

5.0 Extended Features of VSP

VSP 3.0 has many extended features that have not been described so far in this User's Guide. In this section, we discuss some key extended features. The beginning user may not need these features, but a more experienced user will find them invaluable. These features expand on VSP's core capabilities. They are useful once a user has identified a basic sampling design and now wants to explore variations of the design, explore features of the design that are not part of the initial selection parameters, and add more capability to VSP.

The extended features fall into three categories:

- Features found in Main Menu items: **Tools, Options, and View**, and
- Features found in the Dialog Box for individual sampling designs, e.g., the **Cost Tab**, and the **Data Analysis Tab**
- Multiple Areas to be Sampled

5.1 Tools

5.1.1 Largest Unsampld Spot

If VSP has generated a sampling design for a Sample Area and you want to know the largest unsampled area, VSP can display this information. The largest unsampled spot is defined as the largest circle that will fit inside a Sample Area without overlapping a sample point.

In Figure 5.1, we opened the VSP Project File Example1.vsp included with the standard VSP installation. From the Main Menu we select **Tools > Largest Unsampld Spot > Find**. A dialog box tells you that VSP will search the Sample Area to find the largest circle that would fit into the unsampled area. The user is given the option of specifying the accuracy of the circle's radius, whether to consider area corners as additional sample points, and whether to allow the spot to overlap the Sample Area. After hitting the **OK** button, VSP searches the Sample Area, and places the spot on the Map, and displays an Information Box that says the radius of this circle is **205.22 ft.** (see Figure 5.2).

Two other displays are available: **Show Size...** and **Inside Area...**. The Show Size... displays the same Information Box shown in Figure 5.2. **Inside Area...** brings up the Information Box shown in Figure 5.3. It says that 100% of the circle is within the Sample Area. If the option to allow the largest unsampled spot to overlap the Sample Area edges had been selected, there may be situations where the circle extends beyond the boundary of the Sample Area resulting in a percentage less than 100%.

5.1.2 Reset Sampling Design

This command clears the current sampling design and removes all samples from the map (including unselected sample areas).

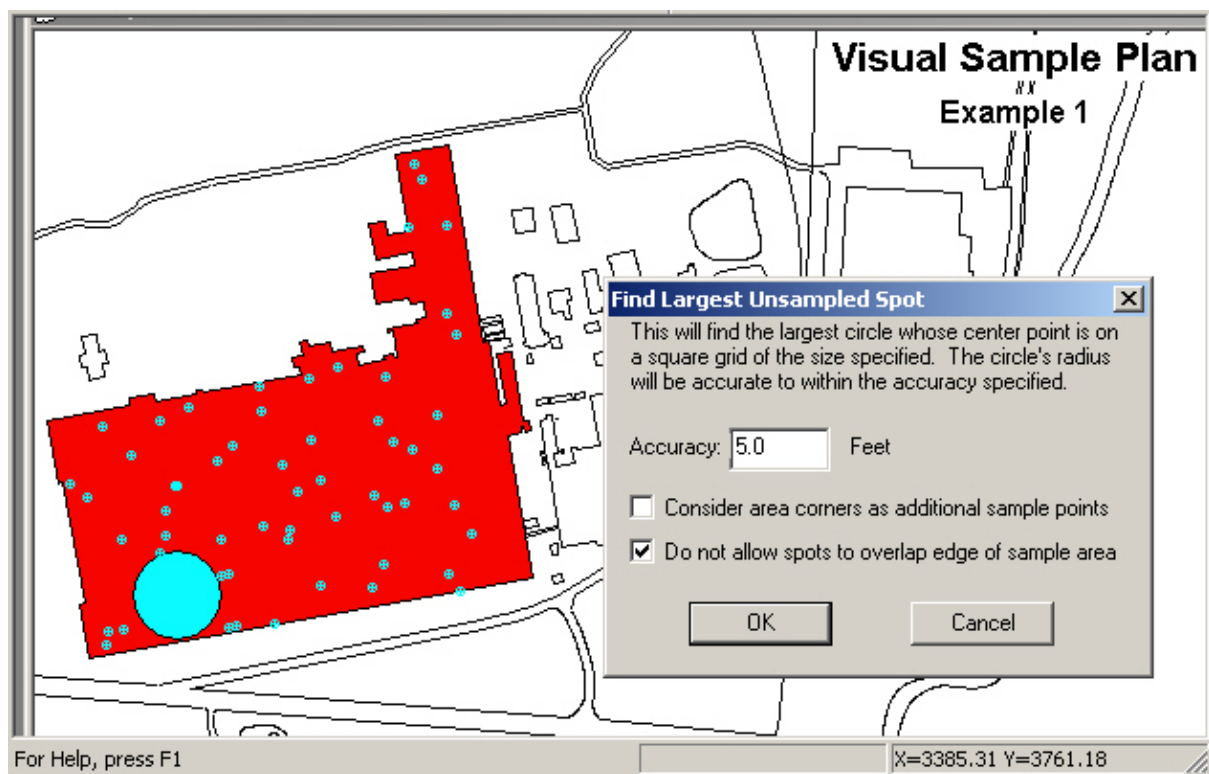


Figure 5.1. Largest Unsamped Spot Displayed on Map

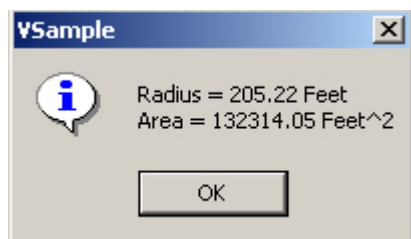


Figure 5.2. Information Box for Largest Circle that Would Fit Within an Unsamped Area

5.1.3 Measure Distance

Use this tool to measure distances on the map. After selecting this command, the cursor will become a ruler. Click on the map or enter a location (x, y) on the keyboard to anchor the first point. A line will be drawn from the anchor point to the cursor as you move

the mouse. The status bar will also indicate the distance from the anchor point to the cursor. After clicking on a second point or entering a second point on the keyboard, a dialog will appear displaying the distance. In Figure 5.4, we see that the distance from the sampling point to the building edge is **547.33 ft.**

Hold the Shift key down to attach either point to an existing point on the map.

