

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development		
	Westinghouse Non-Proprietary Class 3	Revision: 5	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:	14	Description:	Southern Survey Unit in "Area 2"
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
L10-14-01-B-E-S-00	Uniform	S	428.3	427.8	865031.9	827571.0	Excavation 6-inch grab
L10-14-02-B-E-S-00	Uniform	S	420.6	420.2	864986.9	827544.9	Excavation 6-inch grab
L10-14-03-B-E-S-00	Uniform	S	423.5	423.0	864986.9	827597.1	Excavation 6-inch grab
L10-14-04-B-E-S-00	Uniform	S	426.1	425.6	864942.0	827571.0	Excavation 6-inch grab
L10-14-05-B-E-S-00	Uniform	S	415.7	415.2	864942.0	827623.2	Excavation 6-inch grab
L10-14-06-B-E-S-00	Uniform	S	416.9	416.4	864942.0	827675.3	Excavation 6-inch grab
L10-14-07-B-E-S-00	Uniform	S	423.9	423.4	864897.1	827649.2	Excavation 6-inch grab
L10-14-08-B-R-S-00	Uniform	S	429.9	429.0	864897.1	827701.4	Root 4.6-inch composite
L10-14-09-B-E-S-00	Uniform	S	429.0	428.5	864897.1	827701.4	Excavation 6-inch grab
L10-14-06-B-E-Q-00	Uniform	Q	416.9	416.4	864942.0	827675.3	Excavation 6-inch grab
L10-14-10-B-E-B-00	Uniform	B	434.6	423.4	864909.0	827633.0	Biased 6-inch grab
L10-14-11-B-E-B-00	Uniform	B	434.7	417.3	864936.0	827593.0	Biased 6-inch grab
L10-14-12-B-E-B-00	Uniform	B	434.0	419.7	864979.0	827594.0	Biased 6-inch grab
L10-14-13-B-E-B-00	Uniform	B	432.9	432.4	864982.7	827605.3	Sidewall 6-inch grab
L10-14-14-B-E-B-00	Uniform	B	433.5	433.0	864926.1	827642.9	Sidewall 6-inch grab

Green shaded samples are the topmost 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
Preliminary Data Review and Calculation of the Sum-of-Fractions (SOF)

Sample ID	Sample Start Depth (ft)	Type (Systematic, Bias, QC)	TestAmerica Analytical Results																				
			Ra-226						Tc-99					Th-232					Inferred U-234				
			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
L10-14-01-B-E-S-00	5.07	S	0.841	0.135	0.074	NA	-0.229	0.000	-0.022	0.000	0.058	0.227	U	1.130	0.192	0.087	NA	0.130	0.130	2.064	NA	NA	NA
L10-14-02-B-E-S-00	13.74	S	1.230	0.175	0.072	NA	0.160	0.160	0.241	0.241	0.086	0.260	U	1.190	0.198	0.127	NA	0.190	0.190	1.644	NA	NA	NA
L10-14-03-B-E-S-00	10.28	S	1.170	0.154	0.084	NA	0.100	0.100	0.084	0.084	0.047	0.222	U	1.270	0.176	0.115	NA	0.270	0.270	0.373	NA	NA	NA
L10-14-04-B-E-S-00	8.72	S	0.865	0.134	0.069	NA	-0.205	0.000	0.205	0.205	0.026	0.216	U	1.040	0.166	0.106	NA	0.040	0.040	2.095	NA	NA	NA
L10-14-05-B-E-S-00	18.49	S	0.889	0.162	0.099	NA	-0.181	0.000	0.198	0.198	0.039	0.204	U	1.150	0.212	0.157	NA	0.150	0.150	2.582	NA	NA	NA
L10-14-06-B-E-S-00	16.71	S	1.080	0.157	0.076	NA	0.010	0.010	-0.016	0.000	0.054	0.244	U	1.230	0.182	0.132	NA	0.230	0.230	1.960	NA	NA	NA
L10-14-07-B-E-S-00	10.61	S	1.020	0.147	0.073	NA	-0.050	0.000	0.105	0.105	0.075	0.226	U	1.320	0.192	0.095	NA	0.320	0.320	4.378	NA	NA	NA
L10-14-08-B-R-S-00	4.04	S	1.160	0.184	0.094	NA	0.090	0.090	-0.035	0.000	0.012	0.197	U	1.050	0.170	0.141	NA	0.050	0.050	1.872	NA	NA	NA
L10-14-09-B-E-S-00	4.92	S	1.020	0.168	0.093	NA	-0.050	0.000	-0.010	0.000	0.041	0.203	U	1.120	0.221	0.134	NA	0.120	0.120	2.176	NA	NA	NA
L10-14-06-B-E-Q-00	16.71	Q	1.100	0.151	0.067	NA	0.030	0.030	-0.033	0.000	0.072	0.243	U	1.150	0.183	0.107	NA	0.150	0.150	2.747	NA	NA	NA
L10-14-10-B-E-B-00	11.19	B	1.250	0.172	0.073	NA	0.180	0.180	0.011	0.011	0.041	0.243	U	1.050	0.165	0.086	NA	0.050	0.050	28.580	NA	NA	NA
L10-14-11-B-E-B-00	17.36	B	1.020	0.167	0.091	NA	-0.050	0.000	1.430	1.430	0.374	0.262	NA	1.090	0.190	0.133	NA	0.090	0.090	1.816	NA	NA	NA
L10-14-12-B-E-B-00	14.25	B	1.390	0.177	0.058	NA	0.320	0.320	0.148	0.148	0.042	0.245	U	1.160	0.171	0.126	NA	0.160	0.160	1.520	NA	NA	NA
L10-14-13-B-E-B-00	15.91	B	1.250	0.274	0.190	NA	0.180	0.180	0.286	0.286	0.051	0.240	NA	1.260	0.341	0.153	NA	0.260	0.260	3.130	NA	NA	NA
L10-14-14-B-E-B-00	13.62	B	1.640	0.311	0.192	NA	0.570	0.570	0.281	0.281	0.093	0.240	NA	1.530	0.347	0.285	NA	0.530	0.530	1.080	NA	NA	NA
Systematic Minimum			0.000						0.000					0.040					0.373				
Systematic Maximum			0.160						0.241					0.320					4.378				
Systematic Mean			0.040						0.093					0.167					2.127				
Systematic Median			0.000						0.084					0.150					2.064				
Systematic Standard Deviation			0.061						0.100					0.095					1.042				
			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.

