MAINE YANKEE
FINAL STATUS SURVEY RELEASE RECORD
FR-0111 YARD WEST EXCAVATIONS
SURVEY UNIT 18

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A. SURVEY UNIT DESCRIPTION

FR-0111 Yard West Excavations Survey Unit 18 was located East of the former Containment Building and encompasses a partial footprint of the Service Building slab. The survey unit's total area is 997 m^2. The survey unit was centered near coordinates 407,550 N and 623,975E using Maine State Coordinate System (West Zone) NAD 1927 as shown on map FR0111-18 SITE. The location of the survey unit in relation to the Containment Building and the surrounding FR-0111 survey units is shown on map FR0111-18 REF (Attachment 1). The survey unit consists mainly of soil and backfill material. Except as indicated on map FR0111-18c, the survey unit is relatively flat.

B. SURVEY UNIT DESIGN INFORMATION

Survey Unit 18 met the LTP Revision 4 definition for a Class 1 survey unit. The survey unit design parameters are shown in Table 1. Given a relative shift of 0.8, it was determined that 40 direct measurements were required for the Sign Test. The measurement locations were based on a systematic square grid with a random start point, which are illustrated on map FR0111-18a (Attachment 1). Direct measurements (soil samples) were collected from required locations and analyzed with laboratory gamma spectroscopy instrumentation.

In accordance with the LTP, scans covering 100% of the 997 m^2 area were required for the Class 1 survey unit. This was accomplished by use of an *in situ* gamma spectroscopy detector (ISOCS) configured at a 3-meter distance from the surface to obtain overlapping 28-m^2 fields of view. The ISOCS detector was positioned perpendicular to the surface, as appropriate, to provide 100% scan coverage of the surface. Locations and orientation of the 63 survey scans are shown on maps FR0111-18b and FR0111-18c.

The ISOCS scans were configured to ensure 100% scan coverage of all exposed surfaces within Survey Unit 18. The survey instruments used are listed by model and serial number in Attachment 2 (Table 2-1). Scan MDCs are also listed in Attachment 2 (Table 2-2) and are compared to the DCGL, the investigation level, and the $DCGL_{EMC}$. The scan MDC is less than the scan investigation level, thus providing high confidence (95% or higher) that an elevated area would be detected in the scanning process. Further, since the investigation level was always less than the design $DCGL_{EMC}$, no EMC sample size adjustment was necessary.

TABLE 1

SURVEY UNIT DESIGN PARAMETERS

Survey Unit	Design Criteria	Basis
Area	997 m^2	Class 1, < 2,000 m^2
Number of Direct Measurements Required	40	Based on an LBGR of 1.2 pCi/g, sigma[1] of 1.33 pCi/g, and a relative shift of 0.8. Type I = Type II = 0.05
Sample Area	24.93 m^2	997 m^2 / 40 = 24.93 m^2
Sample Grid Spacing	5.0 m	$(24.93)^{1/2}$
Scan Grid Area	ISOCS scan at 3-meters	See Section B
Area Factor	1.8	Class 1 Area, LTP Table 6-12
Scan Area	997 m^2	Class 1 Area – 100%
Scan Investigation Level	1.0 pCi/g Cs-137 0.36 pCi/g Co-60	ISOCS investigation levels with detector at 3-meter height (Reference 3)
DCGL	2.39 pCi/g Cs-137 0.86 pCi/g Co-60	Reference 1
Design $DCGL_{EMC}$	4.30 pCi/g Cs-137 1.55 pCi/g Co-60	DCGL x Area Factor for Class 1 survey unit, per LTP Section 5.6.3

C. SURVEY RESULTS

A total of 40 direct measurements were performed in Survey Unit 18. Two samples contained Cs-137 with levels of residual activity below the DCGL. All other measurements were below the MDA. The results are presented in Table 2.

ISOCS gamma scans were performed at 63 locations using an investigation level of 1.0 pCi/g Cs-137 and 0.36 pCi/g Co-60. Media appropriate geometries were applied to each ISOCS measurement. The gamma scans were performed for a sufficient count time to achieve a Minimum Detectable Activity (MDA) below 30% of the DCGL. All identified scan activity levels and MDAs were below the investigation levels. Therefore, no investigation surveys were performed as a result of the scan surveys.

