

February 20, 2014

John J. Hayes, Project Manager
U.S. Nuclear Regulatory Commission
Materials Decommissioning Branch
Division of Waste Management and Environmental Protection
TWFN Mail Stop T-8F5
Rockville, MD 20852

**SUBJECT: FINAL INTERIM REPORT—INDEPENDENT CONFIRMATORY
SURVEY SUMMARY AND RESULTS FOR SURVEY UNITS LSA 10-06
AND LSA 10-07 FOR THE HEMATITE DECOMMISSIONING PROJECT,
FESTUS, MISSOURI (RFTA NO. 14-003); DCN 5184-SR-04-0**

Dear Mr. Hayes:

Oak Ridge Associated Universities (ORAU) is pleased to provide the enclosed final interim report detailing the independent confirmatory survey activities of Survey Units LSA 10-06 and LSA 10-07 at the Hematite Decommissioning Project in Festus, Missouri. This report provides the summary and results of activities performed by ORAU, under the Oak Ridge Institute for Science and Education contract, during the period of December 16–18, 2013. Comments on the draft report have been incorporated into this final report.

You may contact me via my information below or Erika Bailey at 865.576.6659 if you have any questions.

Sincerely,



Evan M. Harpenau
Health Physicist/Assistant Project Manager
Independent Environmental Assessment
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EMH:fs

Enclosure

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FOR SURVEY UNITS LSA 10-06 AND LSA 10-07
AT THE HEMATITE DECOMMISSIONING PROJECT,
FESTUS, MISSOURI**

FINAL INTERIM REPORT



Prepared by
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Oak Ridge Associated Universities

February 2014

Prepared for the
U.S. Nuclear Regulatory Commission

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1. INTRODUCTION

The Westinghouse Electric Company, LLC (WEC) and its decommissioning contractor, Environmental Chemical Corporation, are in the process of removing radiologically contaminated materials from a former nuclear fuel fabrication facility near Festus, Missouri 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 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 primary radionuclides of concern (ROCs) at the HDP were technetium-99 (Tc-99), thorium-232 (Th-232), uranium-234 (U-234), U-235, and U-238 (WEC 2011). The balance of ROCs, neptunium-237 (Np-237), plutonium-239/240 (Pu-239/240), and americium-241 (Am-241), are considered to be insignificant based on the aggregate dose of these radionuclides being less than 10% of the total effective dose equivalent (TEDE) for each conceptual site model (CSM). However, their dose contributions have been accounted for in the adjusted derived concentration guideline levels (DCGL_{ws}) accordingly (WEC 2011).

The site 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. It is surrounded by forest, agricultural lands, and low-density residential housing (Figure A.1). The entire site consists of approximately 228 acres; however, the impacted portion of the site—referred to as the central tract—includes approximately 19 acres.

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 requested that Oak Ridge

Associated Universities (ORAU), under the Oak Ridge Institute for Science and Education (ORISE) contract, perform confirmatory surveys of final status survey (FSS) units LSA 10-06 and 10-07. Both survey units (SUs), located in the southern half of the Burial Pit Open Land Area, were used to bury radioactive and chemical wastes during the operational lifetime of the Hematite Fuel Fabrication Facility (WEC 2013a and b) (Figure A.2). Confirmatory activities for these areas included document reviews and independent survey data collection.

2. PROCEDURES

The confirmatory survey activities were conducted during December 16–18, 2013, in accordance with a project-specific confirmatory survey plan approved by the NRC, the ORAU/ORISE Survey Procedures, ORAU/ORISE Laboratory Procedures and ORAU Quality Program Manuals (ORAU 2013a, ORAU/ORISE 2013a and b, and ORAU 2013b).

ORAU performed high-density gamma radiation scans of the accessible soil surfaces within each SU. Scans were performed using Ludlum Model 44-10 sodium iodide (NaI) detectors coupled to Ludlum Model 2221 ratemeter-scalers with an audible indicator. The ratemeter-scalers were also coupled to global positioning systems (GPS) that enabled real-time gamma count rate and spatial data capture. Figures A.3 and A.4 show the spatially oriented gamma walkover surveys and associated instrument responses within SUs LSA 10-06 and 10-07, respectively.

A ranked set sampling (RSS) design was used to estimate the mean radionuclide concentration in each SU (EPA 2002). The number of locations to evaluate and sample within each SU were calculated by using the contractor's FSS data and Visual Sample Plan software, version 6.5 (WEC 2013a and b). As a result of the sample planning inputs, 18 ranking locations were evaluated per SU. Following completion of walkover surveys, the RSS locations were laid out in each SU, as illustrated in Figures A.5 and A.6. A one-minute static gamma measurement was made with the NaI at each ranking location. The surface measurements were then ranked, which resulted in the selection of 6 locations per SU for sampling. The 6 sample locations are presented in Figures A.7 and A.8 for LSA 10-06 and LSA 10-07, respectively. Additionally, one judgmental sample was collected from each SU where elevated direct radiation levels were identified during surface scans.

Soil samples were returned to the ORAU/ORISE Radiological and Environmental Analytical Laboratory in Oak Ridge, Tennessee for laboratory analysis. Sample analyses were performed in

accordance with the ORAU/ORISE Laboratory Procedures Manual (ORAU/ORISE 2013b). Samples were analyzed by solid-state gamma spectroscopy for gamma-emitting ROCs. Tc-99 was quantified by radiochemical separation using extraction chromatography and counted by liquid scintillation. Analytical results were reported in units of picocuries per gram (pCi/g). Due to the low U-235 to U-238 concentration ratios observed in the gamma spectroscopy results which were indicative of natural rather than enriched uranium isotopic ratios, alpha spectroscopy of the confirmatory samples was not performed. The U-234 concentrations were calculated using the ORAU U-238/U-235 analytical concentration ratios and then interpolating those data with Table 14-5 of the decommissioning plan (WEC 2009) to calculate the U-234/U-235 ratio. The U-234/U-235 ratio was then multiplied by the U-235 concentration, resulting in an inferred U-234 concentration (Table B.1). The analytical results were evaluated and compared to the applicable Uniform Stratum derived concentration guideline level (Uniform DCGL_W) presented in Table 2.1.

Table 2.1. Adjusted Site-specific Soil DCGL _W s by CSM ^a				
Radionuclide	Three Layer Approach DCGL _W s Values (pCi/g) ^b			Uniform Stratum (pCi/g)
	Shallow Stratum	Root Stratum	Excavation Scenario	
Uranium-234	508.5	235.6	872.4	195.4
Uranium-235+D ^c	20.4	7.0	14.5	5.8
Uranium-238+D ^c	297.6	183.3	551.1	168.8
Technetium-99	151.0	30.1	74.0	25.1
Thorium-232+C ^d	4.7	2.0	5.2	2.0
Radium-226+C ^d	5.0	2.1	5.4	1.9

CSM = conceptual site model

^aTable populated from WEC 2011 Tables 14-4 and 14-9 (Burial Pit SEA).

