VSP Case Study

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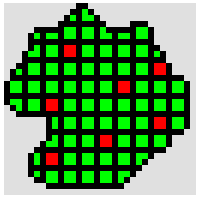
Neptune and Co., Inc.

VSP Sponsors

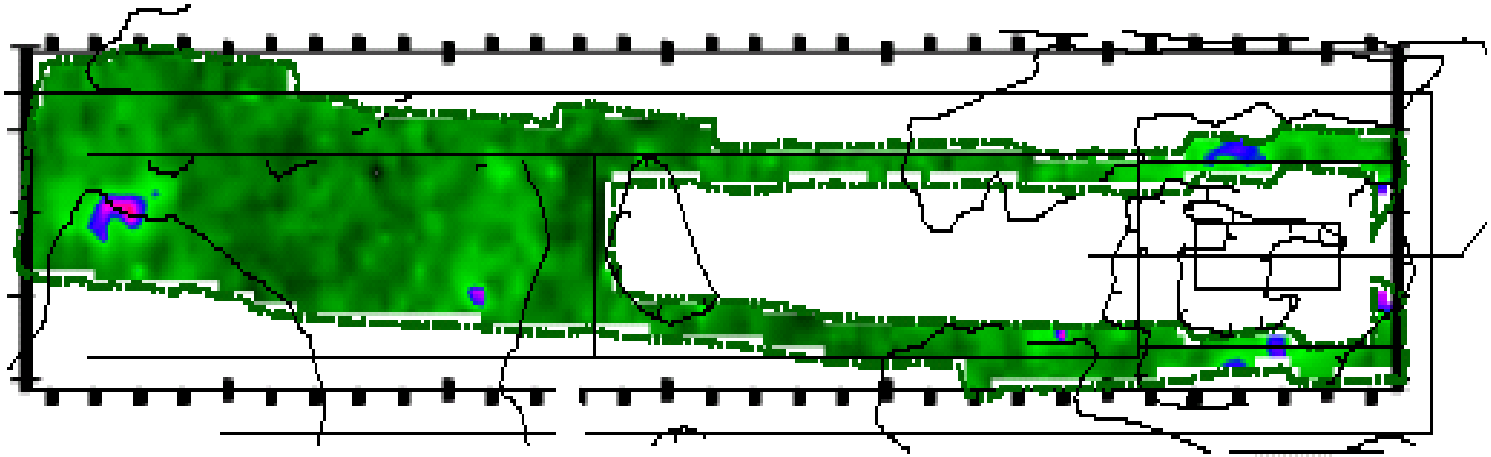


- U.S. EPA
  - Office of Solid Waste and Emergency Response
    - Larry Zaragoza, Mike Carter, Tony Jover
  - Office of Environmental Information
    - John Warren
- U.S. DOE
  - EM-3
    - Dave Bottrell
- DoD
  - Navy
    - Jackie Sample, Fred McLean, Bill Ingersol
  - Strategic Environmental Research 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
  - NaI 10 second field counts
  - NaI 30 second field counts

Data Summary

Analysis Method	Minimum	Mean	Maximum	Standard Deviation
10 second NaI	-2.959	0.498	5.676	3.74
30 second NaI	-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".
  - β error limited to 0.20 by the project team.
- Gray region
  - What is the gray region???

Is this the Gray Region???

