APPENDIX P-4
FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: LSA 10 **Description:** Burial Pits Open Land Area
Survey Unit: 06 **Description:** South Eastern Survey Unit in "Area 9"
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
L100601BES00	Uniform	S	423.339	422.8	865078.8	827674.7	Excavation 6-inch grab
L100602BES00	Uniform	S	422.534	422.0	865068.7	827712.4	Excavation 6-inch grab
L100603BES00	Uniform	S	421.09	420.6	865058.6	827750.1	Excavation 6-inch grab
L100604BES00	Uniform	S	420.315	419.8	865048.5	827787.7	Excavation 6-inch grab
L100605BRQ00	Uniform	Q	424.134	423.6	865038.4	827825.4	Root 6-inch grab
L100605BRS00	Uniform	S	424.134	423.5	865038.4	827825.4	Root 6-inch grab
L100606BES00	Uniform	S	423.5	423.0	865038.4	827825.4	Excavation 6-inch grab
L100607BES00	Uniform	S	422.343	421.8	865031.0	827722.5	Excavation 6-inch grab
L100608BES00	Uniform	S	420.05	419.6	865020.9	827760.2	Excavation 6-inch grab
L100609BES00	Uniform	S	422.373	421.9	864993.3	827732.6	Excavation 6-inch grab
L100610BUB00	Uniform	B	418.0	417.5	865069.0	827698.2	Biased 6-inch grab
L100611BUB00	Uniform	B	422.0	421.5	865011.1	827715.5	Biased 6-inch grab
L100612BUB00	Uniform	B	418.0	417.5	865027.1	827789.4	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

Quality Record

Evaluate Final Status Survey Data: LSA-10-06

TestAmerica Analytical Results Step 8.3.2

Sample ID	Sample Depth (ft)	Type (S=systematic, B=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
L100601BES00	5.51	S	1.260	0.188	0.086	N/A	0.190	0.190	0.047	0.047	0.075	0.220	U	1.040	0.189	0.184	N/A	0.040	0.040	2.754	NA	NA	NA	0.142	0.160	0.278	U	1.840	0.861	1.010	N/A
L100602BES00	5.56	S	1.030	0.147	0.070	N/A	-0.040	0.000	0.013	0.013	0.128	0.227	U	1.060	0.153	0.113	N/A	0.060	0.060	3.028	NA	NA	NA	0.165	0.130	0.171	U	1.060	0.342	0.813	N/A
L100603BES00	6.17	S	1.220	0.187	0.088	N/A	0.150	0.150	0.011	0.011	0.081	0.225	U	1.040	0.236	0.145	N/A	0.040	0.040	6.977	NA	NA	NA	0.385	0.183	0.227	N/A	1.580	0.432	1.010	N/A
L100604BES00	7.45	S	1.170	0.178	0.076	N/A	0.100	0.100	-0.003	0.000	0.076	0.248	U	1.090	0.176	0.134	N/A	0.090	0.090	2.094	NA	NA	NA	0.108	0.147	0.249	U	1.480	0.740	0.936	N/A
L100605BRS00	4.38	S	1.070	0.162	0.093	N/A	0.000	0.000	0.083	0.083	0.095	0.224	U	1.070	0.186	0.187	N/A	0.070	0.070	2.849	NA	NA	NA	0.152	0.150	0.196	U	1.430	0.869	1.040	N/A
L100606BES00	5.00	S	1.120	0.156	0.065	N/A	0.050	0.050	0.057	0.057	0.042	0.222	U	1.090	0.154	0.082	N/A	0.090	0.090	1.705	NA	NA	NA	0.088	0.116	0.186	U	1.220	0.680	0.874	N/A
L100607BES00	7.24	S	1.170	0.184	0.092	N/A	0.100	0.100	0.024	0.024	0.052	0.224	U	1.200	0.193	0.137	N/A	0.200	0.200	2.194	NA	NA	NA	0.118	0.191	0.301	U	1.000	0.410	1.090	U
L100608BES00	9.01	S	1.080	0.151	0.064	N/A	0.010	0.010	-0.004	0.000	0.042	0.238	U	1.110	0.187	0.113	N/A	0.110	0.110	2.242	NA	NA	NA	0.121	0.154	0.240	U	0.949	0.353	0.949	N/A
L100609BES00	8.38	S	1.110	0.164	0.085	N/A	0.040	0.040	-0.041	0.000	0.099	0.270	U	1.070	0.187	0.116	N/A	0.070	0.070	2.562	NA	NA	NA	0.139	0.157	0.257	U	0.981	0.395	0.985	U
L100605BRQ00	4.38	Q	1.150	0.164	0.061	N/A	0.080	0.080	-0.018	0.000	0.036	0.231	U	1.140	0.190	0.135	N/A	0.140	0.140	0.675	NA	NA	NA	0.030	0.150	0.254	U	0.960	0.328	0.807	N/A
L100610BUB00	7.50	B	1.050	0.155	0.068	N/A	-0.020	0.000	-0.005	0.000	0.057	0.229	U	1.260	0.188	0.139	N/A	0.260	0.260	2.273	NA	NA	NA	0.123	0.161	0.244	U	0.924	0.326	0.807	N/A
L100611BUB00	5.50	B	1.130	0.165	0.065	N/A	0.060	0.060	0.013	0.013	0.018	0.221	U	1.030	0.205	0.137	N/A	0.030	0.030	16.094	NA	NA	NA	0.889	0.271	0.265	N/A	3.010	0.940	1.060	N/A
L100612BUB00	7.50	B	0.997	0.143	0.066	N/A	-0.073	0.000	0.009	0.009	0.062	0.224	U	1.080	0.174	0.119	N/A	0.080	0.080	2.681	NA	NA	NA	0.143	0.136	0.221	U	1.340	0.709	0.886	N/A
Systematic Minimum					0.000							0.000				0.040						1.705				0.088				0.949		
Systematic Maximum					0.190							0.083				0.200						16.094				0.385				3.010		
Systematic Mean					0.071							0.020				0.086						2.934				0.158				1.282		
Systematic Median					0.050							0.013				0.070						2.562				0.139				1.220		
Systematic Standard Deviation					0.068							0.026				0.049						1.572				0.222				0.315		
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 inorowth (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	0.083	0.070	2.849	0.152	1.430
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
0.000	**0.083**	**0.070**	**2.849**	**0.152**	**1.430**

