

1.0 Introduction

1.1 What is Visual Sample Plan?

Visual Sample Plan (VSP) is a software tool for selecting the right number and location of environmental samples or transects so that the results of statistical tests performed on the data collected via the sampling plan have the required confidence for decision making. Thousands of users from all over the world and from every U.S. state have downloaded VSP, and hundreds of people have attended VSP training classes. Users include employees of the federal government, state and local governments, and private industry. Sponsors of this public domain software include the U.S. Department of Energy (DOE), U.S. Department of Defense (DOD), U.S. Environmental Protection Agency (EPA), U.S. Department of Homeland Security (DHS), National Institute for Occupational Safety and Health (NIOSH) within the Centers for Disease Control and Prevention (CDC), U.K. Government Decontamination Services, and the U.K. Atomic Weapons Establishment (AWE).

VSP provides sample designs and sample-size equations needed by specific statistical tests appropriate for several types of environmental problems. **Table 1.1** is a list of the sampling goals that can be addressed in the version 7.0 of VSP.

Table 1.1. List of Sampling Goals

Sampling Goal	User's Guide Section
Compare Average to Fixed Threshold	3.2.1
Compare Average to Reference Average	3.2.2
Estimate the Mean	3.2.3
Construct Confidence Interval on Mean	3.2.4
Locate Hot Spots	3.2.5
Show that at least some high % of the sampling area is acceptable	3.2.6
Discover Unacceptable Areas With High Confidence	3.2.7
Combined Average and Individual Measurement Criteria	3.2.8
Detect a Trend	3.2.9
Identify Sampling Redundancy	3.2.10
Add Sampling Locations	3.2.11
Compare Proportion to Fixed Threshold	3.2.12
Compare Proportion to Reference Proportion	3.2.13
Construct Confidence Interval on Proportion	3.2.14
Estimate the Proportion	3.2.15
Establish Boundary of Contamination	3.2.16
UXO Guide	7.10
Find UXO Target Areas	7.1-7.7
Post Remediation Verification Sampling (UXO)	7.8
Remedial Investigation (UXO)	7.9

Sampling within a Building	3.2.21
Radiological Transect Surveying	3.2.22
Item Sampling	3.2.23
Non-statistical sampling approach	3.2.24

VSP is easy to use, highly visual, and graphical. It has extensive online help and tutorial guides. Reports produced by VSP can be pasted directly into a quality assurance project plan, test plan, or sampling and analysis plan. VSP can be used to implement EPA’s systematic planning process (EPA 2000a) for a variety of problems: selection between clearly defined alternatives [Step 7 of the Data Quality Objectives (DQO) process], studies where a confidence interval on an estimated parameter is needed, or determination of whether a hot spot or target exists. The user specifies the criteria for “how good” the answer has to be (Step 6 of the DQO Process), and VSP uses this as input to the formula for calculating the required sample size. VSP is unique in this regard.

VSP is designed primarily for project managers and users who are not statistical experts, although those individuals with statistical expertise also will find the software very useful.

1.2 Installation and System Requirements

VSP 7.0 runs on Microsoft Windows operating systems (Windows 8, Windows 7, Vista, and XP). VSP currently does not run on Macintosh® or UNIX®/Linux systems. Any personal computer with sufficient hardware to run one of the supported operating systems should run VSP. The *minimum* hardware recommended is

- 1 GHz processor
- 256 MB RAM
- 250 MB of free space on the hard drive.

The current version of the VSP setup file is available from <http://vsp.pnl.gov/>. After the setup file is downloaded, installation of VSP is almost automatic. Simply run the VSP setup file, VSP70.exe (or later version), and follow the on-screen instructions. The VSP program and auxiliary files will be copied by default to the C:\Program Files\Visual Sample Plan folder (subdirectory). However, you may specify a different location for the files.

Once installation is complete, you will start VSP using option **Start > Program Files > Visual Sample Plan > Visual Sample Plan**. Alternatively, you may place a VSP shortcut on the desktop by selecting **New > Shortcut** from the menu obtained by right-clicking the mouse on the desktop. The appropriate command line for the default folder is

“C:\Program Files\Visual Sample Plan\VSsample.exe”.

VSP may be uninstalled using the Control Panel icon labeled Add/Remove Programs. You may access this option using the **Start** button and **Control Panel**.

