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September 21, 2012

John J. Hayes, Project Manager
U.S. Nuclear Regulatory Commission
Materials Decommissioning Branch
Division of Waste Management and Environmental Protection
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SUBJECT: FINAL REPORT FOR INDEPENDENT CONFIRMATORY SURVEY SUMMARY AND RESULTS FOR THE HEMATITE DECOMMISSIONING PROJECT, FESTUS, MISSOURI; DCN 5184-SR-01-0 (DOCKET NO. 70-036)

Dear Mr. Hayes:

Enclosed is the final report for independent confirmatory survey activities for the Hematite Decommissioning Project in Festus, Missouri. The information contained in the report provides information and results of activities performed by Oak Ridge Associated Universities, under the Oak Ridge Institute for Science and Education contract, during the U.S. Nuclear Regulatory Commission's June 12 through 13, 2012 inspection. Comments on the draft report have been incorporated.

You may contact me via my information below or Tim Vitkus at 865.576.5073 if you have any questions.

Sincerely,

Erika N. Bailey

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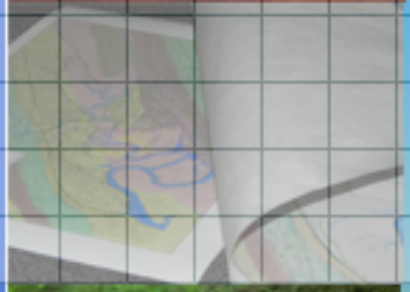

FINAL REPORT FOR INDEPENDENT CONFIRMATORY SURVEY SUMMARY AND RESULTS FOR THE HEMATITE DECOMMISSIONING PROJECT, FESTUS, MISSOURI

Erika N. Bailey
and
Jason D. Lee

Prepared for the
U.S. Nuclear Regulatory Commission

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Oak Ridge Associated Universities manages the Oak Ridge Institute for Science and Education (ORISE) contract for the U.S. Department of Energy. ORISE focuses on scientific initiatives to research health risks from occupational hazards, assess environmental cleanup, respond to radiation medical emergencies, support national security and emergency preparedness, and educate the next generation of scientists.

FINAL REPORT FOR INDEPENDENT CONFIRMATORY SURVEY SUMMARY AND RESULTS FOR THE HEMATITE DECOMMISSIONING PROJECT, FESTUS, MISSOURI

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FINAL REPORT

SEPTEMBER 2012

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FINAL REPORT FOR INDEPENDENT CONFIRMATORY SURVEY SUMMARY AND RESULTS FOR THE HEMATITE DECOMMISSIONING PROJECT, FESTUS, MISSOURI

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FINAL REPORT

SEPTEMBER 2012

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ACRONYMS

COC	contaminant of concern
cpm	counts per minute
CSM	conceptual site model
CZ	contamination zone
$DCGL_W$	radionuclide-specific derived concentration guideline level
DER	normalized absolute zero
DP	decommissioning plan
HDP	Hematite Decommissioning Project
IEAV	Independent Environmental Assessment and Verification
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
NRC	U.S. Nuclear Regulatory Commission
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
pCi/g	picocuries per gram
RCRA	Resource Conservation and Recovery Act
SOF	sum of fractions
SU	survey unit
TEDE	total effective dose equivalent
USEI	U.S. Ecology Idaho
VOC	volatile organic compound
WAC	waste acceptance criteria
WEC	Westinghouse Electric Company, LLC
WHA	Waste Handling Area

INDEPENDENT CONFIRMATORY SURVEY SUMMARY AND RESULTS FOR THE HEMATITE DECOMMISSIONING PROJECT, FESTUS, MISSOURI

1. INTRODUCTION

The Westinghouse Electric Company, LLC (WEC) former fuel cycle facility near Festus, Missouri operated from 1956 to 2001 manufacturing uranium for use as nuclear fuel. The site ceased operational activities in September 2001. WEC is decommissioning the facility now known as the Hematite Decommissioning Project (HDP). From its inception in 1956 through 1974, the facility was used primarily in support of government contracts that required the production of highly enriched uranium products. From 1974 through the plant closure in 2001, the focus changed from government contracts to commercial fuel production. Specifically, operations included the conversion of uranium hexafluoride gas of various uranium enrichments to uranium oxide, uranium carbide, uranium dioxide pellets, and uranium metal. Secondary operations included research and development and uranium scrap recovery processes. The facility's central land area and the site creek were impacted by the fuel fabrication activities.

The U.S. Nuclear Regulatory Commission (NRC) is responsible for oversight of permitted license activities that are currently being conducted at the HDP. The NRC has opted to perform independent (third party) confirmatory evaluations of various site activities to assess the radiological conditions at the site. This included independent reviews of the licensee's documents, survey data, and analytical results to ensure that site documentation accurately and adequately describes the conditions at the site; that procedures are sufficiently robust to meet the requirements for assessing and documenting final radiological status; and that the implementation of plans and procedures was successful. The confirmatory evaluation also included conducting on-site evaluations of the licensee's field activities (i.e., in-process inspections), and generating independent radiological data to evaluate the adequacy and accuracy of the final conclusions.

At NRC's request, the Independent Environmental Assessment and Verification (IEAV) Program of Oak Ridge Associated Universities (ORAU) was responsible for independent confirmatory activities at HPD. ORAU performed this task under the Oak Ridge Institute for Science and Education (ORISE) contract.

2. SITE DESCRIPTION

The Hematite facility is located in Jefferson County, Missouri, less than four miles west of the town of Festus, Missouri, and 35 miles south of the city of St. Louis. The site is surrounded by forest, agricultural lands, and low-density residential housing. The entire site consists of approximately 228 acres; however, the impacted portion of the site—referred to as the central tract—only includes approximately 19 acres. The central tract of the site is bounded by State Road P to the north, the northeast site creek to the east, Union-Pacific railroad tracks to the south, and the site creek/pond to the west.

3. OBJECTIVES

The objective of the confirmatory survey was to provide independent contractor field data reviews and to generate independent radiological data for NRC's use in evaluating the accuracy and adequacy of the licensee's procedures. More specifically, the objective was to ensure that regulatory release and/or waste handling criteria are being met by the licensee and that supporting data were collected in a satisfactory manner. To achieve this objective, ORAU performed document reviews and onsite in-process confirmatory inspections and surveys. Split samples were also provided to ORAU by WEC and analyzed by the ORAU/ORISE radiological laboratory to assess the licensee's analytical capabilities.

4. DOCUMENT REVIEW

Prior to on-site activities, ORAU was provided the *Hematite Decommissioning Plan* (DP) (WEC 2009a) for review to develop a project-specific plan. Upon arrival at the site, Mike LaFranzo (NRC) also provided plans and procedures applicable to the confirmatory survey for ORAU's review. Table 4.1 summarizes the specific procedures reviewed by ORAU. In addition to reviewing the DP, ORAU took into account guidance from the *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* (NRC 2000).

Table 4.1 Procedural Review Summary		
Procedure Number	**Title**	**Revision**
HDP-PR-HP-606	Sampling in NCS Designated Areas	1
HDP-PR-HP-601	Remedial Action Support Surveys	2
HDP-PR-EM-011	Low Flow Well Sampling	4
HDP-PR-EM-005	Sediment Sampling	3
HDP-PR-FSS-710	Final Status Surveys and Radiological Sampling of Re-Use Soil	3
HDP-PR-WM-905	Waste Sampling Methods, Labeling and Custody	2

NCS = nuclear criticality safety

5. APPLICABLE SITE GUIDELINES

Based on past site investigations, the primary contaminants of concern (COCs) at the HDP are technetium (Tc-99), thorium-232 (Th-232), uranium-234 (U-234), uranium-235 (U-235), uranium-238 (U-238), americium-241 (Am-241), neptunium-237 (Np-237), and plutonium-239/240 (Pu-239/240). Each radionuclide-specific derived concentration guideline level ($DCGL_W$) represents the concentration above background of a residual radionuclide that would result in a radiological dose of 25 mrem/yr to the average member of the critical group (WEC 2009a). Because each of the individual $DCGL_W$ represents 25 mrem/yr, the sum-of-the-fractions (SOF) approach is used to demonstrate compliance with the dose limit. SOF calculations are performed as follows:

$$SOF_{TOTAL} = \sum_{j=0}^{n} SOF_j = \sum_{j=0}^{n} \frac{C_j}{DCGL_{W,j}}$$

Where C_j is the concentration of COC "j," and $DCGL_{W,j}$ is the $DCGL_W$ for COC "j." Note that gross concentrations are considered here for conservatism.

