APPENDIX P-4
FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: LSA 08 **Description:** Plant Soils SEA Open Land Area
Survey Unit: 03 **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
L08-03-03-P-E-S-00	Uniform	S	429.9	429.4	865032.0	827162.0	Excavation 6-inch grab
L08-03-04-P-R-S-00	Uniform	S	430.4	428.6	864991.0	827139.0	Root 1.8-ft composite
L08-03-05-P-E-S-00	Uniform	S	428.6	428.1	864991.0	827139.0	Excavation 6-inch grab
L08-03-06-P-E-S-00	Uniform	S	428.6	428.1	864991.0	827186.0	Excavation 6-inch grab
L08-03-07-P-R-S-00	Uniform	S	432.8	430.6	864991.0	827233.0	Root 2.1-ft composite
L08-03-08-P-E-S-00	Uniform	S	430.6	430.1	864991.0	827233.0	Excavation 6-inch grab
L08-03-09-P-E-S-00	Uniform	S	428.3	427.9	864950.0	827210.0	Excavation 6-inch grab
L08-03-10-P-E-S-00	Uniform	S	430.9	430.5	864950.0	827257.0	Excavation 6-inch grab
L08-03-11-P-E-S-00	Uniform	S	429.0	428.6	864909.0	827186.0	Excavation 6-inch grab
L08-03-12-P-E-S-00	Uniform	S	429.3	428.8	864909.0	827233.0	Excavation 6-inch grab
L08-03-09-P-E-Q-00	Uniform	Q	428.3	427.9	864950.0	827210.0	Excavation 6-inch grab
L08-03-13-P-R-B-00	Uniform	B	428.6	428.1	865011.3	827171.9	6-inch Sidewall Sample
L08-03-14-P-R-B-00	Uniform	B	429.0	428.5	864976.2	827237.4	Biased 6-inch gab
L08-03-15-P-R-B-00	Uniform	B	432.2	431.7	865021.7	827177.2	Biased 6-inch gab

