

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development		
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APPENDIX P-4

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area:	LSA 04	Description:	Plant Soils SEA Open Land Area
Survey Unit:	02	Description:	Central Open Land Area
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
L04-02-01-P-S-S-00	Uniform	S	430.4	429.9	864507.4	826736.8	Surface 6-inch grab
L04-02-02-P-R-S-00	Uniform	S	429.91	425.5	864507.4	826736.8	Root 4.4-ft composite
L04-02-04-P-S-S-00	Uniform	S	431.4	430.9	864507.4	826793.2	Surface 6-inch grab
L04-02-05-P-R-S-00	Uniform	S	430.91	426.5	864507.4	826793.2	Root 4.4-ft composite
L04-02-07-P-S-S-00	Uniform	S	431.8	431.3	864458.5	826765.0	Surface 6-inch grab
L04-02-08-P-R-S-00	Uniform	S	431.31	426.9	864458.5	826765.0	Root 4.4-ft composite
L04-02-10-P-S-S-00	Uniform	S	432.2	431.7	864458.5	826821.4	Surface 6-inch grab
L04-02-11-P-R-S-00	Uniform	S	431.71	427.3	864458.5	826821.4	Root 4.4-ft composite
L04-02-13-P-S-S-00	Uniform	S	432	431.5	864409.7	826793.2	Surface 6-inch grab
L04-02-14-P-R-S-00	Uniform	S	431.5	427.1	864409.7	826793.2	Root 4.4-ft composite
L04-02-16-P-S-S-00	Uniform	S	432.7	432.2	864409.7	826849.6	Surface 6-inch grab
L04-02-17-P-R-S-00	Uniform	S	432.2	427.8	864409.7	826849.6	Root 4.4-ft composite
L04-02-19-P-S-S-00	Uniform	S	431.8	431.3	864360.8	826821.4	Surface 6-inch grab
L04-02-20-P-R-S-00	Uniform	S	431.3	426.9	864360.8	826821.4	Root 4.4-ft composite
L04-02-22-P-S-S-00	Uniform	S	429.1	428.6	864311.9	826793.2	Surface 6-inch grab
L04-02-23-P-R-S-00	Uniform	S	428.6	424.2	864311.9	826793.2	Root 4.4-ft composite
L04-02-01-P-S-Q-00	Uniform	Q	430.4	429.9	864507.4	826736.8	Surface 6-inch grab
L04-02-16-P-S-Q-00	Uniform	Q	432.7	432.2	864409.7	826849.6	Surface 6-inch grab
L04-02-25-P-S-B-00	Uniform	B	431.8	431.3	864441.9	826761.2	Sidewall 6-inch grab
L04-02-26-P-S-B-00	Uniform	B	431.8	431.3	864362.1	826802.8	Biased 6-inch grab
L04-02-27-P-S-B-00	Uniform	B	430.4	429.9	864481.9	826733.1	Biased 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

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)

