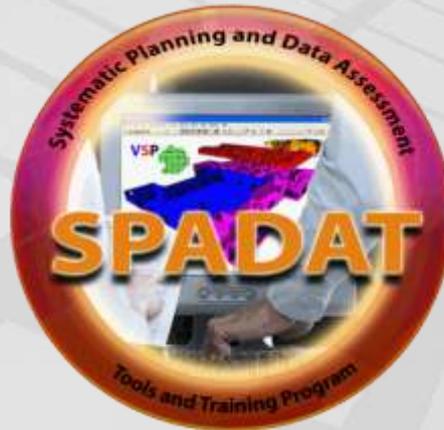


Visual Sample Plan (VSP) Briefing



Pacific Northwest National Laboratory (PNNL)

Brent Pulsipher, John Wilson, Lisa Newburn, Landon
Sego, J. Hathaway, Lisa Bramer, Brett Matzke.



Outline



- ▶ **DOE Support for Systematic Planning and Statistical Evaluation Tools**
- ▶ **VSP Background Information**
- ▶ **VSP Applications and Capabilities**
- ▶ **Recent VSP Additions**
- ▶ **Wishlist Items Generated by DOE Users**



DOE HS SPADAT Program



- ▶ All DOE sites obtain samples for variety of purposes
- ▶ If you don't get the right type, quality, and number of samples, perfect analytical quality still won't provide data to support confident decisions
- ▶ Systematic Planning and Data Analysis Tools and Training (SPADAT) Exists To:
 - Meet the continuing need for maintenance and development of new statistically defensible sampling methods to support all DOE needs
 - Improve VSP tool in response to DOE user requests
 - Continually train new and existing VSP users

Primary Objective: Decrease Costs, Increase Defensibility/Acceptability While Managing Uncertainty

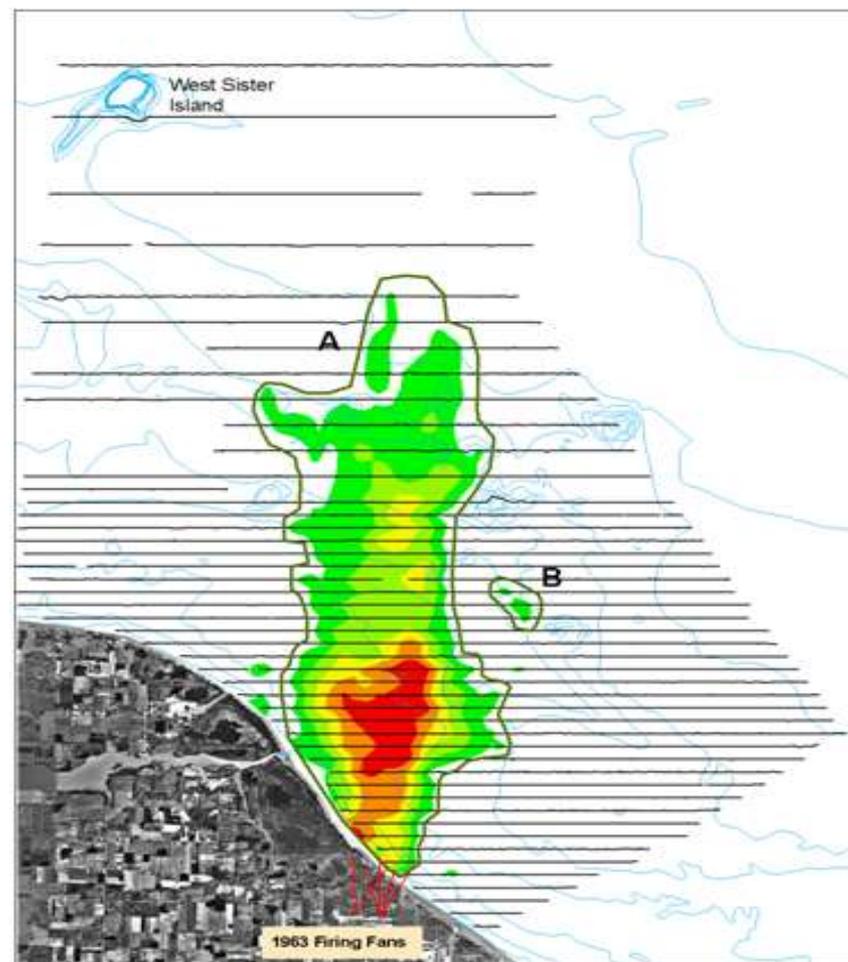




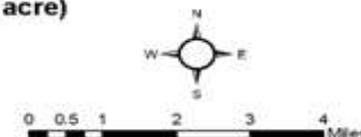
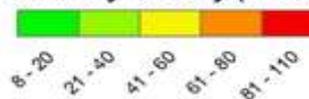
What is Visual Sample Plan (VSP)?



- ▶ **Data Quality Objectives (DQO) based systematic planning software**
 - ▶ **Determines the number and location of samples/transects**
 - ▶ **Ensures confident, statistically defensible decisions**
 - ▶ **Performs statistical and data quality assessment in support of decision making process.**
-
- ▶ Sponsored by DHS, DOE, EPA, DoD, UK, CDC
 - ▶ **Free** VSP Download at <http://vsp.pnl.gov/>
 - ▶ >5000 Users



Anomaly Density (anomalies per acre)