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

Evaluate Final Status Survey Data: LSA-08-03

TestAmerica Analytical Results Step 8.3.2

Sample ID	Sample Depth (ft)	Type (S)ystematic, Bias, QC)	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
L08-03-03-P-E-S-00	4.10	S	0.745	0.108	0.050	N/A	-0.325	0.000	0.063	0.063	0.045	0.240	U	0.753	0.115	0.077	N/A	-0.247	0.000	2.352	NA	NA	NA	0.126	0.120	0.155	U	1.120	0.475	0.579	N/A
L08-03-04-P-R-S-00	3.60	S	0.939	0.150	0.084	N/A	-0.131	0.000	0.032	0.032	0.011	0.220	U	0.976	0.149	0.105	N/A	-0.024	0.000	1.813	NA	NA	NA	0.097	0.128	0.211	U	0.876	0.301	0.829	N/A
L08-03-05-P-E-S-00	5.40	S	0.952	0.162	0.087	N/A	-0.118	0.000	0.018	0.018	0.026	0.231	U	1.150	0.217	0.081	N/A	0.150	0.150	1.394	NA	NA	NA	0.070	0.165	0.262	U	1.180	0.587	0.911	N/A
L08-03-06-P-E-S-00	5.40	S	1.030	0.141	0.057	N/A	-0.040	0.000	0.176	0.176	0.048	0.221	U	0.964	0.164	0.099	N/A	-0.036	0.000	1.586	NA	NA	NA	0.081	0.151	0.233	U	1.230	0.501	0.761	N/A
L08-03-07-P-R-S-00	1.20	S	0.937	0.140	0.066	N/A	-0.133	0.000	0.064	0.064	0.050	0.218	U	1.000	0.156	0.138	N/A	0.000	0.000	1.597	NA	NA	NA	0.084	0.132	0.219	U	0.874	0.311	0.763	N/A
L08-03-08-P-E-S-00	3.40	S	1.170	0.160	0.071	N/A	0.100	0.100	0.081	0.081	0.023	0.222	U	1.180	0.172	0.112	N/A	0.180	0.180	2.048	NA	NA	NA	0.112	0.146	0.223	U	0.654	0.260	0.765	U
L08-03-09-P-E-S-00	5.70	S	0.968	0.162	0.087	N/A	-0.102	0.000	0.205	0.205	0.095	0.225	U	1.030	0.219	0.123	N/A	0.030	0.030	1.600	NA	NA	NA	0.084	0.161	0.297	U	0.975	0.668	0.914	N/A
L08-03-10-P-E-S-00	3.10	S	1.060	0.158	0.077	N/A	-0.010	0.000	0.189	0.189	0.046	0.222	U	0.982	0.169	0.090	N/A	-0.018	0.000	1.905	NA	NA	NA	0.104	0.137	0.245	U	0.636	0.301	0.777	U
L08-03-11-P-E-S-00	5.00	S	1.100	0.153	0.066	N/A	0.030	0.030	0.071	0.071	0.023	0.220	U	1.030	0.196	0.132	N/A	0.030	0.030	2.721	NA	NA	NA	0.148	0.152	0.209	U	1.000	0.300	0.706	N/A
L08-03-12-P-E-S-00	4.70	S	0.983	0.137	0.056	N/A	-0.087	0.000	0.244	0.244	0.057	0.226	N/A	1.010	0.156	0.127	N/A	0.010	0.010	2.018	NA	NA	NA	0.105	0.127	0.168	U	1.250	0.490	0.742	N/A
L08-03-09-P-E-Q-00	5.70	Q	0.814	0.134	0.079	N/A	-0.256	0.000	0.269	0.269	0.051	0.230	N/A	1.120	0.171	0.112	N/A	0.120	0.120	2.632	NA	NA	NA	0.141	0.132	0.220	U	1.220	0.619	0.810	N/A
L08-03-13-P-R-B-00	5.40	B	1.040	0.176	0.097	N/A	-0.030	0.000	0.117	0.117	0.047	0.224	U	0.986	0.187	0.168	N/A	-0.014	0.000	4.634	NA	NA	NA	0.253	0.138	0.226	N/A	1.590	0.372	0.861	N/A
L08-03-14-P-R-B-00	5.00	B	1.110	0.156	0.068	N/A	0.040	0.040	0.003	0.003	0.027	0.225	U	1.070	0.152	0.120	N/A	0.070	0.070	3.570	NA	NA	NA	0.196	0.115	0.172	N/A	1.030	0.501	0.782	N/A
L08-03-15-P-R-B-00	2.80	B	1.110	0.164	0.080	N/A	0.040	0.040	0.114	0.114	0.025	0.228	U	0.941	0.167	0.112	N/A	-0.059	0.000	1.325	NA	NA	NA	0.070	0.143	0.236	U	0.817	0.285	0.808	N/A
Systematic Minimum			0.000						0.018					0.000						1.394				0.070				0.636			
Systematic Maximum			0.100						0.244					0.180						2.721				0.148				1.250			
Systematic Mean			0.013						0.114					0.040						1.903				0.101				0.980			
Systematic Median			0.000						0.076					0.005						1.859				0.100				0.988			
Systematic Standard Deviation			0.032						0.081					0.067						0.403				0.023				0.222			
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	**0.000**	**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	Ave Conc. U-235, RS	Ave Conc. U-238, RS
0.000	0.063	0.000	2.352	0.126	1.120
0.000	0.032	0.000	1.813	0.097	0.876
-	-	-	-	-	-
-	-	-	-	-	-
0.000	0.064	0.000	1.597	0.084	0.874
0.100	0.081	0.180	2.048	0.112	0.654
-	-	-	-	-	-
0.000	0.189	0.000	1.905	0.104	0.636
-	-	-	-	-	-
0.000	0.244	0.010	2.018	0.105	1.250
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
0.017	**0.112**	**0.032**	**1.955**	**0.105**	**0.902**

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	0.0178	0.15	1.3937	0.0702	1.18
0	0.176	0	1.5856	0.0809	1.23
-	-	-	-	-	-
-	-	-	-	-	-
0	0.205	0.03	1.6001	0.0839	0.975
-	-	-	-	-	-
0.03	0.0708	0.03	2.7213	0.148	1
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
0.008	**0.117**	**0.053**	**1.825**	**0.096**	**1.096**

