

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development		
	Westinghouse Proprietary Class 3	Revision: 6	Appendix P-4, Page 1 of 1

APPENDIX P-4

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area:	LSA 11	Description:	Plant Open Land Area
Survey Unit:	01	Description:	Northeast Site Creek in "Area 9"
Survey Type:	FSS	Classification:	Class 2

Measurement or Sample ID	Surface or CSM	Type	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes
L11-01-01-B-S-S-00	Uniform	S	427.0	426.5	865441.0	827549.0	Surface 6-inch grab
L11-01-02-B-R-S-00	Uniform	S	426.5	422.0	865441.0	827549.0	Root 4.4-ft composite
L11-01-04-B-S-S-00	Uniform	S	423.9	423.4	865334.0	827611.0	Surface 6-inch grab
L11-01-05-B-R-S-00	Uniform	S	423.4	419.0	865334.0	827611.0	Root 4.4-ft composite
L11-01-07-B-R-S-00	Uniform	S	424.1	420.5	865227.0	827672.0	Root 3.6-ft composite
L11-01-08-B-E-S-00	Uniform	S	420.5	420.0	865227.0	827672.0	Excavation 6-inch grab
L11-01-09-B-S-S-00	Uniform	S	422.7	422.2	865227.0	827796.0	Surface 6-inch grab
L11-01-10-B-R-S-00	Uniform	S	422.2	417.7	865227.0	827796.0	Root 4.4-ft composite
L11-01-12-B-S-S-00	Uniform	S	422.2	421.7	865227.0	827920.0	Surface 6-inch grab
L11-01-13-B-R-S-00	Uniform	S	421.7	417.3	865227.0	827920.0	Root 4.4-ft composite
L11-01-15-B-S-S-00	Uniform	S	420.9	420.4	865227.0	828043.0	Surface 6-inch grab
L11-01-16-B-R-S-00	Uniform	S	420.4	415.9	865227.0	828043.0	Root 4.4-ft composite
L11-01-18-B-R-S-00	Uniform	S	422.8	421.9	865119.0	827734.0	Root 0.9-ft composite
L11-01-19-B-E-S-00	Uniform	S	421.9	421.4	865119.0	827734.0	Excavation 6-inch grab
L11-01-20-B-R-S-00	Uniform	S	421.4	419.4	865119.0	827858.0	Root 2-ft composite
L11-01-21-B-E-S-00	Uniform	S	419.4	418.9	865119.0	827858.0	Excavation 6-inch grab
L11-01-02-B-R-Q-00	Uniform	Q	426.5	422.0	865441.0	827549.0	Root 4.4-ft composite
L11-01-16-B-R-Q-00	Uniform	Q	420.4	415.9	865227.0	828043.0	Root 4.4-ft composite
L11-01-22-B-S-B-00	Uniform	B	423.0	422.5	865291.0	827544.0	Surface 6-inch grab
L11-01-23-B-S-B-00	Uniform	B	424.0	423.5	865247.0	827842.0	Surface 6-inch grab

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

*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) or Uniform DCGLs used

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

Quality Record

Evaluate Final Status Survey Data: LSA-11-01

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HDP-PR-FSS-721 Final Status Survey Data Evaluation
Steps 8.3 Preliminary Data Review and 8.4 Calculation of the Sum-of-Fractions (SOF)

Use corrected net results for all DE calcs 721 Sec. 8.4.2

MDC-SOF Fraction
0.09
0.10
0.11
0.10
0.10
0.08
0.13
0.10
0.13
0.09
0.11
0.11
0.09
0.13
0.10
0.09
0.13
0.10
0.09
0.13
0.10
0.13
0.10
0.13

Step 8.4.1 DCLG_{SL} Measure Tc-99, All SEAs

	Uniform
U-234	199.4
U-235	51.6
U-238	168.8
Tc-99	25.1
Th-232	2.0
Ra-226	1.9

Step 8.4.5D

Weighted SOF_{MEAN} = 0.03

Fractions	SS	RS	ES
	0.3125	0.5	0.1875

Step 8.4.5c SOF_{MEAN} Re-use Backfill Material

0

Step 8.4.5e SOF_{MEAN} Groundwater

0.15

Step 8.4.5g (c<1)

SOF_{MEAN, SU} 0.15 PASS

Step 8.4.6 Calculate the dose contribution for the SU by multiplying SOF_{MEAN, SU} (including contribution from Re-use backfill and Groundwater) by 25 mrem.