As depicted in Fig. 5.1 (Fig. 5.4 of the DP), $DCGL_W$s were calculated by WEC for four conceptual site models (CSMs), including Shallow, Root, Deep, and Uniform contaminated soil strata. Due to the fact that some areas of the site are known to have contaminated soil underneath clean material (e.g., burial pits), while other areas of the site are believed to be contaminated only on the surface, WEC developed the following CSMs for three layers of contamination: Surface (0–0.15 m), Root (0.15–1.5 m), and Deep (1.5–6.7 m). The thickness of the cover and the

contamination zone (CZ) depth both depend on the CSM. The Uniform stratum approach assumes uniform contamination is present from the surface to a depth of 6.7 m. Due to the fact that subsurface soils could, in the future, be excavated and brought to the surface, WEC also performed an excavation scenario evaluation to ensure that deep strata $DCGL_W$s would be acceptable if those soils were excavated and brought to the surface.

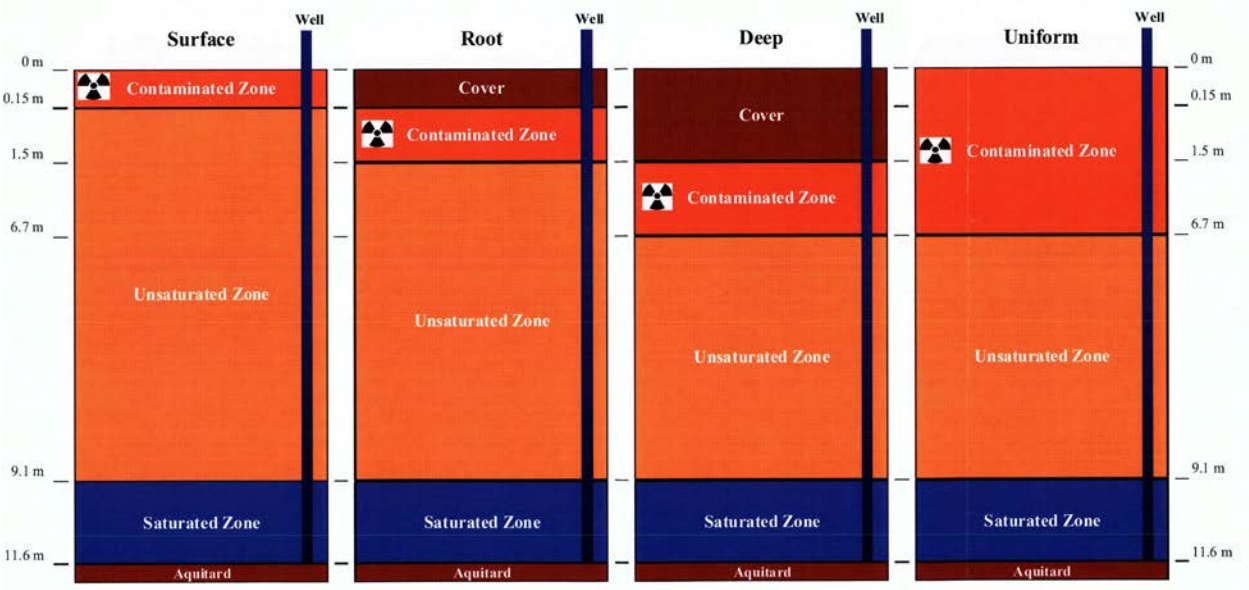

Fig. 5.1 CSMs for Site-Specific $DCGL_w$s

For this report, one of two approaches will be used to determine compliance with applicable site guidelines: (1) the more conservative Uniform approach, or (2) the multi-layered approach. In the case that Uniform criteria are not met, then the multi-layered approach can be tested. When the multilayered approach is applied, a SOF equation will also be used to combine the results of each layer in addition to the equation combining the concentrations of multiple radionuclides. Table 5.1 presents the Uniform $DCGL_W$s used to evaluate analytical results in residual soil and sediment.

Table 5.1 Soil $DCGL_W$ Values				
Radionuclide	**Three Layer Approach $DCGL_W^S$ Values (pCi/g)**			**Uniform $DCGL_W^S$ Values (pCi/g)**
	0 to 0.15 m layer	**0.15 to 1.5 m layer**	**> 1.5 m layer**	
Uranium-234	545.4	252.7	935.6	209.6
Uranium-235+D	109.7	68.7	223.2	55.3
Uranium-238+D	319.2	196.6	591	181.0
Technicium-99	162	23.3	79.4	26.9
Thorium-232+C	5.0	2.1	5.6	2.1
Radium-226+C	5.4	2.3	5.8	2.0
Neptunium-237 +D	17.4	5.0	0.3*	0.3
Plutonium-239/240	239.6	85.1	246.6	83.1
Americium-241	220.7	118.5	229.2	79.3

*Neptunium-237 DCGL for >1.5 m is determined using the Deep CSM, while all other radionuclides are determined using the Excavation CSM

+D indicates the $DCGL_W$ includes short-lived (half-life ≤ 6 mo.) decay products

+C indicates the $DCGL_W$ includes all radionuclides in the associated decay chain

Table source: LaFranzo 2012

Np-237, Pu-239/240, and Am-241 are considered to be insignificant COCs based on the aggregate dose of these radionuclides being less than 10% of the total effective dose equivalent (TEDE) for each CSM. Licensees are required to comply with the applicable dose criteria in 10 Code of Federal Regulations Part 20, Subpart E; thus, the dose contribution from the insignificant radionuclides must be accounted for in demonstrating compliance with the dose criteria. WEC has accounted for the dose contribution from the insignificant radionuclides, and adjusted the $DCGL_w$ accordingly. The adjusted soil $DCGL_W$s are provided in Table 5.2. Deep strata $DCGL_W$s have been replaced by alternate excavation scenario $DCGL_W$s to ensure that any deep strata anomalous contamination would be acceptable if brought to the surface by future excavation following license termination.

Table 5.2 Adjusted Site-Specific Soil $DCGL_W$ by CSM					
Radionuclide	**Units**	**Shallow Stratum**	**Root Stratum**	**Uniform Stratum**	**Excavation Scenario**
Uranium-234	pCi/g	508.5	235.6	195.4	872.4
Uranium-235+D	pCi/g	102.3	64.1	51.6	208.1
Uranium-238+D	pCi/g	297.6	183.3	168.8	551.1
Technicium-99	pCi/g	151.0	30.1	25.1	74.0
Thorium-232+C	pCi/g	4.7	2.0	2.0	5.2
Radium-226+C	pCi/g	6.0	2.3	2.1	5.4

The reported $DCGL_Ws$ are the activities for the parent radionuclide as specified (WEC 2009a) and were calculated to account for the dose contribution from insignificant radionuclides.
+D indicates the $DCGL_W$ includes short-lived (half-life ≤ 6 mo.) decay products
+C indicates the $DCGL_W$ includes all radionuclides in the associated decay chain
Table source: LaFranzo 2012

6. PROCEDURES

At NRC's request, an ORAU survey team visited the Hematite Site from June 12 through 13, 2012 to perform in-process and confirmatory survey activities. These activities included evaluation of the licensee's implementation of site-specific guidance documents/procedures, visual inspections, surface scans, sample collection, and laboratory analysis procedures. The confirmatory survey activities were conducted in accordance with the *Project-Specific Plan for Independent Confirmatory Survey Activities for the Hematite Decommissioning Project* and the ORAU/ORISE Survey Procedures and Quality Program Manuals (ORISE 2012, ORAU/ORISE 2012a, and ORAU 2012). Questions and concerns were brought to the immediate attention of the NRC representative and are also noted in the Findings and Results section of this report.