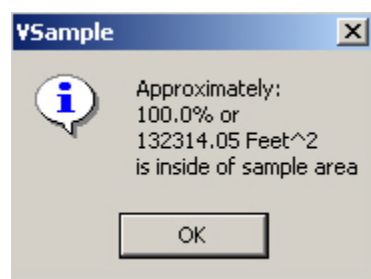


Figure 5.3. Information Box Showing Percentage of Circle Within the Sample Area

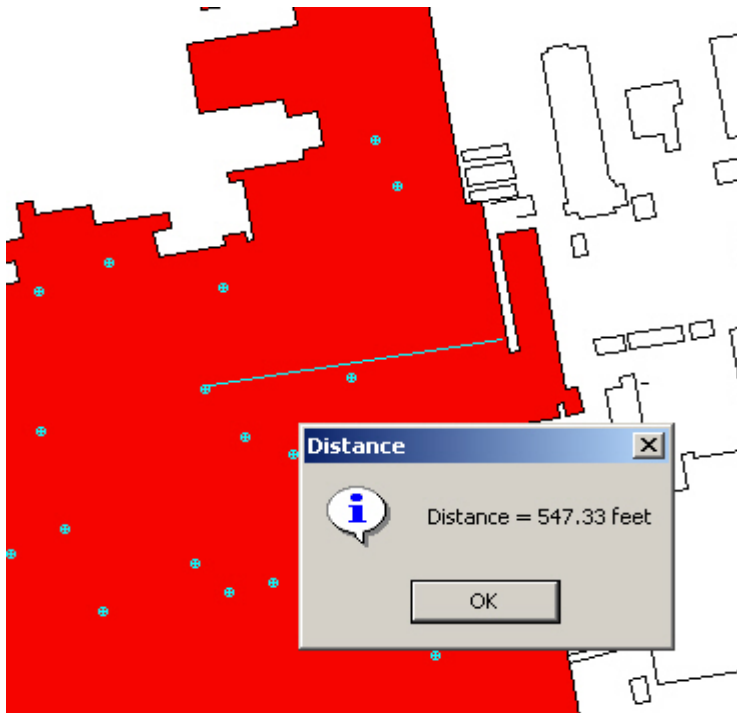


Figure 5.4. Measuring Tool in VSP

5.1.4 Make Sample Labels

Individual samples can have labels and values associated with them. This tool lets the user design the sample label. Selecting **Tools > Make Sample Label** brings up the Dialog Box shown in Figure 5.5. VSP assumes the user will want to assign a unique number to each sample within a Map, so all labels start with “VSP-<NNN>”. Other information can be added to the label, such as the Local X Coordinate and Local Y Coordinate as shown in Figure 5.5, by selecting the information variable names on the list and hitting the **Add** button. (The information can also be added by double-clicking on the list item or by typing in the label format edit box.). Once the **OK** button is pushed, the user sees the current set of Sample Labels in Map View.

Sample labels are discussed in Section 2.4

5.2 Options

5.2.1 Random Numbers

VSP allows the user two options when selecting how random numbers are generated. The random numbers are used to pick coordinates for sampling locations when the design calls for either a random-start grid or random placement of all points. The user selects the desired random number generator using **Options > Random Numbers** from the Main Menu. The two options are **Pseudo-Random Numbers and Quasi-Random Numbers**. The user “toggles” between these two options. This is shown in Figure 5.6. Note that once an option is selected, it remains active until changed. VSP is initialized with the **Pseudo-Random Numbers** option active.

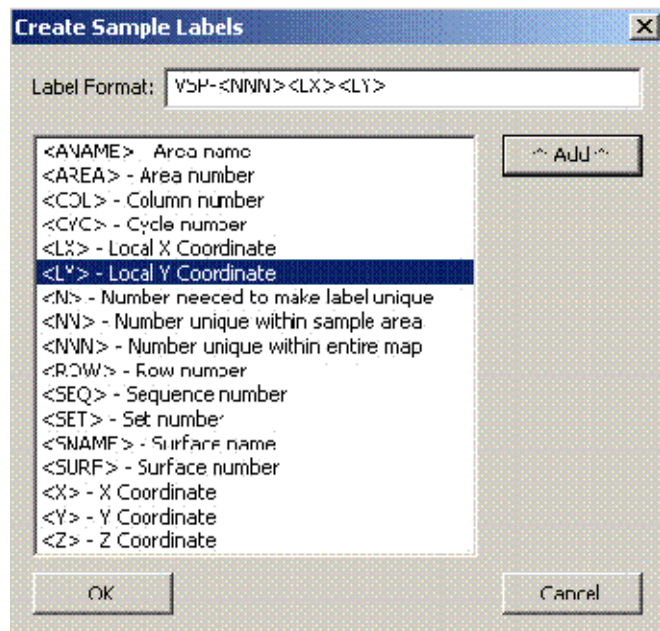


Figure 5.5. Dialog Box for Creating Sample

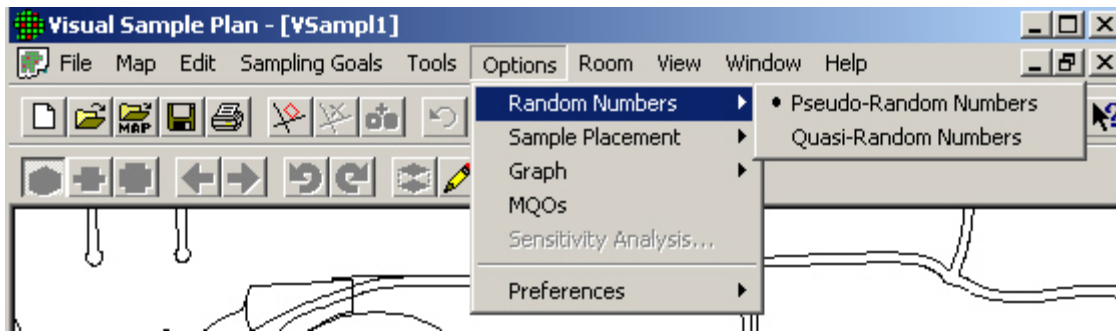


Figure 5.6. Menu for Selecting Type of Random Number Generator

Sampling locations (i.e., the x and y coordinates of the location) chosen with a pseudo-random number generator are not restricted in any way. The first location chosen and the tenth location chosen can be right next to each other or far apart, like throwing darts at a dart board. The locations where the darts hit can be clumped together or spread out, depending on chance.

Quasi-random numbers are generated in pairs. One member of the pair is used for the X coordinate; the other member is used for the Y coordinate. The sequence of paired numbers is generated in such a way that sample points tend to be spread evenly over a sample area. VSP's quasi-random-number generator uses Halton's Sequence. For a discussion of the algorithms used for both the pseudo- and the quasi-random number generator, see Version 2.0 Visual Sample Plan (VSP) Models and Code Verification (Gilbert et al. 2002).

If the current sampling design is being added to a study area with existing sampling locations, the quasi-random number generator will have no knowledge of those locations and might by chance put a new sampling location right next to an existing location. See the **Adaptive-Fill** option in Section 5.2.2 to handle the problem of avoiding existing sampling locations.

5.2.2 Sample Placement

The Adaptive-Fill option allows the addition of "random" sampling locations in such a way as to avoid existing sampling locations. Adaptive Fill has to do with the placement of the sampling locations, not the number of samples. The basic idea is to place new sampling locations so as to avoid existing locations and still randomly fill the Sample Area. The current Sampling Design option determines the number of locations.