4.8 mrem

Infer U234 Step 8.3.4			
U-238/U235	U-234/U235	U-234	%
11.9	19.2	0.6	1.3
10.0	18.8	1.7	1.6
3.9	18.1	2.4	3.9
6.3	18.3	1.1	2.5
14.9	19.6	0.6	1.1
18.3	20.2	0.7	0.9
5.7	18.3	2.5	2.7
6.0	18.3	1.6	2.6
7.8	18.5	1.8	2.1
34.7	20.7	0.7	0.5
9.0	18.7	3.2	1.7
41.3	24.2	0.5	0.4
7.3	18.5	1.5	2.1
9.5	18.7	1.6	1.7
36.5	22.7	0.5	0.5
8.6	18.7	1.4	1.8
9.8	18.8	1.5	1.6
7.9	18.5	1.8	2.0
3.3	18.1	14.9	4.5
11.0	19.1	2.8	1.4
Average Enrichment (%)			1.85

Infer U-234 MDC using U-235 MDC * ratio of U-234 U-235 (i.e. that sample's enrichment

2.472141
3.315686
3.49549
3.095324
3.743619
2.339232
4.163145
3.419441
4.046639
4.138926
3.449277
2.161127
2.291248
4.011659
4.614264
2.519803
3.353344
2.687206
4.381335
4.178651

HDP-PR-FSS-721 Final Status Survey Data Evaluation
Step 8.5 Performance of Statistical Tests

WRS TEST					
SAMPLE ID	AREA (Reference, Survey Unit)	Gross SOF ($X_{i,ref}$, $Y_{i,SU}$) Step 8.5.3a	ADJUSTED SOF (Z_i) Step 8.5.3b	RANKS Step 8.5.3d	REFERENCE AREA RANKS
9574-SS-140910-01-01	Reference	1.31	2.310	46	46
9574-SS-140910-01-02	Reference	1.18	2.179	37	37
9574-SS-140910-01-03	Reference	1.06	2.064	32	32
9574-SS-140910-01-04	Reference	1.10	2.101	33	33
9574-SS-140910-01-05	Reference	1.29	2.293	45	45
9574-SS-140910-01-07	Reference	1.34	2.339	47	47
9574-SS-140910-01-08	Reference	1.15	2.154	36	36
9574-SS-140910-01-09	Reference	1.18	2.182	38	38
9574-SS-140910-01-10	Reference	1.23	2.227	43	43
9574-SS-140910-01-11	Reference	1.38	2.380	48	48
9574-SS-140910-01-12	Reference	1.05	2.055	31	31
9574-SS-140910-01-13	Reference	0.94	1.941	21	21
9574-SS-140910-01-14	Reference	1.12	2.119	34	34
9574-SS-140910-01-15	Reference	1.15	2.152	35	35
9574-SS-140910-01-16	Reference	1.03	2.028	28	28
9574-SS-140910-01-17	Reference	0.44	1.443	17	17
9574-SS-140910-01-18	Reference	1.19	2.188	40	40
9574-SS-140910-01-20	Reference	0.76	1.757	18	18
9574-SS-140910-01-21	Reference	1.02	2.023	27	27
9574-SS-140910-01-22	Reference	1.02	2.018	26	26
9574-SS-140910-01-23	Reference	1.00	2.002	23	23
9574-SS-140910-01-24	Reference	0.87	1.873	20	20
9574-SS-140910-01-25	Reference	1.04	2.040	30	30
9574-SS-140910-01-26	Reference	0.96	1.959	22	22
9574-SS-140910-01-27	Reference	1.20	2.204	41	41
9574-SS-140910-01-28	Reference	1.01	2.007	25	25
9574-SS-140910-01-29	Reference	1.22	2.223	42	42
9574-SS-140910-01-30	Reference	1.03	2.035	29	29
9574-SS-140910-01-31	Reference	1.00	2.005	24	24
9574-SS-140910-01-32	Reference	0.86	1.865	19	19
9574-SS-140910-01-33	Reference	1.24	2.238	44	44
9574-SS-140910-01-34	Reference	1.19	2.185	39	39
L11-01-01-B-S-S-00	Survey Unit	0.35	0.347	1	0
L11-01-02-B-R-S-00	Survey Unit	0.91	0.911	11	0
L11-01-04-B-S-S-00	Survey Unit	0.92	0.919	12	0
L11-01-05-B-R-S-00	Survey Unit	0.90	0.904	10	0
L11-01-07-B-R-S-00	Survey Unit	0.81	0.806	3	0
L11-01-08-B-E-S-00	Survey Unit	0.79	0.793	2	0
L11-01-09-B-S-S-00	Survey Unit	1.21	1.207	16	0
L11-01-10-B-R-S-00	Survey Unit	0.88	0.877	8	0
L11-01-12-B-S-S-00	Survey Unit	0.95	0.948	13	0
L11-01-13-B-R-S-00	Survey Unit	0.88	0.879	9	0
L11-01-15-B-S-S-00	Survey Unit	1.16	1.160	15	0
L11-01-16-B-R-S-00	Survey Unit	0.81	0.806	4	0
L11-01-18-B-R-S-00	Survey Unit	0.85	0.849	6	0
L11-01-19-B-E-S-00	Survey Unit	0.85	0.851	7	0
L11-01-20-B-R-S-00	Survey Unit	1.01	1.005	14	0
L11-01-21-B-E-S-00	Survey Unit	0.84	0.839	5	0
Rank Sums				1176	1040
# Reference Area Measurements				m	32
# Survey Unit Measurements				n	16
Total Number of Measurements Step 8.5.3c				N	48
(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	860

