.15	nd	0.05	nd	0.05	nd	0.28
4A ₂	209	(6.8,8.8)	0.00-0.15	nd	0.05	nd	0.06	nd	0.25
4A ₂	209	(6.2,4.8)	0.00-0.15	nd	0.05	nd	0.06	nd	0.29
4A ₂	209	(8.6,4.8)	0.00-0.15	nd	0.05	nd	0.06	nd	0.27
4A ₂	209	(6.8,2.9)	0.00-0.15	0.04		nd	0.05	nd	0.27

^a nd indicates non detect, MDA reported

^b No entry in MDA columns is provided when residual radioactivity is detected

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Survey	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
4A ₃	210	(9.0,9.0)	0.00-0.15	1.22		0.15		nd	0.29
4A ₃	210	(9.0,6.0)	0.00-0.15	0.63		0.63		nd	0.34
4A ₃	211	(0.5,9.0)	0.00-0.15	0.71		0.05		nd	0.26
4A ₃	192	(1.5,3.0)	0.00-0.15	nd	0.04	nd	0.05	nd	0.26
4A ₃	211	(1.0,6.0)	0.00-0.15	0.16		0.19		nd	0.21
4A ₃	210	(9.0,9.0)	0.15-0.30	0.11		nd	0.07	nd	0.22
4A ₄	209	(9.5,6.5)	0.80-0.95	nd	0.05	nd	0.06	nd	0.25
4A ₄	209	(8.9,9.5)	0.80-0.95	0.17		nd	0.05	nd	0.26
4A ₄	190	(9.5,2.0)	0.80-0.95	nd	0.05	nd	0.05	nd	0.25
4A ₄	190	(8.9,3.5)	0.80-0.95	nd	0.05	nd	0.04	nd	0.24
4A _{deepcore1}	209	(7.1,7.2)	0.60-1.20	nd	0.07	nd	0.07	nd	0.41
4A _{deepcore1}	173	(5.7,6.7)	0.60-1.20	nd	0.05	nd	0.05	nd	0.17
4A _{deepcore1}	135	(0.6,7.1)	0.00-0.60	0.08		nd	0.04	nd	0.22
4A _{deepcore1}	173	(5.7,6.7)	0.00-0.60	nd	0.10	nd	0.09	nd	0.40
4A _{deepcore1}	209	(7.1,7.2)	0.00-0.60	nd	0.05	nd	0.06	nd	0.33
4A _{deepcore1}	209	(7.1,7.2)	0.00-0.60	nd	0.06	nd	0.09	nd	0.32
4A _{deepcore1}	135	(0.6,7.1)	1.20-1.80	nd	0.08	nd	0.03	nd	0.40
4A _{deepcore1}	173	(5.7,6.7)	1.20-1.80	nd	0.06	nd	0.05	nd	0.24
4A _{deepcore1}	209	(7.1,7.2)	1.20-1.80	nd	0.06	nd	0.06	nd	0.32
4A _{deepcore1}	135	(0.6,7.1)	1.80-2.40	nd	0.03	nd	0.03	nd	0.15
4A _{deepcore1}	173	(5.7,6.7)	1.80-2.40	nd	0.06	nd	0.11	nd	0.32
4A _{deepcore1}	209	(7.1,7.2)	1.80-2.40	nd	0.08	nd	0.08	nd	0.28
4A _{deepcore1}	135	(0.6,7.1)	2.40-3.00	nd	0.06	nd	0.10	nd	0.39
4A _{deepcore1}	173	(5.7,6.7)	2.40-3.00	nd	0.07	nd	0.07	nd	0.38
4A _{deepcore1}	209	(7.1,7.2)	2.40-3.00	nd	0.05	nd	0.07	nd	0.36
4A _{deepcore1}	173	(5.7,6.7)	3.00-3.60	nd	0.03	nd	0.05	nd	0.21
4A _{deepcore1}	209	(7.1,7.2)	3.00-3.60	nd	0.08	nd	0.11	nd	0.36
4A _{deepcore1}	135	(0.6,7.1)	3.60-4.20	nd	0.04	nd	0.04	nd	0.27
4A _{deepcore1}	173	(5.7,6.7)	3.60-4.20	nd	0.06	nd	0.11	nd	0.42
4A _{deepcore1}	135	(0.6,7.1)	4.20-4.80	nd	0.04	nd	0.04	nd	0.23
4A _{deepcore1}	209	(7.1,7.2)	4.20-4.80	nd	0.08	nd	0.10	nd	0.41
4A _{deepcore1}	209	(7.1,7.2)	4.80-5.40	nd	0.08	nd	0.13	nd	0.40
4A _{deepcore2}	155	(2.5,7.5)	0.00-0.60	nd	0.04	nd	0.04	nd	0.17
4A _{deepcore2}	155	(2.5,1.5)	0.00-1.20	0.10		nd	0.06	nd	0.23
4A _{deepcore2}	209	(0.5,3.5)	0.30-0.75	nd	0.04	nd	0.05	nd	0.23
4A _{deepcore2}	209	(0.5,3.5)	1.05-1.50	nd	0.04	nd	0.04	nd	0.28
4A _{deepcore2}	155	(2.5,1.5)	1.20-1.80	nd	0.05	nd	0.05	nd	0.23
4A _{deepcore2}	209	(0.5,3.5)	1.80-2.25	nd	0.03	nd	0.05	nd	0.21
4A _{deepcore2}	155	(2.5,1.5)	1.80-2.70	nd	0.04	nd	0.06	nd	0.20
4A _{deepcore2}	209	(0.5,3.5)	2.25-3.00	nd	0.04	nd	0.06	nd	0.24
4A _{deepcore2}	155	(2.5,1.5)	3.00-4.20	nd	0.04	nd	0.04	nd	0.20
4A _{deepcore2}	209	(0.5,3.5)	3.30-3.75	nd	0.03	nd	0.05	nd	0.20
4A _{deepcore2}	209	(0.5,3.5)	4.05-4.44	nd	0.03	nd	0.04	nd	0.17
4A _{deepcore2}	155	(2.5,1.5)	4.20-5.25	nd	0.04	nd	0.06	nd	0.25

^a nd indicates non detect, MDA reported

^b No entry in MDA columns is provided when residual radioactivity is detected

Survey Unit 5(1)

Description

Survey Unit 5(1) is an area of approximately 600 m² located at the southwest edge of the Containment Building. This location encompasses the Stack and the northern section of the Liquid Radwaste Vault. The Liquid Radwaste Vault is a subsurface concrete structure that contains the equipment used by the Liquid Radwaste Processing System. The roof of this structure is located at grade elevation and is composed of concrete covered by asphalt paving. Additional subsurface structures include, the Stack base, Radwaste System piping, fiber optics, electrical conduit, and the footings and foundations of the Equipment Lock, Containment Building and Turbine Building.

History

The HSA has identified radioactivity in this survey unit for localized areas of soil in close proximity to the former rail bed. This location was the transfer point for the removal of primary system resin and filters through disposal access hatches in the Liquid Radwaste Vault. Waste material was then routed to the Radwaste Building in preparation for shipment.

A contaminant migration pathway is known to have existed near the storage tank location in adjacent Survey Unit 5(2). The low topography formerly present along the rail bed once provided a storm water runoff pathway from the tank area into Survey Unit 5(1). Documented radiological events describe a number of piping leaks and spills that are known to have entered Survey Unit 5(1) through this drainage pathway.

Cleanup efforts have been conducted in this survey unit on several occasions. Following the removal of contaminated soil, clean fill was used to return remediated locations to proper grade. As a result, activity depth profiles conducted in these areas have identified an increase in activity near the base elevation of former soil removal locations. This activity is believed to result from contamination left in place during the remediation process.

Radiological Status

Survey Unit 5(1) is relatively small and complex survey area. The Stack and Liquid Radwaste Processing System currently remain in service. As a result, building foundations, subsurface piping, and electrical power hazards limit the extent of soil sampling in many locations. Although trace values of Mn-54 were identified in two of the scoping survey samples used for design of the primary survey, Mn-54 was not identified in any subsequent characterization survey conducted in Survey Unit 5(1). Elevated concentrations of Cs-137 were identified in several samples taken along the rail bed, a former contaminant migration pathway. Further characterization of these areas will continue as systems and equipment are removed from the site.

The results of characterization analyses to date indicate that cleanup efforts may be required following the removal of road surfacing along an area east of the rail bed. This location was paved to satisfy the engineering requirements for movement of spent fuel to the ISFSI. The asphalt paving is scheduled to be removed following dismantlement of the Stack and Liquid Radwaste Processing System.

Excavation will be required for the removal of subsurface structures and equipment in this area. Characterization surveys are scheduled to continue during this excavation and remediation efforts will be conducted as necessary to satisfy the requirements for final status surveys. Survey Unit 5(1) is designated as Class 1.

Primary Survey Design

1. Sample Data Points Required

The scoping survey resulted in the following data:

Nuclide identification	Cs-137	Co-60	Mn-54
Mean value (pCi/g)	2.62	0.61	0.049
Standard deviation (σ)	5.11	1.11	0.09

Applying the Unity Rule,

$$\sigma_{UR} = \sqrt{\left(\frac{\sigma_{Cs}}{5.11_{Cs}}\right)^2 + \left(\frac{\sigma_{Co}}{4.99_{Co}}\right)^2 + \left(\frac{\sigma_{Mn}}{474_{Mn}}\right)^2}$$

$$\sigma_{UR} = \sqrt{\left(\frac{5.11}{5.11_{Cs}}\right)^2 + \left(\frac{1.11}{4.99_{Co}}\right)^2 + \left(\frac{0.09}{474_{Mn}}\right)^2}$$

$$\sigma_{UR} = 1.02$$

For the Unity Rule the DCGL for the weighted sum is 1.0. The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL.

$$\text{Relative Shift} = \frac{DCGL - LBGR}{\sigma} = \frac{1 - 0.5}{1.02} = 0.49$$

With α and β error levels of 0.05, the Sign Test requires 136 sample data points.

A sample size of this magnitude was considered impractical for the primary survey of this complex area. A target value of 50 data points was selected for sample location and spacing determination. Due to inaccessible areas of this survey unit, only 33 data points were available for sampling within the survey unit. This sample size was considered sufficient to develop an initial comprehensive evaluation of the survey unit and provide the necessary input for the design of follow-up supporting surveys.

2. Sample Locations

Sample locations were systematically selected in random start, square grid, pattern with the southwest corner of the survey unit as origin.

Bounding survey unit dimensions 30 X 30 meters

Random Numbers 0.11, 0.99

$$X = (0.11)(30 \text{ m}) = 3.4 \text{ m}$$

$$Y = (0.23)(30 \text{ m}) = 6.9 \text{ m}$$

$$\text{Sample Spacing } L = \sqrt{\text{Area}/N} = \sqrt{600/50} = 3.5 \text{ meters}$$

Supporting Surveys

Supporting surveys 5(1)A₂ and 5(1)A₃ were conducted prior to construction of the ISFSI road. Real time measurements performed during roadway construction identified elevated contamination levels in a suspect area along the former railroad grade. A remediation of this area was conducted; however, the extent of cleanup was limited to the amount of soil disturbance required for removal of the rail bed and surface preparation for construction of the roadway (5(1)B₁).

Deep-core sampling was conducted in five survey efforts to investigate the extent of potential subsurface contamination. The maximum survey depth was approximately six meters. Sample point locations were judgmentally selected based on historical data, process knowledge, survey analyses, and location availability due to subsurface obstructions and equipment.

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Data Summary

The data tabulated below reflects the current status of the survey unit. Data analyses for samples collected from locations that were later remediated have been excluded. The results of survey analyses for all samples collected in each individual survey of Survey Unit 5(1) are included in the survey results table.

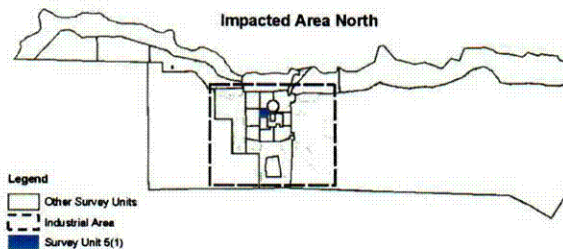
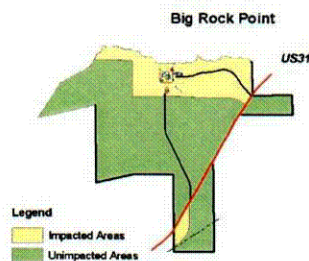
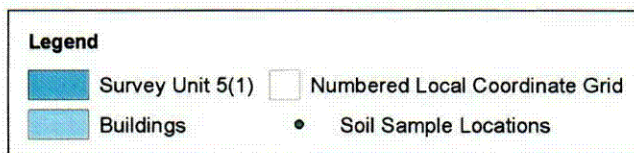
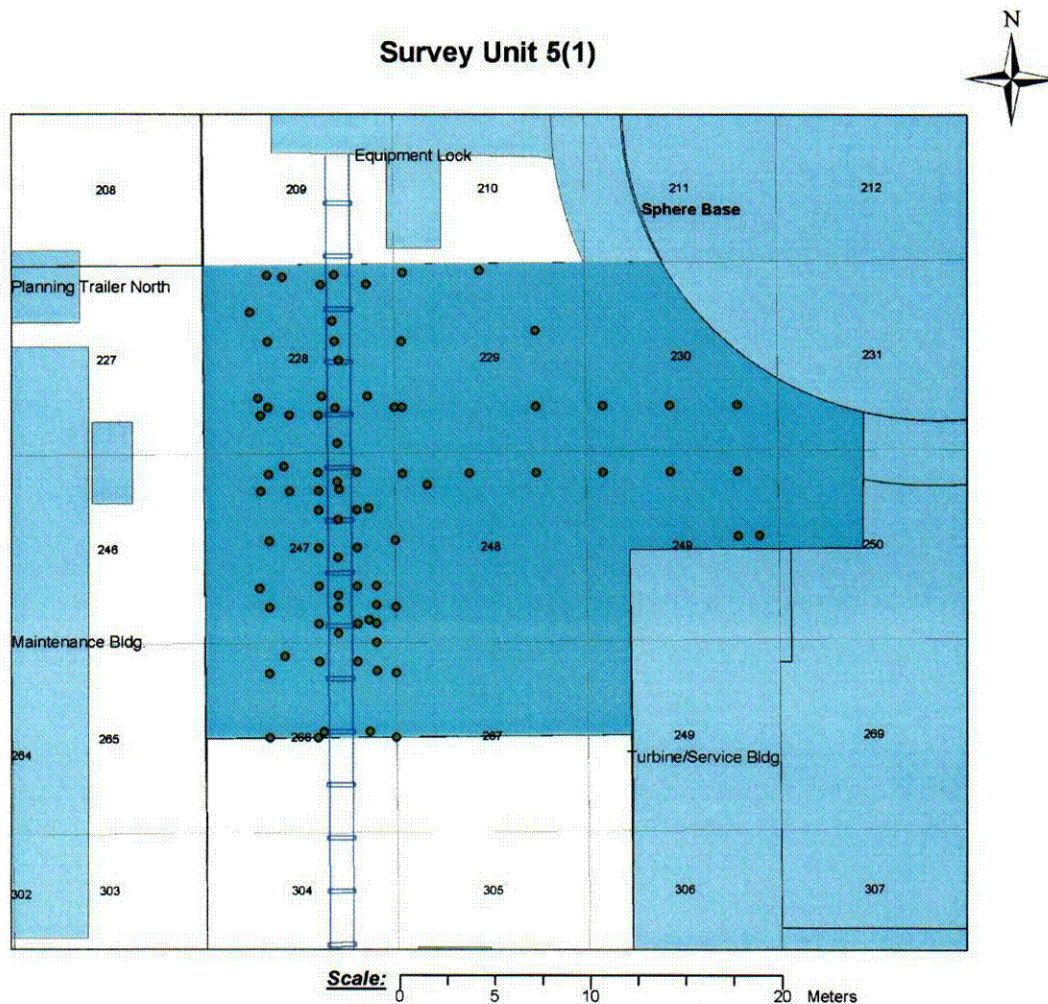
Survey Unit 5(1)

Survey	No. of Samples	Radionuclides	Mean (pCi/g)	Max. Value (pCi/g)
5(1)A ₁	33	Cs ₁₃₇	3.26	12.74
		Co ₆₀	0.54	0.73
5(1)A ₂	13	Cs ₁₃₇	0.45	1.09
		Co ₆₀	nd	nd
5(1)A ₃	7	Cs ₁₃₇	0.06	0.07
		Co ₆₀	nd	nd
5(1)B ₁	23	Cs ₁₃₇	1.81	16.59
		Co ₆₀	0.16	0.76
5(1)deepcore1	21	Cs ₁₃₇	0.06	0.09
		Co ₆₀	nd	nd
5(1)deepcore2	25	Cs ₁₃₇	1.21	12.94 ***
		Co ₆₀	0.19	0.47
5(1)deepcore3	1	nd	-	-
5(1)deepcore4	5	Cs ₁₃₇	0.30	0.79
		Co ₆₀ **	0.17	0.17
5(1)deepcore5	8	Cs ₁₃₇	2.22	6.41
		Co ₆₀	0.36	0.66

*nd indicates non detect

**Co-60 detected in only one sample

***sample taken at (15-30 cm)



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Survey Results

Survey ^c	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
5(1)A ₁	266	(3.4,5.0)	0.0-0.15	nd*	0.11	nd	0.08	nd	0.42
5(1)A ₁	266	(5.9,5.0)	0.0-0.15	nd	0.12	nd	0.07	nd	0.39
5(1)A ₁	266	(3.4,8.4)	0.0-0.15	nd	0.06	nd	0.10	nd	0.39
5(1)A ₁	267	(0.0,5.0)	0.0-0.15	nd	0.06	nd	0.06	nd	0.40
5(1)A ₁	267	(0.0,8.4)	0.0-0.15	nd	0.07	nd	0.06	nd	0.38
5(1)A ₁	247	(3.4,1.9)	0.0-0.15	nd	0.11	nd	0.09	nd	0.41
5(1)A ₁	247	(3.4,5.4)	0.0-0.15	3.10		0.43		nd	0.42
5(1)A ₁	247	(3.4,8.9)	0.0-0.15	nd	0.09	nd	0.02	nd	0.39
5(1)A ₁	248	(0.0,1.9)	0.0-0.15	nd	0.04	nd	0.03	nd	0.19
5(1)A ₁	248	(0.0,5.4)	0.0-0.15	0.21		nd	0.13	nd	0.37
5(1)A ₁	248	(0.4,8.9)	0.0-0.15	12.74		0.7		nd	0.42
5(1)A ₁	248	(3.9,8.9)	0.0-0.15	nd	0.08	nd	0.09	nd	0.42
5(1)A ₁	248	(7.4,8.9)	0.0-0.15	nd	0.04	nd	0.05	nd	0.18
5(1)A ₁	249	(7.9,5.5)	0.0-0.15	nd	0.09	nd	0.08	nd	0.41
5(1)A ₁	249	(9.0,5.5)	0.0-0.15	0.33		nd	0.12	nd	0.36
5(1)A ₁	249	(0.9,8.9)	0.0-0.15	nd	0.05	nd	0.11	nd	0.38
5(1)A ₁	249	(4.4,8.9)	0.0-0.15	nd	0.11	nd	0.10	nd	0.42
5(1)A ₁	249	(7.9,8.9)	0.0-0.15	nd	0.05	nd	0.04	nd	0.23
5(1)A ₁	228	(3.4,2.4)	0.0-0.15	nd	0.08	nd	0.08	nd	0.30
5(1)A ₁	228	(6.9,2.4)	0.0-0.15	8.03		0.73		nd	0.43
5(1)A ₁	228	(3.4,5.9)	0.0-0.15	nd	0.05	nd	0.05	nd	0.20
5(1)A ₁	228	(6.9,5.9)	0.0-0.15	nd	0.04	nd	0.04	nd	0.18
5(1)A ₁	228	(3.4,9.4)	0.0-0.15	nd	0.09	nd	0.10	nd	0.40
5(1)A ₁	228	(6.9,9.4)	0.0-0.15	nd	0.06	nd	0.09	nd	0.37
5(1)A ₁	229	(0.0,2.4)	0.0-0.15	4.50		0.28		nd	0.37
5(1)A ₁	229	(7.4,2.4)	0.0-0.15	nd	0.11	nd	0.09	nd	0.40
5(1)A ₁	229	(0.4,5.9)	0.0-0.15	0.17		nd	0.06	nd	0.27
5(1)A ₁	229	(7.4,6.4)	0.0-0.15	0.17		nd	0.09	nd	0.43
5(1)A ₁	229	(0.5,9.5)	0.0-0.15	nd	0.11	nd	0.10	nd	0.42
5(1)A ₁	229	(4.5,9.6)	0.0-0.15	nd	0.08	nd	0.05	nd	0.34
5(1)A ₁	230	(0.9,2.4)	0.0-0.15	0.12		nd	0.05	nd	0.21
5(1)A ₁	230	(4.4,2.4)	0.0-0.15	nd	0.05	nd	0.11	nd	0.38
5(1)A ₁	230	(7.9,2.4)	0.0-0.15	nd	0.05	nd	0.10	nd	0.33
5(1)A ₁	247	(6.9,8.9)	0.0-0.15	1.66		0.20		nd	0.31
5(1)A ₁	247	(5.9,5.4)	0.0-0.15	0.97		0.14		nd	0.26
5(1)A ₁	247	(7.0,1.9)	0.0-0.15	2.65		0.17		nd	0.34
5(1)A ₁	266	(6.9,8.5)	0.0-0.15	nd	0.07	nd	0.10	nd	0.35

^a nd indicates non detect, MDA provided

^b No entry in MDA columns is provided when residual radioactivity is detected

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				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
5(1)A ₂	266	(4.2,9.3)	0.0-0.15	nd	0.05	nd	0.06	nd	0.33
5(1)A ₂	266	(6.2,5.3)	0.0-0.15	0.18		nd	0.07	nd	0.27
5(1)A ₂	266	(8.6,5.3)	0.0-0.15	nd	0.04	nd	0.07	nd	0.28
5(1)A ₂	247	(2.9,2.9)	0.0-0.15	nd	0.05	nd	0.07	nd	0.28
5(1)A ₂	247	(4.2,9.3)	0.0-0.15	0.08		nd	0.07	nd	0.29
5(1)A ₂	247	(8.6,7.1)	0.0-0.15	1.09		nd	0.07	nd	0.27
5(1)A ₂	228	(2.9,2.9)	0.0-0.15	nd	0.07	nd	0.04	nd	0.26
5(1)A ₂	228	(4.2,9.3)	0.0-0.15	nd	0.05	nd	0.07	nd	0.26
5(1)A ₂	228	(6.2,8.9)	0.0-0.15	nd	0.05	nd	0.07	nd	0.29
5(1)A ₂	228	(8.6,8.9)	0.0-0.15	nd	0.04	nd	0.06	nd	0.22
5(1)A ₂	228	(6.8,7.0)	0.0-0.15	nd	0.05	nd	0.06	nd	0.23
5(1)A ₂	228	(6.2,3.0)	0.0-0.15	nd	0.04	nd	0.06	nd	0.35
5(1)A ₂	228	(8.6,3.0)	0.0-0.15	nd	0.06	nd	0.07	nd	0.26
5(1)A ₂	228	(6.8,1.1)	0.0-0.15	1.72		0.14		nd	0.29
5(1)A ₂	247	(6.2,7.1)	0.0-0.15	nd	0.06	nd	0.05	nd	0.27
5(1)A ₂	247	(6.8,5.2)	0.0-0.15	4.42		0.42		nd	0.43
5(1)A ₂	247	(6.2,1.2)	0.0-0.15	0.17		nd	0.07	nd	0.26
5(1)A ₂	247	(8.6,1.2)	0.0-0.15	4.72		0.61		nd	0.41
5(1)A ₂	266	(6.8,9.3)	0.0-0.15	nd	0.06	nd	0.06	nd	0.28
5(1)A ₂	266	(9.9,8.9)	0.0-0.15	5.68		0.48		nd	0.42
5(1)A ₂	266	(9.9,9.3)	0.0-0.15	nd	0.04	nd	0.06	nd	0.28
5(1)A ₃	247	(3.0,8.0)	0.90-1.05	nd	0.04	nd	0.04	nd	0.27
5(1)A ₃	247	(4.5,8.0)	0.90-1.05	nd	0.04	nd	0.05	nd	0.25
5(1)A ₃	247	(6.0,8.0)	0.90-1.05	nd	0.03	nd	0.04	nd	0.23
5(1)A ₃	228	(3.0,2.0)	0.90-1.05	nd	0.05	nd	0.05	nd	0.25
5(1)A ₃	228	(4.5,2.0)	0.90-1.05	nd	0.05	nd	0.05	nd	0.25
5(1)A ₃	228	(6.0,2.0)	0.90-1.05	nd	0.04	nd	0.06	nd	0.24
5(1)A ₃ ^d	d	d	0.00-1.00	0.06		nd	0.06	nd	0.24
5(1)B ₁	266	(6.0,9.0)	0.30-0.45	2.66		0.47		nd	0.38
5(1)B ₁	266	(8.0,9.0)	0.30-0.45	0.72		0.20		nd	0.28
5(1)B ₁	266	(9.0,8.5)	0.30-0.45	0.94		0.02		nd	0.28
5(1)B ₁	247	(7.0,0.5)	0.30-0.45	0.36		0.05		nd	0.32
5(1)B ₁	247	(6.0,1.0)	0.30-0.45	2.19		0.16		nd	0.35
5(1)B ₁	247	(8.0,1.0)	0.30-0.45	0.91		0.07		nd	0.31
5(1)B ₁	247	(7.0,2.5)	0.30-0.45	0.24		nd	0.06	nd	0.31
5(1)B ₁	247	(6.0,3.0)	0.30-0.45	0.48		0.11		nd	0.24
5(1)B ₁	247	(8.0,3.0)	0.30-0.45	1.26		0.07		nd	0.32
5(1)B ₁	247	(7.0,4.5)	0.30-0.45	0.25		nd	0.06	nd	0.30

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^d Composite sample

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				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
5(1)B ₁	247	(6.0,5.0)	0.30-0.45	0.66		0.10		nd	0.30
5(1)B ₁	247	(8.0,5.0)	0.30-0.45	0.49		nd	0.08	nd	0.27
5(1)B ₁	247	(7.0,6.5)	0.30-0.45	0.07		nd	0.05	nd	0.27
5(1)B ₁	247	(6.0,7.0)	0.30-0.45	0.22		0.06		nd	0.31
5(1)B ₁	247	(8.0,7.0)	0.30-0.45	0.41		0.03		nd	0.22
5(1)B ₁	247	(7.0,8.5)	0.30-0.45	0.13		nd	0.06	nd	0.22
5(1)B ₁	247	(6.0,9.0)	0.30-0.45	0.70		0.06		nd	0.28
5(1)B ₁	247	(8.0,9.0)	0.30-0.45	0.77		nd	0.09	nd	0.26
5(1)B ₁	247	(9.0,0.0)	0.30-0.45	3.17		0.18		nd	0.35
5(1)B ₁	247	(9.0,1.0)	0.30-0.45	1.19		0.05		nd	0.29
5(1)B ₁	247	(9.0,2.0)	0.30-0.45	5.53		0.14		nd	0.39
5(1)B ₁	247	(9.0,3.0)	0.30-0.45	16.59		0.76		nd	0.42
5(1)B ₁	228	(7.0,0.5)	0.30-0.45	1.58		0.16		nd	0.27
5(1)A _{deepcore1}	247	(7.1,8.1)	0.60-1.20	5.00		0.23		nd	0.42
5(1)A _{deepcore1}	248	(1.7,8.3)	0.0-0.60	nd	0.05	nd	0.04	nd	0.19
5(1)A _{deepcore1}	228	(7.1,4.9)	0.0-0.60	nd	0.04	nd	0.04	nd	0.19
5(1)A _{deepcore1}	247	(7.1,8.1)	0.60-1.20	0.09		nd	0.08	nd	0.39
5(1)A _{deepcore1}	248	(1.7,8.3)	0.60-1.20	nd	0.08	nd	0.08	nd	0.31
5(1)A _{deepcore1}	228	(7.1,4.9)	0.60-1.20	nd	0.04	nd	0.04	nd	0.22
5(1)A _{deepcore1}	247	(7.1,8.1)	1.20-1.80	0.04		nd	0.04	nd	0.20
5(1)A _{deepcore1}	248	(1.7,8.3)	1.20-1.80	nd	0.06	nd	0.06	nd	0.29
5(1)A _{deepcore1}	228	(7.1,4.9)	1.20-1.80	nd	0.06	nd	0.08	nd	0.36
5(1)A _{deepcore1}	247	(7.1,8.1)	1.80-2.40	0.05		nd	0.06	nd	0.29
5(1)A _{deepcore1}	228	(7.1,4.9)	1.80-2.40	nd	0.05	nd	0.10	nd	0.35
5(1)A _{deepcore1}	248	(1.7,8.3)	1.80-3.00	nd	0.02	nd	0.06	nd	0.22
5(1)A _{deepcore1}	247	(7.1,8.1)	2.40 - 3.00	nd	0.06	nd	0.10	nd	0.34
5(1)A _{deepcore1}	228	(7.1,4.9)	2.40 - 3.00	nd	0.03	nd	0.04	nd	0.21
5(1)A _{deepcore1}	247	(7.1,8.1)	3.00 - 3.60	nd	0.03	nd	0.04	nd	0.19
5(1)A _{deepcore1}	228	(7.1,4.9)	3.00 - 3.90	nd	0.06	nd	0.09	nd	0.39
5(1)A _{deepcore1}	248	(1.7,8.3)	3.00 - 5.10	nd	0.05	nd	0.08	nd	0.31
5(1)A _{deepcore1}	247	(7.1,8.1)	3.60 - 4.20	nd	0.04	nd	0.04	nd	0.23
5(1)A _{deepcore1}	228	(7.1,4.9)	3.90 - 4.20	nd	0.08	nd	0.13	nd	0.39
5(1)A _{deepcore1}	247	(7.1,8.1)	4.20 - 4.80	nd	0.03	nd	0.04	nd	0.23
5(1)A _{deepcore1}	248	(1.7,8.3)	5.10 - 6.00	nd	0.06	nd	0.08	nd	0.36
5(1)A _{deepcore1}	228**	(7.1,4.9)	0.0-0.60	nd	0.07	nd	0.05	nd	0.26
5(1)A _{deepcore2}	248	(0.0,5.4)	0.15-0.30	12.94		0.47		nd	0.43
5(1)A _{deepcore2}	248	(0.4,8.9)	0.15-0.30	1.14		0.10		nd	0.29

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Survey ^c	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
5(1)A _{deepcore2}	228	(6.9,2.4)	0.15-0.30	0.10		nd	0.07	nd	0.42
5(1)A _{deepcore2}	229	(0.4,2.4)	0.15-0.30	0.13		nd	0.09	nd	0.42
5(1)A _{deepcore2}	229	(0.4,5.9)	0.15-0.30	nd	0.10	nd	0.09	nd	0.38
5(1)A _{deepcore2}	229	(7.4,6.4)	0.15-0.30	nd	0.10	nd	0.07	nd	0.43
5(1)A _{deepcore2}	230	(0.9,2.4)	0.15-0.30	0.08		0.03		nd	0.20
5(1)A _{deepcore2}	247	(7.0,1.9)	0.30-0.60	0.24		nd	0.05	nd	0.23
5(1)A _{deepcore2}	248	(0.0,5.4)	0.30-0.60	1.92		0.15		nd	0.38
5(1)A _{deepcore2}	248	(0.4,8.9)	0.30-0.60	1.91		0.30		nd	0.35
5(1)A _{deepcore2}	228	(6.9,2.4)	0.30-0.60	0.27		nd	0.08	nd	0.35
5(1)A _{deepcore2}	230	(0.9,2.4)	0.30-0.60	0.10		nd	0.09	nd	0.41
5(1)A _{deepcore2}	228	(6.9,2.4)	0.60-0.75	0.53		0.06		nd	0.31
5(1)A _{deepcore2}	247	(7.0,1.9)	0.60-0.90	0.35		nd	0.06	nd	0.24
5(1)A _{deepcore2}	248	(0.0,5.4)	0.60-0.90	0.64		nd	0.06	nd	0.28
5(1)A _{deepcore2}	248	(0.4,8.9)	0.60-0.90	1.27		0.20		nd	0.31
5(1)A _{deepcore2}	248	(0.0,5.4)	0.90-1.20	2.99		0.19		nd	0.39
5(1)A _{deepcore2}	248	(0.4,8.9)	0.90-1.20	0.32		nd	0.09	nd	0.32
5(1)A _{deepcore2}	248	(0.0,5.4)	1.20-1.50	0.34		nd	0.07	nd	0.23
5(1)A _{deepcore2}	248	(0.4,8.9)	1.20-1.50	0.29		nd	0.07	nd	0.23
5(1)A _{deepcore2}	248	(0.0,5.4)	1.20-1.80	1.58		0.20		nd	0.33
5(1)A _{deepcore2}	248	(0.4,8.9)	1.20-1.80	0.33		nd	0.12	nd	0.42
5(1)A _{deepcore2}	248	(0.0,5.4)	1.80-2.10	0.06		nd	0.08	nd	0.37
5(1)A _{deepcore2}	248	(0.4,8.9)	1.80-2.10	0.17		nd	0.05	nd	0.24
5(1)A _{deepcore2}	248	(0.4,8.9)	2.10 - 2.40	0.12		nd	0.06	nd	0.22
5(1)A _{deepcore2}	247	(7.0,1.9)	0.15-0.30	0.71		0.06		nd	0.29
5(1)A _{deepcore2}	247	(6.9,5.4)	0.15-0.30	0.18		nd	0.05	nd	0.21
5(1)A _{deepcore2}	247	(6.9,8.9)	0.15-0.30	0.09		nd	0.04	nd	0.18
5(1)A _{deepcore3}	228	(2.5,7.5)	0.0-0.73	nd	0.05	nd	0.05	nd	0.25
5(1)A _{deepcore4}	249	(7.9,5.5)	0.30-0.60	nd	0.03	nd	0.04	nd	0.23
5(1)A _{deepcore4}	229	(0.4,2.4)	0.30-0.60	0.79		0.17		nd	0.23
5(1)A _{deepcore4}	249	(7.9,5.5)	0.60-0.90	nd	0.03	nd	0.04	nd	0.19
5(1)A _{deepcore4}	229	(0.4,2.4)	0.60-0.90	0.08		nd	0.06	nd	0.24
5(1)A _{deepcore4}	229	(0.4,2.4)	0.90-1.20	0.03		nd	0.05	nd	0.19
5(1)A _{deepcore5}	228	(8.6,8.9)	0.15-0.30	0.07		nd	0.06	nd	0.31
5(1)A _{deepcore5}	228	(8.6,3.0)	0.15-0.30	0.18		0.19		nd	0.30
5(1)A _{deepcore5}	247	(8.6,1.2)	0.30-0.45	6.41		0.24		nd	0.42
5(1)A _{deepcore5}	228	(8.6,8.9)	0.30-0.45	nd	0.06	nd	0.06	nd	0.26

^a nd Indicates non detect, MDA provided

^b No entry in MDA columns is provided when residual radioactivity is detected

^c Italicized entries indicate samples that were collected prior to remediation

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Survey ^c	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
5(1)A _{deepcore5}	228	(8.6,3.0)	0.30-0.45	nd	0.04	nd	0.05	nd	0.23
5(1)A _{deepcore5}	228	(8.6,3.0)	0.45-0.60	nd	0.05	nd	0.08	nd	0.24
5(1)A _{deepcore5}	228	(8.6,8.9)	0.45-0.90	nd	0.05	nd	0.06	nd	0.26
5(1)A _{deepcore5}	228	(8.6,8.9)	0.90-1.05	nd	0.06	nd	0.06	nd	0.29
5(1)A _{deepcore5}	247	(8.6,1.2)	0.15-0.30	32.8		0.66		nd	0.43

^a nd indicates non detect, MDA provided

^b No entry in MDA columns is provided when residual radioactivity is detected

^c Italicized entries indicate samples that were collected prior to remediation

Survey Unit 5(2)

Description

Survey Unit 5(2) is an area of approximately 800 m² located immediately west of the Turbine Building. This location encompasses the Waste Hold Tanks, Condensate Storage Tank, Demineralized Water Tank, and the northern section of the Liquid Radwaste Vault area. The Liquid Radwaste Vault is a subsurface concrete structure that contains the equipment used for liquid radwaste processing. The roof of this structure is located at grade elevation and is composed of concrete covered with asphalt paving. Additional subsurface structures include, the Stack foundation, Liquid Radwaste Processing System piping, fiber optics, electrical conduit, and Turbine Building and storage tank foundations.

History

The HSA has identified radioactivity in this survey unit for localized areas of soil in close proximity to the former rail bed. Both Survey Units 5(1) and 5(2) share similar operational histories and contain components of the Liquid Radwaste Processing System. This location is a transfer point for the removal of primary system resin and filters through disposal access hatches in the Liquid Radwaste Vault. Waste material was then routed to the Radwaste Building in preparation for shipment.

A contaminant migration pathway existed along the rail grade in this survey unit. The low topography formerly present at this location provided a storm water runoff pathway from the tank area into Survey Unit 5(1). Documented radiological events describe a number of piping leaks and spills that are known to have occurred in this area. Remediation efforts have been conducted in this survey unit on several occasions.

Following the removal of contaminated soil, clean fill was used to return remediated locations to proper grade. As a result, activity depth profiles conducted in these areas have identified an increase in activity near the base elevation of soil removal locations. This activity is believed to result from contamination left in place during the remediation process.

Radiological Status

Survey Unit 5(2) is a relatively small and complex survey area. The Liquid Radwaste Processing System remains in service at this time; therefore, building foundations, subsurface piping, and electrical power hazards limit the extent of soil sampling in many locations.

Although trace values of Mn-54 were identified in one of the scoping survey samples used for design of the primary survey, Mn-54 was not identified in any subsequent characterization survey conducted in Survey Unit 5(2). Elevated concentrations of Cs-137 were identified in several samples taken near railroad grade along the former storm water runoff pathway.

The results of characterization analyses to date indicate that remediation may be required following the removal of the road surface east of the rail bed. This location was paved to satisfy the engineering requirements for movement of spent fuel to the ISFSI. The asphalt paving is scheduled for removal following demolition of the Stack and the Liquid Radwaste Processing System.

Excavation will be required for the removal of subsurface structures and equipment in this area. Characterization surveys are scheduled to continue during this process and remediation efforts will be conducted as necessary to satisfy the requirements for final status surveys. This survey unit is considered a Class 1 Area.

Primary Survey Design

1. Sample Data Points Required

The scoping survey resulted in the following data:

Nuclide identification	Cs-137	Co-60	Mn-54
Mean value (pCi/g)	2.14	0.69	0.043
Standard deviation (σ)	1.40	1.24	0.106

Applying the Unity Rule,

$$\sigma = \sqrt{\left(\frac{\sigma_{Cs}}{5.11_{Cs}}\right)^2 + \left(\frac{\sigma_{Co}}{4.99_{Co}}\right)^2 + \left(\frac{\sigma_{Mn}}{474_{Mn}}\right)^2}$$

$$\sigma = \sqrt{\left(\frac{1.40}{5.11_{Cs}}\right)^2 + \left(\frac{1.24}{4.99_{Co}}\right)^2 + \left(\frac{.106}{474_{Mn}}\right)^2}$$

$$\sigma = 0.37$$

For the Unity Rule, the DCGL for the weighted sum is 1.0. The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL.

$$\text{Relative Shift} = \frac{DCGL - LBGR}{\sigma} = \frac{1 - 0.5}{0.37} = 1.3$$

With α and β error levels of 0.05, the Sign Test requires 21 sample data points.

2. Sample Locations

Sample locations were systematically selected in random start, square grid, pattern with the southwest corner of the survey unit as origin.

Bounding survey unit dimensions 30 X 30 meters

Random Numbers 0.14, 0.43

$$X = (0.14)(30 \text{ m}) = 4.2 \text{ m}$$

$$Y = (0.43)(35 \text{ m}) = 15.2 \text{ m}$$

$$\text{Sample Spacing } L = \sqrt{\text{Area}/N} = \sqrt{600/21} = 5.3 \text{ meters}$$

As a conservative measure 26 samples were collected using 5 meter spacing.

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Supporting Surveys

Supporting survey 5(2)A₂, was conducted to provide a radiological evaluation of area soils prior to construction of the ISFSI road. Historical documentation and real time measurements performed during roadway construction identified elevated contamination levels in an area along the former railroad grade. A remediation of this area was conducted; however, the extent of cleanup was limited to the amount of soil disturbance required for removal of the rail bed and preparation of the surface required for construction of the roadway (Survey 5(2)B₁).

Deep-core sampling was conducted in five survey efforts to investigate the extent of potential subsurface contamination. The maximum survey depth was approximately 14 meters. Sample point locations were judgmentally selected based on historical data, process knowledge, survey analyses, and location availability due to subsurface obstructions of systems and equipment.

Data Summary

The data tabulated below reflects the current status of the survey unit. Data analyses for samples collected from locations that were later remediated have been excluded. The results of survey analyses for all samples collected in each individual survey of Survey Unit 5(2) are included in the Survey Results table.