^bThe reported DCGL_Ws are the activities for the parent radionuclide as specified (WEC 2013a) and were calculated to account for the dose contribution from insignificant radionuclides.

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

^d+C indicates the DCGL_W includes all radionuclides in the associated decay chain.

3. RESULTS

Gamma walkover scans of LSA 10-06 did not detect any areas with elevated direct gamma radiation in excess of the background count variability. Overall instrument response for LSA 10-06 ranged from less than 10,500 to 13,500 cpm with a mean count rate of 11,700 cpm (Figure A.3). The

walkover surveys in LSA 10-07 exhibited a count rate that increased as the survey progressed towards the western edge of the SU. Overall instrument response in this SU ranged from less than 10,700 to 15,500 cpm with a mean count rate of 12,300 cpm (Figure A.4). The observed instrument response for LSA 10-07 was also within the background count variability for all areas of the SU with the exception of the western-most tier where count rates exceeded the background range. Although this isolated area already contained WEC flags, and there were indications that sampling activities had been performed, the area was marked for further investigation. ORAU selected the location with the highest observed count rate in LSA 10-06 and the isolated area in LSA 10-07 for judgmental sampling. Judgmental sample locations are identified as 5184S0077 and 5184S0078 in Figures A.7 and A.8 respectively.

A comprehensive summary of ORAU/ORISE Radiological and Environmental Analytical Laboratory sample results for site-related ROCs (excluding Pu-239/240, Am-241, and Np-237) is provided in Table B.2. Table 3.1 summarizes the ROC concentrations reported in Table B.2.

Table 3.1. ORAU ROC Concentration Range Summary in pCi/g			
ROC	Gross Soil Activity Concentration Range		
U-234 ^a	1.62	to	9.08
U-235	0.08	to	0.50
U-238	1.18	to	1.87
Tc-99	-0.18	to	0.56
Th-232	0.99	to	1.34
Ra-226	0.84	to	1.14

^aU-234 = U-238/U-235 sample specific concentration, then determine U-234/U-235 ratio through interpolation using DP Table 14-5 × the U-235 sample-specific concentration.

Analytical laboratory results were compared directly to radionuclide-specific Uniform DCGI_ws. Comparisons to the Uniform DCGI_ws were made using gross concentrations—i.e., the concentrations were not adjusted for soil background— with the exception of Ra-226 and Th-232, which were corrected for background concentrations of 0.9 and 1.0 pCi/g, respectively (WEC 2012). The sum of fractions (SOFs) for each sample was then calculated to demonstrate compliance with the 25 mrem/year release criteria. WEC’s analytical results and SOF averages were evaluated against the confirmatory sample results to determine if the radionuclide concentrations reported from FSS

activities were consistent with the results of the confirmatory surveys for each SU. The average SOF values of the random samples reported by WEC and for ORAU confirmatory samples are presented in Table 3.2 for comparison. All of the ROC concentrations in confirmatory soil samples, including the judgmental samples, were below the individual Uniform Stratum $DCGL_w$, and the SOF calculations were less than unity.

Table 3.2. SOF Statistical Comparison ^a				
SOF	LSA 10-06		LSA 10-07	
	ORAU	WEC ^b	ORAU	WEC ^b
Average	0.15	0.07	0.17	0.11
Standard Deviation^c	0.16	0.04	0.17	0.10
Minimum	0.05	0.05	0.07	0.05
Maximum	0.28	0.12	0.31	0.24

^aSum-of-fractions (SOF) calculated using the unity rule for each radionuclide-of-concern. Background concentrations for Ra-226 and Th-232 were subtracted prior to the calculation; negative values were listed as a zero value in calculations. Based on the WEC analyses, background concentrations are as follows: Th-232 is 1.0 pCi/g and Ra-226 is 0.9 pCi/g (WEC 2012).

^bWEC values calculated from WEC offsite summary data (WEC 2014a and b)

^c95% confidence interval

During the FSS sampling effort, WEC collected a judgmental sample (L100701BUB00) that contained a concentration of U-235 exceeding the Uniform Stratum $DCGL_w$. The preliminary sample results from that sample prompted WEC to collect five additional samples in an attempt to bound the contamination found in L100701BUB00: one from the six inches directly beneath (L100715BUB00) and four from a one square-meter area surrounding that location (L100701BUI01, L100701BUI02, L100701BUI03, and L100701BUI04). The results from the additional samples indicated that the U-235 contamination was isolated and contained within sample L100701BUB00.

4. CONCLUSION

At NRC's request, ORAU conducted confirmatory surveys of 2 FSS survey units at the Hematite Decommissioning Project during the period of December 16–18, 2013. The survey activities included document review, gamma walkover surveys, soil sampling activities, and laboratory analysis of confirmatory soil samples. All final confirmatory survey ROC concentrations from the LSA 10-06 and LSA 10-07 soil samples were below the individual Uniform $DCGL_w$ limits and also satisfied the

SOF DCGL_w criteria. Based on the findings of the confirmatory survey, ORAU is of the opinion that the licensee has adequately demonstrated survey units LSA 10-06 and 10-07 meet the release criteria.

5. REFERENCES

EPA 2002. *Guidance on Choosing a Sampling Design for Environmental Data Collection*. EPA QA/G-5S. U.S. Environmental Protection Agency Washington, DC. December.

ORAU 2013a. *Final—Project-Specific Plan for Independent Confirmatory Survey Activities for the Hematite Decommissioning Project, Festus, Missouri*. 5184-PL-02-0. Oak Ridge Institute for Science and Education, managed by Oak Ridge Associated Universities. Oak Ridge, Tennessee. March 20.

ORAU 2013b. *Quality Program Manual for the Independent Environmental Assessment and Verification Program*. Revision 29. Oak Ridge Associated Universities. Oak Ridge, Tennessee. August 15.

ORAU/ORISE 2013a. *Survey Procedures Manual for the Independent Environmental Assessment and Verification Program*. Revision 23. Prepared by Oak Ridge Associated Universities under the Oak Ridge Institute for Science and Education contract. Oak Ridge, Tennessee. January 18.

ORAU/ORISE 2013b. *Laboratory Procedures Manual for the Independent Environmental Assessment and Verification Program*. Revision 54. Prepared by Oak Ridge Associated Universities under the Oak Ridge Institute for Science and Education contract. Oak Ridge, Tennessee. August 15.

