

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development		
		Revision: 10	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:	05	Description:	South Eastern Survey Unit in "Area 9"
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
L100501BES00	Uniform	S	418.217	417.7	865073.9	827626.8	Excavation 6-inch grab
L100502BEQ00	Uniform	Q	423.203	422.7	865042.8	827595.7	Excavation 6-inch grab
L100502BES00	Uniform	S	423.203	422.7	865042.8	827595.7	Excavation 6-inch grab
L100503BES00	Uniform	S	421.87	421.4	865031.4	827638.2	Excavation 6-inch grab
L100504BES00	Uniform	S	426.368	425.9	865000.3	827607.1	Excavation 6-inch grab
L100505BES00	Uniform	S	422.075	421.6	865020.0	827680.7	Excavation 6-inch grab
L100506BES00	Uniform	S	415.291	414.8	864988.9	827649.6	Excavation 6-inch grab
L100507BES00	Uniform	S	415.278	414.8	864977.5	827692.1	Excavation 6-inch grab
L100508BES00	Uniform	S	422.806	422.3	864966.2	827734.6	Excavation 6-inch grab
L100509BSS00	Uniform	B	418.9	418.9	864973.3	827705.0	Sidewall 6-inch grab
L100510BSS00	Uniform	B	423.2	423.2	865001.2	827615.1	Sidewall 6-inch grab
L100511BSS00	Uniform	B	420.7	420.7	865026.7	827646.8	Sidewall 6-inch grab
L100512BSS00	Uniform	B	421.4	421.4	864989.3	827694.6	Sidewall 6-inch grab
L100513BSS00	Uniform	B	418.3	418.3	864989.3	827694.6	Sidewall 6-inch grab
L100514BSS00	Uniform	B	418.6	418.6	865016.5	827639.8	Sidewall 6-inch grab
L100515BSS00	Uniform	B	417.8	417.8	865017.6	827665.2	Sidewall 6-inch grab
L100516BSS00	Uniform	B	418.2	418.2	865006.5	827683.4	Sidewall 6-inch grab
L100517BSS00	Uniform	B	419.4	419.4	865078.9	827603.6	Sidewall 6-inch grab
L100518BSS00	Uniform	B	419.8	419.8	865056.0	827632.4	Sidewall 6-inch grab
L100519BSS00	Uniform	B	419.1	419.1	865045.2	827623.0	Sidewall 6-inch grab
L100520BSS00	Uniform	B	420.0	420.0	865050.5	827594.7	Sidewall 6-inch grab
L100521BSS00	Uniform	B	420.9	420.9	865086.1	827642.5	Sidewall 6-inch grab
L100522BSS00	Uniform	B	420.4	420.4	865071.3	827649.5	Sidewall 6-inch grab
L100523BSS00	Uniform	B	419.8	419.8	865077.5	827616.6	Sidewall 6-inch grab
L100524BSS00	Uniform	B	419.7	419.7	865086.3	827624.2	Sidewall 6-inch grab
L100525BUB00	Uniform	B	418.0	417.5	864960.9	827711.7	Biased 6-inch grab
L100526BUB00	Uniform	B	414.0	413.5	864964.7	827685.6	Biased 6-inch grab
L100527BUB00	Uniform	B	426.0	425.5	865002.4	827599.2	Biased 6-inch grab
L100528BUB00	Uniform	B	422.0	421.5	865082.4	827591.4	Biased 6-inch grab
L100529BSB00	Uniform	B	424.0	423.5	865030.1	827584.7	Investigation 6-inch grab
L100530BSB00	Uniform	B	418.0	417.5	865061.2	827615.8	Investigation 6-inch grab
L100531BSB00	Uniform	B	424.0	423.5	865092.3	827646.9	Investigation 6-inch grab
L100532BSB00	Uniform	B	422.0	421.5	865018.7	827627.2	Investigation 6-inch grab
L100533BSB00	Uniform	B	424.0	423.5	865049.8	827658.3	Investigation 6-inch grab
L100534BSB00	Uniform	B	416.0	415.5	865007.3	827669.7	Investigation 6-inch grab
L100535BSB00	Uniform	B	422.0	421.5	864995.9	827712.2	Investigation 6-inch grab
L100536BSB00	Uniform	B	422.0	421.5	864953.4	827723.6	Investigation 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