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
0.19	0.0474	0.04	2.7536	0.142	1.84
0	0.0129	0.06	3.0276	0.165	1.06
0.15	0.0112	0.04	6.9765	0.385	1.58
0.1	0	0.09	2.0943	0.108	1.48
-	-	-	-	-	-
-	-	-	-	-	-
0.05	0.0568	0.09	1.7045	0.0879	1.22
0.1	0.0235	0.2	2.1942	0.118	1
0.01	0	0.11	2.2424	0.121	0.949
0.04	0	0.07	2.5617	0.139	0.981
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
0.080	**0.019**	**0.088**	**2.944**	**0.158**	**1.264**

Sample ID	Sample Depth (ft)	Sample Type (S)ystematic, (B)iased, (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 Stream?	Is ROOT Sample SOF > 0.5?	root count	excavation count	surface count	MDC SOF Step 8.4.1.c
L100601BES00	5.51	S	1.2	0.15	EXCAVATION	good		1		0.19
L100602BES00	5.56	S	2.4	0.06	EXCAVATION	good		1		0.13
L100603BES00	6.17	S	3.7	0.15	EXCAVATION	good		1		0.16
L100604BES00	7.45	S	1.2	0.12	EXCAVATION	good		1		0.15
L100605BRS00	4.38	S	1.7	0.08	ROOT	good	1			0.18
L100606BES00	5.00	S	1.2	0.09	EXCAVATION	good		1		0.11
L100607BES00	7.24	S	1.9	0.17	EXCAVATION	good		1		0.17
L100608BES00	9.01	S	2.0	0.08	EXCAVATION	good		1		0.13
L100609BES00	8.38	S	2.2	0.08	EXCAVATION	good		1		0.15
L100605BRQ00	4.38	Q	0.5	0.12		good				0.15
L100610BUB00	7.50	B	2.1	0.15		good				0.15
L100611BUB00	5.50	B	4.4	0.16		good				0.15
L100612BUB00	7.50	B	1.7	0.06		good				0.13
			2.7	0.06						
				0.17						
			Average Enrichment (%)	0.11						
				0.09						
				0.04						
						9 count tot	1	8	0	

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

Step 8.4.1 $DCLG_{EN}$, 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} **0.11**

fractions	SS	RS	ES
	0	0.111111111	0.888888889

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

0

Step 8.4.5e SOF_{MEAN} Groundwater

0.16

Step 8.4.5g (<=1)

$SOF_{MEAN, SU}$ 0.27 **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.