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

WEC 2011. *Final Supplemental Response to NRC Request for Additional Information on the Hematite Decommissioning Plan and Related Revision to a Pending License Amendment Request (License No. SNM-00033, Docket No. 070-00036)*. HEM-11-96. Westinghouse Electric Company, LLC. Festus, Missouri. July 5.

WEC 2012. *Final Status Survey Plan Development*. Hematite Decommissioning Project. HDP-PR-FSS-701; Revision 0. Westinghouse Electric Company, LLC. Festus, Missouri. January 16.

WEC 2013a. *Final Status Survey Plan and Instructions for Survey Area & Unit: LSA 10-06*. Hematite Decommissioning Project Technical Report. HDP-INST-FSS-10-06; Revision 1. Westinghouse Electric Company, LLC. Festus, Missouri. November 25.

WEC 2013b. *Final Status Survey Plan and Instructions for Survey Area & Unit: LSA 10-07*. Hematite Decommissioning Project Technical Report. HDP-INST-FSS-LSA10-07; Revision 1. Westinghouse Electric Company, LLC. Festus, Missouri. November 25.

WEC 2014a. *Data for NRC LSA-10-06*. Westinghouse Electric Company, LLC. Festus, Missouri. January 16.

WEC 2014b. *Data for LSA-10-07*. Westinghouse Electric Company, LLC. Festus, Missouri. January 23.