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)

Sample ID	Sample Depth (ft)	Type (S=soil, B=backfill)	Enrichment (%)	SOF Step 8.4.3	Is backfill in backfill stream?	Is backfill in backfill stream?	net count	enrichment count	verification count
L100501BES00	11.65	S	1.1	0.16	EXCAVATION	good		1	
L100502BES00	7.55	Q	0.6	0.62	EXCAVATION	good			
L100503BES00	7.55	S	1.9	0.07	EXCAVATION	good		1	
L100503BES00	8.71	S	2.1	0.25	EXCAVATION	good		1	
L100504BES00	5.42	S	2.7	0.30	EXCAVATION	good		1	
L100505BES00	8.40	S	4.9	0.13	EXCAVATION	good		1	
L100506BES00	16.07	S	2.9	0.18	EXCAVATION	good		1	
L100507BES00	16.06	S	1.0	0.16	EXCAVATION	good		1	
L100508BES00	8.92	S	0.1	0.12	EXCAVATION	good		1	
L100509BES00	12.56	B	1.2	0.05		good			
L100510BES00	9.01	B	0.4	0.18		good			
L100511BES00	10.47	B	1.3	0.25		good			
L100512BES00	8.92	B	1.4	0.23		good			
L100513BES00	13.28	B	1.5	0.31		good			
L100514BES00	12.43	B	1.6	0.07		good			
L100515BES00	13.36	B	2.1	0.16		good			
L100516BES00	12.71	B	1.9	0.13		good			
L100517BES00	10.27	B	0.4	0.26		good			
L100518BES00	10.19	B	2.1	0.51		good			
L100519BES00	11.75	B	1.1	0.55		good			
L100520BES00	10.75	B	3.5	0.55		good			
L100521BES00	7.73	B	3.9	0.57		good			
L100522BES00	8.95	B	1.7	0.57		good			
L100523BES00	9.97	B	1.8	0.34		good			
L100524BES00	9.45	B	2.6	0.56		good			
L100525BES00	11.70	B	6.3	0.17		good			
L100526BES00	16.10	B	1.6	0.25		good			
L100527BES00	5.40	B	3.2	0.27		good			
L100528BES00	8.40	B	2.5	0.42		good			
L100529BES00	7.55	B	1.3	0.11		good			
L100530BES00	11.65	B	1.7	0.11		good			
L100531BES00	7.55	B	2.0	0.43		good			
L100532BES00	8.40	B	3.0	0.11		good			
L100533BES00	7.55	B	2.0	0.05		good			
L100534BES00	16.07	B	2.4	0.14		good			
L100535BES00	8.40	B	2.5	0.25		good			
L100536BES00	8.40	B	3.4	0.21		good			
Average Enrichment L (%)				2.1					
				0.97					
				0.29					
				0.16					
				0.26					
				count tot	8	0	8	0	

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

MDC for use U-234
0.13
0.22
0.29
0.16
0.13
0.14
0.18
0.17
0.12
0.15
0.13
0.13
0.14
0.17
0.13
0.16
0.15
0.11
0.15
0.11
0.19
0.16
0.19
0.18
0.17
0.14
0.15
0.12
0.14
0.16
0.16
0.13
0.11
0.13
0.12
0.13
0.14
0.12
0.15
0.13
0.14
0.13
0.13
0.12
0.15
0.13
0.14
0.12
0.15
0.13
0.14
0.13

