DMA-TR-30

Dade Moeller & Associates, Inc.

Technical Report

Soil Sampling Plan for the Runkle Canyon Main and Northwest Grading Areas

Tracy A. Ikenberry, CHP
Clark B. Barton, CHP

September 2007

Prepared for
Runkle Canyon, LLC
Los Angeles, CA 90024

Dade Moeller & Associates, Inc.
1835 Terminal Drive, Suite 200
Richland, WA 99354

LIMITATIONS

Dade Moeller & Associates prepared this soil sampling plan pursuant to the directions received from Runkle Canyon, LLC. Our work is based on information available at the time of publication.

TABLE OF CONTENTS

Page left intentionally blank.

1.0 INTRODUCTION

Runkle Canyon is a proposed residential development adjacent to existing neighborhoods at the southern edge of Simi Valley, California. There continues to be concerns raised by some members of the public over low levels of the radionuclide strontium-90 (^{90}Sr) detected in a few surface soil samples. A number of soil samples have previously been collected from the 1,595 acre site. As part of the environmental characterization of the site, several soil sampling campaigns have been conducted (QST 1999; Foster Wheeler 1999; Harding ESE 2000; Miller Brooks 2003a,b,c; Ikenberry 2005a). The initial three campaigns provide useful data because of the lower levels of detection and more complete statistics reported. Ikenberry (Ikenberry 2005a) reported the results of re-sampling at the locations of five samples with the highest positive results from ^{90}Sr from the earlier sampling campaigns.

This sampling plan directs the collection of additional samples from the main and northwest "grading areas" – those areas of the Runkle Canyon development where soil will be moved in preparation for home building. The objective of this additional sampling is to provide further quantitative information to ensure that the potential risk to members of the public remains well below acceptable risk guidelines.

2.0 FUNCTIONS AND REQUIREMENTS

Soil sampling of the Runkle Canyon area includes the following work functions to be performed by an environmental sampling firm and an analytical laboratory contracted by Runkle Canyon, LLC. Dade Moeller & Associates will provide oversight and technical direction as requested by Runkle Canyon, LLC and will prepare a report on the analytical results.

A contracted environmental sampling firm will:

- Review this Plan and develop a soil sampling protocol that that is consistent with ASTM C998-05 "Standard Practice for Sampling Surface Soil for Radionuclides," subject to additional requirements noted in Section 4.0.
- Notify Runkle Canyon, LLC of all planned departures from the Plan.
- Identify potential hazards during sampling and develop controls. Provide safety briefings for sampling personnel.
- Provide all required safety and personal protective equipment.
- Perform soil sampling.
- Document all survey activities and observations in a controlled logbook or equivalent.
- Package samples and ship to the analytical laboratory in a manner that meets all chain-of-custody requirements.

A contracted analytical laboratory will:

- Perform requested sample analyses and provide requested data as stated in Section 5.0 of this plan.
- Interpret the analytical data and prepare a final report.

3.0 NUMBER OF SAMPLES AND LOCATIONS

Determination of the number of sampling locations described below was developed using methods discussed in the *Multi-Agency Radiation Survey and Site Investigation Manual* (EPA 2001). The areas to be sampled are considered to be Class 3 areas using the MARSSIM criteria. Class 3 areas are those considered to be uncontaminated or minimally affected by contaminants. This has been demonstrated by the previously noted sampling reports.

A radiological risk analysis of the Runkle Canyon area (Ikenberry 2005b) estimated that even "highly exposed" residents of Runkle Canyon would have an annual risk level of 1×10^{-6} (one in one million) at a concentration of about 1.1 pCi/g of ^{90}Sr if it was assumed to be distributed evenly throughout the surface soil. Typical residents of Runkle Canyon and visitors to the undisturbed open spaces would experience much lower levels of risk. MARSSIM requires a Derived Concentration Guideline Level (DCGL) as one of the parameters to establish the number of samples required. The DCGL was established at 1 pCi/g, based on an annual risk level to a "highly exposed" Runkle Canyon resident of less than 1×10^{-5}.

