

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**

<b>Survey Area:</b>	LSA 08	<b>Description:</b>	Open Land Area, Tc-99 SEA
<b>Survey Unit:</b>	06	<b>Description:</b>	Central Open Land Area Survey Unit in "Area 6"
<b>Survey Type:</b>	FSS	<b>Classification:</b>	Class 1

Measurement or Sample ID	Surface or CSM	Type	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes
L08-06-01-T-E-S-00	Uniform	S	412.8	412.3	864677	827237	Excavation 6-inch grab
L08-06-02-T-E-S-00	Uniform	S	425.6	425.1	864677	827182	Excavation 6-inch grab
L08-06-03-T-E-S-00	Uniform	S	411.9	411.4	864629	827210	Excavation 6-inch grab
L08-06-04-T-E-S-00	Uniform	S	417.7	417.2	864581	827182	Excavation 6-inch grab
L08-06-05-T-S-S-00	Uniform	S	435.0	434.5	864581	827071	Surface 6-inch grab
L08-06-06-T-R-S-00	Uniform	S	434.5	430.1	864581	827071	Root 4.4-ft composite
L08-06-07-T-E-S-00	Uniform	S	430.1	429.6	864581	827071	Excavation 6-inch grab
L08-06-08-T-S-S-00	Uniform	S	433.4	433.2	864533	827154	Surface 6-inch grab
L08-06-09-T-R-S-00	Uniform	S	433.2	428.8	864533	827154	Root 4.4-ft composite
L08-06-10-T-E-S-00	Uniform	S	428.8	428.3	864533	827154	Excavation 6-inch grab
L08-06-11-T-E-S-00	Uniform	S	424.9	424.4	864581	827126	Excavation 6-inch grab
L08-06-12-T-R-S-00	Uniform	S	425.7	425.6	864629	827154	Root 4.4-ft composite
L08-06-13-T-E-S-00	Uniform	S	425.6	425.1	864629	827154	Excavation 6-inch grab
L08-06-06-T-R-Q-00	Uniform	Q	434.5	430.1	864581	827071	Root 4.4-ft composite
L08-06-14-T-E-B-00	Uniform	B	427.7	427.2	864613	827123	Excavation 6-inch grab
L08-06-15-T-E-B-00	Uniform	B	420.4	419.9	864579	827179	Excavation 6-inch grab
L08-06-16-T-E-B-00	Uniform	B	415.5	415.0	864653	827254	Excavation 6-inch grab
L08-06-17-T-E-B-00	Uniform	B	420.1	419.6	864716	827226	Excavation 6-inch grab
L08-06-18-T-E-B-00	Uniform	B	425.2	424.7	864552	827108	Sidewall Sample

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, G=Groundwater)	Enrichment (%)	SOF	Root Stratum SOP Verification (immaculate/bedrock backfilled only) Step 8.4.4.1	In Backfill in Root Stratum?	In ROOT Stratum? SOP Step 8.4.3	root count	enrichment count	verification count	Average Enrichment (%)
L08-06-01-T-E-S-00	18.63	S	3.3	0.26	EXCAVATION	good			1		
L08-06-02-T-E-S-00	7.37	S	1.7	0.23	EXCAVATION	good			1		
L08-06-03-T-E-S-00	19.58	S	2.3	0.33	EXCAVATION	good			1		
L08-06-04-T-E-S-00	15.50	S	2.9	0.24	EXCAVATION	good			1		
L08-06-05-T-S-S-00	0.00	S	4.2	0.07	SURFACE	good				1	
L08-06-06-T-R-S-00	0.50	S	5.8	0.09	ROOT	good		1			
L08-06-07-T-E-S-00	4.92	S	1.9	0.17	EXCAVATION	good			1		
L08-06-08-T-S-S-00	0.32	S	2.5	0.95	SURFACE	good				1	
L08-06-09-T-R-S-00	0.50	S	2.7	0.11	ROOT	good		1			
L08-06-10-T-E-S-00	4.92	S	0.7	0.21	EXCAVATION	good			1		
L08-06-11-T-E-S-00	8.25	S	1.8	0.95	EXCAVATION	good			1		
L08-06-12-T-R-S-00	4.29	S	3.3	0.42	ROOT	good		1			
L08-06-13-T-E-S-00	4.78	S	2.8	0.20	ROOT	good		1			
L08-06-06-T-R-G-00	4.92	G	2.2	0.95		good					
L08-06-14-T-E-B-00	3.91	B	6.3	0.45		good					
L08-06-15-T-E-B-00	5.41	B	2.1	0.31		good					
L08-06-16-T-E-B-00	5.41	B	1.8	0.81		good					
L08-06-17-T-E-B-00	5.41	B	2.2	0.33		good					
L08-06-18-T-E-B-00	5.41	B	1.0	0.02		good					
			2.7	0.95							
			0.42								
			0.19								
			0.20								
			0.11								
							13	4	7	2	
							count tot				

