**INDEPENDENT VERIFICATION
SURVEY REPORT FOR THE
OPERABLE UNIT-1
LANDFILL TRENCHES
MIAMISBURG CLOSURE PROJECT
MIAMISBURG, OHIO**

W.C. Adams

Prepared for the
U.S. Department of Energy

ORISE

Oak Ridge Institute for Science and Education

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MIAMISBURG, OHIO**

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ABBREVIATIONS AND ACRONYMS

ARC	Accelerated Remediation Company
ARRA	American Recovery and Reinvestment Act
BKG	background
BWXT0	Babcock and Wilcox Technical Services of Ohio
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	centimeter
cm ²	square centimeter
CO	cleanup objectives
cpm	counts per minute
COC	contaminants of concern
DOE	U.S. Department of Energy
D&D	Decontamination and Decommissioning
EIP	Environmental Investigation Plan
EPA	Environmental Protection Agency
FIDLER	Field Instrument for the Detection of Low Energy Radiation
FSS	final status survey
GPS	global positioning system
IEAV	Independent Environmental Assessment and Verification
ISM	Integrated Safety Management
ITP	Intercomparison Testing Program
IVC	Independent Verification Contractor
IVT	Independent Verification Team
JHA	job hazard analysis
kg	kilogram
MAPEP	Mixed Analyte Performance Evaluation Program
MCP	Miamisburg Closure Project
MDC	minimum detectable concentration
MERP	Mound Environmental Restoration Program
MeV	million electron volts
MRC	Monsanto Research Corporation
NaI	sodium iodide
NIST	National Institute of Standards and Technology
NPL	National Priorities List
NRIP	NIST Radiochemistry Intercomparison Program
OEPA	Ohio Environmental Protection Agency
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
OU	Operable Units
pCi/g	picocuries per gram
PRS	Potential Release Site
Pu-238	Plutonium-238
RA	Removal Action
Ra-226	Radium-226

ABBREVIATIONS AND ACRONYMS (continued)

Th-230/232	Thorium-230/232
TAP	total absorption peak
VSAP	Verification Sampling and Analysis Plan
U-233/234	Uranium-233/234
U-235/238	Uranium-235/238

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INTRODUCTION AND SITE HISTORY

The Mound Plant was constructed in the 1940s for the production of nuclear weapons components. In 1948 the original site was operated by the Monsanto Research Corporation (MRC) whose primary mission was to determine the chemical and metallurgical properties of polonium, (BWXT0 1999). In 1949, research involving other radionuclides began and over the course of its 50 years of operation, the facility produced detonators, recovered and purified tritium, and constructed plutonium heat generators for satellites. Mound was the first permanent facility in support of atomic weapons research for the U.S. Department of Energy (DOE) and, prior to 1996, it was a supplier of stable isotopes to the DOE.

The Mound Site was placed on the National Priorities List (NPL) in 1989 because of chemical contamination in the site groundwater (BWXT0 1999). The DOE, U.S. Environmental Protection Agency (EPA), the Ohio Environmental Protection Agency (OEPA) and the DOE “core team”, developed a procedural framework for the remediation of the site under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). In an effort to improve efficiency and streamline operations, a decision-making process known as the “The Mound 2000 Approach” was developed by the Mound Environmental Restoration Program (MERP). This process divided the Mound site into 19 release blocks that contained over 400 Potential Release Sites (PRSs). Eventually, the PRSs were subdivided into nine operable units (OUs) (MERP 1997). Approximately 200 of the PRSs were contaminated soil areas and the remaining PRSs were contaminated buildings (BWXT0 1999).

During the period between 1948 and 1977, an area of about four acres on the southwest portion of the Mound Plant was used as a landfill for general trash and solid and liquid laboratory wastes contaminated with radioactive and non-radioactive materials (ARC 2006 and 2007a). This area would become known as the Operable Unit (OU)-1. Various trenches were opened in OU-1 to dispose of wastes; however, not all of the trenches were used for waste disposal. Between 1977 and 1978, an overflow pond was constructed in the upper portion of the OU-1 area that partially

covered the historic landfill. Waste excavated during the construction of the pond was relocated to other portions of the encapsulated OU-1 Landfill. By 1976, no additional wastes were disposed of in OU-1 (ARC 2007a).