[1] LTP Revision 4, Table 5-1C for RCA Yard West, R0100

TABLE 2

DIRECT MEASUREMENTS

Sample Number	Cs-137 (pCi/g)	Uncertainty (pCi/g)
FR0111181S001	< 4.35E-02	
FR0111181S002	< 4.24E-02	
FR0111181S003	< 5.14E-02	
FR0111181S004	< 4.73E-02	
FR0111181S005	< 3.92E-02	
FR0111181S006	< 3.98E-02	
FR0111181S007	< 4.59E-02	
FR0111181S008	< 4.06E-02	
FR0111181S009	< 4.46E-02	
FR0111181S010	< 4.09E-02	
FR0111181S011	< 5.62E-02	
FR0111181S012	< 4.13E-02	
FR0111181S013	< 4.53E-02	
FR0111181S014	< 4.01E-02	
FR0111181S015	< 4.43E-02	
FR0111181S016	< 3.72E-02	
FR0111181S017	< 4.62E-02	
FR0111181S018	< 4.33E-02	
FR0111181S019	< 4.08E-02	
FR0111181S020	**8.75E-02**	**2.65E-02**
FR0111181S021	< 5.08E-02	
FR0111181S022	< 4.80E-02	
FR0111181S023	< 3.98E-02	
FR0111181S024	< 4.74E-02	
FR0111181S025	< 4.82E-02	
FR0111181S026	< 3.97E-02	
FR0111181S027	< 4.39E-02	
FR0111181S028	< 4.50E-02	
FR0111181S029	< 5.24E-02	
FR0111181S030	**1.03E-01**	**2.94E-02**
FR0111181S031	< 5.38E-02	
FR0111181S032	< 4.10E-02	
FR0111181S033	< 4.47E-02	
FR0111181S034	< 4.11E-02	
FR0111181S035	< 4.42E-02	
FR0111181S036	< 4.18E-02	
FR0111181S037	< 4.35E-02	
FR0111181S038	< 4.58E-02	
FR0111181S039	< 4.41E-02	
FR0111181S040	< 5.63E-02	
Mean	**4.73E-02**	
Median	**4.43E-02**	
Standard Deviation	**1.22E-02**	
Range	**3.72E-02 to 1.03E-01**	

"<" indicates MDA value. Bold indicates positive detection value.
All Co-60 results were <MDA.

D. SURVEY UNIT INVESTIGATIONS PERFORMED AND RESULTS

Based on the scan results, no investigations were required.

E. SURVEY UNIT DATA ASSESSMENT

An analysis of the direct sample measurement results, including the mean, median, standard deviation, and sample result range, is provided in Table 2. Positively detected values are bolded in the table. Of the 40 soil samples collected, two identified Cs-137 activity below the DCGL value of 2.39 pCi/g. All other values were below the MDA. Identified sample activities or Minimum Detectable Activities for Cs-137 are listed in Table 2. The mean and median activities were less than the DCGL. The average of the Cs-137 direct measurements was 0.0473 pCi/g, indicating that the direct measurements averaged 1.98% of the DCGL limit.

For illustrative purposes, as indicated in LTP Section 5.9.3, a simplified general retrospective dose estimate can be calculated from the average residual contamination level by subtracting the mean fallout Cs-137 value (0.19 pCi/g)[2] for disturbed soil from the survey unit sample mean activity (0.047 pCi/g). This would equate to an annual dose rate of 0.0 mrem/year. However, for purposes of demonstrating compliance with the radiological criteria for license termination and the enhanced State criteria, background activity was not subtracted from the sample analysis activity values.

F. ADDITIONAL DATA EVALUATION

Attachment 4 provides additional data evaluation associated with this survey unit, including relevant statistical information. Based on survey unit direct measurement data, this attachment provides the Sign Test Summary, Quantile Plot, Histogram, and Retrospective Power Curve.

1. The Sign Test Summary provides an overall summary of design input (Table 1) and resulting calculated values used to determine the required number (N) of direct measurements (per LTP Section 5.4.2). The Sign Test Summary is a separate statistical analysis that also calculates the mean, median, and standard deviation of the direct measurements.

   The critical value and the result of the Sign Test are provided in the Sign Test Summary table, as well as a listing of the key release criteria. The direct measurements clearly pass the Sign Test. The subject release criteria have been satisfied. In addition, the sample standard deviation is smaller than the design sigma; therefore, no additional samples were required.

2. The Quantile Plot was generated from the data listed in Table 2. The data set and plot are consistent with expectations for a Class 1 survey unit. All of the measurements are below the DCGL of 2.39 pCi/g for Cs-137 for land inside the Restricted Area.

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[2] See Attachment E to Maine Yankee Procedure PMP 6.7.8 (Reference 2).

3. A Histogram Plot was also developed based on the Cs-137 data values. This plot shows a log-normal distribution with two outliers.

4. A Retrospective Power Curve was constructed, based on FSS results. The curve shows that this survey unit having a mean residual activity at a small fraction of the DCGL has a high probability ("power") of meeting the release criteria. Thus, it can be concluded that the direct measurement data support rejection of the null hypothesis, providing high confidence that the survey unit satisfied the release criteria and that the data quality objectives were met.

G. CHANGES IN INITIAL SURVEY UNIT ASSUMPTIONS ON EXTENT OF RESIDUAL ACTIVITY

The survey was designed as a Class 1 land survey area; the FSS results were consistent with that classification. The direct measurement sample standard deviation was less than the design sigma. Thus, a sufficient number of sample measurements were taken and no additional measurements were required.

H. LTP CHANGES SUBSEQUENT TO SURVEY UNIT FSS

The FSS of Survey Unit 18 was designed, performed, and evaluated in the April 2005 time frame. The design was performed to the criteria of the LTP Revision 4 (Reference 1). No subsequent LTP changes with potential impact to this survey unit need to be evaluated.

I. CONCLUSION

The FSS of this survey unit was designed based on the LTP designation as a Class 1 area. The survey design parameters are presented in Table 1. The required number of direct measurements was determined for the Sign Test in accordance with the LTP. As presented in Table 2, all direct measurements were less than the DCGL of 2.39 pCi/g Cs-137.