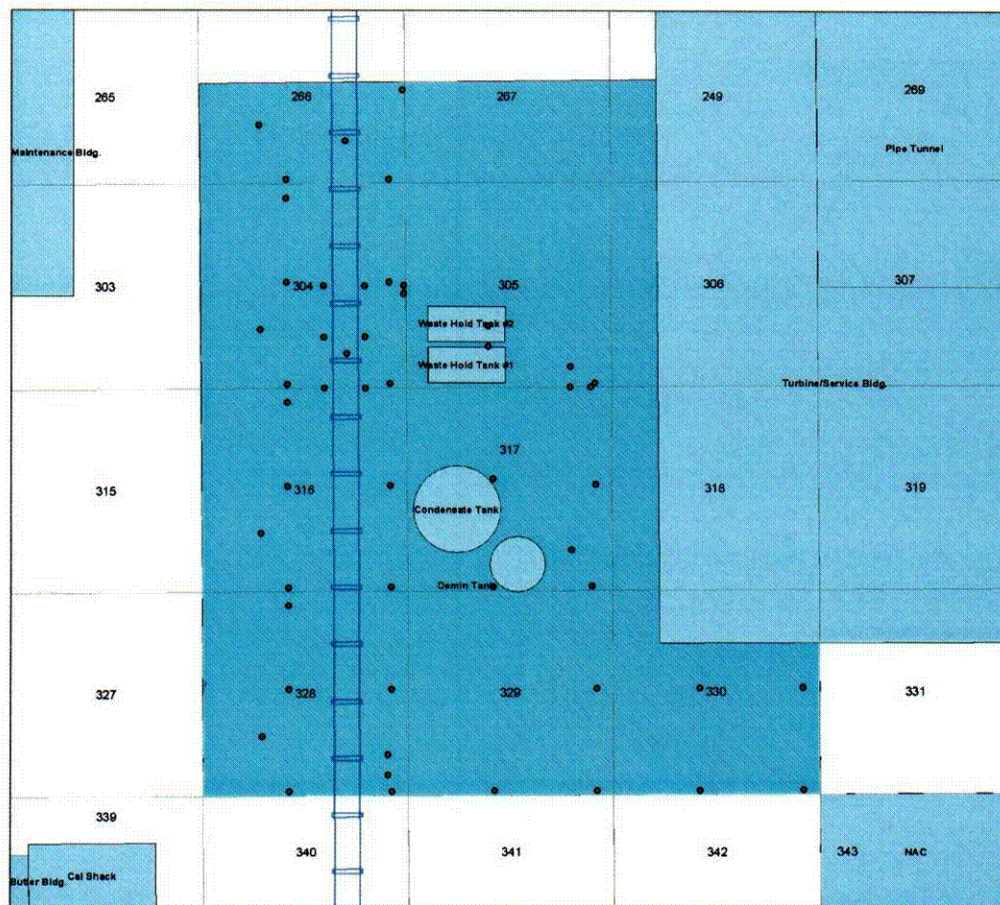
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Survey	No. of Samples	Radionuclides*	Mean (pCi/g)	Max. Value (pCi/g)
5(2)A₁	26	Cs₁₃₇	0.28	1.39
		Co₆₀	0.20	0.42
5(2)A₂	7	Cs₁₃₇	0.04	0.04
5(2)B₁	6	Cs₁₃₇	2.29	5.25
		Co₆₀	0.07	0.09
5(2)_{deepcore1}	16	Cs₁₃₇	1.15	2.73
		Co₆₀	nd	nd
5(2)_{deepcore2}	12	Cs₁₃₇	0.79	2.72
		Co₆₀	0.31	0.98
5(2)_{deepcore3}	19	Cs₁₃₇	2.87	30.70
		Co₆₀ **	1.96	7.50
5(2)_{deepcore4}	19	Cs₁₃₇	0.25	0.67
		Co₆₀ **	0.54	1.45
5(2)_{deepcore5}	3	Cs₁₃₇	nd	nd
		Co₆₀	nd	nd

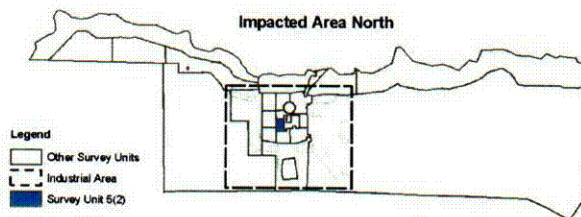
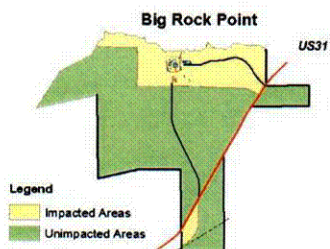
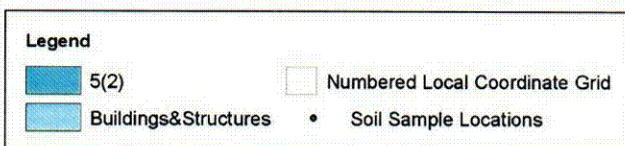
* nd indicates non detect

** Co-60 detected in a limited number of samples

Survey Unit 5(2)



Scale: 0 5 10 20 Meters



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Survey Results

Survey	Grid	Coordinate (x,y)	Depth (meters)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
5(2)A ₁	266	(4.2,0.2)	0.00-0.15	nd	0.12	nd	0.10	nd	0.40
5(2)A ₁	266	(9.2,0.2)	0.00-0.15	1.39		0.42		nd	0.34
5(2)A ₁	304	(4.2,5.2)	0.00-0.15	nd	0.08	nd	0.06	nd	0.37
5(2)A ₁	304	(9.2,5.2)	0.00-0.15	0.45		0.26		nd	0.27
5(2)A ₁	304	(4.2,0.2)	0.00-0.15	nd	0.08	nd	0.08	nd	0.40
5(2)A ₁	304	(9.2,0.2)	0.00-0.15	0.06		0.13		nd	0.31
5(2)A ₁	305	(9.2,0.2)	0.00-0.15	0.19		0.08		nd	0.21
5(2)A ₁	316	(4.2,5.2)	0.00-0.15	0.11		nd	0.15	nd	0.35
5(2)A ₁	316	(9.2,5.2)	0.00-0.15	0.10		0.15		nd	0.32
5(2)A ₁	317	(4.2,5.5)	0.00-0.15	0.14		nd	0.07	nd	0.24
5(2)A ₁	317	(9.2,5.2)	0.00-0.15	0.22		0.14		nd	0.21
5(2)A ₁	316	(4.2,0.2)	0.00-0.15	nd	0.08	nd	0.08	nd	0.37
5(2)A ₁	316	(9.2,0.2)	0.00-0.15	0.10		nd	0.05	nd	0.20
5(2)A ₁	317	(4.2,0.2)	0.00-0.15	0.19		nd	0.12	nd	0.41
5(2)A ₁	317	(9.0,0.2)	0.00-0.15	nd	0.13	nd	0.11	nd	0.28
5(2)A ₁	328	(4.2,5.2)	0.00-0.15	nd	0.09	nd	0.08	nd	0.35
5(2)A ₁	328	(9.2,5.2)	0.00-0.15	nd	0.03	nd	0.05	nd	0.19
5(2)A ₁	329	(9.2,5.2)	0.00-0.15	nd	0.10	nd	0.10	nd	0.39
5(2)A ₁	330	(4.2,5.2)	0.00-0.15	nd	0.04	nd	0.05	nd	0.21
5(2)A ₁	330	(9.2,5.2)	0.00-0.15	nd	0.09	nd	0.06	nd	0.43
5(2)A ₁	328	(4.2,0.2)	0.00-0.15	nd	0.07	nd	0.09	nd	0.38
5(2)A ₁	328	(9.2,0.2)	0.00-0.15	nd	0.10	nd	0.10	nd	0.42
5(2)A ₁	329	(4.2,0.2)	0.00-0.15	nd	0.12	nd	0.06	nd	0.36
5(2)A ₁	329	(9.2,0.2)	0.00-0.15	0.09		nd	0.09	nd	0.39
5(2)A ₁	330	(4.2,0.2)	0.00-0.15	nd	0.07	nd	0.10	nd	0.42
5(2)A ₁	330	(9.2,0.2)	0.00-0.15	nd	0.09	nd	0.06	nd	0.39
5(2)A ₂	328	(2.9,2.9)	0.00-0.15	nd	0.04	nd	0.06	nd	0.28
5(2)A ₂	328	(4.2,9.3)	0.00-0.15	nd	0.04	nd	0.05	nd	0.25
5(2)A ₂	316	(2.9,2.9)	0.00-0.15	nd	0.04	nd	0.05	nd	0.23
5(2)A ₂	316	(4.2,9.3)	0.00-0.15	0.04		nd	0.05	nd	0.24
5(2)A ₂	304	(2.9,2.9)	0.00-0.15	nd	0.04	nd	0.06	nd	0.26
5(2)A ₂	304	(4.2,9.3)	0.00-0.15	nd	0.04	nd	0.05	nd	0.27
5(2)A ₂	266	(2.9,2.9)	0.00-0.15	nd	0.04	nd	0.07	nd	0.28
5(2)B ₁	304	(6.0,0.0)	0.30-0.45	0.98		nd	0.06	nd	0.31
5(2)B ₁	304	(8.0,0.0)	0.30-0.45	5.25		nd	0.07	nd	0.41
5(2)B ₁	304	(6.0,2.5)	0.30-0.45	0.09		nd	0.07	nd	0.30

^a nd indicates non detect, MDA provided

^b No entry in MDA columns is provided when residual radioactivity is detected

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Survey	Grid	Coordinate (x,y)	Depth (meters)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
5(2)B ₁	304	(8.0,2.5)	0.30-0.45	1.87		nd	0.07	nd	0.35
5(2)B ₁	304	(6.0,5.0)	0.30-0.45	1.18		0.09		nd	0.32
5(2)B ₁	304	(8.0,5.0)	0.30-0.45	4.30		0.04		nd	0.36
5(2)A _{deepcore1}	304	(7.1,1.7)	0 - 0.30	1.68		nd	0.08	nd	0.26
5(2)A _{deepcore1}	304	(7.1,1.7)	0.60-1.80	2.73		nd	0.08	nd	0.38
5(2)A _{deepcore1}	304	(7.1,1.7)	1.80-2.40	0.10		nd	0.06	nd	0.23
5(2)A _{deepcore1}	304	(7.1,1.7)	2.40-3.60	nd	0.04	nd	0.07	nd	0.26
5(2)A _{deepcore1}	304	(7.1,1.7)	3.60-4.20	nd	0.04	nd	0.07	nd	0.33
5(2)A _{deepcore1}	304	(7.1,1.7)	4.20-4.80	nd	0.08	nd	0.13	nd	0.38
5(2)A _{deepcore1}	304	(7.1,1.7)	4.80-5.40	nd	0.03	nd	0.04	nd	0.24
5(2)A _{deepcore1}	304	(7.1,1.7)	10.2-10.8	nd	0.04	nd	0.11	nd	0.36
5(2)A _{deepcore1}	304	(7.1,1.7)	11.7-12.3	nd	0.07	nd	0.09	nd	0.39
5(2)A _{deepcore1}	304	(7.1,1.7)	13.2-13.8	nd	0.03	nd	0.06	nd	0.24
5(2)A _{deepcore1}	266	(7.1,2.1)	0 - 0.30	0.10		nd	0.04	nd	0.24
5(2)A _{deepcore1}	266	(7.1,2.1)	0.60-1.20	nd	0.10	nd	0.06	nd	0.35
5(2)A _{deepcore1}	266	(7.1,2.1)	1.20-2.40	nd	0.05	nd	0.05	nd	0.20
5(2)A _{deepcore1}	266	(7.1,2.1)	2.40-3.00	nd	0.07	nd	0.08	nd	0.40
5(2)A _{deepcore1}	266	(7.1,2.1)	3.00-3.60	nd	0.30	nd	0.04	nd	0.18
5(2)A _{deepcore1}	266	(7.1,2.1)	3.60-4.20	nd	0.06	nd	0.09	nd	0.39
5(2)A _{deepcore2}	266	(9.2,0.2)	0.15-0.30	0.41		0.18		nd	0.32
5(2)A _{deepcore2}	266	(9.2,0.2)	0.30-0.60	0.21		nd	0.13	nd	0.40
5(2)A _{deepcore2}	266	(9.2,0.2)	0.60-0.90	nd	0.11	nd	0.12	nd	0.34
5(2)A _{deepcore2}	304	(9.2,5.2)	0.15-0.30	0.60		0.19		nd	0.25
5(2)A _{deepcore2}	304	(9.2,5.2)	0.30-0.60	0.16		0.08		nd	0.27
5(2)A _{deepcore2}	304	(9.2,5.2)	0.60-0.90	0.22		0.16		nd	0.29
5(2)A _{deepcore2}	304	(9.2,0.2)	0.15-0.30	1.39		0.14		nd	0.23
5(2)A _{deepcore2}	304	(9.2,0.2)	0.30-0.60	1.81		0.50		nd	0.33
5(2)A _{deepcore2}	304	(9.2,0.2)	0.60-0.90	2.72		0.98		nd	0.41
5(2)A _{deepcore2}	316	(9.2,5.2)	0.15-0.30	0.16		nd	0.13	nd	0.43
5(2)A _{deepcore2}	316	(9.2,5.2)	0.30-0.60	0.80		0.27		nd	0.34
5(2)A _{deepcore2}	316	(9.2,5.2)	0.60-0.90	0.21		nd	0.11	nd	0.38
5(2)A _{deepcore3}	266	(9.9,4.6)	0.00-0.30	30.70		7.5		nd	0.43
5(2)A _{deepcore3}	266	(9.9,4.6)	0.30-0.60	0.89		0.15		nd	0.26
5(2)A _{deepcore3}	266	(9.9,4.6)	0.60-0.90	0.41		0.11		nd	0.23
5(2)A _{deepcore3}	266	(9.9,4.6)	0.90-1.20	0.11		nd	0.05	nd	0.21
5(2)A _{deepcore3}	266	(9.9,4.6)	1.20-1.50	0.06		nd	0.05	nd	0.21
5(2)A _{deepcore3}	266	(9.9,4.6)	1.50-1.80	0.04		nd	0.05	nd	0.22
5(2)A _{deepcore3}	304	(9.9,5.0)	0.60-0.90	0.13		nd	0.07	nd	0.21

^a nd indicates non detect, MDA provided

^b No entry in MDA columns is provided when residual radioactivity is detected

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Survey	Grid	Coordinate (x,y)	Depth (meters)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
5(2)A _{deepcore3}	304	(9.9,5.0)	0.90-1.20	0.07		nd	0.05	nd	0.18
5(2)A _{deepcore3}	304	(9.9,5.0)	1.20-1.50	0.10		0.07		nd	0.19
5(2)A _{deepcore3}	304	(9.9,5.0)	1.50-1.80	0.05		nd	0.04	nd	0.19
5(2)A _{deepcore3}	304	(9.9,5.0)	1.80-2.10	nd	0.05	nd	0.05	nd	0.23
5(2)A _{deepcore3}	304	(9.9,4.6)	0.30-0.60	1.14		nd	0.06	nd	0.25
5(2)A _{deepcore3}	304	(9.9,4.6)	0.60-0.90	0.72		nd	0.07	nd	0.31
5(2)A _{deepcore3}	317	(8.0,2.0)	0.45-0.60	nd	0.06	nd	0.06	nd	0.29
5(2)A _{deepcore3}	317	(8.0,2.0)	0.60-0.90	nd	0.04	nd	0.05	nd	0.20
5(2)A _{deepcore3}	317	(8.0,2.0)	0.90-1.20	nd	0.03	nd	0.04	nd	0.20
5(2)A _{deepcore3}	317	(8.0,2.0)	1.20-1.50	nd	0.04	nd	0.06	nd	0.26
5(2)A _{deepcore3}	317	(8.0,2.0)	1.50-1.80	nd	0.04	nd	0.05	nd	0.21
5(2)A _{deepcore3}	317	(8.0,2.0)	1.80-2.10	nd	0.04	nd	0.05	nd	0.21
5(2)A _{deepcore4}	305	(4.0,2.0)	0.00-0.30	0.67		1.45		nd	0.23
5(2)A _{deepcore4}	305	(4.0,2.0)	0.30-0.60	0.15		0.33		nd	0.21
5(2)A _{deepcore4}	305	(4.0,2.0)	0.60-0.90	nd	0.08	nd	0.13	nd	0.19
5(2)A _{deepcore4}	305	(4.0,3.0)	0.60-0.90	nd	0.05	nd	0.10	nd	0.19
5(2)A _{deepcore4}	305	(4.0,3.0)	0.90-1.20	nd	0.05	nd	0.12	nd	0.16
5(2)A _{deepcore4}	305	(4.0,3.0)	1.20-1.50	nd	0.07	nd	0.11	nd	0.17
5(2)A _{deepcore4}	305	(4.0,3.0)	1.50-1.80	nd	0.07	nd	0.10	nd	0.21
5(2)A _{deepcore4}	305	(8.0,0.0)	0.30-0.60	nd	0.08	nd	0.11	nd	0.20
5(2)A _{deepcore4}	305	(8.0,0.0)	0.60-0.90	nd	0.08	nd	0.13	nd	0.24
5(2)A _{deepcore4}	305	(8.0,1.0)	0.30-0.60	0.33		0.20		nd	0.16
5(2)A _{deepcore4}	305	(8.0,1.0)	0.60-0.90	0.11		nd	0.13	nd	0.17
5(2)A _{deepcore4}	305	(9.0,0.0)	0.00-0.30	0.41		0.18		nd	0.18
5(2)A _{deepcore4}	305	(9.0,0.0)	0.30-0.60	nd	0.12	nd	0.10	nd	0.19
5(2)A _{deepcore4}	305	(9.0,0.0)	0.60-0.90	nd	0.08	nd	0.07	nd	0.16
5(2)A _{deepcore4}	305	(9.0,1.0)	0.30-0.60	nd	0.09	nd	0.13	nd	0.15
5(2)A _{deepcore4}	328	(9.0,1.0)	0.30-0.60	0.11		nd	0.12	nd	0.16
5(2)A _{deepcore4}	328	(9.0,2.0)	0.00-0.30	0.15		nd	0.13	nd	0.23
5(2)A _{deepcore4}	328	(9.0,2.0)	0.30-0.60	nd	0.08	nd	0.13	nd	0.20
5(2)A _{deepcore4}	328	(9.0,2.0)	0.60-0.90	0.10		nd	0.11	nd	0.24
5(2)A _{deepcore5}	304	(2.9,2.9)	0.15-0.30	nd	0.05	nd	0.06	nd	0.25
5(2)A _{deepcore5}	304	(2.9,2.9)	0.30-0.60	nd	0.04	nd	0.05	nd	0.30
5(2)A _{deepcore5}	304	(2.9,2.9)	0.60-0.75	nd	0.05	nd	0.07	nd	0.29

^a nd indicates non detect, MDA provided

^b No entry in MDA columns is provided when residual radioactivity is detected

Survey Unit 6

Description

Survey Unit 6 is an area of approximately 1500 m² in size that occupies the south-central section of the Protected Area. This area encompasses the New Access Control Building and the former location of the site electrical substation. Subsurface structures and equipment include the Liquid Radwaste Processing discharge line, storm drains, Well Water System piping electrical conduit, and Fire Protection System piping.

History

The HSA has identified this survey unit to potentially contain radioactive contamination in area soils. This area was once the transport route for movement of radioactive waste to the Radwaste Building for temporary storage and shipment preparation.

Radiological Status

Residual radioactivity was identified in this survey unit at a fraction of the IDCGL (0.2 pCi/g Co-60). Subsurface soil contamination is not indicated by the HSA or process knowledge and was not identified in deep-core sampling analyses. The radiological status of this survey unit is Class 1 based on proximity to the following:

- Contaminated material transport pathways,
- Areas of known soil contamination scheduled for excavation and subsurface component removal,
- Locations scheduled for soil remediation, and
- Buildings and foundations scheduled for demolition and removal of contaminated equipment and materials.

Primary Survey Design

1. Sample Data Points Required

The scoping survey resulted in the following data:

Nuclide identification	Cs-137	Co-60
Mean value (pCi/g)	0.16	0.056
Standard deviation (σ)	0.048	0.020

Applying the Unity Rule,

$$\sigma = \sqrt{\left(\frac{\sigma_{Cs}}{5.11_{Cs}}\right)^2 + \left(\frac{\sigma_{Co}}{4.99_{Co}}\right)^2} = \sqrt{\left(\frac{.048}{5.11_{Cs}}\right)^2 + \left(\frac{.020}{4.99_{Co}}\right)^2}$$

$$\sigma = 0.010$$

For the Unity Rule the DCGL for the weighted sum is 1.0. The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL.

$$\text{Relative Shift} = \frac{DCGL - LBGR}{\sigma} = \frac{1 - 0.5}{0.01} = 50$$

With α and β error levels set at 0.05 and an assumed relative shift of 3, the Sign Test requirements specify a sample size of 14 data points.

2. Sample Locations

Sample locations were systematically selected in random start, square grid pattern with the southwest corner of the survey unit as origin.

Bounding survey unit dimensions 40 X 50 meters

Random Numbers 0.00, 0.76

$X = (0.00)(40 \text{ m}) = 0.0 \text{ m}$

$Y = (0.76)(50 \text{ m}) = 38.0 \text{ m}$

$$\text{Sample Spacing } L = \sqrt{\text{Area}/N} = \sqrt{1500/14} = 10.3 \text{ meters}$$

As a conservative measure, 18 samples were collected by random start coordinate location and 9.2 meter spacing.

Supporting Surveys

Supporting survey 6A₂ was conducted to provide further investigation of potential soil contamination prior to construction of the ISFSI road. Deep core sampling was conducted in two survey efforts to investigate the extent of subsurface contamination. The maximum sample depth was approximately 2.7 meters. Sample point locations were judgmentally selected based on historical data, process knowledge, and location availability due to subsurface obstruction.

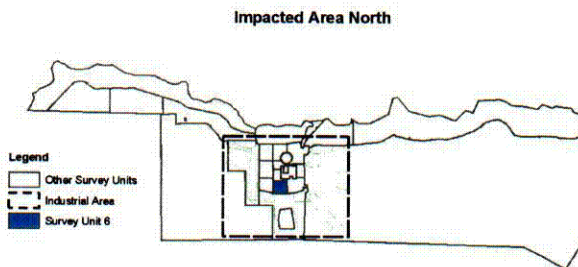
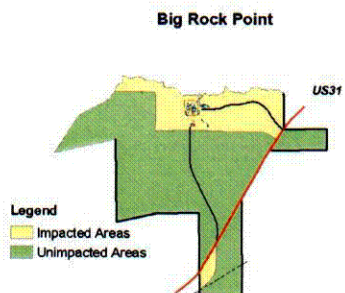
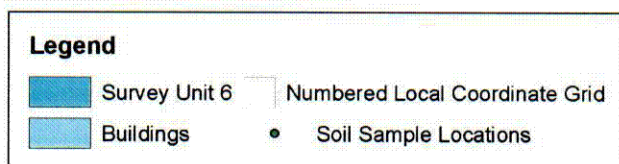
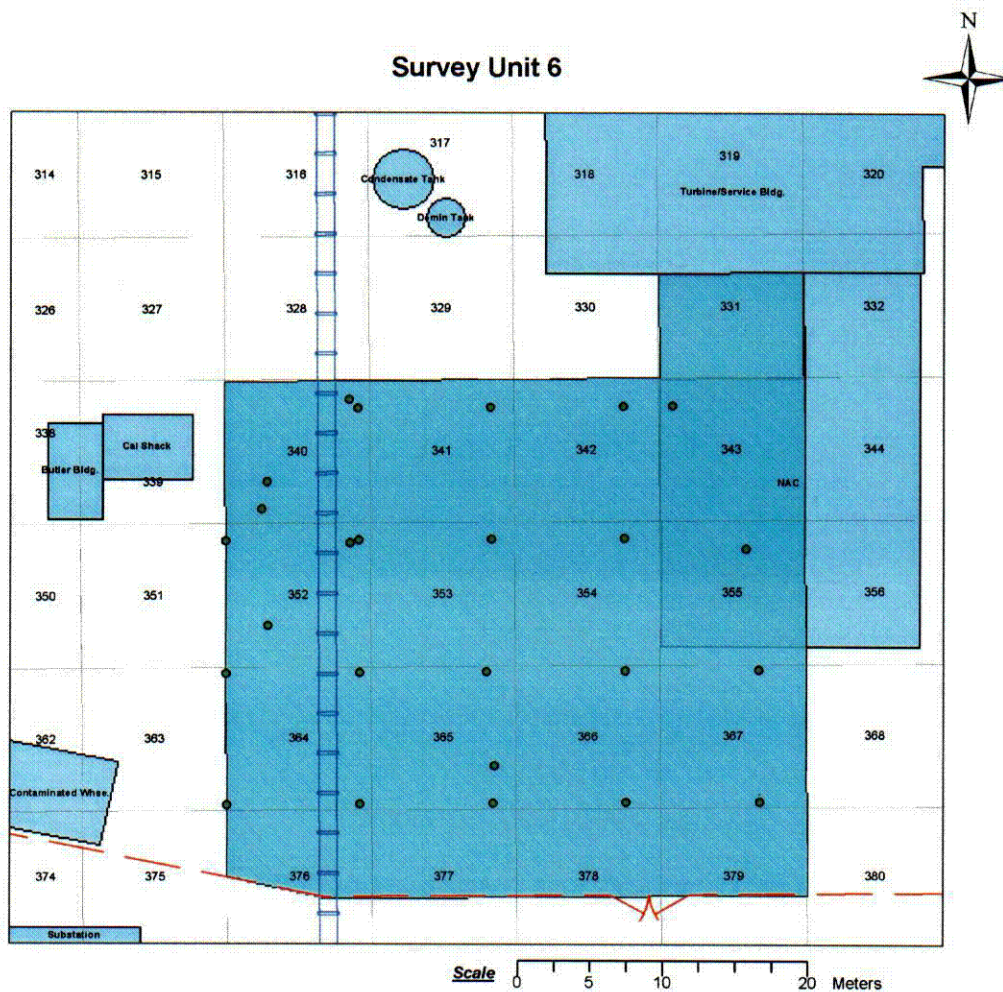
Data Summary

Survey Unit 6

Survey	Data Points	Radionuclide*	Mean (pCi/g)	Max. Value (pCi/g)
6A ₁	18	Cs ₁₃₇	0.09	0.20
		Co ₆₀ **	0.08	0.16
6A ₂	4	Cs ₁₃₇	0.09	0.09
6A _{deepcore1}	5	nd	-	-
6A _{deepcore2}	2	nd	-	-

* nd denotes no activity detected

** Co-60 detected in 3 samples only



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Survey Results

Survey	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
6A ₁	340	(9.2,8.0)	0.00-0.15	nd	0.04	nd	0.04	nd	0.18
6A ₁	341	(8.4,8.0)	0.00-0.15	nd	0.04	nd	0.04	nd	0.20
6A ₁	342	(7.6,8.0)	0.00-0.15	nd	0.05	nd	0.05	nd	0.20
6A ₁	352	(0.0,8.8)	0.00-0.15	0.17		0.04		nd	0.24
6A ₁	352	(9.2,8.8)	0.00-0.15	0.04		nd	0.03	nd	0.19
6A ₁	353	(8.4,8.8)	0.00-0.15	nd	0.03	nd	0.05	nd	0.16
6A ₁	354	(7.6,8.8)	0.00-0.15	0.06		nd	0.04	nd	0.20
6A ₁	364	(0.0,9.6)	0.00-0.15	0.07		0.05		nd	0.24
6A ₁	364	(9.2,9.6)	0.00-0.15	0.20		0.16		nd	0.27
6A ₁	365	(8.0,9.6)	0.00-0.15	0.03		nd	0.05	nd	0.19
6A ₁	366	(7.6,9.6)	0.00-0.15	0.08		nd	0.04	nd	0.24
6A ₁	367	(6.8,9.6)	0.00-0.15	0.11		nd	0.05	nd	0.22
6A ₁	364	(0.0,0.4)	0.00-0.15	0.13		nd	0.05	nd	0.19
6A ₁	364	(9.2,0.4)	0.00-0.15	0.12		nd	0.06	nd	0.23
6A ₁	365	(8.4,0.4)	0.00-0.15	0.03		nd	0.05	nd	0.20
6A ₁	366	(7.6,0.4)	0.00-0.15	nd	0.04	nd	0.03	nd	0.19
6A ₁	367	(6.8,0.4)	0.00-0.15	nd	0.04	nd	0.04	nd	0.20
6A ₁	340	(9.2,8.0)	0.15-0.30	nd	0.03	nd	0.03	nd	0.18
6A ₂	352	(2.9,2.9)	0.00-0.15	nd	0.05	nd	0.04	nd	0.30
6A ₂	352	(8.6,8.6)	0.00-0.15	nd	0.05	nd	0.07	nd	0.24
6A ₂	340	(2.9,2.9)	0.00-0.15	nd	0.05	nd	0.05	nd	0.23
6A ₂	340	(8.6,8.6)	0.00-0.15	0.09		nd	0.06	nd	0.26
6A _{deepcore1}	355	(6.0,8.0)	0.00-0.45	^c					
6A _{deepcore1}	355	(6.0,8.0)	0.45-1.70	nd	0.06	nd	0.11	nd	0.19
6A _{deepcore1}	343	(1.0,8.0)	0.00-0.60	^c					
6A _{deepcore1}	343	(1.0,8.0)	0.60-1.20	nd	0.06	nd	0.07	nd	0.15
6A _{deepcore1}	343	(1.0,8.0)	1.20-1.80	nd	0.07	nd	0.07	nd	0.17
6A _{deepcore1}	343	(1.0,8.0)	1.80-2.40	nd	0.05	nd	0.07	nd	0.16
6A _{deepcore1}	343	(1.0,8.0)	2.40-2.70	nd	0.05	nd	0.07	nd	0.16
6A _{deepcore2}	341	(8.4,8.0)	0.60-0.90	nd	0.04	nd	0.05	nd	0.24
6A _{deepcore2}	341	(8.4,8.0)	0.90-1.05	nd	0.07	nd	0.07	nd	0.33

^a nd indicates non detect, MDA provided

^b No entry in MDA columns is provided when residual radioactivity is detected

^c Sample was not obtained for analysis (surface gravel).

Survey Unit 7

Description

Survey Unit 7 is an area of approximately 2200 m² that occupies the southeast section of the Protected Area. This area contains a portion of the New Access Control Building and the former site electrical substation. Subsurface structures and equipment include the Liquid Radwaste Processing discharge line, storm drains, well water piping, electrical conduit, and Fire Protection System piping.

History

The HSA has identified this survey unit to potentially contain radioactive contamination in area soils. This area is adjacent to the transport route for movement of radioactive waste to the Radwaste Building. This area is also a connecting pathway for the transport of radioactive materials to the Protected Area main gate.

Radiological Status

Residual radioactivity was not identified above background levels in any survey performed in this area. Subsurface soil contamination is not indicated by the HSA or process knowledge and was not identified in deep-core sampling analyses. The radiological status of this survey unit is Class 1 based on proximity to the following area locations:

- Contaminated material transport pathways,
- Areas of known soil contamination scheduled for excavation and subsurface component removal,
- Locations scheduled for soil remediation, and
- Buildings and foundations scheduled for demolition and removal of contaminated equipment and materials.

Primary Survey Design

1. Sample Data Points Required

The scoping survey resulted in the following data:

Nuclide identification	Cs-137
Mean value (pCi/g)	0.21
Standard deviation (σ)	0.23

The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL.

$$\text{Relative Shift} = \frac{\text{DCGL} - \text{LBGR}}{\sigma} = \frac{5.11 - 2.5}{0.23} = 11.1$$

With α and β error levels set at 0.05 and an assumed relative shift of 3, the Sign Test requirements specify a sample size of 14 data points.

2. Sample Locations

Sample locations were systematically selected in random start, square grid pattern with the southwest corner of the survey unit as origin.

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Bounding survey unit dimensions 60 X 60 meters
Random Numbers 0.467, 0.76
 $X = (0.467)(60 \text{ m}) = 28.0 \text{ m}$
 $Y = (0.575)(60 \text{ m}) = 34.5 \text{ m}$

$$\text{Sample Spacing } L = \sqrt{\text{Area}/N} = \sqrt{2200/14} = 12.5 \text{ meters}$$

As a conservative measure, 15 samples were collected by random start coordinate location and 10.5 meter spacing.

Supporting Surveys

One deep core survey was conducted investigate the potential presence of subsurface contamination. The maximum sample depth was approximately 2.25 meters. Sample point locations were judgmentally selected to identify potential areas of contamination using historical information, process knowledge, and location availability based on subsurface obstructions.

Data Summary

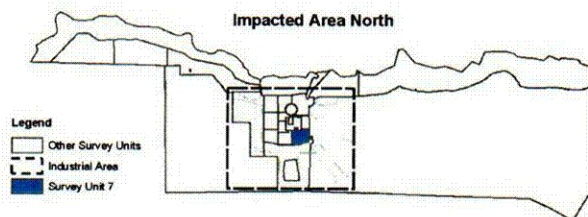
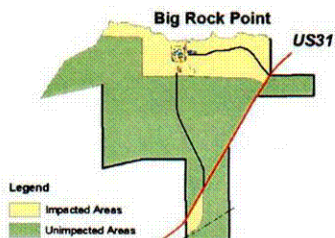
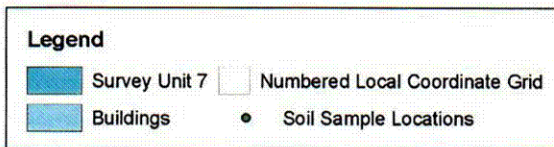
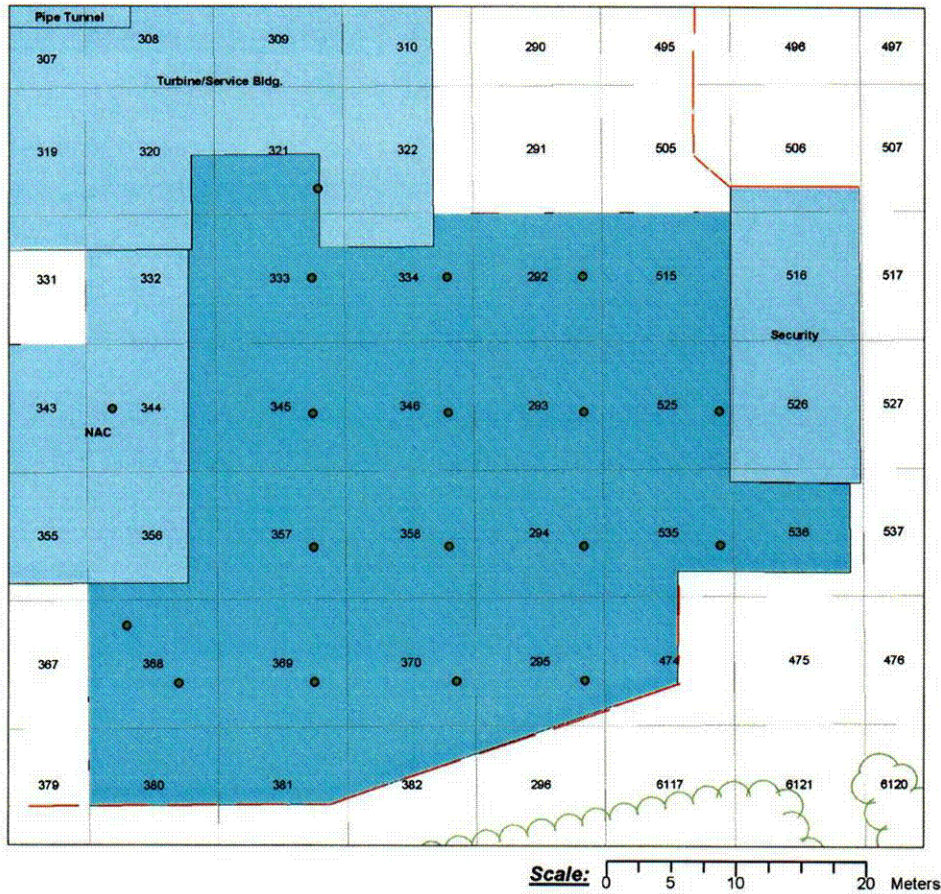
Survey Unit 7

Survey	No. of Samples	Radionuclides*	Mean (pCi/g)	Max. Value (pCi/g)
7A₁	15	Cs₁₃₇**	0.10	0.20
7A_{deepcore1}	6	nd	-	-

* nd indicates non detect

** Radioactivity detected in 3 samples only

Survey Unit 7



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Survey Results

Survey	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
7A ₁	333	(7.5,5.0)	0.00-0.15	nd	0.04	nd	0.04	nd	0.18
7A ₁	334	(8.0,5.0)	0.00-0.15	nd	0.04	nd	0.05	nd	0.24
7A ₁	292	(8.5,5.0)	0.00-0.15	nd	0.04	nd	0.05	nd	0.25
7A ₁	345	(7.5,4.5)	0.00-0.15	nd	0.04	nd	0.04	nd	0.17
7A ₁	346	(8.0,4.5)	0.00-0.15	nd	0.04	nd	0.04	nd	0.21
7A ₁	293	(8.5,4.5)	0.00-0.15	nd	0.04	nd	0.04	nd	0.18
7A ₁	525	(9.0,4.5)	0.00-0.15	nd	0.05	nd	0.05	nd	0.21
7A ₁	357	(7.5,4.0)	0.00-0.15	nd	0.04	nd	0.05	nd	0.24
7A ₁	358	(8.0,4.0)	0.00-0.15	nd	0.04	nd	0.05	nd	0.20
7A ₁	294	(8.5,4.0)	0.00-0.15	nd	0.03	nd	0.04	nd	0.21
7A ₁	535	(9.0,4.0)	0.00-0.15	0.20		nd	0.05	nd	0.27
7A ₁	368	(7.0,3.5)	0.00-0.15	0.06		nd	0.05	nd	0.20
7A ₁	369	(7.5,3.5)	0.00-0.15	nd	0.04	nd	0.04	nd	0.20
7A ₁	370	(8.5,3.5)	0.00-0.15	nd	0.03	nd	0.03	nd	0.16
7A ₁	295	(8.5,3.5)	0.00-0.15	0.04		nd	0.04	nd	0.20
7A deepcore1	321	(8.0,2.0)	0.00-0.60	nd	0.06	nd	0.09	nd	0.15
7A deepcore1	321	(8.0,2.0)	0.60-1.20	nd	0.05	nd	0.09	nd	0.19
7A deepcore1	344	(2.0,5.0)	0.00-0.45	c					
7A deepcore1	344	(2.0,5.0)	0.45-1.05	nd	0.07	nd	0.03	nd	0.20
7A deepcore1	344	(2.0,5.0)	1.05-2.70	nd	0.07	nd	0.11	nd	0.24
7A deepcore1	368	(3.0,8.0)	0.00-0.40	c					
7A deepcore1	368	(3.0,8.0)	0.40-1.60	nd	0.06	nd	0.10	nd	0.19
7A deepcore1	368	(3.0,8.0)	1.60-2.25	nd	0.06	nd	0.08	nd	0.16

^a nd indicates non detect, MDA provided

^b No entry in MDA columns is provided when residual radioactivity is detected

^c Sample was not obtained for analysis (surface gravel).

Survey Unit 8

Description

Survey Unit 8 is approximately 2800 m² in size and encompasses the area beneath the Turbine Building and Containment Building. The concrete base pad supporting the Containment Building extends over 10 meters below grade.

Subsurface structures and equipment in these areas are extensive. During plant operation these buildings were housed all components and interconnecting systems necessary for power generation. A significant amount of subsurface piping and electrical conduit continues to support systems that currently remain in operation.

History

The eastern section of the Turbine Building (also known as the Service Building Annex) was utilized for office space and has always been maintained as a non-radiological area. The HSA has identified residual radioactivity at two locations in soils beneath the Turbine Building floor:

1. Pipe Tunnel – resulting from the migration of contaminants through concrete expansion joints in the floor, and
2. Track Alley - originating from a former subsurface condensate piping leak.

The Pipe Tunnel expansion joints were sealed and the flooring surface in this area has been reinforced to support the removal of heavy equipment and materials from the Containment Building prior to demolition. Remediation efforts were conducted in 1984 after discovery of a condensate piping leak in Track Alley. Following the removal of contaminated soil, clean fill was used to return the remediated area to proper grade.

Radiological Status

- Residual radioactivity was not identified in soil samples collected beneath the Containment Building above established background levels.
- Surveys conducted in the Turbine Building identified residual radioactivity at IDCGL values in the western portion of Track Alley. Soil analyses in this area verify the results of remediation efforts identified in historical documentation.
- Residual Radioactivity was not identified in the eastern section of the Turbine Building above established background levels.
- Analyses of soil sampled collected beneath the Pipe Tunnel floor yielded residual radioactivity (Co-60) above the IDCGL. The Pipe Tunnel is a segregated section in the northern area of the Turbine Building that annexes the Containment Building.

A significant amount of excavation will be required for the removal of subsurface structures and components in Survey Unit 8. Characterization surveys are scheduled to continue during this process and remediation efforts will be conducted as necessary to satisfy the requirements for final status survey. It is expected that this survey unit will be subdivided into smaller areas for evaluation at the time of the Final Status Survey. The radiological status of Survey Unit 8 is Class 1.

