

Appendix A

SNEC CALCULATION COVER SHEET

CALCULATION DESCRIPTION

Calculation Number E900-05-005	Revision Number 0	Effective Date 3/14/05	Page Number 1 of 9
--	-----------------------------	----------------------------------	------------------------------

Subject

Spray Pond - Survey Design

Question 1 - Is this calculation defined as "In QA Scope"? Refer to definition 3.5. Yes No

Question 2 - Is this calculation defined as a "Design Calculation"? Refer to definitions 3.2 and 3.3. Yes No

NOTES: If a "Yes" answer is obtained for Question 1, the calculation must meet the requirements of the SNEC Facility Decommissioning Quality Assurance Plan. If a "Yes" answer is obtained for Question 2, the Calculation Originator's immediate supervisor should not review the calculation as the Technical Reviewer.

DESCRIPTION OF REVISION

APPROVAL SIGNATURES

Calculation Originator	B. Brosey/ <i>B. Brosey</i>	Date	2/9/05
Technical Reviewer	R. Holmes/ <i>R. Holmes</i>	Date	3/10/05
Additional Review	A. Paynter/ <i>A. Paynter</i>	Date	11 March 2005
Additional Review		Date	

SNEC CALCULATION SHEET

Calculation Number E900-05-005	Revision Number 0	Page Number Page 2 of 9
Subject Spray Pond - Survey Design		

1.0 PURPOSE

- 1.1 The purpose of this calculation is to develop a survey design for the Saxton Steam Generating Station (SSGS) "Spray Pond" area which is located in the southwestern section of the SNEC facility site. The Spray Pond area (SP1) is ~6,600 square meters, and is a Class 2 survey unit. This survey unit is shown on **Attachment 1-1**.
- 1.2 SP1 is 60 meters wide by 110 meters long and the actual SSGS Spray Pond location is entirely enclosed within this area.

2.0 SUMMARY OF RESULTS

The following information should be used to develop a survey request for this survey unit. The effective DCGLw values are listed below. The US NRC has reviewed and concurred with the methodology used to derive these values. See **Attachment 2-1 to 2-6**.

Table 1, DCGLw Values

Gross Activity DCGLw (dpm/100 cm ²)	Volumetric DCGLw (pCi/g – Cs-137)
4,802 (3,601 A.L.)	3.94 (2.96 A.L.)

NOTE: A.L. is the site Administrative Limit (75% of effective DCGLw)

2.1 Survey Design

- 2.1.1 Scanning of soil (and fill materials) shall be performed using a **2" D by 2" L NaI detector** with a Cs-137 window setting (**Reference 3.1**). The window will straddle the Cs-137 662 keV full energy peak width (see typical calibration information on **Attachment 3-1**).
- 2.1.2 The instrument conversion factor/efficiency shall not be less than the lowest usable value identified on **Attachment 3-1** as **209 cpm/uR/h – Cs-137**.
- 2.1.3 Other instruments of the type specified in Section 2.1.1 above may be used during the final status survey (FSS), but must demonstrate detection efficiencies at or above the value listed in Section 2.1.2 above.

Table 2, Soil Scanning Parameters

MDCscan (pCi/g) – Cs-137*	Scan Speed (cm/sec)	Maximum Distance from Surface	Action Level	% Coverage
4.9	25	4" (gap between detector face & soil surface)	> 400 gcpm	100%

See Attachment 4-1 through 4-6 for calculations*

Table 3, Surface Scanning Parameters for Solid Misc. Concrete Sections

MDCscan (dpm/100 cm ²)*	Scan Speed (cm/sec)	Maximum Distance from Surface	Action Level	% Coverage
440	10	4" (gap between detector face & surface)	> 400 gcpm	100%

See Attachment 5-1 through 5-3 for calculations*

- 2.1.4 If a count rate greater than the action levels of Tables 2 and 3 are encountered during the scanning process, the surveyor should stop and locate the boundary of the elevated area. The surveyor should then mark the elevated area with stakes or other appropriate marking methods. **Sample the elevated areas(s)** IAW SNEC procedure E900-IMP-4520.04 (**Reference 3.2**), and Section 2.2 of this document.

Calculation Number

E900-05-005

Revision Number

0

Page Number

Page 3 of 9

Subject

Spray Pond - Survey Design

2.1.4.1 **Class 2** soil and concrete surfaces should be scanned using a serpentine pattern that is ~0.5 meters wide.

2.1.4.2 Scanning locations are randomly chosen on a per grid basis and are identified on **Attachment 6-1**. Grids that can not be accessed should be clearly noted along with the reason for not completing the scan in that area.

2.1.5 The minimum number of soil sampling points indicated by the Compass computer program (Reference 3.3) is **16** (see Compass output on **Attachment 7-1 to 7-4**). Sampling depth should be IAW Section 2.2. Because the MDCscan (soil) is above the DCGLW $_{Cs-137}$ (4.9 pCi/g > 2.96 pCi/g), SP1 is assumed to be a Class 1 area for purposes of data entry into the Compass computer program, forcing Compass to calculate the MDCscan and determine the required bounded area size for the number of sampling points assigned. See **Attachment 7-4**.

2.1.6 VSP (Reference 3.4) is used to plot all sampling points on the included diagrams. The actual number of random start systematically spaced measurement points may be greater than that required by the Compass computer code because of any or all of the following:

- placement of the initial random starting point (edge effects),
- odd shaped diagrams, and/or
- coverage concerns

(see **Attachment 8-1** for VSP sampling point locations)

2.1.11 The starting points for physically locating sample sites in the survey unit are based on measurements from site grid pins (see diagram on **Attachment 8-1**). Remaining soil sampling points are positioned using coordinates developed from these markers.

2.1.12 Some sampling points may need to be adjusted to accommodate obstructions within the survey area. Contact the SR coordinator to report any difficulties encountered when laying out systematic grid sampling points.

2.1.13 When an obstruction is encountered that will not allow collection of a sample, **contact the cognizant SR coordinator** for permission to delete the sampling point.

NOTE

If remediation actions are taken as a result of this survey, this survey design must be revised or re-written entirely.

2.2 Sample elevated areas(s) IAW SNEC procedure E900-IMP-4520.04 (Reference 3.2) and the following.

NOTE

Since the site surface dose model is 1 meter in depth, 1 meter deep samples must be collected to satisfy the initial sampling requirements of Section 2.1.6 (of this document). Section 4.2.3, 4.2.6 or 4.2.7 of site procedure E900-IMP-4520.04 are applicable when satisfying Section 2.1.6. Sampling due to an instrument alarm condition should be the upper six (6) inches of soil/material.

Calculation Number E900-05-005	Revision Number 0	Page Number Page 4 of 9
Subject Spray Pond - Survey Design		

- 2.2.1 Subsurface sampling in the eastern portion of SP1 where building debris was deposited, should penetrate the building rubble depth and access the base soil below the rubble. Collect a sample for each meter of depth below the surface model to the base depth. Base soil sample depth should be enough to collect one sample (~6 inches).
- 2.2.2 Clearly mark, identify and document all sample locations.
- 2.3.1 Sample any location that is above the action level cited in Table 2 and 3.
- 2.3.2 Sampling of concrete materials (at a minimum) should remove the first 1" of material and yield a volume of at least 200 cc to ensure an adequate counting MDA for Cs-137 (a 4" diameter area by 1" deep = ~200 cc). As an alternative, a four (4) inch core bore may be taken (as applicable).

3.0 REFERENCES

- 3.1 SNEC Calculation No. E900-03-018, "Optimize Window and Threshold Settings for the Detection of Cs-137 Using the Ludlum 2350-1 and a 44/10 NaI Detector", 8/7/03.
- 3.2 SNEC Procedure E900-IMP-4520.04, "Survey Methodology to Support SNEC License Termination".
- 3.3 Compass Computer Program, Version 1.0.0, Oak Ridge Institute for Science and Education.
- 3.4 Visual Sample Plan, Version 2.0 (or greater), Copyright 2002, Battelle Memorial Institute.
- 3.5 Plan SNEC Facility License Termination Plan.
- 3.6 SNEC Procedure E900-IMP-4500.59, "Final Site Survey Planning and DQA".
- 3.7 SNEC Facility Survey Request No.'s SR-133 & SR-134, "Spray Pond".
- 3.8 GPU Nuclear, SNEC Facility, "Site Area Grid Map", SNECRM-020, Sheet 1, Rev 2, 1/29/03.
- 3.9 SNEC Calculation No. E900-03-012, Effective DCGL Worksheet Verification.
- 3.10 SNEC Calculation No. E900-05-006, "Alternate Source Jig".
- 3.11 SNEC Procedure E900-IMP-4520.06, "Survey Unit Inspection in Support of FSS Design".
- 3.12 NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual", August, 2000.
- 3.13 Microsoft Excel 97, Microsoft Corporation Inc., SR-2, 1985-1997.

4.0 ASSUMPTIONS AND BASIC DATA

- 4.1 The Compass computer program is used to calculate the required number of random start systematic samples to be taken in the survey unit (Reference 3.3).
- 4.2 Scoping and characterization soil samples from this area are used as the initial estimate of variability. These results are shown on Attachment 9-1 to 9-2. The grid locations where these samples were taken are shown on Attachment 9-3.
- 4.3 The MARSSIM Sign Test will be applicable for this survey design. No background subtraction will be performed under this criteria during the DQA phase.

Calculation Number E900-05-005	Revision Number 0	Page Number Page 5 of 9
Subject Spray Pond - Survey Design		

- 4.4 The number of points chosen by Compass are located on the survey map for the survey unit by the Visual Sample Plan (VSP) computer code (Reference 3.4).
- 4.5 Reference 3.5 and 3.6 were used as guidance during the survey design development phase.
- 4.6 Background has been measured in the SP1 area, and ranges from about 100 cpm to about 400 cpm (Reference 3.7).
- 4.7 The site area drawing used to determine the physical extent of this area is listed as Reference 3.8.
- 4.8 Remediation History

SP1 is a layered site area. River sediment, SSGS building rubble, fly ash and native soils are found in this area. However, no remediation has been performed in the Spray Pond area as a result of scoping or characterization activities. Extensive sampling at various elevations has convinced SNEC personnel that this area is below the DCGLw and qualifies as a Class 2 survey unit. More than one hundred and thirty (130) samples have been taken from this area (see Attachment 9-1 and 9-2). The maximum range of Cs-137 activity found has not exceeded the DCGLw administrative limit of Table 1. Sampling at depth (to several meters) has also concluded that this area is below the DCGLw A.L.

When in operation, the Spray Pond received hot water from the SSGS facility. The water/steam was first sent to the Seal Chambers then through the Discharge Tunnel to the Spray Pump and finally out the Spray Pump line to the Spray Pond. Thus the radionuclide concentration mix should be similar to the Discharge Tunnel mix. The Discharge Tunnel mix was based on a significant number of samples and yielded a gross activity surface DCGLw of 6,726 dpm/100 cm² (A.L.), and a volumetric DCGLw of 4.89 pCi/g (Cs-137 A.L.). Thus the effective DCGLw values established for the Spray Pond in Table 1 are considered a conservative mix for this survey unit.