A Sign Test Summary analysis demonstrated that the Sign Test criteria were satisfied. The direct measurement sigma was determined to be less than that used for design, thus indicating that a sufficient number of samples was taken.

The Retrospective Power Curve shown in Attachment 4 confirmed that sufficient samples were taken to support rejection of the null hypothesis, providing high confidence that the survey unit satisfied the release criteria and the data quality objectives were met. Attachment 4 also revealed that direct measurement data represented essentially a log-normal distribution with two outliers.

The scan survey design for this survey unit was developed in accordance with the LTP Revision 4 (Reference 1) with significant aspects of the design discussed in Section B and Table 1. ISOCS scans performed at a distance of 3 meters in a systematic grid pattern throughout the survey unit did not identify activity above the scan investigation levels of 1.0 pCi/g Cs-137 and 0.36 pCi/g Co-60. Therefore, no investigations were required as a result of the scan process.

It is concluded that FR-0111 Survey Unit 18 meets the release criteria of 10CFR20.1402 and the State of Maine enhanced criteria.

J. REFERENCES

1. Maine Yankee License Termination Plan, Revision 4, February 28, 2005 provided by Maine Yankee letter to the NRC, MN-05-010

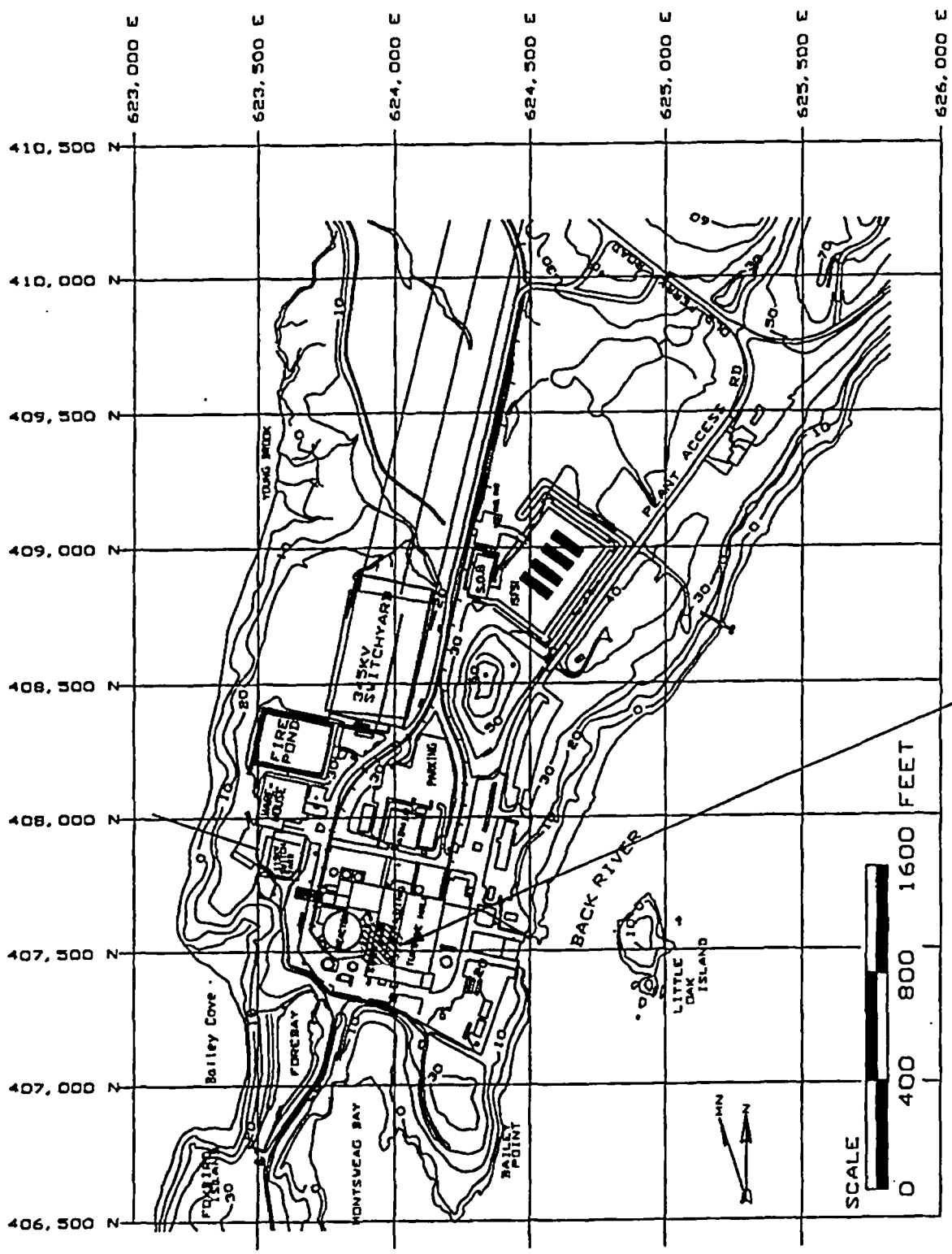
2. Maine Yankee Procedure PMP 6.7.8, FSS Data Processing and Reporting, Attachment E, Approach for Dealing With Background Radioactivity for Maine Yankee Final Status Surveys