Step 8.4.1 DCLGw, Measure To-99, All SEAs

U-234	195.4
U-235	51.6
U-238	168.8
Y-88	25.1
Th-232	2.0
Re-226	1.9

Infer U-234 Step 8.3.4			
U-238/U-235	U-234/U-235	U-234	%
14.9	19.6	2.2	1.1
29.5	21.8	1.0	0.6
10.1	18.8	5.3	1.6
7.3	18.5	3.0	2.1
5.6	18.3	2.8	2.7
3.1	18.1	5.7	4.8
5.3	18.2	3.1	2.9
15.6	19.9	1.1	1.0
400.0	46.3	0.1	0.1
12.8	19.4	1.7	1.2
46.6	24.2	0.8	0.4
12.3	19.2	3.0	1.3
11.1	19.1	2.9	1.4
10.6	18.9	1.7	1.5
9.6	18.8	2.7	1.6
7.4	18.5	3.4	2.1
8.1	18.6	3.0	1.9
45.6	24.2	0.9	0.4
7.3	18.5	3.7	2.1
14.6	19.6	1.9	1.1
4.4	18.1	2.5	3.5
3.8	18.1	2.6	3.9
9.4	18.7	3.0	1.7
8.8	18.7	2.2	1.8
5.9	18.3	2.8	2.6
2.3	18.2	9.3	6.3
9.6	18.8	1.7	1.6
4.9	18.2	3.8	3.2
6.3	18.3	2.9	2.5
12.1	19.2	1.9	1.3
9.3	18.7	1.5	1.7
5.4	18.2	3.3	2.9
5.1	18.2	5.1	3.0
7.9	18.5	2.9	2.0
6.5	18.3	3.2	2.4
6.1	18.3	4.2	2.5
4.5	18.1	3.2	3.4
Average Enrichment (%)			2.05

Infer U-234 MDC using U-235 MDC * ratio of U-234-U-235 @ that sample's enrichment

5.54883
8.48671
13.6771
3.91729
4.91178
3.76705
3.26055
5.47945
12.9219
4.47953
6.8707
3.13256
3.66336
5.00186
5.76474
3.04894
4.83457
5.02396
2.13495
5.37043
5.04
5.86508
5.64257
5.00227
5.05345
4.14955
4.93582
4.17841
5.34813
5.65014
5.54884
3.73415
3.51205
4.25246
4.11019
4.65214
3.25595

Step 8.4.5a

Weighted SOF MEAN **0.29**

fractions SS RS ES

Step 8.4.5c SOF MEAN Re-use Backfill Material

Step 8.4.5e SOF MEAN Groundwater

Step 8.4.5g (<=1)

SOF MEAN SU **U-234** **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 mem.

11.3 mem

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)

[illegible]