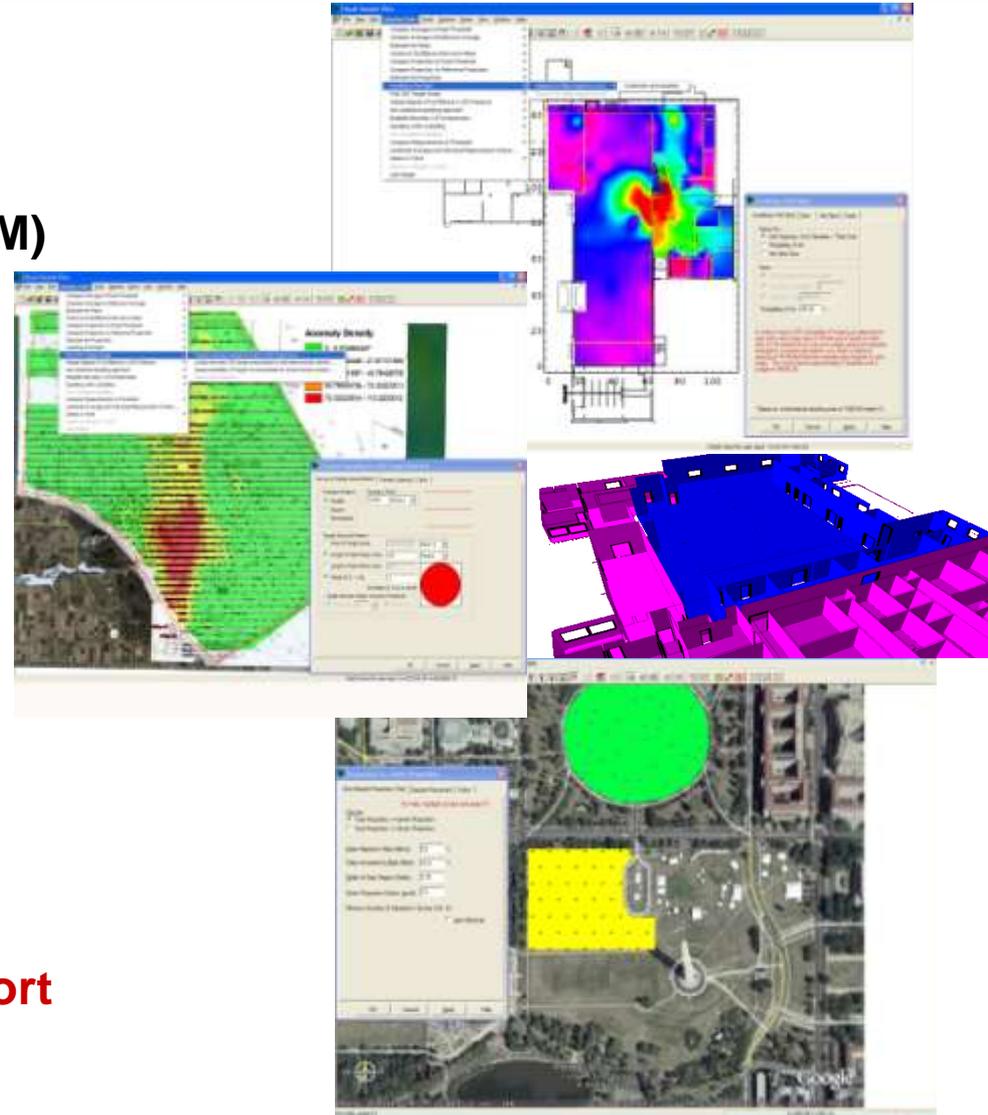




Current VSP Applications



- ▶ Environmental Remediation
- ▶ Health and Safety Assessment
- ▶ Decontamination and Decommissioning (incld MARSSIM)
- ▶ Long-Term Legacy and Groundwater Monitoring
- ▶ Identification, Delineation, and Remediation of UXO Sites
- ▶ Natural Disaster Assessments
- ▶ Within-Building Bio/Chem/Rad Terrorist Event or Manufacturing
- ▶ Outdoor Bio/Chem/Rad Terrorist Event
- ▶ Item audits and surveillance.



Wherever Sampling Is Used to Support Decisions



VSP Screen Shot



Visual Sample Plan - Multiple Analytes DC Mall Demo.vsp

File Map Edit Sampling Goals Tools Options Room View Window Help

Multiple Analytes DC Mall Demo.vsp:1

Multiple Analytes DC Mall Demo.vsp:2

1-Sample t-Test of True Mean vs. Action Level
 $n=21$, $\alpha=5\%$, $\beta=10\%$, $\text{std.dev.}=3$

Diagnostic interactive graphics can be manipulated to quickly see effects on design of changing DQO inputs

Maps, Photos, Images, Floorplans can be imported/exported with sample areas defined and samples displayed.

Sample location coordinates listed and available for output for use in the field (w/GPS)

Detailed 3-15+ page report automatically generated documenting design, assumptions, maps, equations, DQOs, analyses

Area: Ar
X Coord

-121.423	-114.0944	Random
-1.0609		Random
-61.2419		
-91.3326	4.7322	
88.8888	84.8888	

The following table summarizes the sampling design developed. A figure that show



VSP Sponsors

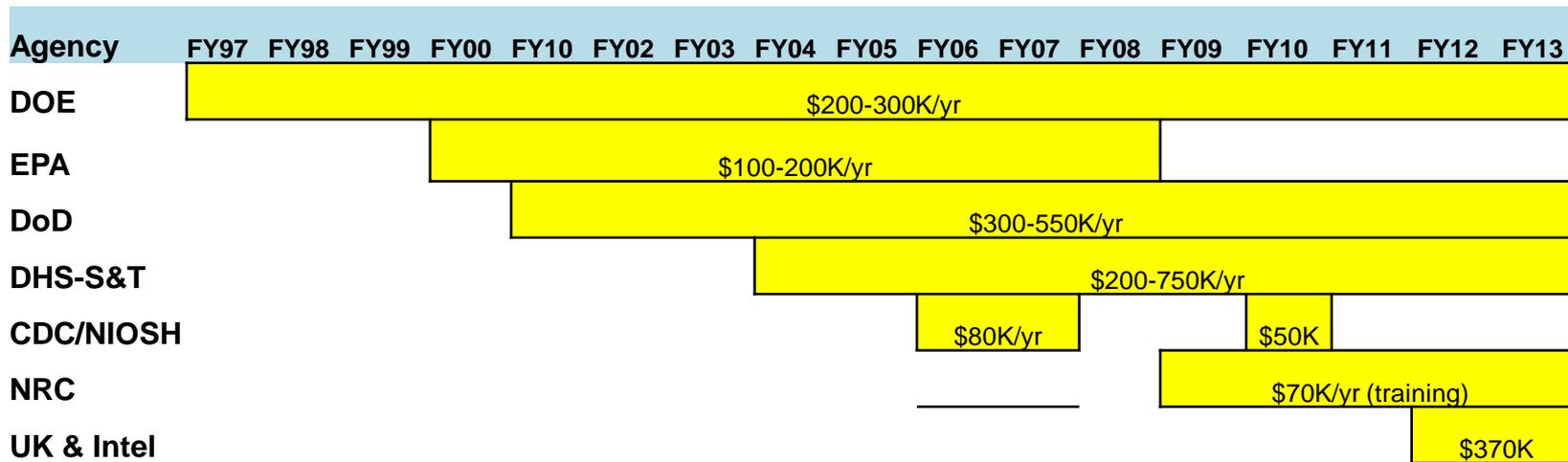


- ▶ **U.S. Environmental Protection Agency (EPA)**
 - Office of Solid Waste and Emergency Response
 - Office of Environmental Information
- ▶ **U.S. Dept. of Energy (DOE)**
 - HSS, LM, EM
- ▶ **U.S. Dept. of Defense (DoD)**
 - Navy & Army Corp. of Engineers
 - SERDP/ESTCP
- ▶ **U.S. Dept. of Homeland Security (DHS)**
 - Technical Support Working Group (TSWG)
 - Chemical and Biological Countermeasures
- ▶ **United Kingdom**
 - Atomic Weapons Establishment
 - Government Decontamination Services
- ▶ **U.S. Centers for Disease Control (CDC/NIOSH)**
- ▶ **U.S. Intelligence Community**

Tools Integration and Leveraging Off All Investments



History of Long Term VSP Related Support



▶ Most Agencies Sponsor

- New Developments
- Maintenance
- Training
- Applications/Demonstrations

▶ Continued VSP Investments By Multiple Agencies Are Planned

▶ Added Three New Agencies in FY13 (UK-GDS, DNDO, Intel)

▶ Currently On VSP Version 6.8; New X.0 Releases Every 2-3 Years.



VSP User Profile



VSP Users (Since 5.0 as of 3/17/11)		
USA	Sites	# Users
	EPA	913
	DOE	467
	States	355
	Army	510
	Navy	303
	Air Force	149
	Other DoD	40
	NRC	58
	Other	1282
Total USA		3707
International	UK	259
	Canada	165
	Australia/NZ	96
	Brazil	48
	Spain	46
	Other	575
Total International		1189
Total Recent Users		4886





General Benefits of Using VSP



- ▶ **Statistically defensible sampling designs**
- ▶ **Statistical rigor hidden... designed for non-statistician**
- ▶ **Quantified confidence**
- ▶ **Real-time cost/benefit tradeoff evaluations**
- ▶ **Just enough sampling**
- ▶ **Visualization supports communication**
- ▶ **Streamlined acceptance by regulators**
- ▶ **Leveraging off multi-agency investments**



Some Comments from the Field



Site	Name	Application	Comments
Rocky Flats	Jody	Vegetation Monitoring	saved me a great deal of time
Oak Ridge	Mike	Scrap Metal Recycling Facility	VSP greatly speeded the process
Pantex	Bill	Railroad ballast material on site compared to background	VSP allowed us to collect useful data and communicate uncertainty to the customer (DOE) with few samples
Hanford	Dave	Radiological Surveys	I find VSP extremely useful as a time and money saver; readily accepted
ORNL	Kevin	Beryllium facility characterization	great time saver; useful for industrial hygiene as well as environmental applications and should continue to be funded by DOE.
LANL	Brett	Many Environmental Restoration Sites	VSP allows us to pinpoint (GPS) every sample and place it on map with ease