New versions of VSP are often released as prototypes for testing. These demonstration versions have expiration dates. After the expiration date has passed, you will be given the option of continuing with the

current version or going to the VSP website to download the latest version. Version 7.0 is not a demonstration version and does not have an expiration date.

1.3 Overview of VSP

Sampling is the process of gaining information about a *population* from a portion of that population called a *sample*. A key goal of *sampling design* is to specify the sample size (number of samples) and sampling locations that will provide reliable information for a specific objective (called the **Sampling Goal**) at the least cost. VSP does the required calculations for sample size and sample location and outputs a sampling design that can be displayed in multiple formats. VSP does not address sample collection methods. It assumes the sample support (amount of material in the sample) is sufficient and the sample is representative of the population. A few designs in VSP assume the sample is taken across an entire grid (say a 10 x 10 cm swipe), but most designs assume the sample is a point sample taken at an X,Y coordinate location, and has sufficient volume for measurement and testing. For appropriate sampling goals, VSP addresses the trade-off between repeated analytical measurements on a single sample to reduce overall sample result variability (measurement quality objectives / MQOs) and provides a sensitivity table for comparing analytical methods of varying accuracy and cost.

VSP can be used to develop a new sampling design. It can also be used to compare alternative designs. VSP automates the mechanical details of calculating sample size, specifying random sampling locations, and comparing sample costs with decision error rates. These activities can be accomplished in the context of your own site map displayed onscreen with various sampling plans overlain on sample areas that you select.

The first thing you will do after opening the program is to import or construct a visual map of the study site. Next, you select the area or areas to be sampled. The **Sample Area** may be only a portion of the study site (see the elliptical sample area in **Figure 1.1**, upper left window).

Then, for the Sampling Goal that you select, VSP will lead you through the quantitative steps of the DQO process (Steps 6 and 7, EPA 2000a) so that the program has the information needed to compute the recommended minimum number of samples (sample size). You can enter sampling costs and test alternative designs against a fixed budget.

The locations of the samples over the Sample Area are determined by the specific sampling design (pattern) that you select. For some Sampling Goals, and for some assumptions about the population, only certain designs are allowed from a statistical theory perspective. For example, sequential sampling is appropriate only for the sampling goal of **Compare Average to a Fixed Threshold** when the population units can be assumed to be distributed normally. When there is a choice of designs, VSP displays a selector for the allowable designs.

VSP can be used for designing samples for environmental settings as well as building/room/surface settings. For environmental settings, site maps and aerial pictures can be loaded into VSP for sample placement. For buildings and rooms, a CAD drawing or floor plan are loaded. **Map View** displays samples placed on maps and room drawings. On a site map, VSP displays the sample locations for easy visualization (see **Figure 1.1**, upper left window). VSP also lists the geographical coordinates of the sample locations (see **Figure 1.1**, lower right corner), which can be saved and exported as a Drawing Exchange Format (DXF) or SHP file for use in a geographical information system (GIS) or saved as a text file for use in global positioning system (GPS) software.

