

Visual Sample Plan Training Course
Module 03 – VSP 3.0 Introductory Exercises

For this exercise set: **OPTIONS→Preferences→Input LBGR/UBGR**

Goal: To select the .dxf map file that you want to open.

To make your screen look like Figure 1 below:

- From **Start→Programs→Visual Sample Plan**, open **Visual Sample Plan**.
- Click the **General (all inclusive) VSP** option in the **Select VSP Version** popup menu.
- Click the **Close** button at the bottom of the **VSP Advisor** help box.
- To load a drawing in the DXF file format, either:
 - From the main menu select **Map**.
 - Click **Load Map from file...**, and then highlight **Millsite.dxf**.

Or

- Click the **Load Map** icon , and then highlight **Millsite.dxf**.
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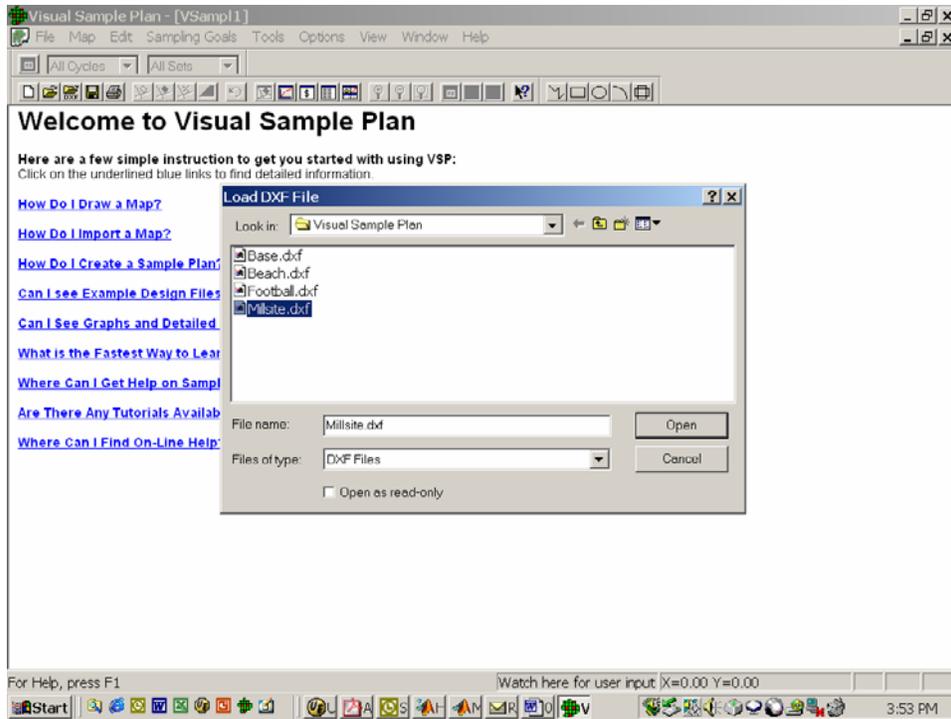


Figure 1. Dialog box for opening a DXF File

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Goal: To open the selected .dxf map file and prepare to select a specific area within the map.

To make your screen look like Figure 2 below:

- With **Millsite.dxf** highlighted, click the **Open** button.
- A VSample dialog box will appear, asking **Load text?** Click **NO**.
- Your Millsite map graphic will not fill the entire map window. To enlarge the map, select **View→Zoom In** from the main menu. Notice that the cursor now looks like a magnifying glass and the icon that looks like a magnifying glass with the plus sign is now selected. This is the **Zoom In** icon . Place the cursor inside the oval (tailings pile) and click six or seven times to enlarge the map. Use the horizontal and vertical scroll bars to position your map like the one in Figure 2. Deselect **Zoom In** by clicking on the **Zoom In** icon. (Click the **Zoom Out** icon  if you need to shrink the map and then deselect it to return cursor to normal arrow.)
- From the main menu select **Edit→Sample Areas→Define New Area,**
- Or simply click the **New Area** icon .
-----▲
- A **Color** dialog box will open. The color yellow is selected by default; click **OK**.
- The cursor has changed to a crosshair and a yellow box of instructions appears.