3. Maine Yankee Calculation No. EC-003-04, Use of Canberra In Situ Object Counting System (ISOCS) for FSS Surveys

Attachment 1

Survey Unit Maps

Maine Yankee Decommissioning Team	*Maine Yankee Decommissioning Project Survey Form*	Map ID #: FR 0111-18 SITE Revised: 4/14/05
Survey Type: ☐ Characterization ☐ Turnover ■ Final Status Survey	Survey Area Name: RCA Yard West Soils	

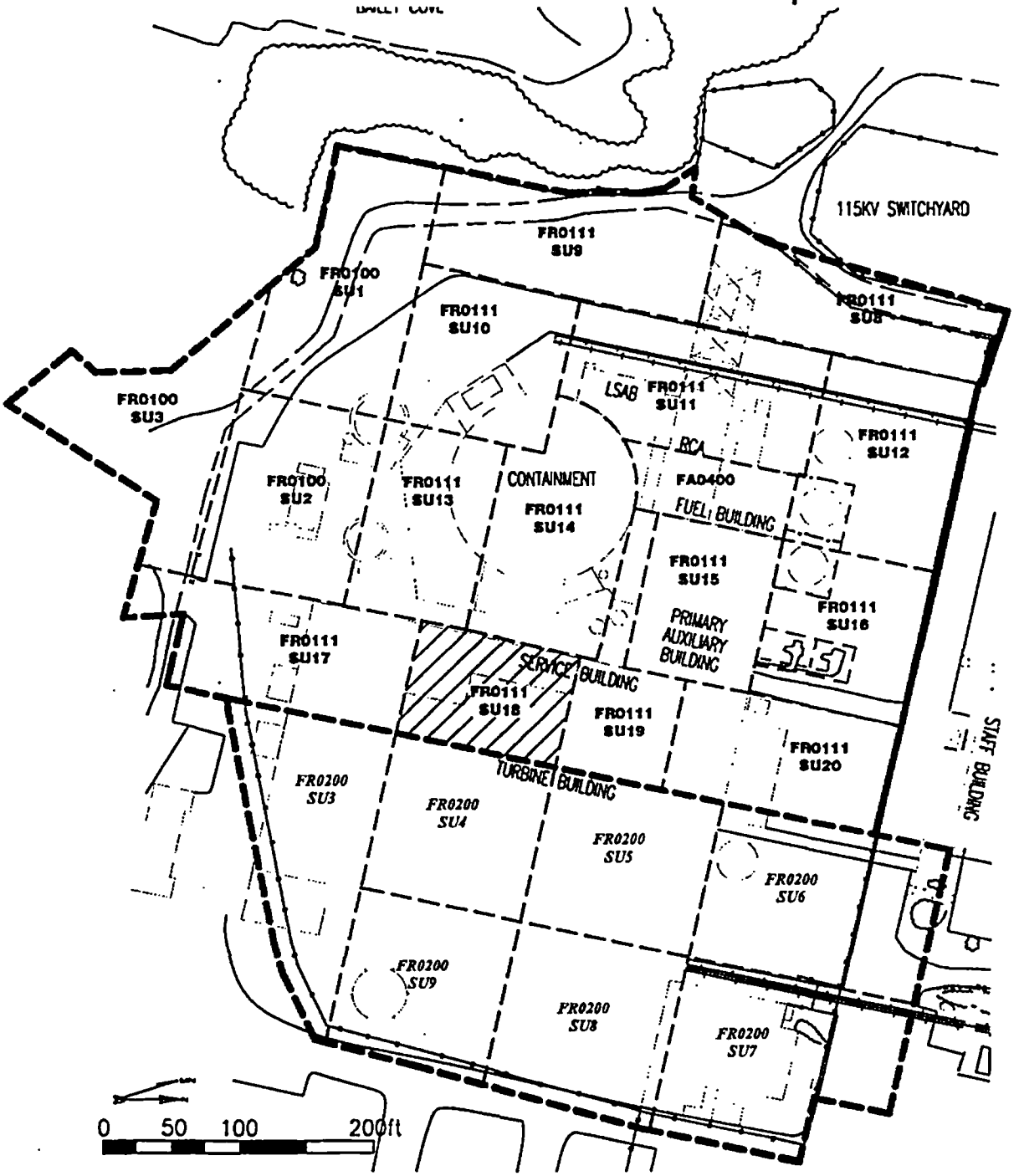


Note: Grid based on Maine State Coordinate System (West Zone) NAD 1927

SURVEY AREA FR 0111, SURVEY UNIT 18

Maine Yankee Decommissioning Team	*Maine Yankee Decommissioning Project Survey Form*	Map ID #: FR0111-18 REF Date: 4/14/05
Survey Type: ☐ Characterization ☐ Turnover ☒ Final Status Survey	Survey Area Name: Yard West Soils	