ATTACHMENT A FIGURES

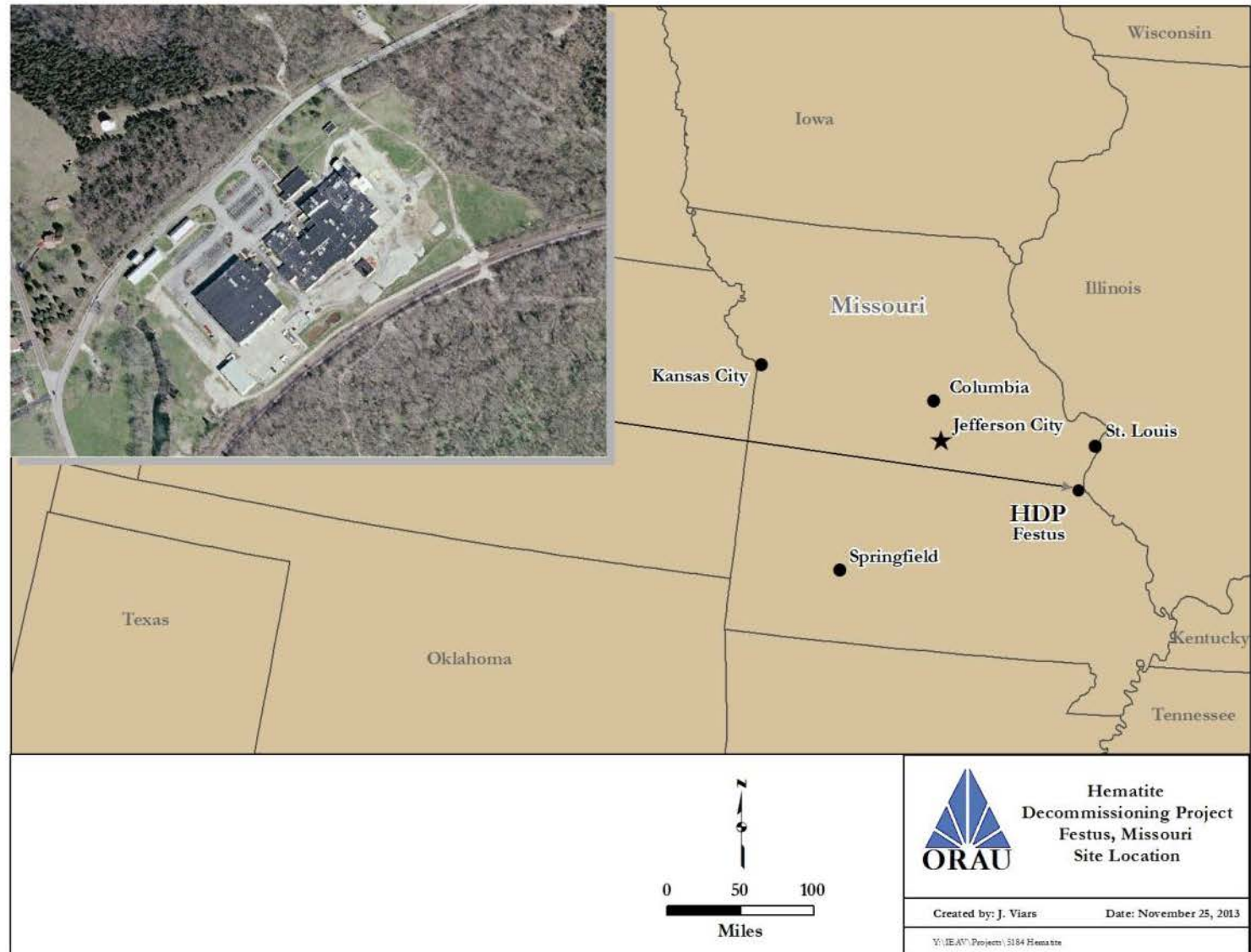


Figure A.1. Location of Hematite Decommissioning Project, Festus, Missouri

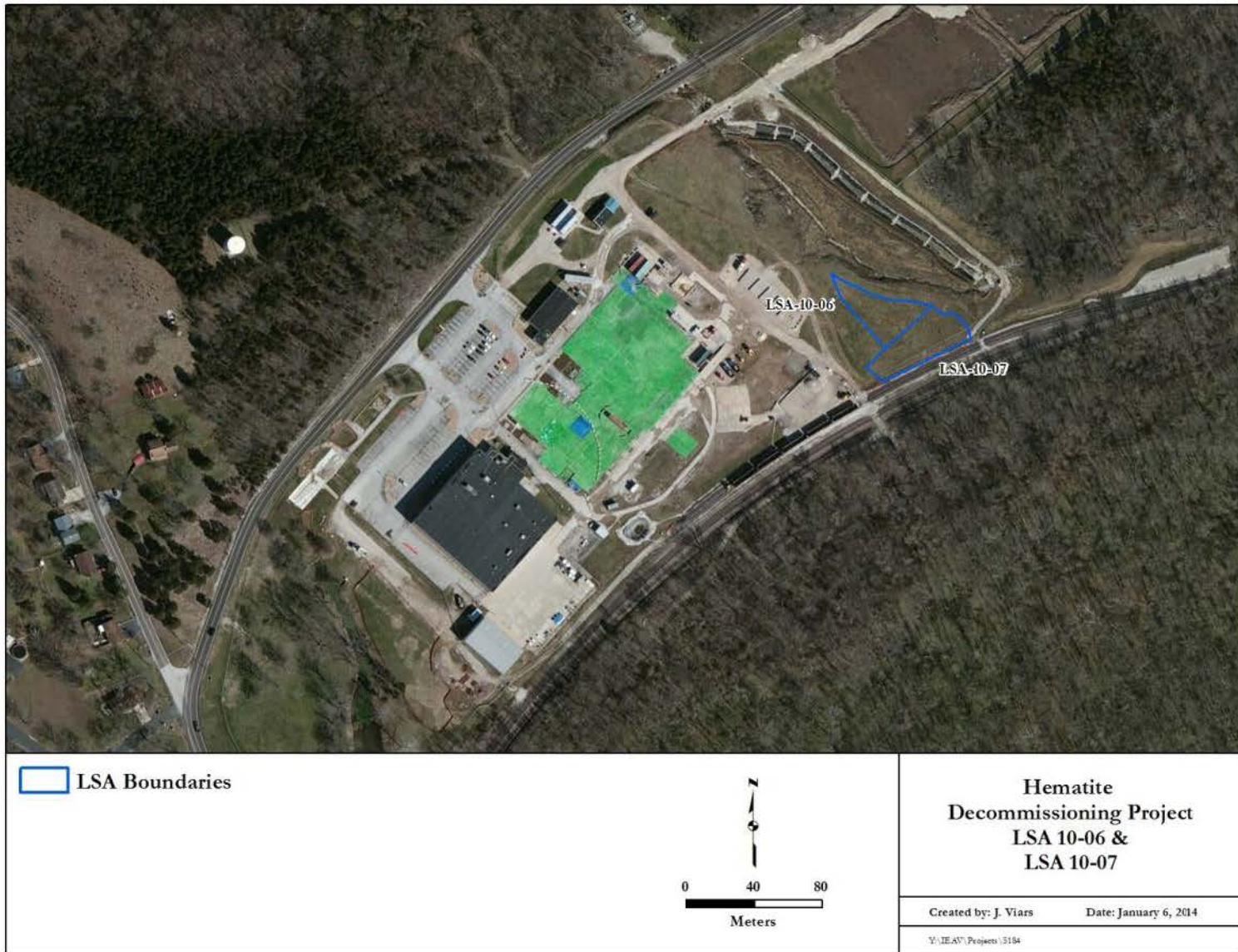


Figure A.2. Plot Plan of LSA 10-06 and LSA 10-07 at the Hematite Decommissioning Project

