

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 05	Description:	Barns and Cistern Open Land Area
Survey Unit:	02	Description:	Tile Barn Area
Survey Type:	FSS	Classification:	Class I

Measurement or Sample ID	Surface or CSM	Type	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes
L050247PRS00	Uniform	S	437.35	436.7	864784.4	826664.3	Root Zone Composite
L050248PES00	Uniform	S	436.7	436.2	864784.4	826664.3	Excavation 6-in grab
L050249PRS00	Uniform	S	437.56	436.7	864757.5	826637.4	Root Zone Composite
L050250PES00	Uniform	S	436.7	436.2	864757.5	826637.4	Excavation 6-in grab
L050251PRS00	Uniform	S	436.66	432.9	864747.7	826674.1	Root Zone Composite
L050252PES00	Uniform	S	432.9	432.4	864747.7	826674.1	Excavation 6-in grab
L050253PES00	Uniform	S	435.8	430.7	864737.8	826710.8	Excavation 6-in grab
L050254PES00	Uniform	S	436.71	431.9	864720.8	826647.2	Excavation 6-in grab
L050255PES00	Uniform	S	436.08	431.1	864693.9	826620.4	Excavation 6-in grab
L050256PRS00	Uniform	S	436.23	431.8	864684.1	826620.4	Root Zone Composite
L050257PES00	Uniform	S	431.8	431.3	864684.1	826620.4	Excavation 6-in grab
L050258PES00	Uniform	S	437.4	431.4	864684.1	826657.1	Excavation 6-in grab
L050259PRS00	Uniform	S	432.6	431.2	864674.3	826693.8	Root Zone Composite
L050260PES00	Uniform	S	431.2	430.7	864674.3	826693.8	Excavation 6-in grab
L050261PRS00	Uniform	S	436.5	433.7	864667.1	826593.5	Root Zone Composite
L050262PES00	Uniform	S	433.7	433.2	864667.1	826593.5	Excavation 6-in grab
L050263PES00	Uniform	S	436.4	431.0	864657.2	826630.2	Excavation 6-in grab
L050264PRS00	Uniform	S	432.3	428.5	864647.4	826666.9	Root Zone Composite
L050265PES00	Uniform	S	428.5	428.0	864647.4	826666.9	Excavation 6-in grab
L050259PRQ00	Uniform	Q	432.6	431.2	864674.3	826693.8	Root Zone Composite
L050266PUB00	Uniform	B	434.5	434.0	864671.6	826587.6	Biased 6-in grab
L050267PUB00	Uniform	B	434.7	434.2	864678.0	826591.5	Biased 6-in grab
L050268PUB00	Uniform	B	435.6	435.1	864686.1	826593.9	Biased 6-in grab
L050269PUB00	Uniform	B	424.7	424.2	864673.0	826687.5	Biased 6-in 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

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

0.15
0.17
0.17
0.15
0.17
0.18
0.31
0.16
0.15
0.16
0.16
0.14
0.29
0.16
0.14
0.13
0.17
0.27
0.20
0.28
0.13
0.14
0.09
0.14

Step 8.4.1 DCLG_W Measure Tc-99, All SEAs

	Uniform
U-234	195.4
U-235	51.6
U-238	168.8
Tc-99	25.1
Tk-232	2.0
Ra-226	1.9

Step 8.4.5b

weighted SOF _{MEAN}	0.34	
SS	RS	ES
0	0.947368421	0.052631579

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

0.1

← 1 layer of SP2 used in LSA 05-0

Step 8.4.5e SOF_{MEAN} Groundwater

0.16

Step 8.4.5g (←1)

SOF_{MEAN, SU} U.231 PASS

Infer U234 Step 8.3.4			
U-238/U235	U-234/U235	U-234	%
5.0	18.2	6.5	3.0
9.5	18.7	2.7	1.7
8.3	18.6	3.3	1.9
9.3	18.7	2.1	1.7
3.6	18.1	4.2	4.2
8.7	18.7	2.2	1.8
4.6	18.2	4.5	3.3
11.1	19.1	2.9	1.4
12.2	19.2	2.2	1.3
9.0	18.7	2.9	1.8
6.1	18.3	4.0	2.3
13.0	19.4	2.2	1.2
7.5	18.5	4.7	2.1
13.1	19.4	2.0	1.2
7.8	18.5	3.6	2.0
9.9	18.8	3.6	1.6
7.0	18.4	2.8	2.2
5.2	18.2	5.2	2.9
6.1	18.3	5.5	2.5
7.5	18.5	4.2	2.1
24.6	21.1	1.3	0.7
12.7	19.2	3.0	1.3
3.7	18.1	3.6	4.1
4.4	18.1	3.9	3.5
Average Enrichment (%)			2.17

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

4.130748
5.492599
4.741599
6.036235
5.177861
5.879539
10.42083
5.484299
6.149808
5.543566
5.985160
5.984867
12.13992
6.341151
5.59726
4.841626
5.805311
14.73924
7.033161
9.34877
5.816071
5.611699
3.512634
5.022405

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.