Accelerated Remediation Company (ARC) is the current decommissioning contractor tasked with an environmental investigation of the unremediated OU-1 Landfill Area. Their objective was to determine boundaries and provide evidence that no remaining contaminated wastes remained in these areas. To determine the boundaries of the OU-1 Landfill Area, ARC excavated trenches in the northeastern corner, eastern border, and southeastern corner of OU-1. The investigative results of these activities will provide support for the future use of the OU-1 Area.

These final investigative activities included visually checking the excavations for waste, performing gamma surface scans, and collecting soil samples to make certain that the radionuclide contaminants-of-concern (COC) meet the site cleanup objectives (CO) for the OU-1 Landfill Area. This investigation was being conducted under the 2009 American Recovery and Reinvestment Act (ARRA) (ARC 2009a).

The U.S. Department of Energy-Miamisburg Closure Project Office (DOE/MCP) is responsible for oversight of the remedial action and final status survey (FSS) activities at the Miamisburg Closure Project (MCP). It is the policy of the DOE to perform independent (third party) verification of FSS activities (DOE 2006). The objectives for independent verifications are to confirm that remedial actions have been effective in meeting established and site-specific guidelines and that the documentation accurately and adequately describes the radiological conditions at the site. The Oak Ridge Institute for Science and Education (ORISE) has been designated by the DOE as the Independent Verification Contractor (IVC) responsible for this task at the MCP and has been requested to verify the final radiological status of the cleanup activities associated with the OU-1 Landfill.

SITE DESCRIPTION

The Mound Plant is located on 305 acres within the southern city limits of Miamisburg, Ohio and is approximately ten miles southwest of Dayton and 45 miles north of Cincinnati. The site is bounded by Mound Avenue to the north which curves to the south becoming Mound Road and the eastern boundary of the site (Figure A-1). The southern boundary is formed by Benner Road with the

Conrail Railroad generally forming the western boundary. To the west of the plant is the Great Miami River flowing from northeast to southwest and the plant is surrounded by residential, recreational and agricultural areas (BWXT0 1999). The OU-1 Landfill occupies approximately 4 acres of land in the southwestern portion of the original Mound Plant property (Figure A-2).

OBJECTIVE

The objectives of the independent verification survey were designed to provide assurance to DOE that the contractor has met the cleanup objectives (CO) that were established and that documentation accurately and adequately describes the current radiological conditions of the northern, eastern and southeastern borders of the OU-1 Landfill Area.

DOCUMENT REVIEW

The Independent Verification Team (IVT) reviewed the Verification Sampling and Analysis Plan (VSAP), the Environmental Investigation plan (EIP), and supporting data and documentation for the release of the OU-1 Landfill Area (ARC 2009a and b). The focus of the review included the survey methodology, instrumentation detection capabilities and calibration, field observations of the trench excavations, and applicable investigative procedure implementation required in the the VSAP and EIP.

VERIFICATION SURVEY PROCEDURES

ORISE personnel visited the MCP Site in Miamisburg, Ohio on April 14 and 15, 2010 to perform independent verification activities at the OU-1 Landfill Area excavated trenches (Figures A-1, A-2 and A-3). Verification activities were conducted in accordance with the ORISE Independent Environmental Assessment and Verification (IEAV) Program's Project-Specific Verification Plan, and the Survey Procedures and Quality Program Manuals (ORISE 2007a and 2008, and ORAU 2009). The collective site areas verified consisted of four trenches; of which, three trenches were along the southeast portion of the Landfill Area (Trenches 30, 31, and 32; Figure A-3) and one along the northwest portion of the Landfill Area (Trench 53; Figure A- 3). Data and sample media collected during ORISE verification surveys were returned to the ORISE laboratory for data interpretation and analyses.