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

U-235				U-238			
Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier
0.111	0.150	0.228	U	0.924	0.293	0.774	NA
0.084	0.163	0.272	U	1.230	0.568	0.878	NA
0.014	0.061	0.254	U	0.975	0.289	0.790	NA
0.109	0.128	0.248	U	1.350	0.534	0.803	NA
0.141	0.187	0.289	U	0.891	0.349	0.954	U
0.102	0.153	0.253	U	1.220	0.512	0.783	NA
0.241	0.120	0.191	NA	1.160	0.309	0.799	NA
0.101	0.156	0.254	U	0.809	0.307	0.841	U
0.111	0.157	0.302	U	1.570	0.925	1.080	NA
0.150	0.143	0.251	U	0.937	0.306	0.868	NA
1.470	0.285	0.290	NA	1.200	0.521	0.801	NA
0.097	0.155	0.286	U	0.843	0.359	1.220	U
0.080	0.133	0.228	U	0.892	0.514	0.819	NA
0.172	0.353	0.595	U	0.886	0.809	2.670	U
0.048	0.113	0.874	U	1.640	1.910	3.220	U
	0.014				0.809		
	0.241				1.570		
	0.113				1.125		
	0.109				1.160		
	0.059				0.247		

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

Use corrected net results for all DE calcs.

Sample ID	Sample Start Depth (ft)	Type (Systematic, Bias, QC)	Enr.	SOF _N	Root Stratum SOF Verification (unexcavated/not backfilled only)						
			Enrichment (%)	SOF _N	Is Sample in the Root Stratum?	Is ROOT Sample SOF > 0.5?	root count	excavation count	surface count		
L10-14-01-B-E-S-00	5.069	S	1.9	0.08	EXCAVATION	good			1		
L10-14-02-B-E-S-00	13.74	S	1.1	0.21	EXCAVATION	good			1		
L10-14-03-B-E-S-00	10.28	S	0.3	0.20	EXCAVATION	good			1		
L10-14-04-B-E-S-00	8.724	S	1.3	0.05	EXCAVATION	good			1		
L10-14-05-B-E-S-00	18.49	S	2.5	0.10	EXCAVATION	good			1		
L10-14-06-B-E-S-00	16.71	S	1.3	0.14	EXCAVATION	good			1		
L10-14-07-B-E-S-00	10.61	S	3.2	0.20	EXCAVATION	good			1		
L10-14-08-B-R-S-00	4.044	S	2.0	0.09	ROOT	good	1				
L10-14-09-B-E-S-00	4.92	S	1.1	0.08	EXCAVATION	good			1		
L10-14-06-B-E-Q-00	16.7	Q	2.5	0.11		good					
L10-14-10-B-E-B-00	11.19	B	16.0	0.30		good					
L10-14-11-B-E-B-00	17.36	B	1.8	0.12		good					
L10-14-12-B-E-B-00	14.25	B	1.4	0.27		good					
L10-14-13-B-E-B-00	15.91	B	3.0	0.26		good					
L10-14-14-B-E-B-00	13.62	B	0.5	0.59		good					
			1.6	0.05							
			Average Enrichment (%)	0.21				9	1	8	0
				0.13				count tot			
				0.10							
				0.10							
				0.06							