6.7 mrem

Infer U234 Step 8.3.4			
U-238/U235	**U-234/U235**	**U-234**	**%**
13.0	19.4	2.8	1.2
6.4	18.3	3.0	2.4
4.1	18.1	7.0	3.7
13.7	19.4	2.1	1.2
9.4	18.7	2.8	1.7
13.9	19.4	1.7	1.2
8.5	18.6	2.2	1.9
7.8	18.5	2.2	2.0
7.1	18.4	2.6	2.2
32.3	22.7	0.7	0.5
7.5	18.5	2.3	2.1
3.4	18.1	16.1	4.4
9.4	18.7	2.7	1.7
		Average Enrichment (%)	**2.02**

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

5.390948
3.137689
4.113433
4.828583
3.67423
3.606893
5.596946
4.447788
4.736396
5.773512
4.508585
4.79733
4.142882

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	1.19	2.188	33	33	
9574-SS-140910-01-02	Reference	0.76	1.757	11	11	
9574-SS-140910-01-03	Reference	1.02	2.023	20	20	
9574-SS-140910-01-04	Reference	1.02	2.018	19	19	
9574-SS-140910-01-05	Reference	1.00	2.002	16	16	
9574-SS-140910-01-07	Reference	0.87	1.873	13	13	
9574-SS-140910-01-08	Reference	1.04	2.040	23	23	
9574-SS-140910-01-09	Reference	0.96	1.959	15	15	
9574-SS-140910-01-10	Reference	1.20	2.204	34	34	
9574-SS-140910-01-11	Reference	1.01	2.007	18	18	
9574-SS-140910-01-12	Reference	1.22	2.223	35	35	
9574-SS-140910-01-13	Reference	1.03	2.035	22	22	
9574-SS-140910-01-14	Reference	1.00	2.005	17	17	
9574-SS-140910-01-15	Reference	0.86	1.865	12	12	
9574-SS-140910-01-16	Reference	1.24	2.238	37	37	
9574-SS-140910-01-17	Reference	1.19	2.185	32	32	
9574-SS-140910-01-18	Reference	1.31	2.310	39	39	
9574-SS-140910-01-20	Reference	1.18	2.179	30	30	
9574-SS-140910-01-21	Reference	1.06	2.064	25	25	
9574-SS-140910-01-22	Reference	1.10	2.101	26	26	
9574-SS-140910-01-23	Reference	1.29	2.293	38	38	
9574-SS-140910-01-24	Reference	1.34	2.339	40	40	
9574-SS-140910-01-25	Reference	1.15	2.154	29	29	
9574-SS-140910-01-26	Reference	1.18	2.182	31	31	
9574-SS-140910-01-27	Reference	1.23	2.227	36	36	
9574-SS-140910-01-28	Reference	1.38	2.380	41	41	
9574-SS-140910-01-29	Reference	1.05	2.055	24	24	
9574-SS-140910-01-30	Reference	0.94	1.941	14	14	
9574-SS-140910-01-31	Reference	1.12	2.119	27	27	
9574-SS-140910-01-32	Reference	1.15	2.152	28	28	Step 8.5.1
9574-SS-140910-01-33	Reference	1.03	2.028	21	21	Min adjusted bkg SOF
9574-SS-140910-01-34	Reference	0.44	1.443	10	10	1.44
L100601BES00	Survey Unit	1.21	1.213	7	0	No WRS test necessary
L100602BES00	Survey Unit	1.10	1.098	1	0	No WRS test necessary
L100603BES00	Survey Unit	1.22	1.215	8	0	No WRS test necessary
L100604BES00	Survey Unit	1.18	1.182	6	0	No WRS test necessary
L100605BRS00	Survey Unit	1.13	1.127	2	0	No WRS test necessary
L100606BES00	Survey Unit	1.15	1.154	5	0	No WRS test necessary
L100607BES00	Survey Unit	1.24	1.236	9	0	No WRS test necessary
L100608BES00	Survey Unit	1.14	1.143	4	0	No WRS test necessary
L100609BES00	Survey Unit	1.14	1.141	3	0	No WRS test necessary
			Rank Sums	861	816	W, Step 8.5.3e
			# Reference Area Measurements	**m**	32	
			# Survey Unit Measurements	**n**	9	
			Total Number of Measurements Step 8.5.3c	**N**	41	
			(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**	725	

TEST: **PASS** Step 8.5.3f

Uniform DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	**SOF (Ra/Tc/Th/Iso U)**
St. Dev.	0.04
$DCGL_{SOF}$	1
LBGR (Mean)	0.11
Shift	0.89
Relative Shift (Δ/σ)	20.85
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 10-06				Survey Unit Description:		Burial Pits Open Land Area South Eastern Survey Unit in "Area 9"					
			Sample (pCi/g)		Field Duplicate Sample (pCi/g)		Average Activity ($\bar{X}$)	Nuclide DCGL				Statistic Exceeds Limit?
Sample ID	Field Duplicate Sample ID	Radionuclide	Activity (x_i)	MDC	Activity (x_i)	MDC	(pCi/g)	(pCi/g)	Statistic[2]	Warning Limit	Control Limit	(Y/N)
L100605BRS00	L100605BRQ00	Ra-226	1.07	0.0931	1.15	0.0609	1.110	1.9	0.08	0.269	0.403	N
L100605BRS00	L100605BRQ00	Tc-99	0.0829	0.224	-0.0176	0.231	0.033	25.1	NA	3.552	5.321	NA
L100605BRS00	L100605BRQ00	Th-232	1.07	0.187	1.14	0.135	1.105	2.0	0.070	0.283	0.424	N
L100605BRS00	L100605BRQ00	U-234[1]	2.849	N/A	0.675	N/A	1.762	195.4	2.174	27.649	41.425	N
L100605BRS00	L100605BRQ00	U-235	0.152	0.196	0.0297	0.254	0.091	51.6	NA	7.301	10.939	NA
L100605BRS00	L100605BRQ00	U-238	1.43	1.04	0.96	0.807	1.195	168.8	0.470	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 10-06 Sys SOF Only