The number of samples required was determined using the Visual Sample Plan (VSP) software version 4.7 (Battelle Memorial Institute 2007, see Appendix A). VSP incorporates the MARSSIM method; Appendix A contains the VSP output. A total of 57 samples were determined to be adequate to determine with 99 percent confidence that the soil concentration of ^{90}Sr would be less than 1 pCi/g in the area of interest. Figure 1 shows the Runkle Canyon main and northwest grading areas with the overlaid soil sampling grid. Table 1 shows the sample locations and coordinates.

4.0 SAMPLE COLLECTION AND HANDLING

Collection of soil samples is required to determine the concentration of the radionuclide strontium-90 in soil. The soil sampling protocol will follow ASTM C998-05 "Standard Practice for Sampling Surface Soil for Radionuclides" or equivalent with the following modifications: one 1-m^2 area will be cleared and sampled rather than two 1-m^2 areas (with 5 cores or plugs rather than 10); and surface soil samples will be taken from a depth of 0 to 6 inches (0 to 15 cm) if possible.[a] Shallower samples (0 to 3 inches) are acceptable if soil conditions prevent deeper sampling, with appropriate documentation in the sampling logbook. An additional 6 deeper-soil samples (10 percent of the 57 surface samples) shall be taken at selected sample locations at depth of 6 to 12 inches (15 to 30 cm) using the same techniques. Samples shall be taken as close to the locations in Table 1 as feasible. Actions shall be taken to prevent cross-contamination between samples. Soil will be sieved using a 10 mesh sieve to remove vegetation and pebbles. 500 ml aliquots (approximately 1 kg each) will be taken and provided to the analytical laboratory using standard chain of custody procedures and forms. Samples shall be collected by qualified individuals using the appropriate equipment and procedures.

[a] One of the purposes of ASTM C998-05 is to provide samples for analysis of radionuclides following a recent airborne release, and to account for associated variability in surface soil deposition. These conditions do not apply for Runkle Canyon soil sampling, therefore modifications to the soil sampling procedure are applicable.