Primary Survey Design

Fire Protection System, Liquid Radwaste Processing System, and other systems supporting continued operation of the Spent Fuel Pool remain in service at this time. As a result, sampling in this area was restricted due to potential breach of operational systems, embedded piping, or electrical power by the boring process required for sample collection. In addition, ongoing decommissioning activities in these areas limit the extent of available sample point locations. A primary survey design based on a systematic sampling approach and the statistical requirements of the Sign Test were not possible in this survey unit.

Sample points were selected at locations of greatest probability to identify radioactivity and define the lateral and vertical extent of potential contaminant migration. Sample size was determined by location availability. The data point selection process was based on documented historical events, process knowledge, and identified contaminant migration pathways defined by hydrogeological evaluation. Samples were collected by mechanically boring through structural steel and concrete and then coring the soil below with specialized sampling equipment. This process has resulted in the collection of 114 samples in four area survey iterations.

Data Summary

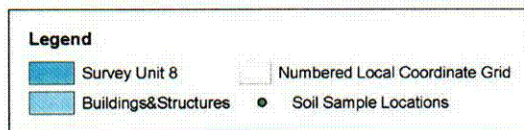
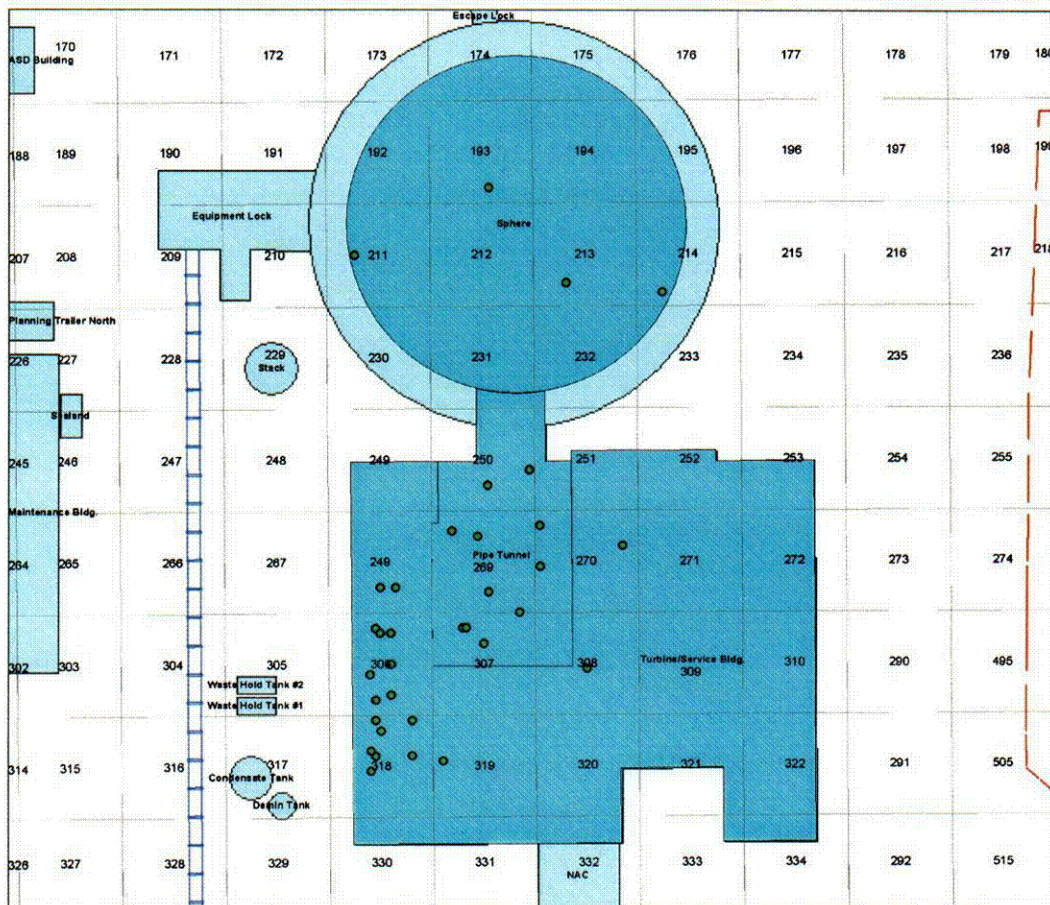
Survey Unit 8

Survey	No. of Samples	Radionuclides*	Mean (pCi/g)	Max. Value (pCi/g)
8A _{Deepcore 1} Turbine Bldg.	14	nd	-	-
8A _{Deepcore 2} Pipe Tunnel	33	Cs ₁₃₇	1.27	12.60
		Co ₆₀	4.84	105.90
		Mn ₅₄ **	1.77	8.68
8A _{Deepcore 3} Turbine Bldg.	58	Cs ₁₃₇	1.22	5.29
		Co ₆₀	0.15	0.17
8A _{Deepcore 4} Containment	9	nd	-	-

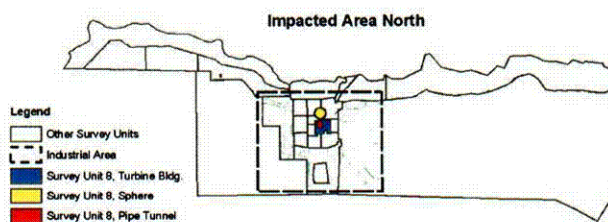
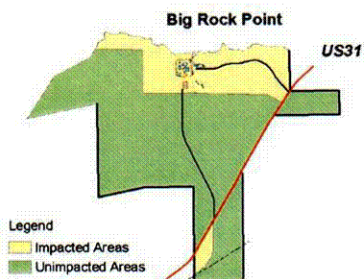
* nd indicates non detect

** Radioactivity detected in one sample only

Survey Unit 8



Scale: 0 5 10 20 Meters



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Survey Results

Survey	Grid	Coordinate ^c (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Mn-54 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
Pipe Tunnel											
8 deepcore 2	250	(5.5,2.5)	0.00-0.30	nd	0.05	0.08		nd	0.06	nd	0.26
8 deepcore 2	250	(5.5,2.5)	0.30-0.60	nd	0.05	0.10		nd	0.06	nd	0.29
8 deepcore 2	250	(5.5,2.5)	0.60-0.90	nd	0.05	nd	0.08	nd	0.07	nd	0.23
8 deepcore 2	250	(9.5,4.0)	0.00-0.30	4.07		105.90		8.68		nd	0.63
8 deepcore 2	250	(9.5,4.0)	0.30-0.60	0.60		15.50		0.92		nd	0.43
8 deepcore 2	250	(9.5,4.0)	0.60-0.90	0.05		0.19		0.03		nd	0.30
8 deepcore 2	269	(2.0,8.0)	0.00-0.30	0.08		0.32		nd	0.07	nd	0.29
8 deepcore 2	269	(2.0,8.0)	0.30-0.60	0.05		0.44		nd	0.07	nd	0.25
8 deepcore 2	269	(2.0,8.0)	0.60-0.90	0.39		3.19		0.17		nd	0.40
8 deepcore 2	269	(2.0,8.0)	0.90-1.20	0.10		0.82		nd	0.07	nd	0.31
8 deepcore 2	269	(2.0,8.0)	1.20-1.50	0.06		0.25		nd	0.05	nd	0.27
8 deepcore 2	269	(2.0,8.0)	1.50-1.80	nd	0.05	0.17		nd	0.04	nd	0.27
8 deepcore 2	269	(2.0,8.0)	1.80-2.10	0.02		0.22		nd	0.06	nd	0.27
8 deepcore 2	269	(4.5,7.5)	0.00-0.15	nd	0.06	0.59		nd	0.11	nd	0.32
8 deepcore 2	269	(4.5,7.5)	0.30-0.60	nd	0.05	0.28		nd	0.08	nd	0.28
8 deepcore 2	269	(4.5,7.5)	0.60-0.90	0.11		0.44		0.09		nd	0.34
8 deepcore 2	269	(4.5,7.5)	0.90-1.20	nd	0.08	0.23		nd	0.08	nd	0.29
8 deepcore 2	269	(4.5,7.5)	1.20-1.50	0.26		8.78		0.73		nd	0.43
8 deepcore 2	269	(4.5,7.5)	1.50-1.80	nd	0.07	nd	0.1	nd	0.05	nd	0.32
8 deepcore 2	269	(4.5,7.5)	1.80-2.10	nd	0.06	0.09		nd	0.06	nd	0.25
8 deepcore 2	269	(4.5,7.5)	2.10-2.40	nd	0.04	0.09		nd	0.05	nd	0.22
8 deepcore 2	269	(5.5,2.0)	0.00-0.15	nd	0.05	0.43		nd	0.07	nd	0.22
8 deepcore 2	269	(5.5,2.0)	0.30-0.60	nd	0.04	0.20		nd	0.07	nd	0.23
8 deepcore 2	269	(8.5,0.0)	0.00-0.15	nd	0.07	1.10		nd	0.10	nd	0.34
8 deepcore 2	269	(8.5,0.0)	0.30-0.60	nd	0.05	0.26		nd	0.07	nd	0.24
8 deepcore 2	270	(0.5,4.5)	0.00-0.15	0.10		1.34		nd	0.12	nd	0.34
8 deepcore 2	270	(0.5,4.5)	0.30-0.60	0.06		0.62		nd	0.10	nd	0.28
8 deepcore 2	270	(0.5,8.5)	0.00-0.15	nd	0.05	0.33		nd	0.08	nd	0.24
8 deepcore 2	270	(0.5,8.5)	0.30-0.60	nd	0.05	0.24		nd	0.07	nd	0.26
8 deepcore 2	307	(3.0,8.5)	0.00-0.15	0.54		0.29		nd	0.08	nd	0.28
8 deepcore 2	307	(3.3,8.5)	0.00-0.15	12.60		2.10		nd	0.07	nd	0.43
8 deepcore 2	307	(5.0,7.0)	0.00-0.15	nd	0.04	0.52		nd	0.08	nd	0.28
8 deepcore 2	307	(5.0,7.0)	0.30-0.60	nd	0.06	nd	0.12	nd	0.06	nd	0.33

^a nd indicates non detect, MDA provided

^b No entry in the MDA column is provided when residual radioactivity is detected

^c Datapoint locations are further defined in individual survey file drawings and floor plans

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Survey	Grid	Coordinate ^c	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Mn-54 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
Turbine/Service Building											
8 deepcore 1	306	(6.0,8.0)	0.00-0.30	nd	0.09	nd	0.13	nd	0.07	nd	0.24
8 deepcore 1	306	(6.0,2.0)	0.00-0.60	nd	0.10	nd	0.06	nd	0.14	nd	0.38
8 deepcore 1	319	(1.0,5.5)	0.00-0.60	nd	0.06	nd	0.1	nd	0.02	nd	0.19
8 deepcore 1	319	(1.0,5.5)	0.60-2.20	nd	0.06	nd	0.09	nd	0.05	nd	0.16
8 deepcore 1	319	(1.0,5.5)	2.20-3.10	nd	0.07	nd	0.07	nd	0.06	nd	0.15
8 deepcore 1	319	(1.0,5.5)	3.10-3.70	nd	0.06	nd	0.09	nd	0.05	nd	0.19
8 deepcore 1	308	(5.0,4.5)	0.00-0.90	nd	0.08	nd	0.10	nd	0.09	nd	0.20
8 deepcore 1	308	(5.0,4.5)	0.90-2.13	nd	0.05	nd	0.08	nd	0.06	nd	0.15
8 deepcore 1	308	(5.0,4.5)	2.13-2.75	nd	0.05	nd	0.04	nd	0.04	nd	0.26
8 deepcore 1	308	(5.0,4.5)	2.75-3.30	nd	0.04	nd	0.05	nd	0.03	nd	0.29
8 deepcore 1	270	(8.5,6.5)	0.00-0.80	nd	0.10	nd	0.11	nd	0.08	nd	0.21
8 deepcore 1	270	(8.5,6.5)	0.80-2.75	nd	0.05	nd	0.11	nd	0.07	nd	0.18
8 deepcore 1	270	(8.5,6.5)	2.75-3.50	nd	0.05	nd	0.08	nd	0.05	nd	0.18
8 deepcore 1	306	(6.0,5.0)	0.00-0.30	nd	0.17	nd	0.21	nd	0.14	nd	0.37
8 deepcore 3	318	(5.0,8.5)	0.00-0.30	0.86		nd	0.06	nd	0.04	nd	0.26
8 deepcore 3	318	(5.0,8.5)	0.30-0.60	3.05		0.17		nd	0.05	nd	0.36
8 deepcore 3	318	(4.5,6.0)	0.00-0.30	nd	0.04	nd	0.05	nd	0.04	nd	0.26
8 deepcore 3	318	(4.5,6.0)	0.30-0.60	0.07		nd	0.06	nd	0.04	nd	0.28
8 deepcore 3	318	(4.5,6.0)	0.60-0.90	4.77		nd	0.09	nd	0.06	nd	0.43
8 deepcore 3	318	(4.5,6.0)	0.90-1.20	2.10		nd	0.05	nd	0.04	nd	0.32
8 deepcore 3	318	(4.0,6.5)	0.00-0.30	nd	0.04	nd	0.07	nd	0.04	nd	0.23
8 deepcore 3	318	(4.0,6.5)	0.30-0.60	0.05		nd	0.05	nd	0.04	nd	0.26
8 deepcore 3	318	(4.0,6.5)	0.60-0.90	4.58		nd	0.07	nd	0.03	nd	0.38
8 deepcore 3	318	(4.0,6.5)	0.90-1.20	2.25		0.13		nd	0.05	nd	0.37
8 deepcore 3	318	(4.0,6.5)	1.20-1.40	0.84		nd	0.07	nd	0.04	nd	0.31
8 deepcore 3	318	(4.0,4.5)	0.00-0.30	nd	0.04	nd	0.06	nd	0.03	nd	0.25
8 deepcore 3	318	(4.0,4.5)	0.30-0.60	nd	0.05	nd	0.05	nd	0.04	nd	0.27
8 deepcore 3	318	(4.0,4.5)	0.60-0.90	5.29		nd	0.04	nd	0.05	nd	0.37
8 deepcore 3	318	(4.0,4.5)	0.90-1.20	1.00		nd	0.06	nd	0.05	nd	0.28
8 deepcore 3	318	(4.0,4.5)	1.20-1.50	0.60		nd	0.08	nd	0.04	nd	0.29
8 deepcore 3	318	(4.0,4.5)	1.50-1.80	0.15		nd	0.06	nd	0.04	nd	0.23
8 deepcore 3	318	(4.0,4.5)	1.80-2.10	nd	0.04	nd	0.04	nd	0.03	nd	0.23
8 deepcore 3	318	(8.0,6.0)	0.00-0.30	0.04		nd	0.05	nd	0.03	nd	0.20
8 deepcore 3	318	(8.0,6.0)	0.30-0.60	nd	0.03	nd	0.06	nd	0.02	nd	0.30
8 deepcore 3	318	(8.0,6.0)	0.60-0.90	nd	0.05	nd	0.06	nd	0.04	nd	0.30
8 deepcore 3	318	(8.0,6.0)	0.90-1.20	nd	0.05	nd	0.06	nd	0.03	nd	0.23
8 deepcore 3	318	(8.0,6.0)	1.20-1.50	nd	0.05	nd	0.06	nd	0.04	nd	0.26
8 deepcore 3	318	(8.0,6.0)	1.50-1.80	nd	0.04	nd	0.05	nd	0.03	nd	0.25
8 deepcore 3	318	(8.0,9.5)	0.00-0.30	nd	0.04	nd	0.04	nd	0.04	nd	0.27

^a nd indicates non detect, MDA provided

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Turbine/Service Building (cont.)											
8 deepcore 3	318	(8.0,9.5)	0.30-0.60	nd	0.04	nd	0.05	nd	0.04	nd	0.25
8 deepcore 3	318	(8.0,9.5)	0.60-0.90	0.10		nd	0.05	nd	0.05	nd	0.24
8 deepcore 3	318	(8.0,9.5)	0.90-1.20	0.10		nd	0.06	nd	0.04	nd	0.26
8 deepcore 3	318	(8.0,9.5)	1.20-1.50	nd	0.05	nd	0.06	nd	0.04	nd	0.26
8 deepcore 3	318	(8.0,9.5)	1.50-1.80	nd	0.04	nd	0.06	nd	0.04	nd	0.25
8 deepcore 3	318	(8.0,9.5)	1.80-2.10	nd	0.04	nd	0.05	nd	0.03	nd	0.25
8 deepcore 3	306	(4.5,1.5)	0.00-0.30	0.04		nd	0.06	nd	0.04	nd	0.27
8 deepcore 3	306	(4.5,1.5)	0.30-0.60	nd	0.06	nd	0.08	nd	0.05	nd	0.34
8 deepcore 3	318	(4.5,9.5)	0.00-0.30	nd	0.04	nd	0.05	nd	0.05	nd	0.26
8 deepcore 3	318	(4.5,9.5)	0.30-0.60	nd	0.05	nd	0.06	nd	0.04	nd	0.28
8 deepcore 3	306	(4.0,4.0)	0.00-0.30	0.14		nd	0.09	nd	0.05	nd	0.28
8 deepcore 3	306	(4.0,4.0)	0.30-0.60	0.06		nd	0.06	nd	0.04	nd	0.27
8 deepcore 3	306	(4.0,4.0)	0.60-0.90	1.16		nd	0.05	nd	0.04	nd	0.26
8 deepcore 3	306	(4.0,4.0)	0.90-1.20	0.55		nd	0.07	nd	0.04	nd	0.23
8 deepcore 3	306	(4.0,4.0)	1.20-1.50	0.19		nd	0.05	nd	0.03	nd	0.25
8 deepcore 3	306	(4.0,4.0)	1.50-1.80	0.06		nd	0.06	nd	0.04	nd	0.24
8 deepcore 3	306	(4.5,8.5)	0.00-0.30	0.04		nd	0.08	nd	0.05	nd	0.31
8 deepcore 3	306	(4.5,8.5)	0.30-0.60	nd	0.04	nd	0.06	nd	0.05	nd	0.27
8 deepcore 3	306	(4.5,8.5)	0.60-0.90	nd	0.05	nd	0.06	nd	0.04	nd	0.23
8 deepcore 3	306	(5.0,8.0)	0.00-0.30	nd	0.06	nd	0.06	nd	0.05	nd	0.28
8 deepcore 3	306	(5.0,8.0)	0.30-0.60	nd	0.05	nd	0.06	nd	0.04	nd	0.26
8 deepcore 3	306	(5.0,8.0)	0.60-0.90	nd	0.05	nd	0.05	nd	0.03	nd	0.28
8 deepcore 3	268	(6.5,2.5)	0.00-0.30	nd	0.05	nd	0.06	nd	0.04	nd	0.26
8 deepcore 3	268	(6.5,2.5)	0.30-0.60	nd	0.06	nd	0.05	nd	0.04	nd	0.26
8 deepcore 3	268	(6.5,2.5)	0.60-0.90	nd	0.04	nd	0.07	nd	0.04	nd	0.26
8 deepcore 3	268	(6.5,2.5)	0.90-1.20	nd	0.06	nd	0.06	nd	0.04	nd	0.26
8 deepcore 3	268	(6.5,2.5)	1.20-1.50	nd	0.05	nd	0.06	nd	0.04	nd	0.22
8 deepcore 3	268	(6.5,2.5)	1.50-1.80	nd	0.04	nd	0.09	nd	0.04	nd	0.24
8 deepcore 3	268	(6.5,2.5)	1.80-2.10	nd	0.04	nd	0.09	nd	0.05	nd	0.30
8 deepcore 3	268	(6.5,2.5)	2.10-2.40	nd	0.04	nd	0.06	nd	0.04	nd	0.27
8 deepcore 3	268	(5.0,2.5)	0.00-0.30	nd	0.04	nd	0.06	nd	0.03	nd	0.23
8 deepcore 3	268	(5.0,2.5)	0.30-0.60	nd	0.04	nd	0.06	nd	0.03	nd	0.25
8 deepcore 3	268	(5.0,2.5)	0.60-0.90	nd	0.05	nd	0.06	nd	0.04	nd	0.24

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^c Datapoint locations are further defined in individual survey file drawings and floor plans

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				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
Containment											
8 deepcore 4	193	(5.8,1.5)	0.00-0.15	nd	0.05	nd	0.08	nd	0.05	nd	0.29
8 deepcore 4	193	(5.8,1.5)	0.15-0.30	nd	0.03	nd	0.06	nd	0.03	nd	0.23
8 deepcore 4	193	(5.8,1.5)	0.30-0.45	nd	0.03	nd	0.05	nd	0.03	nd	0.22
8 deepcore 4	211	(2.7,5.0)	0.00-0.15	nd	0.06	nd	0.08	nd	0.06	nd	0.37
8 deepcore 4	211	(2.7,5.0)	0.15-0.30	nd	0.05	nd	0.07	nd	0.05	nd	0.29
8 deepcore 4	213	(3.2,2.2)	0.00-0.15	nd	0.04	nd	0.08	nd	0.04	nd	0.27
8 deepcore 4	214	(2.5,1.3)	0.00-0.15	nd	0.05	nd	0.08	nd	0.04	nd	0.30
8 deepcore 4	214	(2.5,1.3)	0.15-0.30	nd	0.04	nd	0.06	nd	0.04	nd	0.24
8 deepcore 4	214	(2.5,1.3)	0.30-0.45	nd	0.05	nd	0.07	nd	0.05	nd	0.25

^a nd Indicates non detect, MDA provided

^b No entry in the MDA column is provided when residual radioactivity is detected

^c Datapoint locations are further defined in individual survey file drawings and floor plans

Survey Unit 9

Description

Survey Unit 9 is an area of approximately 2900 m² that occupies the northeast section of the Protected Area. This area encompasses the Screenhouse (lake water inlet), Service Water System piping, and Fire Protection System piping. Other subsurface structures and equipment include the following:

- Diesel storage tanks (2) southeast of the Screen House,
- Diesel storage tank north of the Turbine Building),
- Septic tanks along the southeast boundary of the survey unit,
- Liquid radwaste release piping,
- Transformer station and associated underground power conduit located in survey grid 234, and
- Electrical power and instrumentation conduit, Condenser Cooling Water, Service Water, Well Water and Fire Protection, Compressed Air system piping, and storm drains.

History

The HSA has identified this survey unit to potentially contain residual radioactivity in area soils. A materials transport route to the main gate traverses this survey unit from north to south. The liquid radwaste discharge line for radioactive effluent is located below grade in this area.

Radiological Status

Residual radioactivity was not identified above background values trace values (0.33 pCi/g) in any survey performed in this area. Subsurface soil contamination is not indicated by the HSA or process knowledge and was not identified by characterization analyses. The radiological status of Survey Unit 9 is Class 1 based on proximity to the following area locations:

- Contaminated material transport pathways,
- Areas of known soil contamination,
- Buildings containing contaminated equipment and materials.

Primary Survey Design

1. Sample Data Points Required

The scoping survey resulted in the following data:

Nuclide identification	Cs-137
Mean value (pCi/g)	0.43
Standard deviation (σ)	0.00

Scoping survey analyses resulted in identical concentration values for Cs-137. An estimated standard deviation value of 0.43 is conservatively assumed for relative shift calculation. The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL.

$$\text{Relative Shift} = \frac{\text{DCGL} - \text{LBGR}}{\sigma} = \frac{5.11 - 2.5}{0.43} = 6.1$$

With α and β error levels set at 0.05 and an assumed relative shift of 3, the Sign Test requirements specify a sample size of 14 data points.

2. Sample Locations

Sample data point locations were selected in a random start, square grid pattern with the southwest corner of the survey unit as origin.

The approximate bounding dimensions of survey unit 9 are 40 x 60 meters

Random Numbers 0.52, 0.62

$X = (0.52)(40 \text{ m}) = 20.8 \text{ m}$

$Y = (0.62)(60 \text{ m}) = 37.2 \text{ m}$

$$\text{Sample Spacing } L = \sqrt{\text{Area}/N} = \sqrt{2900/14} = 14.3 \text{ meter spacing}$$

As a conservative measure 22 samples were collected using 11.8 meter spacing. For data points falling outside the survey unit or where obstructions prohibited sample collection, alternate sample locations were identified by the random selection process described above.

Supporting Surveys

One deep-core survey was conducted to investigate the potential presence of subsurface contamination. The maximum sample depth was approximately 2.25 meters. Sample point locations were judgmentally selected using historical documentation, process knowledge, and location availability based on subsurface obstructions.

Data Summary

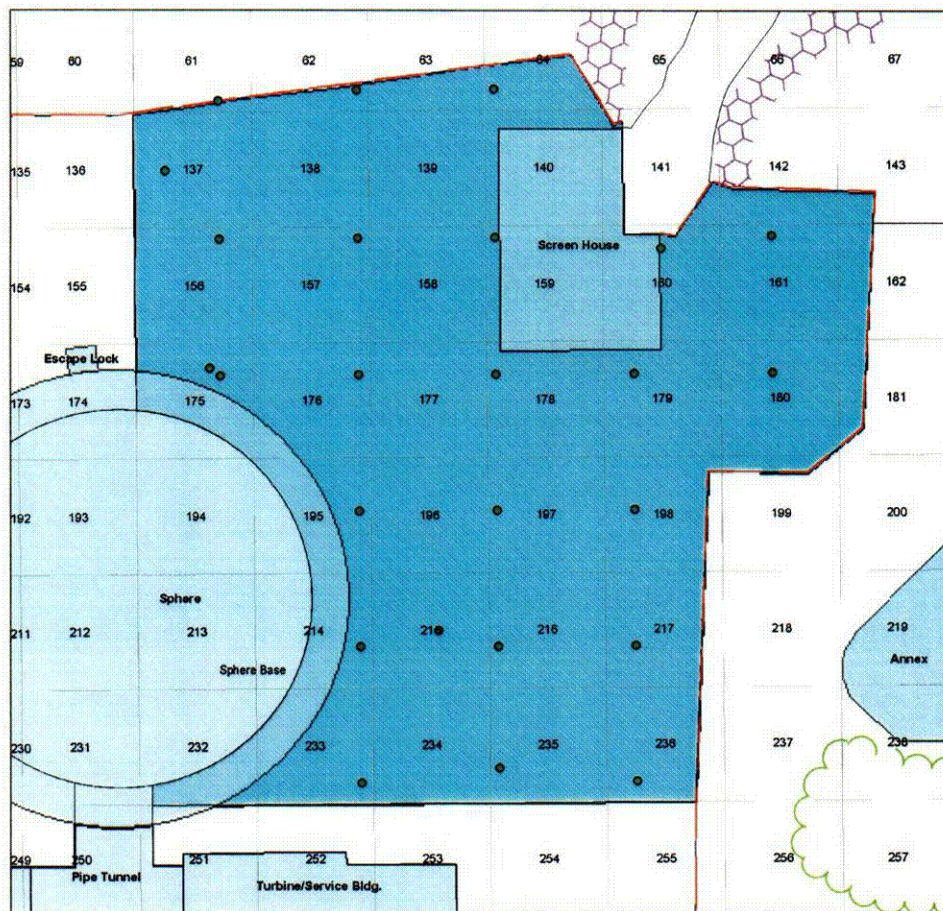
Survey Unit 9

Survey	No. of Samples	Radionuclides	Mean (pCi/g)	Max. Value (pCi/g)
9A ₁	22	Cs ₁₃₇	0.19	0.33
		Co ₆₀ **	0.04	0.04
9A _{deepcore1}	19	Cs ₁₃₇	0.09	0.14
		Co ₆₀	nd	-

* nd indicates no activity detected

** Activity detected in one sample only

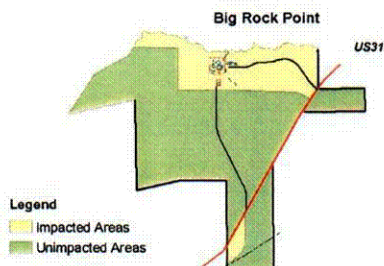
Survey Unit 9



Legend

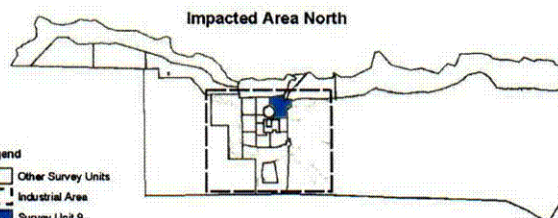
- Survey Unit 9
- Buildings
- Numbered Local Coordinate Grid
- Soil Sample Locations

Scale: 0 5 10 20 Meters



Legend

- Impacted Areas
- Unimpacted Areas



- Other Survey Units
- Industrial Area
- Survey Unit 9

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Survey Results

Survey	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
9A ₁	61	(7.2,1.8)	0.00-0.15	0.09		nd	0.10	nd	0.35
9A ₁	62	(9.0,1.8)	0.00-0.15	0.08		nd	0.04	nd	0.22
9A ₁	64	(0.8,1.8)	0.00-0.15	0.26		nd	0.12	nd	0.31
9A ₁	156	(7.2,9.0)	0.00-0.15	nd	0.08	nd	0.08	nd	0.40
9A ₁	157	(9.0,9.0)	0.00-0.15	nd	0.03	nd	0.04	nd	0.21
9A ₁	159	(0.8,9.0)	0.00-0.15	nd	0.09	nd	0.09	nd	0.42
9A ₁	160	(5.0,8.0)	0.00-0.15	0.20		nd	0.06	nd	0.24
9A ₁	161	(4.4,9.0)	0.00-0.15	0.17		nd	0.05	nd	0.25
9A ₁	175	(7.2,7.2)	0.00-0.15	0.29		nd	0.07	nd	0.25
9A ₁	176	(9.0,7.2)	0.00-0.15	0.23		nd	0.06	nd	0.26
9A ₁	178	(0.8,7.2)	0.00-0.15	nd	0.10	nd	0.08	nd	0.37
9A ₁	179	(2.6,7.2)	0.00-0.15	0.07		nd	0.04	nd	0.22
9A ₁	180	(4.4,7.2)	0.00-0.15	0.14		nd	0.04	nd	0.27
9A ₁	195	(9.0,5.4)	0.00-0.15	0.24		nd	0.06	nd	0.26
9A ₁	197	(0.8,5.4)	0.00-0.15	nd	0.10	nd	0.08	nd	0.42
9A ₁	198	(2.6,5.4)	0.00-0.15	0.13		0.04		nd	0.29
9A ₁	214	(9.0,3.6)	0.00-0.15	0.33		nd	0.06	nd	0.25
9A ₁	216	(0.8,3.6)	0.00-0.15	0.22		nd	0.10	nd	0.40
9A ₁	217	(2.6,3.6)	0.00-0.15	0.25		nd	0.06	nd	0.26
9A ₁	233	(9.0,1.8)	0.00-0.15	0.25		nd	0.11	nd	0.36
9A ₁	235	(0.8,3.0)	0.00-0.15	0.24		nd	0.07	nd	0.42
9A ₁	236	(2.6,1.8)	0.00-0.15	0.11		nd	0.11	nd	0.43
9A _{deepcore1}	137	(2.6,4.9)	0.00-0.60	0.03		nd	0.05	nd	0.21
9A _{deepcore1}	137	(2.6,4.9)	0.60-1.20	nd	0.04	nd	0.05	nd	0.21
9A _{deepcore1}	137	(2.6,4.9)	1.20-1.80	nd	0.05	nd	0.09	nd	0.36
9A _{deepcore1}	137	(2.6,4.9)	1.80-2.40	nd	0.04	nd	0.11	nd	0.34
9A _{deepcore1}	137	(2.6,4.9)	2.40-3.00	nd	0.08	nd	0.11	nd	0.27
9A _{deepcore1}	137	(2.6,4.9)	3.00-3.60	nd	0.08	nd	0.10	nd	0.43
9A _{deepcore1}	175	(6.3,7.9)	0.00-0.60	0.14		nd	0.10	nd	0.41
9A _{deepcore1}	175	(6.3,7.9)	0.60-1.20	nd	0.09	nd	0.11	nd	0.42
9A _{deepcore1}	175	(6.3,7.9)	1.20-1.80	nd	0.08	nd	0.07	nd	0.26
9A _{deepcore1}	175	(6.3,7.9)	1.80-2.40	nd	0.07	nd	0.08	nd	0.41
9A _{deepcore1}	175	(6.3,7.9)	2.40-3.00	nd	0.07	nd	0.09	nd	0.29
9A _{deepcore1}	175	(6.3,7.9)	3.00-3.60	nd	0.04	nd	0.05	nd	0.26
9A _{deepcore1}	175	(6.3,7.9)	3.60-4.10	nd	0.08	nd	0.13	nd	0.42
9A _{deepcore1}	215	(5.7,5.0)	0.00-0.60	c					
9A _{deepcore1}	215	(5.7,5.0)	0.60-1.20	nd	0.07	nd	0.03	nd	0.34
9A _{deepcore1}	215	(5.7,5.0)	1.20-1.80	nd	0.08	nd	0.09	nd	0.29

^a nd indicates non detect, MDA provided

^b No entry in the MDA column is provided when residual radioactivity is detected

^c Sample was not obtained for analysis (surface gravel)

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				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
9A _{deepcore1}	215	(5.7,5.0)	1.80-2.40	nd	0.07	nd	0.10	nd	0.37
9A _{deepcore1}	215	(5.7,5.0)	2.40-3.00	nd	0.04	nd	0.06	nd	0.24
9A _{deepcore1}	215	(5.7,5.0)	3.00-3.60	nd	0.06	nd	0.12	nd	0.44
9A _{deepcore1}	215	(5.7,5.0)	3.60-11.2	nd	0.02	nd	0.04	nd	0.18

^a nd indicates non detect, MDA provided

^b No entry in the MDA column is provided when residual radioactivity is detected

Survey Unit 10

Description

Survey Unit 10 is a relatively small area of approximately 950 m² immediately east of the Service Building. This survey unit is primarily paved open space that provides entry into the Protected Area. Subsurface structures and equipment include the following systems, piping, and conduit:

- Liquid Radwaste discharge,
- Electrical power and instrumentation,
- Condenser Cooling Water,
- Service Water,
- Well Water,
- Fire Protection,
- Compressed Air, and
- Storm drains.

History

The HSA has identified this survey unit to potentially contain residual radioactivity in area soils. A materials transfer route to the main entry gate traverses this survey unit from north to south.

Radiological Status

Residual radioactivity was not identified above background levels in any survey performed in this area. Subsurface residual radioactivity is not indicated by the HSA or process knowledge. The radiological status of Survey Unit 10 is Class 1 based on proximity to the following area locations:

- Contaminated material transport pathways,
- Areas of known soil contamination, and
- Buildings containing contaminated equipment and materials

Primary Survey Design

1. Sample Data Points Required

A scoping survey was not conducted in this area. Based on physical characteristics, historical documentation and the process knowledge of land usage for this area, Survey Unit 10 is identical to the adjoining survey units (7 and 9) within the Protected Area. The standard deviation for determination of relative shift was set at the highest value identified (0.43) in the surrounding area. The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL.

$$\text{Relative Shift} = \frac{\text{DCGL} - \text{LBGR}}{\sigma} = \frac{5.11 - 2.5}{0.43} = 6.1$$

With α and β error levels set at 0.05 and an assumed relative shift of 3, the Sign Test requirements specify a sample size of 14 data points.

2. Sample Locations

Sample data point locations were selected in a random start, square grid pattern with the southwest corner of the survey unit as origin.

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The approximate bounding dimensions of Survey Unit 10 are 20 x 40 meters
Random Numbers 0.07, 0.97
 $X = (0.07)(20 \text{ m}) = 1.4 \text{ m}$
 $Y = (0.97)(40 \text{ m}) = 38.8 \text{ m}$

$$\text{Sample Spacing } L = \sqrt{\text{Area}/N} = \sqrt{950/14} = 8.2 \text{ meter spacing}$$

As a conservative measure 21 samples were collected using 7.1 meter spacing.

Supporting Surveys

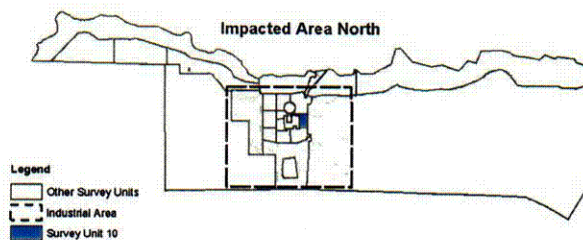
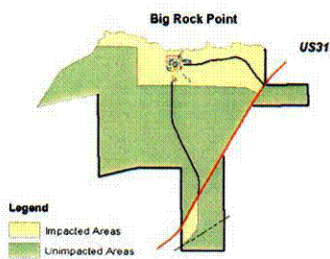
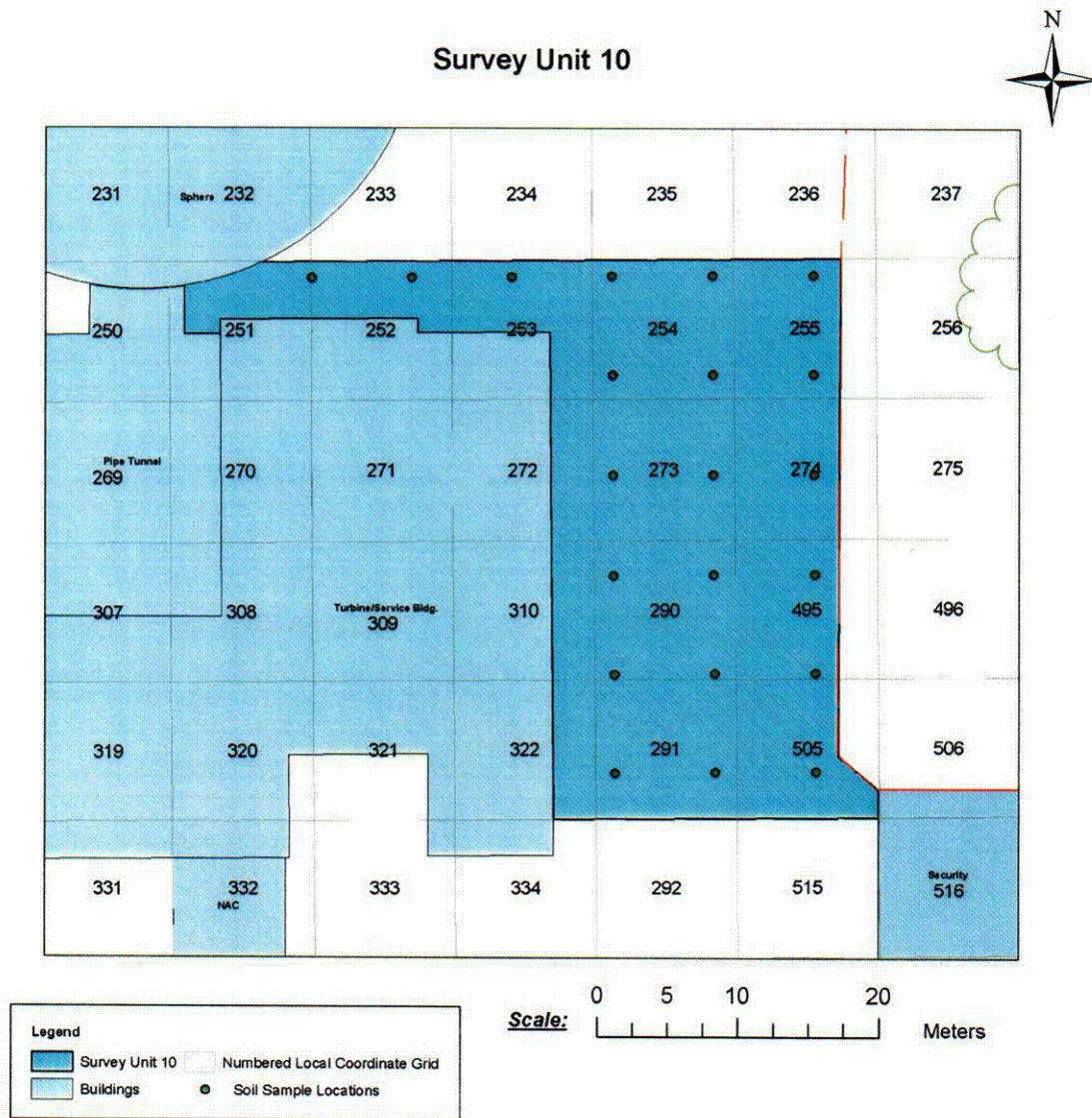
No supporting surveys have been conducted to date.