Comments (continued)



Site	Name	Application	Comments
ORAU/ORISE	Teresa	D&D Independent Verification	VSP is an invaluable tool for planning our survey; saves us many hours
INL and Hanford	Cliff	Burial Ground Post-retrieval character.	VSP has become " part of the culture "; should not only be maintained...it should be enhanced
Paducah	Ken	Often used for Subsurface Soils	VSP has proven to be an instructive tool
Oak Ridge Y12	Andrejs	Surveys for D&D of buildings	provides greater defensibility ; excellent tools to document and communicate; saves time and money
Nevada Test Site	Thomas	Atmospheric Test Site	using VSP at both the front end of the DQO process (planning) as well as the back end
Hanford	Wendy	50-75 Waste Closeout Sites	very easy to use and results in substantial savings ; regulators very supportive of VSP use.



VSP Features



Supports Various Statistical Sampling Options;
Many are in EPA's G-5S Guidance and MARSSIM

- ▶ Simple Random Sampling
- ▶ Systematic Grid Sampling
- ▶ Sequential Sampling
- ▶ Multiple Increment Sampling
- ▶ Collaborative Sampling
- ▶ Stratified Sampling
- ▶ Rank-Set Sampling
- ▶ Adaptive Cluster Sampling
- ▶ Continuous Transect Sampling
- ▶ Item Sampling
- ▶ Judgmental Sampling
- ▶ Combined Judgmental and Probabilistic Sampling

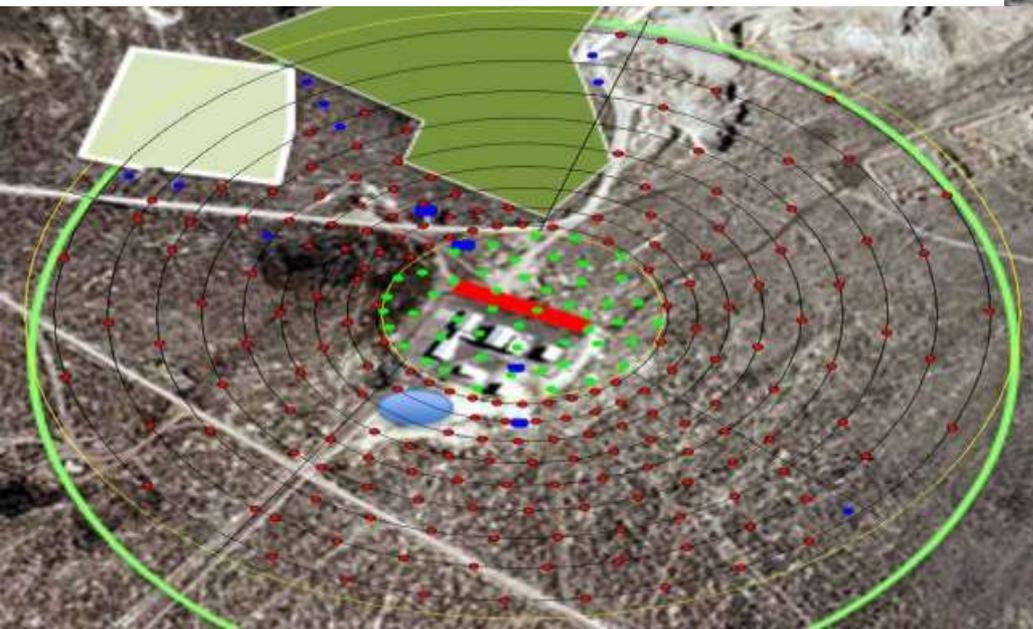




Outdoor Sampling and Analysis



- ▶ Number and placement of samples depends on selection of one of 30+ VSP modules
- ▶ Maps, Photos/Images
- ▶ Maintains Coordinate System
- ▶ Output For GPS
- ▶ Multiple Analytes and Sample Areas

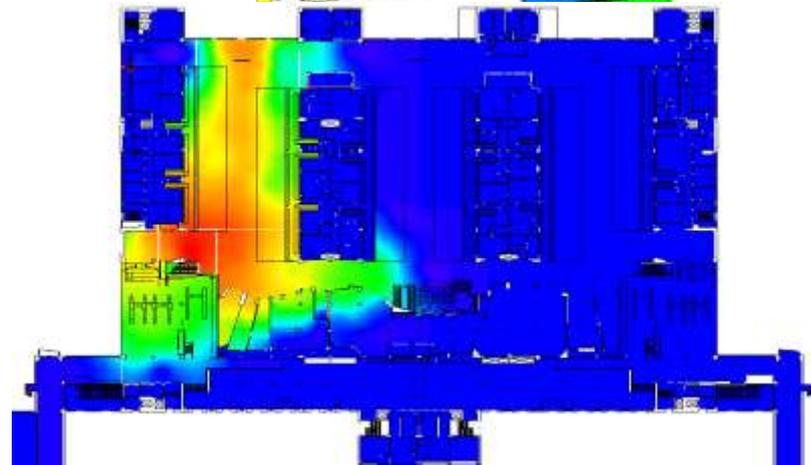
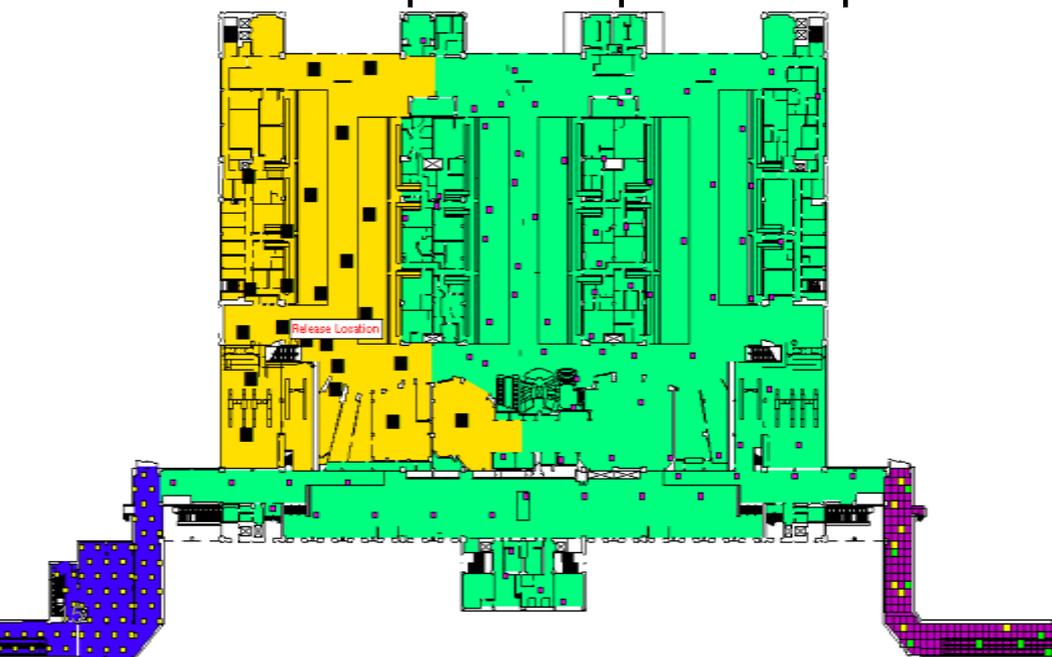
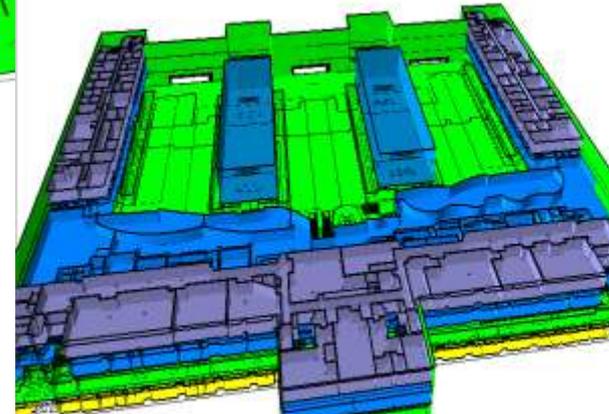
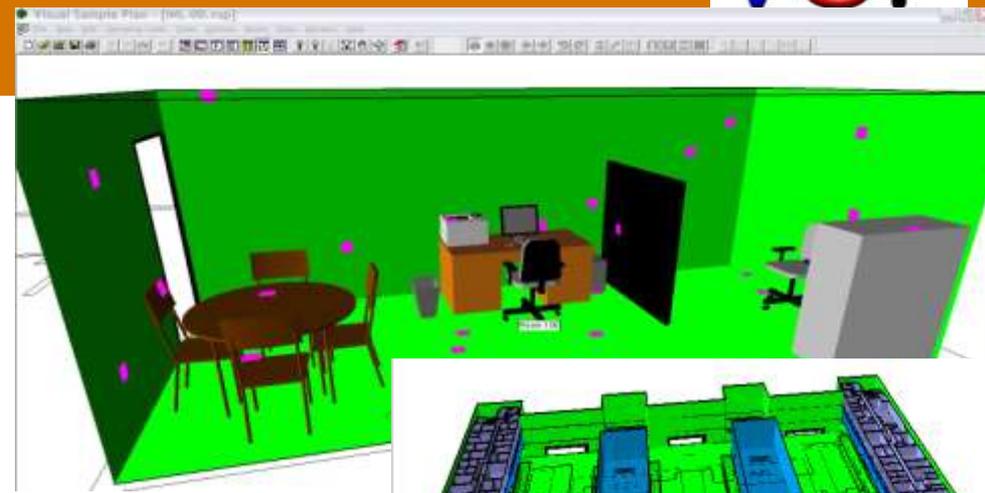