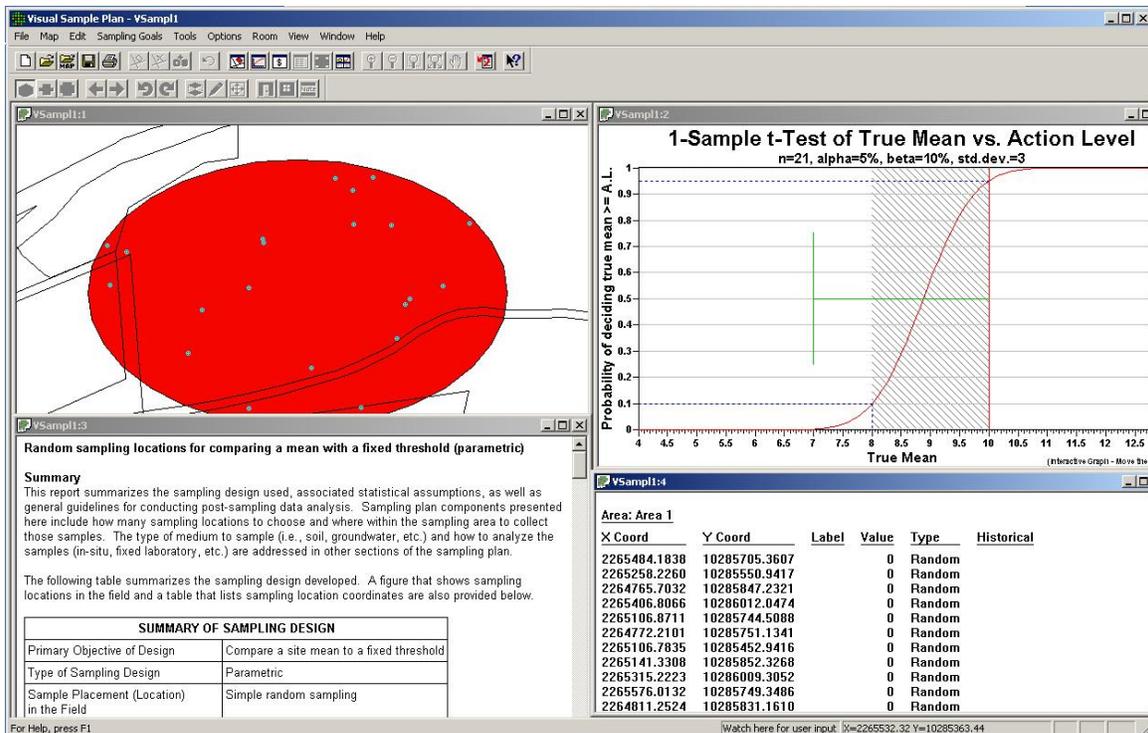
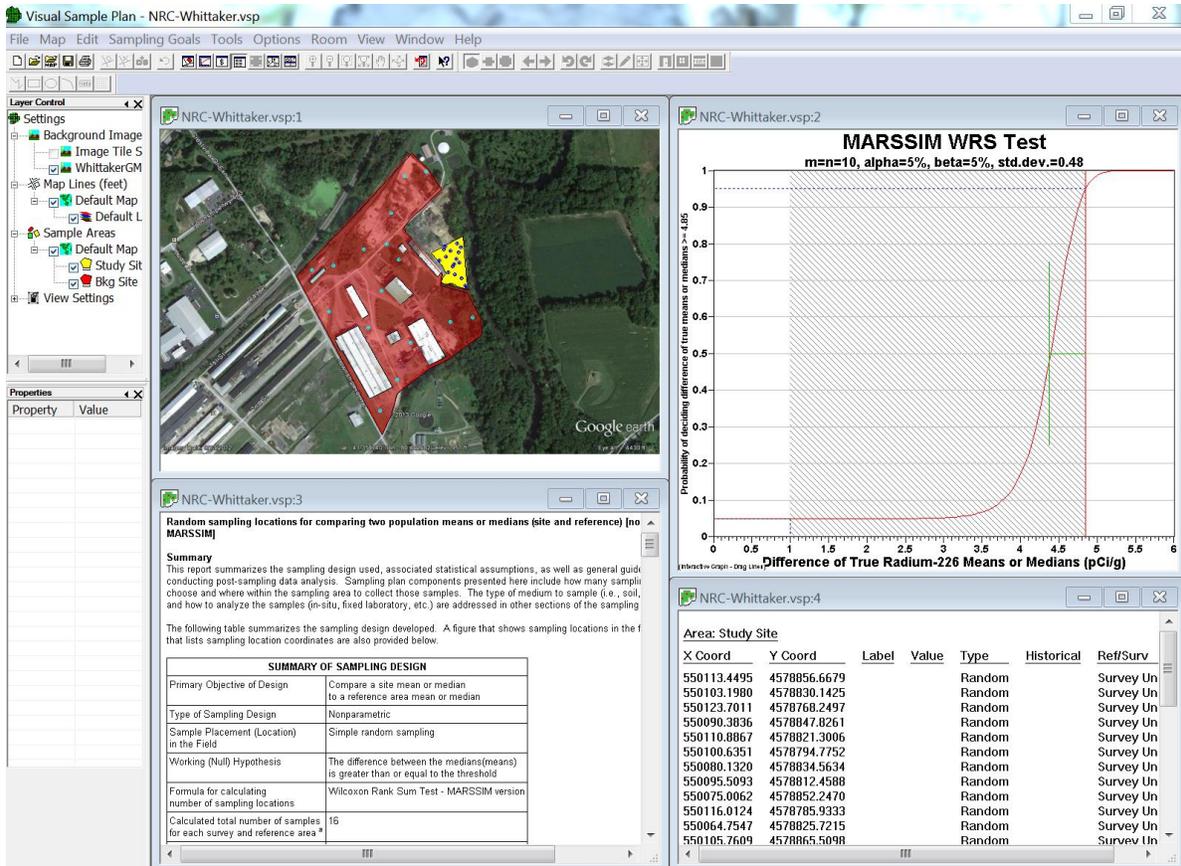