Evaluate Final Status Survey Data: LSA-04-02

Sample ID	Sample Depth (ft)	Type (Systematic, Bias, QC)	TestAmerica Analytical Results Step 8.3.2																													
			Ra-226						Tc-99					Th-232						Inferred U-234				U-235				U-238				
			Result	Uncertainty	MDC	Qualifier	Net Result*	Corrected Result	Result	Corrected Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Net Result**	Corrected Result	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Result
L04-02-01-P-S-S-00	0.00	S	0.837	0.134	0.068	N/A	-0.233	0.000	0.493	0.493	0.085	0.223	N/A	0.888	0.167	0.097	N/A	-0.112	0.000	9.912	NA	NA	NA	0.547	0.171	0.208	N/A	2.230	0.584	0.790	N/A	
L04-02-02-P-R-S-00	0.50	S	1.000	0.149	0.063	N/A	-0.070	0.000	0.213	0.213	0.061	0.237	U	1.050	0.163	0.094	N/A	0.050	0.050	5.083	NA	NA	NA	0.280	0.172	0.219	N/A	1.310	0.563	0.861	N/A	
L04-02-04-P-S-S-00	0.00	S	0.953	0.133	0.057	N/A	-0.117	0.000	0.818	0.818	0.159	0.212	N/A	1.190	0.173	0.132	N/A	0.190	0.190	2.138	NA	NA	NA	0.115	0.146	0.257	U	0.932	0.317	0.915	N/A	
L04-02-05-P-R-S-00	0.50	S	1.190	0.160	0.068	N/A	0.120	0.120	0.089	0.089	0.076	0.222	U	1.300	0.202	0.132	N/A	0.300	0.300	2.706	NA	NA	NA	0.146	0.139	0.240	U	1.150	0.515	0.799	N/A	
L04-02-07-P-S-S-00	0.00	S	0.859	0.131	0.067	N/A	-0.211	0.000	1.050	1.050	0.206	0.225	N/A	0.997	0.150	0.098	N/A	-0.003	0.000	4.851	NA	NA	NA	0.267	0.152	0.196	N/A	1.260	0.348	0.813	N/A	
L04-02-08-P-R-S-00	0.50	S	0.904	0.140	0.052	N/A	-0.166	0.000	0.113	0.113	0.051	0.228	U	0.778	0.164	0.087	N/A	-0.222	0.000	5.359	NA	NA	NA	0.296	0.164	0.189	N/A	0.989	0.300	0.792	N/A	
L04-02-10-P-S-S-00	0.00	S	0.466	0.086	0.056	N/A	-0.604	0.000	0.204	0.204	0.046	0.211	U	0.606	0.109	0.067	N/A	-0.394	0.000	3.009	NA	NA	NA	0.164	0.102	0.141	N/A	1.050	0.379	0.558	N/A	
L04-02-11-P-R-S-00	0.50	S	0.996	0.149	0.067	N/A	-0.074	0.000	0.026	0.026	0.018	0.231	U	1.080	0.162	0.124	N/A	0.080	0.080	1.543	NA	NA	NA	0.080	0.134	0.224	U	0.995	0.516	0.805	N/A	
L04-02-13-P-S-S-00	0.00	S	0.975	0.132	0.052	N/A	-0.095	0.000	1.820	1.820	0.173	0.206	N/A	1.090	0.170	0.077	N/A	0.090	0.090	4.363	NA	NA	NA	0.240	0.155	0.224	N/A	1.170	0.293	0.752	N/A	
L04-02-14-P-R-S-00	0.50	S	1.050	0.149	0.066	N/A	-0.020	0.000	0.025	0.025	0.046	0.223	U	1.040	0.151	0.114	N/A	0.040	0.040	2.053	NA	NA	NA	0.109	0.123	0.223	U	1.100	0.501	0.778	N/A	
L04-02-16-P-S-S-00	0.00	S	0.979	0.152	0.075	N/A	-0.091	0.000	0.482	0.482	0.131	0.209	N/A	1.040	0.187	0.159	N/A	0.040	0.040	1.584	NA	NA	NA	0.080	0.143	0.264	U	1.270	0.545	0.829	N/A	
L04-02-17-P-R-S-00	0.50	S	1.170	0.169	0.080	N/A	0.100	0.100	0.090	0.090	0.067	0.226	U	1.050	0.194	0.103	N/A	0.050	0.050	0.746	NA	NA	NA	0.033	0.140	0.235	U	1.100	0.507	0.780	N/A	
L04-02-19-P-S-S-00	0.00	S	0.932	0.127	0.048	N/A	-0.138	0.000	1.310	1.310	0.150	0.217	N/A	1.100	0.170	0.102	N/A	0.100	0.100	5.056	NA	NA	NA	0.279	0.143	0.171	N/A	1.140	0.300	0.712	N/A	
L04-02-20-P-R-S-00	0.50	S	1.100	0.162	0.079	N/A	0.030	0.030	0.069	0.069	0.077	0.224	U	1.110	0.165	0.098	N/A	0.110	0.110	1.529	NA	NA	NA	0.078	0.133	0.213	U	1.100	0.529	0.828	N/A	
L04-02-22-P-S-S-00	0.00	S	1.150	0.171	0.071	N/A	0.080	0.080	3.130	3.130	0.331	0.218	N/A	1.180	0.189	0.144	N/A	0.180	0.180	8.545	NA	NA	NA	0.472	0.177	0.285	N/A	1.600	0.383	0.936	N/A	
L04-02-23-P-R-S-00	0.50	S	1.150	0.156	0.062	N/A	0.080	0.080	0.020	0.020	0.007	0.223	U	1.190	0.175	0.101	N/A	0.190	0.190	1.926	NA	NA	NA	0.101	0.141	0.238	U	1.190	0.498	0.761	N/A	
L04-02-01-P-S-Q-00	0.00	Q	0.980	0.141	0.066	N/A	-0.090	0.000	0.523	0.523	0.155	0.217	N/A	0.993	0.150	0.108	N/A	-0.007	0.000	10.645	NA	NA	NA	0.585	0.147	0.175	N/A	2.950	0.780	0.846	N/A	
L04-02-16-P-S-Q-00	0.00	Q	0.969	0.130	0.048	N/A	-0.101	0.000	0.467	0.467	0.062	0.205	N/A	0.890	0.136	0.097	N/A	-0.110	0.000	3.299	NA	NA	NA	0.182	0.121	0.162	N/A	0.759	0.269	0.713	N/A	
L04-02-25-P-S-B-00	0.00	B	1.070	0.148	0.060	N/A	0.000	0.000	0.848	0.848	0.126	0.200	N/A	0.970	0.166	0.088	N/A	-0.030	0.000	6.293	NA	NA	NA	0.347	0.149	0.169	N/A	1.520	0.497	0.718	N/A	
L04-02-26-P-S-B-00	0.00	B	1.320	0.198	0.080	N/A	0.250	0.250	0.324	0.324	0.068	0.225	N/A	1.190	0.193	0.144	N/A	0.190	0.190	3.206	NA	NA	NA	0.176	0.195	0.242	U	0.924	0.396	1.060	U	
L04-02-27-P-S-B-00	0.00	B	1.140	0.150	0.054	N/A	0.070	0.070	7.060	7.060	0.695	0.207	N/A	1.150	0.158	0.083	N/A	0.150	0.150	51.285	NA	NA	NA	2.830	0.375	0.272	N/A	8.210	1.410	1.200	N/A	
Systematic Minimum					0.000					0.020									0.000		0.746					0.033				0.932		
Systematic Maximum					0.120					3.130									0.300		9.912					0.547				2.230		
Systematic Mean					0.028					0.622									0.089		3.775					0.205				1.224		
Systematic Median					0.000					0.209									0.065		2.857					0.155				1.145		
Systematic Standard Deviation					0.043					0.857									0.087		2.615					0.147				0.311		
Step 8.3.3																																
Step 8.4.2									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.

