

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development					
	Westinghouse Non-Proprietary Class 3		Revision: 4		Appendix P-4, Page 1 of 1	

APPENDIX P-4 FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES							
Survey Area:	LSA 10		Description:	Burial Pits Open Land Area			
Survey Unit:	02		Description:	North East Corner Survey Unit (North Burial Pit)			
Survey Type:	FSS		Classification:	Class 1			

Measurement or Sample ID	Surface or CSM	Type	Start Elevation	End Elevation	Northing (Y Axis) *	Easting (X Axis) *	Remarks / Notes
L10-02-01-B-S-S-00	Uniform	S	432.6	432.5	865420.7	827351.1	Surface 1-inch grab
L10-02-02-B-R-S-00	Uniform	S	432.5	428.1	865420.7	827351.1	Root 4.4-foot composite
L10-02-04-B-S-S-00	Uniform	S	436.2	435.8	865379.3	827327.1	Surface 5-inch grab
L10-02-05-B-R-S-00	Uniform	S	435.8	431.3	865379.3	827327.1	Root 4.4-foot composite
L10-02-07-B-E-S-00	Uniform	S	424.7	424.2	865379.3	827375.0	Excavation 6-inch grab
L10-02-08-B-E-S-00	Uniform	S	426.9	426.4	865338.0	827351.1	Excavation 6-inch grab
L10-02-09-B-E-S-00	Uniform	S	423.5	423.0	865338.0	827399.0	Excavation 6-inch grab
L10-02-10-B-E-S-00	Uniform	S	418.9	418.4	865338.0	827446.9	Excavation 6-inch grab
L10-02-11-B-E-S-00	Uniform	S	422.3	421.8	865338.0	827494.8	Excavation 6-inch grab
L10-02-12-B-E-S-00	Uniform	S	422.3	421.8	865296.7	827423.0	Excavation 6-inch grab
L10-02-11-B-E-Q-00	Uniform	Q	422.3	421.8	865338.0	827494.8	Excavation 6-inch grab
L10-02-13-B-E-B-00	Uniform	B	429.5	419.6	865341.1	827408.1	Excavation 6-inch grab

Elevations are in feet above mean sea level.

* Missouri - East State Plane Coordinates [North American Datum (NAD) 1983]

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R

CSM: Three-Layer (Surface-Root-Excavation) with conservative use of Uniform DCGLs

Type: Systematic = S, Biased = B; QC =Q; Investigation = I

Green shaded samples are the samples at each sample location, for use in WRS test.

Quality Record

HDP-PR-FSS-721 Final Status Survey Data Evaluation
Data Review and Calculation of the Sum-of-Fractions (SOF)