- 4.9 This survey design uses Cs-137 as a surrogate to bound the average concentration for all SNEC facility related radionuclides in the survey unit. The effective DCGLw is just the permitted Cs-137 concentration (6.6 pCi/g) lowered to compensate for the presence (or potential presence) of other SNEC related radionuclides. In addition, an administrative limit (75%) has been set that further lowers the permissible Cs-137 concentration to an effective DCGLw for this radionuclide.
- 4.10 The sample database used to determine the effective radionuclide mix for the SP1 area has been drawn from samples that were assayed at off-site laboratories. This list is shown on Attachment 2-1 through 2-6, and includes (21) analysis results. Review of the data shows several radionuclides have not been positively identified at any significant concentration. These radionuclides have been removed from the data set and will not be considered further. Radionuclides removed include H-3, Sr-90, Co-60, Eu-152, Ni-63, Pu-238, and Pu-41. Additionally, the data shows Cs-137 to be the predominant radioactive contaminant found in the area.

The decayed set of sample results were input to the spreadsheet titled "Effective DCGL Calculator for Cs-137" (Reference 3.9) to determine the effective volumetric DCGLw values for the SP1 area. The output of this spreadsheet is shown on Attachment 2-5. Additionally, Attachment 2-6 provides the surface gross activity DCGLw value for the mix.

Calculation Number E900-05-005	Revision Number 0	Page Number Page 6 of 9
Subject Spray Pond - Survey Design		

- 4.11 For purposes of this calculation, concrete materials are scanned using the same methodology as that used for soil. However, a slower scan rate is used.
- 4.12 The NaI scan MDC calculation is determined based on a 10 or 25 cm/sec scan rate, a 1.38 index of sensitivity (95% correct detection probability and 60% false positive) and a detector sensitivity of 209 cpm/uR/h for Cs-137. Additionally, the detection system incorporates a Cs-137 window that lowers sensitivity to background in the survey unit. The resulting range of background values varies from about 100 cpm to ~400 cpm, but for most locations in SP1 it lies between 100 and 200 cpm. Additionally, two attenuation factors must be considered. They are:
- Attenuation for moisture in the soil,
 - Attenuation from the heater pack used on the NaI instrument during cold weather.

To compensate for soil moisture several sample from the site were weighed, dried and re-weighed. The mean moisture content was determined to be approximately 18% by weight. Therefore, a reduction in count rate would be expected for wet soil. If the soil model is 6" thick and the density is assumed to be 1.6 g/cc then the weight of the standard soil model used in MicroShield would be $\sim 3.8E04 \text{ cm}^3 \times 1.6 \text{ g/cc} = \sim 6.1E04 \text{ grams}$. The moisture content is then $0.18 \times 6.1E04 \text{ grams} = 1.1E04 \text{ grams}$ of water in this volume of modeled soil. These calculations are carried out in the spreadsheet of **Attachment 4-3** with the results incorporated as a water shield over the modeled soil volume (see **Attachment 4-4** and **4-5**). The attenuation factor is included in the MDCscan calculation of **Attachment 4-1**. The count rate loss due to moisture in typical wet site soil is approximately 18%.

The NaI detector heater wrap has been checked in terms of its attenuation effect and has been found to reduce the count rate from a Cs-137 source by no more than 3% (see **Reference 3.10**). This reduction in counting efficiency has been incorporated into both MDCscan calculations shown on **Attachment 4-1** and **5-1**.

- 4.13 The survey unit described in this survey design was inspected after remediation efforts were shown effective. A copy of portions of the SNEC facility post-remediation inspection report (**Reference 3.11**), is included as **Attachment 10-1** to **10-2**.
- 4.14 No special area characteristics including any additional residual radioactivity (not previously noted during characterization) have been identified in this survey area.
- 4.15 The decision error for this survey design is 0.05 for the α value and 0.1 for the β value.
- 4.16 "Special measurements" (as described in the SNEC LTP) are not included in this survey design.
- 4.17 No additional sampling will be performed IAW this survey design beyond that described herein.
- 4.18 SNEC site radionuclides and their individual DCGLw values are listed on **Exhibit 1** of this calculation.
- 4.19 The survey design checklist is listed in **Exhibit 2**.
- 4.20 Area factors are shown as part of Compass output (see **Attachment 7-1**).

Calculation Number E900-05-005	Revision Number 0	Page Number Page 7 of 9
Subject Spray Pond - Survey Design		

5.0 CALCULATIONS

- 5.1 All calculations are performed internal to applicable computer codes or within an Excel spreadsheet.

6.0 APPENDICES

- 6.1 Attachment 1-1, is a diagram of survey unit SL1 (Spray Pond).
- 6.2 Attachment 2-1 to 2-6 is the sample results from the SL1 area in addition to the DCGL calculation sheets (decayed to January 15, 2005).
- 6.3 Attachment 3-1, is a copy of the calibration data from typical NaI radiation detection instrumentation that will be used in this survey area.
- 6.4 Attachment 4-1 and 4-2, are the MDCscan calculation sheets for volumetric materials in pCi/g.
- 6.4.11 Attachment 4-3, is the moisture estimate for typical site soils.
- 6.4.12 Attachment 4-4, is a MicroShield model of a soil volume used to determine the exposure rate from a 1 pCi/g Cs-137 source term in a cylindrical geometry of six (6) inches in depth for an assumed density of 1.6 g/cc.
- 6.4.13 Attachment 4-5, is the same MicroShield model geometry with the addition of a .1" water shield to simulate the attenuation of the water content of wet site soils.
- 6.5 Attachment 5-1 and 5-2, are the MDCscan calculation sheets for surface activities in dpm/100 cm².
- 6.5.11 Attachment 5-3, is a MicroShield model of a surface deposition used to determine the exposure rate from a 1 pCi/cm² Cs-137 source term in a disk geometry.
- 6.6 Attachment 6-1, are randomly picked scan locations (from VSP) for the SP1 area.
- 6.7 Attachment 7-1 through 7-4, are Compass output for the SP1 area showing the number of sampling points in the survey unit.
- 6.8 Attachment 8-1, is the sample point locations with dimensions for the survey unit.
- 6.9 Attachment 9-1 to 9-3, is the soil variability results for selected soil samples from the SP1 area. Attachment 9-3 shows the grid locations sampled.
- 6.10 Attachment 10-1 and 10-2, is the results of the inspection report for the SP1 area.

Calculation Number E900-05-005	Revision Number 0	Page Number Page 8 of 9
Subject Spray Pond - Survey Design		

Exhibit 1

SNEC Facility Individual Radionuclide DCGL Values ^(a)

Radionuclide	25 mrem/y Limit Surface Area (dpm/100cm ²)	25 mrem/y Limit (All Pathways) Open Land Areas (Surface & Subsurface) (pCi/g)	4 mrem/y Goal (Drinking Water) Open Land Areas ^(b) (Surface & Subsurface) (pCi/g)
Am-241	2.7E+01	9.9	2.3
C-14	3.7E+06	2	5.4
Co-60	7.1E+03	3.5	67
Cs-137	2.8E+04	6.6	397
Eu-152	1.3E+04	10.1	1440
H-3	1.2E+08	132	31.1
Ni-63	1.8E+06	747	1.9E+04
Pu-238	3.0E+01	1.8	0.41
Pu-239	2.8E+01	1.6	0.37
Pu-241	8.8E+02	86	19.8
Sr-90	8.7E+03	1.2	0.61

NOTES:

(a) While drinking water DCGLs will be used by SNEC to meet the drinking water 4 mrem/y goal, only the DCGL values that constitute the 25 mrem/y regulatory limit will be controlled under this LTP and the NRC's approving license amendment.

(b) Listed values are from the subsurface model. These values are the most conservative values between the two models (i.e., surface & subsurface).

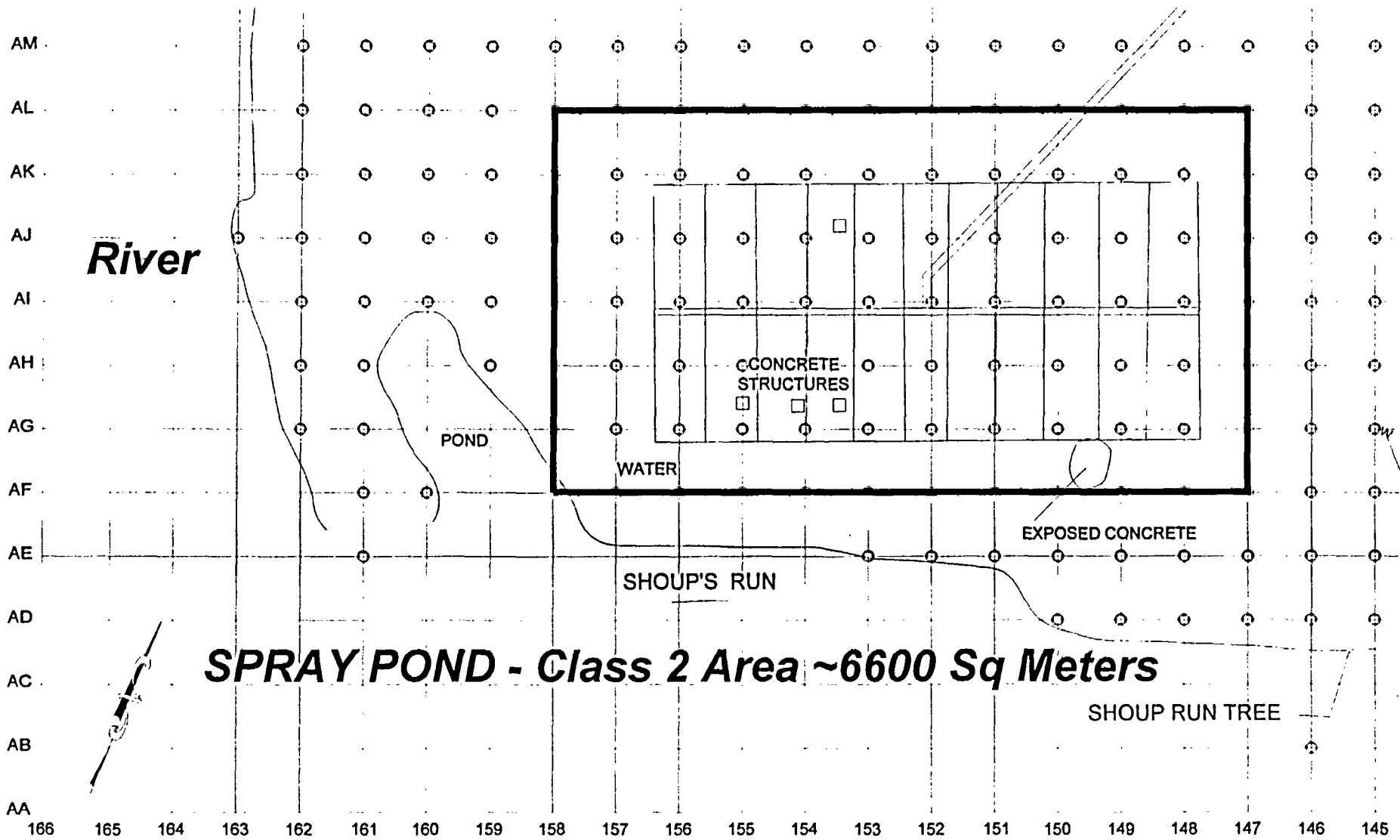
SNEC CALCULATION SHEET

Calculation Number E900-05-005	Revision Number 0	Page Number Page 9 of 9
Subject Spray Pond - Survey Design		