TEST: **PASS** Step 8.5.3f

HDP-PR-FSS-701 Final Status Survey Plan Development

Appendix B.1 Step 8 Calculate the Number of Samples in the Statistical Population

Uniform DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	SOF (Ra/Tc/Th/Iso U)
St. Dev.	0.04
DCGL _{SOF}	1
LBGR (Mean)	0.03
Shift	0.97
Relative Shift (Δ/σ)	25.77
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 p)	$Z_{1-\alpha}$ (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								Revision: 2		Page 1 of 1	
FORM HDP-PR-FSS-703-1 FIELD DUPLICATE SAMPLE ASSESSMENT													
Survey Unit No.:		LSA 11-01				Survey Unit Description:		Plant Soils Open Land Area east of Burial Pits in "Area 9"					
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)	Statistic2	Warning Limit	Control Limit	Statistic Exceeds Limit? (Y/N)	
			Activity (xi)	MDC	Activity (xi)	MDC							
L11-01-02-B-R-S-00	L11-01-02-B-R-Q-00	Ra-226	0.937	0.0507	0.804	0.048	0.8705	1.9	0.133	0.269	0.403	N	
L11-01-02-B-R-S-00	L11-01-02-B-R-Q-00	Tc-99	0.0546	0.241	0.139	0.23	0.0968	25.1	NA	3.552	5.321	NA	
L11-01-02-B-R-S-00	L11-01-02-B-R-Q-00	Th-232	0.716	0.089	0.665	0.057	0.691	2.0	0.051	0.283	0.424	N	
L11-01-02-B-R-S-00	L11-01-02-B-R-Q-00	U-2341	1.701	NA	1.498	NA	1.599	195.4	0.203	27.649	41.425	N	
L11-01-02-B-R-S-00	L11-01-02-B-R-Q-00	U-235	0.0903	0.176	0.0795	0.178	0.085	51.6	NA	7.301	10.939	NA	
L11-01-02-B-R-S-00	L11-01-02-B-R-Q-00	U-238	0.904	0.57	0.783	0.581	0.8435	168.8	0.121	23.885	35.786	N	
L11-01-16-B-R-S-00	L11-01-16-B-R-Q-00	Ra-226	0.822	0.0545	0.847	0.0543	0.8345	1.9	0.025	0.269	0.403	N	
L11-01-16-B-R-S-00	L11-01-16-B-R-Q-00	Tc-99	-0.0235	0.228	-0.0146	0.231	-0.01905	25.1	NA	3.552	5.321	NA	
L11-01-16-B-R-S-00	L11-01-16-B-R-Q-00	Th-232	0.73	0.0866	0.792	0.0729	0.761	2.0	0.062	0.283	0.424	N	
L11-01-16-B-R-S-00	L11-01-16-B-R-Q-00	U-2341	0.520	NA	1.801	NA	1.161	195.4	1.281	27.649	41.425	N	
L11-01-16-B-R-S-00	L11-01-16-B-R-Q-00	U-235	0.0215	0.172	0.0972	0.145	0.059	51.6	NA	7.301	10.939	NA	
L11-01-16-B-R-S-00	L11-01-16-B-R-Q-00	U-238	0.889	0.548	0.769	0.644	0.829	168.8	0.12	23.885	35.786	N	
Comments: 1. U-234 is inferred, no MDC available. 2. Duplicate assessment is not necessary if the result of either sample is < MDC.													
Performed by: _____						Reviewed by: _____							
Date: _____						Date: _____							
Quality Record													