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

MDC OF Net U-234
0.16
0.15
0.13
0.13
0.12
0.11
0.15
0.18
0.13
0.13
0.10
0.12
0.12
0.14
0.12
0.11
0.15
0.13

Step 8.4.1 DCLG<sub>w</sub>, Measure Tc-99, All SEAs

U-234	Uniform
U-234	195.4
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 <sub>MEAN</sub>	0.19
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fractions	SS	RS	ES
	0.153846154	0.307692308	0.538461538

Step 8.4.5c SU<sub>P</sub>MEAN PB-use backfill Material

	0.22
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Step 8.4.5e SOF<sub>MEAN</sub> Groundwater

	0.16
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Step 8.4.5g (<=1)

SOF <sub>MEAN,SU</sub>	0.57	PASS
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Infer U234 Step 8.3.4			
U-238/U235	U-234/U235	U-234	%
4.6	18.2	8.1	3.3
9.3	18.7	2.3	1.7
5.4	18.2	6.9	2.8
5.2	18.2	6.8	2.9
3.6	18.1	3.6	4.2
2.7	18.1	6.0	5.6
9.1	18.7	3.2	1.7
6.2	18.3	2.9	2.5
5.8	18.3	4.4	2.7
23.6	21.1	1.0	0.7
8.9	18.7	2.3	1.8
4.7	18.2	7.4	3.3
5.5	18.2	3.5	2.6
7.1	18.4	5.2	2.2
2.4	18.2	27.5	6.1
7.4	18.5	3.7	2.1
8.8	18.7	3.4	1.8
7.2	18.4	3.0	2.2
16.3	19.9	1.4	1.0
Average Enrichment (%) 2.71			

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

3.70257
6.28765
4.17605
2.59231
2.89671
3.82938
14.91147
5.18498
3.90751
14.78243
3.52241
3.23155
3.39191
3.31732
4.61877
3.98426
4.293
3.04086
3.97052

Step 8.4.6 Calculate the dose contribution for the SU by multiplying SOF<sub>MEAN,SU</sub> (including contribution from Re-use backfill and Groundwater) by 25 mrem.