Figure 1.1. Screen Capture from VSP Using Quad Window Option (Window > Quad Window)

Several additional output formats for the design created in VSP are available: a **Graph View** of the design (see **Figure 1.1**, upper right window), a **Report View** (see **Figure 1.1**, lower left window), a Room View, and a 3D view. The Graph View displays either a Decision Performance Goal Diagram for Sampling Goals that involved selecting between alternative actions, or a performance graph comparing number of samples to a design parameter for the other classes of sampling goals. Some designs do not have a Graph View. The Report View is a text report that describes the sampling design in detail. The report contains the input values, the assumptions, the cost of the design, VSP output, technical description of the sample size formula and algorithms used, and a sensitivity analysis table to assess what would happen if more or fewer samples are collected than the optimal number calculated by VSP. The Room View provides a variety of ways for viewing the surfaces in a room, while the 3D View allows for viewing entire buildings or 3D areas.

The analytical value of lab results for samples can be input into VSP for Data Analysis including summary statistics of results, statistical tests applied to results for making decisions, and graphical displays of results. One of the designs, Sequential Sampling, requires intermediate results to be input to VSP so that VSP can determine whether further sample collection is required.

1.4 How Do I Use VSP to Provide a Defensible Sampling Plan?

To defend a sampling plan to a regulator concerned about safety *and* to a citizens' group concerned about saving taxpayer dollars requires balancing cost and risk. Defensible means that sufficient samples are taken, in a non-biased way, in order to make a decision, estimate a proportion, or declare an area free of UXO/contamination with a stated level of confidence. Additionally, once samples are taken and the results processed, someone needs to apply a statistical test to actually make a decision based on the data or calculate a confidence interval. VSP incorporates all this into the code it uses to calculate a sample size and sample locations. It asks the user to enter the assumptions, acceptable risk, and costs it needs for these calculations.

VSP follows the EPA-sanctioned planning approach for data collection and decision-making called the Data Quality Objectives (DQO) process. The DQO process achieves the user's limit on acceptable risk, at a minimum cost. See EPA (2000a) for an extended discussion of the DQO process. There are 7 steps in the DQO process. Users must complete Steps 1 through 6 in order to have the inputs VSP needs. Then, using VSP, the user can complete Step 7, "Optimize the Design for Obtaining Data," because VSP can be used to try out different sampling designs and find the optimal design for the current problem.

Users familiar with the DQO process know that often a single site may have multiple sampling goals and multiple Sample Areas, each requiring its own set of DQO inputs and hence different sample requirements. VSP can help because it allows rapid prototyping and has many features that allow the overlay of designs and comparisons across designs.

1.5 What's New in VSP 7.0?

VSP 7.0 is a major new release of the software. Features new since version 6.0 include:

Non-UXO Sampling Designs

Design dialogs were improved to use sentence structure and blank defaults:

- Parametric and Non-Parametric Upper Tolerance Limit (UTL)
- Adaptive Cluster
- Confidence interval on a mean (ordinary, MI sampling and non-parametric)
- Hot spot (assuming no false negative and assuming false negatives)
- Compare proportion to a fixed threshold
- Compare proportion to a reference proportion

New sample placement options to support 3D elevation surfaces

New non-geostatistical spatial mapping tools

Added default data columns for Control Chart design

Made improvements to list handling in Control Chart design

Lower / Upper Bound of the Gray Region won't be affected when changing Action Level

Improvements to Kriging design dialog

Modified Collaborative designs to have blank default inputs

Changed Trend designs to use sentence structure

Improved graph and report views for I-Chart design

Updated I-Chart design to include "All Locations" selection

Added Contour sampling design for cases where having samples along contours is needed