Exhibit 2 Survey Design Checklist

ITEM	REVIEW FOCUS	Status (Circle One)	Reviewer Initials & Date
Calculation No. E900-05-005 Location Codes SP1 (Spray Pond)			
1	Has a survey design calculation number been assigned and is a survey design summary description provided?	<input checked="" type="radio"/> Yes, <input type="radio"/> N/A	ASL 3/6/05
2	Are drawings/diagrams adequate for the subject area (drawings should have compass headings)?	<input checked="" type="radio"/> Yes, <input type="radio"/> N/A	ASL 3/10/05
3	Are boundaries properly identified and is the survey area classification clearly indicated?	<input checked="" type="radio"/> Yes, <input type="radio"/> N/A	ASL 3/19/05
4	Has the survey area(s) been properly divided into survey units IAW EXHIBIT 10	<input checked="" type="radio"/> Yes, <input type="radio"/> N/A	ASL 3/19/05
5	Are physical characteristics of the area/location or system documented?	<input checked="" type="radio"/> Yes, <input type="radio"/> N/A	ASL 3/19/05
6	Is a remediation effectiveness discussion included?	Yes, <input checked="" type="radio"/> N/A	ASL 3/19/05
7	Have characterization survey and/or sampling results been converted to units that are comparable to applicable DCGL values?	<input checked="" type="radio"/> Yes, <input type="radio"/> N/A	ASL 3/10/05
8	Is survey and/or sampling data that was used for determining survey unit variance included?	<input checked="" type="radio"/> Yes, <input type="radio"/> N/A	ASL 3/19/05
9	Is a description of the background reference areas (or materials) and their survey and/or sampling results included along with a justification for their selection?	Yes, <input type="radio"/> N/A	ASL 3/19/05
10	Are applicable survey and/or sampling data that was used to determine variability included?	<input checked="" type="radio"/> Yes, <input type="radio"/> N/A	ASL 3/10/05
11	Will the condition of the survey area have an impact on the survey design, and has the probable impact been considered in the design?	Yes, <input checked="" type="radio"/> N/A	ASL 3/10/05
12	Has any special area characteristic including any additional residual radioactivity (not previously noted during characterization) been identified along with its impact on survey design?	Yes, <input checked="" type="radio"/> N/A	ASL 3/10/05
13	Are all necessary supporting calculations and/or site procedures referenced or included?	<input checked="" type="radio"/> Yes, <input type="radio"/> N/A	ASL 3/10/05
14	Has an effective DCGLw been identified for the survey unit(s)?	<input checked="" type="radio"/> Yes, <input type="radio"/> N/A	ASL 3/10/05
15	Was the appropriate DCGL _{EMC} included in the survey design calculation?	<input checked="" type="radio"/> Yes, <input type="radio"/> N/A	ASL 3/10/05
16	Has the statistical tests that will be used to evaluate the data been identified?	<input checked="" type="radio"/> Yes, <input type="radio"/> N/A	ASL 3/10/05
17	Has an elevated measurement comparison been performed (Class 1 Area)?	Yes, <input checked="" type="radio"/> N/A	ASL 3/10/05
18	Has the decision error levels been identified and are the necessary justifications provided?	<input checked="" type="radio"/> Yes, <input type="radio"/> N/A	ASL 3/10/05
19	Has scan instrumentation been identified along with the assigned scanning methodology?	<input checked="" type="radio"/> Yes, <input type="radio"/> N/A	ASL 3/19/05
20	Has the scan rate been identified, and is the MDCscan adequate for the survey design?	<input checked="" type="radio"/> Yes, <input type="radio"/> N/A	ASL 3/19/05
21	Are special measurements e.g., in-situ gamma-ray spectroscopy required under this design, and is the survey methodology, and evaluation methods described?	Yes, <input checked="" type="radio"/> N/A	ASL 3/19/05
22	Is survey instrumentation calibration data included and are detection sensitivities adequate?	<input checked="" type="radio"/> Yes, <input type="radio"/> N/A	ASL 3/19/05
23	Have the assigned sample and/or measurement locations been clearly identified on a diagram or CAD drawing of the survey area(s) along with their coordinates?	<input checked="" type="radio"/> Yes, <input type="radio"/> N/A	ASL 3/19/05
24	Are investigation levels and administrative limits adequate, and are any associated actions clearly indicated?	<input checked="" type="radio"/> Yes, <input type="radio"/> N/A	ASL 3/10/05
25	For sample analysis, have the required MDA values been determined?	Yes, <input checked="" type="radio"/> N/A	ASL 3/10/05
26	Has any special sampling methodology been identified other than provided in Reference 6.3?	Yes, <input checked="" type="radio"/> N/A	ASL 3/10/05

NOTE: a copy of this completed form or equivalent, shall be included within the survey design calculation.



SPRAY POND - Class 2 Area ~6600 Sq Meters

DCGLw Calculation Logic – Spray Pond

- I. **Survey Unit:** Spray Pond (SP1), Class 2 Area
- II. **Description:** The purpose of this calculation is to determine from available sample analyses results, a representative isotopic mix for the Spray Pond. The effective volumetric DCGLw and surface gross activity DCGLw are then determined in accordance with guidance provided by the SNEC License Termination Plan (LTP) and MARSSIM.
- III. **Data Selection Logic Tables:** The radionuclide selection logic and subsequent DCGLw calculations are provided in the following six (6) tables. These tables were developed using Microsoft Excel. Table explanation is as follows.

Table 1: Data Listing for Spray Pond – This table provides a list of the most representative sample analyses from the Spray Pond. Results are from scoping and characterization surveys. The samples consist of soil media that was taken in support of the aforementioned surveys. As applicable, a sample number, sample location, description, radionuclide concentration, and analysis date are provided for each sample. Positive nuclide concentrations are noted with yellow shaded background fields while MDA values are noted in gray shaded fields.

Note 1

With respect to the Spray Pond, the term "soil" is a generic term that can be used to describe individually or in combination traditional soils, fly ash, building rubble, and/or rock materials.

Table 2: Decayed Listing of Positive Sample Results – This table decays the data from Table 1 to January 15, 2005. Half-life values used are taken from "RadDecay for Windows"¹. Non-positive nuclide columns are removed as well as all MDA values. Therefore, the twenty one (21) applicable sample analysis results (from Table 1), have been reduced to nine (9) entries. Of the eleven (11) site specific radionuclides that are routinely assayed at the SNEC facility, only four (4) remain. This table provides the best overall representation of existing data for the Spray Pond area.

Table 3: Ratio to Cs-137 for Positive Radionuclides – This table provides the calculation methodology for determining the surrogate ratio to Cs-137 for each remaining radionuclide. From this information the mean, sigma, and mean % of total are calculated. The mean % of total values are then used to calculate the volumetric DCGLw per MARSSIM equation I-14. See Table 5. Note that the mean percent values were derived by averaging only positive sample results in each column. In some cases only a single nuclide value had a positive result. Thus, this value is listed as the value in the mean result field yielding a higher "mean percent of total" value for the mix which is a conservative approach in developing these values.

Note 2

From Table 3, the "mean % of total" values are used as input to the "Effective DCGLw Calculation Spreadsheet" (as illustrated in Table 5). However, the "Effective DCGLw Calculation Spreadsheet" re-normalizes all input so ratio values (to Cs-137) may also be used.

Table 4: Mean Percent of Total Activity - This table provides the calculation methodology for determining the relative fractions of total activity contributed by each radionuclide. From this information the mean, sigma, and mean % of total are calculated. The mean % of total values are then used to calculate the surface gross activity DCGLw per MARSSIM equation 4-4. See Table 6. Note that since only the positive results of sample

¹ RadDecay for Windows, Grove Engineering, Version 1.13.

ATTACHMENT 2.1

analysis are used, the results are driven by positively detected values, not MDA values which have been removed. The result is therefore conservative.

Table 5: Effective DCGLw Calculator for Cs-137 (in pCi/g) – This table provides the surrogate Cs-137 DCGLw calculation results for data derived from Table 3.

Table 6: Effective DCGLw Calculator for Gross Activity DCGLw & Cs-137 (in dpm/100 cm²) – This table provides the surface gross activity DCGLw calculation result from data derived from Table 4.

IV. Summary – Since the Spray Pond is largely soil, building rubble and rock materials, the existing release limit is primarily based on the volumetric DCGLw. However, for completeness, both types of effective DCGLw values have been developed. Using the above logic tables the calculated Cs-137 volumetric DCGLw is 3.94 pCi/g. The applicable surface gross activity DCGLw is 4,802 dpm/100 cm². These values would be reduced by 25% as part of the SNEC facilities requirement to apply an administrative limit as discussed in the License Termination Plan (LTP).

ATTACHMENT 2 . 2

TABLE 1 - DATA LISTING FOR SPRAY POND (in pCi/g)

SNEC Sample No	LAB No.	Location/Description	H-3	Sr-90	Co-60	Cs-137	Am-241	Pu-238	Pu-239	Pu-241	C-14	Ni-63	Eu-152	Analysis Date	
1	SX11SL99230	ERL 111082	Subsurface Sample #4 (0-4') AI-153, SP1			0.3	0.21							11/18/99	
2	SX11SL990128	ERL 110653	Spray Pond - Sample #5, SP1			0.02	0.29							10/14/99	
3	SX11SL99233	ERL 111084	Subsurface Sample #2 (0-3') AH-156, SP1			0.12	0.33							11/18/99	
5	SX9SL99208	ERL 111068	Subsurface Sample #1 (4-6') AG-156, SP1			0.14	0.45							11/18/99	
6	SX11SL99229	ERL 111080	Subsurface Sample #1 (0-3') AG-156, SP1			0.12	0.47							11/18/99	
7	SX11SL990124	ERL 110649	Spray Pond - Sample #1, SP1			0.02	0.62							10/28/99	
8	SX11SL990125	ERL 110650	Spray Pond - Sample #2, SP1			0.05	0.72							10/28/99	
9	SX11SL990126	ERL 110651	Spray Pond - Sample #3, SP1			0.06	1.8							10/28/99	
10	SX11SL990127	ERL 110652	Spray Pond - Sample #4, SP1			0.05	2.2							10/28/99	
11	SX11SL990120	ERL 110645	Spray Pond - Sample #10, SP1			0.019	0.02							10/28/99	
12	SX11SL990119	ERL 110644	Spray Pond - Sample #6, SP1			0.03	0.03							10/28/99	
13	SX11SL990122	ERL 110647	Spray Pond - Sample #9, SP1			0.03	0.03							10/28/99	
14	SX11SL990123	ERL 110648	Spray Pond - Sample #8, SP1			0.03	0.03							10/28/99	
15	SX11SL990121	ERL 110646	Spray Pond - Sample #7, SP1			0.05	0.05							10/28/99	
16	SX9SL99204	ERL 111064	Subsurface Sample #2 (4-6') AH-156, SP1			0.17	0.06							11/18/99	
17	SX9SL99205	ERL 111065	Subsurface Sample #3 (4-6') AJ-156, SP1			0.1	0.11							11/18/99	
18	SX11SL99226	ERL 111137	Subsurface Sample #3 (0-3') AJ-156, SP1			0.3	0.2							11/18/99	
19	SXSL25262	ERL 111151	Composite of Spray Pond Soil 125, 126 & 127, SP1			0.05	1.57	0.004	0.001	0.004				10/28/99	
20	SX11SL990126	Teledyne; L21441-1	Spray Pond - Sample #3, SP1 (Spray01)	2.08	0.038	0.01	1.56	0.010	0.040	0.009	2.380	0.225	1.190	0.025	10/28/99
21	SX11SL990127	Teledyne; L21441-2	Spray Pond - Sample #4, SP1 (Spray01)	2.04	0.034	0.019	2.8	0.016	0.023	0.032	1.640	0.591	1.220	0.039	10/28/99