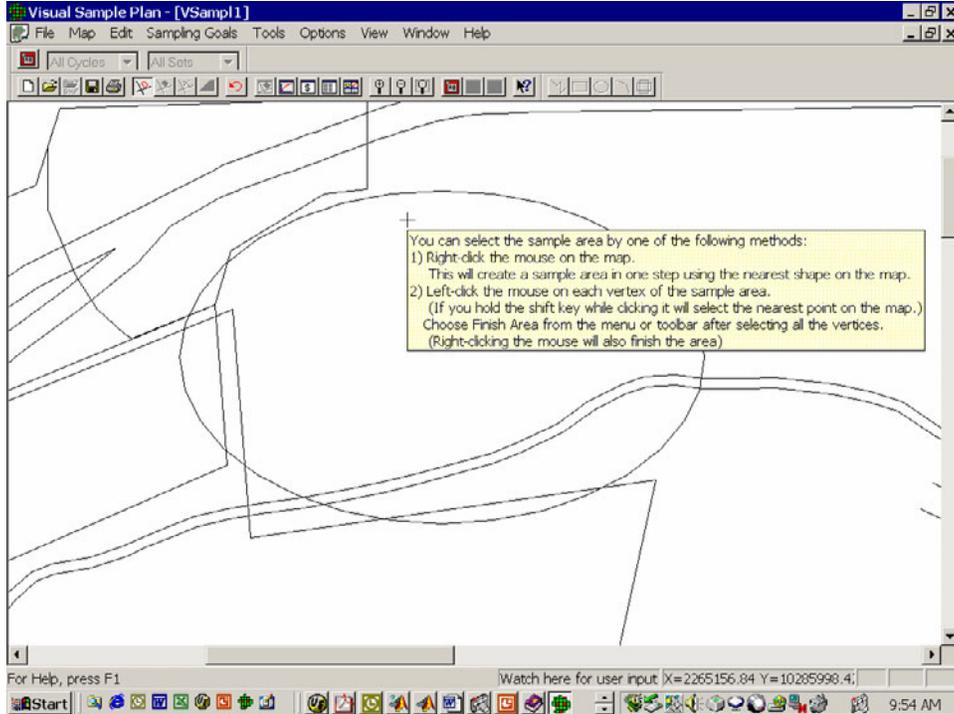


Figure 2. Tool tip for selecting a sample area

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Goal: To finish selecting a specific area within the map.

To make your screen look like Figure 3 below:

- Move the crosshair to the upper right part of the oval shape near the top edge (away from the river) and right click with the mouse.
- A **Select area units** dialog box will open. Use the default area unit of **Feet²** and click **OK**.
- The oval should be filled in with the color yellow.