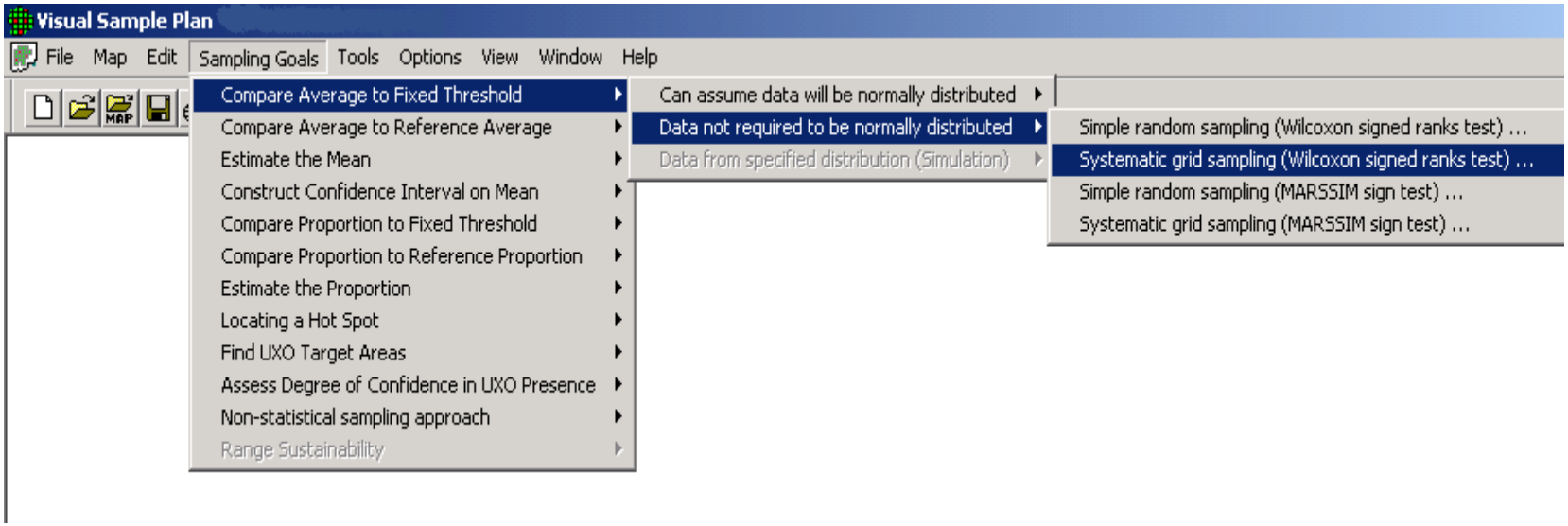
VSP Definition of Gray Region

- "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."

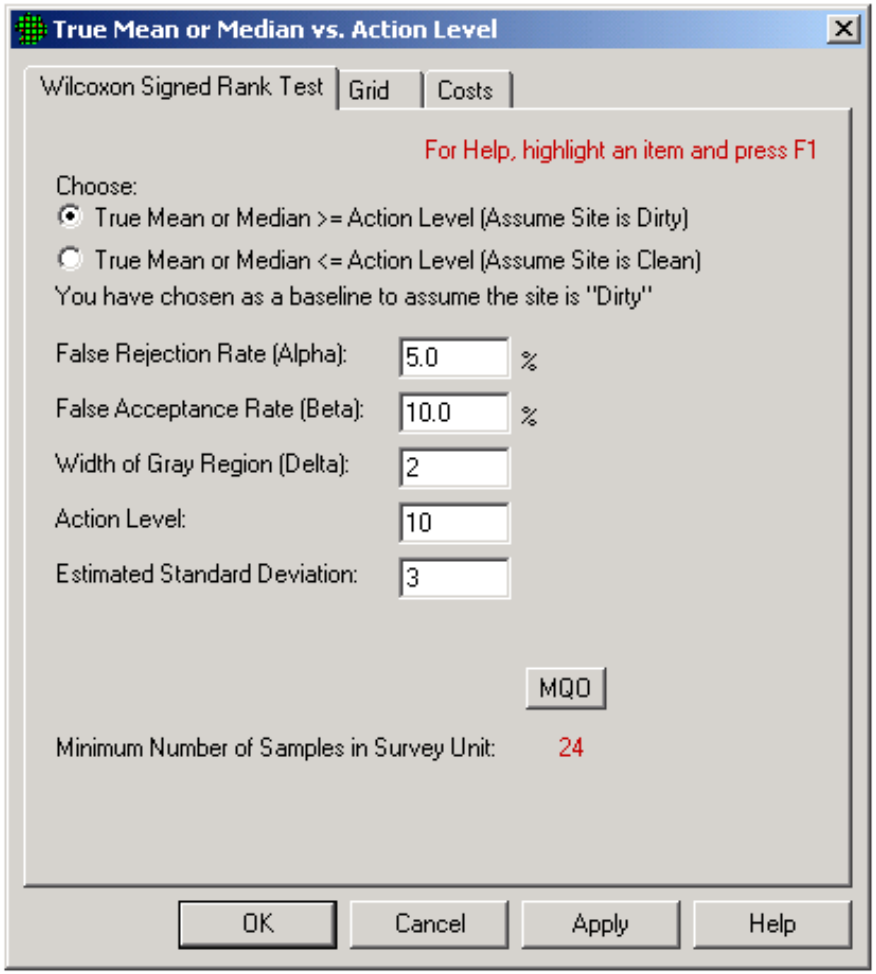
Enough already…the Gray Region

- 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.