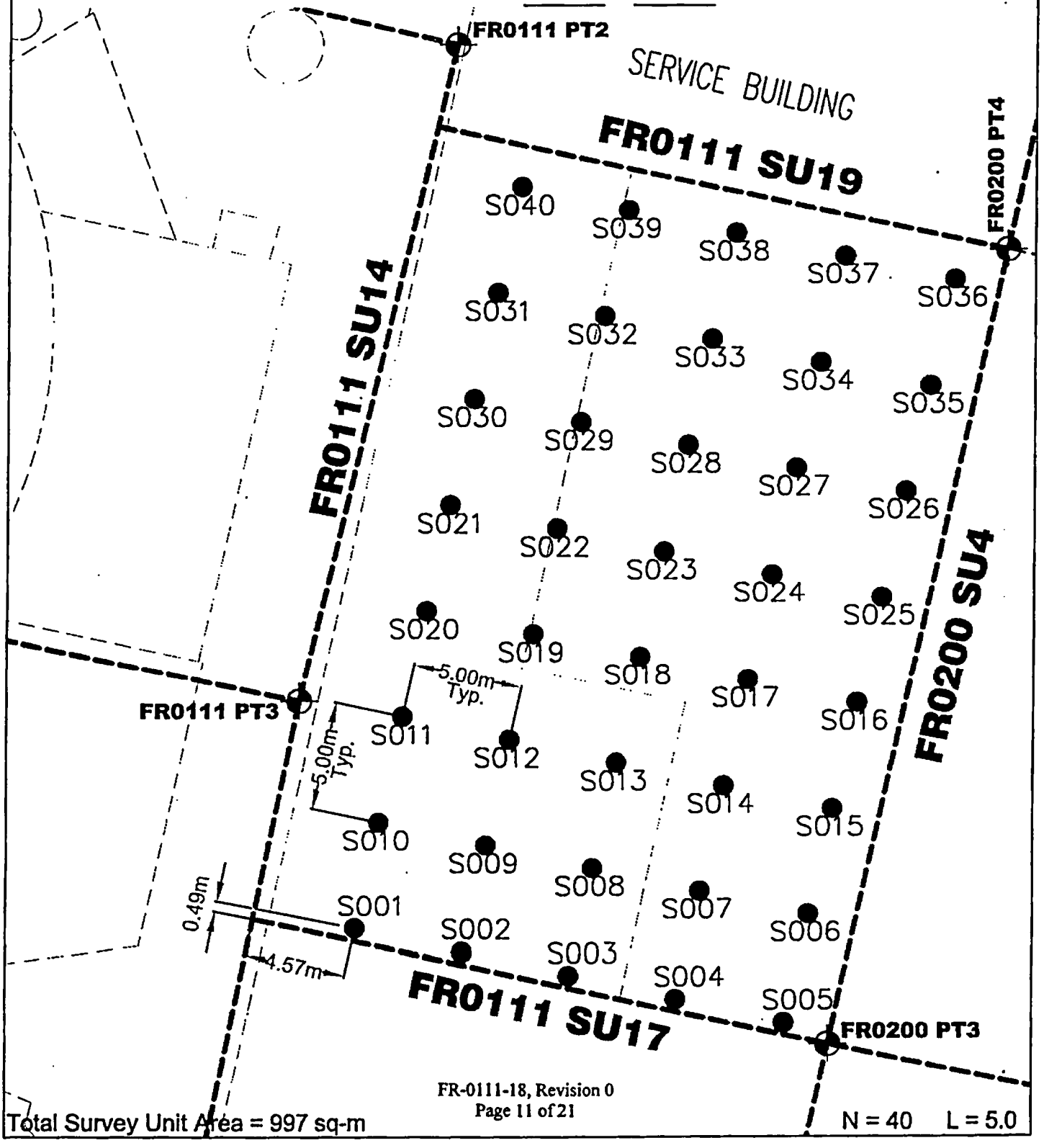
Final Status Survey
FR0111 SU18 Reference Map



FR0111 SU18 Total Survey Unit Area = 997 sq-m

Maine Yankee Decommissioning Team	*Maine Yankee Decommissioning Project Survey Form*	Map ID #: FR0111-18a Date: 4/14/05
Survey Type: ☐ Characterization ☐ Turnover ☒ Final Status Survey	Survey Area Name: Yard West Soils	