Due to the depth and potential for cave in of the trenches, FSS by the site decommissioning contractor and verification surveys by ORISE personnel were conducted only on the excavated soil piles. The bottom of the trenches and the excavated soil piles were to be inspected for evidence of any landfill wastes.

The ORISE survey design approach included direct gamma surface scans and measurements and the collection of soil samples. Locations where gamma surface scans identified elevated radioactivity levels were marked for further investigation.

REFERENCE SYSTEM

ORISE used the reference system and OU-1 Landfill Area trench maps as provided by the decommissioning contractor for referencing sample locations. ARC personnel used a global positioning system (GPS) for documenting trench boundaries and a tape measure to document distances along the trench path for their systematic soil sample locations from the excavated soil piles.

SURFACE SCANS

Surface scans to identify locations of elevated gamma radiation were performed with two different types of instruments. The Field Instrument for the Detection of Low Energy Radiation (FIDLER) detector was used for the detection of low-energy gamma radiation, and the 1.25 inch by 1.50 inch sodium iodide (NaI) scintillation detector was used for the detection of high-energy gamma radiation. Both the NaI and FIDLER detectors were coupled to ratemeters with audible output. Gamma surface scans were performed over approximately 75% of accessible excavated soil pile surface areas and in the immediate vicinity of the four trenches identified by ORISE for independent verification (Figure A-3). Detectors were held at a nominal height of 5 centimeters (cm) above the ground surface when performing scans. Locations of elevated gamma radiation detected by surface scans were marked for further investigation.

SOIL SAMPLING

A random sequence generator (Random.org) was used to define twelve random sample locations from the decommissioning contractor's soil sample locations of the excavated soil from each of the

four available trenches. A static gamma count rate measurement was performed at each location prior to collecting a sample. An additional judgmental soil sample was collected from the east end of Trench 31 based on a slightly elevated FIDLER gamma reading. Sampling locations are provided in Figure A-3.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Soil samples were maintained in accordance with formal chain-of-custody procedures. Samples and data were returned to the ORISE/IEAV laboratory in Oak Ridge, Tennessee for analysis and interpretation. Sample analyses were performed in accordance with the ORISE Laboratory Procedures Manual (ORISE 2010). Soil samples were analyzed by gamma spectroscopy for the radionuclide COCs. The spectra were also reviewed for other identifiable photopeaks that would not be expected at this site and none were identified. Soil sample results were reported in units of picocuries per gram (pCi/g). Data were compared with the approved release criteria established for the MCP OU-1 Landfill Area. Additional information concerning major instrumentation, sampling equipment, and analytical procedures is provided in Appendices C and D.

APPLICABLE SITE GUIDELINES

The applicable COs for the primary radiological COCs are provided in Table 1.

TABLE 1 RADIOLOGICAL CONTAMINANTS OF CONCERN CLEANUP OBJECTIVES^a OPERABLE UNIT-1 LANDFILL TRENCHES MIAMISBURG CLOSURE PROJECT MIAMISBURG, OHIO		
Radionuclide	Cleanup Objective (pCi/g)	Hot Spot Criteria (pCi/g)
Ra-226	2.9	4.7
Th-230	2.8	4.6
Th-232	2.1	3.5
U-233/234	2.0	-- ^b
U-235	3.2	9.6
U-238	2.2	4.2
Pu-238	55.0	165.13

^aCleanup objectives from Soils Verification Sampling & Analysis Plan (ARC 2009b).

^bValue not provided.