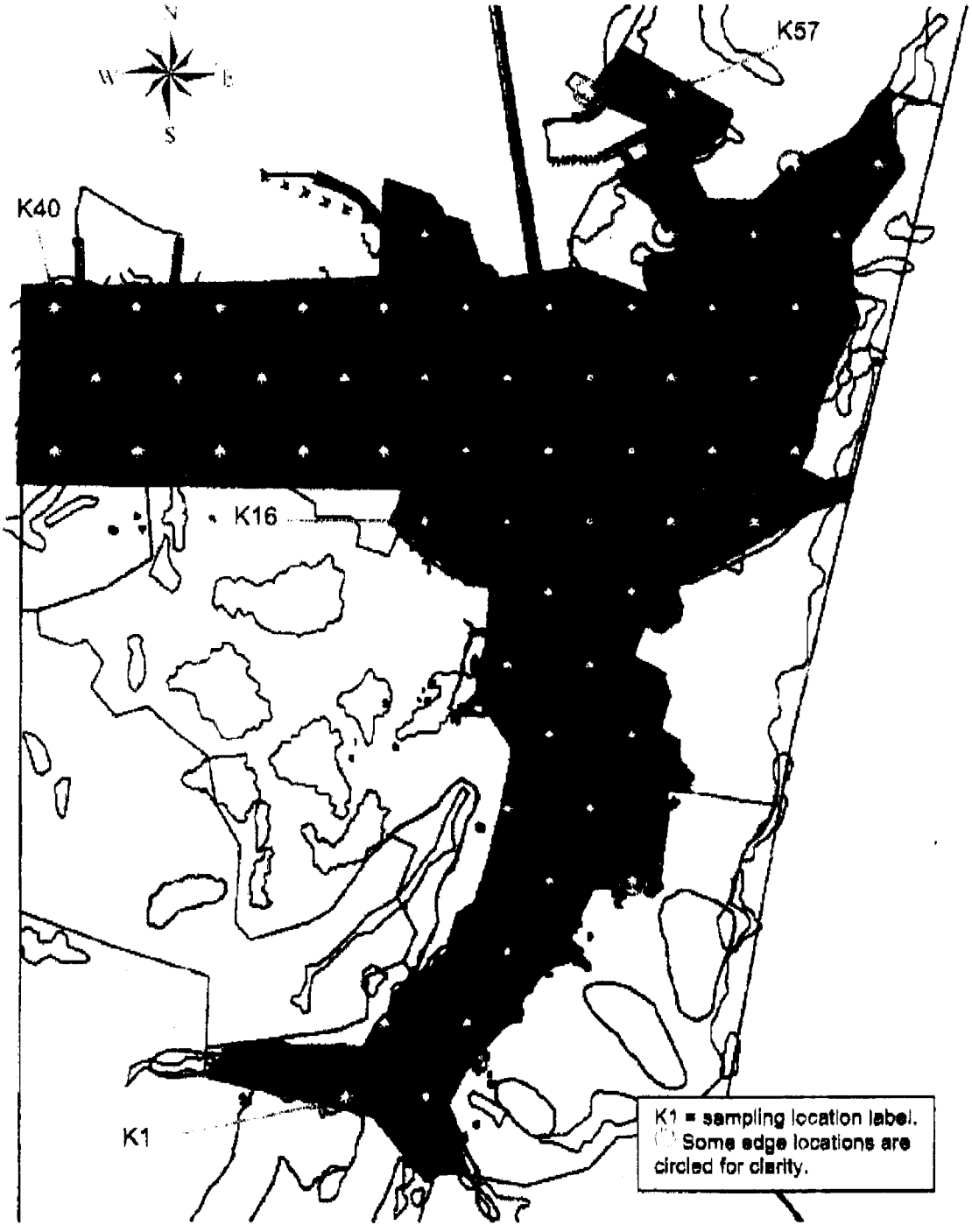


Figure 1. Soil sampling grid for the Runkle Canyon area.

Table 1. Sample Location Coordinates and Sample Designation.

Area: RUNKLE CANYON GRADING AREA & NORTHWEST QUADRANT					
X Coordinate (easting, in feet)	Y Coordinate (northing, in feet)	Label[1]	Value	Type	Historical
1777798.0104	267966.4650	K1		Systematic	
1778390.6043	267966.4650	K2		Systematic	
1778094.3073	268479.6664	K3		Systematic	
1778686.9012	268479.6664	K4		Systematic	
1778983.1981	268992.8677	K5		Systematic	
1779279.4951	269506.0691	K6		Systematic	
1779872.0889	269506.0691	K7		Systematic	
1778983.1981	270019.2704	K8		Systematic	
1779575.7920	270019.2704	K9		Systematic	
1779279.4951	270532.4718	K10		Systematic	
1779872.0889	270532.4718	K11		Systematic	
1778983.1981	271045.6731	K12		Systematic	
1779575.7920	271045.6731	K13		Systematic	
1779279.4951	271558.8745	K14		Systematic	
1779872.0889	271558.8745	K15		Systematic	
1778390.6043	272072.0758	K16		Systematic	
1778983.1981	272072.0758	K17		Systematic	
1779575.7920	272072.0758	K18		Systematic	
1780168.3859	272072.0758	K19		Systematic	
1780760.9798	272072.0758	K20		Systematic	
1775723.9318	272585.2772	K21		Systematic	
1776316.5257	272585.2772	K22		Systematic	
1776909.1196	272585.2772	K23		Systematic	
1777501.7135	272585.2772	K24		Systematic	
1778094.3073	272585.2772	K25		Systematic	
1778686.9012	272585.2772	K26		Systematic	
1779279.4951	272585.2772	K27		Systematic	
1779872.0889	272585.2772	K28		Systematic	
1780464.6828	272585.2772	K29		Systematic	
1781057.2767	272585.2772	K30		Systematic	
1776020.2288	273098.4785	K31		Systematic	
1776612.8226	273098.4785	K32		Systematic	
1777205.4165	273098.4785	K33		Systematic	
1777798.0104	273098.4785	K34		Systematic	
1778390.6043	273098.4785	K35		Systematic	
1778983.1981	273098.4785	K36		Systematic	
1779575.7920	273098.4785	K37		Systematic	
1780168.3859	273098.4785	K38		Systematic	