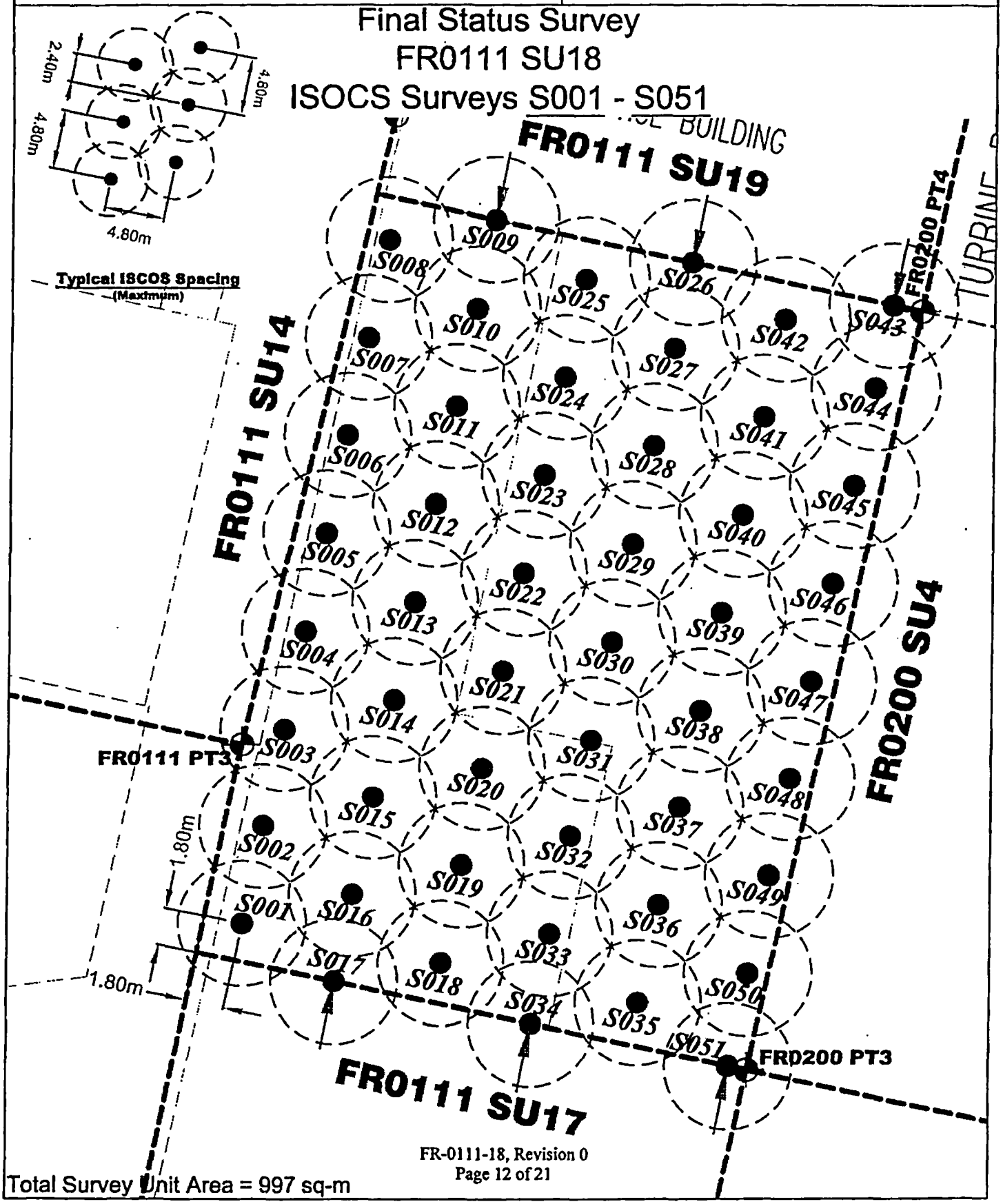
Final Status Survey
FR0111 SU18
Direct Points S001 - S040



Total Survey Unit Area = 997 sq-m

N = 40 L = 5.0

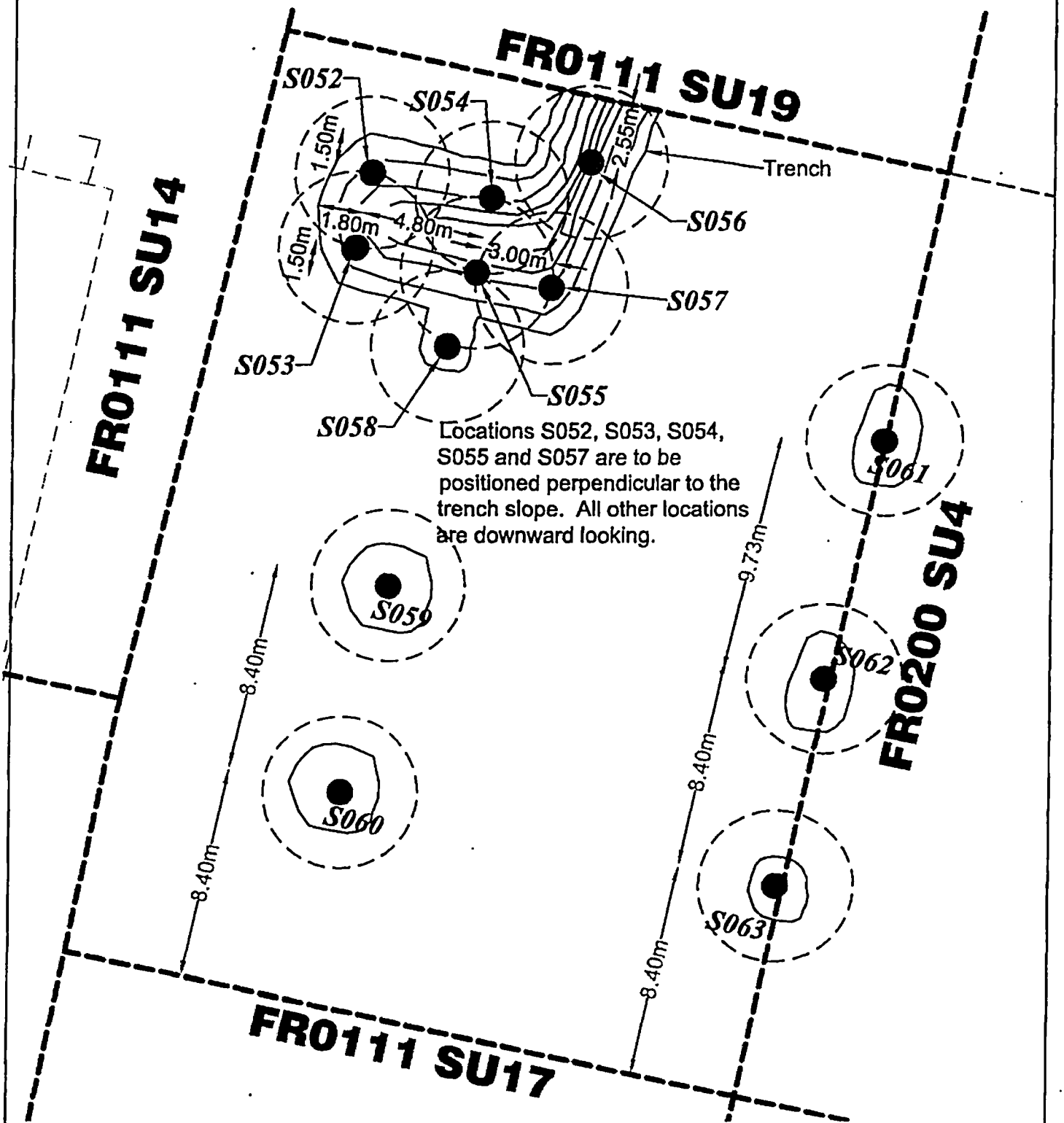
Maine Yankee Decommissioning Team	*Maine Yankee Decommissioning Project Survey Form*	Map ID #: FR0111-18b Date: 4/14/05
Survey Type: ☐ Characterization ☐ Turnover ☒ Final Status Survey	Survey Area Name: Yard West Soils	