	14.2 mrem
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**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	43	43	
9574-SS-140910-01-02	Reference	1.18	2.179	34	34	
9574-SS-140910-01-03	Reference	1.06	2.064	29	29	
9574-SS-140910-01-04	Reference	1.10	2.101	30	30	
9574-SS-140910-01-05	Reference	1.29	2.293	42	42	
9574-SS-140910-01-07	Reference	1.34	2.339	44	44	
9574-SS-140910-01-08	Reference	1.15	2.154	33	33	
9574-SS-140910-01-09	Reference	1.18	2.182	35	35	
9574-SS-140910-01-10	Reference	1.23	2.227	40	40	
9574-SS-140910-01-11	Reference	1.38	2.380	45	45	
9574-SS-140910-01-12	Reference	1.05	2.055	28	28	
9574-SS-140910-01-13	Reference	0.94	1.941	18	18	
9574-SS-140910-01-14	Reference	1.12	2.119	31	31	
9574-SS-140910-01-15	Reference	1.15	2.152	32	32	
9574-SS-140910-01-16	Reference	1.03	2.028	25	25	
9574-SS-140910-01-17	Reference	0.44	1.443	13	13	
9574-SS-140910-01-18	Reference	1.19	2.188	37	37	
9574-SS-140910-01-20	Reference	0.76	1.757	15	15	
9574-SS-140910-01-21	Reference	1.02	2.023	24	24	
9574-SS-140910-01-22	Reference	1.02	2.018	23	23	
9574-SS-140910-01-23	Reference	1.00	2.002	20	20	
9574-SS-140910-01-24	Reference	0.87	1.873	17	17	
9574-SS-140910-01-25	Reference	1.04	2.040	27	27	
9574-SS-140910-01-26	Reference	0.96	1.959	19	19	
9574-SS-140910-01-27	Reference	1.20	2.204	38	38	
9574-SS-140910-01-28	Reference	1.01	2.007	22	22	
9574-SS-140910-01-29	Reference	1.22	2.223	39	39	
9574-SS-140910-01-30	Reference	1.03	2.035	26	26	
9574-SS-140910-01-31	Reference	1.00	2.005	21	21	
9574-SS-140910-01-32	Reference	0.86	1.865	16	16	
9574-SS-140910-01-33	Reference	1.24	2.238	41	41	
9574-SS-140910-01-34	Reference	1.19	2.185	36	36	
L08-06-01-T-E-S-00	Survey Unit	1.34	1.343	11	0	Step 8.5.1 Min adjusted bkg SOF 1.44
L08-06-02-T-E-S-00	Survey Unit	1.29	1.290	9	0	No WRS test necessary
L08-06-03-T-E-S-00	Survey Unit	1.39	1.389	12	0	No WRS test necessary
L08-06-04-T-E-S-00	Survey Unit	1.30	1.300	10	0	No WRS test necessary
L08-06-05-T-S-S-00	Survey Unit	0.82	0.819	1	0	No WRS test necessary
L08-06-06-T-R-S-00	Survey Unit	1.15	1.149	5	0	No WRS test necessary
L08-06-07-T-E-S-00	Survey Unit	1.23	1.233	6	0	No WRS test necessary
L08-06-08-T-S-S-00	Survey Unit	1.04	1.044	2	0	No WRS test necessary
L08-06-09-T-R-S-00	Survey Unit	1.12	1.120	4	0	No WRS test necessary
L08-06-10-T-E-S-00	Survey Unit	1.27	1.273	8	0	No WRS test necessary
L08-06-11-T-E-S-00	Survey Unit	1.06	1.057	3	0	No WRS test necessary
L08-06-12-T-R-S-00	Survey Unit	1.48	1.485	14	0	Perform WRS test
L08-06-13-T-E-S-00	Survey Unit	1.25	1.250	7	0	No WRS test necessary
<b>Rank Sums</b>				1035	943	W, Step 8.5.3e
<b># Reference Area Measurements</b>				m	32	
<b># Survey Unit Measurements</b>				n	13	
<b>Total Number of Measurements Step 8.5.3c</b>				N	45	
<b>(1-<math>\alpha</math>) percentile of a standard normal distribution (MARSSIM Pg. I-10)</b>				z	1.645	$\alpha = 0.05$
<b>WRS Critical Value (MARSSIM Pg. I-10, Eq. I.1)</b>				CV	802	

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.	0.11
DCGL <sub>SOF</sub>	1
LBGR (Mean)	0.19
Shift	0.81
Relative Shift ( $\Delta/\sigma$ )	7.24
MARSSIM Table 5.1 ( $P_r$ )	1.000000
N	12
N + 20%	14.4
N/2	8
FSS N/2	8
Verification Check	<b>SUFFICIENT MEASUREMENTS</b>
"N/2" Corresponds to the number of survey unit measurement locations required for the WRS Test	

MARSSIM Table 5.1

$\Delta/\sigma$	$P_r$
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,  $\alpha = 0.05$ ,  $\beta = 0.10$

$\alpha$ (or $\beta$ )	$Z_{1-\alpha}$ (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

$\alpha$   
 $\beta$

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-703, Final Status Survey Quality Control										
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**FORM HDP-PR-FSS-703-1  
FIELD DUPLICATE SAMPLE ASSESSMENT**

Survey Unit No.:	LSA 08-06				Survey Unit Description:	Central Open Land Area						
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 <sup>2</sup>	Warning Limit	Control Limit	Statistic Exceeds Limit? (Y/N)
			Activity ( $x_i$ )	MDC	Activity ( $x_i$ )	MDC						
L08-06-06-T-R-S-00	L08-06-06-T-R-Q-00	Ra-226	1.14	0.0642	1.06	0.0811	1.100	1.9	0.08	0.269	0.403	N
L08-06-06-T-R-S-00	L08-06-06-T-R-Q-00	Tc-99	0.179	0.222	0.0315	0.22	0.105	25.1	NA	3.552	5.321	NA
L08-06-06-T-R-S-00	L08-06-06-T-R-Q-00	Th-232	1	0.0783	1.02	0.126	1.010	2.0	0.020	0.283	0.424	N
L08-06-06-T-R-S-00	L08-06-06-T-R-Q-00	U-234 <sup>1</sup>	5.971	N/A	5.197	N/A	5.584	195.4	0.774	27.649	41.425	N
L08-06-06-T-R-S-00	L08-06-06-T-R-Q-00	U-235	0.329	0.211	0.282	0.18	0.306	51.6	0.047	7.301	10.939	N
L08-06-06-T-R-S-00	L08-06-06-T-R-Q-00	U-238	0.874	0.888	2.01	0.729	1.442	168.8	NA	23.885	35.786	NA

Comments:

- U-234 is inferred, no MDC available.
- Duplicate assessment is not necessary if the result of either sample is < MDC.