1780760.9798	273098.4785	K39		Systematic	
1775723.9318	273611.6799	K40		Systematic	
1776316.5257	273611.6799	K41		Systematic	
1776909.1196	273611.6799	K42		Systematic	
1777501.7135	273611.6799	K43		Systematic	
1778094.3073	273611.6799	K44		Systematic	
1778686.9012	273611.6799	K45		Systematic	
1779279.4951	273611.6799	K46		Systematic	
1779872.0889	273611.6799	K47		Systematic	
1780464.6828	273611.6799	K48		Systematic	
1781057.2767	273611.6799	K49		Systematic	
1778390.6043	274124.8812	K50		Systematic	
1780168.3859	274124.8812	K51		Systematic	
1780760.9798	274124.8812	K52		Systematic	
1781353.5736	274124.8812	K53		Systematic	
1781057.2767	274638.0826	K54		Systematic	
1781649.8706	274638.0826	K55		Systematic	
1779575.7920	275151.2839	K56		Systematic	
1780168.3859	275151.2839	K57		Systematic	

[1] Labels start in the lower lefthand (southeast) corner of the grid in Figure 1 and move north, west to east.

All sample media, personal protective equipment, and other materials or equipment used during the sampling may be properly disposed as sanitary waste. The waste is not considered radioactive waste.

Activities associated with the soil sampling should be planned and monitored to assure that the health and safety of those performing the sampling and other personnel are adequately protected. Health and safety concerns at this undeveloped site may include heat or cold depending upon the time of year, sharp objects, falling objects, tripping hazards, and biological hazards such as insects and snakes. It is expected that environmental sampling firm will conduct all sampling tasks consistent with their policies and procedures for health and safety. All personnel should be briefed on potential safety hazards prior to performing or observing tasks.

5.0 SAMPLE ANALYSIS

The analytical laboratory shall have written procedures that document its analytical capabilities for ^{90}Sr in soil, and a Quality Assurance/Quality Control (QA/QC) program that ensures the validity of the analytical results. The laboratory shall have a minimum detectable concentration (MDC) capability of 0.1 pCi/g or lower for ^{90}Sr in soil. The laboratory should have performance evaluation results from a recognized laboratory accreditation program, and should be able to provide QA audits or other records to verify its ability to produce valid results. Equipment calibrations shall be performed using National Institute of Standards and Technology (NIST) traceable reference radionuclide standards. For any sample result greater than 0.5 pCi/g ^{90}Sr, another analysis shall be performed of that soil sample. A complete analytical report shall be provided documenting the above information and providing quantitative numerical sample

results (regardless if positive, negative or below the MDC), total propagated uncertainty, and the MDC . An explanation of total propagated uncertainty and the calculation of the MDC shall be provided. Additional requirements shall be in force as agreed with Runkle Canyon, LLC.

6.0 REPORTING

Upon completion of the sampling and laboratory analysis, Dade Moeller & Associates will prepare a report interpreting and analyzing the data.

7.0 REFERENCES

Foster Wheeler Environmental Corporation. 1999. *Runkle Ranch Site Investigation , Simi Valley, California.* Final Report. Foster Wheeler Environmental Corporation, Costa Mesa, CA.

Harding ESE. 2000. *Results of Limited Soil Sampling, Rancho Simi Property. APN 6850-130-180, Simi Valley, California.* November 3, 2000. Harding ESE, Phoenix, AZ.

Ikenberry, T.A. 2005a. Supplemental *Soil Sampling for Strontium-90 in the Runkle Canyon Development Simi Valley, California.* DMA-TR-15. Dade Moeller & Associates, Richland Washington.

Ikenberry, T.A 2005b. *Radiological Health Risks from Strontium-90 in the Runkle Canyon Development Simi Valley, California.* DMA-TR-14. Dade Moeller & Associates, Richland Washington.

Miller Brooks Environmental, Inc. 2003a. *Site Investigation Report of Western 350-Acre Parcel; GreenPark Runkle Canyon, LLC Runkle Canyon Property in Simi Valley, California.* September 17, 2003. Miller Brooks Environmental, Inc., Huntington Beach, CA.

Miller Brooks Environmental, Inc. 2003b. *Site Investigation Report of 550-Acre Parcel; GreenPark Runkle Canyon, LLC Runkle Canyon Property in Simi Valley, California.* September 17, 2003. Miller Brooks Environmental, Inc., Huntington Beach, CA.

Miller Brooks Environmental, Inc. 2003c. *Site Investigation Report of Southern 715-Acre Parcel; GreenPark Runkle Canyon, LLC Runkle Canyon Property in Simi Valley, California.* September 17, 2003. Miller Brooks Environmental, Inc., Huntington Beach, CA.