Total Survey Unit Area = 997 sq-m

Maine Yankee Decommissioning Team	*Maine Yankee Decommissioning Project Survey Form*	Map ID #: FR0111-18c Date: 4/18/05
Survey Type: ☐ Characterization ☐ Turnover ☒ Final Status Survey	Survey Area Name: Yard West Soils	

Final Status Survey FR0111 SU18
ISOCS Surveys S052 - S063



Total Survey Unit Area = 997 sq-m

Attachment 2

Survey Unit Instrumentation

TABLE 2-1

INSTRUMENT INFORMATION

ISOCS Detectors (Field Measurements)

Detector No.	MDC (pCi/g)
7897	0.139 to 0.292
7780	0.106 to 0.330
7607	0.141 to 0.338

HPGe Detectors (Laboratory Analysis)

Detector No.	MDC (pCi/g)
FSS1	0.0359 to 0.0634
FSS2	0.0372 to 0.0548

TABLE 2-2

INSTRUMENT SCAN MDC, DCGL, INVESTIGATION LEVEL AND $DCGL_{EMC}$

Parameter	Instrument: ISOCS	Comments
Scan MDC	0.139 to 0.338 Cs-137 0.106 to 0.237 Co-60	< 30% DCGL
DCGL	2.39 pCi/g Cs-137 0.86 pCi/g Co-60	Approved DCGL for land areas inside the Restricted Area, (Reference 1)
Investigation Level (ISOCS @ 3 m)	1.0 pCi/g Cs-137 0.36 pCi/g Co-60	(Reference 3)
Design $DCGL_{EMC}$	4.30 pCi/g Cs-137 1.55 pCi/g Co-60	DCGL x Area Factor for Class 1 survey unit, per LTP Section 5.6.3