Sample ID	Sample Start Depth (ft)	Type (Systematic, Bias, QC)	TestAmerica Analytical Results																								Sample ID	Sample Start Depth (ft)	Type (Systematic, Bias, QC)	Root Stratum SOF Verification (unexcavated/not backfilled only)				MOE SOF		
			Ra-226						Th-232				Inferred U-234				U-235				U-238				Enr.	SOF ₁₀				SOF ₂₅	In Sample Isotopic Ratio?	In Root Sample SOF - 0.27	root count		excavation count	surface count
			Result	Uncertainty	DOC	Qualifier	Adjusted Result	Corrected Result	Result	Uncertainty	DOC	Qualifier	Result	Uncertainty	DOC	Qualifier	Result	Uncertainty	DOC	Qualifier	Result	Uncertainty	DOC	Qualifier												
L10-02-01-B-S-S-00	0.39	S	0.958	0.146	0.067	NA	-0.072	0.000	0.443	0.143	0.067	0.079	0.243	NA	-0.013	0.000	4.361	NA	NA	NA	0.242	0.115	0.159	NA	0.858	0.308	0.806	NA						0.12		
L10-02-02-B-R-S-S-00	0.492	S	1.110	0.172	0.083	NA	0.040	0.040	0.130	0.130	0.095	0.231	U	1.050	0.191	0.127	NA	0.050	0.050	1.905	NA	NA	NA	0.099	0.161	0.286	U	1.190	0.355	0.929	NA			0.16		
L10-02-04-B-S-S-00	0.06	S	1.160	0.181	0.055	NA	0.090	0.090	0.303	0.303	0.041	0.232	U	0.936	0.222	0.133	NA	-0.064	0.000	3.433	NA	NA	NA	0.188	0.195	0.310	U	1.080	0.699	1.120	NA			0.15		
L10-02-05-B-R-S-S-00	0.492	S	1.210	0.165	0.067	NA	0.140	0.140	0.019	0.019	0.090	0.240	NA	1.110	0.172	0.137	NA	0.110	0.110	0.889	NA	NA	NA	0.042	0.159	0.268	U	0.911	0.316	0.900	U			0.14		
L10-02-07-B-E-S-S-00	6.09	S	1.170	0.211	0.086	NA	0.100	0.100	0.040	0.040	0.129	0.256	U	1.040	0.192	0.161	NA	0.040	0.040	1.125	NA	NA	NA	0.359	0.183	0.320	U	0.626	0.440	1.310	NA			0.20		
L10-02-08-B-E-S-S-00	5.17	S	1.160	0.159	0.066	NA	0.090	0.090	-0.008	0.000	0.059	0.239	U	1.060	0.170	0.119	NA	0.060	0.060	2.268	NA	NA	NA	0.118	0.153	0.261	U	1.410	0.534	0.800	NA			0.14		
L10-02-09-B-E-S-S-00	6.32	S	1.030	0.167	0.083	NA	-0.040	0.000	0.871	0.871	0.119	0.237	U	1.050	0.207	0.084	NA	0.050	0.050	1.760	NA	NA	NA	0.097	0.167	0.256	U	0.515	0.670	1.110	U			0.12		
L10-02-10-B-E-S-S-00	9.53	S	0.941	0.151	0.086	NA	-0.129	0.000	0.353	0.353	0.119	0.290	U	0.936	0.170	0.127	NA	-0.061	0.000	2.274	NA	NA	NA	0.118	0.135	0.246	U	1.680	0.636	0.807	NA			0.14		
L10-02-11-B-E-S-S-00	4.93	S	0.956	0.154	0.074	NA	-0.114	0.000	0.274	0.274	0.038	0.249	NA	0.843	0.160	0.084	NA	-0.157	0.000	2.477	NA	NA	NA	0.135	0.117	0.163	U	0.875	0.498	0.785	U			0.12		
L10-02-12-B-E-S-S-00	7.88	S	0.734	0.107	0.041	NA	-0.336	0.000	0.301	0.301	0.086	0.214	NA	0.336	0.068	0.042	NA	-0.664	0.000	5.938	NA	NA	NA	0.326	0.109	0.119	U	1.710	0.441	0.582	NA			0.09		
L10-02-11-B-E-Q-00	4.93	Q	0.812	0.125	0.059	NA	-0.258	0.000	0.453	0.453	0.210	0.243	NA	0.577	0.127	0.065	NA	-0.423	0.000	1.840	NA	NA	NA	0.101	0.118	0.195	U	0.535	0.244	0.712	NA			0.08		
L10-02-13-B-E-B-00	9.86	B	0.953	0.173	0.101	NA	-0.117	0.000	0.265	0.265	0.024	0.287	NA	1.080	0.220	0.115	NA	0.080	0.080	4.085	NA	NA	NA	0.224	0.184	0.320	NA	1.240	0.700	1.100	NA			0.13		
Systematic Minimum						0.000						0.000								0.889				0.042									2.1	0.03		
Systematic Maximum						0.140						0.110								5.938				0.326									0.14			
Systematic Mean						0.046						0.031								2.645				0.142									0.07			
Systematic Median						0.020						0.288								2.271				0.117									0.07			
Systematic Standard Deviation						0.054						0.038								1.546				0.087									0.03			
With ingrowth, use Ra226 bkg =			1.07						Th232 bkg =						1.0																					
NOTES: Gross results in units of pCi/g * Background with ingrowth (1.07 pCi/g) subtracted from gross result **Background (1.0 pCi/g) subtracted from gross result U Qualifier: Result is less than the sample detection limit. All uncertainty values are reported at the 2-sigma confidence level.																																				
Calculate the dose contribution for the SU by multiplying SOF _{ANALYSIS} (including contribution from Re-use backfill and Groundwater) by 25 mm.																																				
5.8 mrem																																				
</																																				

HDP-PR-FSS-721 Final Status Survey Data Evaluation
Data Review and Calculation of the Sum-of-Fractions (SOF)

Use corrected net results for all DE calcs.