Ave Conc. Ra-226, SS	Ave Conc. Tc-99, SS	Ave Conc. Th-232, SS	Ave Conc. U-234, SS	Ave Conc. U-235, SS	Ave Conc. U-238, SS
0.000	0.493	0.000	9.912	0.547	2.230
-	-	-	-	-	-
0.000	0.818	0.190	2.138	0.115	0.932
-	-	-	-	-	-
0.000	1.050	0.000	4.851	0.267	1.260
0.000	0.204	0.000	3.009	0.164	1.050
-	-	-	-	-	-
0.000	1.820	0.090	4.363	0.240	1.170
-	-	-	-	-	-
0.000	0.482	0.040	1.584	0.080	1.270
-	-	-	-	-	-
0.000	1.310	0.100	5.056	0.279	1.140
-	-	-	-	-	-
0.080	3.130	0.180	8.545	0.472	1.600
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
0.010	1.163	0.075	4.932	0.270	1.332

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)

Infer U234 Step 8.3.4			
U-238/U235	U-234/U235	U-234	%
4.1	18.1	9.9	3.7
4.7	18.2	5.1	3.3
8.1	18.6	2.1	1.9
7.9	18.5	2.7	2.0
4.7	18.2	4.9	3.2
3.3	18.1	5.4	4.5
6.4	18.3	3.0	2.4
12.4	19.2	1.5	1.3
4.9	18.2	4.4	3.1
10.1	18.8	2.1	1.6
15.9	19.9	1.6	1.0
33.5	22.7	0.7	0.5
4.1	18.1	5.1	3.7
14.1	19.6	1.5	1.1
3.4	18.1	8.5	4.4
11.8	19.1	1.9	1.4
5.0	18.2	10.6	3.0
4.2	18.1	3.3	3.6
4.4	18.1	6.3	3.5
5.3	18.2	3.2	2.9
2.9	18.1	51.3	5.1
Average Enrichment (%)			2.72