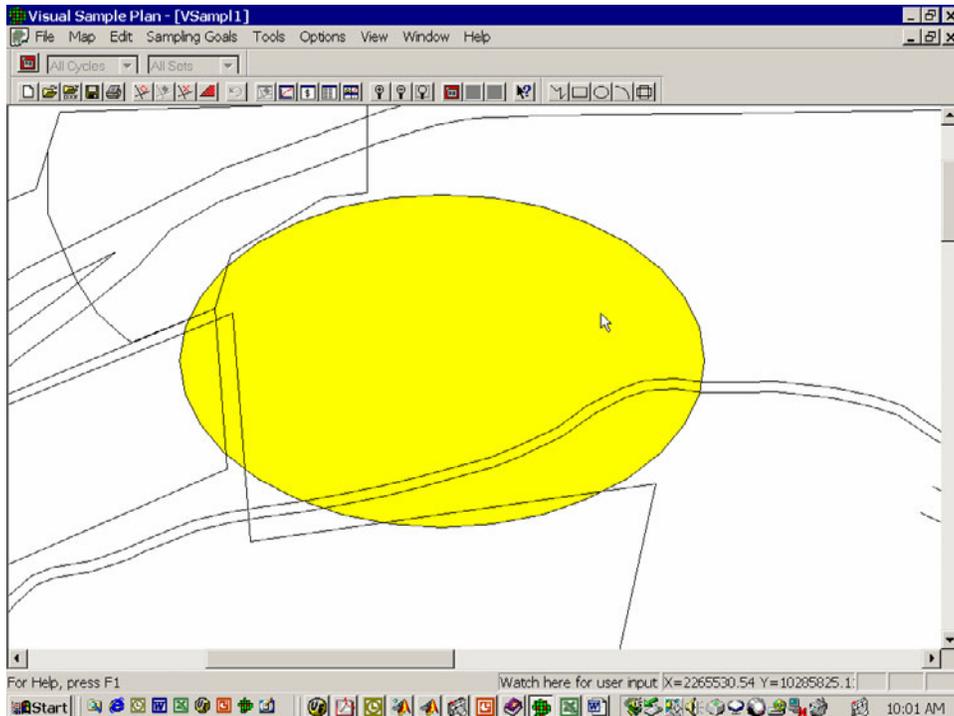


Figure 3. A sample area after it has been selected

NOTE: If you accidentally select the river or some other area instead of the oval, click on the **Remove Areas** icon and start over. It is the 7th icon from the left on the VSP toolbar. Or, click on **Edit→Sample Areas→Delete Selected Sample Areas**. A **Deleting Sample Areas** dialog box will appear, asking: **"Are you sure you want to delete all the selected sample areas?"** Click **OK**.



▲
Remove Areas icon

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Goal: Create a sampling design to compare an average to an Action Level, data assumed normally distributed.

Note: The terms “view” and “window” are used interchangeably in Visual Sample Plan and in the instructions below.

To make your screen look like Figure 4 below:

- From the main menu, select **Sampling Goals→Compare Average to Fixed Threshold→Can assume data will be normally distributed→Simple random sampling ...**
- A **True Mean vs. Action Level** dialog box will appear. Enter the following values under the tab **One-Sample t-Test**:
- **Choose:**
- **True Mean \geq Action Level** (Assume Site is Dirty).
- **False Rejection Rate (Alpha)** 1.0%
- **False Acceptance Rate (Beta)** 1.0%
- **Lower Bound of Gray Region** 8
- **Action Level** 10
- **Estimated Standard Deviation** 3

Note: Make sure that “Lower Bound of Gray Region” appears in the dialog box. If “Width of Gray Region” is showing instead, go to the Main Menu, Click **Options→Preferences→Input Delta** and change to “**Input LBGR/UBGR**”. Hereafter during these exercises, you can select either “Delta” or “LBGR”. Just make sure that you make the necessary arithmetic adjustments.

Click **Apply**. Note the bottom line in the dialog box: **Minimum Samples in Survey Unit: 52**

- To make all sample points visible, move dialog box by placing mouse cursor in blue title bar of the **True Mean vs. Action Level** dialog box, holding left mouse button down, and dragging dialog box away from sample the area.
- Note that the specific sample points on your map are likely to be in different locations. This is due to differences in the random locations for placing sampling points. If you click **Apply** repeatedly, you will see different random patterns of sampling locations.

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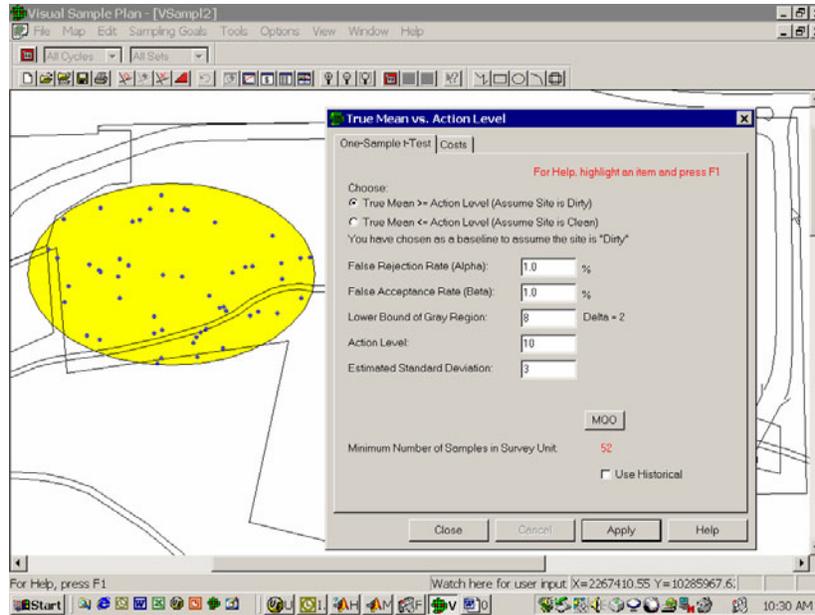


Figure 4. Dialog box for One-Sample t-Test

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Goal: To simultaneously see the map view, the graph view, the report view and the coordinates view of the sampling design.