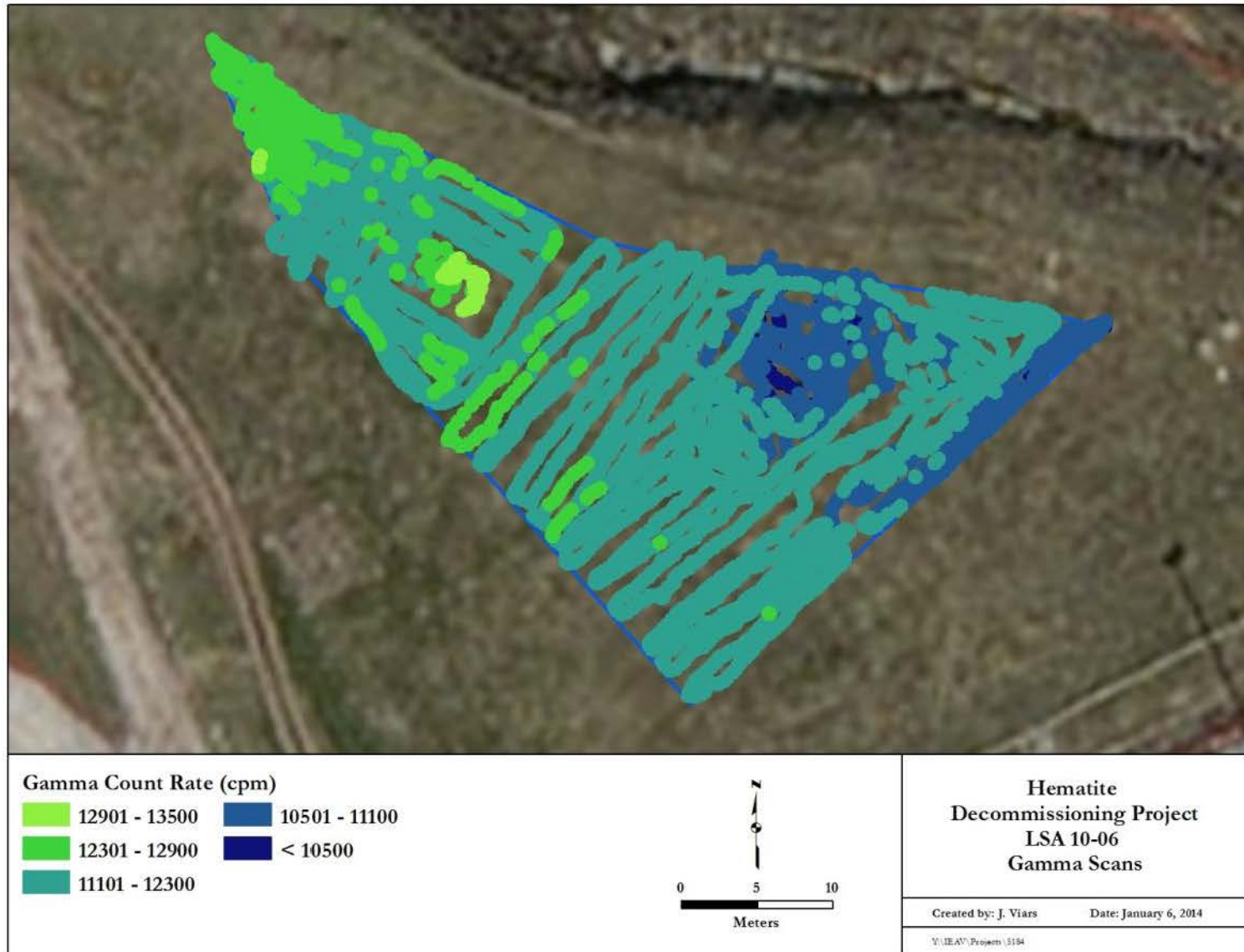


Figure A.3. LSA 10-06—Gamma Walkover Scans

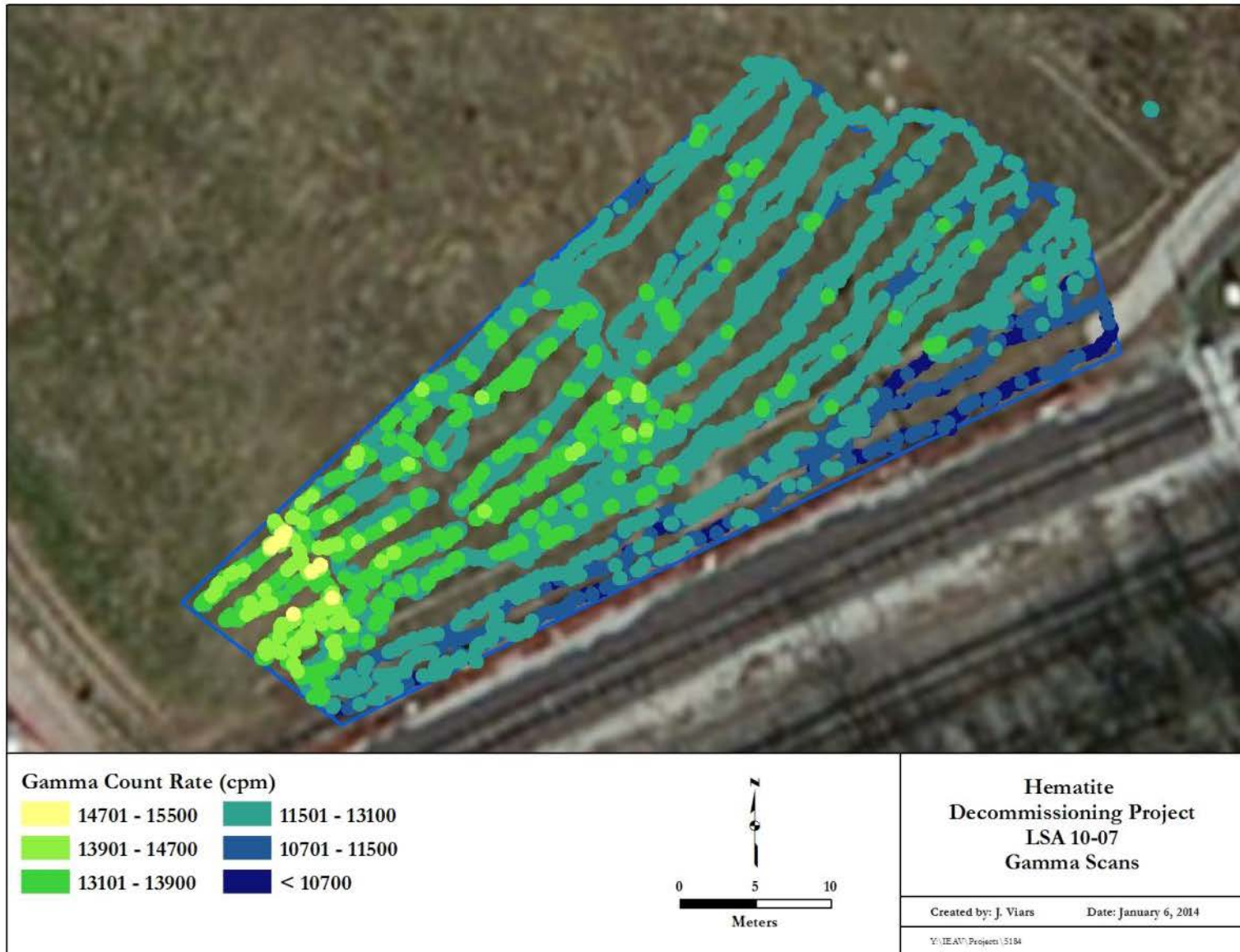


Figure A.4. LSA 10-07—Gamma Walkover Scans

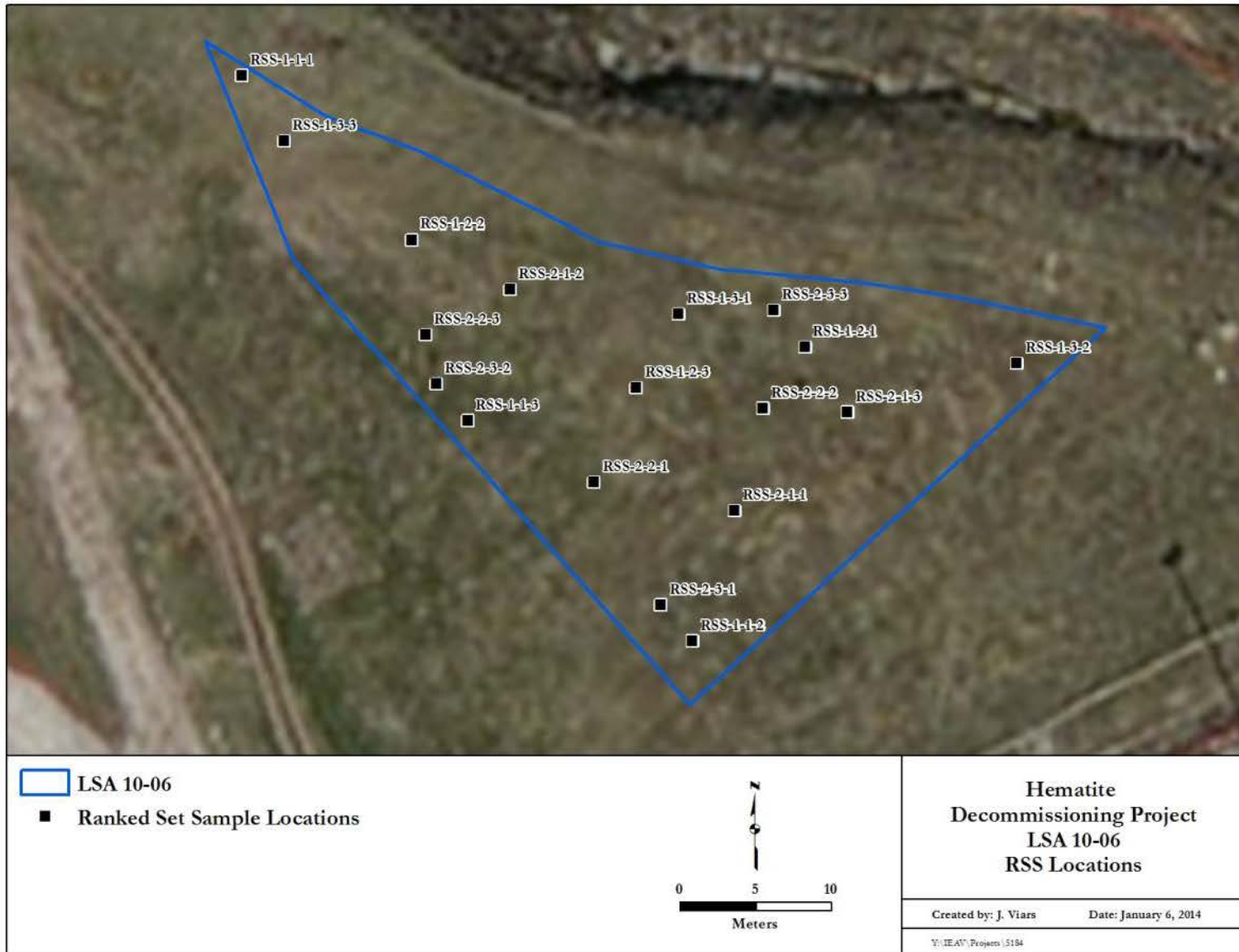


Figure A.5. LSA 10-06—Ranked Set Sampling Measurement Locations

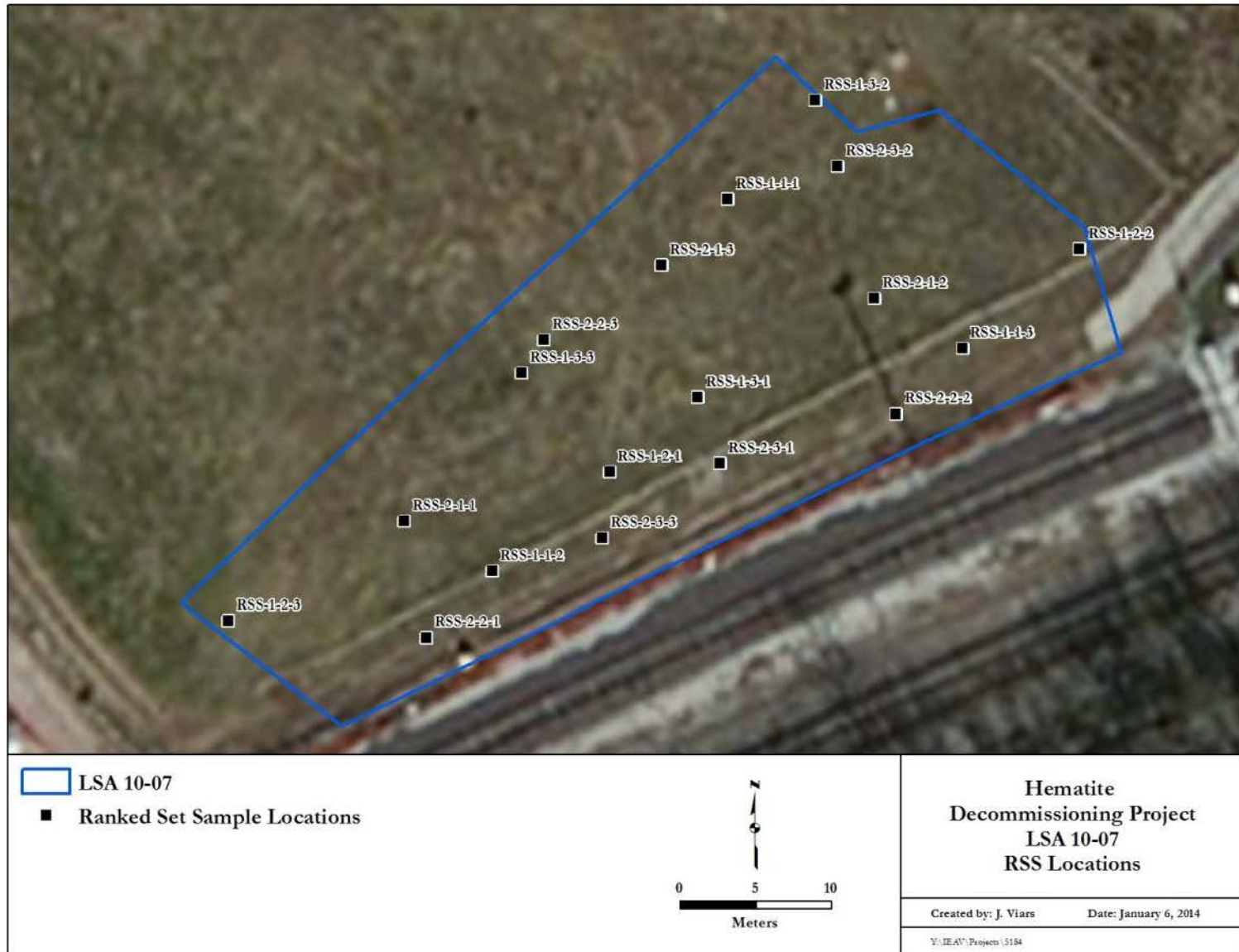


Figure A.6. LSA 10-07—Ranked Set Sampling Measurement Locations

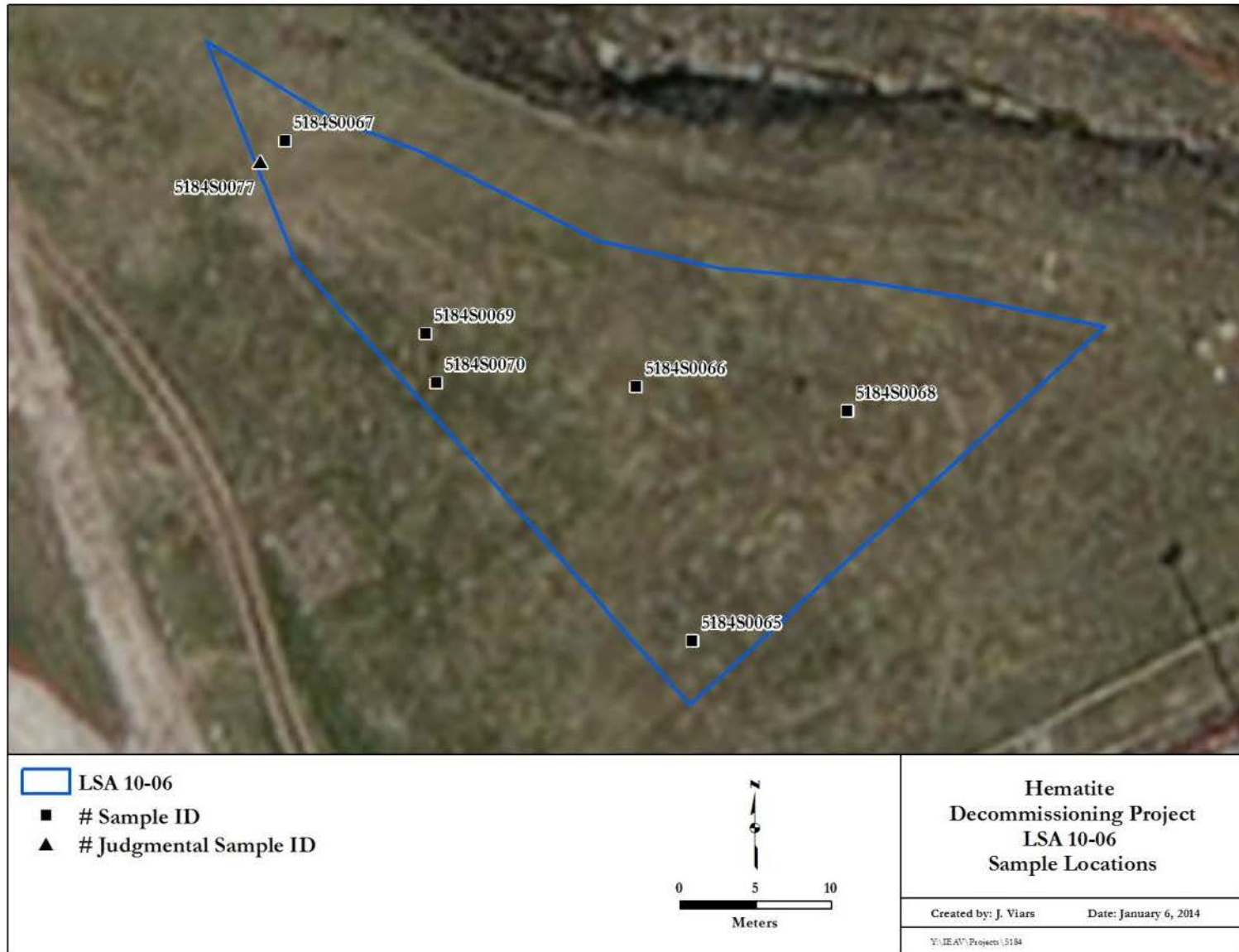


Figure A.7. LSA 10-06—Soil Sampling Locations

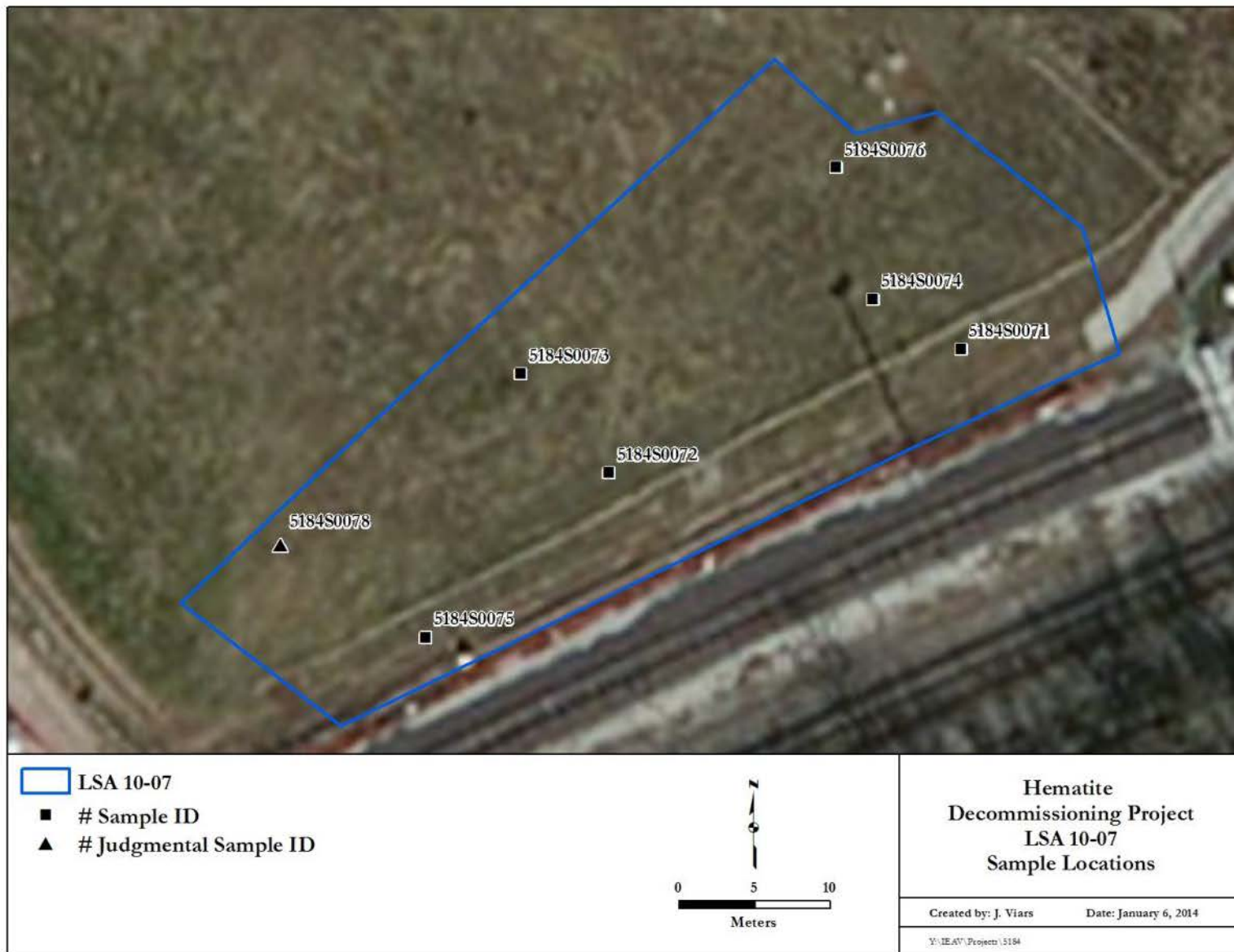


Figure A.8. LSA 10-07—Soil Sampling Locations

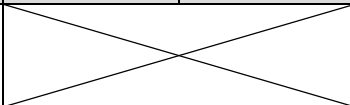
ATTACHMENT B
DATA TABLES

Table B.1. U-234 Calculations from U-238 and U-235 for LSA-10-06, and 10-07 Soil Samples Hematite Decommissioning Project Festus, Missouri						
Sample	U-238 (pCi/g)	U-235 (pCi/g)	U-238/ U-235	U-234/ U-235 ^a	Enrichment (% U-235) ^b	U-234 (pCi/g)
	Result	Result				Result
5184S0065	1.58 ± 0.38	0.12 ± 0.09	13.17	19.46	1.2	2.33 ± 1.75
5184S0066	1.87 ± 0.40	0.17 ± 0.08	11.00	19.08	1.4	3.24 ± 1.53
5184S0067	1.58 ± 0.43	0.12 ± 0.08	13.17	19.46	1.2	2.33 ± 1.56
5184S0068	1.19 ± 0.39	0.12 ± 0.08	9.92	18.90	1.5	2.27 ± 1.51
5184S0069	1.64 ± 0.38	0.21 ± 0.09	7.81	18.56	2	3.90 ± 1.67
5184S0070	1.81 ± 0.47	0.18 ± 0.09	10.06	18.92	1.5	3.41 ± 1.70