14.9 mrem

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	49	49
9574-SS-140910-01-02	Reference	1.18	2.179	40	40
9574-SS-140910-01-03	Reference	1.06	2.064	35	35
9574-SS-140910-01-04	Reference	1.10	2.101	36	36
9574-SS-140910-01-05	Reference	1.29	2.293	48	48
9574-SS-140910-01-07	Reference	1.34	2.339	50	50
9574-SS-140910-01-08	Reference	1.15	2.154	39	39
9574-SS-140910-01-09	Reference	1.18	2.182	41	41
9574-SS-140910-01-10	Reference	1.23	2.227	46	46
9574-SS-140910-01-11	Reference	1.38	2.380	51	51
9574-SS-140910-01-12	Reference	1.05	2.055	34	34
9574-SS-140910-01-13	Reference	0.94	1.941	24	24
9574-SS-140910-01-14	Reference	1.12	2.119	37	37
9574-SS-140910-01-15	Reference	1.15	2.152	38	38
9574-SS-140910-01-16	Reference	1.03	2.028	31	31
9574-SS-140910-01-17	Reference	0.44	1.443	15	15
9574-SS-140910-01-18	Reference	1.19	2.188	43	43
9574-SS-140910-01-20	Reference	0.76	1.757	21	21
9574-SS-140910-01-21	Reference	1.02	2.023	30	30
9574-SS-140910-01-22	Reference	1.02	2.018	29	29
9574-SS-140910-01-23	Reference	1.00	2.002	26	26
9574-SS-140910-01-24	Reference	0.87	1.873	23	23
9574-SS-140910-01-25	Reference	1.04	2.040	33	33
9574-SS-140910-01-26	Reference	0.96	1.959	25	25
9574-SS-140910-01-27	Reference	1.20	2.204	44	44
9574-SS-140910-01-28	Reference	1.01	2.007	28	28
9574-SS-140910-01-29	Reference	1.22	2.223	45	45
9574-SS-140910-01-30	Reference	1.03	2.035	32	32
9574-SS-140910-01-31	Reference	1.00	2.005	27	27
9574-SS-140910-01-32	Reference	0.86	1.865	22	22
9574-SS-140910-01-33	Reference	1.24	2.238	47	47
9574-SS-140910-01-34	Reference	1.19	2.185	42	42
L050247PRS00	Survey Unit	1.26	1.263	2	0
L050248PES00	Survey Unit	1.28	1.275	3	0
L050249PRS00	Survey Unit	1.26	1.256	1	0
L050250PES00	Survey Unit	1.31	1.313	5	0
L050251PRS00	Survey Unit	1.49	1.487	16	0
L050252PES00	Survey Unit	1.42	1.421	12	0
L050253PES00	Survey Unit	1.38	1.383	9	0
L050254PES00	Survey Unit	1.34	1.337	7	0
L050255PES00	Survey Unit	1.42	1.424	13	0
L050256PRS00	Survey Unit	1.51	1.507	18	0
L050257PES00	Survey Unit	1.43	1.435	14	0
L050258PES00	Survey Unit	1.39	1.386	10	0
L050259PRS00	Survey Unit	1.31	1.308	4	0
L050260PES00	Survey Unit	1.50	1.502	17	0
L050261PRS00	Survey Unit	1.33	1.334	6	0
L050262PES00	Survey Unit	1.39	1.386	11	0
L050263PES00	Survey Unit	1.36	1.363	8	0
L050264PRS00	Survey Unit	1.68	1.678	20	0
L050265PES00	Survey Unit	1.54	1.536	19	0
Rank Sums				1326	1131
# Reference Area Measurements				m	32
# Survey Unit Measurements				n	19
Total Number of Measurements Step 8.5.3c				N	51
(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	917

Step 8.5.1
Min adjusted bkg SOF
1.44

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

W_r Step 8.5.3e

$\alpha = 0.05$

TEST: **PASS**

Step 8.5.3f

HDP-PR-FSS-701 Final Status Survey Plan Development
Appendix P-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 _{SOF}	1
LBGR (Mean)	0.34
Shift	0.66
Relative Shift (Δ/σ)	6.16
MARSSIM Table 5.1 (P_r)	1.000000
N	12
N + 20%	14.4
N/2	8
FSS N/2	12
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		
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**FORM HDP-PR-FSS-703-1
FIELD DUPLICATE SAMPLE ASSESSMENT**