VSP usually places new sampling locations using the default option, **Options > Sample Placement > Regular Random**. When Regular Random is selected, the sampling locations produced by either of the two random number generators discussed in Section 5.2.1 are placed in the Sample Area without regard to pre-existing samples. In fact, VSP removes all previous sampling locations prior to placing the new set of sampling locations.

When the **Options > Sample Placement > Adaptive-Fill** option is selected, all pre-existing sampling locations are left in place, and new sampling locations are placed in the Sample Area using an algorithm to maximally avoid preexisting sampling locations. The Adaptive-Fill algorithm can be used with either random number generator. The Adaptive-Fill option is shown in Figure 5.7.

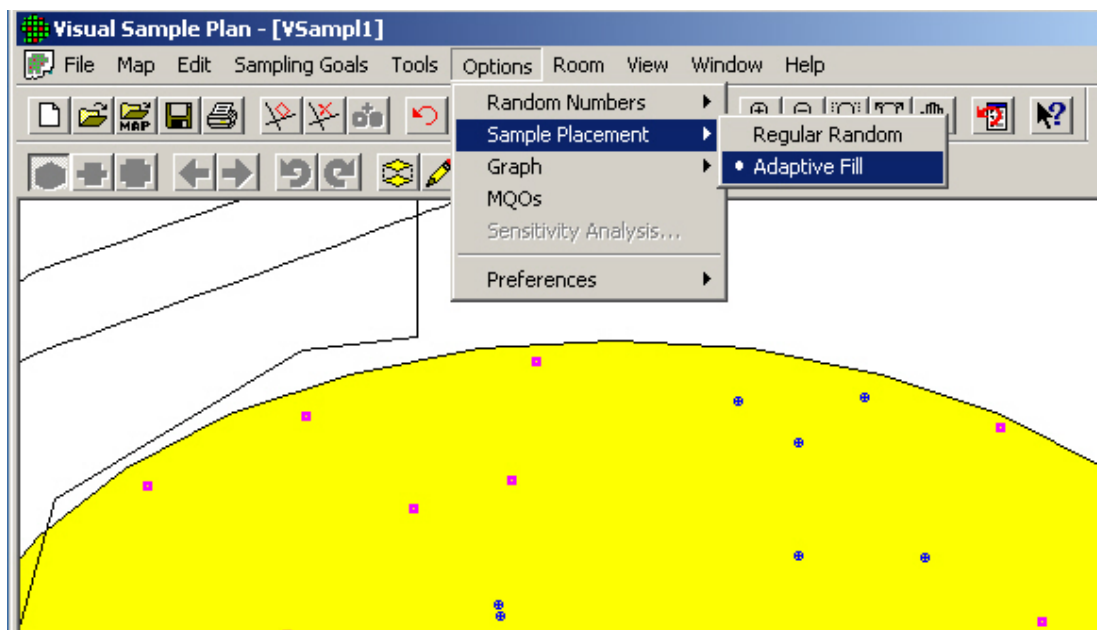


Figure 5.7. Adaptive-Fill Option for Sample Placement (Shown Here with Sample Area from Millsite Map)

Note that in Figure 5.7 the original sampling locations are marked with a circular symbol. In contrast, the Adaptive-Fill sampling locations are marked with a square symbol. If you right-click on a sampling-location symbol, a Sample Information dialog will display the type of sample, the coordinates, and a label input field. The label input field allows a specific sampling location to be given an ID number or remark. The label information is displayed in the Sample Information dialog, the report view, and the coordinate view. The label is also exported along with other sample information when exported to a text file (see Figure 5.9). See Figure 5.8 for an example of right-clicking on an Adaptive-Fill sampling location.

If the sampling locations are exported to a text file using **Map > Sample Points > Export**, an Adaptive-Fill location will be noted and any label the user might have added will be saved. An example text file is shown in Figure 5.9.

5.2.3 Graph

Graphs can be displayed with many different options. Figure 5.10 shows the options that can be selected using **Options > Graph**. Options are selected by clicking the option on or off. Once selected, that option will be in place for all Graphs. Note that we saw these same options in Chapter 4, Figure 4.2a, by right-clicking on a Graph. Table 4.2 describes these options in more detail.

5.2.4 Measurement Quality Objectives (MQOs)

The Measurement Quality Objectives (MQO) module in VSP provides a way to extend the sampling design to consider not only the number and placement of samples in the field but also what happens in the measurement or analysis process. After all, it is the final result of the “measured sample value” that gets

reported back to the project manager and used in statistical tests to make a decision.

There is a trade-off between taking more samples using a crude (i.e., less precise) measuring device vs. taking fewer samples using a precise measuring device and/or method. This is because total decision error is affected by the total standard deviation of the samples. The total standard deviation includes both sampling variability and analytical measurement variability.

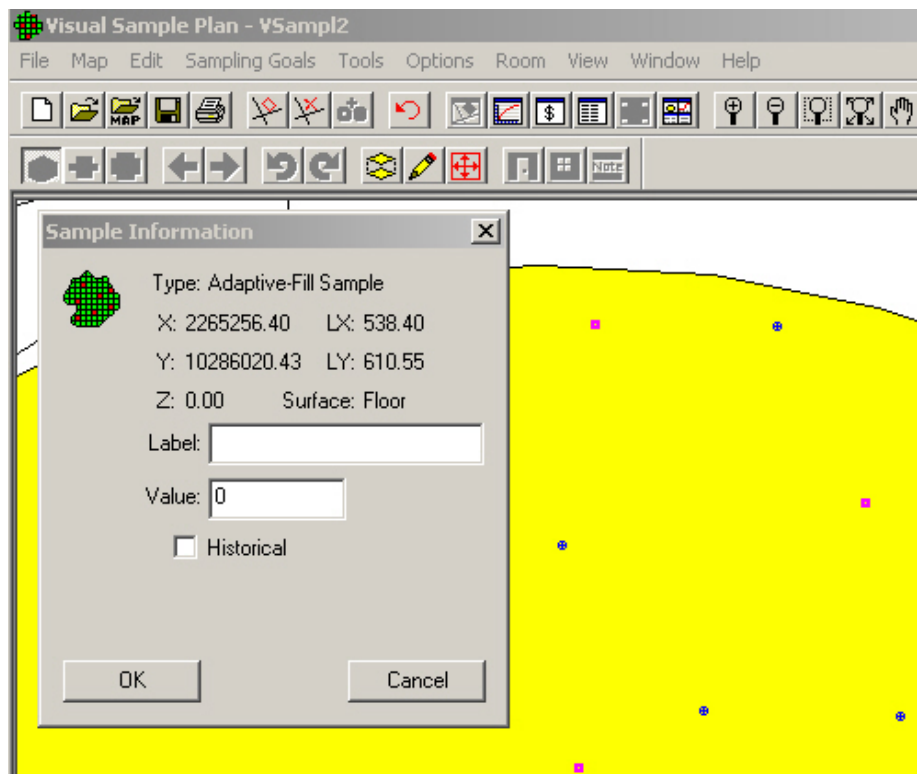


Figure 5.8. Sample Information Window Displayed When the User Right-Clicks on Selected Sample Points on Map

measurements (i.e., replicate measurements) when using these less precise analytical measuring devices and/or methods vs. taking few measurements and using more precise analytical measuring devices and/or methods. The MQO module in VSP lets the user play “what-if” games with various combinations of sampling standard deviation, analytical (i.e., measurement) standard deviation, number of analyses (i.e., replicates) per sample, and number of samples to take. More discussion of this topic and the sample size equations behind the VSP calculations can be found in Version 2.0 Visual Sample Plan (VSP) Models and Code Verification (Gilbert et al. 2002).