Data Summary

Survey Unit 10

Survey	No. of Samples	Radionuclides*	Mean (pCi/g)	Max. Value (pCi/g)
10A ₁	21	Cs ₁₃₇	0.22	0.52

* nd indicates non detect



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Survey Results

Survey	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
10A ₁	252	(0.1,8.8)	0.00-0.15	nd	0.03	nd	0.04	nd	0.20
10A ₁	252	(7.2,8.8)	0.00-0.15	nd	0.03	nd	0.05	nd	0.19
10A ₁	253	(4.3,8.8)	0.00-0.15	nd	0.04	nd	0.04	nd	0.19
10A ₁	254	(1.4,8.8)	0.00-0.15	nd	0.04	nd	0.05	nd	0.19
10A ₁	254	(8.5,8.8)	0.00-0.15	0.03		nd	0.04	nd	0.20
10A ₁	255	(5.6,8.8)	0.00-0.15	0.30		nd	0.07	nd	0.22
10A ₁	254	(1.4,1.7)	0.00-0.15	0.36		nd	0.07	nd	0.26
10A ₁	254	(8.5,1.7)	0.00-0.15	nd	0.04	nd	0.05	nd	0.24
10A ₁	255	(5.6,1.7)	0.00-0.15	0.52		nd	0.08	nd	0.36
10A ₁	273	(1.4,4.6)	0.00-0.15	nd	0.04	nd	0.05	nd	0.17
10A ₁	273	(8.5,4.6)	0.00-0.15	nd	0.04	nd	0.04	nd	0.17
10A ₁	274	(5.6,4.6)	0.00-0.15	nd	0.06	nd	0.06	nd	0.38
10A ₁	290	(1.4,7.5)	0.00-0.15	nd	0.04	nd	0.04	nd	0.20
10A ₁	290	(8.5,7.5)	0.00-0.15	nd	0.05	nd	0.05	nd	0.18
10A ₁	495	(5.6,7.5)	0.00-0.15	0.06		nd	0.05	nd	0.22
10A ₁	290	(1.4,0.4)	0.00-0.15	nd	0.03	nd	0.05	nd	0.17
10A ₁	290	(8.5,0.4)	0.00-0.15	nd	0.04	nd	0.04	nd	0.22
10A ₁	495	(5.6,0.4)	0.00-0.15	nd	0.04	nd	0.05	nd	0.24
10A ₁	291	(1.4,3.3)	0.00-0.15	nd	0.05	nd	0.05	nd	0.22
10A ₁	291	(8.5,3.3)	0.00-0.15	nd	0.05	nd	0.04	nd	0.18
10A ₁	505	(5.6,3.3)	0.00-0.15	0.02		nd	0.05	nd	0.14

^a nd indicates non detect, MDA provided

^b No entry in the MDA column is provided when residual radioactivity is detected

Survey Unit 11

Description

Survey Unit 11 is an area of approximately 2350 m² located south of the Protected Area. This location encompasses the Radwaste Building and Mixed Low-Level Waste Storage Building. Subsurface structures and equipment include the following:

- Radwaste storage vaults,
- Electrical power and fiber optic conduit,
- Drain piping, and
- Remote security camera and motion sensor relay communication.

History

The HSA has identified this survey unit to potentially contain residual radioactivity in soil. This area was the temporary storage and staging location for all plant radioactive waste material prior to shipment to a licensed disposal facility. Contamination events have occurred in this area and extensive soil remediation efforts have been documented.

Radiological Status

Residual radioactivity was identified at less than 1.0 pCi/g in this survey area. The radiological status of Survey Unit 11 is Class 1 based on former building usage, proximity to material transport pathways, and the current radiological status of the solid radwaste vaults.

Primary Survey Design

1. Sample Data Points Required

The scoping survey resulted in the following data:

Nuclide Identification	Cs-137	Co-60
Mean value (pCi/g)	0.16	0.10
Standard deviation (σ)	0.27	0.06

Applying the Unity Rule,

$$\sigma = \sqrt{\left(\frac{\sigma_{Cs}}{DCGL_{Cs}}\right)^2 + \left(\frac{\sigma_{Co}}{DCGL_{Co}}\right)^2} = \sqrt{\left(\frac{0.27_{Cs}}{5.11_{Cs}}\right)^2 + \left(\frac{0.06_{Co}}{4.99_{Co}}\right)^2}$$
$$\sigma = 0.05$$

For the Unity Rule, the DCGL for the weighted sum is 1. The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL.

$$\text{Relative Shift} = \frac{DCGL - LBGR}{\sigma} = \frac{1 - 0.5}{0.05} = 10$$

With α and β error levels set at 0.05 and an assumed relative shift of 3, the Sign Test requirements specify a sample size of 14 data points.

2. Sample Locations

Sample data point locations were selected in a random start, square grid pattern with the southwest corner of the survey unit as origin.

Bounding survey unit dimensions 50 X 60 meters

Random Numbers 0.186, 0.004

$X = (0.186)(50 \text{ m}) = 23.6 \text{ m}$

$Y = (0.004)(60 \text{ m}) = 49.5 \text{ m}$

$$\text{Sample Spacing } L = \sqrt{\text{Area}/N} = \sqrt{2350/14} = 12.9 \text{ meters}$$

As a conservative measure 25 samples were collected using 11 meter spacing.

Supporting Surveys

Two deep-core surveys were conducted for the investigation of potential subsurface contamination. These surveys include samples collected through the concrete flooring in proximity the radwaste vaults and split spoon samples taken in open areas surrounding the Radwaste Building. The maximum sample depth was approximately 1.8 meters. Sample point locations were judgmentally selected based on historical documentation, process knowledge, and location availability where subsurface obstructions were not present.

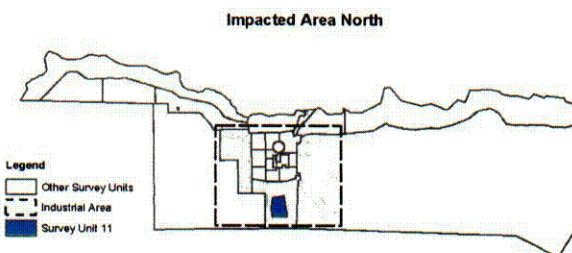
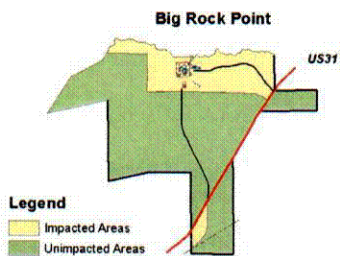
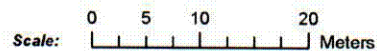
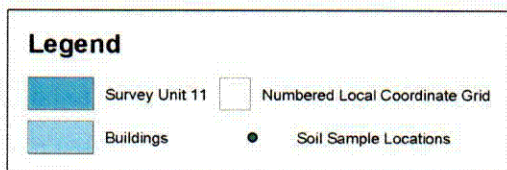
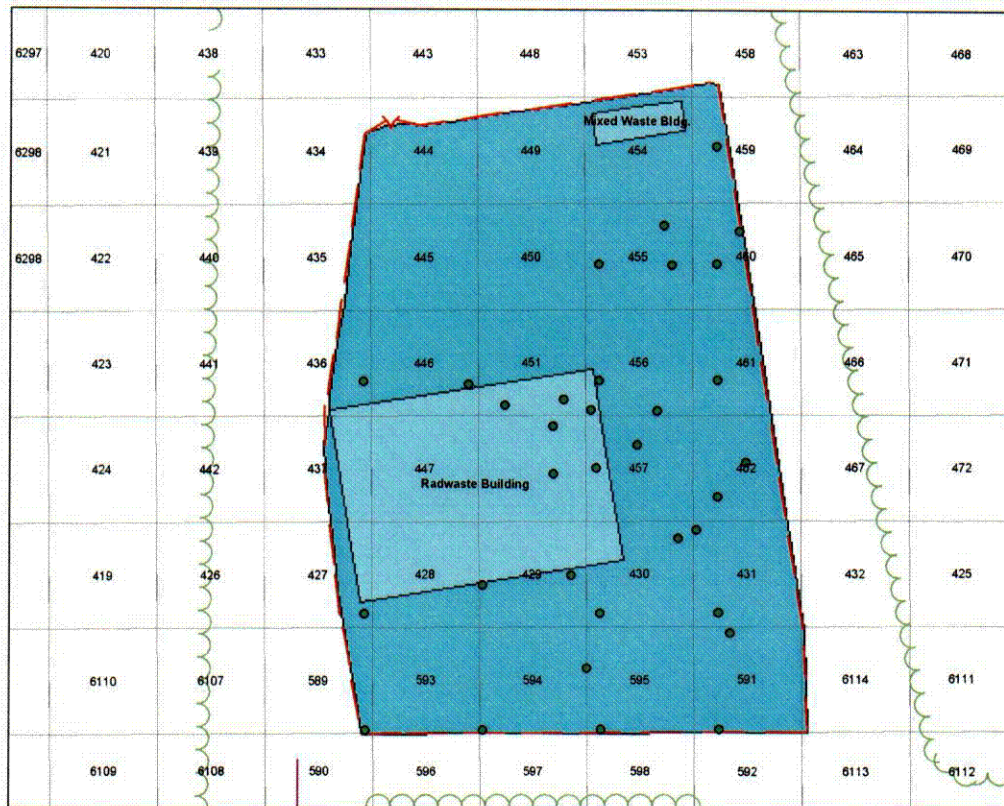
Data Summary

Survey Unit 11

Survey	No. of Samples	Radionuclides	Mean (pCi/g)	Max. Value (pCi/g)
11A ₁	25	Cs ₁₃₇	0.17	0.40
		Co ₆₀ *	0.48	0.64
11A _{deepcore1}	6	Cs ₁₃₇ *	0.28	0.43
11A _{deepcore2}	33	Cs ₁₃₇	0.09	0.93
		Co ₆₀ *	0.19	0.24

*Radioactivity identified in 2 samples only

Survey Unit 11



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Survey Results

Survey	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
11A ₁	589	(9.3,0.3)	0.00-0.15	nd	0.04	nd	0.05	nd	0.19
11A ₁	594	(0.3,0.3)	0.00-0.15	nd	0.04	nd	0.04	nd	0.26
11A ₁	595	(1.3,0.3)	0.00-0.15	0.05		nd	0.06	nd	0.25
11A ₁	591	(2.3,0.3)	0.00-0.15	0.11		nd	0.09	nd	0.28
11A ₁	431	(2.3,1.3)	0.00-0.15	nd	0.06	nd	0.05	nd	0.23
11A ₁	430	(1.3,1.3)	0.00-0.15	0.24		nd	0.05	nd	0.28
11A ₁	429	(0.3,4.0)	0.00-0.15	0.17		nd	0.07	nd	0.24
11A ₁	427	(9.3,1.3)	0.00-0.15	nd	0.04	nd	0.04	nd	0.19
11A ₁	462	(2.3,2.3)	0.00-0.15	0.18		nd	0.06	nd	0.28
11A ₁	461	(2.3,3.3)	0.00-0.15	0.18		nd	0.09	nd	0.28
11A ₁	456	(1.3,3.3)	0.00-0.15	0.07		nd	0.05	nd	0.23
11A ₁	460	(2.3,4.3)	0.00-0.15	0.16		nd	0.06	nd	0.28
11A ₁	455	(1.3,4.3)	0.00-0.15	0.14		nd	0.06	nd	0.30
11A ₁	459	(2.3,5.3)	0.00-0.15	0.12		nd	0.06	nd	0.28
11A ₁	436	(9.3,3.3)	0.00-0.15	0.39		0.64		nd	0.32
11A ₁	429	(8.6,4.9)	0.00-0.15	0.22		nd	0.08	nd	0.24
11A ₁	430	(8.6,8.4)	0.00-0.15	0.10		nd	0.07	nd	0.27
11A ₁	455	(7.4,7.9)	0.00-0.15	0.12		nd	0.07	nd	0.25
11A ₁	460	(4.4,7.3)	0.00-0.15	0.10		nd	0.07	nd	0.23
11A ₁	455	(8.1,4.2)	0.00-0.15	0.13		nd	0.06	nd	0.28
11A ₁	446	(9.1,3.0)	0.00-0.15	0.18		0.31		nd	0.28
11A ₁	591	(3.4,9.4)	0.00-0.15	0.15		nd	0.06	nd	0.24
11A ₁	462	(4.9,5.5)	0.00-0.15	0.40		nd	0.09	nd	0.30
11A ₁	457	(4.8,7.2)	0.00-0.15	0.25		nd	0.08	nd	0.28
11A ₁	595	(0.0,6.1)	0.00-0.15	0.20		nd	0.06	nd	0.28
11A _{deepcore1}	456	(6.7,0.4)	0.00-0.30	nd	0.14	nd	0.13	nd	0.43
11A _{deepcore1}	456	(6.7,0.4)	0.60-1.20	0.43		nd	0.06	nd	0.22
11A _{deepcore1}	456	(6.7,0.4)	1.20-1.80	0.12		nd	0.07	nd	0.39
11A _{deepcore1}	431	(0.3,9.2)	0.00-0.90	nd	0.15	nd	0.13	nd	0.41
11A _{deepcore1}	431	(0.3,9.2)	0.90-1.20	nd	0.10	nd	0.10	nd	0.41
11A _{deepcore1}	431	(0.3,9.2)	1.20-1.80	nd	0.08	nd	0.11	nd	0.34
11A _{deepcore2}	451	(2.5,1.0)	0.00-0.30	nd	0.04	nd	0.06	nd	0.24
11A _{deepcore2}	451	(2.5,1.0)	0.30-0.60	nd	0.05	nd	0.06	nd	0.22
11A _{deepcore2}	451	(2.5,1.0)	0.60-0.90	nd	0.04	nd	0.04	nd	0.24
11A _{deepcore2}	451	(2.5,1.0)	0.90-1.20	0.07		nd	0.05	nd	0.24
11A _{deepcore2}	451	(2.5,1.0)	1.20-1.50	nd	0.04	nd	0.05	nd	0.20
11A _{deepcore2}	451	(2.5,1.0)	1.50-1.80	nd	0.04	nd	0.04	nd	0.23
11A _{deepcore2}	451	(8.0,1.5)	0.00-0.30	0.05		nd	0.07	nd	0.22
11A _{deepcore2}	451	(8.0,1.5)	0.30-0.60	0.06		nd	0.06	nd	0.23
11A _{deepcore2}	451	(8.0,1.5)	0.60-0.90	0.06		nd	0.05	nd	0.25
11A _{deepcore2}	451	(8.0,1.5)	0.90-1.20	0.05		nd	0.06	nd	0.25
11A _{deepcore2}	456	(0.5,0.5)	0.00-0.30	0.93		0.24		nd	0.35
11A _{deepcore2}	456	(0.5,0.5)	0.30-0.60	0.02		0.14		nd	0.22
11A _{deepcore2}	456	(0.5,0.5)	0.60-0.90	0.10		nd	0.05	nd	0.27
11A _{deepcore2}	456	(0.5,0.5)	0.90-1.20	0.05		nd	0.06	nd	0.23
11A _{deepcore2}	456	(0.5,0.5)	1.20-1.50	0.06		nd	0.06	nd	0.20
11A _{deepcore2}	457	(1.0,5.0)	0.00-0.30	0.05		nd	0.06	nd	0.25

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				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
11Adeepcore2	457	(1.0,5.0)	0.30-0.60	0.04		nd	0.07	nd	0.24
11Adeepcore2	457	(1.0,5.0)	0.60-0.90	0.05		nd	0.07	nd	0.23
11Adeepcore2	457	(1.0,5.0)	0.90-1.20	0.05		nd	0.07	nd	0.25
11Adeepcore2	457	(1.0,5.0)	1.20-1.50	nd	0.05	nd	0.05	nd	0.25
11Adeepcore2	457	(1.0,5.0)	1.50-1.80	0.04		nd	0.05	nd	0.18
11Adeepcore2	452	(7.0,4.5)	0.00-0.30	0.04		nd	0.06	nd	0.26
11Adeepcore2	452	(7.0,4.5)	0.30-0.60	nd	0.05	nd	0.06	nd	0.25
11Adeepcore2	452	(7.0,4.5)	0.60-0.90	nd	0.04	nd	0.04	nd	0.20
11Adeepcore2	452	(7.0,4.5)	0.90-1.20	0.05		nd	0.04	nd	0.23
11Adeepcore2	452	(7.0,4.5)	1.20-1.50	0.06		nd	0.05	nd	0.21
11Adeepcore2	452	(7.0,4.5)	1.50-1.80	0.03		nd	0.05	nd	0.21
11Adeepcore2	452	(7.0,9.0)	0.00-0.30	0.07		nd	0.07	nd	0.28
11Adeepcore2	452	(7.0,9.0)	0.30-0.60	0.06		nd	0.07	nd	0.32
11Adeepcore2	452	(7.0,9.0)	0.60-0.90	nd	0.06	nd	0.08	nd	0.25
11Adeepcore2	452	(7.0,9.0)	0.90-1.20	0.07		nd	0.06	nd	0.24
11Adeepcore2	452	(7.0,9.0)	1.20-1.50	nd	0.05	nd	0.05	nd	0.20
11Adeepcore2	452	(7.0,9.0)	1.50-1.80	nd	0.04	nd	0.05	nd	0.21

^a nd indicates non detect, MDA provided

^b No entry in the MDA column is provided when residual radioactivity is detected

Survey Unit 12

Description

Survey Unit 12 is an area of approximately 9800 m² located immediately north of the Protected Area fence along the Lake Michigan shoreline. No buildings have been located in this area. Survey Unit 12 is bound to the east by the discharge canal and encompasses the rip-rap breakwater. Subsurface structures and equipment include storm drain lines, electrical conduit, and septic system piping.

History

The discharge canal has been dredged on several occasions in plant history to maintain water depth and flow characteristics against the sand build-up that results from current and wave action. The HSA has identified residual radioactivity in Survey Unit 12 soil that is believed to originate from the placement of dredging spoils in the beach area.

Radiological Status

Residual radioactivity was identified in a several samples within this survey unit. Although trace values of Mn-54 were identified in two of the scoping survey samples used for design of the primary survey, Mn-54 was not identified in any subsequent characterization survey conducted in Survey Unit 12. Residual radioactivity in subsurface soil was not identified by deep core sample analyses. The radiological status of this survey unit is Class 2.

Primary Survey Design

1. Sample Data Points Required

The scoping survey resulted in the following data:

Nuclide identification	Cs-137	Co-60	Mn-54
Mean value (pCi/g)	0.61	0.31	0.05
Standard Deviation (σ)	0.51	0.64	0.05

Applying the Unity Rule,

$$\sigma = \sqrt{\left(\frac{\sigma_{Cs}}{5.11_{Cs}}\right)^2 + \left(\frac{\sigma_{Co}}{4.99_{Co}}\right)^2 + \left(\frac{\sigma_{Mn}}{474_{Mn}}\right)^2} =$$
$$\sigma = \sqrt{\left(\frac{0.51}{5.11_{Cs}}\right)^2 + \left(\frac{0.64}{4.99_{Co}}\right)^2 + \left(\frac{0.05}{474_{Mn}}\right)^2}$$

$$\sigma = 0.16$$

For the Unity Rule the DCGL for the weighted sum is 1. The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL.

$$\text{Relative Shift} = \frac{DCGL - LBGR}{\sigma} = \frac{1 - 0.5}{0.16} = 3.1$$

With α and β error levels set at 0.05 and an assumed relative shift of 3, the Sign Test requirements specify a sample size of 14 data points.

2. Sample Locations

Sample locations were systematically selected in a random start, square grid pattern with the southwest corner of the survey unit as origin.

Bounding survey unit dimensions 160 x 70 meters

Random Numbers 0.482449, 0.413809

$X = (0.482449)(160 \text{ m}) = 77.2 \text{ meters}$

$Y = (0.413809)(70 \text{ m}) = 29.0 \text{ meters}$

$$\text{Sample Spacing } L = \sqrt{\frac{\text{Area}}{N}} = \sqrt{\frac{9800}{14}} = 26 \text{ meters}$$

As a conservative measure, 25 samples were collected using 21.2 meter spacing.

Supporting Surveys

Surface soil survey 12A₁ was conducted to further investigate the bound of potential contamination resulting from the contour grading of dredge spoils in this area. Deep-core sampling was performed in three survey efforts to investigate the extent of potential subsurface contamination. The maximum sample depth was approximately 3.6 meters. Sample point locations were judgmentally selected based on historical data, process knowledge, and location availability due to subsurface obstruction. Survey 12A_{gpr} was performed in association with the GPR (ground penetrating radar) investigation of possible buried legacy material in this area.

Data Summary

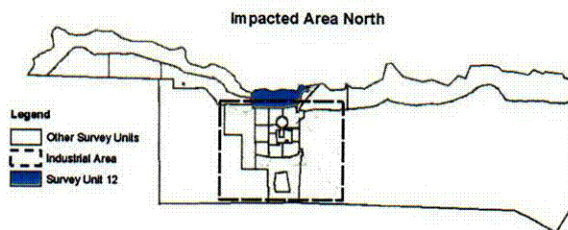
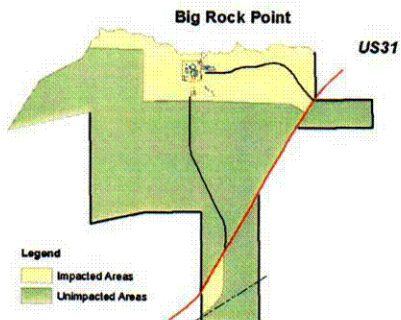
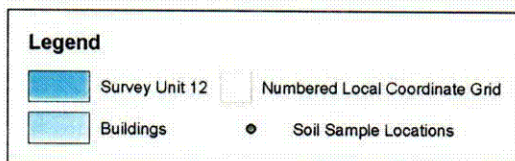
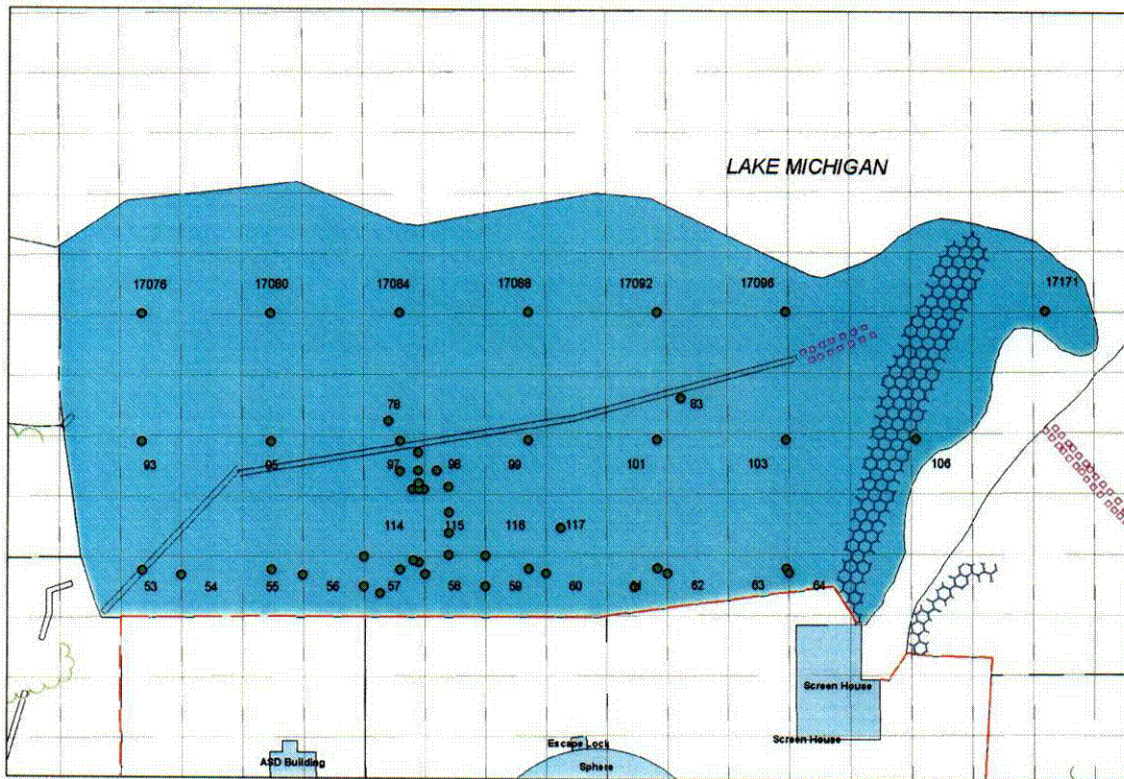
Survey Unit 12

Survey	No. of Samples	Radionuclides	Mean (pCi/g)	Max. Value (pCi/g)
12A ₁	18	Cs ₁₃₇	0.61	1.83
12A ₂	25	Cs ₁₃₇	0.26	1.48
		Co ₆₀ *	0.16	0.18
12A _{deepcore1}	4	Cs ₁₃₇ **	0.08	0.08
12A _{deepcore2}	4	Cs ₁₃₇	0.52	1.56
12A _{deepcore3}	15	Cs ₁₃₇	0.12	0.20
12A _{gpr}	4	Cs ₁₃₇	0.25	0.29

* Co-60 detected in 2 samples only

** Cs-137 detected in 1 sample only

Survey Unit 12



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Survey Results

Survey	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	Activity ^a	MDA ^b	Activity ^a
12A ₁	57	(0.0,5.0)	0.00-0.15	0.13		nd	0.05	nd	0.20
12A ₁	57	(9.0,9.0)	0.00-0.15	0.21		nd	0.04	nd	0.24
12A ₁	57	(9.0,9.0)	0.15-0.30	0.08		nd	0.05	nd	0.23
12A ₁	59	(0.0,5.0)	0.00-0.15	0.21		nd	0.04	nd	0.24
12A ₁	97	(6.0,4.0)	0.00-0.15	0.44		nd	0.06	nd	0.24
12A ₁	97	(8.0,1.0)	0.00-0.15	1.83		nd	0.06	nd	0.32
12A ₁	97	(9.0,1.0)	0.00-0.15	1.38		nd	0.09	nd	0.32
12A ₁	97	(9.0,1.0)	0.15-0.30	1.38		nd	0.06	nd	0.30
12A ₁	97	(9.0,1.0)	0.30-0.45	1.18		nd	0.06	nd	0.28
12A ₁	97	(9.0,1.0)	0.45-0.60	0.43		nd	0.05	nd	0.21
12A ₁	97	(9.0,1.0)	0.60-0.75	0.29		nd	0.05	nd	0.18
12A ₁	97	(9.0,4.0)	0.00-0.30	0.32		nd	0.04	nd	0.17
12A ₁	97	(9.0,7.0)	0.00-0.15	0.11		nd	0.04	nd	0.17
12A ₁	97	(9.0,7.0)	0.15-0.30	0.15		nd	0.04	nd	0.14
12A ₁	98	(0.0,1.0)	0.00-0.15	1.37		nd	0.07	nd	0.32
12A ₁	98	(2.0,4.0)	0.00-0.15	0.91		nd	0.05	nd	0.19
12A ₁	116	(0.0,0.0)	0.00-0.15	0.32		nd	0.06	nd	0.24
12A ₁	114	(0.0,0.0)	0.00-0.15	0.17		nd	0.05	nd	0.19
12A ₂	53	(3.6,7.8)	0.00-0.15	0.32		nd	0.06	nd	0.33
12A ₂	93	(3.6,9.0)	0.00-0.15	0.19		nd	0.02	nd	0.16
12A ₂	17076	(3.6,0.2)	0.00-0.15	0.08		nd	0.06	nd	0.26
12A ₂	55	(4.8,7.8)	0.00-0.15	0.11		nd	0.06	nd	0.24
12A ₂	95	(4.8,9.0)	0.00-0.15	0.12		nd	0.03	nd	0.20
12A ₂	17080	(4.8,0.2)	0.00-0.15	0.15		nd	0.06	nd	0.27
12A ₂	57	(6.0,7.8)	0.00-0.15	0.20		nd	0.06	nd	0.25
12A ₂	97	(6.0,9.0)	0.00-0.15	0.14		nd	0.05	nd	0.21
12A ₂	17084	(6.0,0.2)	0.00-0.15	0.04		nd	0.05	nd	0.29
12A ₂	59	(7.2,7.8)	0.00-0.15	0.20		nd	0.05	nd	0.27
12A ₂	99	(7.2,9.0)	0.00-0.15	0.19		nd	0.04	nd	0.20
12A ₂	17088	(7.2,0.2)	0.00-0.15	0.18		nd	0.06	nd	0.24
12A ₂	61	(8.4,7.8)	0.00-0.15	0.28		nd	0.07	nd	0.30
12A ₂	101	(8.4,9.0)	0.00-0.15	0.16		nd	0.05	nd	0.20
12A ₂	17092	(8.4,0.2)	0.00-0.15	0.07		nd	0.04	nd	0.21
12A ₂	63	(9.6,7.8)	0.00-0.15	0.19		nd	0.06	nd	0.25
12A ₂	103	(9.6,9.0)	0.00-0.15	0.21		nd	0.04	nd	0.22
12A ₂	17096	(9.6,0.2)	0.00-0.15	0.19		nd	0.07	nd	0.25
12A ₂	106	(0.8,9.0)	0.00-0.15	nd	0.07	0.14		nd	0.28
12A ₂	17171	(2.0,0.2)	0.00-0.15	1.48		0.18		nd	0.28
12A ₂	61	(4.6,4.8)	0.00-0.15	nd	0.06	nd	0.05	nd	0.27
12A ₂	83	(2.3,5.9)	0.00-0.15	0.15		nd	0.04	nd	0.22
12A ₂	117	(2.5,4.5)	0.00-0.15	0.89		nd	0.05	nd	0.31
12A ₂	57	(2.6,3.9)	0.00-0.15	0.28		nd	0.06	nd	0.26
12A ₂	78	(4.1,2.3)	0.00-0.15	0.16		nd	0.04	nd	0.20

^a nd indicates non detect, MDA provided

^b No entry in the MDA column is provided when residual radioactivity is detected

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Survey	Grid	Coordinate	Depth (meters)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
12A _{deepcore1}	57	(8.1,9.3)	0.00-0.60	0.08		nd	0.08	nd	0.36
12A _{deepcore1}	57	(8.1,9.3)	0.60-1.80	nd	0.12	nd	0.09	nd	0.40
12A _{deepcore1}	57	(8.1,9.3)	1.80-3.00	nd	0.04	nd	0.04	nd	0.18
12A _{deepcore1}	57	(8.1,9.3)	3.00-3.60	nd	0.04	nd	0.06	nd	0.21
12A _{deepcore2}	97	(9.0,2.0)	0.00-0.60	1.56		nd	0.06	nd	0.27
12A _{deepcore2}	97	(9.0,2.0)	0.60-1.50	0.20		nd	0.07	nd	0.28
12A _{deepcore2}	97	(9.0,2.0)	2.40-3.30	0.21		nd	0.05	nd	0.23
12A _{deepcore2}	97	(9.0,2.0)	3.30-4.05	0.11		nd	0.04	nd	0.18
12A _{deepcore3}	54	(0.0,7.0)	0.00-0.30	nd	0.05	nd	0.05	nd	0.24
12A _{deepcore3}	54	(0.0,7.0)	0.30-0.60	0.03		nd	0.05	nd	0.27
12A _{deepcore3}	56	(0.0,7.0)	0.00-0.30	0.20		nd	0.05	nd	0.26
12A _{deepcore3}	56	(0.0,7.0)	0.30-0.60	0.16		nd	0.06	nd	0.24
12A _{deepcore3}	58	(0.0,7.0)	0.00-0.30	0.12		nd	0.06	nd	0.26
12A _{deepcore3}	58	(0.0,7.0)	0.30-0.60	0.10		nd	0.05	nd	0.22
12A _{deepcore3}	60	(0.0,7.0)	0.00-0.30	0.19		nd	0.05	nd	0.27
12A _{deepcore3}	60	(0.0,7.0)	0.30-0.60	0.11		nd	0.05	nd	0.25
12A _{deepcore3}	60	(0.0,7.0)	0.60-0.90	0.12		nd	0.06	nd	0.25
12A _{deepcore3}	62	(0.0,7.0)	0.00-0.30						
12A _{deepcore3}	62	(0.0,7.0)	0.30-0.60	nd	0.06	nd	0.05	nd	0.27
12A _{deepcore3}	64	(0.0,7.0)	0.00-0.30	nd	0.06	nd	0.06	nd	0.29
12A _{deepcore3}	64	(0.0,7.0)	0.30-0.60	0.12		nd	0.06	nd	0.23
12A _{deepcore3}	64	(0.0,7.0)	0.60-0.90	0.08		nd	0.05	nd	0.26
12A _{deepcore3}	64	(0.0,7.0)	0.90-1.20	0.05		nd	0.05	nd	0.26
12A _{gpr}	98	(4.0,1.3)	1.20-1.50	0.29		nd	0.03	nd	0.19
12A _{gpr}	115	(4.0,7.1)	1.20-1.50	0.20		nd	0.06	nd	0.26
12A _{gpr}	115	(4.0,3.7)	1.20-1.50	nd	0.05	nd	0.06	nd	0.25
12A _{gpr}	115	(4.0,0.1)	1.20-1.50	nd	0.04	nd	0.05	nd	0.25

^a nd indicates non detect, MDA provided

^b No entry in the MDA column is provided when residual radioactivity is detected

^c Large rock obstructed the first 30 cm at this location.

Survey Unit 13

Description

Survey Unit 13 is a narrow expanse of shoreline between the water's edge and the vegetation line in the northeast section of the owner controlled property. This location is approximately 49,500 m² in area and contains no surface or subsurface structures, components, or equipment.

History

Survey Unit 13 is a pristine section of Lake Michigan shoreline that has remained remote from normal plant operational activities. The HSA designates this area as unlikely to contain residual radioactivity in soils.

Radiological Status

Due to near-record lows in Lake Michigan water level, additional shoreline is exposed for surveys conducted in this area. Three samples collected in this survey unit identified residual radioactivity below IDCGLs. The location of this survey unit is near the plant discharge canal where licensed radioactive liquid release occurred; the levels of radionuclides identified in these surveys is consistent with contaminant migration that would result from wind, current, and wave action along the shoreline. The radiological status of this survey unit is Class 3.

Primary Survey Design

1. Sample Data Points Required

The scoping survey resulted in the following data:

Nuclide identification	Cs-137
Mean value (pCi/g)	0.19
Standard Deviation (σ)	0.15

The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL.

$$\text{Relative Shift} = \frac{\text{DCGL} - \text{LBGR}}{\sigma} = \frac{5.11 - 2.5}{0.15} = 16.6$$

With α and β error levels set at 0.05 and an assumed relative shift of 3, the Sign Test requirements specify a sample size of 14 data points.

As a conservative measure 20 sample data points were selected for this survey unit.

2. Sample Locations

Sample locations were selected by random method. Random numbers were generated and applied to the bounding survey unit dimensions to determine data point coordinate locations. This process was continued until 20 sample data points fell within the survey unit boundary.

Supporting Surveys

No supporting surveys were conducted in this survey unit.

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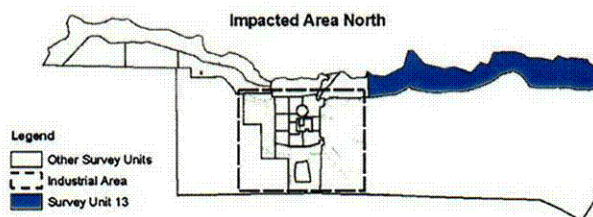
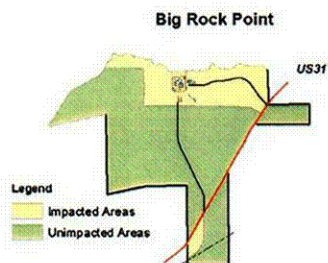
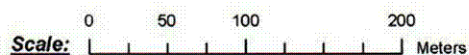
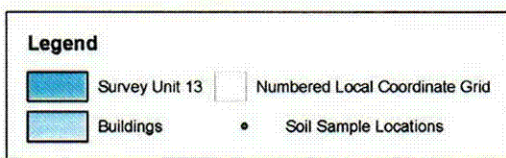
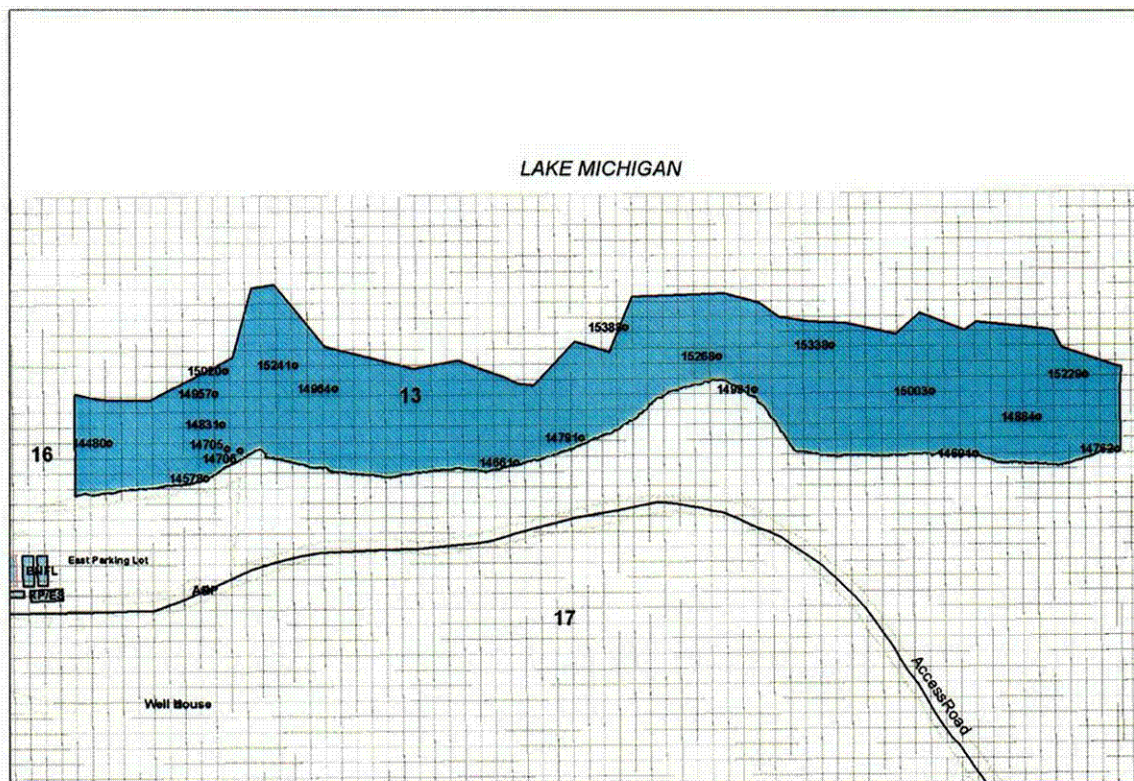
Data Summary

Survey Unit 13

Survey	No. of Samples	Radionuclides	Mean (pCi/g)	Max. Value (pCi/g)
13A₁	20	Cs₁₃₇	0.36	0.97
		Co₆₀*	0.07	0.10

* Activity detected in 3 samples only.

Survey Unit 13



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Survey Results

Survey	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
13A ₁	15338	(8.5,0.7)	0.00-0.15	0.22		nd	0.05	nd	0.22
13A ₁	14480	(2.6,0.3)	0.00-0.15	0.33		0.04		nd	0.28
13A ₁	14691	(0.0,9.6)	0.00-0.15	0.03		nd	0.07	nd	0.25
13A ₁	14884	(0.6,3.0)	0.00-0.15	0.07		nd	0.08	nd	0.25
13A ₁	15229	(0.8,0.7)	0.00-0.15	0.03		nd	0.08	nd	0.33
13A ₁	14831	(5.4,1.7)	0.00-0.15	0.54		nd	0.08	nd	0.30
13A ₁	15388	(5.8,3.3)	0.00-0.15	0.06		nd	0.06	nd	0.25
13A ₁	15268	(5.8,4.2)	0.00-0.15	0.12		nd	0.06	nd	0.21
13A ₁	15241	(2.1,0.0)	0.00-0.15	0.95		nd	0.07	nd	0.28
13A ₁	14705	(8.0,6.1)	0.00-0.15	0.71		nd	0.05	nd	0.26
13A ₁	14706	(6.5,4.9)	0.00-0.15	0.93		nd	0.06	nd	0.25
13A ₁	14762	(1.0,2.0)	0.00-0.15	0.33		nd	0.06	nd	0.27
13A ₁	14964	(7.6,4.5)	0.00-0.15	0.09		nd	0.06	nd	0.26
13A ₁	15020	(7.4,6.5)	0.00-0.15	0.20		0.07		nd	0.24
13A ₁	14578	(4.7,6.9)	0.00-0.15	0.23		nd	0.05	nd	0.24
13A ₁	14991	(8.6,2.3)	0.00-0.15	0.07		nd	0.06	nd	0.24
13A ₁	14957	(0.8,1.8)	0.00-0.15	0.14		nd	0.07	nd	0.23
13A ₁	14791	(6.9,1.7)	0.00-0.15	0.55		nd	0.05	nd	0.27
13A ₁	15003	(2.3,0.4)	0.00-0.15	0.61		0.10		nd	0.28
13A ₁	14661	(4.6,5.8)	0.00-0.15	0.97		nd	0.06	nd	0.27

^a nd indicates non detect, MDA provided

^b No entry in the MDA column is provided when residual radioactivity is detected

Survey Unit 14

Description

Survey Unit 14 is a narrow expanse of shoreline between the waters edge and the vegetation line in the northwest section of the owner controlled property. This location is approximately 33,000 m² in area and contains no surface or subsurface structures, components, or equipment.

History

Survey Unit 14 is a pristine section of Lake Michigan shoreline that has remained remote from normal plant operational activities. The HSA designates this area as unlikely to contain residual radioactivity in area soils

Radiological Status

Residual radioactivity was not identified in any soil samples collected in Survey Unit 14 above established background levels. The radiological status of this survey unit is Class 3.

Primary Survey Design

1. Sample Data Points Required

The scoping survey resulted in the following data:

Nuclide identification	Cs-137
Mean value (pCi/g)	0.50
Standard Deviation (σ)	0.40

The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL.

$$\text{Relative Shift} = \frac{\text{DCGL} - \text{LBGR}}{\sigma} = \frac{5.11 - 2.5}{0.15} = 6.2$$

With α and β error levels set at 0.05 and an assumed relative shift of 3, the Sign Test requirements specify a sample size of 14 data points.