Indoor Surface Sampling and Analysis



- ▶ Accurate 3-D Representations
- ▶ Zoning of Areas
- ▶ Indoor Coordinate System
- ▶ Furniture Placement/Sampling
- ▶ Sample Results Visualized
- ▶ Wipe or Point Samples
- ▶ dxf or shp files imported/exported



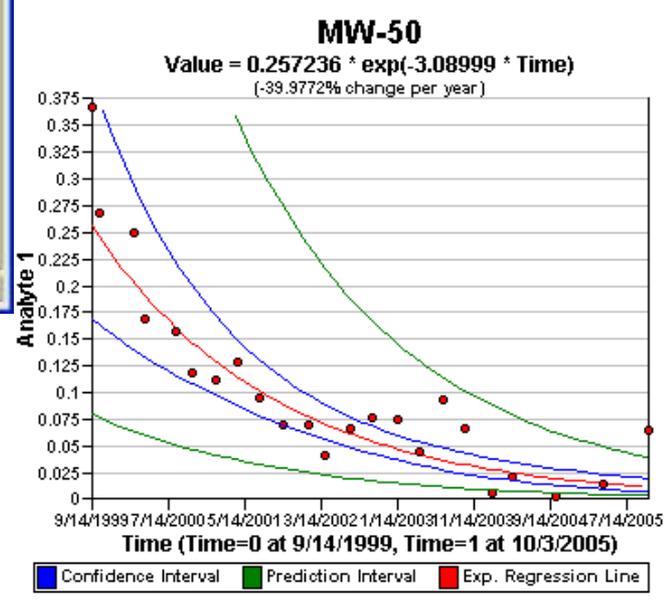
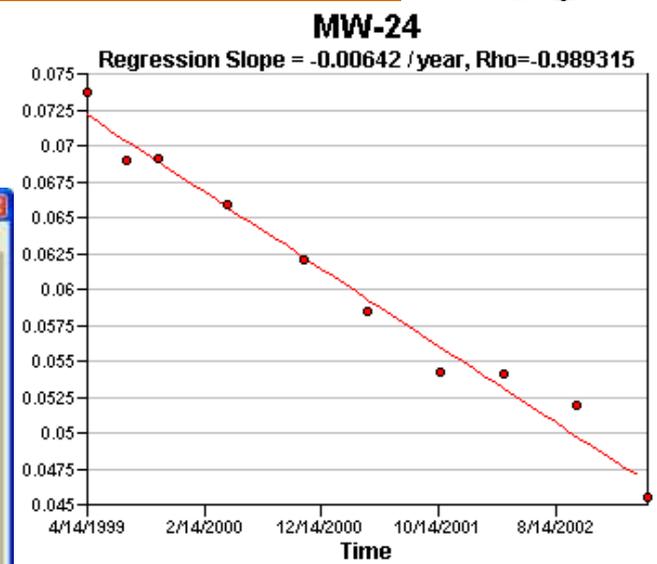
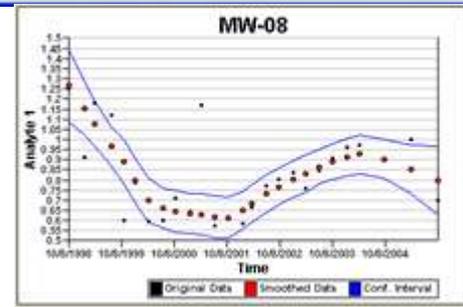
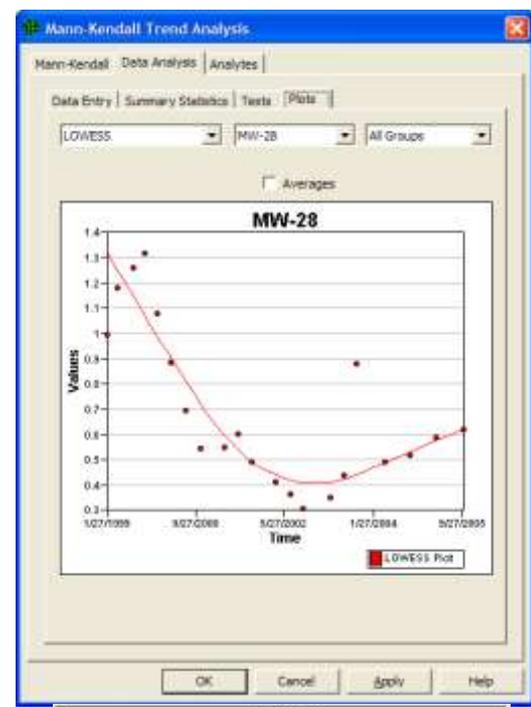


Sampling and Analysis Over Time



Helps Answer:

- ▶ Do I have significant linear or nonlinear trends?
- ▶ Can I sample less frequently?
- ▶ Is my treatment process effectively reducing contamination?
- ▶ How often do I need to sample to detect a trend?
- ▶ Are there seasonal effects?