There is also a trade-off between taking more

Adaptivefil - Notepad

File Edit Format Help

Area: Area 1

X Coord	Y Coord	Label	value	Type	Historical
2265360.4119		10286018.5656		0	Random
2265154.3781		10286019.3080		0	Random
2265527.7386		10285652.8735		0	Random
2264968.2468		10285943.7654		0	Random
2265553.7714		10285969.7340		0	Random
2265237.1418		10285893.1275		0	Random
2264932.5650		10285669.9642		0	Random
2264828.4294		10285643.1315		0	Random
2265110.5094		10285940.4634		0	Random
2265546.5042		10285678.4244		0	Random
2265546.8848		10285876.9308		0	Random
2265182.9435		10285677.3041		0	Random
2265319.0035		10285798.5887		0	Random
2265352.2179		10285493.7450		0	Random
2265626.6409		10285846.5670		0	Random
2265050.9263		10285562.4568		0	Random
2265175.7800		10285848.4426		0	Random
2264980.4530		10285503.9339		0	Random
2265431.7034		10285795.6380		0	Random
2265418.6400		10285457.3675		0	Random
2265609.9606		10285540.6370		0	Random
2264769.1991		10285811.1219		0	Adaptive-Fill
2265155.4709		10285447.9189		0	Adaptive-Fill
2265693.2918		10285676.7124		0	Adaptive-Fill
2264998.6415		10285808.7434		0	Adaptive-Fill
2265311.5072		10285636.5713		0	Adaptive-Fill
2264838.5901		10285909.0286		0	Adaptive-Fill

Figure 5.9. Sample Exported Text File of Sampling Locations

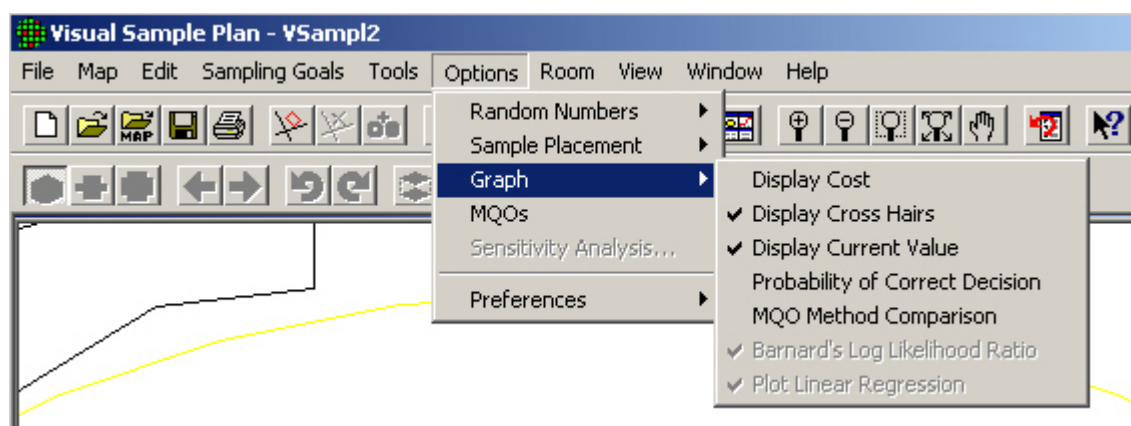


Figure 5.10. Graph Options

True Mean vs. Action Level

One-Sample t-Test | Costs | Data Analysis

For Help, highlight an item and press F1

Choose:

☒ True Mean \geq Action Level (Assume Site is Dirty)

☐ True Mean \leq 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

Action Level: 10

Estimated Sampling StdDev: 3

Estimated Analytical StdDev: 0

Analyses per Sample: 1

Minimum Number of Samples in Survey Unit: 21

☐ Use Historical

Figure 5.11. MQO Input Dialog Box with Default Values Displayed

The MQO option is selected from the dialog that pops up after a Sampling Design has been selected. The MQO option can also be toggled using **Options > MQOs** from the main menu. In Figure 5.11, we see a dialog box that contains the MQO button (**Sampling Goals > Compare Average to Fixed Threshold**). This dialog box allows you to provide additional inputs, such as the analytical standard deviation and number of analyses per sample. There is also a **Pick** button (not active at this time but planned in future versions of VSP) to provide access to a library of standard analytical methods with their reported analytical standard deviations.

Note that the default values are **0** for the **Estimated Analytical Standard Deviation** and **1** for the **Analyses per Sample**. This means that the user-selected analytical or measurement method does not add a significant component of variability to the total standard deviation; i.e., the method provides essentially the same numeric value when repeated measurements are made on a sample. Using the input parameter values shown in Figure 5.11 and with these default MQO values, we get $n = 21$ samples.

Now let's start changing the MQO input values. First, we change the **Estimated Analytical Standard Deviation** to **3**. We still take only one analysis per sample. We see VSP now tells us we need to take **40** field samples to obtain the desired error rates we specified. This is shown in Figure 5.12.

True Mean vs. Action Level

One-Sample t-Test | Costs | Data Analysis

For Help, highlight an item and press F1

Choose:

- ☒ True Mean \geq Action Level (Assume Site is Dirty)
- ☐ True Mean \leq 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

Action Level: 10

Estimated Sampling StdDev: 3

Estimated Analytical StdDev: 3

Analyses per Sample: 1

Minimum Number of Samples in Survey Unit: 40

☐ Use Historical

Figure 5.12. MQO Input Dialog Box Showing Positive Value for **Estimated Analytical Standard Deviation** with **1 Analysis per Sample**

If we take two repeated measurements of each sample (**Analyses per Sample** set to **2**), we see in Figure 5.13 that the number of field samples is now only **31**.

You can try different values in the MQO input boxes and see the effect on the resulting number of field samples.