KEY

Yellow Shaded Background	= Positive Result
Gray Shaded Background	= MDA

TABLE 2 - DECAYED LISTING OF POSITIVE SAMPLE RESULTS - MDAs REMOVED (in pCi/g)

SNEC Sample No	LAB No.	Location/Description	Cs-137	Am-241	Pu-239	C-14	Analysis Date	
1	SX11SL990128	110653	Spray Pond - Sample #5, SP1	0.26				10/14/99
2	SX11SL990124	110649	Spray Pond - Sample #1, SP1	0.55				10/28/99
3	SX11SL990126	Teledyne; L21441-1	Spray Pond - Sample #3, SP1 (Spray01)	1.38			0.22	10/28/99
4	SX11SL990127	Teledyne; L21441-2	Spray Pond - Sample #4, SP1 (Spray01)	2.48			0.59	10/28/99
5	SXSL25262	111151	Composite of Spray Pond Soil 125, 126 & 127, SP1	1.40	0.0035	0.0043		10/28/99
6	SX11SL99229	111080	Subsurface Sample #1 (0-3') AG-156, SP1	0.42				11/18/99
7	SX11SL99230	111082	Subsurface Sample #4 (0-4') AI-153, SP1	0.19				11/18/99
8	SX11SL99233	111084	Subsurface Sample #2 (0-3') AH-156, SP1	0.29				11/18/99
9	SX9SL99208	111068	Subsurface Sample #1 (4-6') AG-156, SP1	0.40				11/18/99
			Average=>	0.8185	0.0035	0.0043	0.4077	
			Standard Deviation=>	0.7766			0.2586	

TABLE 3 - RATIO TO Cs-137 FOR POSITIVE RADIONUCLIDES

SNEC Sample No	LAB No.	Location/Description	Cs-137	Am-241	Pu-239	C-14	Sum	
1	SX11SL990128	110653	Spray Pond - Sample #5, SP1	1.00				1.00
2	SX11SL990124	110649	Spray Pond - Sample #1, SP1	1.00				1.00
3	SX11SL990126	Teledyne; L21441-1	Spray Pond - Sample #3, SP1 (Spray01)	1.00			0.16	1.16
4	SX11SL990127	Teledyne; L21441-2	Spray Pond - Sample #4, SP1 (Spray01)	1.00			0.24	1.24
5	SXSL25262	111151	Composite of Spray Pond Soil 125, 126 & 127, SP1	1.00	0.0025	0.0031		1.01
6	SX11SL99229	111080	Subsurface Sample #1 (0-3') AG-156, SP1	1.00				1.00
7	SX11SL99230	111082	Subsurface Sample #4 (0-4') AI-153, SP1	1.00				1.00
8	SX11SL99233	111084	Subsurface Sample #2 (0-3') AH-156, SP1	1.00				1.00
9	SX9SL99208	111068	Subsurface Sample #1 (4-6') AG-156, SP1	1.00				1.00
			<i>Average=></i>	1.000	0.0025	0.0031	0.2001	1.206
			<i>Sigma=></i>	0.000			0.053	
			<i>Normalized Average (as %)=></i>	82.94%	0.21%	0.26%	16.60%	100.00%

TABLE 4 - MEAN % OF TOTAL ACTIVITY

SNEC Sample No	LAB No.	Location/Description	Cs-137	Am-241	Pu-239	C-14	Total	
1	SX11SL990128	110653	Spray Pond - Sample #5, SP1	100.00%				100%
2	SX11SL990124	110649	Spray Pond - Sample #1, SP1	100.00%				100%
3	SX11SL990126	Teledyne; L21441-1	Spray Pond - Sample #3, SP1 (Spray01)	86.02%			13.98%	100%
4	SX11SL990127	Teledyne; L21441-2	Spray Pond - Sample #4, SP1 (Spray01)	80.79%			19.21%	100%
5	SXSL25262	111151	Composite of Spray Pond Soil 125, 126 & 127, SP1	99.45%	0.25%	0.31%		100%
6	SX11SL99229	111080	Subsurface Sample #1 (0-3') AG-156, SP1	100.00%				100%
7	SX11SL99230	111082	Subsurface Sample #4 (0-4') AI-153, SP1	100.00%				100%
8	SX11SL99233	111084	Subsurface Sample #2 (0-3') AH-156, SP1	100.00%				100%
9	SX9SL99208	111068	Subsurface Sample #1 (4-6') AG-156, SP1	100.00%				100%
			<i>Average=></i>	96.25%	0.25%	0.31%	16.59%	113%
			<i>Sigma=></i>	7.40%			3.70%	
			<i>Normalized Average (as%)=></i>	84.88%	0.22%	0.27%	14.63%	100%

TABLE 5 – EFFECTIVE DCGLw CALCULATOR FOR Cs-137 (in pCi/g)

Effective DCGL Calculator for Cs-137 (in pCi/g)								SNEC AL		75%		Total Activity Limit DCGLw		Administrative Limit					
								4.75		pCi/g		3.56		pCi/g					
SAMPLE NUMBER(s)⇒ <u>Spray Pond Samples - Input as % of Total</u>								Cs-137 Limit		3.94		pCi/g		Cs-137 Administrative Limit		2.96		pCi/g	
								25.0		mrem/y TEDE Limit									
								4.0		mrem/y Drinking Water (DW) Limit									
Isotope	Sample Input (pCi/g, uCi, etc.)	% of Total	25 mrem/y TEDE Limits (pCi/g)	4 mrem/y DW Limits (pCi/g)	A - Allowed pCi/g for 25 mrem/y TEDE	B - Allowed pCi/g for 4 mrem/y DW	Value Checked from Column A or B	This Sample mrem/y TEDE	This Sample mrem/y DW										
1 Am-241	0.210	0.210%	9.9	2.3	0.01	0.05	0.01	0.53	0.37	Am-241									
2 C-14	16.60	16.598%	2.0	5.4	0.79	4.07	0.79	207.50	12.30	C-14									
3 Co-60		0.000%	3.5	67.0	0.00	0.00	0.00	0.00	0.00	Co-60									
4 Cs-137	82.94	82.932%	6.6	397	3.94	20.34	3.94	314.17	0.84	Cs-137									
5 Eu-152		0.000%	10.1	1440	0.00	0.00	0.00	0.00	0.00	Eu-152									
6 H-3		0.000%	132	31.1	0.00	0.00	0.00	0.00	0.00	H-3									
7 Ni-63		0.000%	747	19000	0.00	0.00	0.00	0.00	0.00	Ni-63									
8 Pu-238		0.000%	1.8	0.41	0.00	0.00	0.00	0.00	0.00	Pu-238									
9 Pu-239	0.260	0.260%	1.6	0.37	0.01	0.06	0.01	4.06	2.81	Pu-239									
10 Pu-241		0.000%	86	19.8	0.00	0.00	0.00	0.00	0.00	Pu-241									
11 Sr-90		0.000%	1.2	0.61	0.00	0.00	0.00	0.00	0.00	Sr-90									
					4.75	24.53	4.75	526.259	16.308										
					Maximum Permissible pCi/g (25 mrem/y)	Maximum Permissible pCi/g (4 mrem/y)		To Use This Information, Sample Input Units Must Be In pCi/g											

TABLE 6 – EFFECTIVE DCGLw CALCULATOR FOR GROSS ACTIVITY DCGLw & Cs-137 (in dpm/100^{cm}2)

Effective DCGL Calculator for Cs-137 (dpm/100 cm ²)					Gross Activity DCGLw		Gross Activity Administrative Limit	
					4802	dpm/100 cm ²	3601	dpm/100 cm ²
<input type="text" value="25.0"/> mrem/y TEDE Limit								
SAMPLE NO(s)⇒ <input type="text" value="Spray Pond Samples - Input As Mean % of Total"/>								
					Cs-137 Limit		Cs-137 Administrative Limit	
					4076	dpm/100 cm ²	3057	dpm/100 cm ²
					SNEC AL		75%	
Isotope	Sample Input (pCi/g, uCi, etc.)	% of Total	Individual Limits (dpm/100 cm ²)	Allowed dpm/100 cm ²	mrem/y TEDE	Beta dpm/100 cm ²	Alpha dpm/100 cm ²	
1 Am-241	2.20E-01	0.220%	27	10.56	9.78	N/A	10.56	Am-241
2 C-14	1.46E+01	14.630%	3,700,000	702.47	0.00	702.47	N/A	C-14
3 Co-60		0.000%	7,100	0.00	0.00	0.00	N/A	Co-60
4 Cs-137	8.49E+01	84.880%	28,000	4075.60	3.64	4075.6	N/A	Cs-137
5 Eu-152		0.000%	13,000	0.00	0.00	0.00	N/A	Eu-152
6 H-3		0.000%	120,000,000	0.00	0.00	Not Detectable	N/A	H-3
7 Ni-63		0.000%	1,800,000	0.00	0.00	Not Detectable	N/A	Ni-63
8 Pu-238		0.000%	30	0.00	0.00	N/A	0.00	Pu-238
9 Pu-239	2.70E-01	0.270%	28	12.96	11.58	N/A	12.96	Pu-239
10 Pu-241		0.000%	880	0.00	0.00	Not Detectable	N/A	Pu-241
11 Sr-90		0.000%	8,700	0.00	0.00	0.00	N/A	Sr-90
		100.000%		4802	25.0	4778	24	
				Maximum Permissible dpm/100 cm ²				

2350 INSTRUMENT AND PROBE EFFICIENCY CHART
 1/03/05 Remove 126198 & 117566 Add 129407

Inst.#	Cal Due	AP #		Probe #	Cal Due	cpm/mR/h
95361	6/25/05	P & W		25686 Pk	6/28/05	211,799
98620	12/01/05	G&W		196022 Pk	12/01/05	204,609
For remediation only			For remediation only		For remediation only	
98625	5/18/05	R & Y		211680 Pk	5/18/05	214,882
98642	9/28/05	B&W		185844 Pk	9/28/05	209,771
98647	11/02/05	G & Y		211667 Pk	11/02/05	213,180
117573	5/18/05	O & Y		211674 Pk	5/18/05	212,173
129407	12/17/05	White		206280	12/17/05	222,724
129423	5/18/05	P & Y		211687 Pk	5/18/05	213,539
129440	11/01/05	O&W		210938 Pk	11/01/05	196,636
For remediation only			For remediation only		For remediation only	

Different Instrument/Probe Cal. Due Cesium only instruments (10mV to 100)