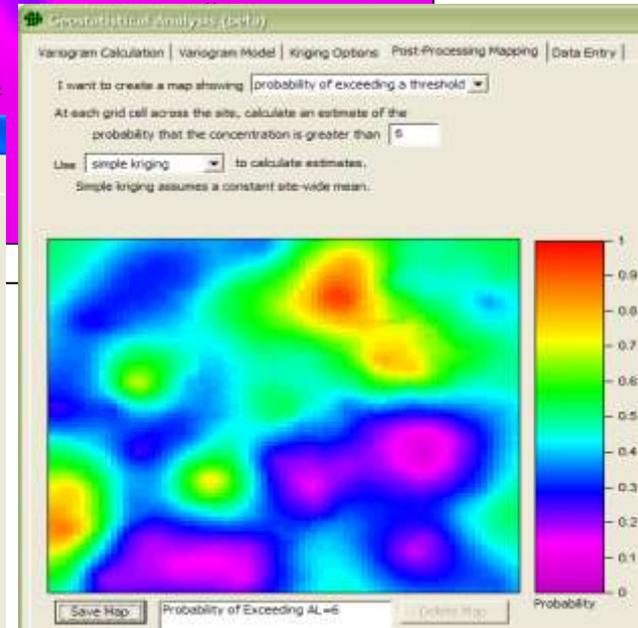
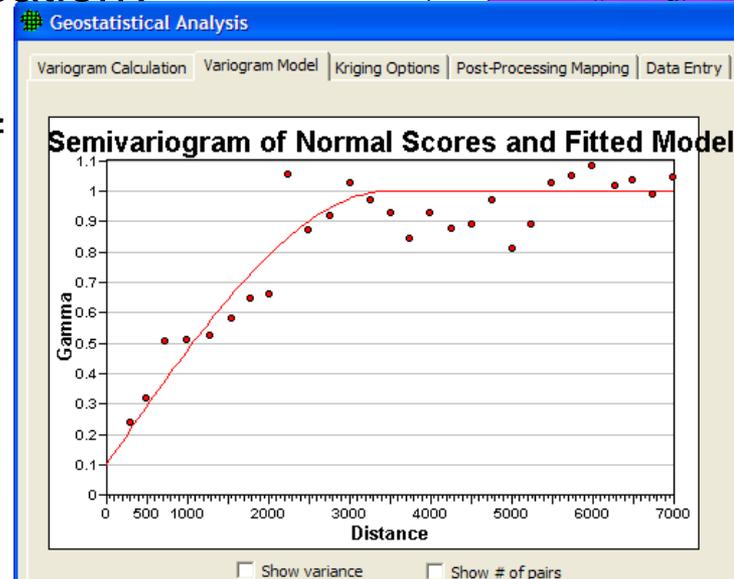
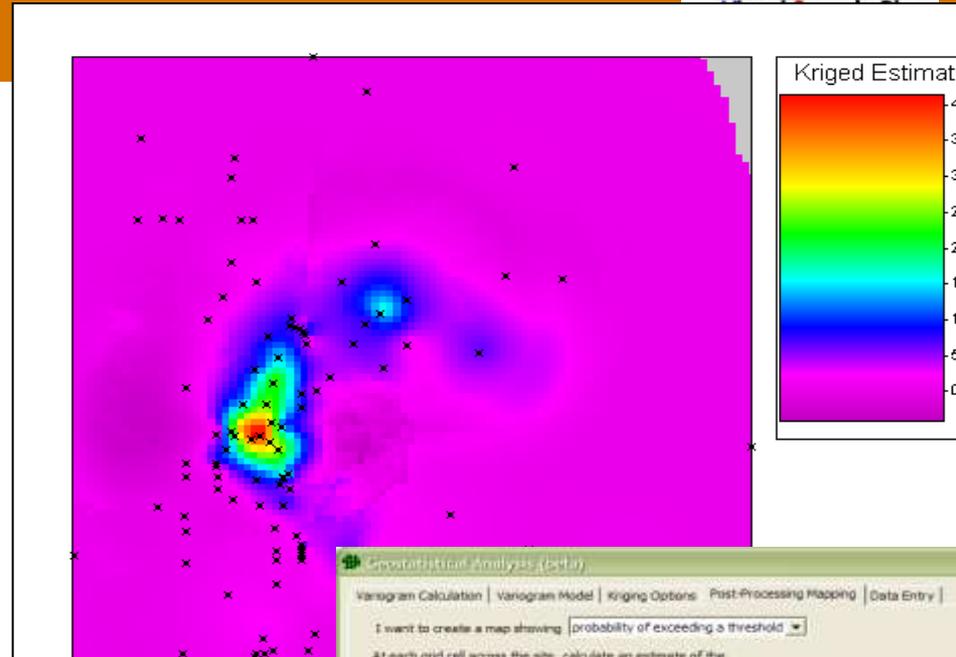


Spatial Sampling and Mapping



Helps Answer:

- ▶ What does my contamination look like spatially?
- ▶ Are samples close together more alike than samples further apart?
- ▶ Can I reduce the number of samples or wells?
- ▶ Where is the best place to add a well or sample location?
- ▶ Where is there a high probability of exceeding some concentration threshold?





Radiological Transect Surveys



Helps Answer:

- ▶ What transect spacing is needed to detect hotspots?
- ▶ How can I map spatial contamination patterns?
- ▶ Where are the hotspots and how can I delineate them?
- ▶ What will hotspot remediation cost?

Visual Sample Plan - [Rad Site Transformed w data.vsp]

Layer Control

- Settings
 - Map Lines
 - Default Map
 - Default Layer
 - Sample Areas
 - Default Map
 - Area 1
 - View Settings

Properties

Property	Value
Area Name	Area 1
Area Color	Yellow
Room Height	0
3D Height	0
Below Ground	
Include Floor	<input checked="" type="checkbox"/>
Include Ceiling	<input checked="" type="checkbox"/>
Include Walls	<input checked="" type="checkbox"/>
Area Type	Undefined
Floor Surface	Undefined
Ceiling Surface	Undefined
Default Wall ...	Undefined
Base Area	119078
Total Surface...	119078
Perimeter	2286.91
Volume	0

Potential Target Areas

Histogram

Kriged Values

Frequency

0 10 20 30 40 50 60 70

1000

100

10

1

Radiological Transect Survey Geostatistical Analysis

Variogram Calculation | Variogram Model | Kriging Options | Delineate Hot Areas | Data

Select Area

Name	Color	Creation Params
Area 1 Bkg	Yellow	N/A
Hot Area 2	Green	Auto Krig: 25, 40 meters*2 min
Hot Area 3	Blue	Auto Krig: 25, 40 meters*2 min
Hot Area 1	Orange	Auto Krig: 25, 40 meters*2 min