FINDINGS AND RESULTS

DOCUMENT REVIEW

ORISE provided technical review and comments on the VSAP for the Mound Operable Unit-1 Landfill Area on April 30, 2007 (ORISE 2007b). ORISE reviewed the EIP for the OU-1 Landfill Area; however, no additional technical comments were provided (ARC 2009a). ORISE reviewed the initial data package for Trenches 29 and 30 and determined that an ARC soil sample number had been inadvertently placed in the wrong area of the trench map. This was brought to the attention of the ARC personnel and was immediately corrected.¹

GAMMA SURFACE SCANS

The gross (including background) area ambient gamma radiation scan results for the NaI detector were generally between 3,200 and 5,100 counts per minute (cpm). FIDLER scan results were generally between 400 and 720 cpm. Scans using the FIDLER detector identified one slightly elevated and isolated location of radioactivity (Figure A-3). This location was marked for sampling.

RADIONUCLIDE CONCENTRATIONS

The radionuclide concentration ranges for the primary radiological COCs are provided in Table 2. The radionuclide concentrations for individual soil sample results, as determined by gamma spectrometry, for randomly selected soil samples and the judgemental sample are reported in Table B-1.

TABLE 2 ORISE RADIONUCLIDE CONCENTRATION RANGES IN SOIL SAMPLES SUMMARY RESULTS FOR OPERABLE UNIT-1 LANDFILL TRENCHES MIAMISBURG CLOSURE PROJECT MIAMISBURG, OHIO					
Trench	Radionuclide Concentrations (pCi/g)				
	Ra-226	Th-230	Th-232	U-235	U-238
All Trenches	0.58 to 0.93	-0.8 to 1.9	0.37 to 0.60	0.02 to 0.06	0.57 to 0.96

All verification soil samples results were below the COs established for the site.

¹Electronic mail from C. Gerbig (ARC) to W. Adams (ORISE), RE: Maps and Sample Coordinates; May 10, 2010.

ORISE also reviewed ARC's field screening gamma spectroscopy results for the ORISE evaluated trenches. The qualitative review indicated that with the exception of Th-230 concentration, the ARC gamma spectroscopy method has the necessary radiological sensitivity to detect the primary radiological COCs.

VISUAL OBSERVATIONS

Visual observation of the trench bottoms and excavated soil was performed to identify waste. ORISE did not observe any visible wastes within the soil piles or trenches.

COMPARISON OF RESULTS WITH GUIDELINES

Gamma spectroscopy results indicated that all soil sample radionuclide concentrations were at background levels; therefore, no need to perform alpha spectroscopy to determine isotopic abundances for plutonium or uranium. This approach was accepted by the DOE Project Manager. Radionuclide concentrations in all soil samples collected are listed in Table B-1.

SUMMARY

On April 14 and 15, 2010, the ORISE IVT conducted independent verification survey activities in a four acre area of the OU-1 Landfill at the Miamisburg Closure Project in Miamisburg, Ohio. The IVT performed gamma scans and collected soil samples to quantify the remaining radiological concentrations of the contaminants of concern in the OU-1 Landfill Area. Low energy gamma radiation scans performed by the IVT identified and sampled a small isolated soil location with activity greater than background. Analysis of the sample indicated that the COCs were well below the concentration guidelines. A qualitative comparison of the ORISE results and the contractor results indicated that the contractors' field screening method has the detection sensitivity necessary to evaluate the radiological COC concentrations, with the exception of Th-230 concentrations. The minimum detectable activity reported by the contractor for field screening gamma spectroscopy was higher than the clean-up goal of 2.8 pCi/g. However, all individual sample and mean concentrations were below the guidelines. Visual observations did not identify any wastes in the open excavated pits. Therefore, ORISE is of the opinion that the process for evaluating the pits sufficiently allows the contractor to meet site clean-up objectives.

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- Oak Ridge Institute for Science and Education. *Laboratory Procedures Manual for the Independent Environmental Assessment and Verification Program*. Oak Ridge, Tennessee; March 1, 2010.
- U.S. Department of Energy(DOE). *Environment, Safety and Health Bulletin: A Guide to Good Practices for the Control and Release of Property*. DOE/EH-0697. Washington, DC; July 2006.