To make your screen look like Figure 5 below:

- Click the **Close** button to close the **True Mean vs. Action Level** dialog box.
- From the main menu, select **Window**→**Quad Window**.
- If necessary, use the horizontal and vertical scroll bars to move the yellow sampling area into the center of the visible map.

You now will see the four views (or windows) available in VSP:

- Map View
- Graph View
- Report View
- Coordinates View

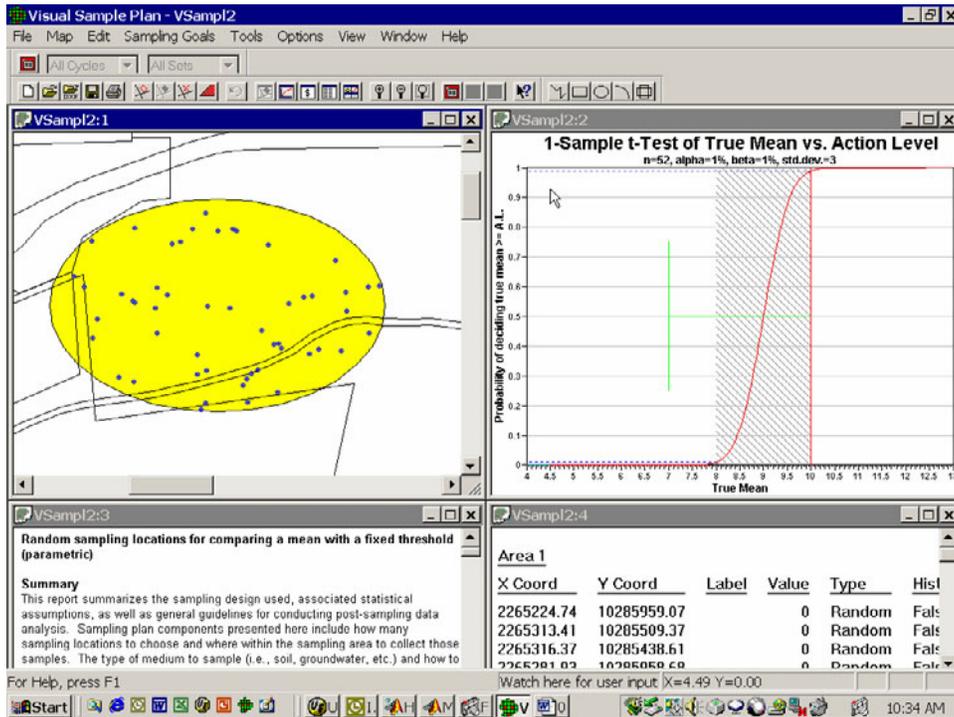


Figure 5. Example of the Quad Window

If you choose, each window can be resized for better visibility. For example, place your cursor exactly between the map window and the report window on the left side of the screen. The normal arrow cursor will change to a vertical double-headed arrow that can be used to change the size of a window. Please note that on slower PCs changing the size of the report window can take a few moments while the report is being updated.

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Goal: To see how the probability of deciding that the site mean is above the action level changes as a function of the true mean of the site.

To make your screen look like Figure 6 below:

- From the **Quad Window** in Figure 5, enlarge the graph in the upper right hand corner until it covers the full screen (Click the **Maximize** button in the top right corner of the **Graph View**, i.e., a small square.)