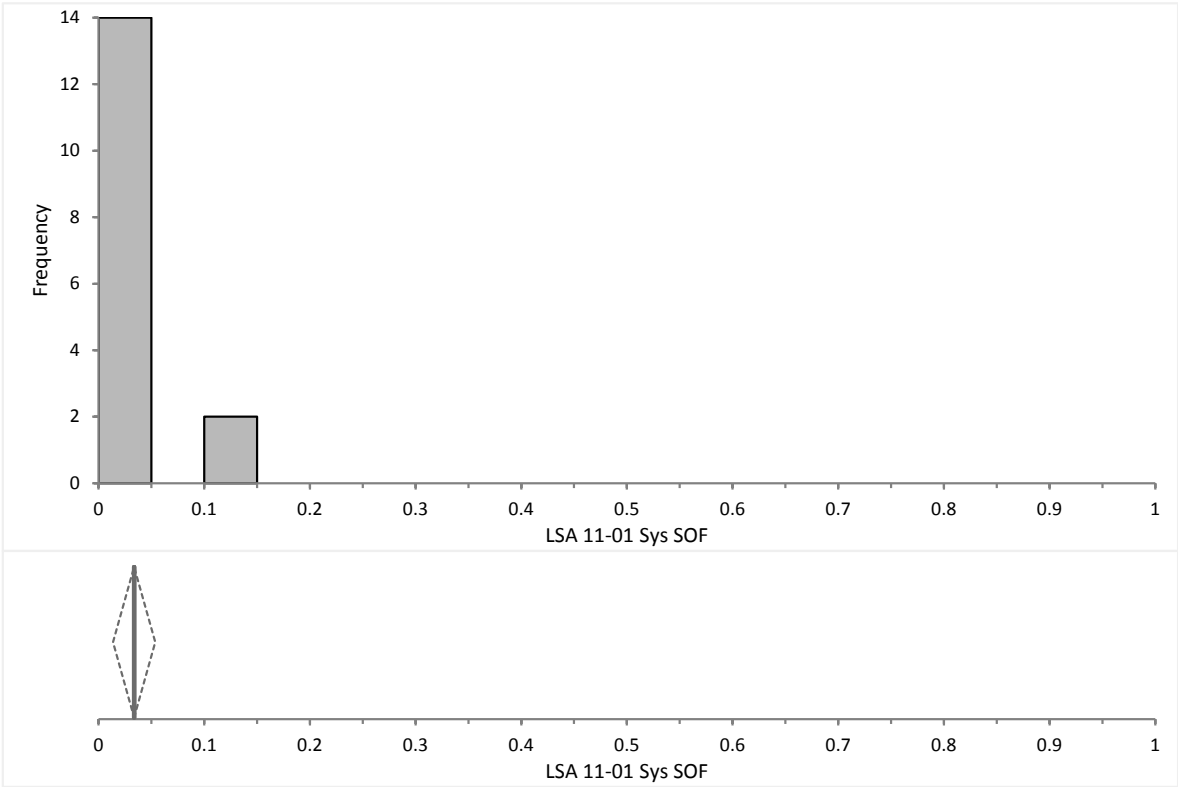
LSA 11-01 Sys SOF

0.0
0.0
0.0
0.0
0.0
0.0
0.1
0.0
0.0
0.0
0.1
0.0
0.0
0.0
0.0
0.0

SOFn Only A1:A17

Last updated 10 November 2016 at 16:21 by W. Clark Evers

Descriptives



N		16						
		Mean	95% CI	Mean SE	SD	Variance	Skewness	Kurtosis
LSA 11-01 Sys SOF		0.03	0.01 to 0.05	0.009	0.04	0.00	2.3	5.04
		Minimum	1st quartile	Median	97.87% CI	3rd quartile	Maximum	IQR
LSA 11-01 Sys SOF		0.0	0.01	0.02	0.01 to 0.04	0.03	0.1	0.02