True Mean vs. Action Level

One-Sample t-Test | **Costs** | Data Analysis

For Help, highlight an item and press F1

Choose:

☒ True Mean \geq Action Level (Assume Site is Dirty)

☐ True Mean \leq 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

Action Level: 10

Estimated Sampling StdDev: 3

Estimated Analytical StdDev: 3

Analyses per Sample: 2

Minimum Number of Samples in Survey Unit: 31

☐ Use Historical

Figure 5.13. MQO Input Dialog Showing Positive Value for Estimated Analytical Standard Deviation with Multiple Analyses per Sample

When you select the **COSTS** tab at the top of the screen, a new display and set of inputs is shown. This is shown in Figure 5.14. In this dialog box, we can enter costs for **Field Collection** (shown here as **\$100** per sample) and **Analytical Cost per Analysis** (shown here as **\$400** per analysis). This screen also provides a **Cost Comparison** between two possible options, Analytical Methods A and B. We see the Method A Analytical Standard Deviation of **3** that we entered on the previous screen. We can also enter an Analytical Standard Deviation for Method B. Initially, VSP displays the default values of **0** for Method B as shown in Figure 5.14. VSP displays the comparison for one, two, or three replicate analyses for only Method A because Method B has an analysis cost of \$0.00.

True Mean vs. Action Level

One-Sample t-Test | **Costs** | Data Analysis

Total Area to Sample:

Sampling Costs

Fixed Planning and Validation Cost: \$

Field Collection Cost per Sample: \$

Analytical Cost per Analysis: \$

Total Cost for 31 Samples: \$28900.00

Cost Comparison

Method A Analytical StdDev: 3

Method B Analytical StdDev:

Method B Analytical Cost per Analysis: \$

Reps	A Samples	A Cost	B Samples	B Cost
1	40	21000.00	21	
2	31	28900.00	21	
3	28	37400.00	21	

Close Cancel Apply Help

Figure 5.14. Cost Input Dialog Box for MQO Option

Next we show input values for Method B. Here, we enter a **Method B Analytical Standard Deviation** of **4** (somewhat higher than Method A), but with a lower **Cost per Sample** (shown here as **\$100**). In Figure 5.15 we see that the Method Comparison is now filled in with the new values. The lowest cost option (Method B with 1 Analysis per Sample) is highlighted in blue.

Notice that the lowest cost sampling design for this problem has the most field samples, $n = 55$. This is because Method B has a very low analysis cost of only \$100 vs. the much higher cost for Method A of \$400. Therefore, Method B can reduce the uncertainty in the final decision by allowing many more field samples to be analyzed compared with Method A.

True Mean vs. Action Level

One-Sample t-Test | **Costs** | Data Analysis

Total Area to Sample:

Sampling Costs

Fixed Planning and Validation Cost: \$

Field Collection Cost per Sample: \$

Analytical Cost per Analysis: \$

Total Cost for 31 Samples: \$28900.00

Cost Comparison

Method A Analytical StdDev: 3

Method B Analytical StdDev:

Method B Analytical Cost per Analysis: \$

Reps	A Samples	A Cost	B Samples	B Cost
1	40	21000.00	55	12000.00
2	31	28900.00	38	12400.00
3	28	37400.00	33	14200.00

Close Cancel Apply Help

Figure 5.15. Display of Cost Comparison for Method A and Method B from MQO Module

Note also that the sampling design will not automatically change to the Method B case highlighted in blue. If you want a sampling design based on Method B, you must update the **Analytical Cost per Analysis** for Method A to match the Method B cost. Then return to the **One-Sample t-Test** tab, change the **Estimated Analytical Standard Deviation** value to match the Method B value, and press the **Apply** button to get the Method B-based sampling design.

A graphical comparison of the analytical methods is shown on the Decision Performance Curve when **Options > Graph > MQO Method Comparison** is checked. You must go to **View > Graph** to see the chart. Figure 5.16 shows an example.

The yellow circle is placed above the lowest-cost sampling design that meets the objectives. In this case, the circle is above a green bar representing the cost of using sampling design Method B with one analysis per sample.

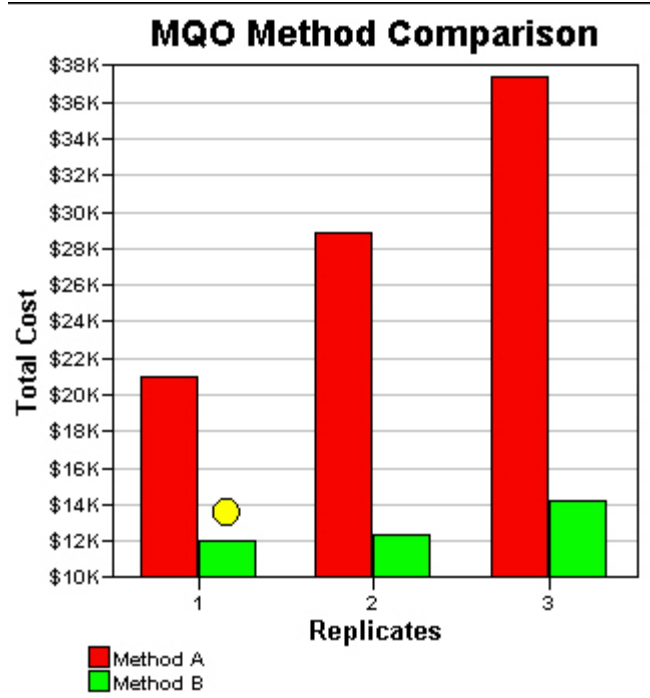


Figure 5.16. MQO Method Comparison Chart

1.2, and 0.6. For each of these levels, we want to look at three levels of Beta, and three levels of Alpha. VSP calculates sample size for each of these $2 \times 3 \times 3 = 18$ options and displays the values in the table.

This option is a very powerful tool for looking at “what if” scenarios and determining trade-offs for risk and cost. Tables for Number of Samples, Sampling Cost, or both can be displayed. Figure 5.18 shows 4 of the DQO Parameters being changed, and shows the results of the sensitivity analysis for both number of samples and cost.

5.2.6 Preferences

Figure 5.19 shows the Preferences available in VSP. Table 5.1 provides a brief description of each Preference. Consult VSP **Help > Help Topics > Menus > Options menu > Preferences** for a more detail discussion of each menu item.

5.3 View Menu

The View Menu offers the user options for how VSP displays information. Table 5.2 gives a brief description of each option. Consult VSP **Help > Help Topics > Menus > View menu** for a more detail discussion of each menu item. Many of these items have been discussed previously in this manual and will be mentioned only briefly here.

5.2.5 Sensitivity Analysis

This option accesses the sensitivity analysis parameters on the Report View. The sensitivity analysis parameters may also be accessed by right-clicking on the Report View itself. The example shown in Figure 5.17 is from the VSP Project File Example1.vps. With **View > Report** selected, scroll down to the section on Sensitivity Analysis. Now select **Options > Sensitivity Analysis**, and the Dialog Box shown in Figure 5.17 is displayed. The user can do sensitivity analysis on up to 4 variables (only 3 are shown here), can select a starting and ending value for each variable, and can specify the number of steps for incrementing the variable. VSP displays the values for each step in Red below the Step window. For this example, in Figure 5.17, we say we want to see the number of samples required at values of the Standard Deviation $s =$

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying s , β and α and examining the resulting changes in the number of samples. The following table shows the results of this analysis.