QST Environmental, Inc. 1999. "Results of Preliminary Soil Samples at Runkle Ranch in Simi Valley, California." Letter Report from John S. Kim to Ms. Marina Robertson, GreenPark Ventures, LLC. dated February 5, 1999.

U.S. Environmental Protection Agency (EPA). 2001. *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM).* EPA-402-R-97-016, Rev.1 (also NUREG-1575, Rev. 1, DOE/EH-0624, Rev. 1). U.S. Environmental Protection Agency, Washington, DC.
URL: www.epa.gov/radiation/marssim/obtain.htm

APPENDIX A. SYSTEMATIC SAMPLING LOCATIONS FOR COMPARING A MEDIAN WITH A FIXED THRESHOLD (NONPARAMETRIC - MARSSIM)

Summary
This report summarizes the sampling design used, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design developed. A figure that shows sampling locations in the field and a table that lists sampling location coordinates are provided as **Figure 1** and **Table 1**, respectively, in the main text of this sampling plan.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean or median to a fixed threshold
Type of Sampling Design	Nonparametric
Sample Placement (Location) In the Field	Systematic with a random start location
Working (Null) Hypothesis	The median(mean) value at the site exceeds the threshold
Formula for calculating number of sampling locations	Sign Test - MARSSIM version
Calculated total number of samples	57
Number of samples on map [a]	57
Number of selected sample areas [b]	1
Specified sampling area [c]	17334838.54 ft^2 *(398 acres)*
Size of grid / Area of grid cell [d]	592.594 feet / 304120 ft^2 *(6.98 acres)*
Grid pattern	Triangular

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Size of grid / Area of grid cell gives the linear and square dimensions of the grid used to systematically place samples.

Primary Sampling Objective
The primary purpose of sampling at this site is to compare a site median or mean value with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the median(mean) value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the median(mean) value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative one, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A nonparametric systematic sampling approach with a random start was used to determine the number of samples and to specify sampling locations. A nonparametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that typical parametric assumptions may not be true.

Both parametric and non-parametric equations rely on assumptions about the population. Typically, however, non-parametric equations require fewer assumptions and allow for more uncertainty about the

statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than if a non-parametric equation was used.

Locating the sample points over a systematic grid with a random start ensures spatial coverage of the site. Statistical analyses of systematically collected data are valid if a random start to the grid is used. One disadvantage of systematically collected samples is that spatial variability or patterns may not be discovered if the grid spacing is large relative to the spatial patterns.

Number of Total Samples: Calculation Equation and Inputs

The equation used to calculate the number of samples is based on a Sign test (see PNNL 13450 for discussion). For this site, the null hypothesis is rejected in favor of the alternative one if the median(mean) is sufficiently smaller than the threshold. The number of samples to collect is calculated so that if the inputs to the equation are true, the calculated number of samples will cause the null hypothesis to be rejected.

The formula used to calculate the number of samples is:

$$n = 1.20\left[\frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{4(SignP - 0.5)^2}\right]$$

where

$$SignP = \Phi\left[\frac{\Delta}{\left(s^2_{sample} + \frac{s^2_{analytical}}{r}\right)^{1/2}}\right]$$

$\Phi(z)$ is the cumulative standard normal distribution on $(-\infty,z)$ (see PNNL-13450 for details).
n is the number of samples,
S is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site median(mean) is less than the threshold.
β is the acceptable probability of incorrectly concluding the site median(mean) exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

Note: MARSSIM suggests that the number of samples should be increased by at least 20% to account for missing or unusable data and uncertainty in the calculated value of n. VSP allows a user-supplied percent overage as discussed in MARSSIM (EPA 2000, p. 5-33).