MDC SOF
0.12
0.15
0.15
0.13
0.18
0.15
0.12
0.16
0.17
0.13
0.13
0.16
0.13
0.27
0.39

weighted SOF_{MEAN} 0.13

SS

fractions

SOF_{MEAN} Re-use B

SOF_{MEAN} Groundw

SOF_{TOT} <=1

SOF_{MEAN}, SU

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

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

DCLG_w, Measure Tc-99, All SEAs

	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

RS ES

0.111111111	0.88889
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backfill Material
Stockpile 1&2

water

Infer U234 Step 8.3.4			
U-238/U235	U-234/U235	U-234	%
8.3	18.6	2.1	1.9
14.7	19.6	1.6	1.1
69.6	26.6	0.4	0.3
12.4	19.2	2.1	1.3
6.3	18.3	2.6	2.5
12.0	19.2	2.0	1.3
4.8	18.2	4.4	3.2
8.0	18.5	1.9	2.0
14.1	19.6	2.2	1.1
6.2	18.3	2.7	2.5
0.8	19.4	28.6	16.0
8.7	18.7	1.8	1.8
11.2	19.1	1.5	1.4
5.2	18.2	3.1	3.0
34.5	22.7	1.1	0.5
Average Enrichment (%)			1.63

Infer U-234 MDC using U- 235 MDC * ratio of U-234:U-235 @ that sample's enrichment
4.239547488
5.331227359
6.766598719
4.766100926
5.29318659
4.86219167
3.4698995
4.707242793
5.919230376
4.597196658
5.6381499
5.338248405
4.348294676
10.82729146
19.86633803

0.39	PASS
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Grouted pipe dose to be added if applicable.

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

Ave Conc. Ra-226, SS	Ave Conc. Tc-99, SS	Ave Conc. Th-232, SS	Ave Conc. U-234, SS
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
0.000	0.000	0.000	0.000
Ave Conc. Ra-226, RS	Ave Conc. Tc-99, RS	Ave Conc. Th-232, RS	Ave Conc. U-234, RS
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
0.090	0.000	0.050	1.872
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
0.090	0.000	0.050	1.872
Ave Conc. Ra-226, ES	Ave Conc. Tc-99, ES	Ave Conc. Th-232, ES	Ave Conc. U-234, ES
0	0	0.13	2.064
0.16	0.241	0.19	1.6444
0.1	0.0839	0.27	0.373
0	0.205	0.04	2.0948
0	0.198	0.15	2.5825
0.01	0	0.23	1.9603
0	0.105	0.32	4.3783
-	-	-	-
0	0	0.12	2.1756
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
0.034	0.104	0.181	2.159

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

Ave Conc. U-235, SS

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0.000

Ave Conc. U-238, SS

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-
-
-
-
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-
-