6.1 CONFIRMATORY SURVEY FOCUS AREA

Specific geographical locations for survey, sampling, and/or procedural inspection were selected by the NRC and included three groundwater monitoring wells, two sediment collection sites, the reusable soil pile area, a four-bin Waste Handling Area (WHA), and survey unit (SU) North 4, which is located in the "burial pit" area. Walkover survey measurements and sampling locations are

provided in Appendix A Figs. A-1, A-2, and A-3. Appendix A Fig. A-4 shows the location of SU North 4 . Table 6.1 provides a summary of the locations addressed during the confirmatory survey.

Table 6.1 Confirmatory Survey Focus Areas

Survey Location	Description
Waste Handling Area	Segregated area used for staging soil that cannot be utilized for re-use due to debris and/or low-level radioactive contamination
Soil Re-Use Pile	Segregated area where excavated soil that is reusable is delivered by truck, scanned, and stored for later use as fill material
Groundwater Monitoring Well NB-71	Groundwater monitoring well located outside the fence line northeast of the burial pit boundary and across Northeast Site Creek from the site
Groundwater Monitoring Well GWW	Groundwater monitoring well located immediately adjacent to the Evaporation Pond to the southeast
Groundwater Monitoring Well GWU	Groundwater monitoring well located outside and adjacent to the fence line on the southeast side of main site area
Sediment Sampling Location SS-52	Storm water point source discharge monitoring station just inside the northeast corner of the fence line
Sediment Sampling Location SS-17	Tributary southeast of the main site area where the site pond discharges into the Joachim creek via Site Creek
Survey Unit North 4	Survey unit in the northwest portion of the burial pit excavation area

6.2 SURFACE SCANS

High-density gamma walkover scans were performed over SU North 4 using a Ludlum model 44-10 2 × 2 sodium iodide detector coupled to a Ludlum model 12 ratemeter-scaler with an audible indicator. Electronic data collection was facilitated using global positioning system equipment that logged real-time detector responses with their corresponding coordinates using North American Datum 1983 State Plane Missouri East FIPS 2401 U.S. Survey Feet. Scan results are illustrated in Appendix A Fig. A-2. Locations of elevated direct gamma radiation were marked for further investigation. In order to evaluate the licensee's data collection processes and procedures, the ORAU technician followed directly behind the licensee's technician, matching scan coverage and speed. Flags were posted by the licensee's technician at each turn in order to ensure complete coverage of the SU.

In addition, ORAU performed radiological scans of excavated material designated for the Soil Re-use Pile. These scans were performed on material excavated from the burial pits and delivered via truck. Per WEC procedure, the excavated soil was dumped and spread out prior to scanning and visual inspection. Appendix A Fig. A-3 presents scan results of the spread material prior to being moved to the Soil Re-use Pile.

6.3 SOIL AND SEDIMENT SAMPLING

Four soil samples and two sediment samples were collected by the licensee, utilizing the applicable site procedure(s) listed in Table 4.1 and under direct observation of ORAU personnel. Following sample collection and homogenization, site personnel provided split samples for the purpose of independent analysis by the ORAU/ORISE radiological laboratory.

Per direction of the NRC representative, one composite soil sample was collected from Bin 1 and one from Bin 4, both located in the WHA. Per WEC waste sampling procedures, each bin-specific composite sample was generated by combining material from four randomly selected sub-sample locations. The remaining two composite samples were collected from the Soil Re-Use Pile. Per WEC soil re-use and final status survey sampling procedures, each composite sample consisted of soil from four randomly selected sub-sample locations. However, ORAU noted the samples were not truly random in nature, such as would result from using a random number generating approach; rather, the licensee went to the north, south, east, and west areas of the bins/piles to collect the four sub-samples. The licensee's assumption was that the media was fairly well homogenized by the time it reached the bins/re-use piles from the mixing that occurred during the truck loading and unloading process.

The two sediment sample locations included SS-52 (NPDES Outfall 6) and SS-17 (convergence of Site Creek and Joachim Creek). Sediment samples were collected according to the WEC sediment sampling procedure identified in Section 4. Table 6.2 presents a summary of the sample identifications associated with soil and sediment samples.

Table 6.2 Soil and Sediment Sample Summary			
ORAU Sample ID	**WEC Sample ID**	**Description**	**Applicable Procedure**
5184S0001	2849-RU-120612-01-07	Re-Use Pile	Composite
5184S0002	2848-WM-120612-06-01	Re-Use Pile	Composite
5184S0003	2848-WM-120612-06-02	WHA Bin 1	Composite
5184S0004	2848-WM-120612-06-03	WHA Bin 4	Composite
5184S0005	SS-52	Outfall 6	Grab
5184S0006	SS-17	Site Creek Tributary	Grab

6.4 MONITORING WELL SAMPLING

Three groundwater samples were collected by the licensee under direct observation of ORAU personnel and utilizing the low flow well sampling procedure identified in Table 4.1. Samples were collected in duplicate to allow for split analysis by the ORAU/ORISE radiological laboratory. Each sample was collected directly from the peristaltic pump into an appropriate sample container. Collection into a common container for the purpose of homogenization was not deemed necessary based on the stability of pre-sampling water quality parameters; these parameters included temperature, dissolved oxygen, pH, oxidation-reduction potential, and turbidity. Both sample sets were dispensed in immediate succession.

It is common practice for the ORAU/ORISE laboratory to filter groundwater samples prior to acidification in order to include only the dissolved fraction of the analyte in the quantified result. When sampling, the WEC technician collected samples directly into a container pre-preserved with nitric acid. The water collected from these wells was high in dissolved iron and possibly manganese that oxidized and precipitated in the unpreserved ORAU sample. The WEC sample did not undergo the same effect due to acid solubility. As a result, if ORAU were to filter prior to acidification, any of the target analytes in precipitate form would be filtered out prior to analysis. This would likely result in lower target analyte recovery when later compared to samples collected by WEC. In the interest

of evaluating laboratory proficiency, the NRC requested ORAU acidify samples prior to filtration and report the total recoverable analyte fraction, matching the WEC methodology.

Table 6.3 presents a summary of the sample identifications associated with groundwater samples.

Table 6.3 Monitoring Well Sample Summary

ORAU Sample ID	WEC Sample ID	Description	Sample Type
5184W0001	GW-NB71-061212	Northeast of Burial Pit	Grab
5184W0002	GW-GWW-061212	Southeast Side of Central Tract	Grab
5184W0003	GW-GWU-061312	Adjacent to Evaporation Pond	Grab

7. SAMPLE ANALYSIS AND DATA INTERPRETATION

Scan data and volumetric samples were returned to the ORAU facility in Oak Ridge, Tennessee for laboratory analysis and data interpretation. Sample analyses were performed in accordance with the ORAU/ORISE Laboratory Procedures Manual (ORAU/ORISE 2012b). Notable sample preparation steps performed by the ORAU/ORISE laboratory included the acidification of water samples prior to filtration and the passing of soil/sediment samples through a 0.25 inch sieve. Samples were analyzed by solid-state gamma spectroscopy, alpha spectroscopy, liquid scintillation, and low background proportional counting. Analytical laboratory results were evaluated and compared to applicable guidelines.

In response to NRC's request to perform split analyses, Appendix B Table B-2 provides sample results obtained from the licensee's laboratory (Test America, St. Louis) and compares them to the results provided by the ORAU/ORISE laboratory. Acceptance criteria for split analyses are based upon a normalized absolute zero (DER). If the DER is less than or equal to 3, results do not differ significantly while taking into account their respective uncertainties. The following equation was used.

$$DER = \frac{|S-D|}{\sqrt{(Us^2)+(Ud^2)}} = \leq 3$$

Where :

S = WEC sample result
D = split result
Us = WEC sample uncertainty
Ud = split uncertainty

8. FINDINGS AND RESULTS

This section discusses results for each confirmatory activity.

8.1 SURFACE SCANS

Surface scan results for SU North 4 and the soil re-use pile are discussed below. The reported surface activities represent gross counts that have not been subjected to background correction.