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

3.769137
3.975891
4.778788
4.447788
3.560735
3.421787
2.587217
4.304865
4.072561
4.2011
5.241216
5.341636
3.098666
4.174821
5.159608
4.539009
3.184497
2.936624
3.064821
4.40812
4.929133

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)

Ave Conc. Ra-226, RS	Ave Conc. Tc-99, RS	Ave Conc. Th-232, RS	Ave Conc. U-234, RS	Ave Conc. U-235, RS	Ave Conc. U-238, RS
-	-	-	-	-	-
0.000	0.213	0.050	5.083	0.280	1.310
-	-	-	-	-	-
0.120	0.089	0.300	2.706	0.146	1.150
-	-	-	-	-	-
0.000	0.113	0.000	5.359	0.296	0.989
-	-	-	-	-	-
0.000	0.026	0.080	1.543	0.080	0.995
-	-	-	-	-	-
0.000	0.025	0.040	2.053	0.109	1.100
-	-	-	-	-	-
0.100	0.090	0.050	0.746	0.033	1.100
-	-	-	-	-	-
0.030	0.069	0.110	1.529	0.078	1.100
-	-	-	-	-	-
0.080	0.020	0.190	1.926	0.101	1.190
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
0.041	0.081	0.103	2.618	0.140	1.117
Ave Conc. Ra-226, ES	Ave Conc. Tc-99, ES	Ave Conc. Th-232, ES	Ave Conc. U-234, ES	Ave Conc. U-235, ES	Ave Conc. U-238, ES
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
0.000	0.000	0.000	0.000	0.000	0.000

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.	0.08
DCGL _{SOF}	1
LBGR (Mean)	0.11
Shift	0.89
Relative Shift (Δ/σ)	11.39
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

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

Survey Unit No.:	LSA 04-02				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 ²	Warning Limit	Control Limit	Statistic Exceeds Limit? (Y/N)
			Activity (x_i)	MDC	Activity (x_i)	MDC						
L04-02-01-P-S-S-00	L04-02-01-P-S-Q-00	Ra-226	0.837	0.0681	0.98	0.0655	0.909	1.9	0.143	0.269	0.403	N
L04-02-01-P-S-S-00	L04-02-01-P-S-Q-00	Tc-99	0.493	0.223	0.523	0.217	0.508	25.1	0.03	3.552	5.321	N
L04-02-01-P-S-S-00	L04-02-01-P-S-Q-00	Th-232	0.888	0.0974	0.993	0.108	0.941	2.0	0.105	0.283	0.424	N
L04-02-01-P-S-S-00	L04-02-01-P-S-Q-00	U-234 ¹	9.912	N/A	10.645	N/A	10.279	195.4	0.733	27.649	41.425	N
L04-02-01-P-S-S-00	L04-02-01-P-S-Q-00	U-235	0.547	0.208	0.585	0.175	0.566	51.6	0.038	7.301	10.939	N
L04-02-01-P-S-S-00	L04-02-01-P-S-Q-00	U-238	2.23	0.79	2.95	0.846	2.590	168.8	0.720	23.885	35.786	N

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

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

Survey Unit No.:		LSA 04-02					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 ²	Warning Limit	Control Limit	Statistic Exceeds Limit? (Y/N)	
			Activity (x_i)	MDC	Activity (x_i)	MDC							
L04-02-16-P-S-S-00	L04-02-16-P-S-Q-00	Ra-226	0.979	0.0747	0.969	0.0476	0.974	1.9	0.01	0.269	0.403	N	
L04-02-16-P-S-S-00	L04-02-16-P-S-Q-00	Tc-99	0.482	0.209	0.467	0.205	0.475	25.1	0.015	3.552	5.321	N	
L04-02-16-P-S-S-00	L04-02-16-P-S-Q-00	Th-232	1.04	0.159	0.89	0.0971	0.965	2.0	0.150	0.283	0.424	N	
L04-02-16-P-S-S-00	L04-02-16-P-S-Q-00	U-234 ¹	1.584	N/A	3.299	N/A	2.442	195.4	1.715	27.649	41.425	N	
L04-02-16-P-S-S-00	L04-02-16-P-S-Q-00	U-235	0.0798	0.264	0.182	0.162	0.131	51.6	NA	7.301	10.939	NA	
L04-02-16-P-S-S-00	L04-02-16-P-S-Q-00	U-238	1.27	0.829	0.759	0.713	1.015	168.8	0.511	23.885	35.786	N	