5184S0071	1.30 ± 0.31	0.22 ± 0.07	5.91	18.30	2.6	4.03 ± 1.28
5184S0072	1.31 ± 0.43	0.10 ± 0.10	13.10	19.44	1.2	1.94 ± 1.94
5184S0073	1.30 ± 0.37	0.50 ± 0.10	2.60	18.15	5.6	9.08 ± 1.82
5184S0074	1.38 ± 0.35	0.09 ± 0.12	15.33	19.84	1	1.79 ± 2.38
5184S0075	1.43 ± 0.45	0.19 ± 0.09	7.53	18.52	2	3.52 ± 1.67
5184S0076	1.40 ± 0.36	0.08 ± 0.07	17.50	20.24	0.9	1.62 ± 1.42
5184S0077	1.18 ± 0.29	0.13 ± 0.08	9.08	18.76	1.7	2.44 ± 1.50
5184S0078	1.62 ± 0.35	0.09 ± 0.08	18.00	20.33	0.9	1.83 ± 1.63

^aU-234 concentrations are calculated by determining the gamma spectroscopy U-238/U-235 ratio, then using Table 14-5 from the DP to determine the U-234/U-235 ratio (using interpolation) and hence the enrichment percentage. The U-235 value is then multiplied by the U-234/U-235 ratio to determine the U-234 concentration result. The U-234 error was propagated by assuming the U-234/U-235 ratio did not have an error.

^bFrom Table 14-5 "Radioactivity and Isotopic Ratios Relative to Enrichment" in the Hematite DP Rev 1.2.

Table B.2. Radionuclide Concentrations in LSA 10-06 and 10-07 Soil Samples
Hematite Decommissioning Project
Festus, Missouri

Sample ID	Sample Coordinates (ft)		Radionuclide Concentration (pCi/g) ^a						SOF ^c
	East	North	Tc-99	Ra-226	Th-232	U-234 ^b	U-235	U-238	