ATTACHMENT 3-1

Nal Scan MDC Calculation

$b := 300$ $p := 0.5$ $HS_d := 56.42$ $SR := 25$ $d := 1.38$

$Conv := 209.771 \cdot 97$ $MS_{output} := \frac{1.741}{2.115} \cdot 2.115 \cdot 10^{-4}$

$\frac{HS_d}{SR} = 2.257$ *Observation Interval (seconds)*

$O_i := \frac{HS_d}{SR}$ *Observation Interval (seconds)*

$b_i := \frac{(b \cdot O_i)}{60}$

$MDCR_i := \left(d \cdot \sqrt{b_i} \right) \cdot \frac{60}{O_i}$

$MDCR_i = 123.245$ *net counts per minute*

$MDCR_{surveyor} := \frac{MDCR_i}{\sqrt{p}}$

$MDCR_{surveyor} = 174.295$ *net counts per minute*

$MDER := \frac{MDCR_{surveyor}}{Conv}$

$MDER = 0.857$ $\mu R/h$

$MDC_{scan} := \frac{MDER}{MS_{output} \cdot 1 \cdot 10^3}$

$MDC_{scan} = 4.92$ pCi/g

where:

b = background in counts per minute

b_i = background counts in observation interval

$Conv$ = Nal manufacturers reported response to energy of contaminant (cpm/uR/h)

d = index of sensitivity (Table 6.5 MARSSIM), 1.38 = 95% of correct detection's, 60% false positives

HS_d = hot spot diameter (in centimeters)

MDC_{scan} = Minimum Detectable Concentration for scanning (pCi/g)

$MDCR_i$ = Minimum Detectable Count Rate (ncpm)

$MDCR_{surveyor}$ = $MDCR_i$ corrected by human performance factor (ncpm)

$MDER$ = Minimum Detectable Exposure Rate (uR/h)

MS_{output} = MicroShield output exposure rate for 1 pCi/g of contaminant (mR/h)

O_i = observation Interval (seconds)

p = human performance factor

SR = scan rate in centimeters per second

NOTE

This is an example of an MDCscan calculation that is valid for a specific set of site conditions including the computer model used, soil density, soil moisture content, surveyor efficiency, ground cover, soil background and other variables that influence the calculated results. However, this and similar scan MDC's have been deemed valid for survey planning.

Samples for Shonka Research Associates - Soil Moisture Assessment

Sample #	Volume	"Wet" weight (gms)	Dry weight (gms)	"Wet" Density (Lbs/Ft3)	"Wet" Density (gm/cc)	% Moisture
SRA-PRE-1	~2 Liters	1861	1508	58.09	0.93	19.0
SRA-PRE-2	~2 Liters	2011	1624	62.77	1.01	19.2
SRA-PRE-3	~2 Liters	2182	1749	68.11	1.09	19.8
SRA-PRE-4	~2 Liters	2081	1681	64.96	1.04	19.2
SRA-PRE-5	~2 Liters	1992	1645	62.18	1.00	17.4
SRA-PRE-6	~1 liter	1310	1061	81.78	1.31	19.0
SRA-PRE-7	~1 liter	1470	1244	91.77	1.47	15.4
SRA-PRE-8	~1 liter	1468	1210	91.64	1.47	17.6
SRA-PRE-9	~1 liter	1460	1207	91.14	1.46	17.3
SRA-PRE-10	~1 liter	1376	1124	85.90	1.38	18.3
Mean=>						18.2
Assumed Soil Density (g/cc)=>						1.6
Soil Volume (cm^3)=>						38101
Soil Weight (g)=>						60962
Water weight (g)=>						11113
Water Model Thickness (cm)=>						2.54
Volume of Water Model (cm^3)=>						6350
Water Density of Model (g/cc)=>						1.75

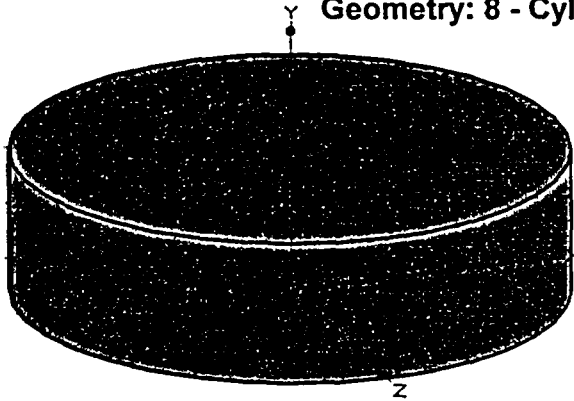
ATTACHMENT 4 . 3

MicroShield v5.05 (5.05-00121)
GPU Nuclear

Page : 1
 DOS File : SOIL.MS5
 Run Date : February 4, 2005
 Run Time : 3:23:05 PM
 Duration : 00:00:02

File Ref: _____
 Date: _____
 By: _____
 Checked: _____

Case Title: Soil
Description: Soil Density 1.6 g/cc, 6" Deep Cylinder @ 5" from Surface
Geometry: 8 - Cylinder Volume - End Shields



Source Dimensions		
Height	15.24 cm	6.0 in
Radius	28.21 cm	11.1 in

Dose Points			
	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	0 cm	27.94 cm	0 cm
	0.0 in	11.0 in	0.0 in

Shields			
<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	3.81e+04 cm ³	Concrete	1.6
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Ba-137m	5.7670e-008	2.1338e+003	1.5136e-006	5.6003e-002
Cs-137	6.0962e-008	2.2556e+003	1.6000e-006	5.9200e-002

Buildup
 The material reference is : Source

Integration Parameters	
Radial	40
Circumferential	40
Y Direction (axial)	40

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u>		<u>Exposure Rate</u>	
		<u>MeV/cm²/sec</u> <u>No Buildup</u>	<u>MeV/cm²/sec</u> <u>With Buildup</u>	<u>mR/hr</u> <u>No Buildup</u>	<u>mR/hr</u> <u>With Buildup</u>
0.0318	4.418e+01	6.794e-06	8.222e-06	5.659e-08	6.849e-08
0.0322	8.150e+01	1.306e-05	1.591e-05	1.051e-07	1.280e-07
0.0364	2.966e+01	7.236e-06	9.448e-06	4.111e-08	5.368e-08
0.6616	1.920e+03	6.179e-02	1.091e-01	1.198e-04	2.115e-04
TOTALS:	2.075e+03	6.182e-02	1.091e-01	1.200e-04	2.118e-04

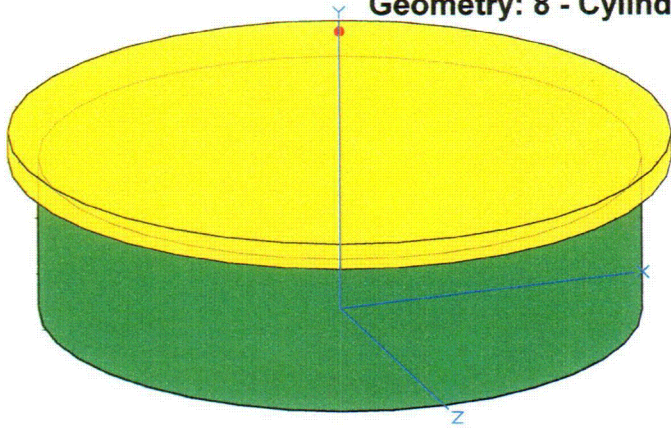
ATTACHMENT 4.4

MicroShield v5.05 (5.05-00121)
GPU Nuclear

Page : 1
 DOS File : SOIL1.MS5
 Run Date : February 7, 2005
 Run Time : 3:12:39 PM
 Duration : 00:00:01

File Ref: _____
 Date: _____
 By: _____
 Checked: _____

Case Title: Soil/Shield
Description: Soil Density 1.6 g/cc, 6" Deep Cylinder @ 5" from Surface
Geometry: 8 - Cylinder Volume - End Shields



Source Dimensions			
Height		15.24 cm	6.0 in
Radius		28.21 cm	11.1 in
Dose Points			
#	X	Y	Z
1	0 cm 0.0 in	27.94 cm 11.0 in	0 cm 0.0 in
Shields			
Shield Name	Dimension	Material	Density
Source	2325.091 in ³	Concrete	1.6
Shield 1	1.0 in	Water	1.75
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm^3
Ba-137m	5.7670e-008	2.1338e+003	1.5136e-006	5.6003e-002
Cs-137	6.0962e-008	2.2556e+003	1.6000e-006	5.9200e-002

Buildup
 The material reference is : Source

Integration Parameters

Radial	40
Circumferential	40
Y Direction (axial)	40

Results

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		No Buildup	With Buildup	No Buildup	With Buildup
0.0318	4.418e+01	9.253e-07	1.318e-06	7.708e-09	1.098e-08
0.0322	8.150e+01	1.831e-06	2.632e-06	1.474e-08	2.118e-08
0.0364	2.966e+01	1.298e-06	2.079e-06	7.376e-09	1.181e-08
0.6616	1.920e+03	3.624e-02	8.981e-02	7.026e-05	1.741e-04

ATTACHMENT 4.5

Page : 2
DOS File : SOIL1.MS5
Run Date: February 7, 2005
Run Time: 3:12:39 PM
Duration : 00:00:01

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u> <u>No Buildup</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u> <u>With Buildup</u>	<u>Exposure Rate</u> <u>mR/hr</u> <u>No Buildup</u>	<u>Exposure Rate</u> <u>mR/hr</u> <u>With Buildup</u>
TOTALS:	2.075e+03	3.625e-02	8.982e-02	7.029e-05	1.742e-04

ATTACHMENT 4.6

Nal Scan MDC Calculation - Surface Deposition

$b := 300$ $p := 0.5$ $HS_d := 56.42$ $SR := 10$ $d := 1.38$

$Conv := 209.771 \cdot 97$ $MS_{output} := 2.714 \cdot 10^{-4}$ $O_i := \frac{HS_d}{SR}$

$O_i = 5.642$ *Observation Interval (seconds)*

$b_i := \frac{(b \cdot O_i)}{60}$

$MDCR_i := (d \cdot \sqrt{b_i}) \cdot \frac{60}{O_i}$

$MDCR_i = 77.947$ *net counts per minute*

$MDCR_{surveyor} := \frac{MDCR_i}{\sqrt{p}}$

$MDCR_{surveyor} = 110.234$ *net counts per minute*

$MDER := \frac{MDCR_{surveyor}}{Conv}$

$MDER = 0.542$ $\mu R/h$

$MDC_{scan} := \frac{MDER}{MS_{output} \cdot 1 \cdot 10^3}$

$MDC_{scan} = 1.996$ pCi/cm^2

$MDC_{scan} \cdot 222 = 443.139$ *dpm/100 cm²*

Nal Scan MDC Calculation - Surface

where:

b = background in counts per minute

b_i = background counts in observation interval

$Conv$ = NaI manufacturers or calibration information reported response to energy of contaminant (cpm/uR/h)

d = index of sensitivity (Table 6.5 MARSSIM), 1.38 = 95% of correct detection's, 60% false positives

HS_d = hot spot diameter (in centimeters)

MDC_{scan} = Minimum Detectable Concentration for scanning (pCi/cm²)

$MDCR_i$ = Minimum Detectable Count Rate (ncpm)

$MDCR_{surveyor}$ = $MDCR_i$ corrected by human performance factor (ncpm)

$MDER$ = Minimum Detectable Exposure Rate (uR/h)

MS_{output} = MicroShield output exposure rate for 1 pCi/cm² of contaminant (mR/h)

O_i = observation Interval (seconds)

p = human performance factor

SR = scan rate in centimeters per second

NOTE

This is an example of an MDCscan calculation that is valid for a specific set of site conditions including the computer model used, soil density, soil moisture content, surveyor efficiency, ground cover, soil background and other variables that influence the calculated results. However, this and similar scan MDC's have been deemed valid for survey planning.