DCLG_{IN} Measure Tc-99, All SEAs

	Uniform
U-234	195.4
U-235	51.6
U-238	168.6
Tc-99	25.1
Th-232	2.0
Re-226	1.9

weighted SOF_{MEAN} 0.07

	SS	RS	ES
fractions	0.2	0.2	0.6

SOF_{MEAN} Re-use Backfill Material

0 Off-Site Backfill

SOF_{MEAN} Groundwater

0.16

SOF_{TOT} <= 1

SOF_{MEAN, SU} 0.23 PASS

Infer U234			
U-238/U235	U-234/U235	U-234	%
9.5	18.1	4.4	4.3
12.0	19.2	1.9	1.3
5.7	18.3	3.4	2.7
21.5	21.0	0.9	0.7
10.5	18.9	1.1	1.5
11.9	19.2	2.3	1.3
5.3	18.2	1.8	2.9
14.5	19.6	2.3	1.1
6.5	18.3	2.5	2.4
5.2	18.2	5.9	2.9
5.3	18.2	1.8	2.9
5.5	18.2	4.1	2.8
Average Enrichment (%)			2.11

Infer U-234
MDC using U-
235 MDC * ratio
of U-234/U-235
@ that
sample's
enrichment
2.8785
5.4964
5.6604
5.6169
6.0629
5.0159
4.6631
4.8216
2.9909
2.1676
3.5520
5.8355

HDP-PR-FSS-721 Final Status Survey Data Evaluation
Performance of Statistical Tests

WRS TEST					
SAMPLE ID	AREA (Reference, Survey Unit)	Gross SOF ($X_{i,ref}$, $Y_{i,SU,gross}$)	ADJUSTED SOF (Z_i)	RANKS	REFERENCE AREA RANKS
9574-SS-140910-01-01	Reference	1.31	2.310	40	40
9574-SS-140910-01-02	Reference	1.18	2.179	31	31
9574-SS-140910-01-03	Reference	1.06	2.064	26	26
9574-SS-140910-01-04	Reference	1.10	2.101	27	27
9574-SS-140910-01-05	Reference	1.29	2.293	39	39
9574-SS-140910-01-07	Reference	1.34	2.339	41	41
9574-SS-140910-01-08	Reference	1.15	2.154	30	30
9574-SS-140910-01-09	Reference	1.18	2.182	32	32
9574-SS-140910-01-10	Reference	1.23	2.227	37	37
9574-SS-140910-01-11	Reference	1.38	2.380	42	42
9574-SS-140910-01-12	Reference	1.05	2.055	25	25
9574-SS-140910-01-13	Reference	0.94	1.941	15	15
9574-SS-140910-01-14	Reference	1.12	2.119	28	28
9574-SS-140910-01-15	Reference	1.15	2.152	29	29
9574-SS-140910-01-16	Reference	1.03	2.028	22	22
9574-SS-140910-01-17	Reference	0.44	1.443	11	11
9574-SS-140910-01-18	Reference	1.19	2.188	34	34
9574-SS-140910-01-20	Reference	0.76	1.757	12	12
9574-SS-140910-01-21	Reference	1.02	2.023	21	21
9574-SS-140910-01-22	Reference	1.02	2.018	20	20
9574-SS-140910-01-23	Reference	1.00	2.002	17	17
9574-SS-140910-01-24	Reference	0.87	1.873	14	14
9574-SS-140910-01-25	Reference	1.04	2.040	24	24
9574-SS-140910-01-26	Reference	0.96	1.959	16	16
9574-SS-140910-01-27	Reference	1.20	2.204	35	35
9574-SS-140910-01-28	Reference	1.01	2.007	19	19
9574-SS-140910-01-29	Reference	1.22	2.223	36	36
9574-SS-140910-01-30	Reference	1.03	2.035	23	23
9574-SS-140910-01-31	Reference	1.00	2.005	18	18
9574-SS-140910-01-32	Reference	0.86	1.865	13	13
9574-SS-140910-01-33	Reference	1.24	2.238	38	38
9574-SS-140910-01-34	Reference	1.19	2.185	33	33
L10-02-01-B-S-S-00	Survey Unit	1.07	1.069	4	0
L10-02-02-B-R-S-00	Survey Unit	1.13	1.133	7	0
L10-02-04-B-S-S-00	Survey Unit	1.12	1.118	6	0
L10-02-05-B-R-S-00	Survey Unit	1.20	1.203	10	0
L10-02-07-B-E-S-00	Survey Unit	1.15	1.148	8	0
L10-02-08-B-E-S-00	Survey Unit	1.16	1.163	9	0
L10-02-09-B-E-S-00	Survey Unit	1.12	1.116	5	0
L10-02-10-B-E-S-00	Survey Unit	1.00	1.003	3	0
L10-02-11-B-E-S-00	Survey Unit	0.96	0.956	2	0
L10-02-12-B-E-S-00	Survey Unit	0.61	0.613	1	0
Rank Sums				903	848
# Reference Area Measurements				m	32
# Survey Unit Measurements				n	10
Total Number of Measurements				N	42
(1-α) percentile of a standard normal distribution (MARSSIM Pg. I-10)				z	1.645
WRS Critical Value (MARSSIM Pg. I-10, Eq. I.1)				CV	744