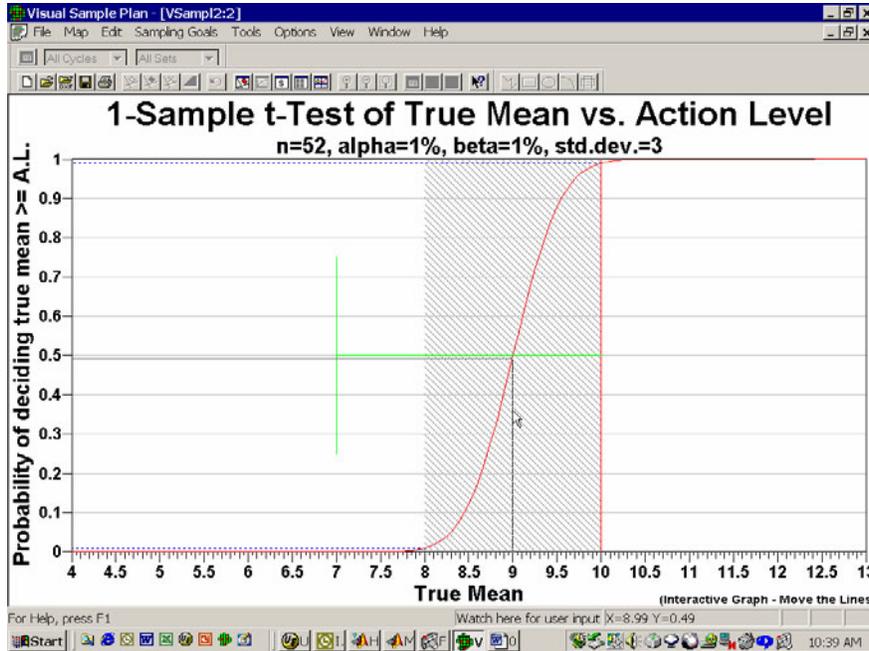


Figure 6. Example of the Graph View

The Graph View provides an interactive way to change the alpha error rate, beta error rate, the width of the gray region, etc. The dashed blue line near the top of the graph allows you to interactively change the alpha error rate by placing your mouse on the blue line and dragging the line up or down. Similarly, the dashed blue line near the bottom of the graph allows you to change the beta error rate. The green vertical line allows you to change the estimated value of the standard deviation. Finally, dragging the left side of the gray region left or right changes its value.

Drag the lines representing these values and observe the changing results in the graph subtitle. For example, drag the top dashed blue line down so that the alpha error rate is reported as 5% in the subtitle. Now drag the bottom dashed blue line up so that the beta error rate is reported as 10%. Finally, drag the green line to the left until the std. dev. equals 4. Note the change in sample size (now = 36) from the original value of 52. (These interactive changes made on the graph do not change the values you entered in an open dialog box. However, if you close the dialog box and reopen it, the values from the graph will be the new defaults.)

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Goal: Create a sampling design to compare an average to an Action Level, data not assumed normally distributed.

To make your screen look like Figure 7 below:

- From the main menu select **View→Map**.
- From the main menu, select **Sampling Goals→Compare Average to Fixed Threshold→Data not required to be normally distributed→Simple random sampling (Wilcoxon signed ranks test) ...**
- A **True Mean or Median vs. Action Level** dialog box will appear. Be sure that it contains the following values under the **Wilcoxon Signed Rank Test** tab:
 - **Choose:** True Mean >= Action Level
 (Assume Site is Dirty).
 - **False Rejection Rate (Alpha)** 1.0%
 - **False Acceptance Rate (Beta)** 1.0%
 - **Lower Bound of Gray Region** 8
 - **Action Level** 10
 - **Estimated Standard Deviation** 3
- If you click **Apply** repeatedly, you will see different random patterns of sampling locations.
- Note the bottom line in the dialog box: **Minimum Number of Samples in Survey Unit: 60**. A parametric sampling design (e.g., the one-sample *t*-test) generally requires fewer samples than a nonparametric design (e.g., the Wilcoxon Signed Ranks test) to meet the same error tolerance rates, but a parametric design requires that we assume the sampling distribution of means when, in this case, $n = 60$ (or the actual data distribution) will be approximately normal.
- EPA recommends using decision error rates of 1% as a starting point (EPA 2000a, p. 6-11). However, the DQO guidance acknowledges that consequences of a decision error may not be severe enough to warrant this stringent decision error and the values relaxed and the rationale documented (EPA 2000a, p. 6-11). Make the following changes to the error rates and note the reduction in sample size:
 - **False Rejection Rate (Alpha)** 5.0%
 - **False Acceptance Rate (Beta)** 10.0%
- Click **Apply**. The new sample size should now be: **24**. Whether this new sample size is justified depends on the consequences of decision errors and the relative costs of unnecessary cleanup vs. sampling costs (Beta error) and the relative costs of threats to human health and the environment vs. sampling costs (Alpha error).