0.1
0.1
0.2
0.1
0.1
0.1
0.2
0.1
0.1

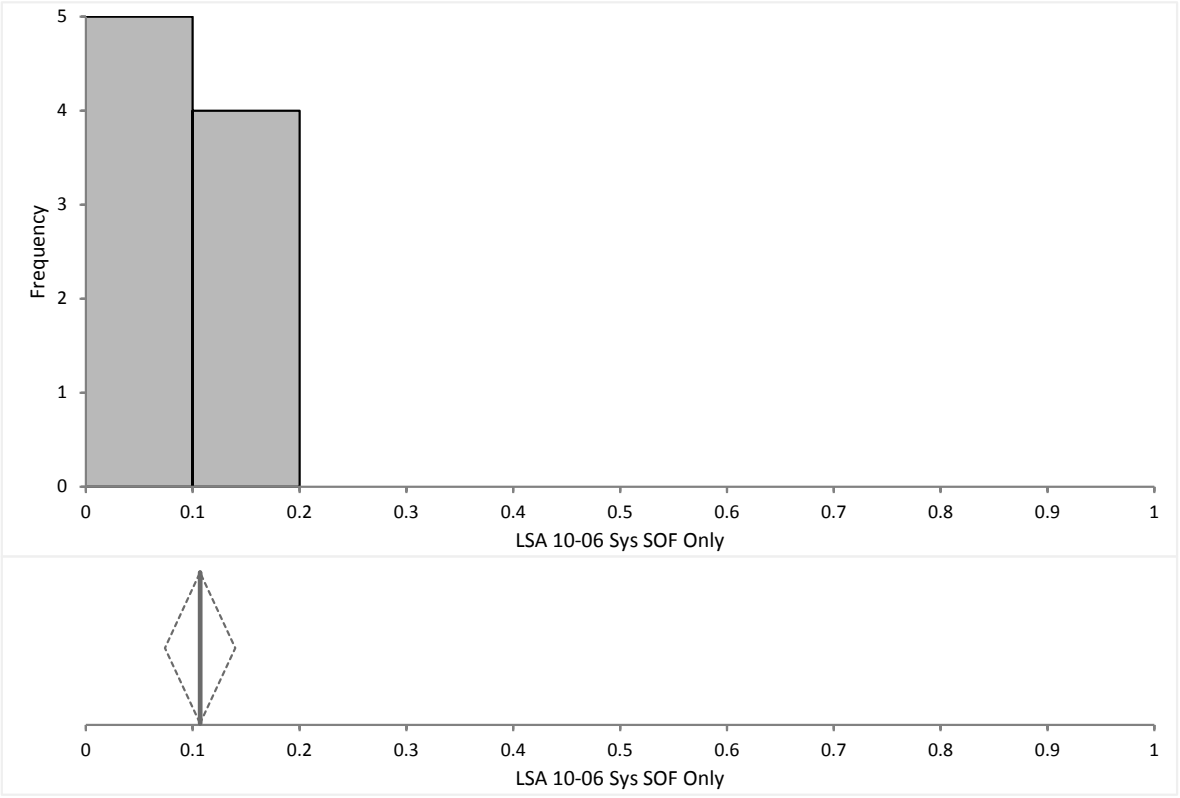
Distribution: LSA 10-06 Sys SOF Only

Analyse-it v4.65.2

SOFn Only A1:A10

Last updated 6 January 2017 at 15:54 by W. Clark Evers

Descriptives



	N
	9

	Mean	95% CI	Mean SE	SD	Variance	Skewness	Kurtosis
LSA 10-06 Sys SOF Only	0.11	0.07 to 0.14	0.014	0.04	0.00	0.4	-1.53

	Minimum	1st quartile	Median	96.09% CI	3rd quartile	Maximum	IQR
LSA 10-06 Sys SOF Only	0.1	0.07	0.09	0.06 to 0.15	0.15	0.2	0.08