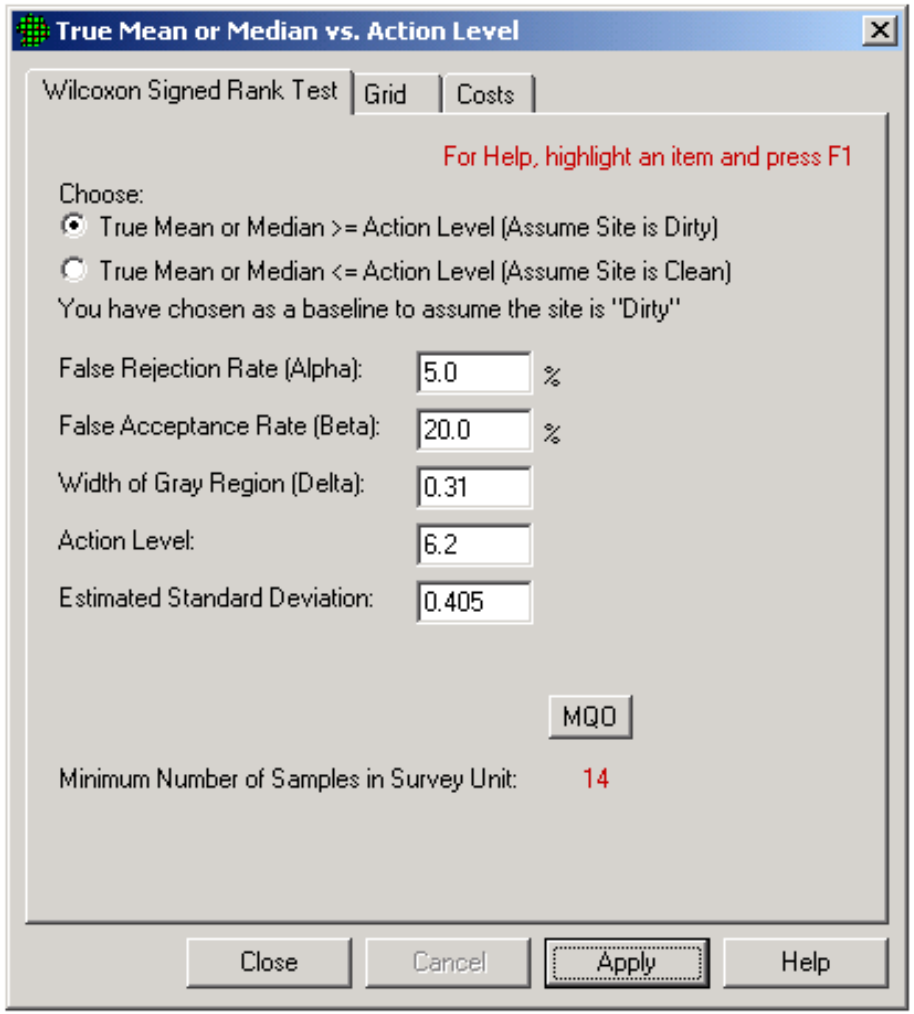
Choosing the VSP Design



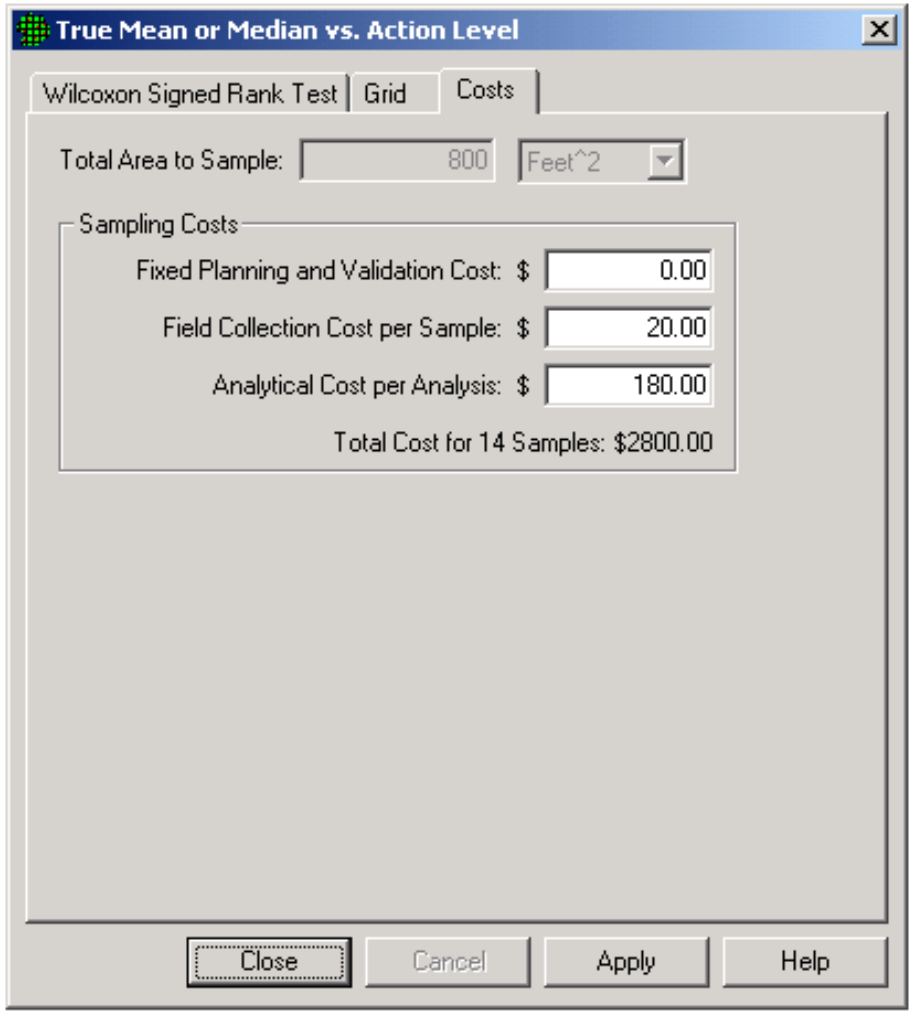
Using VSP to Determine Sample Size



HPGe Sample Size



HPGe Costs

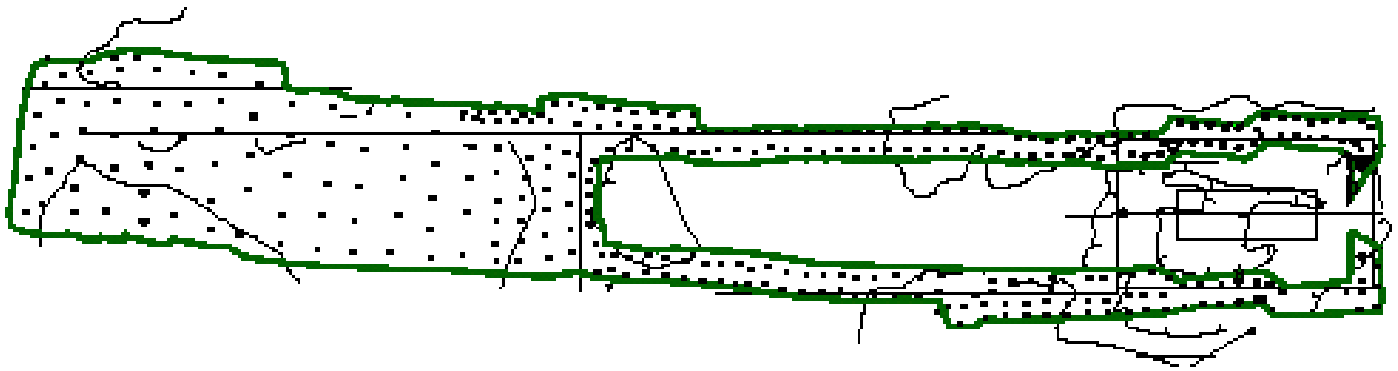

True Mean or Median vs. Action Level
Wilcoxon Signed Rank Test
Grid
Costs
Total Area to Sample:
800
Feet^2
Sampling Costs
Fixed Planning and Validation Cost: $
0.00
Field Collection Cost per Sample: $
20.00
Analytical Cost per Analysis: $
180.00
Total Cost for 14 Samples: $2800.00
Close
Cancel
Apply
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 NaI sampling was agreed upon.
- A triangular grid design was developed in VSP
  - Map and coordinates given to field team.



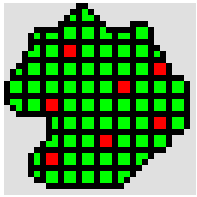
Rambling On…the Negative Side

- 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.

VSP Contacts



http://dqo.pnl.gov/vsp

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