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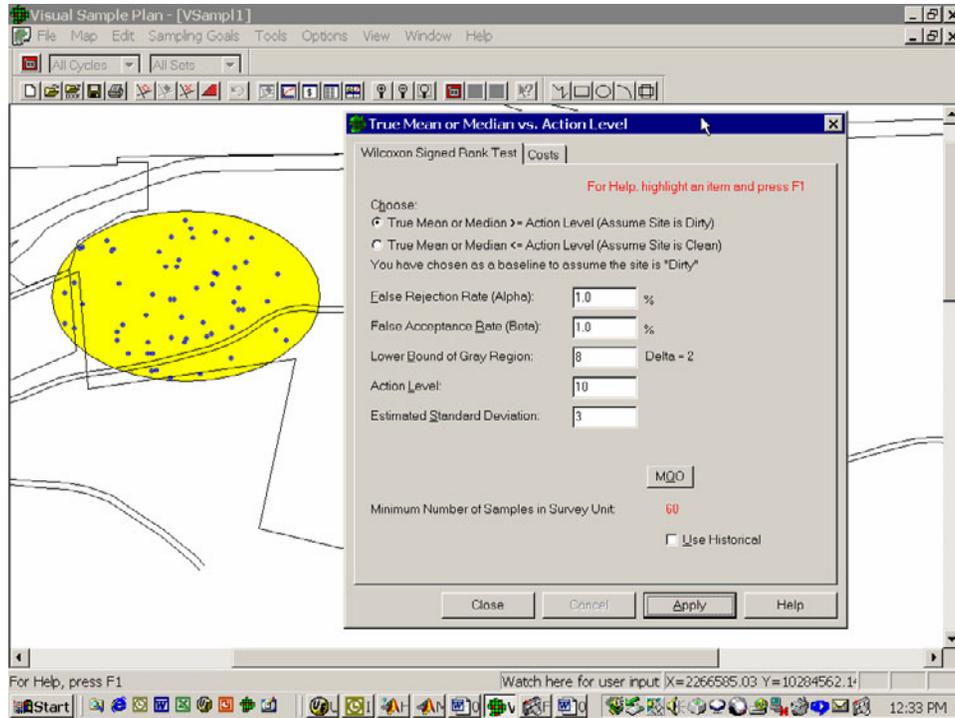


Figure 7. Wilcoxon Signed Rank Test dialog box and simple random sampling design

- **Close** the dialog box.
- From the main menu select **Window**→**Quad Window**.

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Goal: Create a sampling design suitable for a Wilcoxon Signed Rank Test using systematic grid sampling.

To make your screen look like Figure 8 below:

- From the main menu select **Sampling Goals**→**Compare Average to Fixed Threshold**→**Data not required to be normally distributed**→**Systematic grid sampling (Wilcoxon signed ranks test) ...**
- A **True Mean or Median vs. Action Level** dialog box will open. Verify that the last input values used in the previous example are the new defaults. If not, input the last input values noting that the alpha error = 5% and the beta error = 10%.
- Select the **Grid** tab.
- Select **Triangular** as the **Grid Type**.
- Check **Random Start**, if not already checked.
- Click **Apply**.
- Now position the dialog box so that the yellow sampling area is visible.
- A similar number of sampling locations are mapped as in Figure 7, but in a random-start grid pattern rather than a simple random pattern.