Sample ID	Sample Depth (ft)	Type (S)ystematic, (B)ias, (Q)C)	Enr. Enrichment (%)	SOF SOF Step 8.4.3	Root Stratum SOF Verification (unexcavated/not backfilled only) Step 8.4.4a.1 Is Sample in the Root Stratum?	Is ROOT Sample SOF > 0.5?	root count	excavation count	surface count	MDC SOF Step 8.1.1c
L08-03-03-P-E-S-00	4.10	S	1.8	0.02	ROOT	good	1			0.10
L08-03-04-P-R-S-00	3.60	S	1.7	0.02	ROOT	good	1			0.13
L08-03-05-P-E-S-00	5.40	S	1.0	0.09	EXCAVATION	good		1		0.13
L08-03-06-P-E-S-00	5.40	S	1.1	0.02	EXCAVATION	good		1		0.12
L08-03-07-P-R-S-00	1.20	S	1.5	0.02	ROOT	good	1			0.14
L08-03-08-P-E-S-00	3.40	S	2.6	0.16	ROOT	good	1			0.13
L08-03-09-P-E-S-00	5.70	S	1.4	0.04	EXCAVATION	good		1		0.16
L08-03-10-P-E-S-00	3.10	S	2.5	0.02	ROOT	good	1			0.13
L08-03-11-P-E-S-00	5.00	S	2.3	0.06	EXCAVATION	good		1		0.14
L08-03-12-P-E-S-00	4.70	S	1.3	0.03	ROOT	good	1			0.13
L08-03-09-P-E-Q-00	5.70	Q	1.8	0.09		good				0.14
L08-03-13-P-R-B-00	5.40	B	2.5	0.04		good				0.17
L08-03-14-P-R-B-00	5.00	B	2.9	0.08		good				0.13
L08-03-15-P-R-B-00	2.80	B	1.4	0.04		good				0.14
			1.8	0.02						
				0.16						
				0.05						
				0.03						
				0.05						
		Average Enrichment (%)				count tot	10	6	4	0

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

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
Th-232	2.0
Ra-226	1.9

Step 8.4.5b

Weighted SOF_{MEAN} **0.05**

fractions	SS	RS	ES
	0	0.6	0.4

Additional Structures
0.029

Step 8.4.5e SOF_{MEAN} Groundwater
0.16

Step 8.4.5g (<=1)

$SOF_{MEAN, SU}$ 0.24 **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 mrem.

5.95 mrem

Infer U234 Step 8.3.4			
U-238/U235	**U-234/U235**	**U-234**	**%**
8.9	18.7	2.4	1.8
9.1	18.7	1.8	1.7
16.8	19.9	1.4	1.0
15.2	19.6	1.6	1.1
10.4	18.9	1.6	1.5
5.8	18.3	2.0	2.6
11.6	19.1	1.6	1.4
6.1	18.3	1.9	2.5
6.8	18.4	2.7	2.3
11.9	19.2	2.0	1.3
8.7	18.7	2.6	1.8
6.3	18.3	4.6	2.5
5.3	18.2	3.6	2.9
11.8	19.1	1.3	1.4
	Average Enrichment (%)		**1.84**

Infer U-234 MDC using U-235 MDC * ratio of U-234:U-235 @ that sample's enrichment
2.893107
3.955421
5.201509
4.566823
4.149271
4.077729
5.664226
4.487304
3.842856
3.228649
4.106345
4.139309
3.133044
4.500866