As a conservative measure 20 sample data points were selected for this survey unit.

2. Sample Locations

Sample locations were selected by random method. Random numbers were generated and applied to the bounding survey unit dimensions to determine data point coordinate locations. This process was continued until 20 sample data points fell within the survey unit boundary.

Supporting Surveys

No supporting surveys were conducted in this survey unit.

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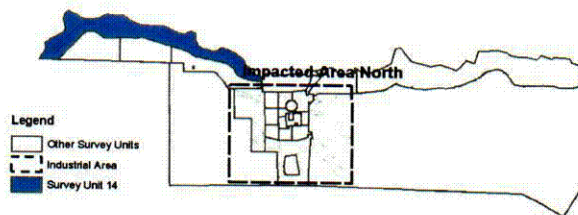
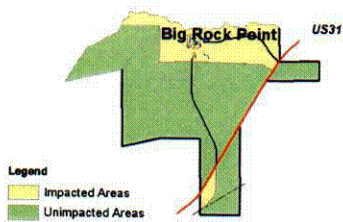
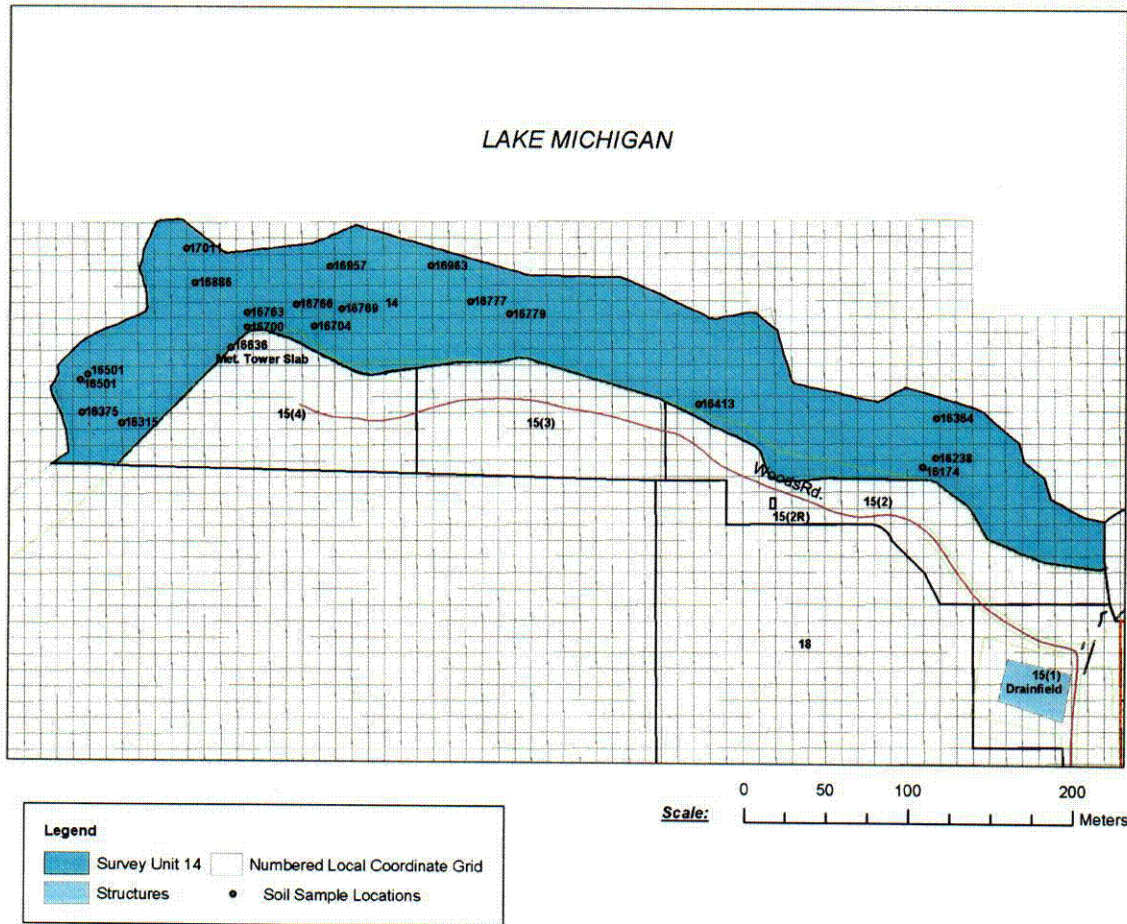
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Data Summary

Survey Unit 14

Survey	No. of Samples	Radionuclides	Mean (pCi/g)	Max. Value (pCi/g)
14A₁	20	CS₁₃₇	0.16	0.40

Survey Unit 14



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Survey Results

Survey	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
14A ₁	6886	(4.9,2.2)	0.00-0.15	0.10		nd	0.06	nd	0.2
14A ₁	16501	(9.1,4.4)	0.00-0.15	0.20		nd	0.05	nd	0.2
14A ₁	16779	(7.2,1.7)	0.00-0.15	0.04		nd	0.05	nd	0.2
14A ₁	16769	(4.5,5.5)	0.00-0.15	0.40		nd	0.04	nd	0.2
14A ₁	17011	(9.7,3.6)	0.00-0.15	0.20		nd	0.05	nd	0.2
14A ₁	16501	(4.6,1.1)	0.00-0.15	0.09		nd	0.05	nd	0.2
14A ₁	16762	(6.7,3.2)	0.00-0.15	0.20		nd	0.07	nd	0.2
14A ₁	16963	(9.5,2.1)	0.00-0.15	0.09		nd	0.06	nd	0.2
14A ₁	16704	(7.8,4.4)	0.00-0.15	0.20		nd	0.05	nd	0.2
14A ₁	16413	(3.2,4.7)	0.00-0.15	nd	0.04	nd	0.05	nd	0.2
14A ₁	16957	(7.4,2.0)	0.00-0.15	0.10		nd	0.05	nd	0.2
14A ₁	16364	(8.3,5.6)	0.00-0.15	0.30		nd	0.06	nd	0.2
14A ₁	16174	(9.8,5.4)	0.00-0.15	0.20		nd	0.06	nd	0.2
14A ₁	16777	(3.4,9.8)	0.00-0.15	0.08		nd	0.04	nd	0.2
14A ₁	16766	(6.9,8.4)	0.00-0.15	nd	0.05	nd	0.05	nd	0.3
14A ₁	16375	(5.7,0.8)	0.00-0.15	nd	0.04	nd	0.06	nd	0.2
14A ₁	16700	(6.7,3.9)	0.00-0.15	0.07		nd	0.06	nd	0.2
14A ₁	16636	(6.6,1.4)	0.00-0.15	0.06		nd	0.04	nd	0.2
14A ₁	16315	(0.0,4.0)	0.00-0.15	nd	0.06	nd	0.04	nd	0.2
14A ₁	16238	(7.8,0.8)	0.00-0.15	nd	0.05	nd	0.05	nd	0.2

^a nd indicates non detect, MDA provided

^b No entry in the MDA column is provided when residual radioactivity is detected

Survey Unit 15(1)

Description

Survey Unit 15(1) is an area of approximately 11,500 m² located adjacent to the western boundary of the surface water drainage stream. This area encompasses the north/south section of the Woods Road and the plant septic drainfield. The drainfield is a mound constructed pump-back system that connects to septic effluent holding tanks located inside the Protected Area. Subsurface structures and components include electrical conduit and septic piping in vicinity of the Woods Road.

History

The Woods Road is an unimproved lane that provided access to the weather station tower formerly located in Survey Unit 15(4). Several locations in connecting survey units along this road were used as locations for the storage construction debris and refuse.

Radiological Status

Residual radioactivity was not identified in any soil samples collected in Survey Unit 15(1) above established background levels. The drainfield connection to the site septic system represents a potential contaminant migration pathway into this area. The drainfield is scheduled for further evaluation when the septic system is removed from service. The radiological status of this survey unit is Class 2.

Primary Survey Design

1. Sample Data Points Required

The scoping survey resulted in the following data:

Nuclide identification	Cs-137
Mean value (pCi/g)	0.19
Standard Deviation (σ)	0.25

The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL.

$$\text{Relative Shift} = \frac{\text{DCGL} - \text{LBGR}}{\sigma} = \frac{5.11 - 2.5}{0.25} = 10.4$$

With α and β error levels set at 0.05 and an assumed relative shift of 3, the Sign Test requirements specify a sample size of 14 data points.

2. Sample Locations

Sample locations were systematically selected in random start, square grid pattern with the southwest corner of the survey unit as origin.

Bounding survey unit dimensions 85 X 190 meters

Random Numbers 0.866992, 0.791992

$$X = (0.866992)(85 \text{ m}) = 73.6 \text{ m}$$

$$Y = (0.791992)(190 \text{ m}) = 150.4 \text{ m}$$

$$\text{Sample Spacing } L = \sqrt{\frac{\text{Area}}{N}} = \sqrt{\frac{11534}{14}} = 28.7 \text{ meters}$$

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As a conservative measure 25 samples were collected using 20 meter spacing.

Supporting Surveys

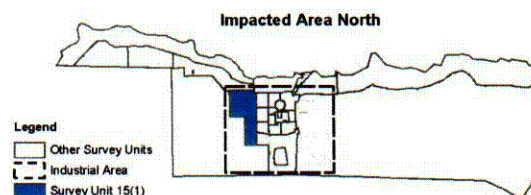
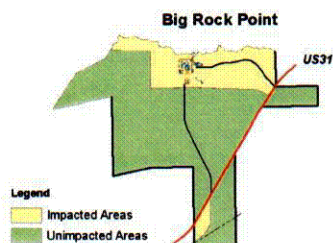
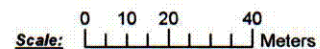
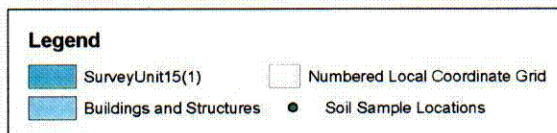
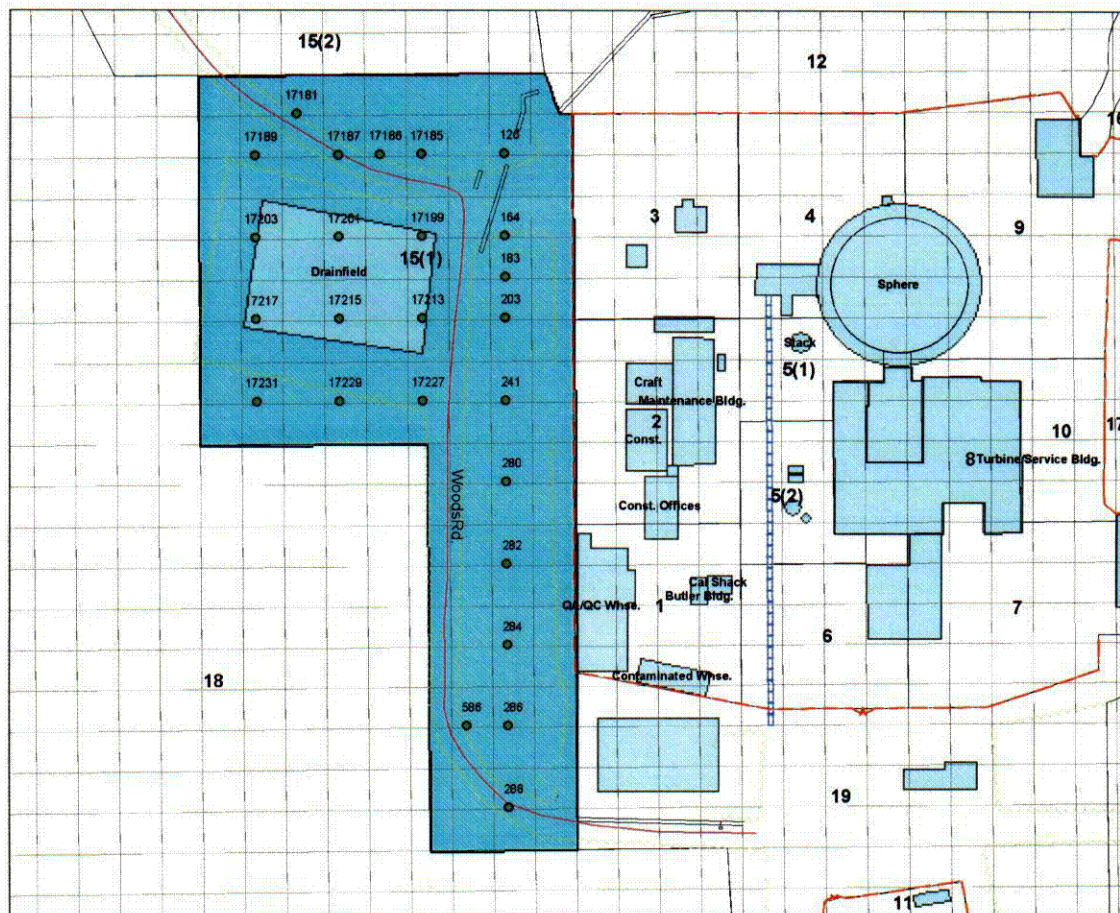
No supporting surveys were conducted in this survey unit.

Data Summary

Survey Unit 15(1)

Survey	No. of Samples	Radionuclid	Mean (pCi/g)	Max. Value (pCi/g)
15(1)A ₁	25	Cs ₁₃₇	0.22	1.20

Survey Unit 15(1)



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Survey Results

Survey	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
15(1)A1	288	(3.6,0.5)	0.00-0.15	0.06		nd	0.06	nd	0.27
15(1)A1	286	(3.6,0.5)	0.00-0.15	0.37		nd	0.07	nd	0.29
15(1)A1	284	(3.6,0.5)	0.00-0.15	0.33		nd	0.04	nd	0.22
15(1)A1	282	(3.6,0.5)	0.00-0.15	0.17		nd	0.05	nd	0.23
15(1)A1	280	(3.6,0.5)	0.00-0.15	0.21		nd	0.05	nd	0.23
15(1)A1	241	(3.6,0.5)	0.00-0.15	0.06		nd	0.05	nd	0.26
15(1)A1	203	(3.6,0.5)	0.00-0.15	0.20		nd	0.05	nd	0.28
15(1)A1	164	(3.6,0.5)	0.00-0.15	0.08		nd	0.06	nd	0.25
15(1)A1	126	(3.6,0.5)	0.00-0.15	0.12		nd	0.06	nd	0.25
15(1)A1	17185	(3.6,0.5)	0.00-0.15	0.13		nd	0.05	nd	0.22
15(1)A1	17189	(3.6,0.5)	0.00-0.15	0.18		nd	0.06	nd	0.31
15(1)A1	17213	(3.6,0.5)	0.00-0.15	0.27		nd	0.05	nd	0.28
15(1)A1	17227	(3.6,0.5)	0.00-0.15	0.14		nd	0.06	nd	0.29
15(1)A1	17229	(3.6,0.5)	0.00-0.15	0.13		nd	0.05	nd	0.19
15(1)A1	17215	(3.6,0.5)	0.00-0.15	0.15		nd	0.06	nd	0.29
15(1)A1	17201	(3.6,0.5)	0.00-0.15	0.19		nd	0.06	nd	0.27
15(1)A1	17187	(3.6,0.5)	0.00-0.15	1.20		nd	0.06	nd	0.31
15(1)A1	17189	(3.6,0.5)	0.00-0.15	0.18		nd	0.04	nd	0.22
15(1)A1	17203	(3.6,0.5)	0.00-0.15	0.18		nd	0.06	nd	0.28
15(1)A1	17217	(3.6,0.5)	0.00-0.15	0.23		nd	0.06	nd	0.29
15(1)A1	17231	(3.6,0.5)	0.00-0.15	0.06		nd	0.05	nd	0.26
15(1)A1	586	(0.1,2.2)	0.00-0.15	nd	0.05	nd	0.05	nd	0.26
15(1)A1	183	(6.1,5.8)	0.00-0.15	0.19		nd	0.05	nd	0.24
15(1)A1	17186	(4.7,3.7)	0.00-0.15	0.20		nd	0.05	nd	0.25
15(1)A1	17181	(8.5,7.3)	0.00-0.15	0.25		nd	0.05	nd	0.22

^a nd indicates non detect, MDA provided

^b No entry in the MDA column is provided when residual radioactivity is detected

Survey Unit 15(2)

Description

Survey Unit 15(2) is an area of approximately 10,300 m² west of the Protected Area that parallels the shoreline south of Survey Unit 14. This area encompasses an east/west section of the Woods Road connecting Survey Units 15(1) and 15(3). Survey Unit 15(2R) is contained within this area along the southwest section of the Woods Road. Subsurface structures and components do not exist in this wooded area.

History

The Woods Road is an unimproved lane that provided access to the former weather station tower located in Survey Unit 15(4). Low levels of radioactivity have been identified in construction debris (Survey Unit 15(2R)) that was once stored along this road. Cleanup efforts have resulted in the removal of all construction waste in this area.

Radiological Status

Residual radioactivity was not identified in any soil samples collected in this survey unit above established background levels. The radiological status of Survey Unit 15(2) is Class 2.

Primary Survey Design

1. Sample Data Points Required

The scoping survey resulted in the following data:

Nuclide identification	Cs-137
Mean value (pCi/g)	0.36
Standard Deviation (σ)	0.11

The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL.

$$\text{Relative Shift} = \frac{\text{DCGL} - \text{LBGR}}{\sigma} = \frac{5.11 - 2.5}{0.11} = 23.7$$

With α and β error levels set at 0.05 and an assumed relative shift of 3, the Sign Test requirements specify a sample size of 14 data points.

2. Sample Locations

Sample locations were systematically selected in random start, square grid pattern with the southwest corner of the survey unit as origin.

Bounding survey unit dimensions 270 X 130 meters

Random Numbers 0.444554, 0.428292

$X = (0.444554)(270 \text{ m}) = 120.0 \text{ m}$

$Y = (0.428292)(130 \text{ m}) = 55.7 \text{ m}$

$$\text{Sample Spacing } L = \sqrt{\frac{\text{Area}}{N}} = \sqrt{\frac{10255}{14}} = 27.0 \text{ meters}$$

As a conservative measure 25 samples were collected using 20 meter spacing.

Supporting Surveys

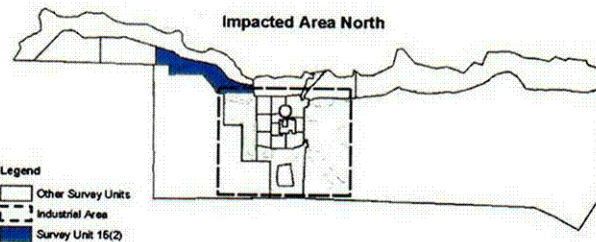
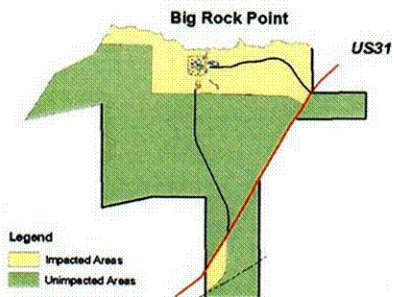
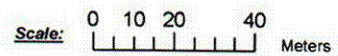
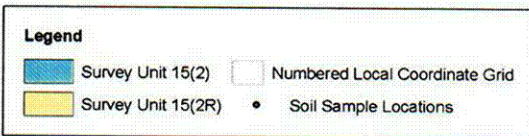
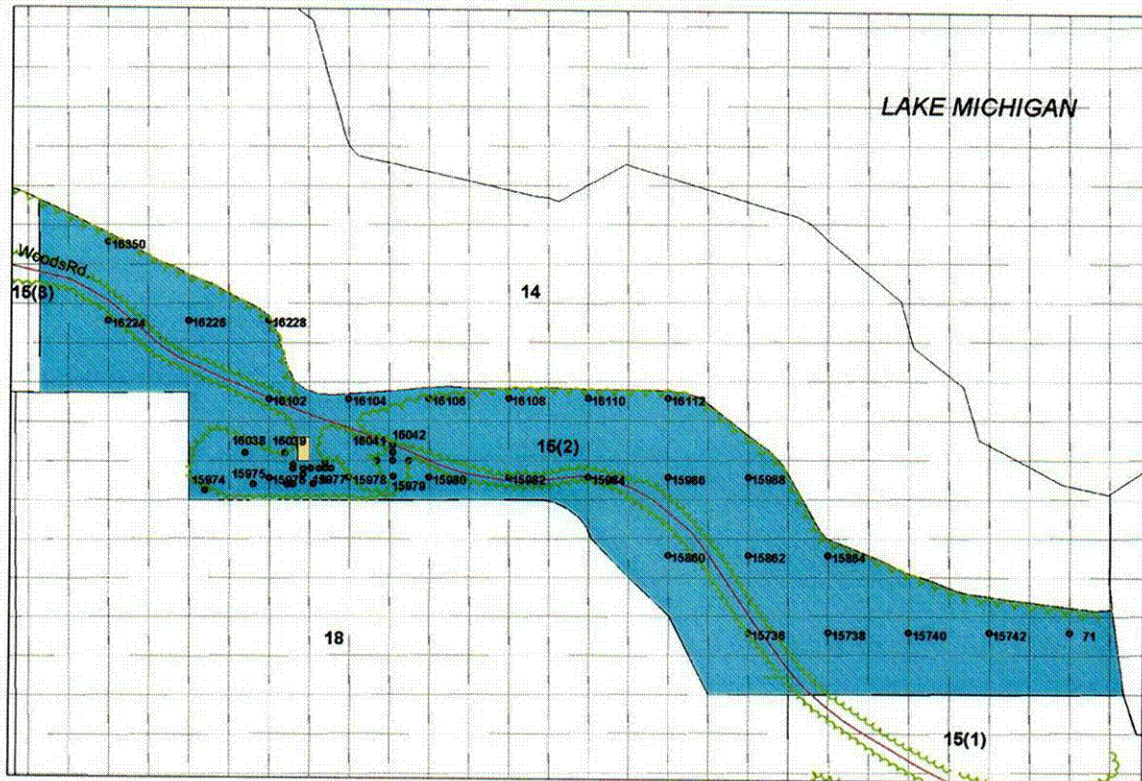
Supporting survey 15(2)A₁ was performed for the evaluation of surface and subsurface soils in the vicinity of construction debris along the Woods Road. Data point locations were judgmentally selected based on historical information and process knowledge for areas of greatest potential to contain radioactivity.

Data Summary

Survey Unit 15(2)

Survey	No. of Samples	Radionuclides	Mean (pCi/g)	Max.Value (pCi/g)
15(2)A ₁	44	Cs ₁₃₇	0.18	1.06
15(2)A ₂	25	Cs ₁₃₇	0.22	0.53

Survey Unit 15(2)



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Survey Results

Survey	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
15(2)A ₁	15979	(1.0,7.7)	0.00-0.15	0.24		nd	0.05	nd	0.24
15(2)A ₁	16042	(5.0,1.7)	0.00-0.15	0.15		nd	0.06	nd	0.24
15(2)A ₁	16042	(1.0,1.7)	0.00-0.15	0.29		nd	0.04	nd	0.23
15(2)A ₁	16041	(7.0,0.0)	0.00-0.30	0.12		nd	0.05	nd	0.24
15(2)A ₁	16042	(1.0,0.0)	0.30-0.60	nd	0.05	nd	0.04	nd	0.22
15(2)A ₁	16042	(1.0,2.0)	0.00-0.30	0.44		nd	0.03	nd	0.21
15(2)A ₁	16042	(1.0,4.0)	0.00-0.30	0.11		nd	0.05	nd	0.18
15(2)A ₁	15976	(6.0,4.0)	0.00-0.30	0.15		nd	0.04	nd	0.25
15(2)A ₁	15976	(6.0,4.0)	0.30-0.60	0.06		nd	0.06	nd	0.22
15(2)A ₁	15976	(6.0,4.0)	0.60-0.90	nd	0.04	nd	0.05	nd	0.22
15(2)A ₁	15976	(6.0,4.0)	0.90-1.20	nd	0.04	nd	0.05	nd	0.20
15(2)A ₁	15976	(4.5,4.0)	0.00-0.30	0.07		nd	0.06	nd	0.22
15(2)A ₁	15976	(4.5,4.0)	0.30-0.60	0.03		nd	0.04	nd	0.23
15(2)A ₁	15976	(4.5,4.0)	0.60-0.90	nd	0.04	nd	0.04	nd	0.22
15(2)A ₁	15976	(6.0,9.0)	0.00-0.30	0.12		nd	0.05	nd	0.21
15(2)A ₁	15976	(6.0,9.0)	0.30-0.60	nd	0.03	nd	0.05	nd	0.21
15(2)A ₁	15977	(1.0,4.0)	0.00-0.30	0.09		nd	0.06	nd	0.24
15(2)A ₁	15977	(1.0,4.0)	0.30-0.60	nd	0.03	nd	0.03	nd	0.20
15(2)A ₁	15977	(4.0,8.0)	0.00-0.30	0.13		nd	0.06	nd	0.21
15(2)A ₁	15977	(4.0,8.0)	0.30-0.60	nd	0.04	nd	0.03	nd	0.21
15(2)A ₁	15977	(4.0,8.0)	0.60-0.90	nd	0.05	nd	0.05	nd	0.19
15(2)A ₁	15977	(5.5,8.0)	0.00-0.30	0.04		nd	0.05	nd	0.23
15(2)A ₁	15977	(5.5,8.0)	0.30-0.60	nd	0.04	nd	0.04	nd	0.18
15(2)A ₁	15977	(2.5,8.0)	0.00-0.30	0.02		nd	0.04	nd	0.20
15(2)A ₁	15977	(2.5,8.0)	0.30-0.60	nd	0.05	nd	0.05	nd	0.28
15(2)A ₁	15977	(4.0,5.0)	0.00-0.30	0.14		nd	0.06	nd	0.21
15(2)A ₁	15977	(4.0,5.0)	0.30-0.60	nd	0.04	nd	0.05	nd	0.22
15(2)A ₁	15976	(8.5,8.0)	0.00-0.30	0.80		nd	0.09	nd	0.27
15(2)A ₁	15976	(8.5,8.0)	0.30-0.60	0.08		nd	0.06	nd	0.21
15(2)A ₁	15976	(8.5,8.0)	0.60-0.90	0.03		nd	0.06	nd	0.21
15(2)A ₁	15977	(0.5,8.0)	0.00-0.30	0.11		nd	0.05	nd	0.23
15(2)A ₁	15977	(0.5,8.0)	0.30-0.60	1.06		nd	0.07	nd	0.28
15(2)A ₁	15977	(0.5,8.0)	0.60-0.90	nd	0.04	nd	0.04	nd	0.19
15(2)A ₁	15976	(6.0,8.0)	0.00-0.30	0.12		nd	0.06	nd	0.21
15(2)A ₁	15976	(6.0,8.0)	0.30-0.60	0.03		nd	0.05	nd	0.22
15(2)A ₁	15976	(6.0,8.0)	0.60-0.90	nd	0.03	nd	0.05	nd	0.19
15(2)A ₁	16038	(4.0,2.0)	0.00-0.30	0.10		nd	0.05	nd	0.21
15(2)A ₁	16038	(4.0,2.0)	0.30-0.60	nd	0.04	nd	0.05	nd	0.22
15(2)A ₁	15975	(6.0,4.0)	0.00-0.30	0.12		nd	0.06	nd	0.21
15(2)A ₁	15975	(6.0,4.0)	0.30-0.60	nd	0.05	nd	0.06	nd	0.19
15(2)A ₁	15974	(4.0,2.5)	0.00-0.30	0.24		nd	0.05	nd	0.22
15(2)A ₁	15976	(8.5,6.5)	0.30-0.60	0.07		nd	0.04	nd	0.18
15(2)A ₁	15976	(8.5,6.5)	0.60-0.90	nd	0.05	nd	0.04	nd	0.19
15(2)A ₁	15976	(8.5,8.0)	0.90-1.20	nd	0.04	nd	0.05	nd	0.19
15(2)A ₂	71	(0.0,5.7)	0.00-0.15	0.34		nd	0.04	nd	0.21
15(2)A ₂	15742	(0.0,5.7)	0.00-0.15	0.46		nd	0.05	nd	0.23
15(2)A ₂	15740	(0.0,5.7)	0.00-0.15	0.23		nd	0.04	nd	0.23
15(2)A ₂	15738	(0.0,5.7)	0.00-0.15	0.13		nd	0.05	nd	0.28
15(2)A ₂	15736	(0.0,5.7)	0.00-0.15	0.53		nd	0.05	nd	0.26
15(2)A ₂	15864	(0.0,5.7)	0.00-0.15	0.10		nd	0.06	nd	0.21

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Survey	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
15(2)A ₂	15862	(0,0,5.7)	0.00-0.15	0.13		nd	0.07	nd	0.34
15(2)A ₂	15860	(0,0,5.7)	0.00-0.15	0.29		nd	0.03	nd	0.29
15(2)A ₂	15988	(0,0,5.7)	0.00-0.15	0.20		nd	0.06	nd	0.24
15(2)A ₂	15986	(0,0,5.7)	0.00-0.15	0.27		nd	0.05	nd	0.22
15(2)A ₂	15984	(0,0,5.7)	0.00-0.15	0.26		nd	0.05	nd	0.30
15(2)A ₂	15982	(0,0,5.7)	0.00-0.15	0.16		nd	0.05	nd	0.24
15(2)A ₂	15980	(0,0,5.7)	0.00-0.15	0.08		nd	0.05	nd	0.21
15(2)A ₂	15978	(0,0,5.7)	0.00-0.15	0.15		nd	0.05	nd	0.26
15(2)A ₂	15976	(0,0,5.7)	0.00-0.15	0.23		nd	0.05	nd	0.23
15(2)A ₂	16112	(0,0,5.7)	0.00-0.15	0.16		nd	0.05	nd	0.25
15(2)A ₂	16110	(0,0,5.7)	0.00-0.15	0.08		nd	0.05	nd	0.23
15(2)A ₂	16108	(0,0,5.7)	0.00-0.15	0.28		nd	0.05	nd	0.19
15(2)A ₂	16106	(0,0,5.7)	0.00-0.15	0.23		nd	0.04	nd	0.2
15(2)A ₂	16104	(0,0,5.7)	0.00-0.15	0.16		nd	0.04	nd	0.18
15(2)A ₂	16102	(0,0,5.7)	0.00-0.15	0.44		nd	0.05	nd	0.29
15(2)A ₂	16228	(0,0,5.7)	0.00-0.15	0.09		nd	0.05	nd	0.22
15(2)A ₂	16226	(0,0,5.7)	0.00-0.15	0.24		nd	0.05	nd	0.24
15(2)A ₂	16224	(0,0,5.7)	0.00-0.15	0.17		nd	0.04	nd	0.21
15(2)A ₂	16350	(0,0,5.7)	0.00-0.15	0.05		nd	0.04	nd	0.17

^a nd indicates non detect, MDA provided

^b No entry in the MDA column is provided when residual radioactivity is detected

Survey Unit 15(2R)

Description

Survey Unit 15(2R) is an area of approximately 18 m² located along the south edge of the Woods Road within the boundaries of Survey Unit 15(2). Subsurface structures and components do not exist in this wooded area.

History

This location was a storage area for minor volumes of miscellaneous refuse and construction debris. Surveys conducted during removal of this material identified radioactivity of plant origin in a small area of approximately two crumbling red bricks. All construction debris has been removed from the area. A post-remediation survey was conducted and confirmatory measurements were performed by representatives of the Michigan Department of Environmental Quality (MDEQ) and USNRC, Region 3.

Radiological Status

The results of surveys conducted following the removal of soil and construction debris have identified this area to contain radioactivity levels similar to the established reference background value for northwestern Michigan. The radiological status of Survey Unit 15(2R) is Class 1.

Primary Survey Design

1. Sample Data Points Required

The scoping survey resulted in the following data:

Nuclide identification	Cs-137	Co-60
Mean value (pCi/g)	1.84	0.06
Standard Deviation σ	1.46	0.02

Applying the Unity Rule,

$$\sigma = \sqrt{\left(\frac{\sigma_{Cs}}{DCGL_{Cs}}\right)^2 + \left(\frac{\sigma_{Co}}{DCGL_{Co}}\right)^2} = \sigma = \sqrt{\left(\frac{1.46_{Cs}}{5.11_{Cs}}\right)^2 + \left(\frac{0.02_{Co}}{4.99_{Co}}\right)^2}$$

$$\sigma = 0.29$$

The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL.

$$\text{Relative Shift} = \frac{IDCGL - LBGR}{\sigma} = \frac{1 - 0.5}{0.29} = 1.7$$

With α and β error levels set at 0.05 and an assumed relative shift of 3, the Sign Test requirements specify a sample size of 17 data points.

2. Sample Locations

Sample locations were systematically selected in random start, square grid pattern with the southwest corner of the survey unit as origin.

Bounding survey unit dimensions 3 X 6 meters

Random Numbers 0.866667, 0.762408

Random Start Location

$$X = (0.866667)(3 \text{ m}) = 2.6 \text{ m}$$

$$Y = (0.762408)(6 \text{ m}) = 4.6 \text{ m}$$

$$\text{Sample Spacing } L = \sqrt{\frac{\text{Area}}{y}} = \sqrt{\frac{18}{17}} = 1.02 \text{ meters}$$

As a conservative measure, 19 sample datapoints were collected for the primary survey.

Supporting Surveys

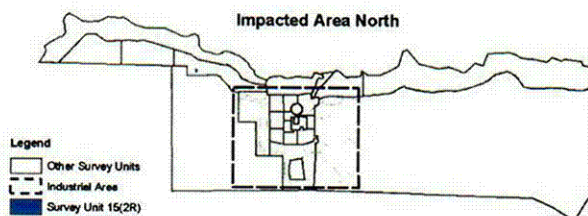
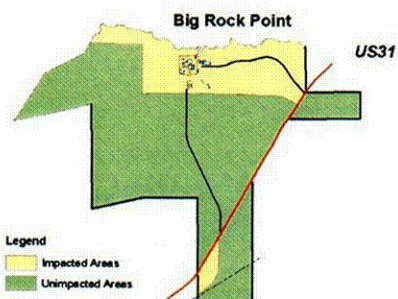
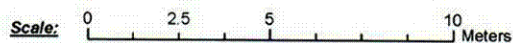
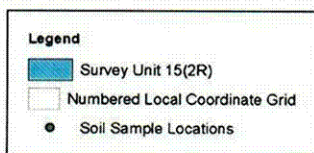
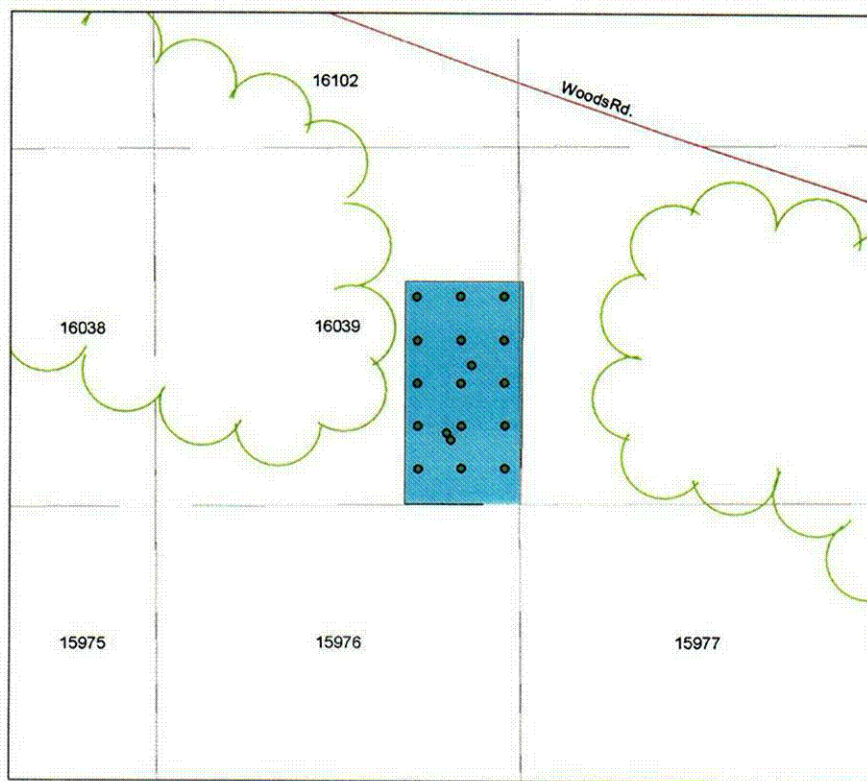
A surface scan survey of 100% coverage was conducted for the investigation of potential areas of elevated contamination. Supporting surveys 15(2R)B_{deepcore1} and 15(2R)B_{deepcore2} were performed for the evaluation of potential contaminants in subsurface soil. In addition, data point locations were selected by regulatory personnel for split sample comparison with MDEQ and USNRC.

Data Summary

Survey Unit 15(2R)

Survey	Data Points	Radionuclides	Mean Ci/g	Max. Value pCi/g
15(2R)B ₁	19	Cs ₁₃₇	0.75	2.03
15(2R)B _{deepcore1}	5	Cs ₁₃₇	0.06	0.08

Survey Unit 15(2R)



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Survey Results

Survey	Grid	Coordinate ^c (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
15(2R)B ₁	16039	(7.2)(1.0)	0.00-0.15	0.29		nd	0.07	nd	0.24
15(2R)B ₁	16039	(8.4)(1.0)	0.00-0.15	0.02		nd	0.05	nd	0.27
15(2R)B ₁	16039	(9.6)(1.0)	0.00-0.15	0.07		nd	0.05	nd	0.22
15(2R)B ₁	16039	(7.2)(2.2)	0.00-0.15	0.25		nd	0.05	nd	0.22
15(2R)B ₁	16039	(8.1)(1.8) s	0.00-0.15	0.24		nd	0.06	nd	0.22
15(2R)B ₁	16039	(8.4)(2.2)	0.00-0.15	0.24		nd	0.06	nd	0.26
15(2R)B ₁	16039	(9.6)(2.2)	0.00-0.15	0.49		nd	0.05	nd	0.28
15(2R)B ₁	16039	(7.2)(3.4)	0.00-0.15	0.51		nd	0.06	nd	0.24
15(2R)B ₁	16039	(8.4)(3.4)	0.00-0.15	1.40		nd	0.05	nd	0.25
15(2R)B ₁	16039	(9.6)(3.4)	0.00-0.15	2.03		nd	0.08	nd	0.34
15(2R)B ₁	16039	(7.2)(4.6)	0.00-0.15	1.15		nd	0.06	nd	0.29
15(2R)B ₁	16039	(8.4)(4.6)	0.00-0.15	0.42		nd	0.04	nd	0.20
15(2R)B ₁	16039	(9.6)(4.6)	0.00-0.15	1.53		nd	0.04	nd	0.23
15(2R)B ₁	16039	(7.2)(5.8)	0.00-0.15	0.77		nd	0.05	nd	0.20
15(2R)B ₁	16039	(8.4)(5.8)	0.00-0.15	1.74		nd	0.03	nd	0.28
15(2R)B ₁	16039	(9.6)(5.8)	0.00-0.15	0.53		nd	0.04	nd	0.24
15(2R)B ₁	16039	(8.7)(3.9) s	0.00-0.15	1.55		nd	0.07	nd	0.27
15(2R)B _{1deepcore}	16039	(8.1)(1.8) s	0.15-0.30	nd	0.04	nd	0.05	nd	0.22
15(2R)B _{1deepcore}	16039	(8.7)(3.9) s	0.15-0.30	0.23		nd	0.04	nd	0.20
15(2R)B _{1deepcore}	16039	(8.7)(3.9) s	0.30-0.60	0.08		nd	0.05	nd	0.22
15(2R)B _{2deepcore}	16039	(8.0)(2.0)	0.00-0.15						
15(2R)B _{2deepcore}	16039	(8.0)(2.0)	0.15-0.30	0.04		nd	0.05	nd	0.26
15(2R)B _{2deepcore}	16039	(8.0)(2.0)	0.30-0.45	nd	0.04	nd	0.04	nd	0.21
15(2R)B _{2deepcore}	16039	(8.0)(2.0)	0.45-0.60	nd	0.04	nd	0.05	nd	0.21
15(2R)B _{2deepcore}	16039	(8.0)(2.0)	0.60-0.90	nd	0.03	nd	0.05	nd	0.19

^a nd indicates non detect, MDA provided

^b no entry in the MDA column is provided when residual radioactivity is detected

^c stone/gravel, sample not obtainable

^s S indicates sample splits with NRC and MDEQ

Survey Unit 15(3)

Description

Survey Unit 15(3) is an area of approximately 10,100 m² west of the Protected Area that parallels the shoreline south of Survey Unit 14. This area encompasses an east/west section of the Woods Road connecting Survey Units 15(2) and 15(4). Subsurface structures and components do not exist in this wooded area.

History

The Woods Road is an unimproved lane to former plant weather station located in Survey Unit 15(4). A small area along the road in this survey unit was once used for the storage of construction debris and miscellaneous refuse. All debris has been removed and the radiological investigation of this location did not identify residual radioactivity.

Radiological Status

Residual radioactivity was not identified in any sample collected in this survey unit above established background levels. The radiological status of survey Unit 15(3) is Class 3.