8.1.1 Survey Unit North 4

The licensee and ORAU technicians performed a slow and thorough high-density walkover scan of the SU, placing flags at any location exhibiting elevated activity. Overall instrument response ranged from background to the order of 20,000 counts per minute (cpm). The discreet location associated with a detector response of 20,000 cpm was one of five areas identified as exhibiting elevated activity. All five areas of elevated activity were identified by both the licensee and ORAU technician with comparable detector responses. The ORAU technician did not identify any areas of elevated activity in addition to those identified by the licensee's technician. Figure A-2 shows ORAU gamma scan coverage and detector response in cpm for the entire SU.

8.1.2 Soil Re-Use Pile

Scans of soil excavated from the burial pit and destined for re-use did not exhibit a detector response distinguishable from background. The scan range was 8,000 to 10,000 cpm. Scan results are provided in Appendix A Fig. A-3.

8.2 RADIONUCLIDE CONCENTRATIONS IN SOILS, SEDIMENTS, AND WATERS

A comprehensive summary of ORAU/ORISE laboratory sample results for site-related COCs (excluding Pu-239/240) are provided in Table B-1. Table 8.1 presents activity ranges for soil,

sediment, and groundwater irrespective of the analytical minimum detectable concentration (MDC) (i.e., both non-detected and detected results are presented). The comparison of analytical data between split samples sent to ORAU/ORISE laboratory and the licensee's laboratory were all considered to be within an acceptable range of variance based on the criteria discussed in Section 7. Table B-2 provides a complete comparison summary.

8.2.1 Soil Results

Samples collected from the WHA resulted in low-level detections of Cs-137, Ra-226, Tc-99, Th-232, U-234, U-235/236 (as reported but interpreted here as U-235), and U-238. Neither sample contained concentrations of Np-237 or Am-241 above the analytical MDC. WHA Bin 1 exhibited slightly higher concentrations of all detected isotopes as compared to Bin 4.

Results for samples collected from the Soil Re-Use Area indicate only low-level detections of Ra-226, Th-232, U-234, U-235/236 and U-238. Neither sample contained concentrations of Cs-137, Tc-99, Np-237, or Am-241 above the respective analytical MDC.

8.2.2 Sediment Results

Samples collected from locations SS-52 and SS-17 exhibit low-level detections of Cs-137, Ra-226, Tc-99, Th-232, U-234, U-235/236, and U-238. Neither sample contained concentrations of Np-237 or Am-241 above the respective analytical MDC.

8.2.3 Groundwater Results

With the exception of extremely low-level detections of U-234 at GW-GWU and U-238 at GW-GWW, there were no COCs detected above the respective analytical MDC. Three groundwater-sampling-related observations were made during the in-process inspection.

- First, equipment rinse blanks are/were not procedurally required due to the use of dedicated well tubing. However, the sampling technicians, on a routine basis, utilize the same water level indicator tape/probe for all wells. The equipment is decontaminated between each well per procedure, but could be considered a source of cross-contamination between two wells.

- Second, while sampling the monitoring well closest to the evaporation pond, technicians were experiencing difficulty with gaseous bubbles in the sample withdraw tubing and multi-meter manifold block. As no fluctuations were identified in regards to certain real-time field parameters such as dissolved oxygen, it is possible that the air bubbles were resulting from the liberation of volatile organic compounds (VOCs). While this may cause issues with field measurements, it could also result in a reduction of VOCs captured in the vial compared to the actual concentrations within the source water table.

- Third, it is also suggested that photo ionization detector readings be taken when accessing this well to determine the level of VOCs in the breathing zone.

These three observations are noteworthy, though matters related to non-radiological data are outside of the ORAU scope.

Table 8.1 COC Activity Range Summary in pCi/g or pCi/L

ROC	Soil Activity Range			Sediment Activity Range			Groundwater		
U-234	3.5	to	35	1.3	to	3.7	0.018	to	0.23
U-235/236	0.16	to	1.4	0.06	to	0.13	-0.022	to	0.032
U-238	1.2	to	2.6	0.71	to	1.2	0.089	to	0.30
Tc-99	0.14	to	5.3	0.92	to	1.1	-5.2	to	-0.20
Th-232	0.83	to	1.1	0.66	to	0.91	-1.5	to	12
Ra-226	0.56	to	0.91	0.51	to	0.81	-0.90	to	4.2
Np-237	-0.05	to	0.02	-0.05	to	0.02	0.40	to	3.4
Am-241	-0.01	to	0.04	0.00	to	0.01	1.6	to	5.2
Cs-137	0.02	to	0.04	0.08	to	0.08	-3.7	to	2.7

pCi/g = picocuries per gram
pCi/L = picocuries per liter

9. COMPARISON OF RESULTS WITH GUIDELINES

Analytical laboratory results for the soil re-use pile and sediment collection locations were compared to radionuclide-specific Uniform $DCGL_W$s, both by considering individual COCs and using a SOF calculation. Note, these comparisons are made using gross concentration (i.e., are not adjusted for soil background).

Table 9.1 compares average sample results from the Soil Re-Use Pile quantified above the analytical MDC to the Uniform $DCGL_W$s. Neither of the Soil Re-Use Area composite soil samples resulted in COC concentrations above the Uniform $DCGL_W$, considering either individual or SOF comparisons. A similar comparison of sediment samples is provided in Table 9.2. However, SOF calculations in Table 9.2 use the maximum and not average detected concentrations. This approach is based on the rationale that the two sediment samples are discreet in nature, as they were collected from widely dispersed locations. By comparing maximum detected values, a single conservative summary value can be determined.

NRC requested that soils collected from the WHA be compared to U.S. Ecology Idaho (USEI) waste acceptance criteria (WAC) and not DCGLs. The WAC are presented in the U.S. Environmental Protection Agency Resource Conservation and Recovery Act Part B permit held by USEI (EPA 2004). Based on a review of analytical data and Table C.1 of the USEI Part B permit, an applicable set of criteria is not available. The WHA sample results indicate a quantifiable presence of enriched uranium. The USEI WAC does not include a basis for comparison of enriched uranium with regards to disposal. Per NRC direction, sample results obtained from the WHA bins were compared to a WAC limit of 3,000 pCi/g (total activity) as requested by WEC, in a 2009 document titled, *Request for Alternate Disposal Approval and Exemptions for Specific Hematite Decommissioning Project Waste* (WEC 2009b). Table 9.3 compares analytical results of samples collected from WHA Bins 1 and 4 to the prescribed USEI WAC.

Table 9.1 Comparison of Soil Re-Use Samples to Uniform $DCGL_W$s (pCi/g)

COC	Min	Max	Avg	Uniform $DCGL_W$	Avg SOF_j
U-234	3.5	3.6	3.6	206.9	0.017
U-235/236	0.16	0.17	0.17	77.8	0.0022
U-238	1.2	1.4	1.3	181	0.0072
Th-232	1.0	1.1	1.0	2.2	0.45
Ra-226	0.72	0.72	0.72	2.0	0.36
				SOF_{TOTAL} =	**0.84**

Table 9.2 Comparison of Sediment Samples to Uniform $DCGL_W$s (pCi/g)					
COC	**Min**	**Max**	**Avg**	**Uniform $DCGL_W$**	**MAX SOF**
U-234	1.3	3.7	2.5	206.9	0.018
U-235/236	0.063	0.13	0.10	77.8	0.0017
U-238	0.71	1.2	0.95	181	0.0066
Th-232	0.66	0.91	0.79	2.2	0.41
Ra-226	0.51	0.81	0.66	2.0	0.41
				SOF_{TOTAL} =	**0.84**

Table 9.3 Comparison of WHA Samples to USEI WAC					
Location	**Units**	**Total Activity of Uranium Isotopes***	**Total Activity of Uranium Isotopes Plus Progeny****	**Total Activity for all Detected COCs*****	**Below/Above USEI WAC Limit of 3000 pCi/g?**
WHA Bin 1	pCi/g	39.29	45.95	53.15	Below WAC
WHA Bin 4	pCi/g	25.08	30.95	33.66	Below WAC

*Includes uranium 234, 235/236 and 238
** Includes short lived uranium decay; thorium-234, protactinium-234, and thorium-231
***Includes uranium and short lived uranium decay products plus americium-241, cesium-137, neptunium-237, radium-226, technecium-99, and thorium-232 where results are above the MDC— conservative comparison

10. SUMMARY

At NRC's request, ORAU conducted confirmatory surveys of the Hematite site during the period of June 12 through June 13, 2012. The survey activities included in-process inspections, document review, walkover surveys, sampling activities, and laboratory analysis of split samples.