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: _____

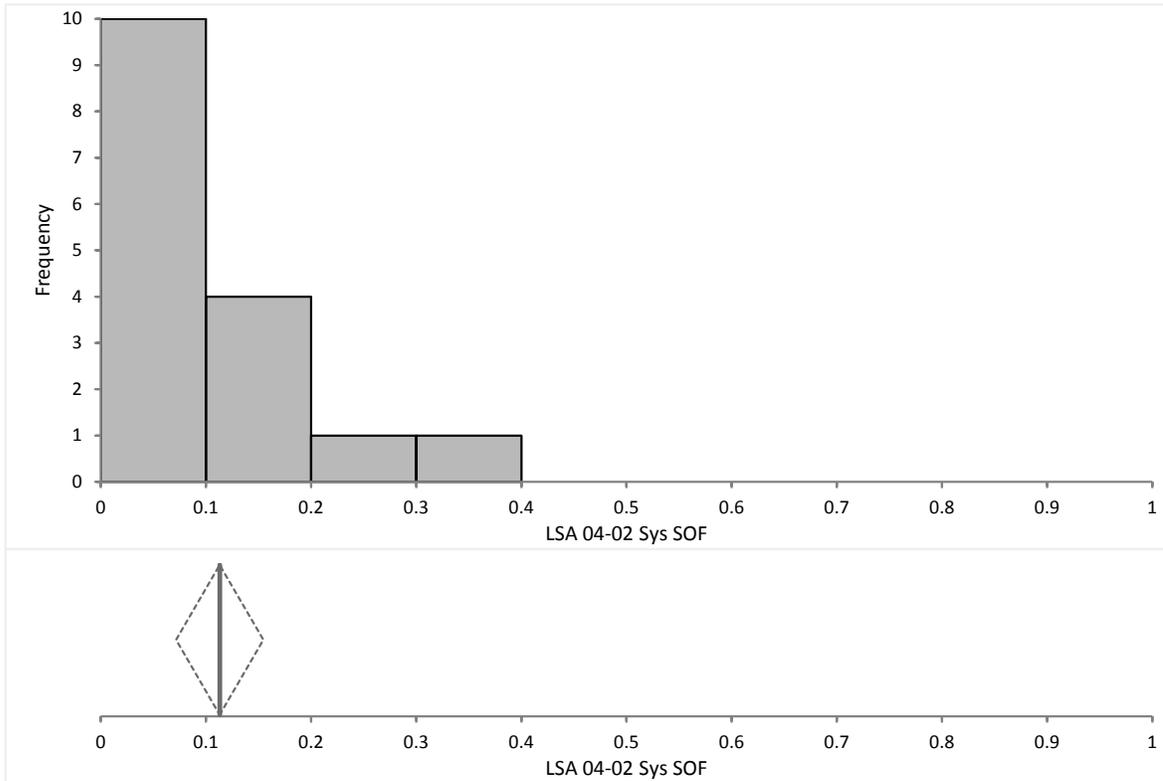
Date: _____

Quality Record

LSA 04-02 Sys SOF

0.1
0.1
0.1
0.2
0.1
0.0
0.0
0.1
0.2
0.0
0.1
0.1
0.1
0.1
0.1
0.3
0.2

Descriptives



N	16						
LSA 04-02 Sys SOF	Mean	95% CI	Mean SE	SD	Variance	Skewness	Kurtosis
	0.11	0.07 to 0.15	0.019	0.08	0.01	1.5	2.21
LSA 04-02 Sys SOF	Minimum	1st quartile	Median	97.87% CI	3rd quartile	Maximum	IQR
	0.03	0.06	0.09	0.06 to 0.15	0.15	0.3	0.09