Primary Survey Design

1. Sample Data Points Required

The scoping survey resulted in the following data:

Nuclide Identification	Cs-137
Mean value (pCi/g)	0.22
Standard Deviation (σ)	0.08

The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL.

$$\text{Relative Shift} = \frac{\text{DCGL} - \text{LBGR}}{\sigma} = \frac{5.11 - 2.5}{0.08} = 32.6$$

With α and β error levels set at 0.05 and an assumed relative shift of 3, the Sign Test requirements specify a sample size of 14 data points.

2. Sample Locations

Sample locations were systematically selected in random start, square grid pattern with the southwest corner of the survey unit as origin.

Bounding survey unit dimensions 155X 80 meters

Random Numbers 0.216531, 0.112314

Random start Location

$$X = (0.216531)(155 \text{ m}) = 33.6 \text{ m}$$

$$Y = (0.112314)(80 \text{ m}) = 9.0 \text{ m}$$

$$\text{Sample Spacing } L = \sqrt{\frac{\text{Area}}{N}} = \sqrt{\frac{10056}{14}} = 26.8 \text{ meters}$$

As a conservative measure 25 samples were collected using 19.8 meter spacing.

Supporting Surveys

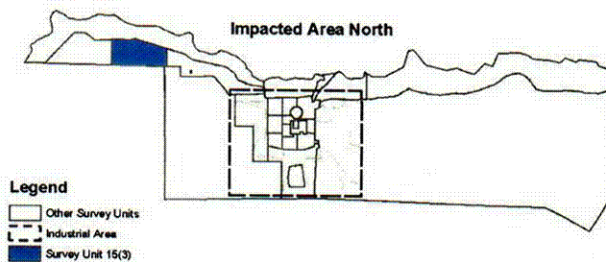
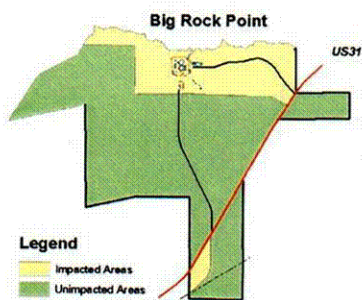
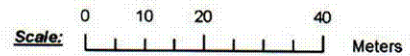
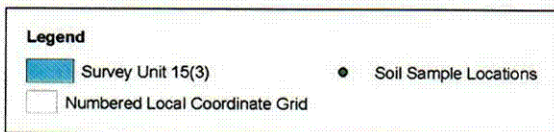
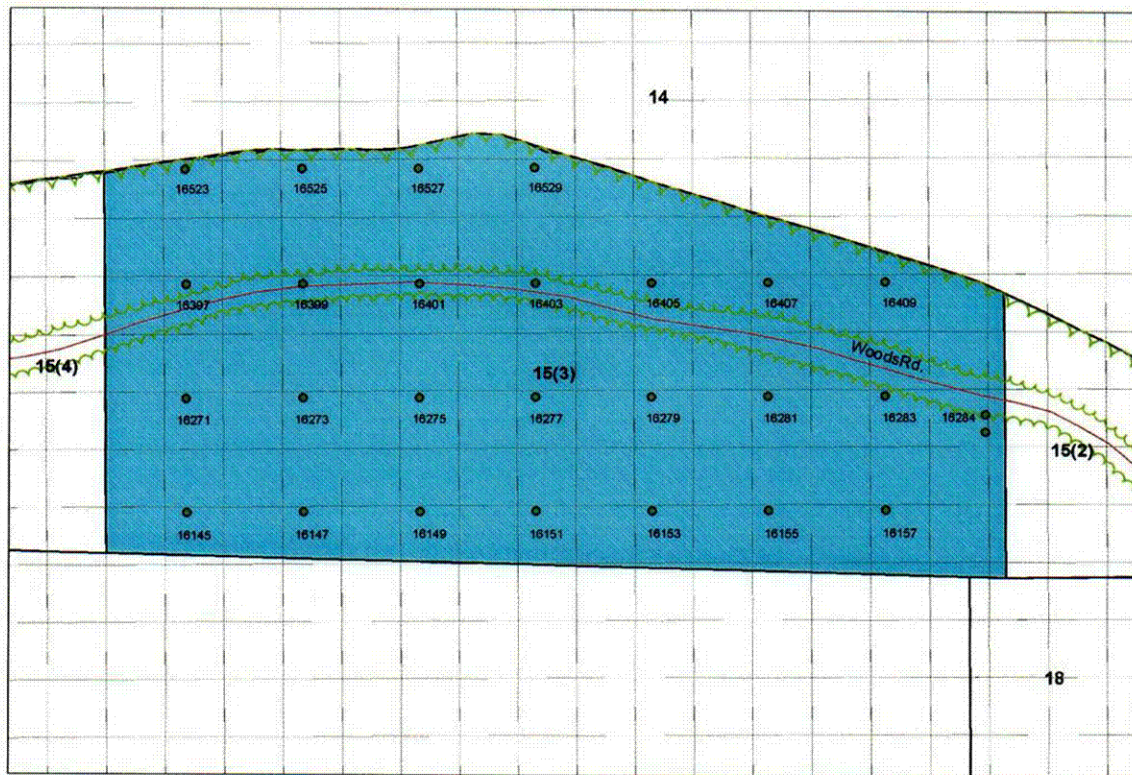
Supporting survey 15(3)A₁ was performed for the investigation of soil contamination in vicinity of the construction debris cleanup along the Woods Road. Data point locations were judgmentally selected based on historical information and process knowledge for areas of greatest potential to contain radioactivity.

Data Summary

Survey Unit 15(3)

Survey	No. of Samples	Radionuclides	Mean (pCi/g)	Max. Value (pCi/g)
15(3)A ₁	2	Cs ₁₃₇	0.12	0.12
15(3)A ₂	25	Cs ₁₃₇	0.38	1.05

Survey Unit 15(3)



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Survey Results

Survey	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
15(3)A ₁	16284	(9.5,5.5)	0.00-0.30	0.11		nd	0.04	nd	0.22
15(3)A ₁	16284	(9.5,2.5)	0.00-0.30	0.12		nd	0.05	nd	0.26
15(3)A ₂	16145	(3.8,9.0)	0.00-0.15	0.36		nd	0.05	nd	0.25
15(3)A ₂	16147	(3.6,9.0)	0.00-0.15	1.05		nd	0.08	nd	0.37
15(3)A ₂	16149	(3.4,9.0)	0.00-0.15	0.30		nd	0.05	nd	0.24
15(3)A ₂	16151	(3.2,9.0)	0.00-0.15	0.68		nd	0.05	nd	0.32
15(3)A ₂	16153	(3.0,9.0)	0.00-0.15	0.44		nd	0.05	nd	0.25
15(3)A ₂	16155	(2.8,9.0)	0.00-0.15	0.41		nd	0.05	nd	0.22
15(3)A ₂	16157	(2.6,9.0)	0.00-0.15	0.66		nd	0.03	nd	0.22
15(3)A ₂	16283	(2.6,8.8)	0.00-0.15	0.32		nd	0.04	nd	0.23
15(3)A ₂	16281	(2.8,8.8)	0.00-0.15	0.17		nd	0.04	nd	0.27
15(3)A ₂	16279	(3.0,8.8)	0.00-0.15	0.61		nd	0.06	nd	0.29
15(3)A ₂	16277	(3.2,8.8)	0.00-0.15	0.48		nd	0.05	nd	0.29
15(3)A ₂	16275	(3.4,8.8)	0.00-0.15	0.52		nd	0.06	nd	0.33
15(3)A ₂	16273	(3.6,8.8)	0.00-0.15	0.48		nd	0.05	nd	0.25
15(3)A ₂	16271	(3.8,8.8)	0.00-0.15	0.29		nd	0.06	nd	0.25
15(3)A ₂	16397	(3.8,8.6)	0.00-0.15	0.54		nd	0.06	nd	0.26
15(3)A ₂	16399	(3.6,8.6)	0.00-0.15	0.12		nd	0.06	nd	0.17
15(3)A ₂	16401	(3.4,8.6)	0.00-0.15	0.12		Nd	0.05	nd	0.24
15(3)A ₂	16403	(3.2,8.6)	0.00-0.15	0.26		Nd	0.06	nd	0.17
15(3)A ₂	16405	(3.0,8.6)	0.00-0.15	0.92		Nd	0.05	nd	0.34
15(3)A ₂	16407	(2.8,8.6)	0.00-0.15	0.25		Nd	0.05	nd	0.28
15(3)A ₂	16409	(2.6,8.6)	0.00-0.15	0.09		Nd	0.06	nd	0.23
15(3)A ₂	16529	(3.2,8.4)	0.00-0.15	0.11		Nd	0.04	nd	0.20
15(3)A ₂	16527	(3.4,8.4)	0.00-0.15	0.12		Nd	0.04	nd	0.20
15(3)A ₂	16525	(3.6,8.4)	0.00-0.15	0.10		Nd	0.05	nd	0.23
15(3)A ₂	16523	(3.8,8.4)	0.00-0.15	0.07		Nd	0.04	nd	0.22

^a nd indicates non detect, MDA provided

^b No entry in the MDA column is provided when residual radioactivity is detected

Survey Unit 15(4)

Description

Survey Unit 15(4) is an area of approximately 11,000 m² west of the Protected Area that parallels the shoreline south of Survey Unit 14. The Woods Road terminates in the central portion of this survey unit. Subsurface structures and components include the footings and foundation slab of the former weather station tower.

History

The Woods Road is an unimproved lane that provided access to the former weather station tower located in this survey unit. The tower, in use until 1963, was subsequently dismantled and all that currently remains are the footings and foundation slab.

An area of the Woods Road within this survey unit was once used for the storage of construction debris and miscellaneous refuse. Cleanup efforts have resulted in the removal of all materials from this area. Radiological surveys conducted during this removal process did not identify residual radioactivity in construction debris or area soils.

Radiological Status

Residual radioactivity was not identified in any sample collected in this survey unit above established background levels. The radiological status of Survey Unit 15(4) is Class 3.

Primary Survey Design

1. Sample Data Points Required

The scoping survey resulted in the following data:

Nuclide identification	Cs-137
Mean value (pCi/g)	0.21
Standard Deviation (σ)	0.07

The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL.

$$\text{Relative Shift} = \frac{\text{DCGL} - \text{LBGR}}{\sigma} = \frac{5.11 - 2.5}{0.07} = 37.2$$

With α and β error levels set at 0.05 and an assumed relative shift of 3, the Sign Test requirements specify a sample size of 14 data points.

2. Sample Locations

Sample locations were systematically selected in random start, square grid pattern with the southwest corner of the survey unit as origin.

Bounding survey unit dimensions 190 x 100 meters
Random Numbers 0.919787, 0.607572
Random start Location
 $X = (0.919787)(190 \text{ m}) = 174.8 \text{ m}$

$$Y = (0.607572)(100 \text{ m}) = 60.8 \text{ m}$$

$$\text{Sample Spacing } L = \sqrt{\text{Area}/N} = \sqrt{10955/14} = 27.9 \text{ meters}$$

As a conservative measure 25 samples were collected using 20 meter spacing.

Supporting Surveys

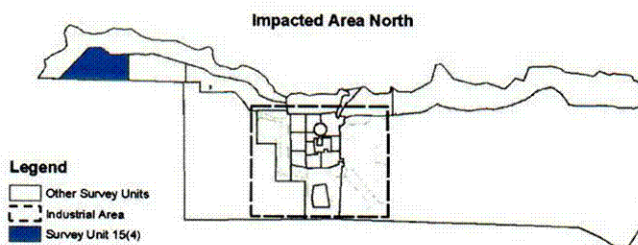
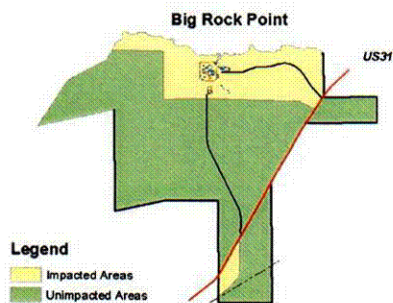
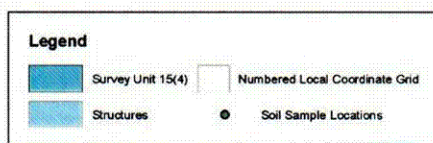
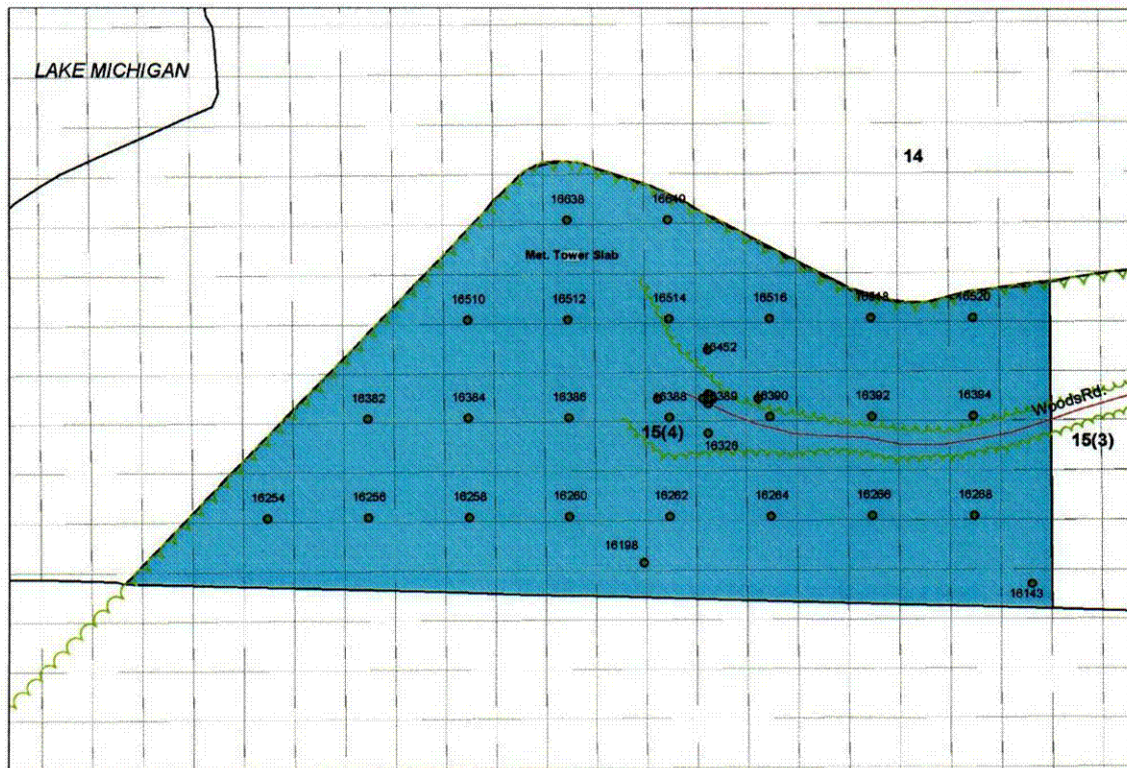
Supporting survey 15(4)A₁ was performed for the investigation of soil contamination in vicinity of the construction debris cleanup along the Woods Road. Data point locations were judgmentally selected based on historical information and process knowledge for areas of greatest potential to contain radioactivity.

Data Summary

Survey Unit 15(4)

Survey	No. of Samples	Radionuclides	Mean (pCi/g)	Max. Value (pCi/g)
15(4)A ₁	9	Cs ₁₃₇	0.16	0.64
15(4)A ₂	25	Cs ₁₃₇	0.23	0.43

Survey Unit 15(4)



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Survey Results

Survey	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
15(4)A ₁	16390	(2.5,4.5)	0.00-0.15	0.03		nd	0.05	nd	0.24
15(4)A ₁	16326	(2.5,7.5)	0.00-0.15	0.12		nd	0.06	nd	0.23
15(4)A ₁	16388	(2.5,4.5)	0.00-0.15	0.09		nd	0.05	nd	0.22
15(4)A ₁	16452	(2.5,4.5)	0.00-0.15	0.64		nd	0.09	nd	0.36
15(4)A ₁	16389	(2.5,3.5)	0.00-0.15	0.11		nd	0.06	nd	0.22
15(4)A ₁	16389	(3.5,4.5)	0.00-0.15	0.05		nd	0.05	nd	0.22
15(4)A ₁	16389	(2.5,5.5)	0.00-0.15	0.16		nd	0.06	nd	0.28
15(4)A ₁	16389	(1.5,4.5)	0.00-0.15	0.08		nd	0.05	nd	0.20
15(4)A ₁	16389	(2.5,4.5)	0.00-0.15	0.17		nd	0.06	nd	0.25
15(4)A ₂	16520	(4.8,0.8)	0.00-0.15	0.13		nd	0.04	nd	0.21
15(4)A ₂	16394	(4.8,0.8)	0.00-0.15	0.13		nd	0.03	nd	0.17
15(4)A ₂	16268	(4.8,0.8)	0.00-0.15	0.29		nd	0.05	nd	0.26
15(4)A ₂	16266	(4.8,0.8)	0.00-0.15	0.43		nd	0.06	nd	0.25
15(4)A ₂	16392	(4.8,0.8)	0.00-0.15	0.31		nd	0.06	nd	0.25
15(4)A ₂	16518	(4.8,0.8)	0.00-0.15	0.09		nd	0.05	nd	0.20
15(4)A ₂	16516	(4.8,0.8)	0.00-0.15	0.32		nd	0.06	nd	0.25
15(4)A ₂	16390	(4.8,0.8)	0.00-0.15	0.28		nd	0.05	nd	0.21
15(4)A ₂	16264	(4.8,0.8)	0.00-0.15	0.09		nd	0.03	nd	0.20
15(4)A ₂	16262	(4.8,0.8)	0.00-0.15	0.12		nd	0.04	nd	0.22
15(4)A ₂	16388	(4.8,0.8)	0.00-0.15	0.10		nd	0.05	nd	0.23
15(4)A ₂	16514	(4.8,0.8)	0.00-0.15	0.42		nd	0.05	nd	0.27
15(4)A ₂	16640	(4.8,0.8)	0.00-0.15	0.14		nd	0.04	nd	0.23
15(4)A ₂	16638	(4.8,0.8)	0.00-0.15	0.12		nd	0.05	nd	0.22
15(4)A ₂	16512	(4.8,0.8)	0.00-0.15	0.29		nd	0.05	nd	0.29
15(4)A ₂	16386	(4.8,0.8)	0.00-0.15	0.14		nd	0.05	nd	0.26
15(4)A ₂	16260	(4.8,0.8)	0.00-0.15	0.29		nd	0.07	nd	0.25
15(4)A ₂	16258	(4.8,0.8)	0.00-0.15	0.16		nd	0.05	nd	0.24
15(4)A ₂	16384	(4.8,0.8)	0.00-0.15	0.18		nd	0.05	nd	0.23
15(4)A ₂	16510	(4.8,0.8)	0.00-0.15	0.38		nd	0.06	nd	0.28
15(4)A ₂	16382	(4.8,0.8)	0.00-0.15	0.32		nd	0.06	nd	0.30
15(4)A ₂	16256	(4.8,0.8)	0.00-0.15	0.23		nd	0.04	nd	0.24
15(4)A ₂	16254	(4.8,0.8)	0.00-0.15	0.10		nd	0.06	nd	0.20
15(4)A ₂	16143	(6.2,7.0)	0.00-0.15	0.32		nd	0.05	nd	0.28
15(4)A ₂	16198	(9.5,1.5)	0.00-0.15	0.41		nd	0.05	nd	0.27

^a nd indicates non detect, MDA provided

^b No entry in the MDA column is provided when residual radioactivity is detected

Survey Unit 16

Description

Survey Unit 16 is located immediately east of the discharge canal and encompasses approximately 8300 m² of Lake Michigan shore area from the waters edge to the tree line. Vehicle barricades traverse this survey unit approximately 23 meters east of the security fence. Subsurface structures and components have not been identified in this area.

History

Asphalt, concrete, and other construction rubble were once visible in a localized area along the waters edge in this survey unit. The material is believed to be early construction debris left in place as rip-rap protection against shoreline erosion. This area was investigated for the potential presence of buried man-made material. Radiological surveys were conducted and these materials were excavated and removed from the area. Residual radioactivity was not identified in any excavated soil or debris removed from the shoreline.

Radiological Status

Due to near-record lows in Lake Michigan water level, additional shoreline was exposed for surveys conducted in this area. The location of this survey unit is east of the plant discharge canal where licensed radioactive liquid release occurred; the levels of radionuclides identified in these surveys is consistent with expectations for sediment migration that would result from wind, current, and wave action along the shoreline. The radiological status of this survey unit is Class 2.

Primary Survey Design

1. Sample Data Points Required

The scoping survey resulted in the following data:

Nuclide identification	Cs-137	Co-60	Mn-54
Mean value (pCi/g)	0.32	0.11	0.04
Standard Deviation (σ)	0.19	0.04	0.02

Applying the Unity Rule,

$$\sigma = \sqrt{\left(\frac{\sigma_{Cs}}{5.11_{Cs}}\right)^2 + \left(\frac{\sigma_{Co}}{4.99_{Co}}\right)^2 + \left(\frac{\sigma_{Mn}}{474_{Mn}}\right)^2}$$
$$\sigma = \sqrt{\left(\frac{0.19}{5.11_{Cs}}\right)^2 + \left(\frac{0.04}{4.99_{Co}}\right)^2 + \left(\frac{0.01}{474_{Mn}}\right)^2}$$

$$\sigma = 0.04$$

For the Unity Rule, the DCGL for the weighted sum is 1. The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL.

$$\text{Relative Shift} = \frac{DCGL - LBGR}{\sigma} = \frac{1 - 0.5}{0.04} = 12.5$$

With α and β error levels set at 0.05 and an assumed relative shift of 3, the Sign Test requirements specify a sample size of 14 data points.

2. Sample Locations

Sample locations were systematically selected in a random start, square grid pattern with the southwest corner of the survey unit as origin.

Bounding survey unit dimensions 140 x 60 meters

Random Numbers 0.845432, 0.201667

Random Start Location

$X = (0.845432)(140 \text{ m}) = 118.4 \text{ meters}$

$Y = (0.201667)(60 \text{ m}) = 12.1 \text{ meters}$

$$\text{Sample Spacing } L = \sqrt{\text{Area}/N} = \sqrt{8290/14} = 24.3 \text{ meters}$$

As a conservative measure 22 samples were collected using 20.5 meter spacing.

Supporting Surveys

No supporting surveys were conducted in this area.

Data Summary

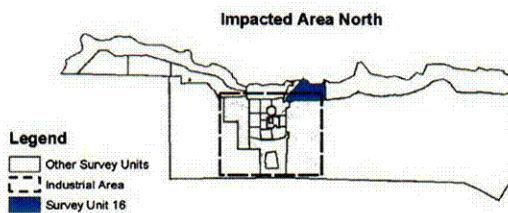
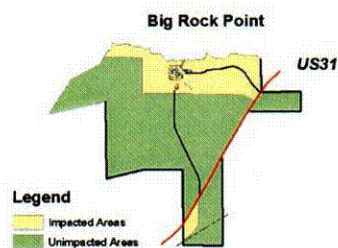
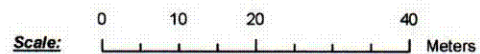
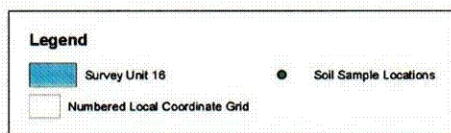
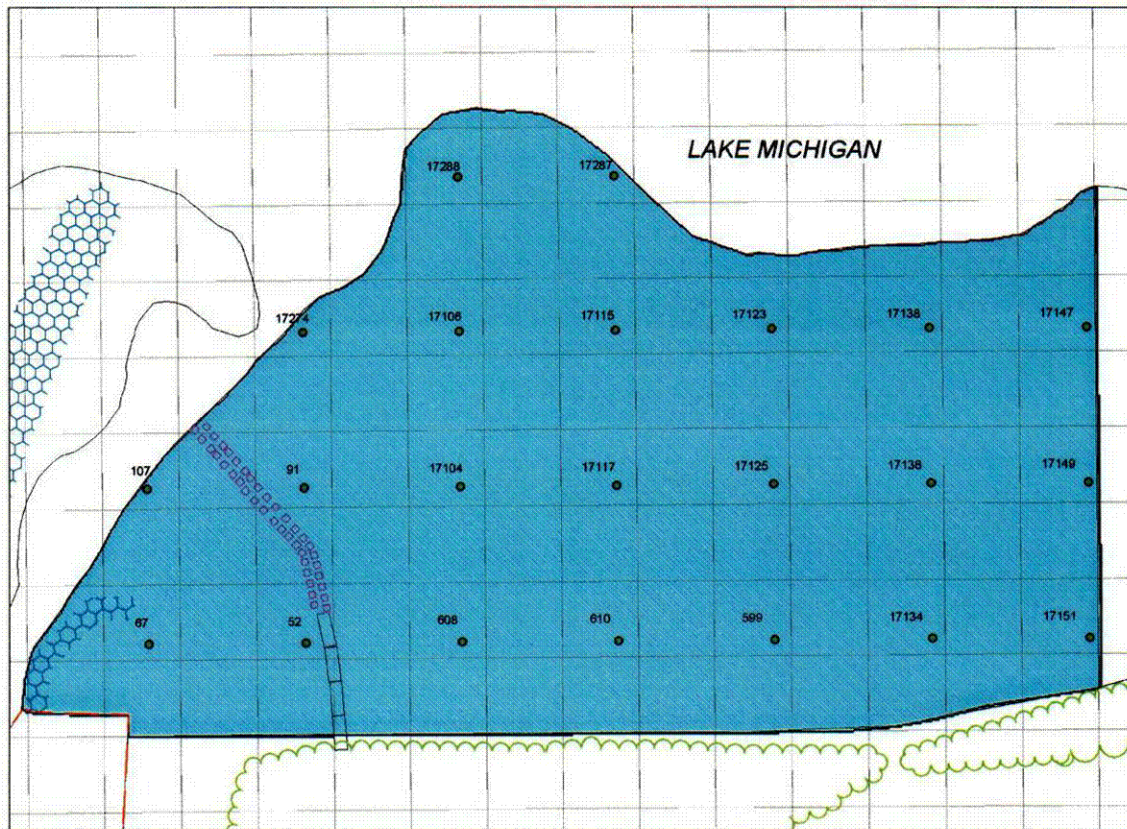
Survey Unit 16

Survey	No. of Samples	Radionuclides*	Mean (pCi/g)	Max. Value (pCi/g)
16A ₁	22	Cs ₁₃₇	0.41	1.38
		**Co ₆₀	0.10	0.13

* nd indicated no detected

** Activity identified in 3 samples only.

Survey Unit 16



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Survey Results

Survey	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
16A ₁	17151	(8.9,2.1)	0.00-0.15	0.53		nd	0.06	nd	0.24
16A ₁	17149	(8.9,2.6)	0.00-0.15	0.09		nd	0.06	nd	0.22
16A ₁	17147	(8.9,3.1)	0.00-0.15	0.28		nd	0.07	nd	0.27
16A ₁	17134	(8.4,2.1)	0.00-0.15	0.55		nd	0.07	nd	0.28
16A ₁	17136	(8.4,2.6)	0.00-0.15	0.06		nd	0.08	nd	0.30
16A ₁	17138	(8.4,3.1)	0.00-0.15	0.24		0.10		nd	0.30
16A ₁	599	(7.9,2.1)	0.00-0.15	1.15		nd	0.07	nd	0.27
16A ₁	17125	(7.9,2.6)	0.00-0.15	0.06		nd	0.06	nd	0.29
16A ₁	17123	(7.9,3.1)	0.00-0.15	0.29		nd	0.07	nd	0.29
16A ₁	610	(7.4,2.1)	0.00-0.15	1.38		nd	0.06	nd	0.27
16A ₁	17117	(7.4,2.6)	0.00-0.15	0.09		nd	0.06	nd	0.26
16A ₁	17115	(7.4,3.1)	0.00-0.15	0.79		0.07		nd	0.24
16A ₁	17287	(7.4,3.6)	0.00-0.15	0.11		nd	0.07	nd	0.22
16A ₁	608	(6.9,2.1)	0.00-0.15	0.98		nd	0.06	nd	0.29
16A ₁	17104	(6.9,2.6)	0.00-0.15	0.09		nd	0.07	nd	0.26
16A ₁	17106	(6.9,3.1)	0.00-0.15	0.12		nd	0.07	nd	0.29
16A ₁	17288	(6.9,3.6)	0.00-0.15	0.75		nd	0.08	nd	0.32
16A ₁	52	(6.4,2.1)	0.00-0.15	0.32		nd	0.06	nd	0.26
16A ₁	91	(6.4,2.6)	0.00-0.15	0.42		0.13		nd	0.28
16A ₁	17274	(6.4,3.1)	0.00-0.15	nd	0.05	nd	0.07	nd	0.32
16A ₁	67	(5.9,2.1)	0.00-0.15	0.19		nd	0.05	nd	0.28
16A ₁	107	(5.9,2.6)	0.00-0.15	0.07		nd	0.07	nd	0.25

^a nd indicates non detect, MDA provided

^b No entry in the MDA column is provided when residual radioactivity is detected

Survey Unit 17

Description

Survey Unit 17 is an area of approximately 256,500 m² located in the southeast quadrant of the Impacted area along the southern boundary of Survey Units 13 and 16. This area is primarily woodland; however, the following buildings and structures are located in the western quarter of the survey unit:

- Well House,
- Security Building,
- South Warehouse,
- Annex Building, and
- Portable Office Buildings.

The Big Rock Point access road and the former 138kv power easement traverse Survey Unit 17 from US Route 31 to the Industrial Area. The Big Rock Point access road provides paved access to the plant parking area located next to the Security Building. Subsurface structures and components include storm drains, conduit, Well Water System piping, and building foundations.

History

The power-line right of way was used as a storage location for large volumes of discarded concrete and asphalt rubble, structural steel, and other miscellaneous construction debris. An investigation of this area was conducted and all materials have been removed. Residual radioactivity was not identified in any construction debris or contact soil in this investigation.

The paved area adjacent to the security building was occasionally used as a transport route for the movement radioactive material from the plant main gate to the Radwaste Building.

Storm-drain piping originating from the Protected Area passes through a small section of Survey Unit 17 adjacent to the northeast section of the plant fence. Trace levels of residual radioactivity have been identified in the sediment of connecting storm drain piping within the Protected Area. The entire length of this piping system has been decontaminated and is currently monitored on a routine basis by Radiation Protection personnel .

Two areas along the former power-line easement have been established for the storage and staging of demolition debris. These materials have met the radiological criteria for staging prior to final evaluation and shipment to a Type II landfill. These areas are known as "Quality Verification Areas" (QVA).

Radiological Status

Residual radioactivity identified in this survey unit are consistent with established background levels. The radiological status of Survey Unit 17 is Class 3. Areas within this survey unit may be upgraded in classification due to future requirements for additional lay-down and staging locations during large scale structure demolition. Characterization surveys are scheduled to continue as buildings and components are dismantled and removed from the site.

Primary Survey Design

1. Sample Data Points Required

The scoping survey resulted in the following data:

Nuclide identification	Cs-137
Mean value (pCi/g)	0.50
Standard Deviation (σ)	0.40

The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL.

$$\text{Relative Shift} = \frac{\text{DCGL} - \text{LBGR}}{\sigma} = \frac{5.11 - 2.5}{0.40} = 6.5$$

With α and β error levels set at 0.05 and an assumed relative shift of 3, the Sign Test requirements specify a sample size of 14 data points. As a conservative measure 20 samples were collected for this survey.

2. Sample Locations

Sample locations were selected by random method

Bounding survey unit dimensions 780 x 400 meters.

Random numbers were generated and applied to bounding survey unit dimensions to determine data point coordinate locations. This process was continued until 20 sample point locations successfully fell within the survey unit.

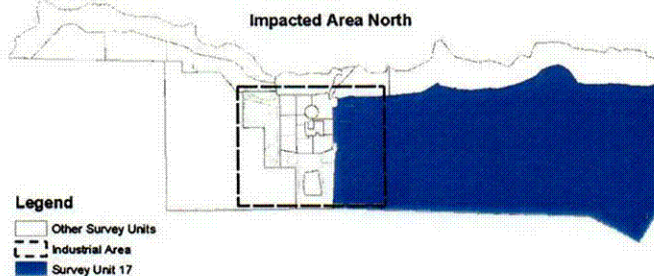
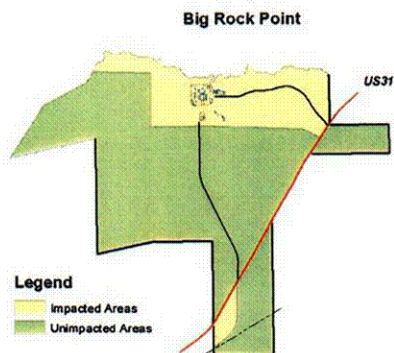
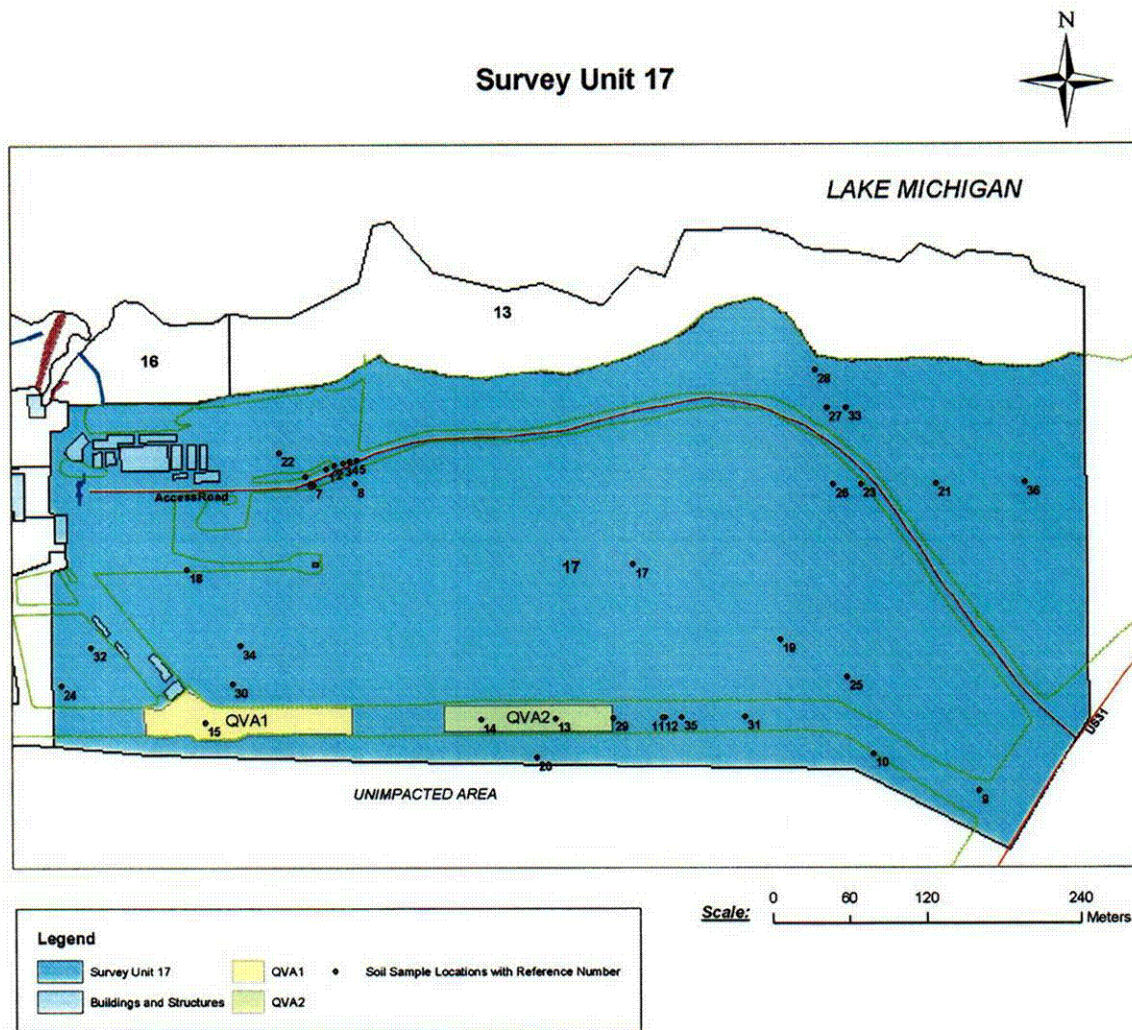
Supporting Surveys

Supporting surveys 17A₂ and 17A₃ were conducted for the radiological evaluation of soil prior to construction of the new Security Building located on the BRP Access Road. Survey 17A_{pl} was performed for the investigation of residual radioactivity in vicinity of the construction storage location on the power-line easement. Data point locations were judgmentally selected for areas of greatest potential to contain radioactivity based on historical information and process knowledge.

Data Summary

Survey Unit 17

Survey	No. of Samples	Radionuclide	Mean (pCi/g)	Max. Value (pCi/g)
17A ₁	20	Cs ₁₃₇	0.57	1.59
17A ₂	5	Cs ₁₃₇	0.38	0.48
17A ₃	3	Cs ₁₃₇	0.06	0.06
17A _{pl}	7	Cs ₁₃₇	0.53	1.43



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Survey Results

Survey	Grid	Coordinate (x,y) (X:Longitude, Y:Latitude)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
17A ₂	17346	(5.5,5.0)	0.00-0.15	0.32		nd	0.07	nd	0.38
17A ₂	17347	(2.0,7.5)	0.00-0.15	0.45		nd	0.07	nd	0.30
17A ₂	17347	(9.0,9.5)	0.00-0.15	0.48		nd	0.06	nd	0.32
17A ₂	17349	(4.5,1.0)	0.00-0.15	0.38		nd	0.07	nd	0.32
17A ₂	17351	(0.0,1.5)	0.00-0.15	0.28		nd	0.03	nd	0.23
17A ₃	17343	(9.0,9.0)	0.00-2.00	nd	0.06	nd	0.05	nd	0.26
17A ₃	17344	(5.5,2.0)	0.00-2.00	nd	0.05	nd	0.06	nd	0.24
17A ₃	17348	(8.5,3.0)	0.00-2.00	0.06		nd	0.05	nd	0.25
17A _{pl}		N45° 21' 25.9", W85° 11' 08.4"	0.00-0.15	0.40		nd	0.06	nd	0.30
17A _{pl}		N45° 21' 27.3", W85° 11' 12.2"	0.00-0.15	0.42		nd	0.06	nd	0.28
17A _{pl}		N45° 21' 28.0", W85° 11' 19.7"	0.00-0.15	0.35		nd	0.06	nd	0.30
17A _{pl}		N45° 21' 27.8", W85° 11' 19.8"	0.00-0.15	1.43		nd	0.04	nd	0.26
17A _{pl}		N45° 21' 27.9", W85° 11' 23.7"	0.00-0.15	0.49		nd	0.07	nd	0.30
17A _{pl}		N45° 21' 28.1", W85° 11' 26.4"	0.00-0.15	0.61		nd	0.05	nd	0.31
17A _{pl}		N45° 21' 27.9", W85° 11' 36.4"	0.00-0.15	0.14		nd	0.09	nd	0.32
17A ₁		N45° 21' 31.5", W85° 11' 20.8"	0.00-0.15	0.49		nd	0.08	nd	0.38
17A ₁		N45° 21' 31.9", W85° 11' 37.0"	0.00-0.15	0.08		nd	0.05	nd	0.27
17A ₁		N45° 21' 29.5", W85° 11' 15.5"	0.00-0.15	0.30		nd	0.04	nd	0.30
17A ₁		N45° 21' 27.2", W85° 11' 24.4"	0.00-0.15	0.45		nd	0.06	nd	0.32
17A ₁		N45° 21' 34.1", W85° 11' 09.8"	0.00-0.15	0.66		nd	0.07	nd	0.35
17A ₁		N45° 21' 34.6", W85° 11' 33.6"	0.00-0.15	0.10		nd	0.07	nd	0.33
17A ₁		N45° 21' 33.9", W85° 11' 12.5"	0.00-0.15	0.48		nd	0.05	nd	0.29
17A ₁		N45° 21' 29.2", W85° 11' 41.6"	0.00-0.15	0.76		nd	0.09	nd	0.36
17A ₁		N45° 21' 29.2", W85° 11' 13.1"	0.00-0.15	0.51		nd	0.08	nd	0.42
17A ₁		N45° 21' 33.5", W85° 11' 13.5"	0.00-0.15	0.54		nd	0.05	nd	0.39
17A ₁		N45° 21' 35.7", W85° 11' 13.7"	0.00-0.15	0.49		nd	0.06	nd	0.31
17A ₁		N45° 21' 36.7", W85° 11' 14.1"	0.00-0.15	0.92		nd	0.06	nd	0.26
17A ₁		N45° 21' 27.5", W85° 11' 21.6"	0.00-0.15	0.54		nd	0.06	nd	0.29
17A ₁		N45° 21' 29.1", W85° 11' 35.4"	0.00-0.15	0.61		nd	0.08	nd	0.29

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Survey	Grid Coordinate (x,y) (X Longitude, Y Latitude)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
			Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
17A ₁	N45° 21' 28.3", W85° 11' 16.8"	0.00-0.15	0.44		nd	0.07	nd	0.37
17A ₁	N45° 21' 30.2", W85° 11' 40.5"	0.00-0.15	1.59		nd	0.10	nd	0.41
17A ₁	N45° 21' 36.3", W85° 11' 13.0"	0.00-0.15	0.32		nd	0.05	nd	0.29
17A ₁	N45° 21' 30.2", W85° 11' 35.1"	0.00-0.15	0.91		nd	0.08	nd	0.41
17A ₁	N45° 21' 27.8", W85° 11' 19.1"	0.00-0.15	0.20		nd	0.05	nd	0.27
17A ₁	N45° 21' 34.2", W85° 11' 06.6"	0.00-0.15	0.92		nd	0.07	nd	0.38

^a nd indicates non detect, MDA provided

^b No entry in the MDA column is provided when residual radioactivity is detected

Survey Unit 18

Description

Survey Unit 18 is an area of approximately 84,000 m² located west of the Protected Area. There are no structures, components, and systems in this survey unit.