Added Multiple increment hot spot sampling design

Added Discovery sampling design

UXO Sampling Designs

UXO 100% transect coverage analysis (for entire coverage of sample area and for 100% areas within larger sample areas)

UXO design to augment existing paths with new transects

UXO Presumptively clean design

Remedial Investigation design

TOI Rate design

Made various formatting changes to UXO Transect Spacing design dialog

Made improvements to Window Sizing option on locate and mark UXO design

Made improvements to UXO verification sampling, such as no default value for transect length and grid size, random start for first transect

Made improvements to speed up UXO geostat functions

Added ability to see windowed densities used for UXO geostats

Added scaling option to UXO geostats to allow kriging to complete where it previously failed on high densities

Added waypoint display for transects

Added ability to load text-based Recon data

Added Area Labels to Box Plots

Increased UXO Graph generation speed by using multiple processors

Added ability to pick a different point on Graph without re-running

Added import function to High Density Areas dialog page

Fixed UXO Transect Augmentation design dialog so that “Select All” COG updates properly

Made optimization improvements to Find Gaps in UXO Transect Augmentation design

Made improvements to Transect creation in UXO Transect Augmentation design

Made optimization improvements to Anomaly file import

Added option of keeping or removing transects when importing 100% Survey Areas

Added Target area definition options based on munition characteristics

Fixed storage and display of lag distance and lag tolerance for UXO Geostatistical analyses

“Save Graph” works from UXO Spacing page, even if Apply is not pressed

Made improvements to “Help me choose” Window Size dialog

Made improvements to UXO Transect Power Curve Graphs

Fixed UXO Transect design to correctly calculate significant number of anomalies

Miscellaneous

Unaligned Grid Sample placement added for most designs that previously had the choice between random and systematic grid sampling

Added dynamic sample groupings

Added ability to filter imported data based on built-in and user-defined parameters

Improvements to Analyte Page including user defined columns

Ability to import kriged data

Ability to move samples in rooms to specified surface or furniture

Improvements to samples on furniture

Improvements to show costs for actual number of samples on reports

Improvements to Furniture editor tool

Improvements to drawing guide spacing

Improvements to selection of Furniture, Surface Overlays and Room Labels

Improvements to Color Legends

Added ability to automatically create user-defined sample parameters during data import

Added plots to Mann-Kendall report when accounting for non-detects

Added room transparency in 3D view

Improved background image storage compression

Stair and Landing Editor

Four corner method for Google Earth image calibration

Floors in 3D view can be transparent

Displayed vertical faces for raised surface overlays

Added storage compression for image data

Improved Kriged Data import

Added support for multiple lines on Property bar

Added elevation interpolation from contours to create 3D elevation surfaces

Added loading / saving of 3D elevation surfaces

Support for multiple raster data sets with accompanying layer controls

Added optional display of lines from ceiling sample points to floor in 3D View

Improved handling of Legends

Fixed problems with coloring of samples in 3D View

Fixed error with exporting kriged data to .ASC files

Improved layer control for multiple data raster sets

Improved Layer response when there are many sample areas

Improved SHP file export of Gap Areas

Added Sample Area Expand function

Added labels for transects

Improvements to Sample Area Information dialog – allowing changing size units

Added display of map lines to floor in Room View

Added Delete All menu item for deleting all raster data layers

Added more furniture files to the library

Improved Sample Symbol scaling

Improvements to DXF map loading

Display of map units on Layer control

Can add new Analyte by clicking on blank part of analyte list

New HTML-based Help system / new location of Help files

New location of Furniture files

Map Tile Server support Coordinate System support

File Save As previous VSP version

RAMS Import/Export

Building Footprints on wide area map

Allow manual moving of samples

Ft/Inch display options on map and coordinate view

UXO Guide

Sampling Height for rooms

Find Targets / UXO Geostat Mapping can select subset of transects for analysis

Crisis Management Mentor

Scale Map to Background Image

Ability to include/exclude 100% grid areas in GAMV & KT3D calculations

Outlier marking for data grid differences

Contour Sampling design Report / Help

Automatic removal of duplicate transects and anomalies

Added display of furniture to map view

New OLE Automation functions

Show Grid Cell Corner Coordinates