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	1.19	2.188	32	32
9574-SS-140910-01-02	Reference	0.76	1.757	9	9
9574-SS-140910-01-03	Reference	1.02	2.023	18	18
9574-SS-140910-01-04	Reference	1.02	2.018	17	17
9574-SS-140910-01-05	Reference	1.00	2.002	14	14
9574-SS-140910-01-07	Reference	0.87	1.873	11	11
9574-SS-140910-01-08	Reference	1.04	2.040	22	22
9574-SS-140910-01-09	Reference	0.96	1.959	13	13
9574-SS-140910-01-10	Reference	1.20	2.204	33	33
9574-SS-140910-01-11	Reference	1.01	2.007	16	16
9574-SS-140910-01-12	Reference	1.22	2.223	34	34
9574-SS-140910-01-13	Reference	1.03	2.035	21	21
9574-SS-140910-01-14	Reference	1.00	2.005	15	15
9574-SS-140910-01-15	Reference	0.86	1.865	10	10
9574-SS-140910-01-16	Reference	1.24	2.238	36	36
9574-SS-140910-01-17	Reference	1.19	2.185	31	31
9574-SS-140910-01-18	Reference	1.31	2.310	38	38
9574-SS-140910-01-20	Reference	1.18	2.179	29	29
9574-SS-140910-01-21	Reference	1.06	2.064	24	24
9574-SS-140910-01-22	Reference	1.10	2.101	25	25
9574-SS-140910-01-23	Reference	1.29	2.293	37	37
9574-SS-140910-01-24	Reference	1.34	2.339	39	39
9574-SS-140910-01-25	Reference	1.15	2.154	28	28
9574-SS-140910-01-26	Reference	1.18	2.182	30	30
9574-SS-140910-01-27	Reference	1.23	2.227	35	35
9574-SS-140910-01-28	Reference	1.38	2.380	40	40
9574-SS-140910-01-29	Reference	1.05	2.055	23	23
9574-SS-140910-01-30	Reference	0.94	1.941	12	12
9574-SS-140910-01-31	Reference	1.12	2.119	26	26
9574-SS-140910-01-32	Reference	1.15	2.152	27	27
9574-SS-140910-01-33	Reference	1.03	2.028	19	19
9574-SS-140910-01-34	Reference	0.44	1.443	8	8
L100501BES00	Survey Unit	1.25	1.250	5	0
L100502BES00	Survey Unit	2.03	2.031	20	0
L100503BES00	Survey Unit	1.31	1.311	6	0
L100504BES00	Survey Unit	1.36	1.362	7	0
L100505BES00	Survey Unit	1.25	1.246	4	0
L100506BES00	Survey Unit	1.24	1.242	3	0
L100507BES00	Survey Unit	1.22	1.225	2	0
L100508BES00	Survey Unit	1.19	1.186	1	0
Rank Sums				820	772
# Reference Area Measurements				m	32
# Survey Unit Measurements				n	8
Total Number of Measurements Step 8.5.3c				N	40
(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	705

Step 8.5.1

Min adjusted bkg SOF
1.44

No WRS test necessary
Perform WRS test
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, Step 8.5.3e

$\alpha = 0.05$

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.	0.28
DCGL _{SOF}	1
LBGR (Mean)	0.29
Shift	0.71
Relative Shift (Δ/σ)	2.54
MARSSIM Table 5.1 (P_r)	0.961428
N	14
N + 20%	16.8
N/2	9
FSS N/2	8
Verification Check	ADDITIONAL DATA REVIEW REQUIRED
"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											
								Revision: 2		Page 1 of 1		

FORM HDP-PR-FSS-703-1 FIELD DUPLICATE SAMPLE ASSESSMENT												
--	--	--	--	--	--	--	--	--	--	--	--	--

Survey Unit No.:	LSA 10-05				Survey Unit Description:	Burial Pits Open Land Area South Eastern Survey Unit 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)	Statistic ²	Warning Limit	Control Limit	Statistic Exceeds Limit? (Y/N)
			Activity (x_i)	MDC	Activity (x_i)	MDC						
L100502BES00	L100502BEQ00	Ra-226	1.76	0.264	1.81	0.146	1.785	1.9	0.05	0.269	0.403	N
L100502BES00	L100502BEQ00	Tc-99	0.0144	0.282	-0.00268	0.298	0.006	25.1	NA	3.552	5.321	NA
L100502BES00	L100502BEQ00	Th-232	2.11	0.148	1.43	0.149	1.770	2.0	0.680	0.283	0.424	Y
L100502BES00	L100502BEQ00	U-234 ¹	5.313	NA	0.975	NA	3.144	195.4	4.338	27.649	41.425	N
L100502BES00	L100502BEQ00	U-235	0.282	0.726	0.0448	0.39	0.163	51.6	NA	7.301	10.939	NA
L100502BES00	L100502BEQ00	U-238	2.86	3.29	1.32	1.24	2.090	168.8	NA	23.885	35.786	NA

Comments:

1. U-234 is inferred, no MDC available.

2. Duplicate assessment is not necessary if the result of either sample is < MDC.

Th-232 statistic exceeds Control Limit, RSO notified, review concludes results area acceptable.