WEC was forthcoming with information relating to practices, procedures, and surface scan results. Scans performed by the WEC technician were extremely thorough and methodical. The WEC and ORAU technicians identified the same areas of elevated activity with comparable detector responses.

WEC sampling of re-use soils, waste soils, sediments, and groundwater were conducted under ORAU observation. The sampling efforts observed by ORAU were performed in accordance with site-specific procedures and in a manner sufficient to provide quality supporting data.

Three observations were made during groundwater sampling activities. First, the water level indicator was re-used without submitting rinse blank. Second, bubbles created during tubing extraction could indicate the presence of volatilized organic compounds. Third, samplers did not use a photo ionization detector prior to sample collection to indicate the presence of volatile organic vapors.

Results of split samples indicated a high level of comparability between the WEC and ORAU/ORISE radiological laboratories. Analytical practices and procedures appear to be sufficient in providing quality radiochemical data.

All concentrations from the Soil Re-Use Area and sediment samples are below Uniform $DCGL_W$ limits; thus, comparisons to the less conservative stratified geometry were not required. Results were compared to individual DCGLs and using the SOF approach. Both composite soil samples collected from the WHA (Bins 1 and 4) were well below the prescribed USEI WAC.

11. REFERENCES

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WEC 2009a. *Hematite Decommissioning Plan.* D0-08-004; Revision 0.0. Westinghouse Electric Company, LLC. Festus, Missouri. August.

WEC 2009b. *Request for Alternate Disposal Approval and Exemptions for Specific Hematite Decommissioning Project Waste.* Westinghouse Electric Company, LLC. Festus, Missouri. May.