Uniform Stratum DCG _{LW} ^d			25.1	1.9	2.0	195.4	5.8	168.8	<1
LSA 10-06 ^e									
5184S0065	827750	864982	0.10 ± 0.18 ^f	1.14 ± 0.08	1.07 ± 0.15	2.33 ± 1.75	0.12 ± 0.09	1.58 ± 0.38	0.21
5184S0066	827738	865037	0.10 ± 0.16	0.90 ± 0.07	1.15 ± 0.17	3.24 ± 1.53	0.17 ± 0.08	1.87 ± 0.40	0.14
5184S0067	827662	865091	0.23 ± 0.17	1.01 ± 0.07	1.34 ± 0.17	2.33 ± 1.56	0.12 ± 0.08	1.58 ± 0.43	0.28
5184S0068	827784	865032	0.02 ± 0.17	0.86 ± 0.07	1.01 ± 0.16	2.27 ± 1.51	0.12 ± 0.08	1.19 ± 0.39	0.05
5184S0069	827692	865049	0.28 ± 0.19	0.84 ± 0.07	1.09 ± 0.16	3.90 ± 1.67	0.21 ± 0.09	1.64 ± 0.38	0.12
5184S0070	827695	865038	0.07 ± 0.16	0.91 ± 0.07	1.08 ± 0.16	3.41 ± 1.70	0.18 ± 0.09	1.81 ± 0.47	0.11
LSA 10-06 Judgmental Sample ^e									
5184S0077	827650	865106	-0.11 ± 0.18	0.99 ± 0.06	1.29 ± 0.16	2.44 ± 1.50	0.13 ± 0.08	1.18 ± 0.29	0.23
LSA 10-07 ^g									
5184S0071	827880	864987	0.56 ± 0.20	1.09 ± 0.07	0.99 ± 0.14	4.03 ± 1.28	0.22 ± 0.07	1.30 ± 0.31	0.19
5184S0072	827803	864960	-0.14 ± 0.18	0.94 ± 0.08	1.12 ± 0.18	1.94 ± 1.94	0.10 ± 0.10	1.31 ± 0.43	0.12
5184S0073	827785	864982	-0.16 ± 0.18	1.09 ± 0.08	1.14 ± 0.17	9.08 ± 1.82	0.50 ± 0.10	1.30 ± 0.37	0.31
5184S0074	827861	864998	-0.11 ± 0.18	1.14 ± 0.07	1.12 ± 0.15	1.79 ± 2.38	0.09 ± 0.12	1.38 ± 0.35	0.22