0.000

Ave Conc. U-235, RS

-
-
-
-
-
-
0.101

0.101

Ave Conc. U-238, RS

-
-
-
-
-
-
0.809

0.809

Ave Conc. U-235, ES

0.111
0.0839
0.014
0.109
0.141
0.102
0.241
-
0.111
-
-
-
-
-

0.114

Ave Conc. U-238, ES

0.924
1.23
0.975
1.35
0.891
1.220
1.160
-
1.570
-
-
-
-
-

1.165

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 ($X_{i,ref}$, $Y_{i,SU,gross}$)	ADJUSTED SOF (Z_i)	RANKS	REFERENCE AREA RANKS
9574-SS-140910-01-01	Reference	1.31	2.310	38	38
9574-SS-140910-01-02	Reference	1.18	2.179	29	29
9574-SS-140910-01-03	Reference	1.06	2.064	24	24
9574-SS-140910-01-04	Reference	1.10	2.101	25	25
9574-SS-140910-01-05	Reference	1.29	2.293	37	37
9574-SS-140910-01-07	Reference	1.34	2.339	39	39
9574-SS-140910-01-08	Reference	1.15	2.154	28	28
9574-SS-140910-01-09	Reference	1.18	2.182	30	30
9574-SS-140910-01-10	Reference	1.23	2.227	35	35
9574-SS-140910-01-11	Reference	1.38	2.380	40	40
9574-SS-140910-01-12	Reference	1.05	2.055	23	23
9574-SS-140910-01-13	Reference	0.94	1.941	13	13
9574-SS-140910-01-14	Reference	1.12	2.119	26	26
9574-SS-140910-01-15	Reference	1.15	2.152	27	27
9574-SS-140910-01-16	Reference	1.03	2.028	20	20
9574-SS-140910-01-17	Reference	0.44	1.443	9	9
9574-SS-140910-01-18	Reference	1.19	2.188	32	32
9574-SS-140910-01-20	Reference	0.76	1.757	10	10
9574-SS-140910-01-21	Reference	1.02	2.023	19	19
9574-SS-140910-01-22	Reference	1.02	2.018	18	18
9574-SS-140910-01-23	Reference	1.00	2.002	15	15
9574-SS-140910-01-24	Reference	0.87	1.873	12	12
9574-SS-140910-01-25	Reference	1.04	2.040	22	22
9574-SS-140910-01-26	Reference	0.96	1.959	14	14
9574-SS-140910-01-27	Reference	1.20	2.204	33	33
9574-SS-140910-01-28	Reference	1.01	2.007	17	17
9574-SS-140910-01-29	Reference	1.22	2.223	34	34
9574-SS-140910-01-30	Reference	1.03	2.035	21	21
9574-SS-140910-01-31	Reference	1.00	2.005	16	16
9574-SS-140910-01-32	Reference	0.86	1.865	11	11
9574-SS-140910-01-33	Reference	1.24	2.238	36	36
9574-SS-140910-01-34	Reference	1.19	2.185	31	31
L10-14-01-B-E-S-00	Survey Unit	1.03	1.026	2	0
L10-14-02-B-E-S-00	Survey Unit	1.27	1.269	8	0
L10-14-03-B-E-S-00	Survey Unit	1.26	1.262	7	0
L10-14-04-B-E-S-00	Survey Unit	1.00	1.004	1	0
L10-14-05-B-E-S-00	Survey Unit	1.07	1.072	3	0
L10-14-06-B-E-S-00	Survey Unit	1.20	1.203	5	0
L10-14-07-B-E-S-00	Survey Unit	1.23	1.235	6	0
L10-14-08-B-R-S-00	Survey Unit	1.15	1.152	4	0
Rank Sums				820	784
# Reference Area Measurements				m	32
# Survey Unit Measurements				n	8
Total Number of Measurements				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

TEST: PASS

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

Min adjusted bkg SOF: 1.44

No WRS test necessary
No WRS test necessary
No WRS test necessary
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_r

$\alpha = 0.05$

HDP-PR-FSS-721 Final Status Survey Data Evaluation

Retrospective Sample Size Verification

Uniform DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	SOF (Ra/Tc/Th/Iso U)
St. Dev.	0.06
DCGL _{SOF}	1
LBGR (Mean)	0.13
Shift	0.87
Relative Shift (Δ/σ)	14.58
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

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

Survey Unit No.:		LSA 10-14			Survey Unit Description:		Burial Pits Open Land Area Southern Survey Unit in "Area 2"					
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						
L10-14-06-B-E-S-00	L10-14-06-B-E-Q-00	Ra-226	1.08	0.0762	1.1	0.067	1.090	1.9	0.02	0.269	0.403	N
L10-14-06-B-E-S-00	L10-14-06-B-E-Q-00	Tc-99	-0.0158	0.244	-0.0329	0.243	-0.024	25.1	NA	3.552	5.321	NA
L10-14-06-B-E-S-00	L10-14-06-B-E-Q-00	Th-232	1.23	0.132	1.150	0.107	1.190	2.0	0.08	0.283	0.424	N
L10-14-06-B-E-S-00	L10-14-06-B-E-Q-00	U-234 ¹	1.960	NA	2.747	NA	2.354	195.4	0.787	27.649	41.425	N
L10-14-06-B-E-S-00	L10-14-06-B-E-Q-00	U-235	0.102	0.253	0.15	0.251	0.126	51.6	NA	7.301	10.939	NA
L10-14-06-B-E-S-00	L10-14-06-B-E-Q-00	U-238	1.22	0.783	0.937	0.868	1.079	168.8	0.283	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 10-14 Sys SOF