Name: Hot Area 1

Change Color Transparent Show Centers

Graph Graph All Area: 2034.38 Feet*2

Number of Measurements in Area: 12

Average Kriged Value: 30.6194

Minimum Measurement: 12.7993

Average Measurement: 34.7747

Maximum Measurement: 49.7363

Center: 983447.92, 233632.75

Delete Define New Edit Shape Merge Delete All

Automatic from Kriged Automatic from Target Markers

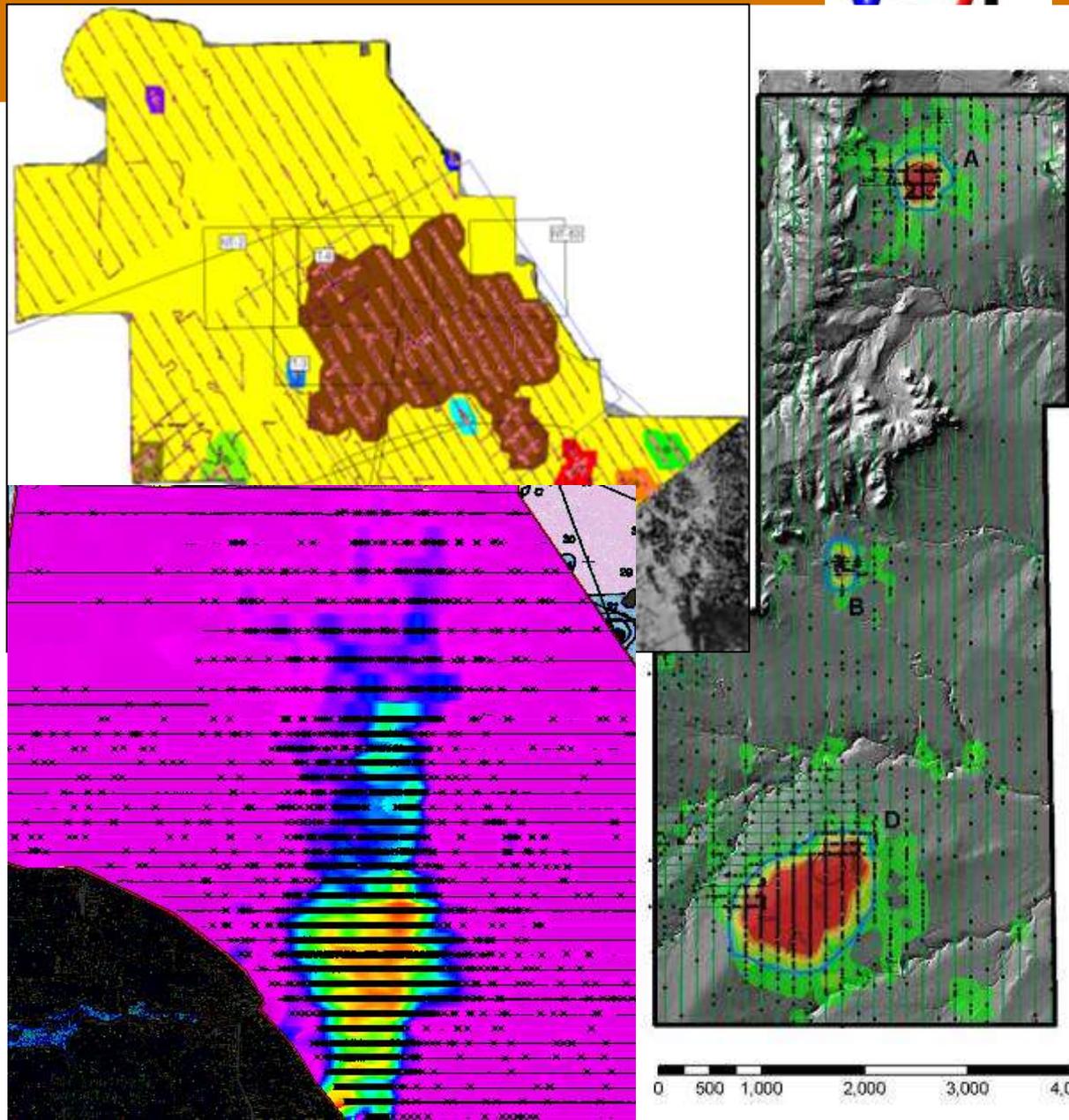
For Help, press F1

Unexploded Ordnance Sites



Helps Answer:

- ▶ What transect spacing will ensure target area detection?
- ▶ Where are high magnetic or geophysical anomaly density areas?
- ▶ What does the anomaly density spatial map look like?
- ▶ How can I verify that remediation has been effective?

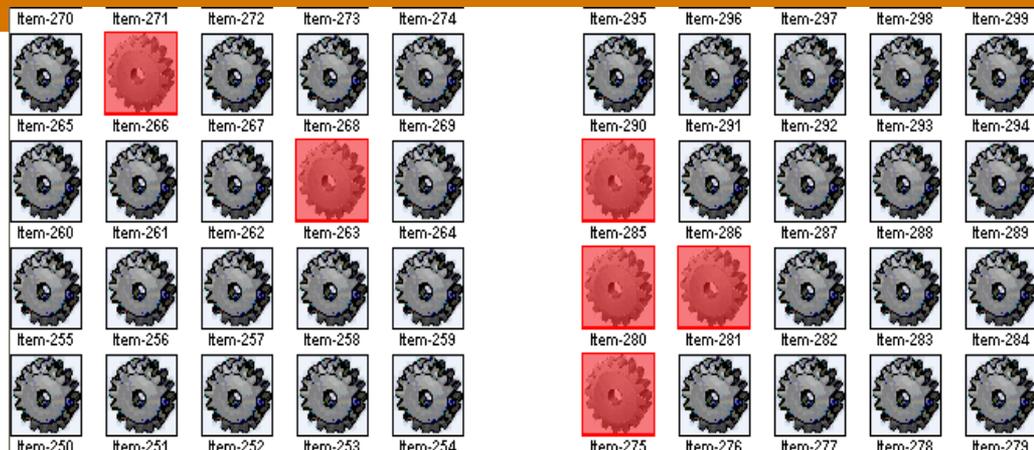




Item Sampling



- ▶ How Many Items Should I Sample?
- ▶ Drums, Folders, Property, Equipment, Widgets....
- ▶ X% Confident that Y% Are Acceptable
- ▶ 4 Options Available
 - Using Prior Knowledge
 - Judgment w/ Random
 - Probabilistic Only
 - Allow Some Unacceptable



Item Sampling (beta)

Item Sampling | Arrangement

None of the items in my sample can be unacceptable

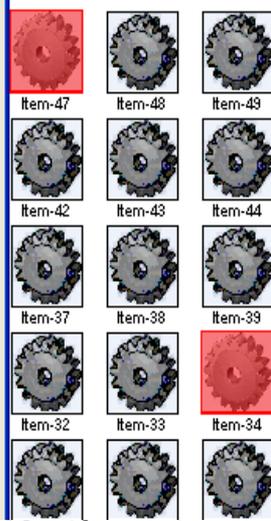
I don't want to account for prior belief in my design

I need to sample 1000 items.

I want to be 95 % confident that at least 98 % of all the items are acceptable.

Number of items that must be examined and found to be acceptable to achieve desired confidence: 138

Therefore, if 138 of the 1000 items are selected using simple random sampling and all 138 are acceptable, then you will be 95% confident that at least 98% of all the items are acceptable.