Attachment 3

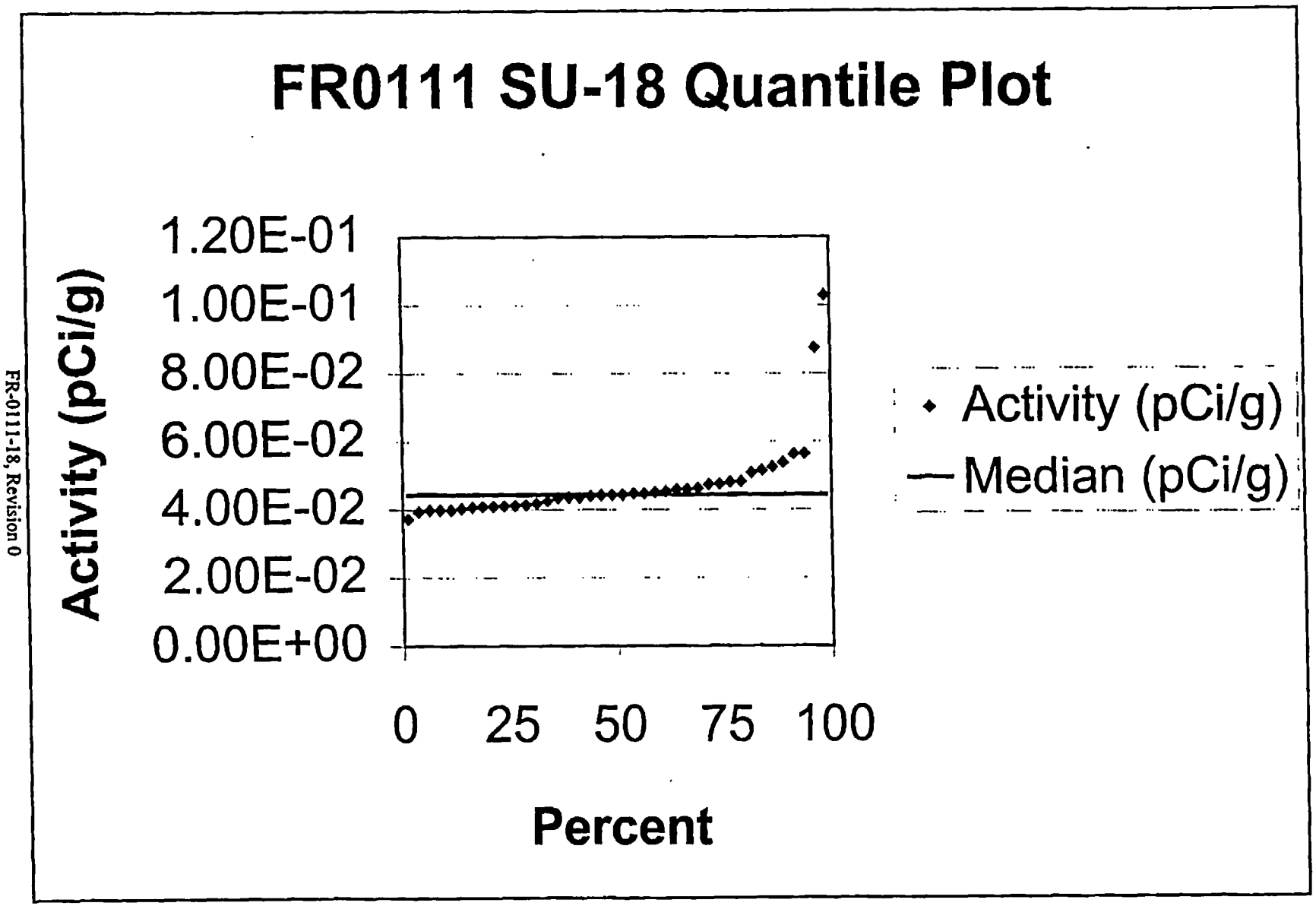
Investigation Table
(not used)

Attachment 4

Statistical Data

Survey Package FR0111 Unit 18 CS-137 Soil Sign Test Summary

Evaluation Data		Comments
Survey Package:	FR0111	
Survey Unit:	18	
Evaluator:	DR	
$DCGL_w$:	2.39E+00	only Cs-137 detected
$DCGL_{emc}$:	4.30E+00	
LBGR:	1.20E+00	
Sigma:	1.33E+00	
Type I error:	0.05	
Type II error:	0.05	
Nuclide:	CS-137	
Soil Type:	N/A	
Calculated Values		**Comments**
$Z_{1-\alpha}$:	1.645	
$Z_{1-\beta}$:	1.645	
Sign p:	0.788145	
Calculated Relative Shift:	0.8	
Relative Shift Used:	0.8	Uses 3.0 if Relative Shift is >3
N-Value:	33	
N-Value+20%:	40	
Sample Data Values		**Comments**
Number of Samples:	40	
Median:	4.43E-02	
Mean:	4.73E-02	
Net Sample Standard Deviation:	1.22E-02	
Total Standard Deviation:	1.22E-02	Sum of samples and reference
Maximum:	1.03E-01	
Sign Test Results		**Comments**
Adjusted N Value:	40	
S+ Value:	40	
Critical Value:	25	
Sign test results:	Pass	
Criteria Satisfaction		**Comments**
Sufficient samples collected:	Pass	
Maximum value <$DCGL_w$:	Pass	
Median value <$DCGL_w$:	Pass	
Mean value <$DCGL_w$:	Pass	
Maximum value <$DCGL_{emc}$:	Pass	
Total Standard Deviation <=Sigma:	Pass	
Criteria comparison results:	Pass	
Final Status		**Comments**
The survey unit passes all conditions:	Pass	SU Passes


FR0111 SU-18 Quantile Plot
Activity (pCi/g)
1.20E-01
1.00E-01
8.00E-02
6.00E-02
4.00E-02
2.00E-02
0.00E+00
0
25
50
75
100
Percent
Activity (pCi/g)
Median (pCi/g)

One-Sample T-Test Report

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Database
Variable C2

Plots Section

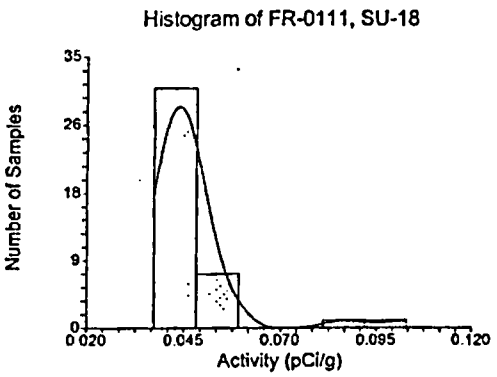

Chart Section