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	40	40	
9574-SS-140910-01-02	Reference	1.18	2.179	31	31	
9574-SS-140910-01-03	Reference	1.06	2.064	26	26	
9574-SS-140910-01-04	Reference	1.10	2.101	27	27	
9574-SS-140910-01-05	Reference	1.29	2.293	39	39	
9574-SS-140910-01-07	Reference	1.34	2.339	41	41	
9574-SS-140910-01-08	Reference	1.15	2.154	30	30	
9574-SS-140910-01-09	Reference	1.18	2.182	32	32	
9574-SS-140910-01-10	Reference	1.23	2.227	37	37	
9574-SS-140910-01-11	Reference	1.38	2.380	42	42	
9574-SS-140910-01-12	Reference	1.05	2.055	25	25	
9574-SS-140910-01-13	Reference	0.94	1.941	15	15	
9574-SS-140910-01-14	Reference	1.12	2.119	28	28	
9574-SS-140910-01-15	Reference	1.15	2.152	29	29	
9574-SS-140910-01-16	Reference	1.03	2.028	22	22	
9574-SS-140910-01-17	Reference	0.44	1.443	11	11	
9574-SS-140910-01-18	Reference	1.19	2.188	34	34	
9574-SS-140910-01-20	Reference	0.76	1.757	12	12	
9574-SS-140910-01-21	Reference	1.02	2.023	21	21	
9574-SS-140910-01-22	Reference	1.02	2.018	20	20	
9574-SS-140910-01-23	Reference	1.00	2.002	17	17	
9574-SS-140910-01-24	Reference	0.87	1.873	14	14	
9574-SS-140910-01-25	Reference	1.04	2.040	24	24	
9574-SS-140910-01-26	Reference	0.96	1.959	16	16	
9574-SS-140910-01-27	Reference	1.20	2.204	35	35	
9574-SS-140910-01-28	Reference	1.01	2.007	19	19	
9574-SS-140910-01-29	Reference	1.22	2.223	36	36	
9574-SS-140910-01-30	Reference	1.03	2.035	23	23	
9574-SS-140910-01-31	Reference	1.00	2.005	18	18	
9574-SS-140910-01-32	Reference	0.86	1.865	13	13	Step 8.5.1
9574-SS-140910-01-33	Reference	1.24	2.238	38	38	Min adjusted bkg SOF
9574-SS-140910-01-34	Reference	1.19	2.185	33	33	1.44
L08-03-03-P-E-S-00	Survey Unit	0.79	0.792	1	0	No WRS test necessary
L08-03-04-P-R-S-00	Survey Unit	1.00	1.000	2	0	No WRS test necessary
L08-03-05-P-E-S-00	Survey Unit	1.09	1.092	8	0	No WRS test necessary
L08-03-06-P-E-S-00	Survey Unit	1.05	1.048	4	0	No WRS test necessary
L08-03-07-P-R-S-00	Survey Unit	1.01	1.011	3	0	No WRS test necessary
L08-03-08-P-E-S-00	Survey Unit	1.23	1.226	10	0	No WRS test necessary
L08-03-09-P-E-S-00	Survey Unit	1.05	1.048	5	0	No WRS test necessary
L08-03-10-P-E-S-00	Survey Unit	1.07	1.072	7	0	No WRS test necessary
L08-03-11-P-E-S-00	Survey Unit	1.12	1.119	9	0	No WRS test necessary
L08-03-12-P-E-S-00	Survey Unit	1.05	1.052	6	0	No WRS test necessary
			Rank Sums	903	848	W_r Step 8.5.3e
			# Reference Area Measurements	**m**	32	
			# Survey Unit Measurements	**n**	10	
			Total Number of Measurements Step 8.5.3c	**N**	42	
			(1-α) percentile of a standard normal distribution (MARSSIM Pg. I-10)	**z**	1.645	α = 0.05
			WRS Critical Value (MARSSIM Pg. I-10, Eq. I.1)	**CV**	744	

TEST: PASS Step 8.5.3f

Uniform DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	**SOF (Ra/Tc/Th/Iso U)**
St. Dev.	0.05
$DCGL_{SOF}$	1
LBGR (Mean)	0.05
Shift	0.95
Relative Shift (Δ/σ)	20.74
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, α = 0.05, β = 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 08-03 | 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						
L08-03-09-P-E-S-00	L08-03-09-P-E-Q-00	Ra-226	0.968	0.0874	0.814	0.0793	0.891	1.9	0.154	0.269	0.403	N
L08-03-09-P-E-S-00	L08-03-09-P-E-Q-00	Tc-99	0.205	0.225	0.269	0.23	0.237	25.1	NA	3.552	5.321	NA
L08-03-09-P-E-S-00	L08-03-09-P-E-Q-00	Th-232	1.03	0.123	1.12	0.112	1.075	2.0	0.090	0.283	0.424	N
L08-03-09-P-E-S-00	L08-03-09-P-E-Q-00	U-234[1]	1.600	N/A	2.632	N/A	2.116	195.4	1.032	27.649	41.425	N
L08-03-09-P-E-S-00	L08-03-09-P-E-Q-00	U-235	0.0839	0.297	0.141	0.22	0.112	51.6	NA	7.301	10.939	NA
L08-03-09-P-E-S-00	L08-03-09-P-E-Q-00	U-238	0.975	0.914	1.22	0.81	1.098	168.8	0.245	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: Thomas Yardy