History

This outlying area has remained remote from normal plant operational activities. The HSA designates this area to be unlikely to contain residual radioactivity.

Radiological Status

Residual radioactivity in soils in this survey unit are consistent with established background levels. The radiological status of Survey Unit 17 is Class 3 due to its proximity to other Class 2 Areas.

Primary Survey Design

1. Sample Data Points Required

The scoping survey resulted in the following data:

Nuclide identification	Cs-137
Mean value (pCi/g)	0.50
Standard Deviation (σ)	0.40

The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL.

$$\text{Relative Shift} = \frac{\text{DCGL} - \text{LBGR}}{\sigma} = \frac{5.11 - 2.5}{0.40} = 6.5$$

With α and β error levels set at 0.05 and an assumed relative shift of 3, the Sign Test requirements specify a sample size of 14 data points. As a conservative measure 20 samples were collected for this survey.

2. Sample Locations

Sample locations were selected by random method

Bounding survey unit dimensions 330 x 375 meters. Random numbers were generated and applied to bounding survey unit dimensions to determine data point coordinate locations. This process was continued until 20 sample point locations successfully fell within the survey unit.

Supporting Surveys

Supporting surveys were not conducted in this area..

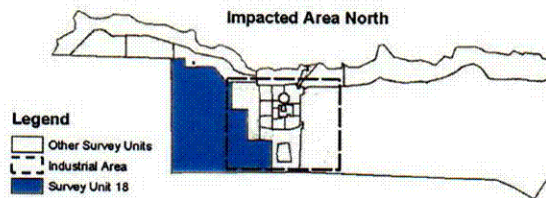
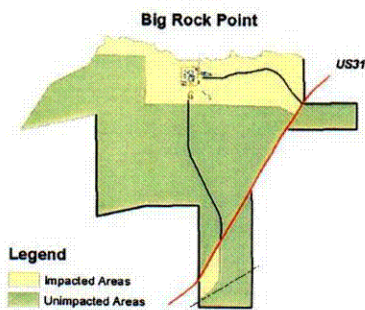
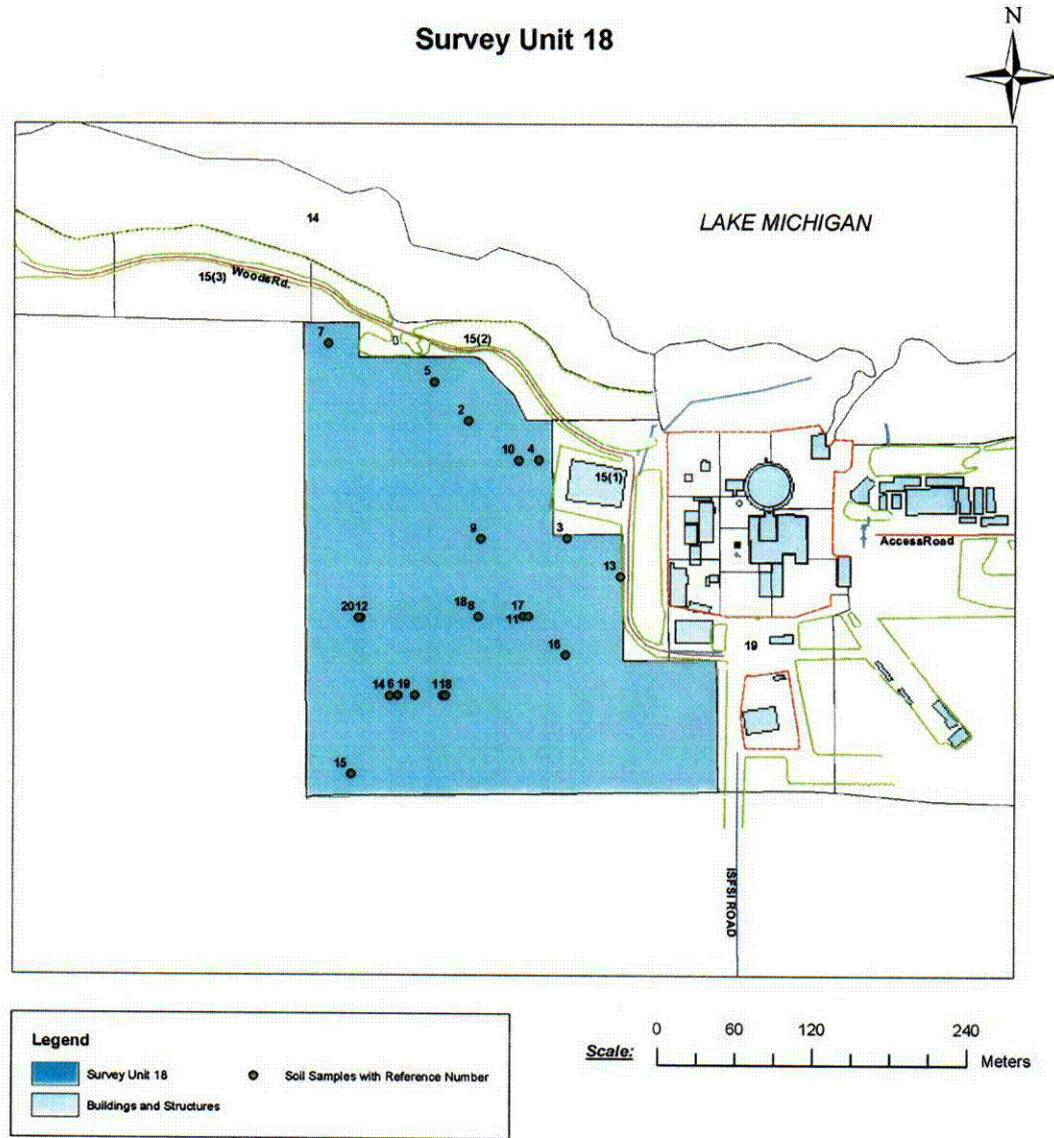
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Data Summary

Survey Unit 18A

Survey	No. of Samples	Radionuclides	Mean (pCi/g)	Max. Value (pCi/g)
18A ₁	20	Cs ₁₃₇	0.60	1.00



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Survey Results

Surveys	Coordinate (X:Longitude, Y:Latitude)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
		Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
18A ₁	N45 21'29.8", W85 11'55.9"	0.48		nd	0.06	nd	0.32
18A ₁	N45 21'37.3", W85 11'54.9"	0.51		nd	0.06	nd	0.28
18A ₁	N45 21'33.5", W85 11'51.4"	0.53		nd	0.06	nd	0.39
18A ₁	N45 21'36.2", W85 11'52.4"	0.48		nd	0.07	nd	0.30
18A ₁	N45 21'37.9", W85 11'56.1"	0.49		nd	0.06	nd	0.26
18A ₁	N45 21'29.9", W85 11'57.5"	0.31		nd	0.06	nd	0.34
18A ₁	N45 21'38.6", W85 11'59.9"	0.50		nd	0.07	nd	0.31
18A ₁	N45 21'31.5", W85 11'54.6"	1.00		nd	0.09	nd	0.43
18A ₁	N45 21'33.8", W85 11'54.5"	0.60		nd	0.05	nd	0.24
18A ₁	N45 21'36.3", W85 11'53.1"	0.55		nd	0.06	nd	0.26
18A ₁	N45 21'32.5", W85 11'53.0"	0.37		nd	0.05	nd	0.27
18A ₁	N45 21'32.5", W85 11'58.8"	0.82		nd	0.07	nd	0.37
18A ₁	N45 21'32.7", W85 11'49.5"	0.93		nd	0.08	nd	0.41
18A ₁	N45 21'30.2", W85 11'57.8"	0.47		nd	0.06	nd	0.34
18A ₁	N45 21'28.3", W85 11'59.2"	0.74		nd	0.08	nd	0.43
18A ₁	N45 21'31.3", W85 11'51.5"	0.53		nd	0.06	nd	0.31
18A ₁	N45 21'32.4", W85 11'52.8"	0.60		nd	0.06	nd	0.40
18A ₁	N45 21'29.9", W85 11'55.8"	0.75		nd	0.08	nd	0.35
18A ₁	N45 21'29.9", N85 11'56.9"	0.93		nd	0.09	nd	0.34
18A ₁	N45 21'32.0", W85 11'58.9"	0.35		nd	0.07	nd	0.34

^a nd indicates non detect, MDA provided

^b No entry in the MDA column is provided when residual radioactivity is detected

Table format not consistent with others (grid, depth??)

Survey Unit 19

Description

Survey Unit 19 is an area of approximately 12,000 m² located directly south of the Protected Area. A large portion of this location has been paved to support the transport of materials to the Radwaste Storage Building located in Survey Unit 11. The Radwaste Office Building and plant substation located in the northern section of this survey unit were both constructed subsequent to final plant shut-down. Subsurface structures and components include substation footings, storm drain piping, groundwater monitoring wells, station power conduit, and electronic communication wiring.

History

This area was used as a transport and staging location for the movement of radioactive materials to the Radwaste Building. A road construction project was conducted following final plant shutdown to pave areas north of the Radwaste Building and construct a roadway to the ISFSI storage facility for spent fuel transport. Surveys conducted prior to road construction in these areas did not identify residual radioactivity in soil above established background levels.

Radiological Status

Residual radioactivity was not identified above established background levels in any survey conducted in this area. The radiological status of Survey Unit 19 is Class 2. Further characterization of this area is scheduled to continue as systems and structures are removed from the site.

Primary Survey Design

The first characterization surveys performed following cessation of power operations were conducted to investigate areas scheduled for construction (trenching, excavation, road surfacing) prior to soil disturbance. Initial surveys performed in Survey Unit 19 were conducted to support paving of the transport route north of the Radwaste Building and construction of the spent fuel roadway to the ISFSI facility. Due to sampling limitations resulting from accessibility, subsurface obstruction, and electrical hazards in northern portions of this survey unit, primary surveys were conducted by the following two methods:

1. **Survey Design, Sections North And West**
In-Situ measurements were performed in 100 m² increments in all accessible areas. Soil samples were collected for laboratory analysis and confirmation of contaminant homogeneity. Survey results for In-Situ measurements and corresponding soil analyses are presented by survey grid location in Table 2.
2. **Survey Design, Sections South And East**
Area evaluation performed by soil sampling and laboratory analysis. Sample size and data point locations were based on NUREG-1575 guidance.

a. Sample Data Points Required

The scoping survey resulted in the following data:

Nuclide identification	C-137
Mean value (pCi/g)	0.52
Standard Deviation (σ)	0.48

The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL.

$$\text{Relative Shift} = \frac{\text{DCGL} - \text{LBGR}}{\sigma} = \frac{5.11 - 2.5}{0.48} = 5.45$$

With α and β error levels set at 0.05 and an assumed relative shift of 3, the Sign Test requirements specify a sample size of 14 data points.

b. Sample Locations

Sample locations were systematically selected in random start, square grid pattern with the southwest corner of the survey unit as origin.

Bounding survey unit dimensions 80 X 130 meters

Random Numbers 0.694949, 0.979969

Random Start Location

$$X = (0.694949)(80 \text{ m}) = 55.6 \text{ m}$$

$$Y = (0.979969)(130 \text{ m}) = 127.4 \text{ m}$$

$$\text{Sample Spacing } L = \sqrt{\text{Area}/N} = \sqrt{5600/14} = 20.0 \text{ m}$$

As a conservative measure 25 samples were collected using 15 meter spacing.

Soil analyses for all samples collected in the south and east sections Survey Unit 19 are summarized by survey in Table 1.

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Supporting Surveys

Surveys were conducted prior to construction in areas scheduled for fiber optics installation, storm drain modification, and erection of the plant substation.

Data Summary

Survey Unit 19

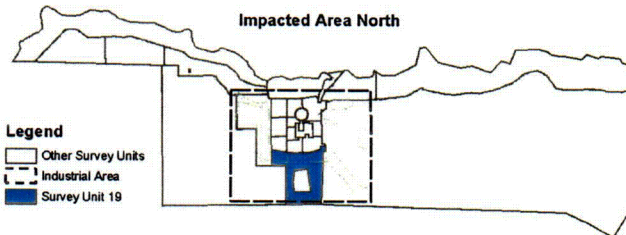
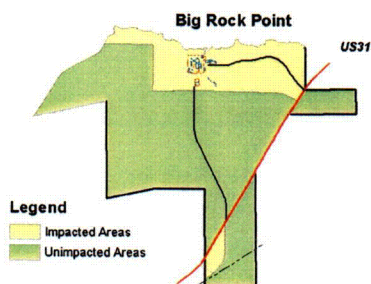
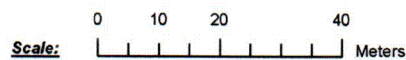
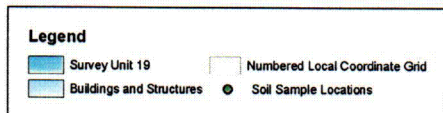
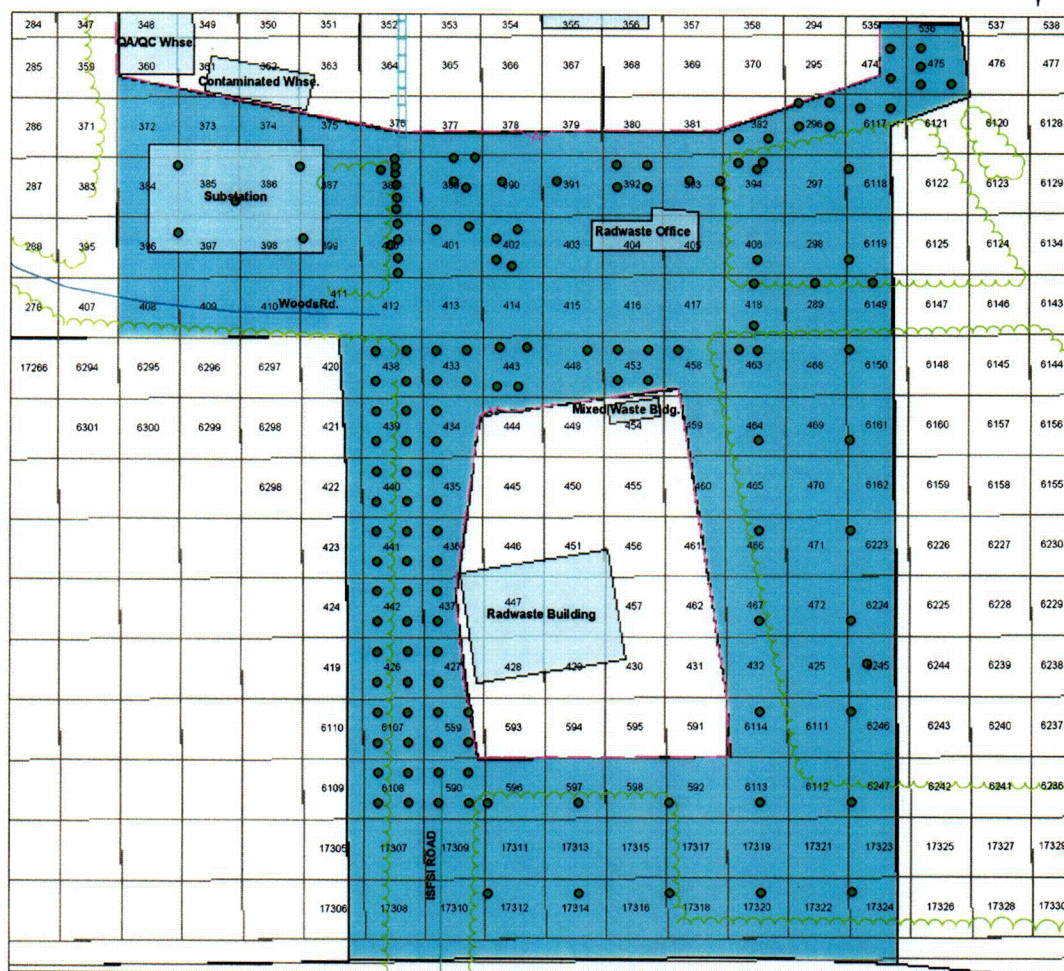
Survey **	No. of Samples	Radionuclides*	Mean (pCi/g)	Max. Value (pCi/g)
19A ₁	79	Cs ₁₃₇	0.18	0.45
19A ₂	26	Cs ₁₃₇	0.15	0.31
19A ₃	25	Cs ₁₃₇	0.61	1.10
		***Co ₆₀	0.12	0.12
19A _{culvert connection}	4	Cs ₁₃₇	0.22	0.35
19A _{deepcore}	2	nd	-	-
19A _{td}	15	nd	-	-

*nd - non detect

**td – trenching and digging surveys

***Co-60 identified in one sample only

Survey Unit 19



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Survey Results – Table 1

Survey ^c	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
19A ₁	401	(2.5,7.5)	0.00-0.15	nd	0.10	nd	0.08	nd	0.19
19A ₁	402	(5.0,1.5)	0.00-0.15	nd	0.11	nd	0.10	nd	0.20
19A ₁	402	(6.0,7.5)	0.00-0.15	nd	0.08	nd	0.10	nd	0.16
19A ₁	402	(2.5,2.5)	0.00-0.15	0.31		nd	0.12	nd	0.20
19A ₁	402	(2.5,6.0)	0.00-0.15	0.45		nd	0.16	nd	0.20
19A ₁	418	(5.0,8.5)	0.00-0.15	0.14		nd	0.11	nd	0.22
19A ₁	418	(5.0,1.5)	0.00-0.15	nd	0.14	nd	0.17	nd	0.25
19A ₁	418	(5.0,1.5)	0.15-0.30	nd	0.10	nd	0.06	nd	0.21
19A ₁	289	(5.0,8.5)	0.00-0.15	nd	0.09	nd	0.10	nd	0.24
19A ₁	6149	(4.5,8.5)	0.00-0.15	nd	0.14	nd	0.10	nd	0.21
19A ₁	438	(2.5,2.5)	0.00-0.15	0.27		nd	0.07	nd	0.20
19A ₁	438	(7.5,2.5)	0.00-0.15	nd	0.09	nd	0.08	nd	0.17
19A ₁	438	(2.5,7.5)	0.00-0.15	0.07		nd	0.08	nd	0.16
19A ₁	438	(7.5,7.5)	0.00-0.15	nd	0.09	nd	0.08	nd	0.17
19A ₁	433	(2.5,2.5)	0.00-0.15	nd	0.09	nd	0.06	nd	0.16
19A ₁	433	(7.5,2.5)	0.00-0.15	nd	0.07	nd	0.07	nd	0.15
19A ₁	433	(2.5,7.5)	0.00-0.15	0.24		nd	0.12	nd	0.16
19A ₁	433	(2.5,7.5)	0.15-0.30	0.07		nd	0.02	nd	0.17
19A ₁	433	(7.5,7.5)	0.00-0.15	nd	0.07	nd	0.07	nd	0.16
19A ₁	443	(2.5,1.5)	0.00-0.15	0.17		nd	0.12	nd	0.19
19A ₁	443	(6.0,1.5)	0.00-0.15	0.12		nd	0.11	nd	0.19
19A ₁	443	(6.0,1.5)	0.15-0.30	0.12		nd	0.12		0.21
19A ₁	443	(3.0,8.0)	0.00-0.15	0.24		nd	0.11	nd	0.17
19A ₁	443	(7.5,8.0)	0.00-0.15	0.20		nd	0.13	nd	0.16
19A ₁	448	(7.5,7.5)	0.00-0.15	nd	0.06	nd	0.07	nd	0.17
19A ₁	453	(2.5,2.5)	0.00-0.15	nd	0.09	nd	0.1	nd	0.17
19A ₁	453	(7.5,2.5)	0.00-0.15	nd	0.12	nd	0.16	nd	0.17
19A ₁	453	(2.5,7.5)	0.00-0.15	0.16		nd	0.10	nd	0.18
19A ₁	453	(7.5,7.5)	0.00-0.15	0.12		nd	0.10	nd	0.19
19A ₁	453	(7.5,7.5)	0.15-0.30	0.17		nd	0.10	nd	0.22
19A ₁	458	(2.5,7.5)	0.00-0.15	0.11		nd	0.11	nd	0.17
19A ₁	439	(2.5,2.5)	0.00-0.15	0.32		nd	0.03	nd	0.23
19A ₁	439	(7.5,2.5)	0.00-0.15	nd	0.05	nd	0.07	nd	0.18
19A ₁	439	(2.5,7.5)	0.00-0.15	0.23		nd	0.06	nd	0.25
19A ₁	439	(7.5,7.5)	0.00-0.15	nd	0.04	nd	0.04	nd	0.21
19A ₁	434	(2.5,2.5)	0.00-0.15	0.09		nd	0.04	nd	0.18
19A ₁	434	(2.5,7.5)	0.00-0.15	nd	0.07	nd	0.07	nd	0.18
19A ₁	440	(2.5,2.5)	0.00-0.15	0.14		nd	0.03	nd	0.23
19A ₁	440	(7.5,2.5)	0.00-0.15	0.02		nd	0.03	nd	0.21
19A ₁	440	(2.5,7.5)	0.00-0.15	0.23		nd	0.07	nd	0.26

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				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
19A ₁	440	(7.5,7.5)	0.00-0.15	nd	0.09	nd	0.06	nd	0.18
19A ₁	435	(2.5,2.5)	0.00-0.15	0.05		nd	0.04	nd	0.23
19A ₁	435	(2.5,7.5)	0.00-0.15	0.14		nd	0.08	nd	0.18
19A ₁	441	(2.5,2.5)	0.00-0.15	0.25		nd	0.05	nd	0.27
19A ₁	441	(7.5,2.5)	0.00-0.15	nd	0.09	nd	0.07	nd	0.14
19A ₁	441	(2.5,7.5)	0.00-0.15	0.20		nd	0.09	nd	0.21
19A ₁	441	(7.5,7.5)	0.00-0.15	nd	0.07	nd	0.07	nd	0.14
19A ₁	436	(2.5,2.5)	0.00-0.15	nd	0.08	nd	0.08	nd	0.15
19A ₁	436	(2.5,7.5)	0.00-0.15	0.19		nd	0.07	nd	0.15
19A ₁	442	(2.5,2.5)	0.00-0.15	0.36		nd	0.12	nd	0.2
19A ₁	442	(2.5,2.5)	0.15-0.30	0.26		nd	0.14	nd	0.19
19A ₁	442	(7.5,2.5)	0.00-0.15	nd	0.08	nd	0.11	nd	0.19
19A ₁	442	(2.5,7.5)	0.00-0.15	0.13		nd	0.11	nd	0.22
19A ₁	442	(7.5,7.5)	0.00-0.15	nd	0.08	nd	0.08	nd	0.17
19A ₁	437	(2.5,2.5)	0.00-0.15	nd	0.07	nd	0.08	nd	0.18
19A ₁	437	(2.5,7.5)	0.00-0.15	nd	0.06	nd	0.07	nd	0.18
19A ₁	426	(2.5,2.5)	0.00-0.15	0.28		nd	0.04	nd	0.23
19A ₁	426	(7.5,2.5)	0.00-0.15	nd	0.08	nd	0.12	nd	0.18
19A ₁	426	(2.5,7.5)	0.00-0.15	0.32		nd	0.08	nd	0.21
19A ₁	426	(7.5,7.5)	0.00-0.15	nd	0.04	nd	0.04	nd	0.23
19A ₁	427	(2.5,2.5)	0.00-0.15	nd	0.06	nd	0.07	nd	0.13
19A ₁	427	(2.5,7.5)	0.00-0.15	0.02		nd	0.03	nd	0.19
19A ₁	6107	(2.5,2.5)	0.00-0.15	nd	0.13	nd	0.09	nd	0.20
19A ₁	6107	(7.5,2.5)	0.00-0.15	nd	0.10	nd	0.11	nd	0.21
19A ₁	6107	(2.5,7.5)	0.00-0.15	0.09		nd	0.13	nd	0.22
19A ₁	6107	(7.5,7.5)	0.00-0.15	nd	0.06	nd	0.02	nd	0.15
19A ₁	589	(2.5,2.5)	0.00-0.15	nd	0.05	nd	0.09	nd	0.17
19A ₁	589	(7.5,2.5)	0.00-0.15	nd	0.06	nd	0.09	nd	0.19
19A ₁	589	(2.5,7.5)	0.00-0.15	nd	0.06	nd	0.08	nd	0.20
19A ₁	589	(7.5,7.5)	0.00-0.15	nd	0.03	nd	0.04	nd	0.20
19A ₁	6108	(2.5,2.5)	0.00-0.15	nd	0.10	nd	0.07	nd	0.19
19A ₁	6108	(7.5,2.5)	0.00-0.15	nd	0.09	nd	0.08	nd	0.21
19A ₁	6108	(2.5,7.5)	0.00-0.15	nd	0.13	nd	0.11	nd	0.20
19A ₁	6108	(7.5,7.5)	0.00-0.15	nd	0.07	nd	0.08	nd	0.19
19A ₁	590	(2.5,2.5)	0.00-0.15	nd	0.10	nd	0.09	nd	0.21
19A ₁	590	(7.5,2.5)	0.00-0.15	nd	0.09	nd	0.10	nd	0.14
19A ₁	590	(2.5,7.5)	0.00-0.15	0.11		nd	0.05	nd	0.26
19A ₁	590	(2.5,7.5)	0.15-0.30	0.19		nd	0.07	nd	0.21
19A ₁	590	(7.5,7.5)	0.00-0.15	nd	0.06	nd	0.10	nd	0.20
19A ₂	388	(3.5,7.5)	0.00-0.15	0.11		nd	0.06	nd	0.22
19A ₂	389	(5.5,5.5)	0.00-0.15	0.20		nd	0.14	nd	0.15
19A ₂	390	(3.5,5.5)	0.00-0.15	0.31		nd	0.09	nd	0.18

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				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
19A ₂	391	(2.5,5.5)	0.00-0.15	0.07		nd	0.09	nd	0.21
19A ₂	392	(2.5,4.5)	0.00-0.15	nd	0.10	nd	0.13	nd	0.21
19A ₂	392	(7.5,4.5)	0.00-0.15	0.25		nd	0.16	nd	0.23
19A ₂	392	(2.5,8.2)	0.00-0.15	0.15		nd	0.09	nd	0.17
19A ₂	392	(7.5,8.2)	0.00-0.15	0.14		nd	0.13	nd	0.18
19A ₂	393	(4.5,5.5)	0.00-0.15	0.10		nd	0.13	nd	0.20
19A ₂	393	(9.5,5.5)	0.00-0.15	0.11		nd	0.05	nd	0.13
19A ₂	394	(2.5,8.5)	0.00-0.15	0.20		nd	0.14	nd	0.19
19A ₂	394	(6.5,8.5)	0.00-0.15	0.13		nd	0.13	nd	0.23
19A ₂	382	(2.5,2.5)	0.00-0.15	nd	0.10	nd	0.07	nd	0.21
19A ₂	382	(7.5,2.5)	0.00-0.15	0.13		nd	0.16	nd	0.18
19A ₂	296	(2.5,4.5)	0.00-0.15	0.16		nd	0.12	nd	0.16
19A ₂	296	(7.5,4.5)	0.00-0.15	nd	0.08	nd	0.12	nd	0.19
19A ₂	296	(2.5,8.5)	0.00-0.15	0.09		nd	0.11	nd	0.19
19A ₂	296	(7.5,8.5)	0.00-0.15	nd	0.07	nd	0.15	nd	0.15
19A ₂	6117	(2.5,7.5)	0.00-0.15	nd	0.09	nd	0.12	nd	0.19
19A ₂	6117	(7.5,7.5)	0.00-0.15	0.09		nd	0.14	nd	0.18
19A ₂	474	(2.5,2.5)	0.00-0.15	nd	0.10	nd	0.12	nd	0.18
19A ₂	474	(2.5,7.5)	0.00-0.15	nd	0.10	nd	0.16	nd	0.22
19A ₂	475	(2.5,1.5)	0.00-0.15	0.19		nd	0.13	nd	0.16
19A ₂	475	(2.5,4.5)	0.00-0.15	nd	0.11	nd	0.13	nd	0.18
19A ₂	475	(2.5,7.5)	0.00-0.15	nd	0.08	nd	0.09	nd	0.16
19A ₂	475	(7.5,1.5)	0.00-0.15	nd	0.14	nd	0.09	nd	0.18
19A ₃	394	(5.6,7.4)	0.00-0.15	0.26		nd	0.11	nd	0.42
19A ₃	6118	(0.6,7.4)	0.00-0.15	0.52		0.12		nd	0.28
19A ₃	406	(5.6,2.4)	0.00-0.15	0.60		nd	0.08	nd	0.31
19A ₃	6119	(0.6,2.4)	0.00-0.15	0.98		nd	0.08	nd	0.37
19A ₃	463	(5.6,7.4)	0.00-0.15	0.97		nd	0.09	nd	0.40
19A ₃	6150	(0.6,7.4)	0.00-0.15	0.55		nd	0.10	nd	0.32
19A ₃	464	(5.6,2.4)	0.00-0.15	0.72		nd	0.09	nd	0.36
19A ₃	6161	(0.6,2.4)	0.00-0.15	0.86		nd	0.06	nd	0.27
19A ₃	466	(5.6,7.4)	0.00-0.15	0.22		nd	0.05	nd	0.24
19A ₃	6223	(0.6,7.4)	0.00-0.15	0.83		nd	0.07	nd	0.42
19A ₃	467	(5.6,2.4)	0.00-0.15	1.10		nd	0.08	nd	0.41
19A ₃	6224	(0.6,2.4)	0.00-0.15	0.77		nd	0.09	nd	0.42
19A ₃	6114	(5.6,7.4)	0.00-0.15	0.44		nd	0.08	nd	0.40
19A ₃	6246	(0.6,7.4)	0.00-0.15	0.58		nd	0.07	nd	0.36
19A ₃	596	(0.6,2.4)	0.00-0.15	0.24		nd	0.07	nd	0.30
19A ₃	597	(5.6,2.4)	0.00-0.15	0.59		nd	0.09	nd	0.32
19A ₃	592	(0.6,2.4)	0.00-0.15	0.33		nd	0.06	nd	0.25
19A ₃	6113	(5.6,2.4)	0.00-0.15	0.86		nd	0.11	nd	0.37
19A ₃	6247	(0.6,2.4)	0.00-0.15	0.40		nd	0.09	nd	0.38

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				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
19A ₃	28S, 6E	(0.6,7.4)	0.00-0.15	0.69		nd	0.07	nd	0.33
19A ₃	28S, 7E	(5.6,7.4)	0.00-0.15	0.50		nd	0.12	nd	0.36
19A ₃	28S, 9E	(0.6,7.4)	0.00-0.15	0.50		nd	0.09	nd	0.35
19A ₃	28S, 10E	(5.6,7.4)	0.00-0.15	0.35		nd	0.08	nd	0.36
19A ₃	28S, 12E	(0.6,7.4)	0.00-0.15	1.08		nd	0.08	nd	0.40
19A ₃	6245	(3.2,5.3)	0.00-0.15	0.37		nd	0.07	nd	0.35
19A _{cc}	401	(8.0,8.0)	0.00-0.15	0.19		nd	0.06	nd	0.23
19A _{cc}	389	(7.5,4.5)	0.00-0.15	nd	0.05	nd	0.06	nd	0.23
19A _{cc}	389	(5.5,9.5)	0.00-0.15	0.12		nd	0.06	nd	0.21
19A _{cc}	389	(9.0,9.5)	0.00-0.15	0.35		nd	0.06	nd	0.29
19A _{deepcore}	400	(5.0,5.0)	0.00-1.80	nd	0.04	nd	0.03	nd	0.17
19A _{deepcore}	400	(5.0,5.0)	1.80-3.00	nd	0.03	nd	0.03	nd	0.18
19A _{td}	385	(0.5,8.4)	0.00-0.15	nd	^d	nd	^d	nd	^d
19A _{td}	385	(9.4,2.6)	0.00-0.15	nd	^d	nd	^d	nd	^d
19A _{td}	386	(0.9,8.0)	0.00-0.15	nd	^d	nd	^d	nd	^d
19A _{td}	388	(5.4,0.5)	0.00-0.15	nd	^d	nd	^d	nd	^d
19A _{td}	388	(5.4,3.0)	0.00-0.15	nd	^d	nd	^d	nd	^d
19A _{td}	388	(5.4,5.5)	0.00-0.15	nd	^d	nd	^d	nd	^d
19A _{td}	388	(5.4,8.0)	0.00-0.15	nd	^d	nd	^d	nd	^d
19A _{td}	397	(0.5,7.0)	0.00-0.15	nd	^d	nd	^d	nd	^d
19A _{td}	399	(0.6,6.2)	0.00-0.15	nd	^d	nd	^d	nd	^d
19A _{td}	400	(5.4,0.5)	0.00-0.15	nd	^d	nd	^d	nd	^d
19A _{td}	400	(5.4,2.0)	0.00-0.15	nd	^d	nd	^d	nd	^d
19A _{td}	400	(5.4,3.5)	0.00-0.15	nd	^d	nd	^d	nd	^d
19A _{td}	400	(5.4,6.0)	0.00-0.15	nd	^d	nd	^d	nd	^d
19A _{td}	400	(5.4,7.5)	0.00-0.15	nd	^d	nd	^d	nd	^d
19A _{td}	400	(5.4,9.0)	0.00-0.15	nd	^d	nd	^d	nd	^d

^a nd indicates non detect, MDA provided

^b No entry in the MDA column is provided when residual radioactivity is detected

^c td – trenching and digging surveys, cc – culvert connection

^d MDA values for samples collected during substation construction unavailable

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Survey Results – Table 2

Grid	Coordinate	Soil Samples Analyses				Insitu Gamma Measurement			
		Cs-137 (pCi/g)		Co-60 (pCi/g)		Cs-137 (pCi/g)		Co-60 (pCi/g)	
		Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
400	c					Nd	0.34	nd	0.37
401	(2.5,7.5)	nd	0.10	nd	0.08	0.20		nd	0.44
402	(5.0,1.5)	nd	0.11	nd	0.10	Nd	0.35	nd	0.44
	(6.0,7.5)	nd	0.08	nd	0.10				
	(2.5,2.5)	0.31		nd	0.12				
	(2.5,6.0)	0.45		nd	0.16				
403	c					Nd	0.32	nd	0.43
404	c								
405	c					Nd	0.26	nd	0.36
412	c					Nd	0.35	nd	0.45
413	c					Nd	0.36	nd	0.48
414	c					Nd	0.38	nd	0.50
415	c					Nd	0.36	nd	0.51*
416	c								
417	c					nd	0.32	nd	0.46
418	(5.0,8.5)	0.14		nd	0.11	0.28		nd	0.40
	(5.0,1.5)	nd	0.14	nd	0.17				
	(5.0,1.5) 15-30 cm	nd	0.10	nd	0.06				
289	(5.0,8.5)	nd	0.09	nd	0.10	nd	0.31	nd	0.34
6149	(4.5,8.5)	nd	0.14	nd	0.10	nd	0.30	nd	0.30
438	(2.5,2.5)	0.27		nd	0.07	nd	0.44	nd	0.57**
	(7.5,2.5)	nd	0.09	nd	0.08				
	(2.5,7.5)	0.07		nd	0.08				
	(7.5,7.5)	nd	0.09	nd	0.08				
433	(2.5,2.5)	nd	0.09	nd	0.06	nd	0.42	nd	0.60**
	(7.5,2.5)	nd	0.07	nd	0.07				
	(2.5,7.5)	0.24		nd	0.12				
	(2.5,7.5) 15-30 cm	0.07		nd	0.02				
443	(7.5,7.5)	nd	0.07	nd	0.07				
	(2.5,1.5)	0.17			0.12	nd	0.51	nd	0.72**
	(6.0,1.5)	0.12			0.11				
	(6.0,1.5)	0.12		nd	0.12				
	(3.0,8.0)	0.24			0.11				
	(7.5,8.0)	0.20			0.13				
448	(7.5,7.5)	nd	0.06	nd	0.07	nd	0.45	0.51	0.66**
453	(2.5,2.5)	nd	0.09	nd	0.1				
	(7.5,2.5)	nd	0.12	nd	0.16				
	(2.5,7.5)	0.16		nd	0.1				
	(7.5,7.5)	0.12		nd	0.1				
	(7.5,7.5)	0.17		nd	0.10				
458	(2.5,7.5)	0.11		nd	0.11				
439	(2.5,2.5)	0.32		nd	0.03	0.47		nd	0.66**

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Grid	Coordinate	Soil Samples Analyses				Insitu Gamma Measurement			
		Cs-137 (pCi/g)		Co-60 (pCi/g)		Cs-137 (pCi/g)		Co-60 (pCi/g)	
		Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
439	(7.5,2.5)	nd	0.05	nd	0.07				
	(2.5,7.5)	0.23		nd	0.06				
	(7.5,7.5)	nd	0.04	nd	0.04				
434	(2.5,2.5)	0.09		nd	0.04	nd	0.49	nd	0.70**
	(2.5,7.5)	nd	0.07	nd	0.07				
440	(2.5,2.5)	0.14		nd	0.03	nd	0.33	nd	0.48
	(7.5,2.5)	0.02		nd	0.03				
	(2.5,7.5)	0.23		nd	0.07				
	(7.5,7.5)	nd	0.09	nd	0.06				
435	(2.5,2.5)	0.05		nd	0.04	nd	0.84**	nd	0.93**
	(2.5,7.5)	0.14		nd	0.08				
441	(2.5,2.5)	0.25		nd	0.05	nd	0.51	nd	0.70**
	(7.5,2.5)	nd	0.09	nd	0.07				
	(2.5,7.5)	0.2		nd	0.09				
	(7.5,7.5)	nd	0.07	nd	0.07				
436	(2.5,2.5)	nd	0.08	nd	0.08	^d			
	(2.5,7.5)	0.19		nd	0.07				
442	(2.5,2.5)	0.36		nd	0.12	nd	0.52**	nd	0.73**
	(2.5,2.5)	0.26		nd	0.14				
	(7.5,2.5)	nd	0.08	nd	0.11				
	(2.5,7.5)	0.13		nd	0.11				
	(7.5,7.5)	nd	0.08	nd	0.08				
437	(2.5,2.5)	nd	0.07	nd	0.08	^d			
	(2.5,7.5)	nd	0.06	nd	0.07				
426	(2.5,2.5)	0.28		nd	0.04	nd	0.50	nd	0.66**
	(7.5,2.5)	nd	0.08	nd	0.12				
	(2.5,7.5)	0.32		nd	0.08				
	(7.5,7.5)	nd	0.04	nd	0.04				
427	(2.5,2.5)	nd	0.06	nd	0.07	^d			
	(2.5,7.5)	0.02		nd	0.03				
6107	(2.5,2.5)	nd	0.13	nd	0.09	nd	0.50	nd	0.65**
	(7.5,2.5)	nd	0.10	nd	0.11				
	(2.5,7.5)	0.09		nd	0.13				
	(7.5,7.5)	nd	0.06	nd	0.02				
589	(2.5,2.5)	nd	0.05	nd	0.09	nd	0.51	nd	0.66**
	(7.5,2.5)	nd	0.06	nd	0.09				
	(2.5,7.5)	nd	0.06	nd	0.08				
	(7.5,7.5)	nd	0.03	nd	0.04				
6108	(2.5,2.5)	nd	0.10	nd	0.07	nd	0.51	nd	0.60
	(7.5,2.5)	nd	0.09	nd	0.08				
	(2.5,7.5)	nd	0.13	nd	0.11				
	(7.5,7.5)	nd	0.07	nd	0.08				

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Grid	Coordinate	Soil Samples Analyses				Insitu Gamma Measurement			
		Cs-137 (pCi/g)		Co-60 (pCi/g)		Cs-137 (pCi/g)		Co-60 (pCi/g)	
		Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
590	(2.5,2.5)	nd	0.10	nd	0.09	nd	0.50	nd	0.60**
	(7.5,2.5)	nd	0.09	nd	0.10				
	(2.5,7.5)	0.11		nd	0.05				
	(2.5,7.5)	0.19		nd	0.07				
	(7.5,7.5)	nd	0.06	nd	0.10				
388	(3.5,7.5)	0.11		nd	0.06		0.29		0.38
389	(5.5,5.5)	0.20		nd	0.14		0.31		0.39
390	(3.5,5.5)	0.31		nd	0.09		0.30		0.34
391	(2.5,5.5)	0.07		nd	0.09	^c			
392	(2.5,4.5)	nd	0.10	nd	0.13	^d			
	(7.5,4.5)	0.25		nd	0.16				
	(2.5,8.2)	0.15		nd	0.09				
	(7.5,8.2)	0.14		nd	0.13				
393	(4.5,5.5)	0.10		nd	0.13	^d			
	(9.5,5.5)	0.11		nd	0.05				
394	(2.5,8.5)	0.20		nd	0.14	^d			
	(6.5,8.5)	0.13		nd	0.13				
382	(2.5,2.5)	nd	0.10	nd	0.07	^d			
	(7.5,2.5)	0.13		nd	0.16				
296	(2.5,4.5)	0.16		nd	0.12	^d			
	(7.5,4.5)	nd	0.08	nd	0.12				
	(2.5,8.5)	0.09		nd	0.11				
	(7.5,8.5)	nd	0.07	nd	0.15				
6117	(2.5,7.5)	nd	0.09	nd	0.12	^d			
	(7.5,7.5)	0.09		nd	0.14				
474	(2.5,2.5)	nd	0.10	nd	0.12				
	(2.5,7.5)	nd	0.10	nd	0.16				
475	(2.5,1.5)	0.19		nd	0.13				
	(2.5,4.5)	nd	0.11	nd	0.13				
	(2.5,7.5)	nd	0.08	nd	0.09				
	(7.5,1.5)	nd	0.14	nd	0.09				
6143	^c					nd	0.24	nd	0.27
6146	^c					nd	0.28	nd	0.27
6147	^c					nd	0.29	nd	0.28

^a nd indicates non detect, MDA provided

^b No entry in the MDA column is provided when residual radioactivity is detected

^c Soil sample unobtainable due to subsurface electrical hazard

^d Insitu measurement unobtainable due to powerline obstruction or elevated background activity.