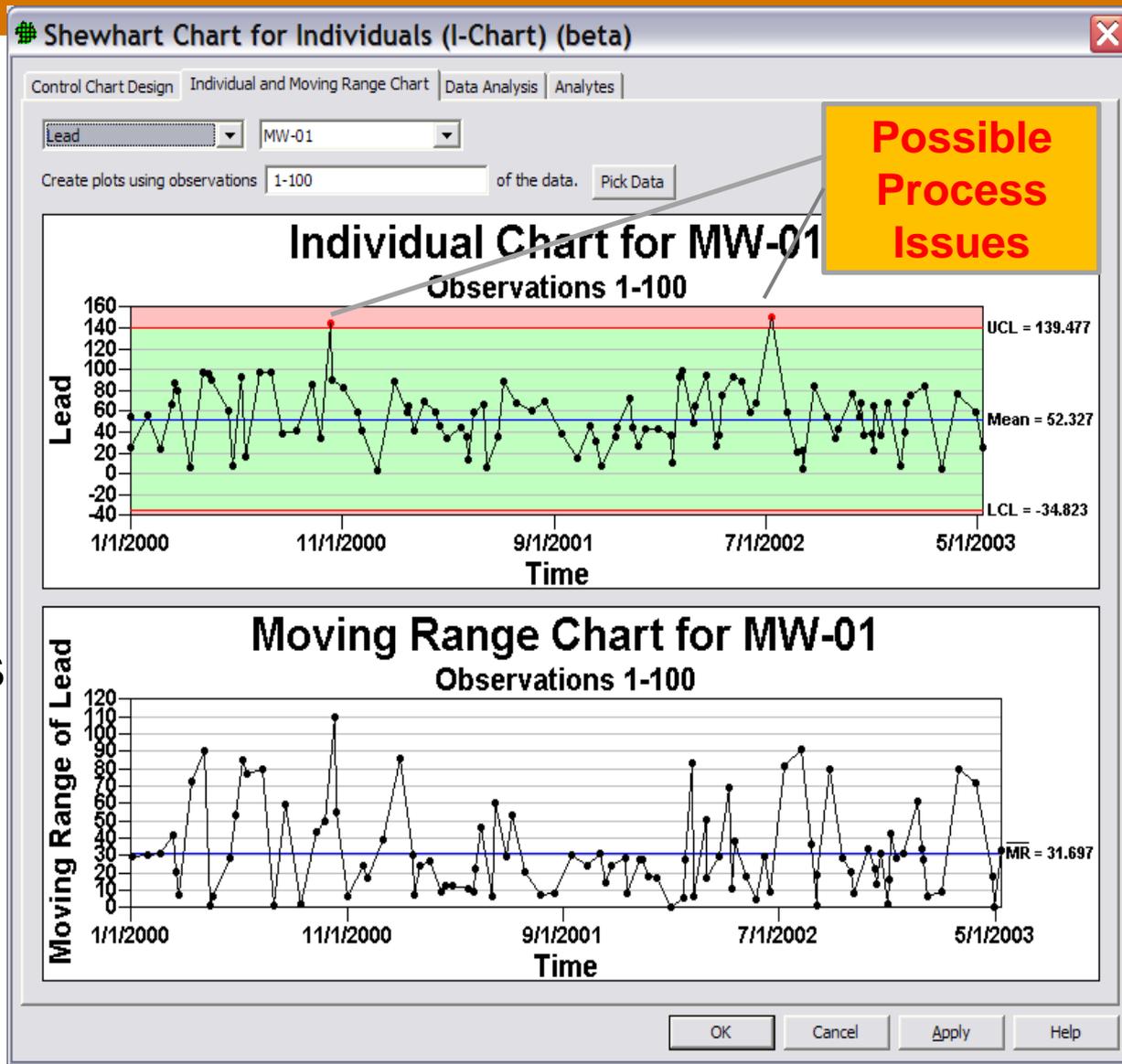




Process Monitoring Control Charts (Effluent Monitoring)



- ▶ Monitoring processes or wells over time
- ▶ Detects out-of-the-ordinary changes
- ▶ Flexible setup options
- ▶ Individual and moving range charts





FY13 VSP Courses

Very High Demand; Turn away many from each course



2 DOE-Sponsored Courses Completed Given Limited FY13 Funds

- | | |
|---|--------------------|
| ▶ Brookhaven National Lab & NYC-DEP | Aug 2013 |
| ▶ Hanford- CHPRC | Nov 2012 |
| ▶ DoD UXO Courses (Albuquerque, Boston) | Oct 2012, Mar 2012 |
| ▶ NRC (Harrisburg, Chicago) | Jan 2013, Jan 2014 |
| ▶ EPA/DHS | Jul 2013 |
| ▶ UK-AMEC/Magnox | May 2013 |

Will be offering VSP courses through
DOE National Training Center

- ▶ Registration Fee for Each Participant
- ▶ Anticipate starting at Oak Ridge: April
- ▶ 2-4 offerings per year
- ▶ Hosting Interest? Contact Brent





What's New and Exciting



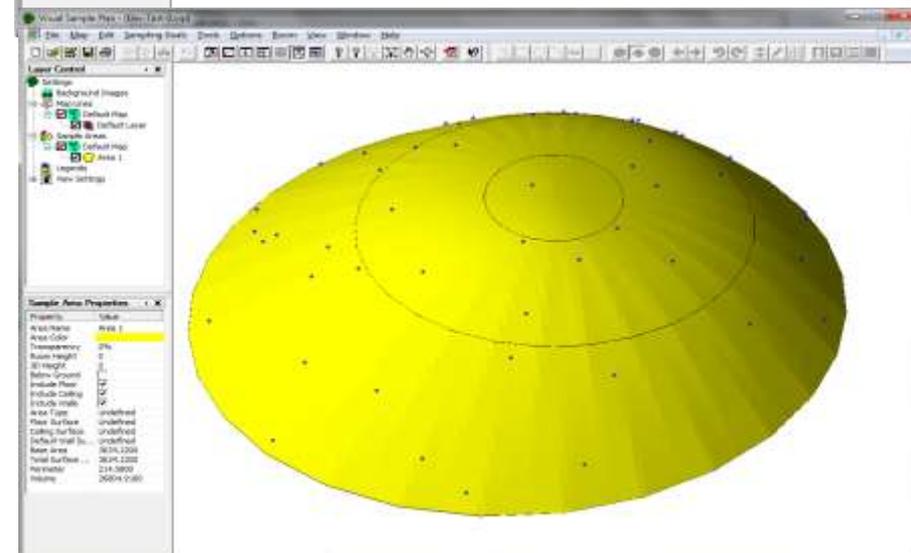
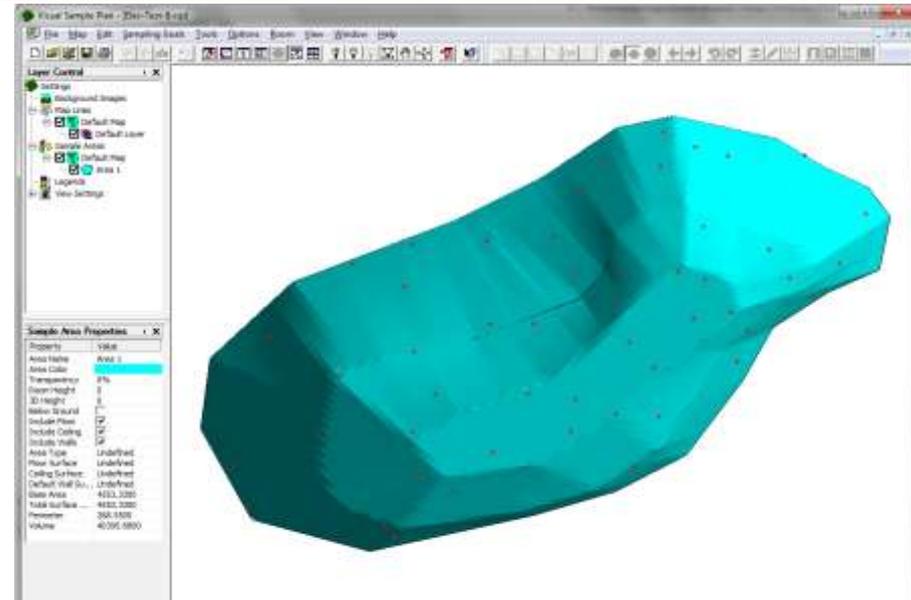
- ▶ **Piles and 3-D Volume Sampling**
- ▶ **VSP Process Workflow Guidance System Framework**
- ▶ **Discovery Sampling**
- ▶ **New Proportion Upper Confidence Limit Module**
- ▶ **Expert Mentor for Buildings**
- ▶ **Revamped HTML Based Online Help**
- ▶ **Addition of Many Case Studies to Training Materials**
- ▶ **Many Minor Improvements**
 - **Grid cell outputs, data entry mappings, multiple layer rasters, visualization enhancements**



Piles and Subsurface Sampling



- ▶ Allows creation and sampling of uneven 3-D piles, ponds, lakes, etc.
- ▶ Can define contour shapes and number of contours
- ▶ Can sample surfaces or within volume
- ▶ Sample placement on each layer, randomly, systematically