APPENDIX A
FIGURES

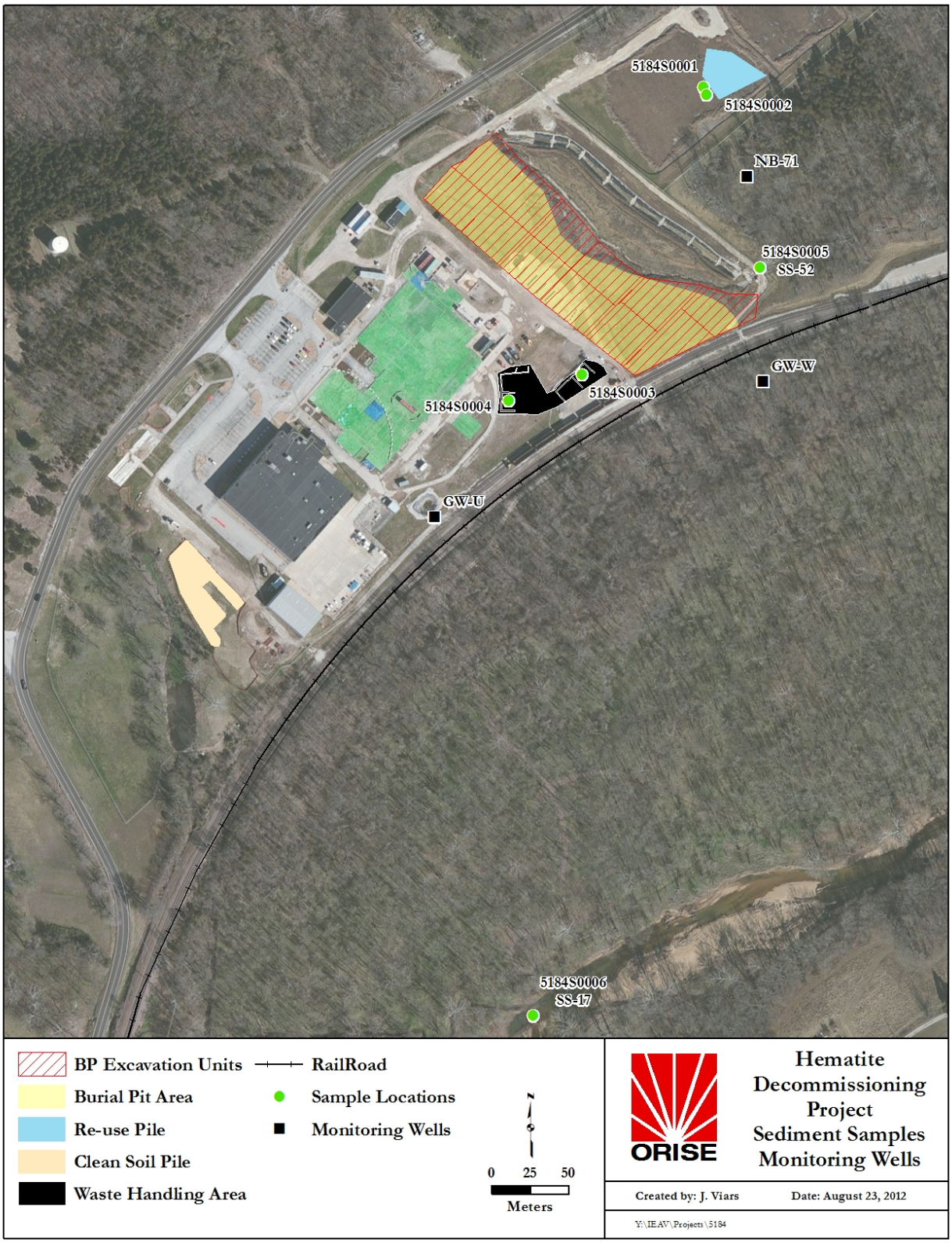

Fig. A-1. Hematite Decommissioning Project Sample Locations

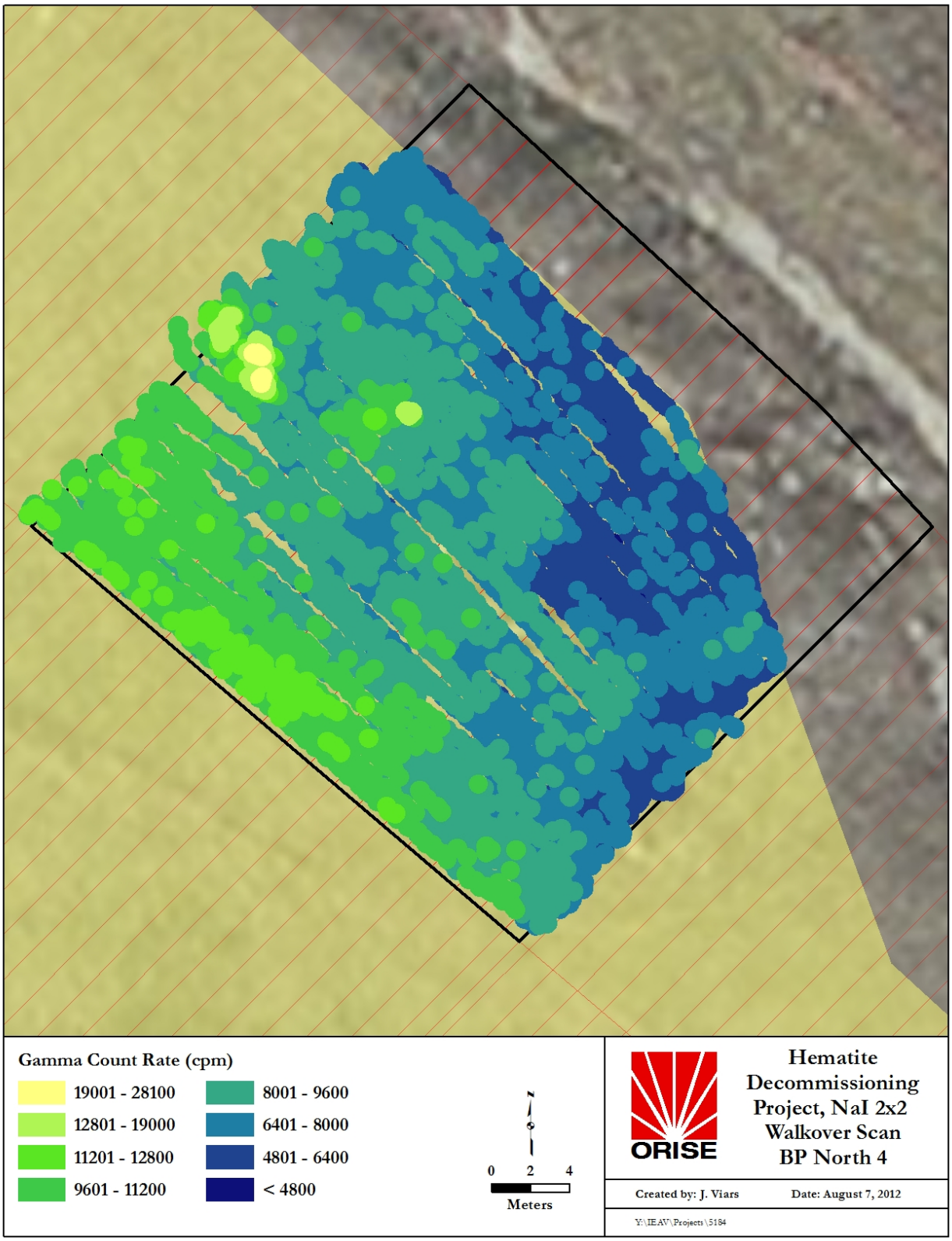

Fig. A-2. Survey Unit North 4 Gamma Walkover Data

Fig. A-3. Soil Re-Use Pile Walkover Data

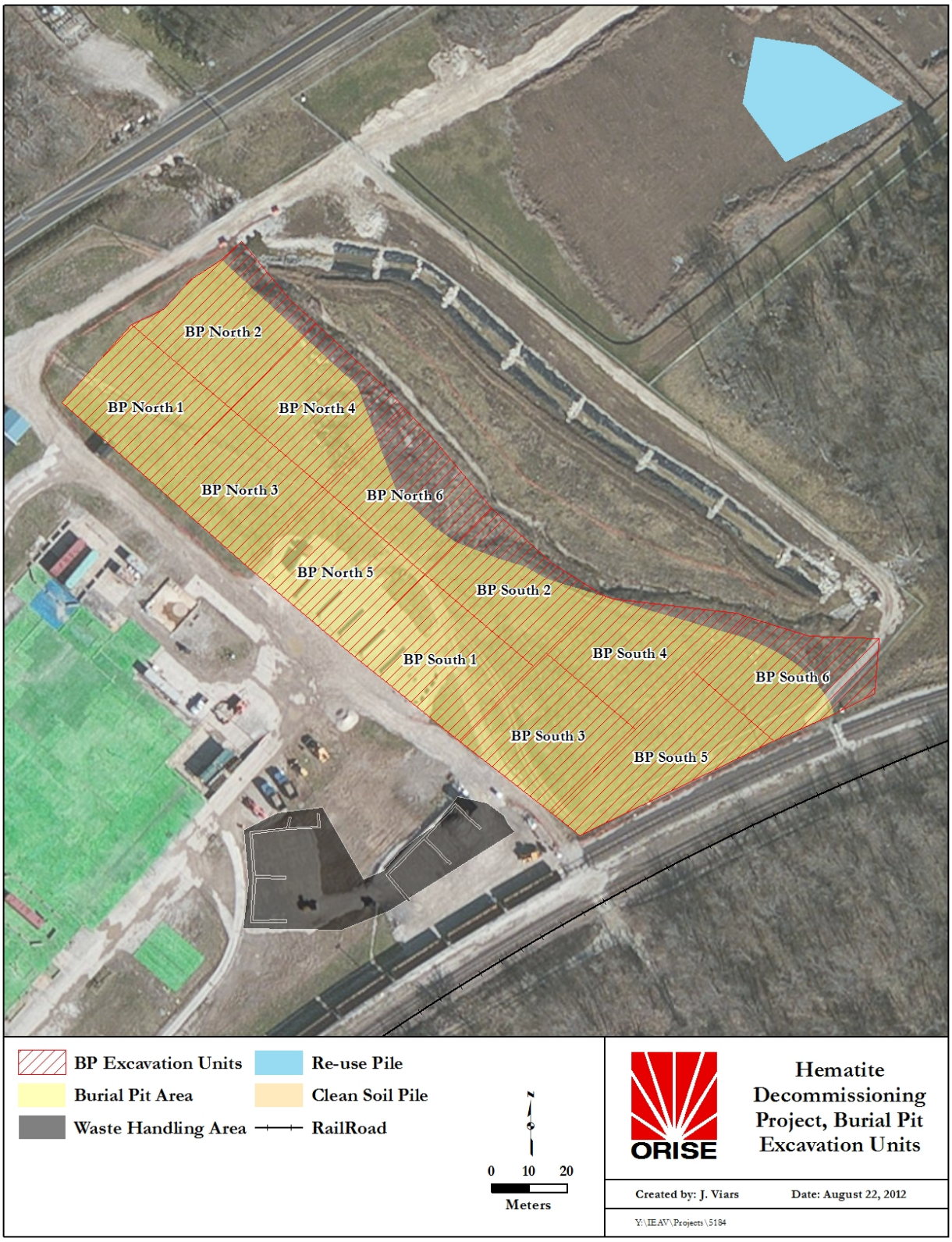

Fig. A-4. Burial Pit Area—Survey Units

APPENDIX B
DATA TABLES

ORAU ID	WEC ID	Isotope	ORAU Result	ORAU Uncertainty	ORAU MDC	WEC Result	WEC Uncertainty	WEC MDC	ABOVE ORAU MDC	Uniform DCGL	Above DCGL
5184S0001	2849-RU-120612-01-07	Am-241	-0.01	0.07	0.13	0.01	0.06	0.097	NO	79.3	No
5184S0001	2849-RU-120612-01-07	Cs-137	0.03	0.02	0.04	NR	NR	NA	NO	NA	NA
5184S0001	2849-RU-120612-01-07	Np-237 (by Pa-233)	0.01	0.05	0.09	NR	NR	NA	NO	0.3	No
5184S0001	2849-RU-120612-01-07	Ra-226 (By Pb-214)	0.72	0.07	0.07	0.89	0.13	0.06	YES	2	No
5184S0001	2849-RU-120612-01-07	Tc-99	0.15	0.15	0.24	0.16	0.25	0.41	NO	26.9	No
5184S0001	2849-RU-120612-01-07	Th-232 (by Ac-228)	1.05	0.15	0.15	1.01	0.15	0.1	YES	2.2	No
5184S0001	2849-RU-120612-01-07	U-234	3.51	0.45	0.02	4.37	0.45	0.02	YES	206.9	No
5184S0001	2849-RU-120612-01-07	U-235 / U-236	0.16	0.04	0.21	0.20	0.06	0.013	NO	77.8	No
5184S0001	2849-RU-120612-01-07	U-238	1.38	0.19	0.02	1.31	0.18	0.02	YES	181	No
5184S0002	2848-WM-120612-06-01	Am-241	0.01	0.06	0.10	-0.02	0.08	0.1	NO	79.3	No
5184S0002	2848-WM-120612-06-01	Cs-137	0.02	0.01	0.03	NR	NR	NA	NO	NA	NA
5184S0002	2848-WM-120612-06-01	Np-237 (By Pa-233)	0.02	0.05	0.08	NR	NR	NA	NO	0.3	No
5184S0002	2848-WM-120612-06-01	Ra-226 (By Pb-214)	0.72	0.06	0.06	0.93	0.15	0.07	YES	2	No
5184S0002	2848-WM-120612-06-01	Tc-99	0.14	0.15	0.24	0.07	0.24	0.42	NO	26.9	No
5184S0002	2848-WM-120612-06-01	Th-232 (by Ac-228)	1.03	0.13	0.12	1.14	0.20	0.09	YES	2.2	No
5184S0002	2848-WM-120612-06-01	U-234	3.60	0.47	0.03	3.43	0.37	0.02	YES	206.9	No
5184S0002	2848-WM-120612-06-01	U-235 / U-236	0.17	0.04	0.01	0.19	0.06	0.012	YES	77.8	No
5184S0002	2848-WM-120612-06-01	U-238	1.23	0.17	0.02	1.07	0.15	0.02	YES	181	No
5184S0003	2848-WM-120612-06-02	Am-241	0.04	0.07	0.11	0.02	0.06	0.098	NO	79.3	No
5184S0003	2848-WM-120612-06-02	Cs-137	0.04	0.02	0.03	NR	NR	NA	YES	NA	NA
5184S0003	2848-WM-120612-06-02	Np-237 (By Pa-233)	-0.05	0.04	0.07	NR	NR	NA	NO	0.3	No
5184S0003	2848-WM-120612-06-02	Ra-226 (By Pb-214)	0.91	0.08	0.07	0.83	0.12	0.05	YES	2	No
5184S0003	2848-WM-120612-06-02	Tc-99	5.26	0.38	0.24	6.11	0.78	0.43	YES	26.9	No
5184S0003	2848-WM-120612-06-02	Th-232 (by Ac-228)	0.99	0.15	0.17	0.89	0.16	0.09	YES	2.2	No
5184S0003	2848-WM-120612-06-02	U-234	35.26	4.36	0.03	26.80	2.30	0.02	YES	206.9	No
5184S0003	2848-WM-120612-06-02	U-235 / U-236	1.41	0.23	0.01	1.27	0.19	0.01	YES	77.8	No
5184S0003	2848-WM-120612-06-02	U-238	2.62	0.37	0.01	4.06	0.42	0.01	YES	181	No
5184S0004	2848-WM-120612-06-03	Am-241	0.02	0.07	0.14	0.00	0.04	0.075	NO	79.3	No