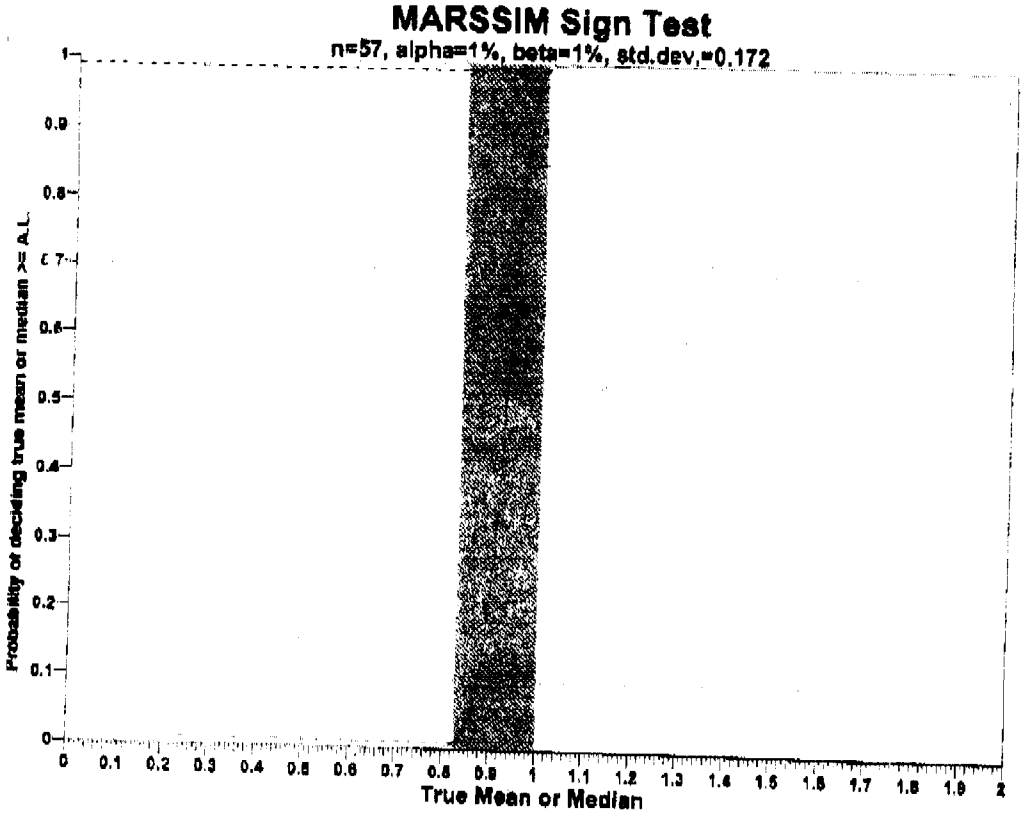
The values of these inputs that result in the calculated number of sampling locations are:

Analyte	n[a]	Parameter					
		S	Δ	α	β	$Z_{1-\alpha}$ [b]	$Z_{1-\beta}$ [c]
	57	0.172	0.172	0.01	0.01	2.32635	2.32635

[a] The final number of samples has been increased by the MARSSIM Overage of 20%.
[b] This value is automatically calculated by VSP based upon the user defined value of α.
[c] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000). It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true median(mean) values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions

The assumptions associated with the formulas for computing the number of samples are:

1. the computed sign test statistic is normally distributed,
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected probabilistically.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the gridded sample locations were selected based on a random start.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that $\mu >$ action level and alpha (%), probability of mistakenly concluding that $\mu <$ action level and examining the resulting changes in the number of samples. The following table shows the results of this analysis.

Number of Samples										
AL=1		α=1			α=1.5			α=2		
		Standard deviation			Standard deviation			Standard deviation		
		0.258	0.172	0.086	0.258	0.172	0.086	0.258	0.172	0.086
LBGR=87.8	β=1	197	96	38	184	90	35	176	86	33
	β=1.5	184	90	35	172	84	33	162	80	32
	β=2	176	86	33	162	80	32	154	75	29
LBGR=82.8	β=1	107	57	29	100	53	28	95	51	27
	β=1.5	100	53	28	93	50	26	88	47	24
	β=2	95	51	27	88	47	24	83	45	23
LBGR=77.8	β=1	71	41	28	66	39	26	63	36	24
	β=1.5	66	39	26	62	36	24	58	34	23
	β=2	63	36	24	58	34	23	58	33	22

LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that $\mu >$ action level
α = Alpha (%), Probability of mistakenly concluding that $\mu <$ action level
AL = Action Level (Threshold)

Sample standard deviation (s) of 0.172 was determined from sample analysis documented by Ikenberry (Ikenberry 2005a).