0.1

0.2

0.2

0.0

0.1

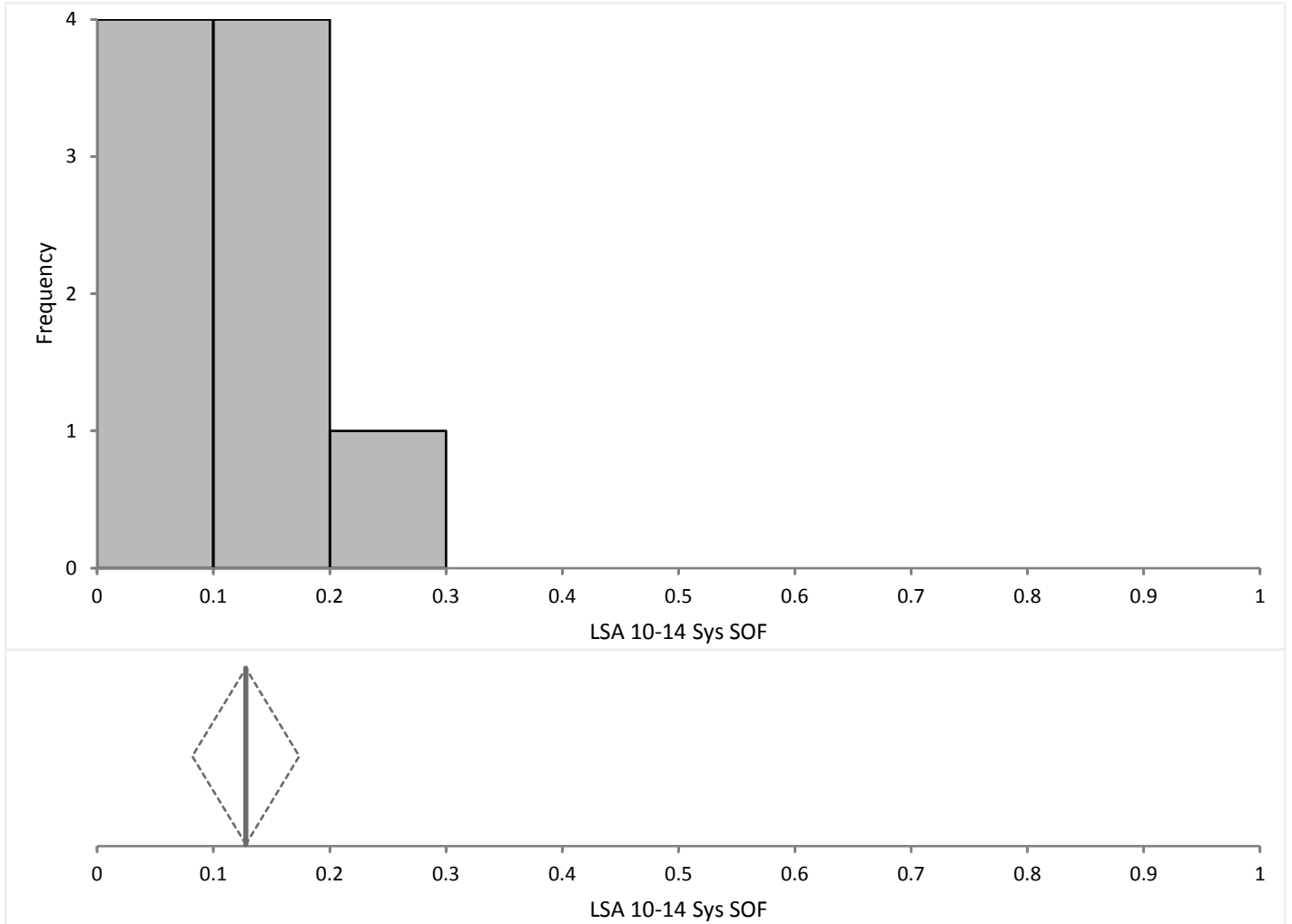
0.1

0.2

0.1

0.1

Descriptives



	N	9				
	Mean	95% CI	Mean SE	SD	Variance	
LSA 10-14 Sys SOF	0.13	0.08 to 0.17	0.020	0.06	0.00	
	Minimum	1st quartile	Median	96.09% CI	3rd quartile	
LSA 10-14 Sys SOF	0.0	0.08	0.10	0.08 to 0.20	0.20	

Skewness	Kurtosis
0.3	-1.70
Maximum	IQR
0.2	0.12