Number of Samples				
		$\alpha=5$	$\alpha=10$	$\alpha=15$
$s=1.2$	$\beta=15$	261	195	156
	$\beta=20$	224	164	128
	$\beta=25$	196	139	106
$s=0.6$	$\beta=15$	67	50	40
	$\beta=20$	57	42	33
	$\beta=25$	50	36	27

s = Standard Deviation

β = Beta (%), Probability of mistakenly concluding

α = Alpha (%), Probability of mistakenly concluding

Cost of Sampling

The total cost of the completed sampling program, in addition to the other costs that are based on the number of samples determined above, the estimated total cost of sampling is \$200,000.00 at a per sample cost of \$500.00. The following table shows the cost information.

COST INFORMATION	
Cost Details	Per Analysis
Field collection costs	
Analytical costs	\$400.00
Sum of Field & Analytical costs	
Field collection and validation costs	

Sensitivity Analysis

☒ Number of Samples
 ☐ Sampling Cost
 ☐ Both

Variable 1

Standard Deviation Beg: 1.2

Steps: 2 End: 0.6

1.2 0.6

Variable 2

Beta (%) Beg: 15

Steps: 3 End: 25

15 20 25

Variable 3

Alpha (%) Beg: 5

Steps: 3 End: 15

5 10 15

Variable 4

--None--

1 2 3

OK Cancel

Figure 5.17. Sensitivity Analysis for 3 DQO Input Parameters. Results are shown for Number of Samples, as displayed in a table in Report View.

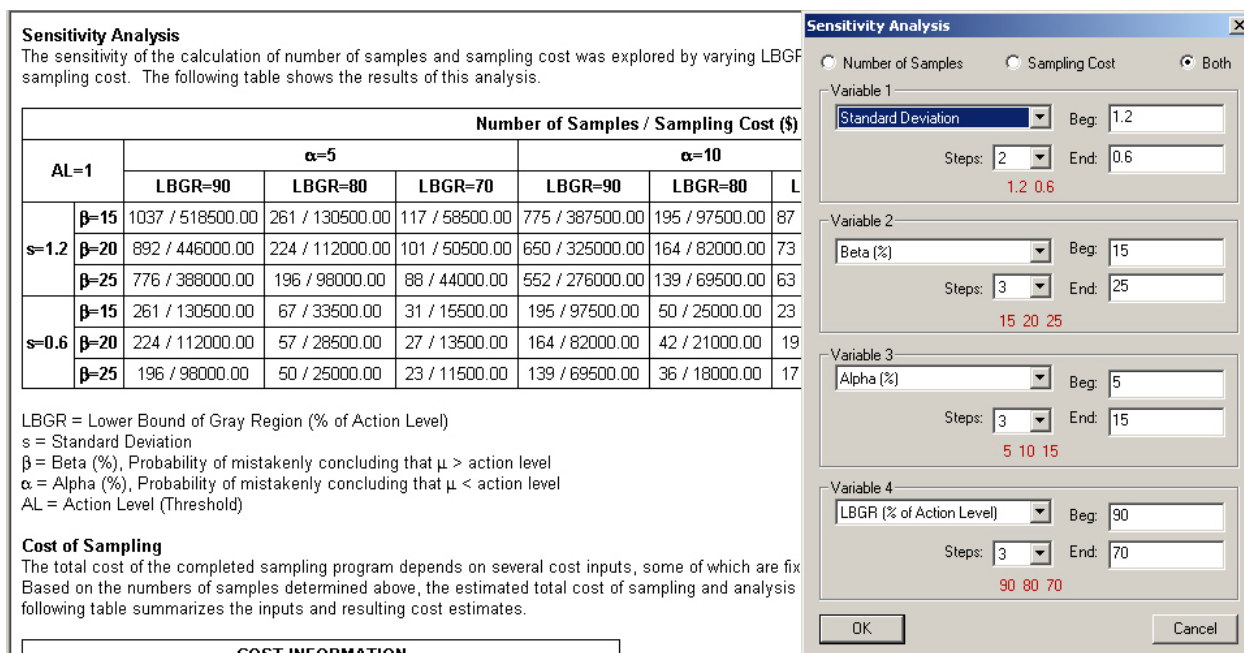


Figure 5.18. Sensitivity Analysis for 4 DQO Input Parameters. Results are shown for Number of Samples and Cost, as Display in a Table in Report View

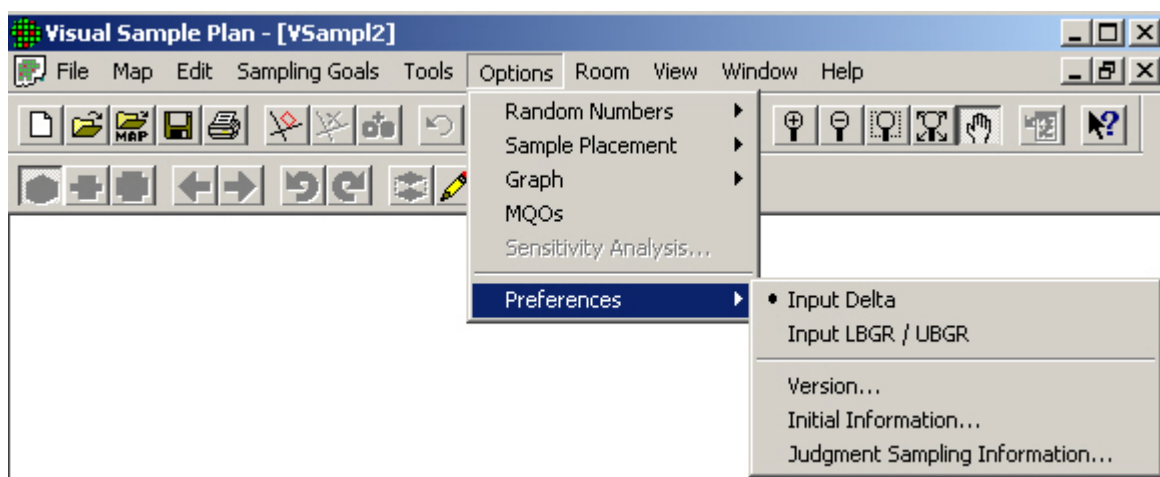


Table 5.1. Preferences Menu Items

Input Delta	Allows the input of Delta in design dialog boxes
Input LBGR / UBGR	Allows the input of LBGR / UBGR in design dialog boxes.
Version	Changes the sub-version of VSP (which eliminates some of the sampling design choices)
Initial Information	Displays the initial information associated with the chosen sub-version of VSP.
Judgment Sampling Information	Displays informational dialog when judgment sampling is used.