**MicroShield v5.05 (5.05-00121)
GPU Nuclear**

Page : 1
 DOS File : SUR-1.MS5
 Run Date: February 7, 2005
 Run Time: 1:39:46 PM
 Duration : 00:00:00

File Ref: _____
 Date: _____
 By: _____
 Checked: _____

**Case Title: Surface
 Description: Surface Source Evaluation (Nal)
 Geometry: 3 - Disk**



Source Dimensions
 Radius 28.21 cm 11.1 in

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	7.62 cm 3.0 in	0 cm 0.0 in	0 cm 0.0 in

Shields

<u>Shield Name</u>	<u>Material</u>	<u>Density</u>
Air Gap	Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm²</u>	<u>Bq/cm²</u>
Ba-137m	2.3651e-009	8.7508e+001	9.4600e-007	3.5002e-002
Cs-137	2.5001e-009	9.2503e+001	1.0000e-006	3.7000e-002

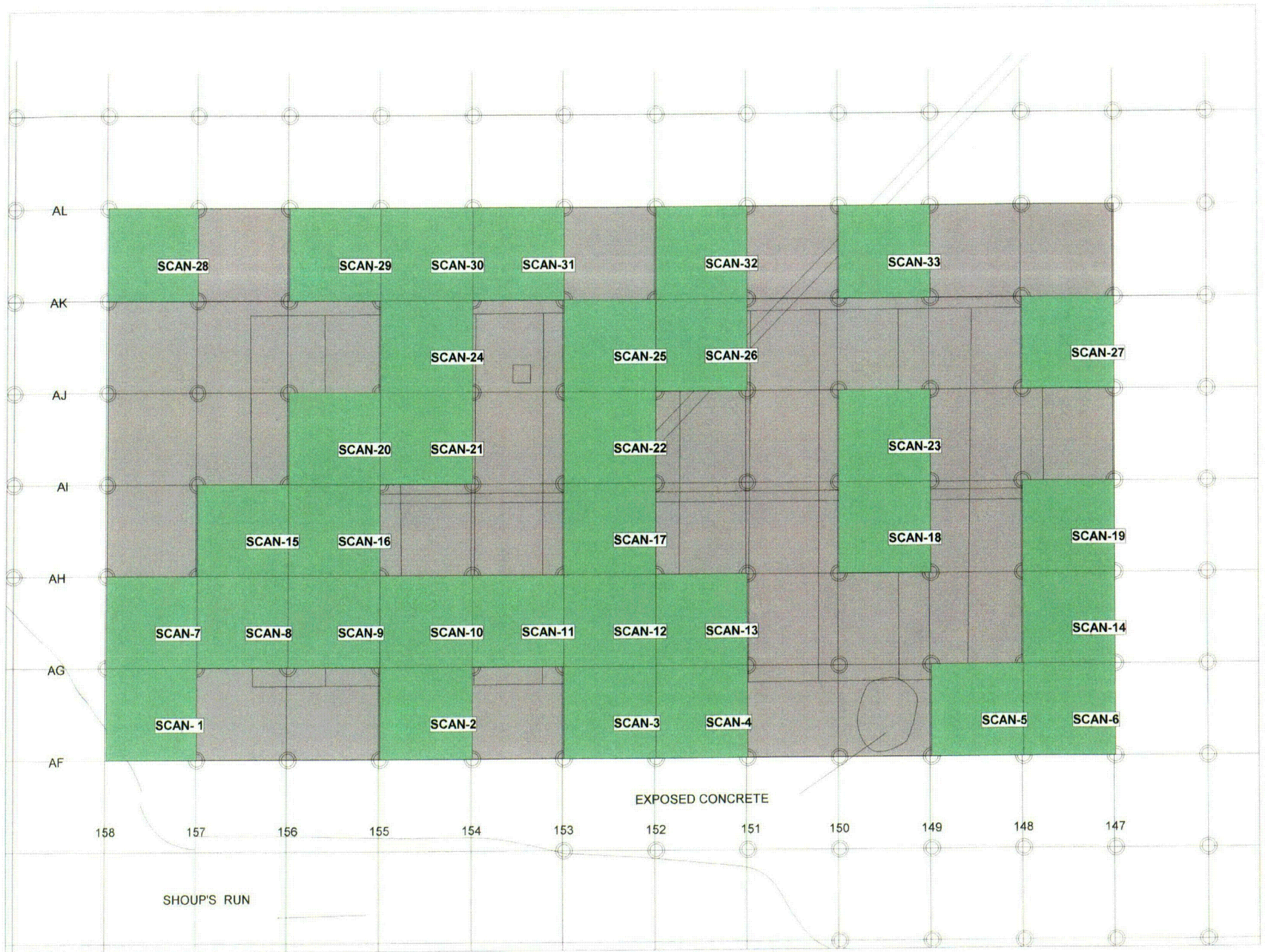
Buildup
 The material reference is : Air Gap

Integration Parameters

Radial	40
Circumferential	40

Results

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u>		<u>Exposure Rate</u> <u>mR/hr</u>	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	1.812e+00	1.540e-05	1.552e-05	1.283e-07	1.292e-07
0.0322	3.343e+00	2.876e-05	2.897e-05	2.315e-07	2.331e-07
0.0364	1.216e+00	1.184e-05	1.193e-05	6.729e-08	6.777e-08
0.6616	7.874e+01	1.398e-02	1.400e-02	2.711e-05	2.714e-05
TOTALS:	8.511e+01	1.404e-02	1.406e-02	2.754e-05	2.757e-05





Site Report

Site Summary

Site Name: Spray Pond 1
Planner(s): BHB

Contaminant Summary

NOTE: Surface soil DCGLw units are pCi/g.
Building surface DCGLw units are dpm/100 cm².

Contaminant	Type	DCGLw	Screening Value Used?	Area (m ²)	Area Factor
Cs-137	Surface Soil	2.96	No	1	28.7
				25	4.7
				100	3.6
				400	3
				2,500	2.3
10,000	1				



Surface Soil Survey Plan

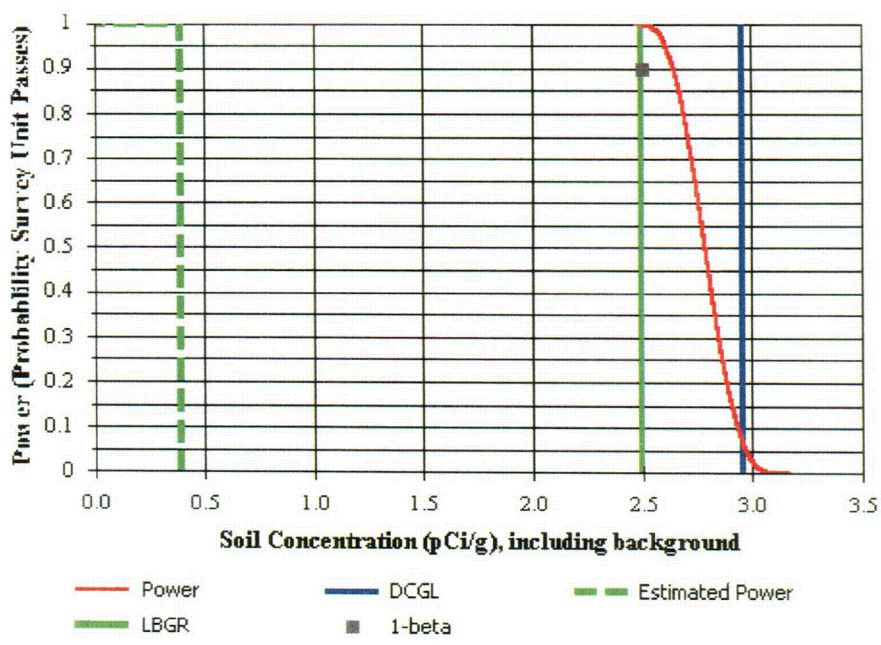
Survey Plan Summary

Site: Spray Pond 1
 Planner(s): BHB
 Survey Unit Name: SP1 Area - Spray Pond 1
 Comments: Class 2 - Input as Class 1
 Area (m²): 6,600
 Selected Test: Sign
 DCGL (pCi/g): 2.96
 LBGR (pCi/g): 2.5
 Alpha: 0.050
 Beta: 0.100
 Scanning Instrumentation: 2" x 2" NaI (w)

Classification: 3148
 2 + (see note)
 Estimated Sigma (pCi/g): 0.346
 Sample Size (N): 16
 Estimated Conc. (pCi/g): 0.4
 Estimated Power: 1
 EMC Sample Size (N): 16

NOTE →

Prospective Power Curve





Surface Soil Survey Plan

Contaminant Summary

Contaminant	DCGLw (pCi/g)	Inferred Contaminant	Ratio	Modified DCGLw (pCi/g)	Scan MDC (pCi/g)
Cs-137	2.96	N/A	N/A	N/A	4.92

Contaminant	Survey Unit Estimate (Mean \pm 1-Sigma) (pCi/g)	Reference Area Estimate (Mean \pm 1-Sigma) (pCi/g)
Cs-137	0.389 \pm 0.346	0.28 \pm 0.39

Elevated Measurement Comparison (EMC)

Enter in a description for the scanning instrumentation used. Then enter a scan MDC for each measured contaminant. Click the CALCULATE button to view the integrated survey design results. All entered and calculated scan MDC and DCGL units are in pCi/g.