New Expert Guide Framework



Expert Guide

VSP Process Workflow Guide

Introduction Delineate Areas Verify Remediation Munitions-Free Areas Finish

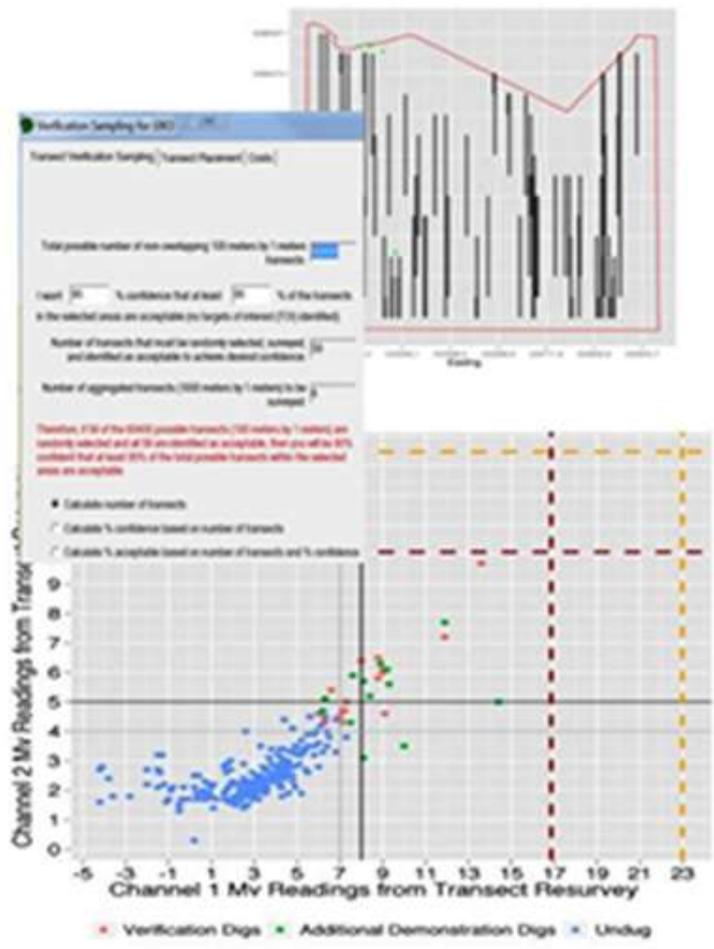
My site contains

- Areas with known or suspect target areas that I need to identify and delineate
- Areas where some TOI may be present but target area discovery/delineation is not a design objective
- Areas that are believed to be free of targets of interest (presumptively clean) but additional confirmation is required
- Areas that have already undergone remediation and I need to demonstrate effectiveness of that remediation
- Areas where transect surveys have been performed and where anomalies were dug for some grids and I need an improved estimate of remediation efforts that may be required

CANCEL BACK NEXT

VSP

Post Remediation Verification Sampling, Transect Verification



► Design Driver

- The effectiveness of site remediation needs to be evaluated.

► Data/Information Needs

- Geophysical survey of random transects and dig results from all identified anomalies.

► Additional Information

- Want to show that you are X% confident that at least Y% of all possible transects do not contain targets of interest.
- VSP will determine how many transects are required.



New Discovery Sampling Module



- ▶ Want high confidence of getting at least 1 unacceptable sample if at least Y% of area (or items) are unacceptable.
- ▶ VSP determines # of samples needed to achieve desired confidence.

Visual Sample Plan - [BuildingA.vsp]

Discover Unacceptable Grid Cells With High Probability (beta)

Discovery Sampling | Sample Placement | Costs | Data Analysis | Analytes

I need to sample from a population of grid cells.

I want to be % confident that I will discover at least one unacceptable grid cell if at least % of all of the grid cells are unacceptable.

Number of grid cells that must be sampled to achieve desired confidence:

If 148 of the 11392 1-foot square grid cells are sampled using random sampling and at least 2% (228) of the 11392 grid cells are unacceptable, you will be 95% confident of discovering at least one unacceptable grid cell in your sample of 148 grid cells.

If all 148 of the selected grid cells are identified as acceptable, then you will also be 95% confident that at least 98% of the grid cells in the decision area are acceptable.

Calculate number of samples
 Calculate % confidence based on number of samples
 Calculate % unacceptable based on number of samples and % confidence

Close Cancel Apply

Property	Value
Area Name	Room 10
Area Color	
Transpar...	0%
Room Hei...	96
3D Height	0
Below Ge...	
Include Fl...	<input checked="" type="checkbox"/>
Include C...	<input checked="" type="checkbox"/>
Include ...	<input checked="" type="checkbox"/>
Area Type	Undefined
Floor Surf...	Undefined
Ceiling S...	Undefined
Default W...	Undefined
Base Area	20583.9200
Total Surf...	94471.3400
Perimeter	585.2400
Volume	1976056....



New Proportion UCL Module



- ▶ Want to estimate the proportion of contaminated area to within desired \pm . UCL calculation also performed.

Construct Confidence Interval on a Proportion

Confidence Interval | Sample Placement | Costs | Calculate UCL | Analytes

Analyte	Number of Samples Obtained	Number of Unacceptable Samples	Desired Confidence (%)	Estimated Proportion	Upper Confidence Limit (UCL)
Lead	46	1	95	0.022	0.099
Arsenic	46	0	95	0.000	0.067
Old Lace	10	0	90	0.000	0.167

Inputs:

- Column 2: Number of samples obtained
- Column 3: Number of those samples that were contaminated or deemed unacceptable
- Column 4: Desired confidence level

Outputs:

- Column 5: The estimated proportion that is unacceptable
- Column 6: The Upper Confidence Limit (UCL) on the unacceptable proportion

For

provided you have taken 46 samples and found 1 unacceptable (contaminated) samples, the estimated proportion of unacceptable (contaminated) samples is 0.022 and you can be 95% confident that the true proportion of unacceptable (contaminated) samples in the sample area is less than 0.099.



What's New and Exciting



- ▶ Piles and 3-D Volume Sampling
- ▶ VSP Process Workflow Guidance System Framework
- ▶ Discovery Sampling
- ▶ New Proportion Upper Confidence Limit Module
- ▶ **Expert Mentor for Buildings**
- ▶ **Revamped HTML Based Online Help**
- ▶ **Addition of Many Case Studies to Training Materials**
- ▶ **Many Minor Improvements**
 - **Grid cell outputs, data entry mappings, multiple layer rasters, visualization enhancements**



What's on the Wishlist?



- ▶ **Revised MARSSIM VSP Support and Workflow Guidance**
- ▶ **Designs Supporting Sum/Ratio of Analytes Decision Rules**
- ▶ **Sample Location Photo Registration**
- ▶ **Multiple Decision Objectives – Automatically Generated Reports**
- ▶ **More VSP Training Courses**
- ▶ **Stream and Piping Sampling (sampling along a line)**
- ▶ **Collaborative Sampling for UTL Objective**
- ▶ **Contour Lines for GeoStats Spatial Models**
- ▶ **Requested High Priority VSP Enhancements**
- ▶ **VSP 7.0 – Early CY14**



DOE VSP Support



- ▶ **DOE-HS Budget is Dwindling**
- ▶ **Need for New VSP Developments and Maintenance**
- ▶ **DOE Benefits**
 - **Decreased costs for sampling/analysis**
 - **Increased defensibility**
 - **Streamlined regulator acceptance**
- ▶ **Seeking support from other DOE offices**



Questions?



Thank you for your attention and Thanks to George Detsis and Josh Silverman (DOE-HS) for continued support

Additional interest or questions to Brent.Pulsipher@pnnl.gov