Table 5.2. View Menu Items

Main Toolbar	Shows or hides the main toolbar
Map Drawing Toolbar	Shows or hides the toolbar used for drawing on maps.
Ranked Set Toolbar	Shows or hides the toolbar used for ranked set sampling
Room Toolbar	Shows or hides the toolbar used for room manipulation
Status Bar	Shows or hides the status bar.
Labels	Shows or hides the sample labels on the map. Any combination of Labels, Coordinates, Local Coordinates and Values can be displayed.
Background Picture	Shows or hides the background picture.
Transparent Sample Area	Allow background picture to be seen behind sample areas.
Largest Unsamped Spots	Shows or hides the largest unsampled spots.
All Grid Cells	Shows or hides all grid cells used for adaptive cluster sampling
Leading Edge	Shows only the leading edge of an open-type sample area
Map Scale	Shows or hides the coordinate scale on the map.
Map Legend	Shows or hides the map size legend.
Swath Corners	Shows the coordinates at the corners of swaths
Room North Arrow	Shows or hides the north arrow in the room view.
Room Perspective Ceiling	Shows or hides the ceiling in the perspective room view.
Map	Change current project view to map view.
Graph	Change current project view to graph view.
Report	Change current project view to report view.
Coordinates	Change current project view to coordinate view.
Room	Change current project view to room view.
Zoom In	Increase the map view size.
Zoom Out	Decrease the map view size.
Zoom Max	Change map view size to fit window
Zoom Window	Increase map view size to selected area.
Pan	Move the visible portion of the map.

5.4 The Cost Tab: Setting Up Sampling Costs – Inputs for the General Screen

VSP allows users to enter sampling costs so that the total cost of a sampling program is available. Once a sampling design is selected and the DQO inputs have been entered into one of the dialog boxes, click on the Costs tab to enter costs. A sample **Costs** screen is shown in Figure 5.20. The inputs for this example were entered in the Dialog Box shown in Figure 5.21.

The screenshot shows a software window titled "True Mean vs. Action Level" with three tabs: "One-Sample t-Test", "Costs", and "Data Analysis". The "Costs" tab is active. It contains a "Total Area to Sample" field with the value "5000" and a unit dropdown menu set to "Feet^2". Below this is a "Sampling Costs" section with three input fields: "Fixed Planning and Validation Cost: \$" with "1000.00", "Field Collection Cost per Sample: \$" with "100.00", and "Analytical Cost per Analysis: \$" with "400.00". At the bottom of this section, it displays "Total Cost for 21 Samples: \$11500.00".

Figure 5.20. Screen for Entering Sampling Costs for a Sampling Design – Accessed through the Cost Tab

VSP enables you to break down costs into the following categories:

- *fixed planning and validation costs* - This is the fixed cost that is incurred, regardless of how many samples are taken. Examples of fixed costs are the cost to mobilize a sampling crew and get the equipment into the field.
- *field collection cost per sample* - This is the per-sample Figure 5.22. Screen for Entering cost. Examples of per-unit field costs are the costs paid to Sampling Costs for Sampling Design technicians to collect the sample and package and transport it.
- *analytical cost per analysis* - This is the cost to analyze a specimen or a sample. As discussed in Section 5.4, you can specify how many repeated analyses you want taken per sample or specimen.

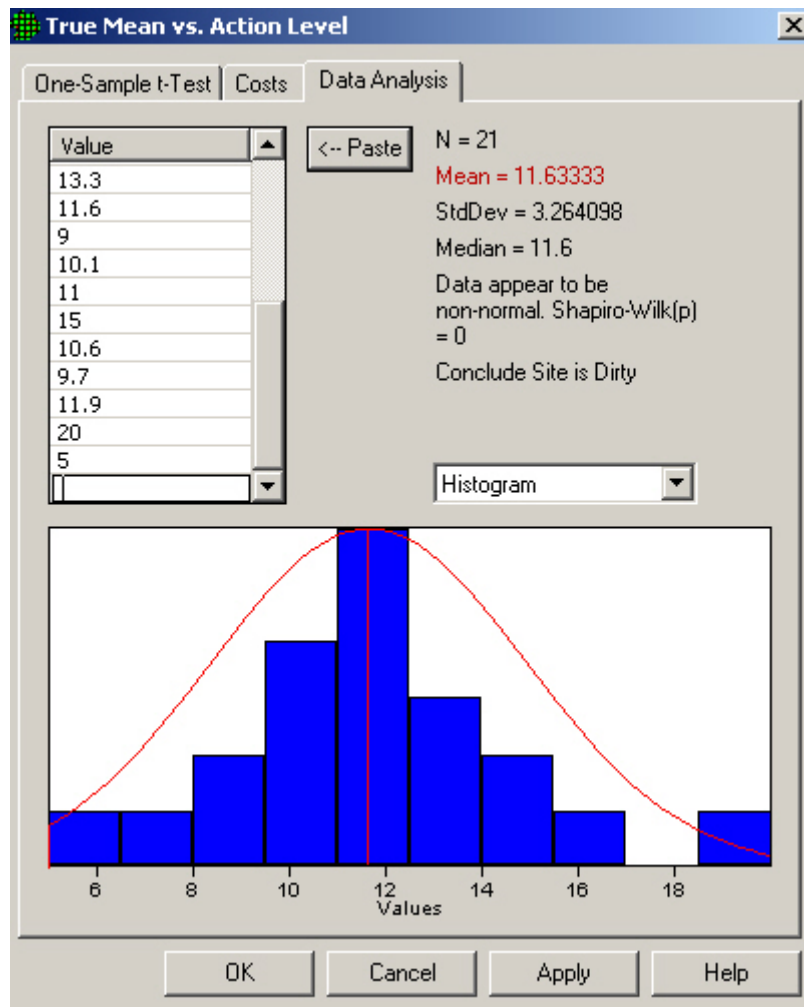
VSP calculates a total cost for the design specified, shown here as \$11,500. Total cost is the sum of the fixed cost, shown here as \$1,000, plus per-sample field collection cost of \$100, plus analytical cost per analysis of \$400, multiplied by the number of samples, 21. No duplicate analyses were specified, so the total per-unit cost is \$500. Thus, the total sampling cost is $\$1000 + 21 \times \$500 = \$11,500$.