Survey Unit No.:	LSA 05-02				Survey Unit Description:	Tile Barn 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 ²	Warning Limit	Control Limit	Statistic Exceeds Limit? (Y/N)
			Activity (x_i)	MDC	Activity (x_i)	MDC						
L050259PRS00	L050259PRQ00	Ra-226	1.29	0.2	1.46	0.159	1.375	1.9	0.17	0.269	0.403	N
L050259PRS00	L050259PRQ00	Tc-99	0.096	0.245	0.112	0.229	0.104	25.1	NA	3.552	5.321	NA
L050259PRS00	L050259PRQ00	Th-232	1.17	0.298	1.22	0.312	1.195	2.0	0.050	0.283	0.424	N
L050259PRS00	L050259PRQ00	U-234 ¹	4.730	N/A	4.231	N/A	4.481	195.4	0.499	27.649	41.425	N
L050259PRS00	L050259PRQ00	U-235	0.26	0.657	0.23	0.506	0.243	51.6	NA	7.301	10.939	NA
L050259PRS00	L050259PRQ00	U-238	1.91	2.28	1.72	3.08	1.815	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.

Performed by: Thomas Yardy _____

Reviewed by: Clark Evers _____

Date: _____

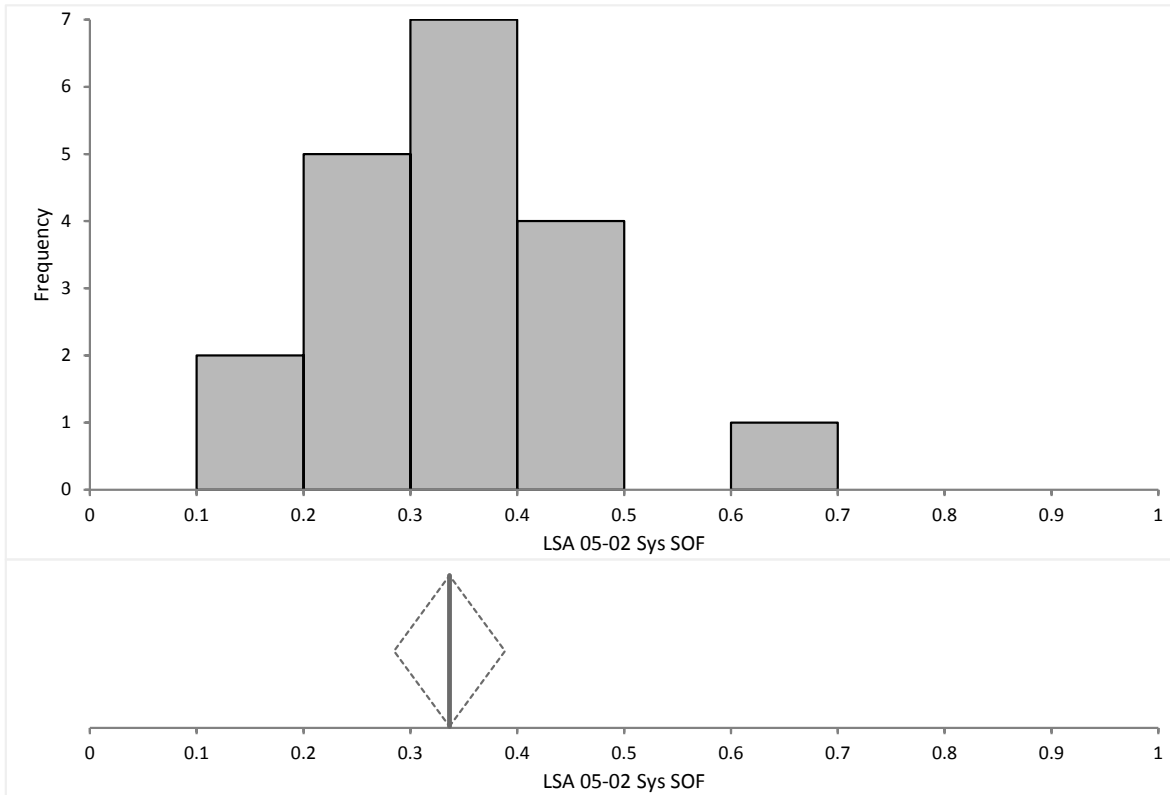
Date: _____

Quality Record

LSA 05-02 Sys SOF

0.2
0.2
0.2
0.2
0.4
0.4
0.3
0.3
0.4
0.4
0.4
0.4
0.3
0.2
0.4
0.3
0.3
0.3
0.6
0.5

Descriptives



N | 19

	Mean	95% CI	Mean SE	SD	Variance	Skewness	Kurtosis
LSA 05-02 Sys SOF	0.34	0.28 to 0.39	0.025	0.11	0.01	0.9	0.93
	Minimum	1st quartile	Median	98.08% CI	3rd quartile	Maximum	IQR
LSA 05-02 Sys SOF	0.2	0.25	0.32	0.25 to 0.42	0.42	0.6	0.16