Performed by: Thomas Yardy \_\_\_\_\_

Reviewed by: Clark Evers \_\_\_\_\_

Date: \_\_\_\_\_

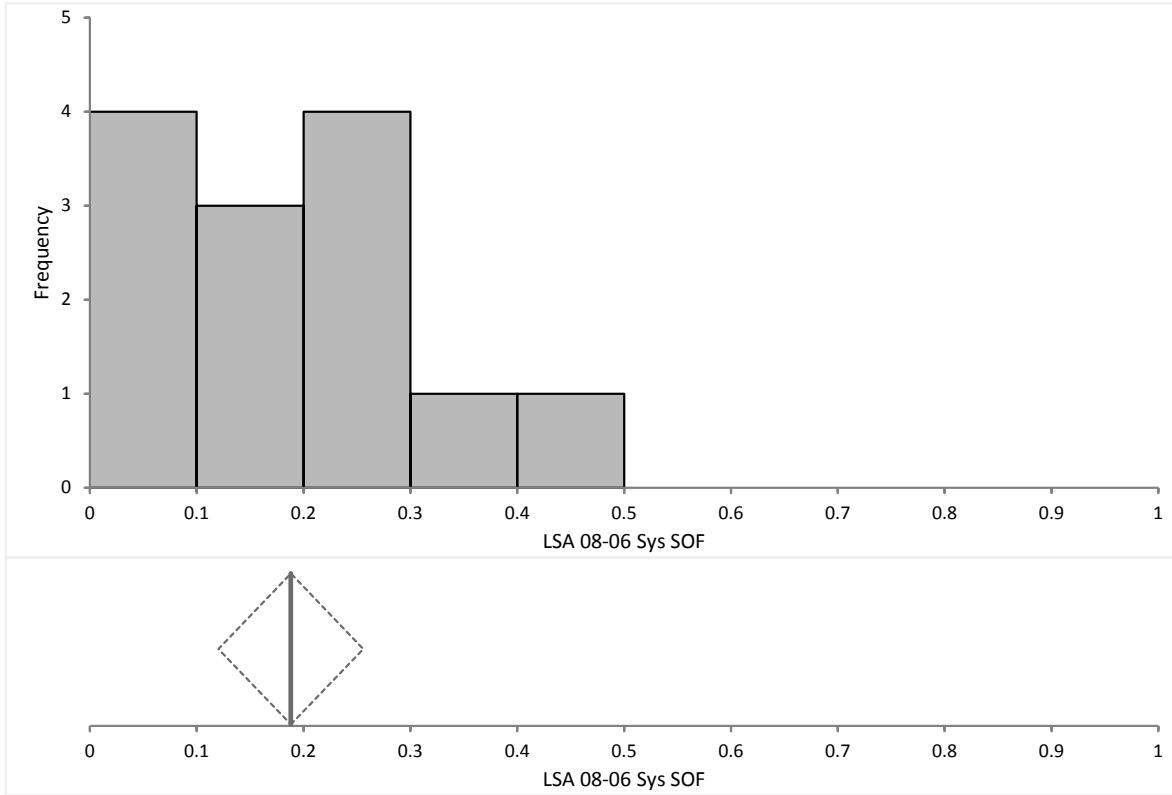
Date: \_\_\_\_\_

Quality Record

LSA 08-06 Sys SOF

0.3  
0.2  
0.3  
0.2  
0.1  
0.1  
0.2  
0.1  
0.1  
0.2  
0.1  
0.4  
0.2

Descriptives



N | 13

	Mean	95% CI	Mean SE	SD	Variance	Skewness	Kurtosis
LSA 08-06 Sys SOF	0.19	0.12 to 0.26	0.031	0.11	0.01	0.6	-0.18
	Minimum	1st quartile	Median	97.75% CI	3rd quartile	Maximum	IQR
LSA 08-06 Sys SOF	0.1	0.08	0.20	0.07 to 0.28	0.25	0.4	0.17