Scanning Instrumentation Description: 2" x 2" NaI (w)

Contaminant	Scan MDC
Cs-137	4.92

Enter Scan MDC

Scan MDC:

SAVE

NUREG-1507

CALCULATE

Statistical Design		Hot Spot Design	
N:	16	Actual Scan MDC:	4.92
Bounded Area (m ²):	412.5	Area Factor:	N/A
Area Factor:	3	Bounded Area (m ²):	N/A
DCGLw:	2.96	Post-EMCN:	16
Scan MDC Required:	8.9		

COMPASS



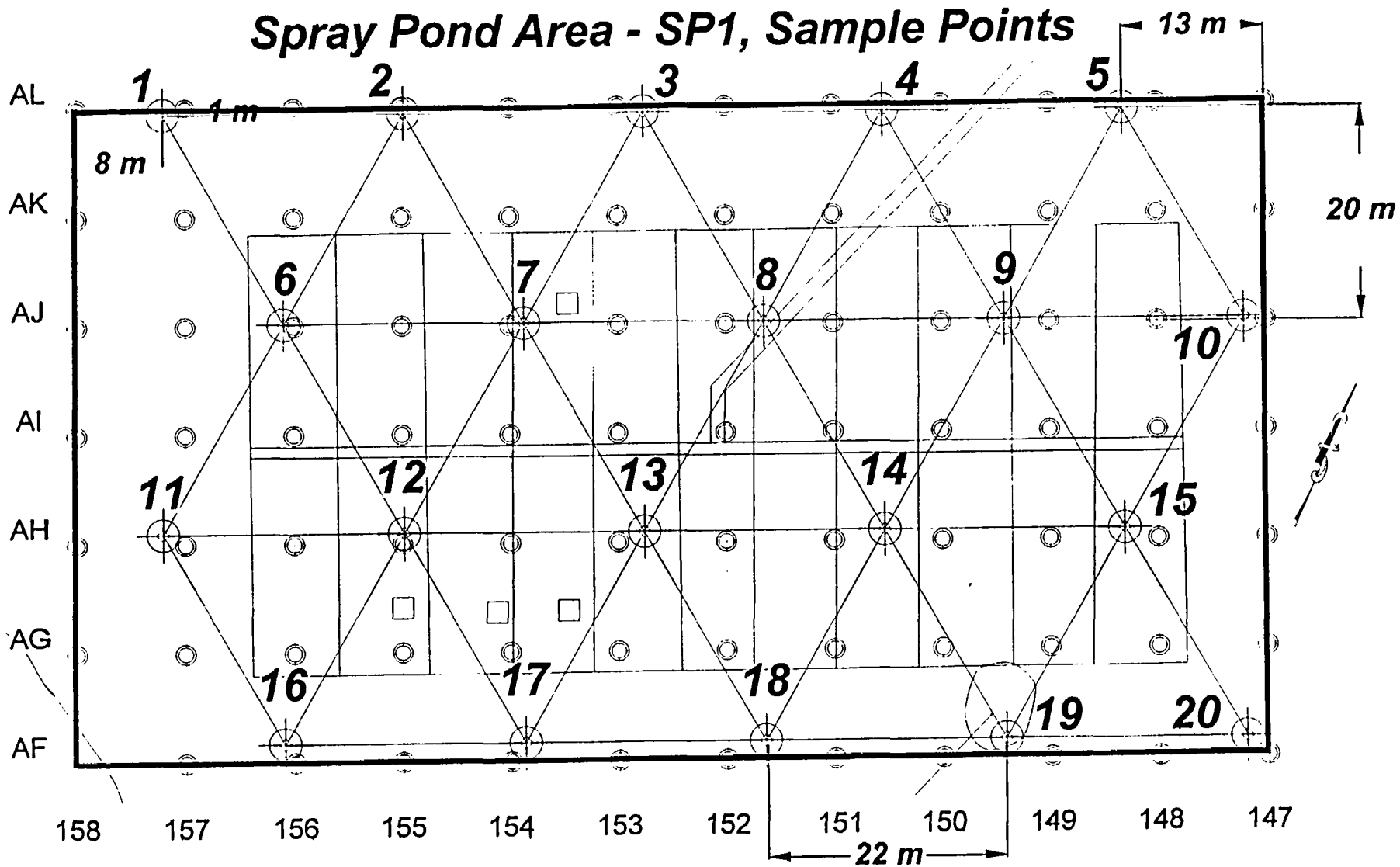
No additional samples are required because the actual scan MDC is less than the required scan MDC.



Enable Training Card Help
v1.0.0

OK

Spray Pond Area - SP1, Sample Points



SPI SAMPLE LISTING

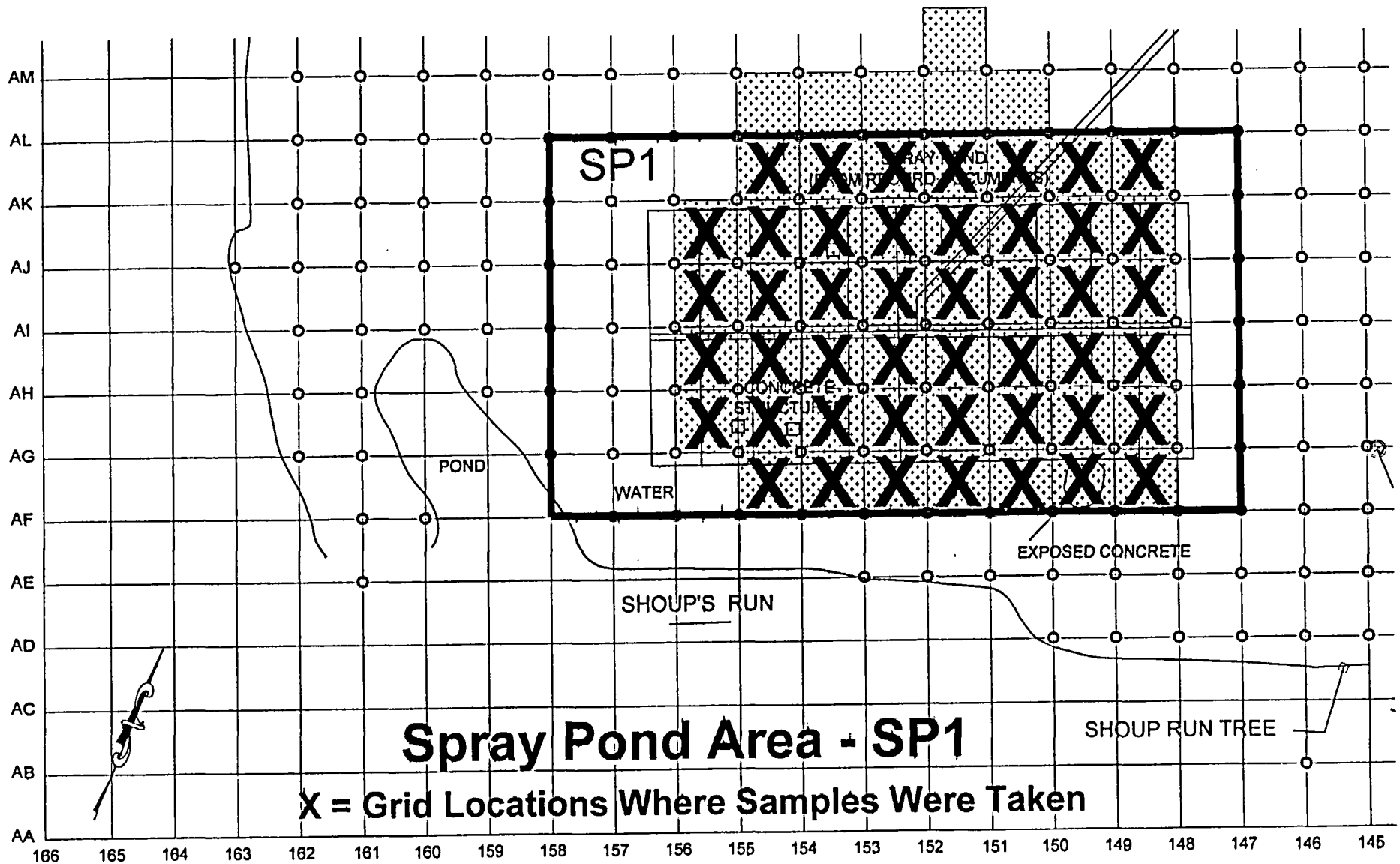
SPRAY POND SAMPLES (pCi/g)- SR-133 & 134						
Sample No.	Cs-137	Co-60	Grid	Date	Depth (in)	Comments
1	SXSL5956	0.2	0.1	AF-149	7/1/2004	0" - 6"
2	SXSL5957	0.1	0.1	AF-149	7/1/2004	0" - 6"
3	SXSL6003	0.15	0.15	AF-150	7/6/2004	0" - 6"
4	SXSL6004	0.1	0.06	AF-150	7/6/2004	0" - 6"
5	SXSL6001	0.2	0.1	AF-151	7/6/2004	0" - 6"
6	SXSL6002	0.14	0.1	AF-151	7/6/2004	0" - 6"
7	SXSL5999	1.2	0.13	AF-152	7/6/2004	0" - 6"
8	SXSL6000	1.4	0.1	AF-152	7/6/2004	0" - 6"
9	SXSL6043	1	0.08	AF-153	7/7/2004	0" - 6"
10	SXSL6044	0.8	0.1	AF-153	7/7/2004	0" - 6"
11	SXSL6039	0.9	0.13	AF-154	7/7/2004	0" - 6"
12	SXSL6040	1.2	0.08	AF-154	7/7/2004	0" - 6"
13	SXSL6053	0.2	0.1	AF-155	7/8/2004	0" - 6"
14	SXSL6054	0.6	0.1	AF-155	7/8/2004	0" - 6"
15	SXSL5953	0.28	0.09	AG-149	7/1/2004	0" - 6"
16	SXSL5954	0.24	0.09	AG-149	7/1/2004	0" - 6"
17	SXSL5965	0.14	0.1	AG-150	7/1/2004	0" - 6"
18	SXSL5966	0.1	0.1	AG-150	7/1/2004	0" - 6"
19	SXSL5963	0.14	0.09	AG-151	7/1/2004	0" - 6"
20	SXSL5964	0.1	0.08	AG-151	7/1/2004	0" - 6"
21	SXSL6005	0.16	0.09	AG-152	7/6/2004	0" - 6"
22	SXSL6006	0.1	0.1	AG-152	7/6/2004	0" - 6"
23	SXSL6007	0.1	0.1	AG-152	7/6/2004	0" - 6"
24	SXSL6008	1	0.1	AG-152	7/6/2004	0" - 6"
25	SXSL6009	0.13	0.14	AG-152	7/6/2004	0" - 6"
26	SXSL6105	0.13	0.08	AG-152	7/13/2004	24"
27	SXSL6106	0.09	0.1	AG-152	7/13/2004	79"
28	SXSL6041	0.95	0.09	AG-153	7/7/2004	0" - 6"
29	SXSL6042	0.86	0.06	AG-153	7/7/2004	0" - 6"
30	SXSL6029	0.93	0.1	AG-154	7/7/2004	0" - 6"
31	SXSL6030	0.4	0.1	AG-154	7/7/2004	0" - 6"
32	SXSL5910	0.3	0.1	AG-155	6/30/2004	0" - 6"
33	SXSL5911	0.5	0.09	AG-155	6/30/2004	0" - 6"
34	SXSL5912	0.3	0.09	AG-155	6/30/2004	0" - 6"
35	SXSL5913	0.7	0.1	AG-155	6/30/2004	0" - 6"
36	SXSL5914	1.8	0.1	AG-155	6/30/2004	0" - 6"
37	SXSL5915	1	0.09	AG-155	6/30/2004	0" - 6"
38	SXSL6117	0.17	0.1	AG-155	7/13/2004	0" - 24"
39	SXSL6010	0.7	0.09	AG-156	7/7/2004	0" - 6"
40	SXSL5969	0.28	0.1	AH-149	7/1/2004	0" - 6"
41	SXSL5970	0.17	0.09	AH-149	6/30/2004	0" - 6"
42	SXSL5961	0.16	0.08	AH-150	7/1/2004	0" - 6"
43	SXSL5962	0.2	0.09	AH-150	7/1/2004	0" - 6"
44	SXSL5943	0.15	0.1	AH-151	7/1/2004	0" - 6"
45	SXSL5944	0.1	0.09	AH-151	7/1/2004	0" - 6"
46	SXSL6045	0.2	0.07	AH-153	7/7/2004	0" - 6"
47	SXSL6046	0.38	0.1	AH-153	7/7/2004	0" - 6"
48	SXSL6031	0.18	0.1	AH-154	7/7/2004	0" - 6"
49	SXSL6032	0.8	0.09	AH-154	7/7/2004	0" - 6"
50	SXSL6018	1	0.1	AH-155	7/7/2004	0" - 6"
51	SXSL6019	0.35	0.09	AH-155	7/7/2004	0" - 6"
52	SXSL6113	0.12	0.08	AH-155	7/13/2004	0" - 36"
53	SXSL6114	0.09	0.08	AH-155	7/13/2004	36" - 38"
54	SXSL6115	0.09	0.09	AH-155	7/13/2004	36" - 38"
55	SXSL6116	0.09	0.09	AH-155	7/13/2004	38" - 79"
56	SXSL5971	0.3	0.09	AI-149	7/1/2004	0" - 6"
57	SXSL5972	0.2	0.1	AI-149	7/1/2004	0" - 6"
58	SXSL5967	0.25	0.1	AI-150	7/1/2004	0" - 6"
59	SXSL5968	0.35	0.1	AI-150	7/1/2004	0" - 6"
60	SXSL5926	0.17	0.09	AI-151	6/30/2004	0" - 6"
61	SXSL5927	0.4	0.08	AI-151	6/30/2004	0" - 6"
62	SXSL5938	0.2	0.14	AI-152	7/1/2004	0" - 6"
63	SXSL5939	0.2	0.1	AI-152	7/1/2004	0" - 6"
64	SXSL5940	0.3	0.08	AI-152	7/1/2004	0" - 6"
65	SXSL5941	0.27	0.08	AI-152	7/1/2004	0" - 6"