Min adjusted bkg SOF:
1.44

No WRS test necessary
No WRS test necessary
No WRS test necessary
No WRS test necessary
No WRS test necessary
No WRS test necessary
No WRS test necessary
No WRS test necessary
No WRS test necessary
No WRS test necessary

W_r

$\alpha = 0.05$

TEST: **PASS**

**HDP-PR-FSS-721 Final Status Survey Data Evaluation
Retrospective Sample Size Verification**

Uniform DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	SOF (Ra/Tc/Th/Iso U)
St. Dev.	0.03
DCGL _{SOF}	1
LBGR (Mean)	0.07
Shift	0.93
Relative Shift (Δ/σ)	28.87
MARSSIM Table 5.1 (P_r)	1.000000
N	12
N + 20%	14.4
N/2	8
FSS N/2	8
Verification Check	SUFFICIENT MEASUREMENTS
"N/2" Corresponds to the number of survey unit measurement locations required for the WRS Test	

MARSSIM Table 5.1

Δ/σ	P_r
0.1	0.528182
0.2	0.556223
0.3	0.583985
0.4	0.611335
0.5	0.638143
0.6	0.664290
0.7	0.689665
0.8	0.714167
0.9	0.737710
1.0	0.760217
1.1	0.781627
1.2	0.801892
1.3	0.820978
1.4	0.838864
1.5	0.855541
1.6	0.871014
1.7	0.885299
1.8	0.898420
1.9	0.910413
2.0	0.921319
2.25	0.944167
2.5	0.961428
2.75	0.974067
3.0	0.983039
3.5	0.993329
4.0	0.997658
4.01	1.000000

MARSSIM Table 5.2, $\alpha = 0.05$, $\beta = 0.10$

α (or β)	$Z_{1-\alpha}$ (or $Z_{1-\beta}$)
0.005	2.576
0.01	2.326
0.015	2.241
0.025	1.960
0.05	1.645
0.10	1.282
0.15	1.036
0.2	0.842
0.25	0.674
0.30	0.524

α
 β

Hematite Decommissioning Project					Procedure: HDP-PR-FSS-703, Final Status Survey Quality Control							
					Westinghouse Non-Proprietary Class 3				Revision: 1		Page 1 of 1	
FORM HDP-PR-FSS-703-1 FIELD DUPLICATE SAMPLE ASSESSMENT												
Survey Unit No.:		LSA 10-02			Survey Unit Description:		North East Corner Survey Unit (North Burial Pits)					
Sample ID	Field Duplicate Sample ID	Radionuclide	Sample (pCi/g)		Field Duplicate Sample (pCi/g)		Average Activity (\bar{x}) (pCi/g)	Nuclide DCGL (pCi/g)	Statistic ²	Warning Limit	Control Limit	Statistic Exceeds Limit? (Y/N)
			Activity (x_i)	MDC	Activity (x_i)	MDC						
L10-02-11-B-E-S-00	L10-02-11-B-E-Q-00	Ra-226	0.956	0.0738	0.812	0.0586	0.884	1.9	0.144	0.269	0.403	N
L10-02-11-B-E-S-00	L10-02-11-B-E-Q-00	Tc-99	0.274	0.249	0.453	0.243	0.3635	25.1	0.179	3.552	5.321	N
L10-02-11-B-E-S-00	L10-02-11-B-E-Q-00	Th-232	0.843	0.0839	0.577	0.0649	0.710	2.0	0.266	0.283	0.424	N
L10-02-11-B-E-S-00	L10-02-11-B-E-Q-00	U-234 ¹	2.477	NA	1.840	NA	2.158	195.4	0.637	27.649	41.425	N
L10-02-11-B-E-S-00	L10-02-11-B-E-Q-00	U-235	0.135	0.163	0.101	0.195	0.118	51.6	NA	7.301	10.939	NA
L10-02-11-B-E-S-00	L10-02-11-B-E-Q-00	U-238	0.875	0.785	0.536	0.712	0.706	168.8	NA	23.885	35.786	NA
Comments: 1. U-234 is inferred, no MDC available. 2. U-235 results are less than the related MDC, therefore duplicate assessment is not necessary.												
Performed by: Ellen C. Jakub						Reviewed by: Brian A. Miller						
Date: 02/26/2015						Date: 03/16/2015						
Quality Record												