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VSP Sponsors



U.S. EPA

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- Office of Environmental Information
 - John Warren

U.S. DOE

- EM-3
 - Dave Bottrell
- DoD
 - Navy
 - Jackie Sample, Fred McLean, Bill Ingersol
 - Strategic Environmental Research and Development Program (SERDP)
 - Anne Andrews

Cs-137 Contaminated Site

Has this field been remediated such that acceptable levels of Cs-137 have been achieved?

 Remediation of the shallow zone is complete pending verification of attainment of cleanup standard.

- Grid sampling proposed to verify cleanup.

The Site...



Available Information

- The target cleanup level is 6.2 pCi/g.
- Data from a nearby site that had been subjected to the same remediation was available.
 - HPGe fixed laboratory analyses
 - Nal 10 second field counts
 - Nal 30 second field counts

Data Summary

Analysis Method	Minimum	Mean	Maximum	Standard Deviation
10 second Nal	-2.959	0.498	5.676	3.74
30 second Nal	-1.679	0.225	2.740	1.118
HPGe	0.031	0.273	1.890	0.405

None of these data were normally distributed.



The Questions...

Which analysis method should we use?

How many samples will be needed?

How much will it cost?

Comparing Methods

Analysis Method	Reliable Reporting Limit	Approximate Cost per Sample
10 second counts	2.76 pCi/g	\$1.50
30 second counts	1.57 pCi/g	\$3.00
HPGe	0.08 pCi/g	\$200.00

Determining Sample Size

We have:

- The threshold of interest
- Estimate of standard deviation
- Shape of distribution

We need:

- Acceptable false positive rate
- Acceptable false negative rate
- Area of gray region

Decision Error Tolerances

If we assume that the site is "dirty", then we have to prove it is "clean" to say we've attained the cleanup standard.

– False positive error (Type I or α error)

• The probability of incorrectly deciding that the site is "clean". That is, the chance of determining that cleanup has been sufficiently achieved when, in fact, the site is still contaminated above the threshold level.

– α error limited to 0.05 by the project team.

Decision Error Tolerances

False negative error (Type II or β error)

- The probability of incorrectly deciding that the site is "dirty".
- $-\beta$ error limited to 0.20 by the project team.

Gray region – What is the gray region???

Is this the Gray Region???



VSP Definition of Gray Region

"The range of true concentrations where the consequences of deciding a clean site is dirty are considered relatively minor. The lower bound of the gray region is defined as the concentration where the consequences of concluding that the site is dirty would be too costly, require too much unnecessary cleanup, or be politically embarrassing. The type II error rate is associated with the lower bound of the gray region."

Enough already...the Gray Region

Gray region: The range of outcomes for which data is insufficient to make a decision.

Gray region set to 5% of target cleanup
level (0.31) by the project team.

Choosing the VSP Design

Visual Sample Plan

💭 File Map Edit Sampling Goals Tools Options View Window Help



JI.	Compare Average to Fixed Threshold		Can assume data will be normally distributed		
	Compare Average to Reference Average	Þ	Data not required to be normally distributed	Þ	Simple random sampling (Wilcoxon signed ranks test)
	Estimate the Mean	۲	Data from specified distribution (Simulation)	Þ	Systematic grid sampling (Wilcoxon signed ranks test)
	Construct Confidence Interval on Mean	۲T			Simple random sampling (MARSSIM sign test)
	Compare Proportion to Fixed Threshold	۲I			Systematic grid sampling (MARSSIM sign test)
	Compare Proportion to Reference Proportion	۲I			
	Estimate the Proportion	۲I			
	Locating a Hot Spot	۲I			
	Find UXO Target Areas	۲I			
	Assess Degree of Confidence in UXO Presence				
	Non-statistical sampling approach				
	Range Sustainability	Þ.			

Using VSP to Determine Sample Size

🗯 True Mean or Median vs. Action Level 📃 💈	<				
Wilcoxon Signed Rank Test Grid Costs					
For Help, highlight an item and press F1					
Choose: True Mean or Median >= Action Level (Assume Site is Dirty)					
True Mean or Median <= Action Level (Assume Site is Clean) You have chosen as a baseline to assume the site is "Dirty"					
False Rejection Rate (Alpha): 5.0 %					
False Acceptance Rate (Beta): 10.0 %					
Width of Gray Region (Delta): 2	l				
Action Level: 10	l				
Estimated Standard Deviation: 3	l				
	l				
MQO	l				
Minimum Number of Samples in Survey Unit: 24					
	l				
OK Cancel Apply Help					

HPGe Sample Size

True Mean or Median vs. Action Level	×			
Wilcoxon Signed Rank Test Grid Costs				
For Help, highlight an item and press F	1			
Choose: True Mean or Median >= Action Level (Assume Site is Dirty)				
O True Mean or Median <= Action Level (Assume Site is Clean) You have chosen as a baseline to assume the site is "Dirty"				
False Rejection Rate (Alpha): 5.0 %				
False Acceptance Rate (Beta): 20.0 %				
Width of Gray Region (Delta): 0.31				
Action Level: 6.2				
Estimated Standard Deviation: 0.405				
MQO				
Minimum Number of Samples in Survey Unit: 14				
Close Cancel Apply Help				

HPGe Costs

🗰 True Mean or Median vs. Action Level	×
Wilcoxon Signed Rank Test Grid Costs	
Total Area to Sample: 800 Feet^2 💌	
Sampling Costs	
Fixed Planning and Validation Cost: \$ 0.00	
Field Collection Cost per Sample: \$ 20.00	
Analytical Cost per Analysis: \$ 180.00	
Total Cost for 14 Samples: \$2800.00	
Close Cancel Apply Help	

Comparison of Methods

Analysis Method	Sample Size	Total Sampling and Analysis Cost
10 second counts	1046	\$1569.00
30 second counts	95	\$285.00
HPGe	14	\$2800.00

30 Second Count Sampling Design

- 30 second count Nal sampling was agreed upon.
- A triangular grid design was developed in VSP
 - Map and coordinates given to field team.



Rambling On...the Negative Side

Oh, my...what trouble you can get into if you don't understand:

- Setting up your null hypothesis
- α and β errors
- Gray regions
- Distributional assumptions

Rambling On...the Positive Side

VSP provides a quick and easy way to determine sample sizes and to plot the sample locations on a map of the site.

Underlying theories used in VSP generally from EPA guidance.

Defensible, reproducible results.







http://dqo.pnl.gov/vsp

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