Survey Unit 59

Description

Survey Unit 59 is an extension of the owner-controlled property that is separated from the main site by US Route 31. This location is approximately 33,589 m² in area and encompasses a portion of an abandoned railroad spur that once serviced the site during plant construction. The railroad grade remains; however, the rails and ties have been removed. Survey Unit 59 is an open field with forested areas located south and east of the rail grade. An unimproved lane connects the rail grade to US Route 31 provides access into this area. Subsurface structures and components do not exist in this survey unit.

History

This survey unit is an outlying area that has remained remote from plant operational activities. At the time of final plant shut down this area met the classification requirements for Non Impacted Area status. Subsequent decommissioning activities have required this area to be used for the storage of clean bulk soil. A physical inspection of the area following soil storage identified chunks of broken concrete that had inadvertently been transported with the soil. An investigation of this event identified Co-60 (< 0.1 pCi/g) in a firebrick found in this material. All construction materials have been removed from this location for offsite disposal. Extensive surveys following this event did not identify residual radioactivity above established background concentrations in soils within this area.

Radiological Status

Soil radioactivity in this survey unit is consistent with levels established as standard background for soils of this type in northwestern Michigan. Based on historical data, the radiological status of Survey Unit 59 is Class 2.

Primary Survey Design

1. Sample Data Points Required

The scoping survey resulted in the following data:

Nuclide identification	Cs-137
Mean value (pCi/g)	0.25
Standard Deviation (σ)	0.11

The relative shift for characterization surveys is determined using LBGR values set at 50% of the IDCGL.

$$\text{Relative Shift} = \frac{\text{DCGL} - \text{LBGR}}{\sigma} = \frac{5.11 - 2.5}{0.11} = 23.7$$

With α and β error levels set at 0.05 and an assumed relative shift of 3, the Sign Test requirements specify a sample size of 14 data points. As a conservative measure 36 samples were collected in this survey unit.

2. Sample Locations

Sample locations were selected by random method

Bounding survey unit dimensions 410 x 810 meters.

Random numbers were generated and applied to bounding survey unit dimensions to determine data point coordinate locations. This process was continued until 36 sample point locations successfully fell within the survey unit.

Supporting Surveys

Extensive soil sampling and laboratory analyses (59_{sd}) were conducted in this area early in the decommissioning process to establish area soil radioactivity baselines for development of the In-situ and surface scan measurement systems. The results of survey 59A₂ represent randomly selected data points falling within Survey Unit 59 that were part of a larger area study conducted to define regional background radioactivity levels in soil. Supporting survey 59A₃ was to investigate potential contamination in contact soils resulting from the movement of plant materials into this area.

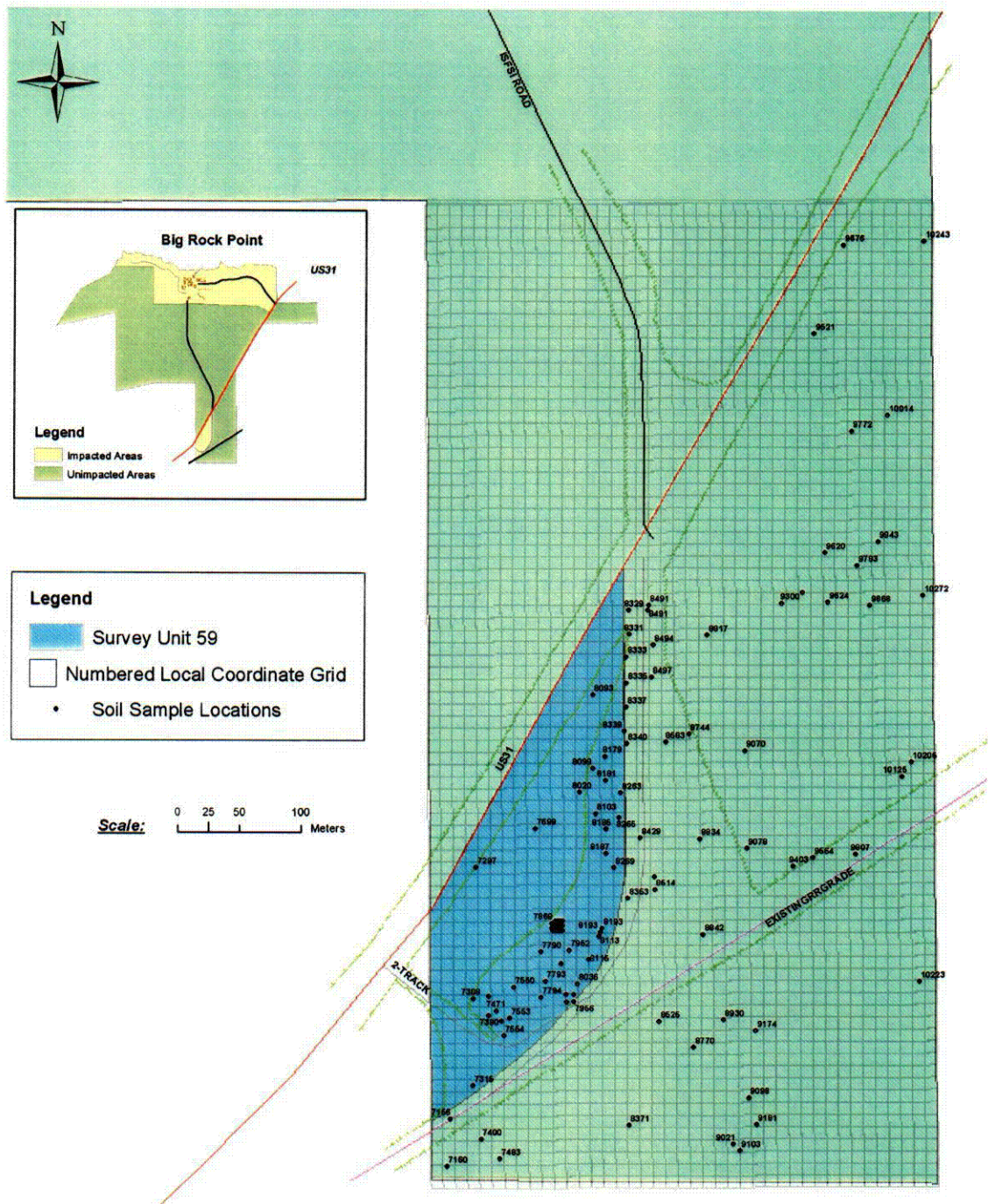
Data Summary

Survey Unit 59

Survey	No. of Samples	Radionuclides	Mean (pCi/g)	Max. Value (pCi/g)
59A ₁	36	Cs ₁₃₇	0.31	0.72
59A ₂	6	Cs ₁₃₇	0.37	0.49
59A ₃	10	Cs ₁₃₇	0.26	0.47
59A _{sd}	67	Cs ₁₃₇	0.26	0.62

*sd indicates supplemental data

Survey Unit 59



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Survey Results

Survey	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
59A _{ed}	7297	(9.5,4.5)	0.00-0.15	0.25		nd	0.12	nd	0.19
59A _{ed}	7308	(6.5,5.5)	0.00-0.15	0.10		nd	0.02	nd	0.20
59A _{ed}	7315	(5.6,4.2)	0.00-0.15	nd	0.07	nd	0.07	nd	0.23
59A _{ed}	7869	(1.5,1.5)	0.00-0.15	0.38		nd	0.17	nd	0.32
59A _{ed}	7869	(3.5,1.5)	0.00-0.15	0.36		nd	0.14	nd	0.32
59A _{ed}	7869	(5.5,1.5)	0.00-0.15	0.26		nd	0.14	nd	0.32
59A _{ed}	7869	(7.5,1.5)	0.00-0.15	0.13		nd	0.11	nd	0.24
59A _{ed}	7869	(9.5,1.5)	0.00-0.15	0.32		nd	0.14	nd	0.29
59A _{ed}	7869	(0.5,3.5)	0.00-0.15	0.29		nd	0.11	nd	0.35
59A _{ed}	7869	(2.5,3.5)	0.00-0.15	0.38		nd	0.14	nd	0.28
59A _{ed}	7869	(2.5,3.5)	0.15-0.30	0.16		nd	0.15	nd	0.31
59A _{ed}	7869	(4.5,3.5)	0.00-0.15	0.27		nd	0.03	nd	0.28
59A _{ed}	7869	(6.5,3.5)	0.00-0.15	0.26		nd	0.11	nd	0.30
59A _{ed}	7869	(8.5,3.5)	0.00-0.15	0.19		nd	0.14	nd	0.27
59A _{ed}	7869	(8.5,3.5)	0.15-0.30	nd	0.05	nd	0.06	nd	0.29
59A _{ed}	7869	(1.5,5.5)	0.00-0.15	0.28		nd	0.10	nd	0.26
59A _{ed}	7869	(3.5,5.5)	0.00-0.15	0.34		nd	0.11	nd	0.25
59A _{ed}	7869	(5.5,5.5)	0.00-0.15	0.31		nd	0.11	nd	0.30
59A _{ed}	7869	(5.5,5.5)	0.15-0.30	0.11		nd	0.16	nd	0.43
59A _{ed}	7869	(7.5,5.5)	0.00-0.15	0.14		nd	0.09	nd	0.27
59A _{ed}	7869	(9.5,5.5)	0.00-0.15	0.33		nd	0.07	nd	0.34
59A _{ed}	7869	(0.5,7.5)	0.00-0.15	0.46		nd	0.15	nd	0.30
59A _{ed}	7869	(2.5,7.5)	0.00-0.15	0.30		nd	0.04	nd	0.31
59A _{ed}	7869	(2.5,7.5)	0.15-0.30	nd	0.10	nd	0.15	nd	0.26
59A _{ed}	7869	(4.5,7.5)	0.00-0.15	0.28		nd	0.15	nd	0.32
59A _{ed}	7869	(6.5,7.5)	0.00-0.15	0.23		nd	0.05	nd	0.25
59A _{ed}	7869	(6.5,7.5)	0.15-0.30	0.14		nd	0.10	nd	0.29
59A _{ed}	7869	(8.5,7.5)	0.00-0.15	0.24		nd	0.12	nd	0.33
59A _{ed}	7869	(3.5,9.5)	0.00-0.15	0.39		nd	0.14	nd	0.33
59A _{ed}	7869	(5.5,9.5)	0.00-0.15	0.28		nd	0.16	nd	0.30
59A _{ed}	7869	(7.5,9.5)	0.00-0.15	0.38		nd	0.14	nd	0.31
59A _{ed}	7869	(9.5,9.5)	0.00-0.15	0.37		nd	0.14	nd	0.32
59A _{ed}	7956	(2.0,2.5)	0.00-0.15	nd	0.07	nd	0.09	nd	0.22
59A _{ed}	7956	(8.0,2.5)	0.00-0.15	nd	0.09	nd	0.11	nd	0.24
59A _{ed}	7956	(2.0,8.5)	0.00-0.15	nd	0.07	nd	0.07	nd	0.17
59A _{ed}	7956	(8.0,8.5)	0.00-0.15	nd	0.06	nd	0.06	nd	0.22
59A _{ed}	8020	(4.2,5.8)	0.00-0.15	0.18		nd	0.13	nd	0.43
59A _{ed}	8036	(1.2,7.3)	0.00-0.15	0.26		nd	0.08	nd	0.16
59A _{ed}	8093	(5.5,5.6)	0.00-0.15	0.19		nd	0.12	nd	0.43
59A _{ed}	8099	(5.2,5.2)	0.00-0.15	0.27		nd	0.15	nd	0.26
59A _{ed}	8113	(8.8,6.5)	0.00-0.15	0.46		nd	0.08	nd	0.26
59A _{ed}	8115	(0.3,7.5)	0.00-0.15	nd	0.10	nd	0.10	nd	0.21
59A _{ed}	8179	(5.0,5.0)	0.00-0.15	0.16		nd	0.10	nd	0.21
59A _{ed}	8181	(5.5,5.5)	0.00-0.15	0.38		nd	0.11	nd	0.44

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Survey	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
59A _{ed}	8185	(5.5,5.2)	0.00-0.15	0.31		nd	0.11	nd	0.43
59A _{ed}	8187	(5.2,5.2)	0.00-0.15	0.62		nd	0.12	nd	0.44
59A _{ed}	8269	(1.5,3.5)	0.00-0.15	0.44		nd	0.12	nd	0.22
59A _{ed}	8183	(0.0,0.0)	0.00-0.15	0.09		nd	0.10	nd	0.27
59A _{ed}	8193	(1.5,3.2)	0.00-0.15	0.40		nd	0.12	nd	0.22
59A _{ed}	8263	(7.5,5.2)	0.00-0.15	0.52		nd	0.12	nd	0.42
59A _{ed}	8265	(6.0,5.0)	0.00-0.15	0.24		nd	0.15	nd	0.43
59A _{ed}	8329	(5.0,5.0)	0.00-0.15	0.28		nd	0.10	nd	0.20
59A _{ed}	8331	(5.0,5.0)	0.00-0.15	0.13		nd	0.10	nd	0.18
59A _{ed}	8333	(2.5,6.5)	0.00-0.15	0.14		nd	0.07	nd	0.19
59A _{ed}	8335	(2.8,5.2)	0.00-0.15	0.21		nd	0.07	nd	0.12
59A _{ed}	8337	(2.5,5.5)	0.00-0.15	0.09		nd	0.09	nd	0.19
59A _{ed}	8339	(0.5,5.5)	0.00-0.15	0.19		nd	0.07	nd	0.20
59A _{ed}	8340	(2.5,5.5)	0.00-0.15	0.11		nd	0.08	nd	0.14
59A _{ed}	8353	(2.5,8.0)	0.00-0.15	0.38		nd	0.08	nd	0.19
59A _{ed}	8491	(0.2,5.2)	0.00-0.15	0.24		nd	0.05	nd	0.20
59A _{ed}	8494	(4.5,6.2)	0.00-0.15	0.15		nd	0.03	nd	0.22
59A _{ed}	8513	(4.2,5.8)	0.00-0.15	0.25		nd	0.11	nd	0.22
59A _{ed}	8514	(4.6,5.2)	0.00-0.15	0.14		nd	0.03	nd	0.22
59A _{ed}	8583	(4.4,6.5)	0.00-0.15	0.20		nd	0.10	nd	0.21
59A _{ed}	8842	(3.2,7.8)	0.00-0.15	nd	0.10	nd	0.09	nd	0.22
59A _{ed}	9807	(6.5,3.5)	0.00-0.15	nd	0.07	nd	0.16	nd	0.43
59A _{ed}	10125	(4.5,7.2)	0.00-0.15	0.13		nd	0.20	nd	0.44
59A ₁	8834	(1.0,7.0)	0.00-0.15	0.28		nd	0.06	nd	0.34
59A ₁	9078	(9.0,9.0)	0.00-0.15	0.72		nd	0.10	nd	0.42
59A ₁	9403	(6.0,4.0)	0.00-0.15	0.62		nd	0.09	nd	0.38
59A ₁	9564	(2.0,1.0)	0.00-0.15	0.21		nd	0.06	nd	0.28
59A ₁	10205	(2.0,9.0)	0.00-0.15	0.25		nd	0.09	nd	0.37
59A ₁	8103	(7.0,8.0)	0.00-0.15	0.18		nd	0.06	nd	0.32
59A ₁	7699	(8.0,6.0)	0.00-0.15	0.36		nd	0.11	nd	0.43
59A ₁	8744	(3.0,3.0)	0.00-0.15	0.27		nd	0.08	nd	0.36
59A ₁	8491	(1.0,9.0)	0.00-0.15	0.04		nd	0.06	nd	0.33
59A ₁	8817	(8.0,4.0)	0.00-0.15	0.22		nd	0.08	nd	0.34
59A ₁	9070	(8.0,9.0)	0.00-0.15	0.19		nd	0.09	nd	0.37
59A ₁	10272	(2.0,6.0)	0.00-0.15	0.30		nd	0.09	nd	0.43
59A ₁	9868	(9.0,8.0)	0.00-0.15	0.18		nd	0.08	nd	0.33
59A ₁	9462	(5.0,9.0)	0.00-0.15	0.21		nd	0.09	nd	0.39
59A ₁	9300	(8.0,0.0)	0.00-0.15	0.62		nd	0.09	nd	0.38
59A ₁	9943	(6.0,1.0)	0.00-0.15	0.40		nd	0.09	nd	0.42
59A ₁	9620	(3.0,2.0)	0.00-0.15	0.19		nd	0.07	nd	0.34
59A ₁	9676	(9.0,5.0)	0.00-0.15	0.40		nd	0.10	nd	0.41
59A ₁	10243	(4.0,8.0)	0.00-0.15	0.29		nd	0.10	nd	0.39
59A ₁	9521	(5.0,3.0)	0.00-0.15	0.22		nd	0.07	nd	0.43
59A ₁	8930	(9.0,7.0)	0.00-0.15	0.52		nd	0.09	nd	0.43
59A ₁	9174	(5.0,8.0)	0.00-0.15	0.58		nd	0.10	nd	0.42
59A ₁	9098	(9.0,3.0)	0.00-0.15	0.34		nd	0.08	nd	0.41
59A ₁	9181	(5.0,1.0)	0.00-0.15	0.42		nd	0.09	nd	0.42

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Survey	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
59A ₁	9021	(6.0,5.0)	0.00-0.15	0.30		nd	0.10	nd	0.43
59A ₁	7400	(2.0,0.0)	0.00-0.15	0.28		Nd	0.08	nd	0.38
59A ₁	7160	(4.0,8.0)	0.00-0.15	0.15		nd	0.07	nd	0.36
59A ₁	7156	(7.0,7.0)	0.00-0.15	0.28		nd	0.08	nd	0.42
59A ₁	8371	(2.0,1.0)	0.00-0.15	0.44		nd	0.09	nd	0.42
59A ₁	7483	(7.0,4.0)	0.00-0.15	0.39		nd	0.09	nd	0.42
59A ₁	7472	(9.0,7.0)	0.00-0.15	0.21		nd	0.08	nd	0.30
59A ₁	8525	(7.0,6.0)	0.00-0.15	0.26		nd	0.08	nd	0.36
59A ₁	7872	(8.0,4.0)	0.00-0.15	0.2		nd	0.08	nd	0.31
59A ₁	8429	(3.0,8.0)	0.00-0.15	0.05		nd	0.05	nd	0.30
59A ₁	10014	(4.0,5.0)	0.00-0.15	0.43		nd	0.09	nd	0.43
59A ₁	9772	(5.0,2.0)	0.00-0.15	0.33		nd	0.08	nd	0.43
59A ₂	9624	(5.3,0.8)	0.00-0.15	0.48		nd	0.08	nd	0.39
59A ₂	9783	(9.0,1.3)	0.00-0.15	0.39		nd	0.10	nd	0.41
59A ₂	8497	(3.0,9.8)	0.00-0.15	0.2		nd	0.06	nd	0.33
59A ₂	10223	(7.2,7.8)	0.00-0.15	0.49		nd	0.08	nd	0.37
59A ₂	9103	(1.4,9.4)	0.00-0.15	0.32		nd	0.09	nd	0.43
59A ₂	8770	(4.8,4.8)	0.00-0.15	0.34		nd	0.08	nd	0.42
59A ₃	7554	(1.0,5.2)	0.00-0.15	0.12		nd	0.05	nd	0.27
59A ₃	7390	(8.8,1.6)	0.00-0.15	0.24		nd	0.07	nd	0.32
59A ₃	7389	(8.8,7.5)	0.00-0.15	0.47		nd	0.06	nd	0.33
59A ₃	7471	(4.9,5.3)	0.00-0.15	0.31		nd	0.07	nd	0.32
59A ₃	7553	(5.9,9.2)	0.00-0.15	0.22		nd	0.07	nd	0.34
59A ₃	7794	(1.5,6.3)	0.00-0.15	0.22		nd	0.07	nd	0.32
59A ₃	7550	(9.5,4.8)	0.00-0.15	0.12		nd	0.07	nd	0.31
59A ₃	7793	(5.2,9.7)	0.00-0.15	0.37		nd	0.07	nd	0.32
59A ₃	7952	(4.7,5.3)	0.00-0.15	0.28		nd	0.05	nd	0.29
59A ₃	7790	(1.5,4.1)	0.00-0.15	0.21		nd	0.07	nd	0.28

^a nd Indicates non detect, MDA provided

^b No entry in the MDA column is provided when residual radioactivity is detected

Canal Survey Unit

Description

The BRP Discharge Canal (or Canal) is an area of Lake Michigan north of the Owner Controlled Property that extends from the Screenhouse to the normal beach contour line. This location is approximately 600 m² in size and includes the submerged area from the Canal bottom to the waters edge. Normal water depths in the Canal range from 4 to 7 feet; however, current near record lows in Lake Michigan water levels have greatly reduced this depth. The Canal is the licensed release pathway for plant effluent waters. Circulation Water System discharge rates have historically been approximately 50,000 gal/min, resulting in a scouring effect on the Canal bottom. The Canal bottom consists of a layer of dense cobble resting on a base of hard clay. The cobble is estimated to be between 15 and 90 cm thick. Dynamics in effluent discharge have resulted in minor locations of sediment build-up in backwater eddies and areas of low flow.

Components and equipment in this area include the following:

- Liquid radioactive release pipe located next to the Screenhouse weir at the point of effluent discharge,
- Storm water discharge piping approximately ten meters north of the Screenhouse,
- Liquid process monitor intake piping that traverses the Canal approximately eight meters from the Screenhouse, and
- The concrete floor and foundation footings of the Screenhouse.

History

Routine environmental sampling of the Canal has identified trace levels of residual radioactivity in area sediment. Minor quantities of residual radioactivity has also been identified in dredge spoils taken from maintenance excavations of the Canal.

Radiological Status

The Canal is the permitted release pathway for plant effluent water discharge into Lake Michigan. Characterization analyses have identified elevated levels of residual radioactivity in sediment in the Canal. This area is scheduled to be returned to normal lakeshore contour to achieve the Big Rock Point Greenfield condition. The radiological status of the Canal survey unit is Class 1. Characterization of the Canal is scheduled to continue and remediation efforts will be conducted as necessary to meet the requirements of unrestricted site release.

Survey Design

The survey size and data point locations were judgmentally selected. The survey objective was to collect representative samples of Canal sediment at systematic intervals from the point of effluent discharge. Sediment sampling was performed by underwater divers using hand auger tools. Sample point locations were selected to be representative of the Canal bottom; however, visible locations of sediment build-up were specifically targeted based on historical knowledge of increased potential for these areas to contain residual radioactivity.

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Core profiles greater than 15 cm were unobtainable by deep-water sampling. To investigate potential depth of activity in Canal sediment a series of caissons were installed traversing the Canal in a sediment rich area of shallow water. Samples were collected to a depth of 30 cm by removing water and excavating the sediment in 15 cm intervals.

Supporting Surveys

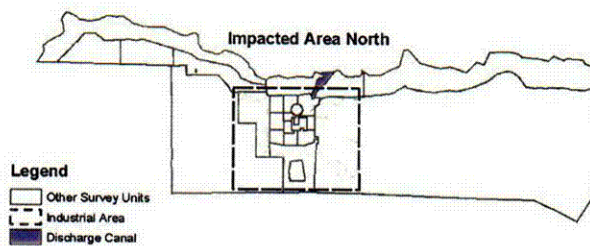
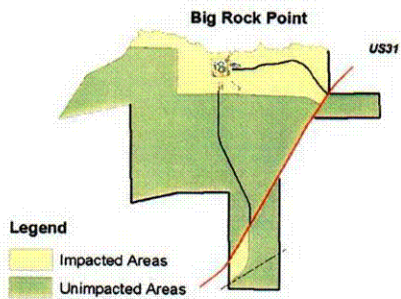
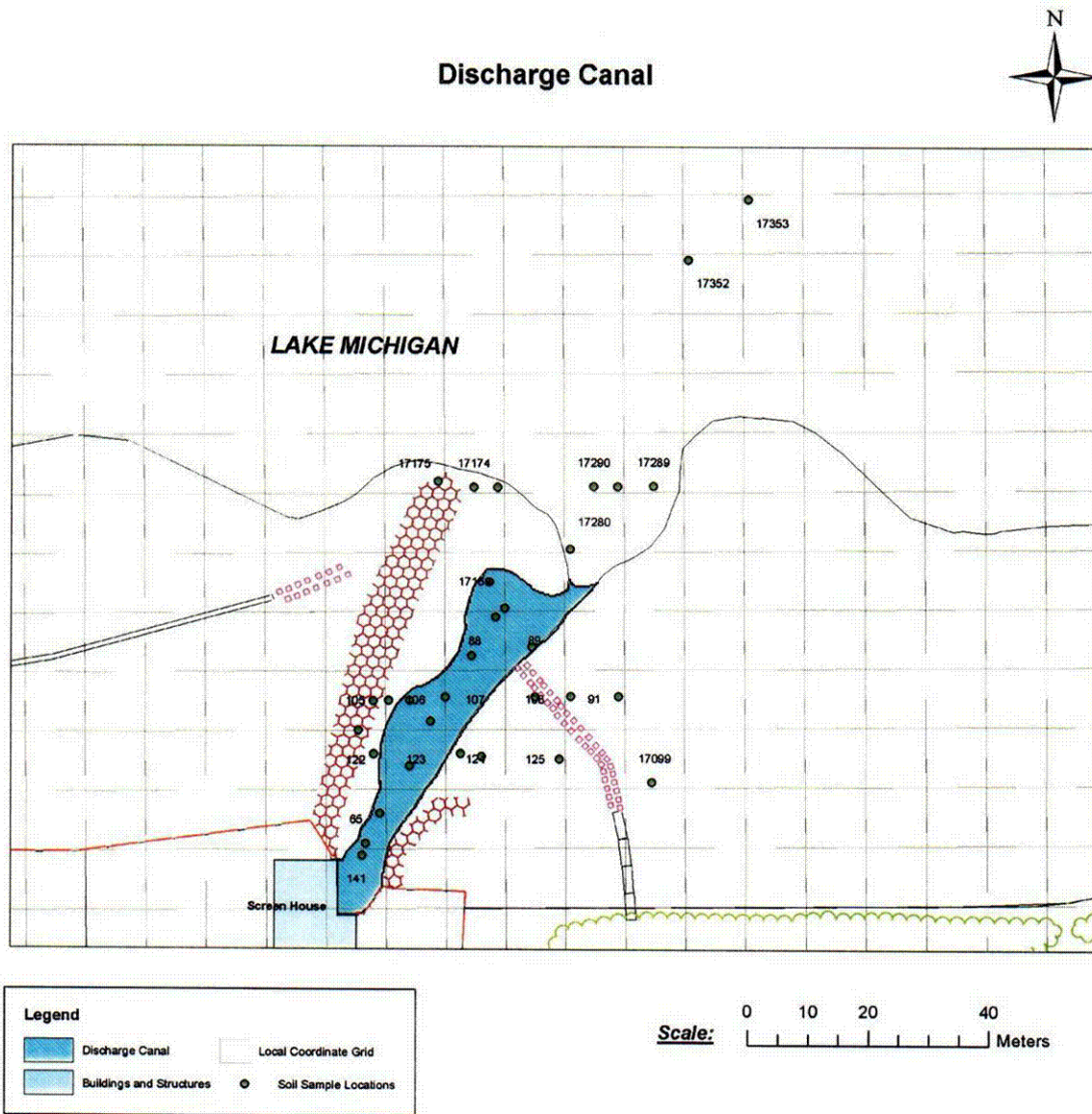
The extent of terrain in this survey unit has increased due to the current low water levels of Lake Michigan. Some survey data points overlap adjoining survey unit boundaries due to the fluctuation in Lake Michigan water levels. Survey Canal A₁ was conducted to include shoreline areas normally under water in this survey unit.

Data Summary

Canal Survey Unit

Survey	No. of Samples	Radionuclides	Mean (pCi/g)	Max. Value (pCi/g)
CanalA₁	18	Cs₁₃₇	0.61	1.90
		Co₆₀	0.38	2.68
		Mn₅₄*	0.12	0.23
CanalA₂	17	Cs₁₃₇	1.39	3.31
		Co₆₀	2.87	17.74
		Mn₅₄	0.32	1.04

*Mn-54 detected in 3 samples.



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Survey Results

Survey	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Mn-54 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
Canal A ₁	124	(2.5,6.0)	0.00-0.15	0.85		0.17		nd	0.04	nd	0.25
Canal A ₁	124	(6.0,5.5)	0.00-0.15	0.34		0.09		nd	0.04	nd	0.27
Canal A ₁	125	(8.0,5.0)	0.00-0.15	0.33		0.16		nd	0.04	nd	0.29
Canal A ₁	108	(5.0,5.5)	0.00-0.15	0.16		0.14		0.02		nd	0.27
Canal A ₁	91	(1.0,5.5)	0.00-0.15	nd	0.06	nd	0.06	nd	0.04	nd	0.27
Canal A ₁	91	(9.0,5.5)	0.00-0.15	0.23		0.06		nd	0.04	nd	0.23
Canal A ₁	17290	(5.0,1.0)	0.00-0.15	0.36		0.09		nd	0.04	nd	0.24
Canal A ₁	17290	(9.0,1.0)	0.00-0.15	0.33		0.16		nd	0.04	nd	0.25
Canal A ₁	17289	(5.0,1.0)	0.00-0.15	0.42		0.09		nd	0.04	nd	0.25
Canal A ₁	17099	(4.5,1.0)	0.00-0.15	0.20		0.09		nd	0.04	nd	0.24
Canal A ₁	122	(8.0,6.0)	0.00-0.15	1.20		2.68		0.23		nd	0.39
Canal A ₁	105	(5.5,0.0)	0.00-0.15	1.90		1.37		0.12		nd	0.31
Canal A ₁	106	(4.0,5.0)	0.00-0.15	nd	0.04	0.13		nd	0.05	nd	0.24
Canal A ₁	106	(0.5,5.0)	0.00-0.15	0.26		0.18		nd	0.05	nd	0.25
Canal A ₁	105	(8.0,5.0)	0.00-0.15	0.67		0.65		nd	0.06	nd	0.31
Canal A ₁	17174	(9.0,1.0)	0.00-0.15	0.96		0.11		nd	0.04	nd	0.23
Canal A ₁	17174	(5.0,1.0)	0.00-0.15	1.37		0.14		nd	0.05	nd	0.28
Canal A ₁	17175	(9.0,2.0)	0.00-0.15	0.21		0.09		nd	0.03	nd	0.24
Canal A ₂	141	(6.0,9.0)	0.00-0.15	3.31		17.74		1.04		nd	0.43
Canal A ₂	65	(6.5,1.0)	0.00-0.15	1.24		2.38		0.19		nd	0.37
Canal A ₂	65	(9.0,6.0)	0.00-0.15	1.26		2.21		0.12		nd	0.35
Canal A ₂	123	(4.0,4.0)	0.00-0.15	1.41		5.03		0.38		nd	0.41
Canal A ₂	106	(7.5,1.5)	0.00-0.15	1.08		2.10		0.15		nd	0.36
Canal A ₂	107	(0.0,5.5)	0.00-0.15	1.19		2.56		0.28		nd	0.36
Canal A ₂	88	(4.5,2.5)	0.00-0.15	1.59		2.22		0.10		nd	0.38
Canal A ₂	88	(8.5,9.0)	0.00-0.15	1.22		0.75		0.06		nd	0.29
Canal A ₂	17280	(1.0,0.5)	0.00-0.15	1.25		0.29		nd	0.06	nd	0.26
Canal A ₂	17352	(1.0,9.0)	0.00-0.15	1.74		0.16		nd	0.04	nd	0.29
Canal A ₂	17353	(1.0,9.0)	0.00-0.15	0.64		0.21		nd	0.05	nd	0.32
Canal A ₂	89	(4.5,4.0)	0.00-0.15	2.17		8.32		0.82		nd	0.43
Canal A ₂	89	(4.5,4.0)	0.15-0.30	0.84		0.22		0 nd	0.05	nd	0.31
Canal A ₂	17170	(0.0,0.5)	0.00-0.15	1.78		1.97		0.13		nd	0.37
Canal A ₂	17170	(0.0,0.5)	0.15-0.30	0.42		0.15		nd	0.03	nd	0.07
Canal A ₂	17169	(7.5,5.0)	0.00-0.15	1.58		2.00		0.23		nd	0.34
Canal A ₂	17169	(7.5,5.0)	0.15-0.30	0.92		0.40		nd	0.04	nd	0.32

^a nd indicates non detect, MDA provided

^b No entry in the MDA column is provided when residual radioactivity is detected

Drainage Ditch Survey Unit

Description

The Drainage Ditch is a seasonal stream less than one meter wide that extends approximately 370 meters from the northern boundary of the Non-Impacted Area to Lake Michigan. Surface waters from wetland elevations to the south concentrate in low areas along the railroad grade and flow north into the Industrial Area. Stormwater runoff is diverted around the Protected Area to the Drainage Ditch and discharges into Lake Michigan. The Drainage Ditch also receives water from a series of catch basins and corrugated metal piping that act to remove storm water away from buildings and parking lots in the Industrial Area. Subsurface structures and components include storm water culverts and piping. The stream is traversed in limited areas by septic piping and electrical conduit.

History

Residual radioactivity has been identified in the sediment of storm water piping in the Protected Area and in Drainage Ditch soils near the west pipe discharge. Sediment accumulations have been removed from all east section storm water piping originating in the Protected Area. In addition, a sediment collection barrel was installed in the west section piping and locations of potential sediment accumulation are routinely monitored to identify the potential migration of contaminants in this system. Sample analyses have not identified residual radioactivity in the liquid effluent of the storm water system.

Radiological Status

Residual radioactivity was identified at trace level concentrations (<0.2 pCi/g) in several sediment samples collected in the Drainage Ditch stream. The Drainage Ditch Survey Unit is designated as a Class 2 Area.

Survey Design

The size and data point locations of this survey were judgmentally selected. Samples were systematically collected at 20 meter intervals in straight sections of the stream. Additional samples were collected in stream bends, areas of low flow, and visible locations of sediment accumulation. Samples were also collected in suspect areas at every culvert outlet and discharge pipe to the Drainage Ditch.

Supporting Surveys

Supporting surveys were not conducted in this survey unit.

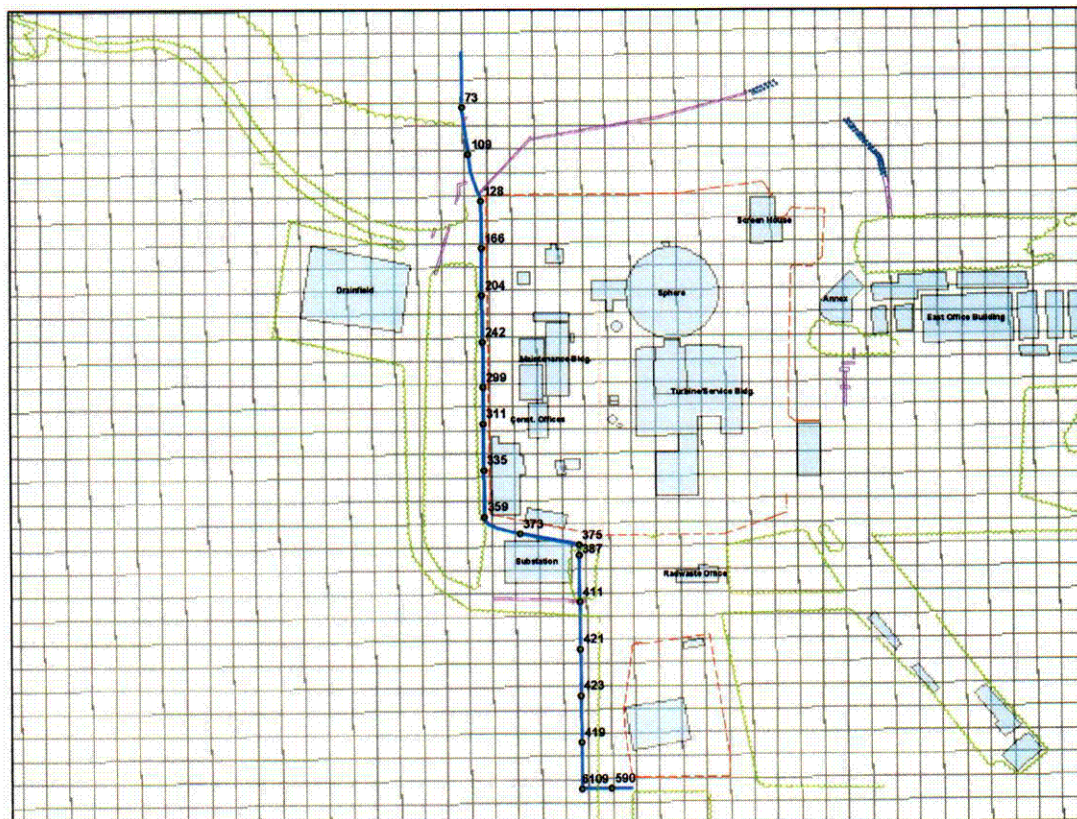
Data Summary

Drainage Ditch

Survey	No. of Samples	Radionuclides	Mean (pCi/g)	Max. Value (pCi/g)
Stream ₁	19	Cs ₁₃₇	0.13	0.32
		Co ₆₀ *	0.11	0.17

*Co-60 detected in 2 samples.

Surface Water Drainage Ditch



- Legend**
- Surface Water Drainage Ditch
 - Buildings and Structures
 - Numbered Local Coordinate Grid
 - Sediment Sample Locations

Scale: 0 20 40 80 Meters

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Survey Results

Survey	Grid	Coordinate (x,y)	Depth (m)	Cs-137 (pCi/g)		Co-60 (pCi/g)		Am-241 (pCi/g)	
				Activity ^a	MDA ^b	Activity ^a	MDA ^b	Activity ^a	MDA ^b
StreamA ₁	590	(0.0,5.5)	0.00-0.15	nd	0.04	nd	0.05	nd	0.25
StreamA ₁	6109	(7.5,5.5)	0.00-0.15	nd	0.06	nd	0.08	nd	0.30
StreamA ₁	419	(7.5,5.5)	0.00-0.15	nd	0.04	nd	0.04	nd	0.21
StreamA ₁	423	(7.5,5.5)	0.00-0.15	nd	0.05	nd	0.07	nd	0.30
StreamA ₁	421	(7.5,5.5)	0.00-0.15	nd	0.07	nd	0.08	nd	0.39
StreamA ₁	411	(7.5,5.5)	0.00-0.15	0.03		nd	0.05	nd	0.30
StreamA ₁	387	(7.5,5.5)	0.00-0.15	0.06		nd	0.08	nd	0.26
StreamA ₁	375	(7.5,0.0)	0.00-0.15	0.32		0.17		nd	0.30
StreamA ₁	373	(2.5,5.0)	0.00-0.15	0.07		nd	0.05	nd	0.20
StreamA ₁	359	(7.5,2.5)	0.00-0.15	0.14		nd	0.06	nd	0.30
StreamA ₁	335	(7.5,2.5)	0.00-0.15	nd	0.07	nd	0.06	nd	0.32
StreamA ₁	311	(7.5,2.5)	0.00-0.15	0.12		nd	0.06	nd	0.27
StreamA ₁	299	(7.5,8.0)	0.00-0.15	0.18		nd	0.05	nd	0.25
StreamA ₁	242	(7.5,7.5)	0.00-0.15	0.14		0.05		nd	0.30
StreamA ₁	204	(7.5,7.5)	0.00-0.15	0.22		nd	0.05	nd	0.23
StreamA ₁	166	(7.5,7.5)	0.00-0.15	0.08		nd	0.05	nd	0.24
StreamA ₁	128	(7.5,7.5)	0.00-0.15	0.07		nd	0.04	nd	0.18
StreamA ₁	109	(2.5,7.5)	0.00-0.15	0.07		nd	0.04	nd	0.21
StreamA ₁	73	(0.0,7.5)	0.00-0.15	0.20		nd	0.05	nd	0.19

^a nd indicates non detect, MDA provided

^b No entry in the MDA column is provided when residual radioactivity is detected

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