5184S0004	2848-WM-120612-06-03	Cs-137	0.04	0.02	0.03	0.05	0.02	0.024	YES	NA	NA
5184S0004	2848-WM-120612-06-03	Np-237 (By Pa-233)	0.00	0.05	0.08	NR	NR	NA	NO	0.3	No
5184S0004	2848-WM-120612-06-03	Ra-226 (By Pb-214)	0.56	0.06	0.07	0.57	0.10	0.061	YES	2	No
5184S0004	2848-WM-120612-06-03	Tc-99	1.29	0.20	0.24	1.47	0.36	0.43	YES	26.9	No
5184S0004	2848-WM-120612-06-03	Th-232 (by Ac-228)	0.83	0.13	0.14	0.71	0.11	0.08	YES	2.2	No
5184S0004	2848-WM-120612-06-03	U-234	21.78	2.71	0.03	33.40	2.90	0.02	YES	206.9	No
5184S0004	2848-WM-120612-06-03	U-235 / U-236	0.74	0.14	0.05	1.43	0.20	0.02	YES	77.8	No
5184S0004	2848-WM-120612-06-03	U-238	2.56	0.36	0.01	3.15	0.34	0.02	YES	181	No
5184S0005	SS-52	Am-241	0.01	0.05	0.10	-0.01	0.04	0.069	NO	79.3	No
5184S0005	SS-52	Cs-137	0.08	0.02	0.03	NR	NR	NR	YES	NA	NA
5184S0005	SS-52	Np-237 (By Pa-233)	0.02	0.05	0.08	NR	NR	NA	NO	0.3	No
5184S0005	SS-52	Ra-226 (By Pb-214)	0.51	0.06	0.06	0.58	0.10	0.05	YES	2	No
5184S0005	SS-52	Tc-99	0.92	0.18	0.24	0.86	0.35	0.5	YES	26.9	No
5184S0005	SS-52	Th-232 (by Ac-228)	0.66	0.12	0.15	0.47	0.11	0.08	YES	2.2	No
5184S0005	SS-52	U-234	1.33	0.19	0.02	1.22	0.17	0.02	YES	206.9	No
5184S0005	SS-52	U-235 / U-236	0.06	0.03	0.02	0.08	0.04	0.03	YES	77.8	No
5184S0005	SS-52	U-238	0.71	0.11	0.02	0.75	0.13	0.03	YES	181	No
5184S0006	SS-17	Am-241	0.00	0.05	0.10	0.05	0.07	0.11	NO	79.3	No
5184S0006	SS-17	Cs-137	0.08	0.03	0.05	0.12	0.05	0.042	YES	NA	NA
5184S0006	SS-17	Np-237 (By Pa-233)	-0.05	0.05	0.08	NR	NR	NA	NO	0.3	No
5184S0006	SS-17	Ra-226 (By Pb-214)	0.81	0.08	0.08	0.87	0.14	0.05	YES	2	No
5184S0006	SS-17	Tc-99	1.13	0.20	0.25	1.09	0.38	0.02	YES	26.9	No
5184S0006	SS-17	Th-232 (by Ac-228)	0.91	0.16	0.16	0.67	0.16	0.14	YES	2.2	No
5184S0006	SS-17	U-234	3.68	0.48	0.04	4.39	0.45	0.02	YES	206.9	No
5184S0006	SS-17	U-235 / U-236	0.13	0.04	0.02	0.16	0.06	0.028	YES	77.8	No
5184S0006	SS-17	U-238	1.18	0.17	0.04	1.23	0.17	0.02	YES	181	No
5184W0001	GW-NB71-061212	Am-241	5.20	4.30	8.4	NR	NR	NA	NO	79.3	No
5184W0001	GW-NB71-061212	Cs-137	-3.70	2.40	6.20	1.60	6.10	11	NO	NA	NA
5184W0001	GW-NB71-061212	Np-237 (By Pa-233)	2.10	5.90	10.00	NR	NR	NA	NO	0.3	Yes
5184W0001	GW-NB71-061212	Ra-226 (By Pb-214)	3.20	4.40	10.0	NR	NR	NA	NO	2	Yes
5184W0001	GW-NB71-061212	Tc-99	-0.20	7.87	13.80	-1.15	0.86	1.6	NO	26.9	No
5184W0001	GW-NB71-061212	Th-232 (by Ac-228)	11.00	13.00	24	NR	NR	NA	NO	2.2	Yes
5184W0001	GW-NB71-061212	U-234	0.02	0.09	0.26	0.01	0.04	0.078	NO	206.9	No
5184W0001	GW-NB71-061212	U-235 / U-236	0.00	0.06	0.21	0.00	0.01	0.032	NO	77.8	No
5184W0001	GW-NB71-061212	U-238	0.09	0.09	0.17	0.02	0.03	0.025	NO	181	No
5184W0002	GW-GWW-061212	Am-241	1.60	3.80	7.2	NR	NR	NA	NO	79.3	No
5184W0002	GW-GWW-061212	Cs-137	2.70	3.00	5.20	0.04	5.80	10	NO	NA	NA
5184W0002	GW-GWW-061212	Np-237 (By Pa-233)	0.40	5.90	9.2	NR	NR	NA	NO	0.3	Yes