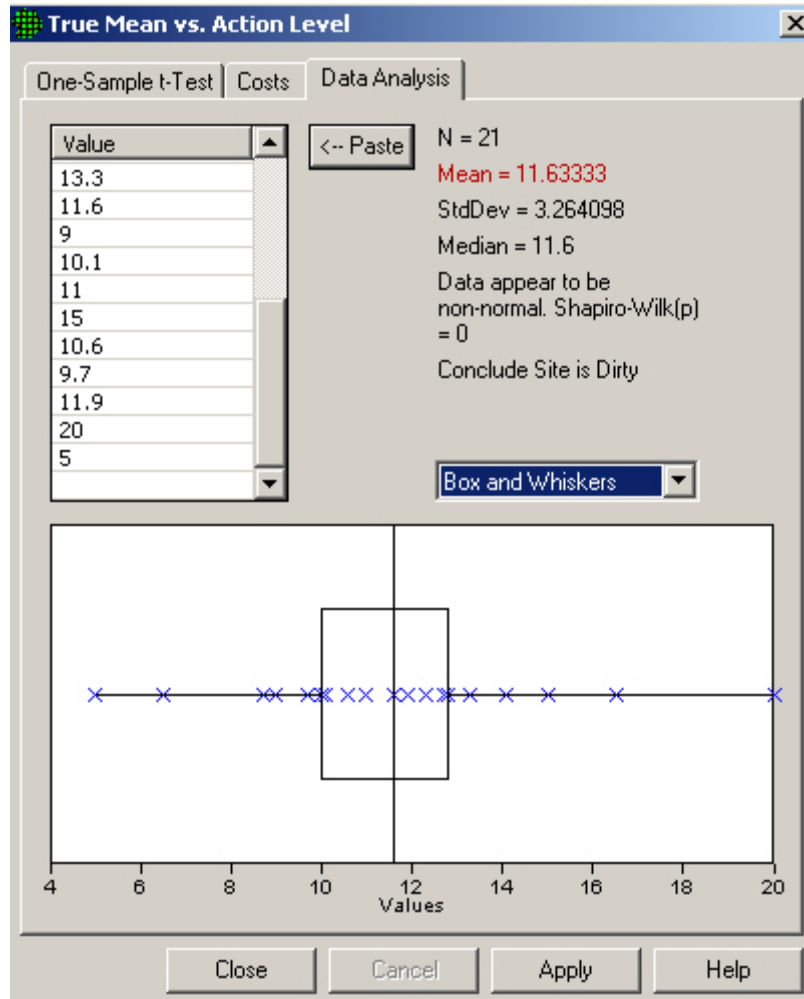
The hot spot sampling goal has some unique cost features. First, costs are displayed in one of the tables in the **Report View** and not on the **Cost** tab of the dialog box. Second, this is the only Sampling Goal for which you can specify a cost as a design criteria and VSP will calculate the number of samples to meet that goal (see Section 3.2.8). This is done by selecting from the main menu **Sampling Goal > Locating a Hot Spot > Systematic Grid Sampling > Predetermined fixed cost**.

5.5 Multiple Areas To Be Sampled

VSP allows the user to select multiple areas as sampling areas. All the examples shown so far involved a single Sample Area. When multiple areas are selected, VSP allocates the samples to the areas in

proportion to the area of the respective individual sample areas. For example, if one area is twice as large as the other sample area, it will receive twice as many sample points. This is shown in Figure 5.23.





In Figure 5.23, we show two sample areas -- a rectangle and a circle. We next assume that a sampling-design algorithm not currently in VSP called for $n = 25$ samples. Using option Sampling Goals > Non-statistical sampling approach > Predetermined number of samples > Simple random sampling, VSP allocated 7 of the 25 requested samples to the rectangle and 18 to the circle. This is because the circle covers an area approximately three times larger than the rectangle.

Note that when multiple sample areas are drawn on a Map, you can select or deselect sample areas using Main Menu option Edit > Sample Areas > Select/Deselect Sample Areas. Alternatively, you can select or deselect a sample area by clicking on it with the mouse.

The Change Color option can be used to change a sample area's color. First, select those sample areas to be given a new color. Then use the Edit > Sample Areas > Change Color sequence and choose the new color for the currently selected sample areas.

Note that when multiple sample areas are selected, VSP-derived sampling requirements assume that the decision criteria and summary statistic of interest (mean, median) apply to the combined sample areas and not to the individual areas.

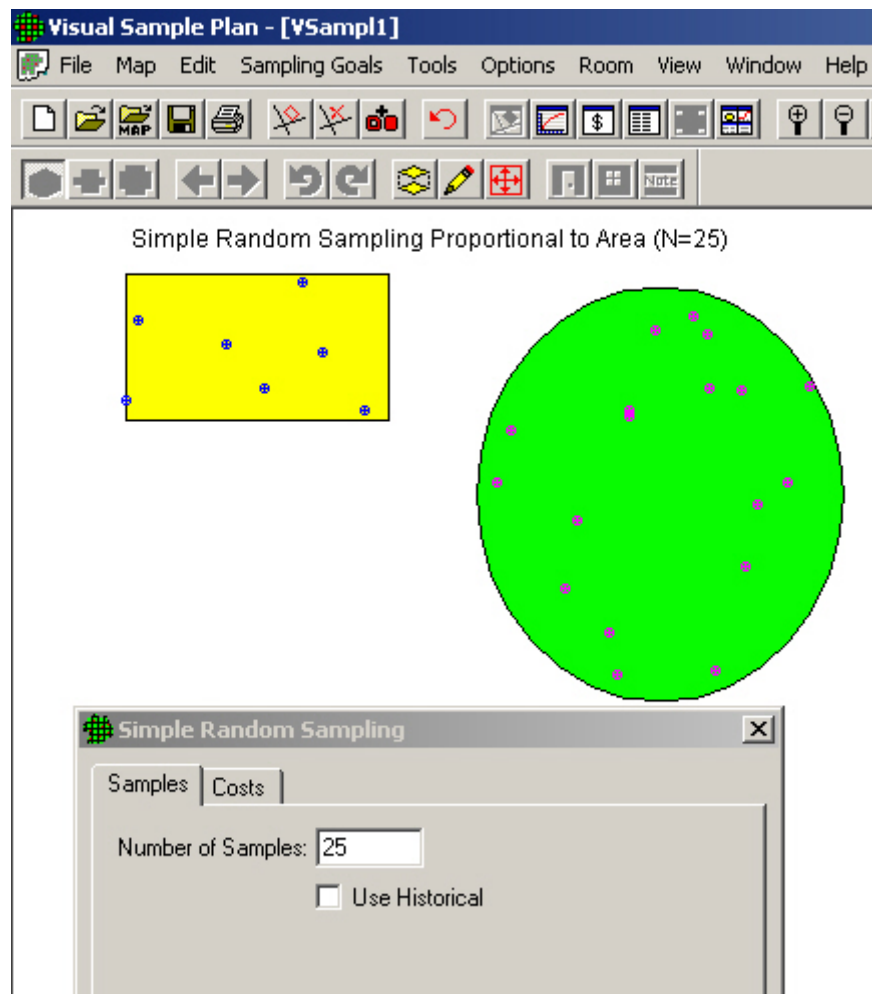


Figure 5.23. Proportional Allocation of Samples to Multiple Sample Areas