5184S0075	827764	864925	0.21 ± 0.20	0.85 ± 0.08	1.12 ± 0.18	3.52 ± 1.67	0.19 ± 0.09	1.43 ± 0.45	0.13
5184S0076	827853	865027	-0.18 ± 0.18	0.86 ± 0.06	1.08 ± 0.14	1.62 ± 1.42	0.08 ± 0.07	1.40 ± 0.36	0.07
LSA 10-07 Judgmental Samples ^g									
5184S0078	827735	864944	-0.09 ± 0.18	1.11 ± 0.07	1.13 ± 0.15	1.83 ± 1.63	0.09 ± 0.08	1.62 ± 0.35	0.21

^aThese values are gross concentrations; background concentrations have not been subtracted.

^bU-234 concentrations and uncertainties calculated from the U-238/U-235 ratios and using Table 14-5 in the Hematite DP, Rev. 1.2. Full details of calculations are provided in Table B.1.

^cSum-of-fractions (SOF) calculated using the unity rule for each radionuclide-of-concern (ROC). Background concentrations for Ra-226 and Th-232 were subtracted prior to the calculation; negative values were listed as a zero value in calculations. Based on the HDP FSS Data for Reuse Stockpile 2, background concentrations are as follows: Th-232 is 1.0 pCi/g and Ra-226 is 0.9 pCi/g (WEC 2012).

^dDCGL_W values are from the Uniform Stratum column in Table 2.1.

^eRefer to Figure A.7.

^fUncertainties represent the 95% upper confidence level interval, based on total propagated uncertainties.

^gFigure A.8.