ATTACHMENT 9 - 1

SP! SAMPLE LISTING

66	SXSL5942	1.7	0.1	AI-152	7/1/2004	0" - 6"
67	SXSL6102	0.19	0.09	AI-152	7/13/2004	24"
68	SXSL6103	0.7	0.1	AI-152	7/13/2004	24"
69	SXSL6104	0.36	0.08	AI-152	7/13/2004	79"
70	SXSL6047	0.5	0.07	AI-153	7/7/2004	0" - 6"
71	SXSL6048	0.6	0.1	AI-153	7/7/2004	0" - 6"
72	SXSL6049	0.2	0.07	AI-153	7/7/2004	0" - 6"
73	SXSL6033	0.46	0.09	AI-154	7/7/2004	0" - 6"
74	SXSL6034	1.5	0.1	AI-154	7/7/2004	0" - 6"
75	SXSL6111	0.08	0.07	AI-154	7/13/2004	0" - 6"
76	SXSL6112	0.17	0.1	AI-154	7/13/2004	0" - 6"
77	SXSL6020	0.7	0.09	AI-155	7/7/2004	0" - 6"
78	SXSL6021	0.6	0.15	AI-155	7/7/2004	0" - 6"
79	SXSL6014	0.5	0.1	AI-156	7/7/2004	0" - 6"
80	SXSL6015	0.28	0.1	AI-156	7/7/2004	0" - 6"
81	SXSL5951	0.16	0.1	AJ-149	7/1/2004	0" - 6"
82	SXSL5952	0.2	0.09	AJ-149	7/1/2004	0" - 6"
83	SXSL5947	0.5	0.1	AJ-150	7/1/2004	0" - 6"
84	SXSL5948	0.4	0.1	AJ-150	7/1/2004	0" - 6"
85	SXSL5945	0.3	0.1	AJ-151	7/1/2004	0" - 6"
86	SXSL5946	0.5	0.07	AJ-151	7/1/2004	0" - 6"
87	SXSL5932	0.28	0.1	AJ-152	7/1/2004	0" - 6"
88	SXSL5933	0.3	0.1	AJ-152	7/1/2004	0" - 6"
89	SXSL5934	0.34	0.08	AJ-152	7/1/2004	0" - 6"
90	SXSL5935	0.15	0.1	AJ-152	7/1/2004	0" - 6"
91	SXSL5937	0.2	0.09	AJ-152	7/1/2004	0" - 6"
92	SXSL6108	0.18	0.08	AJ-152	7/13/2004	79"
93	SXSL6055	0.07	0.07	AJ-153	7/8/2004	0" - 6"
94	SXSL6056	0.15	0.1	AJ-153	7/8/2004	0" - 6"
95	SXSL6035	0.9	0.1	AJ-154	7/7/2004	0" - 6"
96	SXSL6036	0.3	0.1	AJ-154	7/7/2004	0" - 6"
97	SXSL6022	0.5	0.1	AJ-155	7/7/2004	0" - 6"
98	SXSL6023	0.6	0.16	AJ-155	7/7/2004	0" - 6"
99	SXSL6016	0.6	0.1	AJ-156	7/7/2004	0" - 6"
100	SXSL6017	0.3	0.1	AJ-156	7/7/2004	0" - 6"
101	SXSL5924	0.4	0.1	AK-149	6/30/2004	0" - 6"
102	SXSL5925	0.5	0.09	AK-149	6/30/2004	0" - 6"
103	SXSL5922	0.6	0.1	AK-150	6/30/2004	0" - 6"
104	SXSL5923	0.3	0.06	AK-150	6/30/2004	0" - 6"
105	SXSL5996	0.2	0.09	AK-152	7/6/2004	0" - 6"
106	SXSL5998	0.4	0.15	AK-152	7/6/2004	0" - 6"
107	SXSL6057	0.19	0.09	AK-153	7/8/2004	0" - 6"
108	SXSL6058	0.15	0.12	AK-153	7/8/2004	0" - 6"
109	SXSL5916	0.15	0.09	AK-154	6/30/2004	0" - 6"
110	SXSL5917	0.17	0.09	AK-154	6/30/2004	0" - 6"
111	SXSL5918	0.13	0.07	AK-154	6/30/2004	0" - 6"
112	SXSL5919	0.3	0.08	AK-154	6/30/2004	0" - 6"
113	SXSL5920	0.6	0.08	AK-154	6/30/2004	0" - 6"
114	SXSL5921	0.35	0.09	AK-154	6/30/2004	0" - 6"
115	SXSL6119	0.15	0.1	AK-154	7/14/2004	24"
116	SXSL6024	0.9	0.1	AK-155	7/7/2004	0" - 6"
117	SXSL6025	0.36	0.1	AK-155	7/7/2004	0" - 6"
118	SXSL6061	0.2	0.1	AL-152	7/8/2004	0" - 6"
119	SXSL6062	0.12	0.09	AL-152	7/8/2004	0" - 6"
120	SXSL6059	0.17	0.1	AL-153	7/8/2004	0" - 6"
121	SXSL6060	0.3	0.08	AL-153	7/8/2004	0" - 6"
122	SXSL6037	0.12	0.1	AL-154	7/7/2004	0" - 6"
123	SXSL6038	0.16	0.1	AL-154	7/7/2004	0" - 6"
124	SXSL6026	0.35	0.1	AL-155	7/7/2004	0" - 6"
125	SXSL6027	0.19	0.1	AL-155	7/7/2004	0" - 6"
126	SXSL6063	0.1	0.1	AM-152	7/8/2004	0" - 6"
127	SXSL6064	0.14	0.09	AM-152	7/8/2004	0" - 6"
128	SXSL6065	0.14	0.1	AM-152	7/8/2004	0" - 6"
Average=>		0.389	0.095	NOTE: Samples with incomplete information have been removed from this listing		
STDEV=>		0.346	0.016			

ATTACHMENT 9 2



ORIGINAL

SECTION 1 - SURVEY UNIT INSPECTION DESCRIPTION								
Survey Unit #		SP1		Survey Unit Location		Spray Pond Open Land Area		
Date	2/16/05	Time	1200	Inspection Team Members		D. Sarge		
SECTION 2 - SURVEY UNIT INSPECTION SCOPE								
Inspection Requirements (Check the appropriate Yes/No answer.)						Yes	No	N/A
1	Have sufficient surveys (i.e., post remediation, characterization, etc.) been obtained for the survey unit?					X		
2	Do the surveys (from Question 1) demonstrate that the survey unit will most likely pass the FSS?					X		
3	Is the physical work (i.e., remediation & housekeeping) in or around the survey unit complete?					X		
4	Have all tools, non-permanent equipment, and material not needed to perform the FSS been removed?					X		
5	Are the survey surfaces relatively free of loose debris (i.e., dirt, concrete dust, metal filings, etc.)?					X		
6	Are the survey surfaces relatively free of liquids (i.e., water, moisture, oil, etc.)?						X	
7	Are the survey surfaces free of all paint, which has the potential to shield radiation?					X		
8	Have the Surface Measurement Test Areas (SMTA) been established? (Refer to Exhibit 2 for instructions.)							X
9	Have the Surface Measurement Test Areas (SMTA) data been collected? (Refer to Exhibit 2 for instructions.)							X
10	Are the survey surfaces easily accessible? (No scaffolding, high reach, etc. is needed to perform the FSS)					X		
11	Is lighting adequate to perform the FSS?					X		
12	Is the area industrially safe to perform the FSS? (Evaluate potential fall & trip hazards, confined spaces, etc.)					X		
13	Have photographs been taken showing the overall condition of the area?					X		
14	Have all unsatisfactory conditions been resolved?						X	
<p>NOTE: If a "No" answer is obtained above, the inspector should immediately correct the problem or initiate corrective actions through the responsible site department, as applicable. Document actions taken and/or justifications in the "Comments" section below. Attach additional sheets as necessary.</p> <p>Comments:</p> <p>Response to Question 6:</p> <p>Low-lying areas contain freestanding water. If surveys are needed to be performed in these areas, de-watering will have to be performed. Notified L. Shamenek.</p>								
Survey Unit Inspector (print/sign)				D. Sarge / <i>[Signature]</i>		Date	2/16/05	
Survey Designer (print/sign)						Date		

ATTACHMENT 10-1

ORIGINAL

EXHIBIT 3
Surface Measurement Test Area (SMTA) Data Sheet

SECTION 1 - DESCRIPTION								
SMTA Number	Non-applicable			Survey Unit Number	SP1			
SMTA Location	Spray Pond Open Land Areas							
Survey Unit Inspector	D. Sarge			Date	11/22/04	Time	1400	
SECTION 2 - CALIPER INFORMATION & PERSONNEL INVOLVED								
Caliper Manufacturer				Caliper Model Number				
Caliper Serial Number				Calibration Due Date (as applicable)				
Rad Con Technician				Date			Time	
Survey Unit Inspector Approval	D. Sarge			Date	2/16/05			
SECTION 3 - MEASUREMENT RESULTS								
SMTA Grid Map & Measurement Results in Units of mm (Insert Results in White Blocks Below)					Comments			
1	7	13	19	25	31	<ul style="list-style-type: none">• Approx. 25% of the surface has been top-dressed with a combination of building debris and coal slag varying in depth from 4' to 6'.• Approx. 30% on the surface area has river silt deposits varying in depth of 1" to several feet. These deposits are a result of severe flooding of the Juniata River during the summer of 2004.• Stone retaining berm (along AF grid line) has moss growing on sides. This may shield contamination and compromise surface scan results. Notified B. Brosey for guidance		
2	8	14	20	26	32			
3	9	15	21	27	33			
4	10	16	22	28	34			
5	11	17	23	29	35			
6	12	18	24	30	36			
Average Measurement - mm								
Additional Measurements Required								

ATTACHMENT 10-2