Reviewed by: Clark Evers

Date:

Date:

Quality Record

LSA 08-03 Sys SOF

0.0
0.0
0.1
0.0
0.0
0.2
0.0
0.0
0.1
0.0

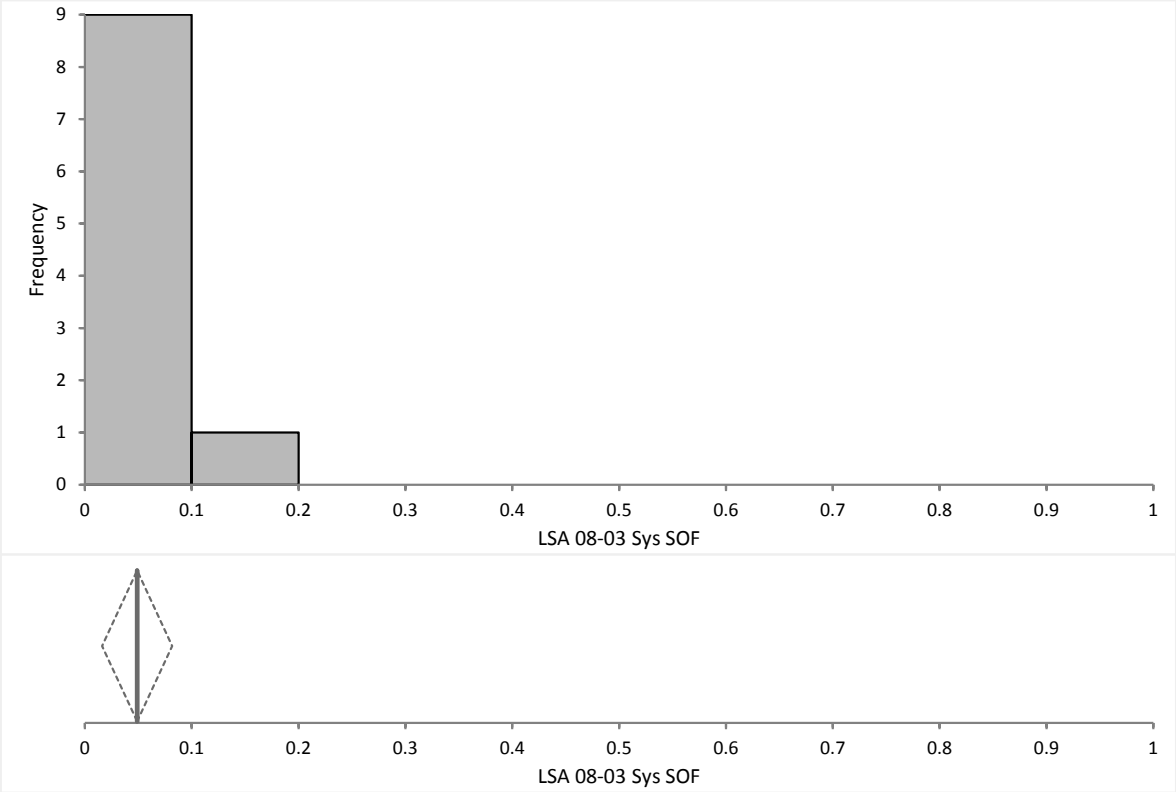
Distribution: LSA 08-03 Sys SOF

Analyse-it v4.65.2

SOFn Only A1:A11

Last updated 21 June 2017 at 13:48 by W. Clark Evers

Descriptives



	N
	10

	Mean	95% CI	Mean SE	SD	Variance	Skewness	Kurtosis
LSA 08-03 Sys SOF	0.05	0.02 to 0.08	0.015	0.05	0.00	2.1	4.17

	Minimum	1st quartile	Median	97.85% CI	3rd quartile	Maximum	IQR
LSA 08-03 Sys SOF	0.02	0.02	0.03	0.02 to 0.09	0.06	0.2	0.04