Performed by: _____

Date: _____

Reviewed by: _____

Date: _____

Quality Record

LSA 10-05 Sys SOF

0.2

1.0

0.2

0.3

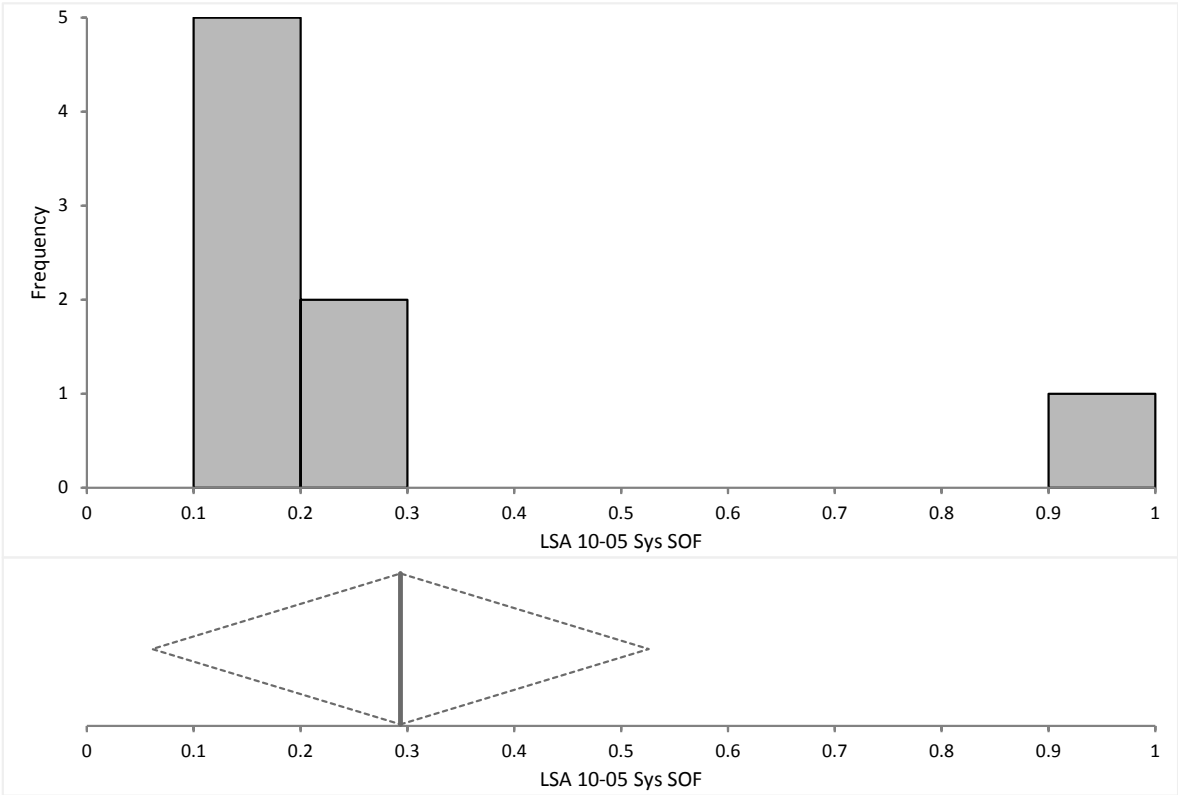
0.2

0.2

0.2

0.1

Descriptives



N		8							
		Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LSA 10-05 Sys SOF		0.29	0.06 to 0.53		0.098	0.28	0.08	2.6	7.11
		Minimum	1st quartile	Median	99.22% CI		3rd quartile	Maximum	IQR
LSA 10-05 Sys SOF		0.1	0.17	0.18	0.12 to 0.97		0.28	1.0	0.11