APPENDIX A

FIGURES

Figure A-2: Miamisburg Closure Project Operable Unit-1 Landfill Area Plot Plan

**Figure A-3: Miamisburg Closure Project Operable Unit-1 Landfill Area
Trench Soil Sample Locations**

APPENDIX B

DATA TABLE

TABLE B-1
RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES
OPERABLE UNIT-1 LANDFILL TRENCHES
MIAMISBURG CLOSURE PROJECT
MIAMISBURG, OHIO

Sample ID/Location ^a	Sample Coordinates ^b		Gamma Measurement (cpm)	Radionuclide Concentrations (pCi/g)				
	Northing	Easting		Ra-226	Th-230	Th-232	U-235	U-238
Trench 30								
S057	597053	1464432	4,200	0.80 ± 0.06 ^c	-0.5 ± 1.2	0.44 ± 0.05	0.04 ± 0.02	0.72 ± 0.08
S058	597053	1464432	4,100	0.78 ± 0.05	0.60 ± 0.88	0.47 ± 0.05	0.02 ± 0.02	0.72 ± 0.09
S059	597056	1464389	3,900	0.81 ± 0.05	0.75 ± 0.21	0.44 ± 0.05	0.06 ± 0.01	0.82 ± 0.07
Average			4,100	0.80	0.28	0.45	0.04	0.75
Trench 31								
S060	597080	1464426	4,500	0.80 ± 0.05	1.36 ± 0.63	0.50 ± 0.05	0.05 ± 0.01	0.79 ± 0.08
S061	597080	1464426	4,600	0.78 ± 0.05	0.57 ± 0.68	0.45 ± 0.05	0.04 ± 0.01	0.74 ± 0.08
S062	597083	1464396	3,900	0.80 ± 0.07	1.11 ± 0.59	0.49 ± 0.06	0.04 ± 0.02	0.78 ± 0.09
Average			4,300	0.79	1.01	0.48	0.04	0.77
S063 ^d	597080	1464425	4,200	0.78 ± 0.04	0.7 ± 1.1	0.60 ± 0.07	0.05 ± 0.01	0.77 ± 0.07
Trench 53								
S064	597510	1464033	4,400	0.88 ± 0.06	1.1 ± 2.6	0.49 ± 0.05	0.05 ± 0.01	0.69 ± 0.08
S065	597497	1464036	3,800	0.58 ± 0.03	-0.8 ± 1.1	0.37 ± 0.05	0.04 ± 0.02	0.57 ± 0.07
Average			4,100	0.73	0.15	0.43	0.05	0.63
Trench 32								
S066	597110	1464361	4,100	0.84 ± 0.07	0.89 ± 0.60	0.47 ± 0.06	0.05 ± 0.02	0.85 ± 0.10
S067	597110	1464373	4,400	0.84 ± 0.05	0.67 ± 0.47	0.46 ± 0.05	0.06 ± 0.01	0.88 ± 0.08
S068	597109	1464373	4,200	0.93 ± 0.06	1.9 ± 1.2	0.48 ± 0.05	0.05 ± 0.01	0.96 ± 0.09
S069	597108	1464397	4,300	0.85 ± 0.05	1.23 ± 0.10	0.43 ± 0.05	0.05 ± 0.01	0.75 ± 0.07
Average			4,300	0.87	1.17	0.46	0.05	0.86

^aRefer to Figure A-3.

^bSample coordinates provided by DeNuke.

^cUncertainties are at the 95% confidence level based on total propagated uncertainties.