ORAU ID	WEC ID	Isotope	ORAU Result	ORAU Uncertainty	ORAU MDC	WEC Result	WEC Uncertainty	WEC MDC	ABOVE ORAU MDC	Uniform DCGL	Above DCGL
5184W0002	GW-GWW-061212	Ra-226 (By Pb-214)	-0.90	3.90	9.4	NR	NR	NA	NO	2	No
5184W0002	GW-GWW-061212	Tc-99	-5.20	7.60	13.80	0.90	1.60	2.7	NO	26.9	No
5184W0002	GW-GWW-061212	Th-232 (by Ac-228)	-1.50	7.20	17.0	NR	NR	NA	NO	2.2	No
5184W0002	GW-GWW-061212	U-234	0.10	0.17	0.41	0.01	0.03	0.063	NO	206.9	No
5184W0002	GW-GWW-061212	U-235 / U-236	0.03	0.11	0.30	0.01	0.03	0.065	NO	77.8	No
5184W0002	GW-GWW-061212	U-238	0.10	0.10	0.08	0.01	0.02	0.027	YES	181	No
5184W0003	GW-GWU-061312	Am-241	3.40	4.00	6.7	NR	NR	NA	NO	79.3	No
5184W0003	GW-GWU-061312	Cs-137	1.40	1.50	3.40	-0.40	4.90	8.8	NO	NA	NA
5184W0003	GW-GWU-061312	Np-237 (By Pa-233)	3.40	4.10	8.1	NR	NR	NA	NO	0.3	Yes
5184W0003	GW-GWU-061312	Ra-226 (By Pb-214)	4.20	4.50	11.0	NR	NR	NA	NO	2	Yes
5184W0003	GW-GWU-061312	Tc-99	-1.70	7.80	13.80	2.00	1.20	1.9	NO	26.9	No
5184W0003	GW-GWU-061312	Th-232 (by Ac-228)	11.70	8.50	19.0	NR	NR	NA	NO	2.2	Yes
5184W0003	GW-GWU-061312	U-234	0.23	0.14	0.17	0.28	0.12	0.1	YES	206.9	No
5184W0003	GW-GWU-061312	U-235 / U-236	-0.02	0.07	0.27	0.00	0.03	0.076	NO	77.8	No
5184W0003	GW-GWU-061312	U-238	0.30	0.20	0.36	0.15	0.09	0.081	NO	181	No

ORAU ID	WEC ID	Isotope	ORAU Result	WEC Result	ORAU Uncertainty	WEC Uncertainty	DER
5184S0001	2849-RU-120612-01-07	Am-241	-0.01	0.01	0.07	0.06	0.2
5184S0002	2848-WM-120612-06-01	Am-241	0.01	-0.02	0.06	0.08	0.3
5184S0003	2848-WM-120612-06-02	Am-241	0.04	0.02	0.07	0.06	0.2
5184S0004	2848-WM-120612-06-03	Am-241	0.02	0.00	0.07	0.04	0.2
5184S0005	SS-52	Am-241	0.01	-0.01	0.05	0.04	0.3
5184S0006	SS-17	Am-241	0.00	0.05	0.05	0.07	0.6
5184S0004	2848-WM-120612-06-03	Cs-137	0.04	0.05	0.02	0.02	0.2
5184S0006	SS-17	Cs-137	0.08	0.12	0.03	0.05	0.6
5184W0001	GW-NB71-061212	Cs-137	-3.70	1.60	2.40	6.10	0.8
5184W0002	GW-GWW-061212	Cs-137	2.70	0.04	3.00	5.80	0.4
5184W0003	GW-GWU-061312	Cs-137	1.40	-0.40	1.50	4.90	0.4
5184S0001	2849-RU-120612-01-07	Ra-226 (By Pb-214)	0.72	0.89	0.07	0.13	1.2
5184S0002	2848-WM-120612-06-01	Ra-226 (By Pb-214)	0.72	0.93	0.06	0.15	1.3
5184S0003	2848-WM-120612-06-02	Ra-226 (By Pb-214)	0.91	0.83	0.08	0.12	0.6
5184S0004	2848-WM-120612-06-03	Ra-226 (By Pb-214)	0.56	0.57	0.06	0.10	0.1
5184S0005	SS-52	Ra-226 (By Pb-214)	0.51	0.58	0.06	0.10	0.6
5184S0006	SS-17	Ra-226 (By Pb-214)	0.81	0.87	0.08	0.14	0.4
5184S0001	2849-RU-120612-01-07	Tc-99	0.15	0.16	0.15	0.25	0.0
5184S0002	2848-WM-120612-06-01	Tc-99	0.14	0.07	0.15	0.24	0.2
5184S0003	2848-WM-120612-06-02	Tc-99	5.26	6.11	0.38	0.78	1.0
5184S0004	2848-WM-120612-06-03	Tc-99	1.29	1.47	0.20	0.36	0.4
5184S0005	SS-52	Tc-99	0.92	0.86	0.18	0.35	0.2
5184S0006	SS-17	Tc-99	1.13	1.09	0.20	0.38	0.1
5184W0001	GW-NB71-061212	Tc-99	-0.20	-1.15	7.87	0.86	0.1
5184W0002	GW-GWW-061212	Tc-99	-5.20	0.90	7.60	1.60	0.8
5184W0003	GW-GWU-061312	Tc-99	-1.70	2.00	7.80	1.20	0.5
5184S0001	2849-RU-120612-01-07	Th-232 (by Ac-228)	1.05	1.01	0.15	0.15	0.2
5184S0002	2848-WM-120612-06-01	Th-232 (by Ac-228)	1.03	1.14	0.13	0.20	0.5
5184S0003	2848-WM-120612-06-02	Th-232 (by Ac-228)	0.99	0.89	0.15	0.16	0.5
5184S0004	2848-WM-120612-06-03	Th-232 (by Ac-228)	0.83	0.71	0.13	0.11	0.7
5184S0005	SS-52	Th-232 (by Ac-228)	0.66	0.47	0.12	0.11	1.2
5184S0006	SS-17	Th-232 (by Ac-228)	0.91	0.67	0.16	0.16	1.1
5184S0001	2849-RU-120612-01-07	U-234	3.51	4.37	0.45	0.45	1.3
5184S0002	2848-WM-120612-06-01	U-234	3.60	3.43	0.47	0.37	0.3
5184S0003	2848-WM-120612-06-02	U-234	35.26	26.80	4.36	2.30	1.7
5184S0004	2848-WM-120612-06-03	U-234	21.78	33.40	2.71	2.90	2.9
5184S0005	SS-52	U-234	1.33	1.22	0.19	0.17	0.4
5184S0006	SS-17	U-234	3.68	4.39	0.48	0.45	1.1
5184W0001	GW-NB71-061212	U-234	0.02	0.01	0.09	0.04	0.1
5184W0002	GW-GWW-061212	U-234	0.10	0.01	0.17	0.03	0.5
5184W0003	GW-GWU-061312	U-234	0.23	0.28	0.14	0.12	0.3
5184S0001	2849-RU-120612-01-07	U-235 / U-236	0.16	0.20	0.04	0.06	0.4
5184S0002	2848-WM-120612-06-01	U-235 / U-236	0.17	0.19	0.04	0.06	0.3
5184S0003	2848-WM-120612-06-02	U-235 / U-236	1.41	1.27	0.23	0.19	0.5
5184S0004	2848-WM-120612-06-03	U-235 / U-236	0.74	1.43	0.14	0.20	2.8
5184S0005	SS-52	U-235 / U-236	0.06	0.08	0.03	0.04	0.3
5184S0006	SS-17	U-235 / U-236	0.13	0.16	0.04	0.06	0.4
5184W0001	GW-NB71-061212	U-235 / U-236	0.00	0.00	0.06	0.01	0.0
5184W0002	GW-GWW-061212	U-235 / U-236	0.03	0.01	0.11	0.03	0.2
5184W0003	GW-GWU-061312	U-235 / U-236	-0.02	0.00	0.07	0.03	0.3
5184S0001	2849-RU-120612-01-07	U-238	1.38	1.31	0.19	0.18	0.3
5184S0002	2848-WM-120612-06-01	U-238	1.23	1.07	0.17	0.15	0.7
5184S0003	2848-WM-120612-06-02	U-238	2.62	4.06	0.37	0.42	2.6
5184S0004	2848-WM-120612-06-03	U-238	2.56	3.15	0.36	0.34	1.2
5184S0005	SS-52	U-238	0.71	0.75	0.11	0.13	0.3
5184S0006	SS-17	U-238	1.18	1.23	0.17	0.17	0.2
5184W0001	GW-NB71-061212	U-238	0.09	0.02	0.09	0.03	0.7
5184W0002	GW-GWW-061212	U-238	0.10	0.01	0.10	0.02	0.9
5184W0003	GW-GWU-061312	U-238	0.30	0.15	0.20	0.09	0.7