^dJudgmental soil sample collected based on FIDLER gamma scan reading

APPENDIX C
MAJOR INSTRUMENTATION

APPENDIX C

MAJOR INSTRUMENTATION

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

SCANNING INSTRUMENT/DETECTOR COMBINATIONS

Fluke NaI Scintillation Detector Model 489-55, Crystal: 3.2 cm x 3.8 cm
(Fluke, Cleveland, OH)

coupled to:

Ludlum Ratemeter-Scaler Model 2221

(Ludlum Measurements, Inc., Sweetwater, TX)

Bicron Field Instrument Detector for Low Energy Radiation (FIDLER) Model G5
(Bicron Corporation, Newburg, OH)

coupled to:

Ludlum Ratemeter-Scaler Model 2221

(Ludlum Measurements, Inc., Sweetwater, TX)

LABORATORY ANALYTICAL INSTRUMENTATION

High Purity Extended Range Intrinsic Detector
CANBERRA/Tennelec Model No: ERVDS30-25195
(Canberra, Meriden, CT)

Used in conjunction with:

Lead Shield Model G-11

(Nuclear Lead, Oak Ridge, TN) and

Multichannel Analyzer

(Canberra, Meriden, CT)

High Purity Extended Range Intrinsic Detector
Model No. GMX-45200-5

(AMETEK/ORTEC, Oak Ridge, TN)

used in conjunction with:

Lead Shield Model SPG-16-K8

(Nuclear Data)

Multichannel Analyzer

(Canberra, Meriden, CT)

Canberra Apex Gamma Software

(Dell Workstation)

LABORATORY ANALYTICAL INSTRUMENTATION (CONTINUED)

High-Purity Germanium Detector

Model GMX-30-P4, 30% Eff.

(AMETEK/ORTEC, Oak Ridge, TN)

Used in conjunction with:

Lead Shield Model G-16

(Gamma Products, Palos Hills, IL) and

Multichannel Analyzer

(Canberra, Meriden, CT)

APPENDIX D

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX D

SURVEY AND ANALYTICAL PROCEDURES

PROJECT HEALTH AND SAFETY

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

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

CALIBRATION AND QUALITY ASSURANCE

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to the National Institute of Standards and Technology (NIST).

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

- Survey Procedures Manual (May 2008)
- Laboratory Procedures Manual (March 2010)
- Quality Program Manual (June 2009)

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

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Participation in Mixed-Analyte Performance Evaluation Program (MAPEP), NIST Radiochemistry Intercomparison Testing Program (NRIP), and Intercomparison Testing Program (ITP) Laboratory Quality Assurance Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

SURVEY PROCEDURES

Surface Scans

Scans for elevated gamma radiation were performed by passing the detector slowly over the surface. The distance between the detector and surface was maintained at a nominal distance of about 1 to 5 cm. Identification of elevated radiation levels was based on increases in the audible signal from the instrument.

The scan minimum detectable concentrations (MDCs) for the NaI scintillation detector for the contaminants of concern in surface soil were obtained directly from NUREG-1507 when available or estimated using the calculation approach described in NUREG-1507². A typical NaI detector (1.5 inch × 1.25 inch) MDC is 4.5 pCi/g for Ra-226, 3000 pCi/g for Th-230, 2.8 pCi/g for Th-232, 115 pCi/g for natural uranium (56 pCi/g for U-238, 56 pCi/g for U-234 and 3 pCi/g for U-235). ORISE used the FIDLER for qualitative measurements. An audible increase in the activity rate was investigated by ORISE. It is standard procedure for the ORISE staff to pause and investigate any locations where gamma radiation is distinguishable from background levels.

Soil Sampling

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

²NUREG-1507. Minimum Detectable Concentrations With Typical Radiation Survey Instruments for Various Contaminants and Field Conditions. U.S. Nuclear Regulatory Commission. Washington, DC; June 1998.

RADIOLOGICAL ANALYSIS

Gamma Spectroscopy

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

Radionuclide	TAP (MeV)	MDC (pCi/g)
U-238 (from Th-234)	0.063	0.21
U-235	0.143	0.06
Ra-226 (from Pb-214)	0.351	0.19
Pb-210	0.046	0.54
Th-230	0.067	5.0
Th-232 (from Ac-228)	0.911	0.05

Spectra were also reviewed for other identifiable TAPs.

Uncertainties

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

DETECTION LIMITS

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