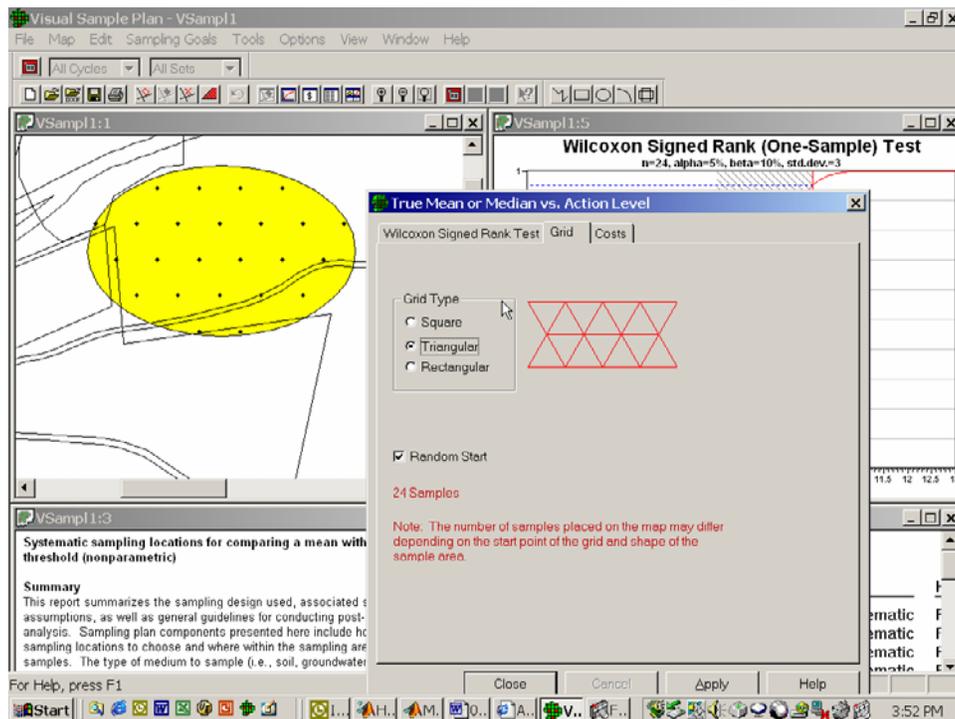


Figure 8. Example of random-start systematic grid and Wilcoxon Signed Rank Test dialog box

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Goal: To learn how to change sampling costs for the Wilcoxon Signed Rank systematic grid sampling design above.

To make your screen look like Figure 9 below:

- Within the **True Mean or Median vs. Action Level** dialog box, select the **Costs** tab.
- Check that the following values are entered:
 - **Fixed Planning and Validation Cost \$3000.00**
 - **Field Collection Cost per Sample \$50.00**
 - **Analytical Cost per Analysis \$500.00**
- Click **Apply**.
- The bottom-most line in the dialog box says **Total Cost for 24 Samples: \$16200.00.**

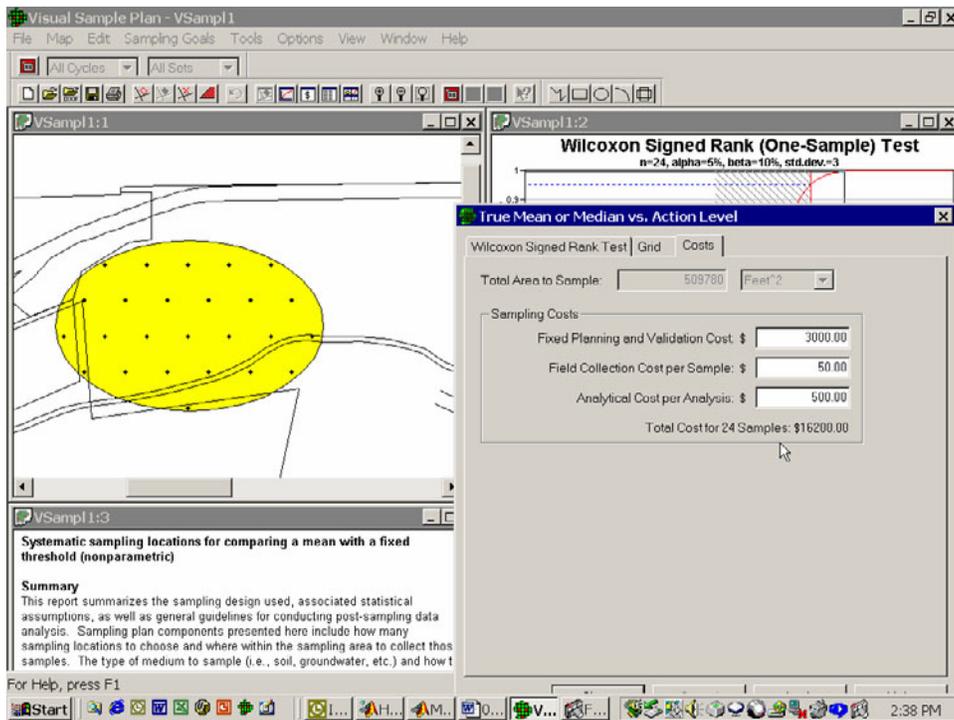


Figure 9. General tab for Wilcoxon Signed Rank Test with example costs

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Goal: To learn how to export the coordinates of a sampling design to a .txt file.

- **Close** the **True Mean or Median vs. Action Level** dialog box.
- Enlarge the Coordinates View, the lower-right window with X, Y locations, to fill the screen by clicking on its **Maximize** button or double clicking in its title bar. 
- From the main menu select **Map**→**Sample Points**→**Export**.
- At this point, your screen should look like Figure 10.
- A dialog box entitled **Save Sample Coordinates to a File** allows you to save the sample coordinates to a text file of your choice. These coordinates can be used in the field to determine the sampling locations.
- Press **Cancel** to close the dialog box.

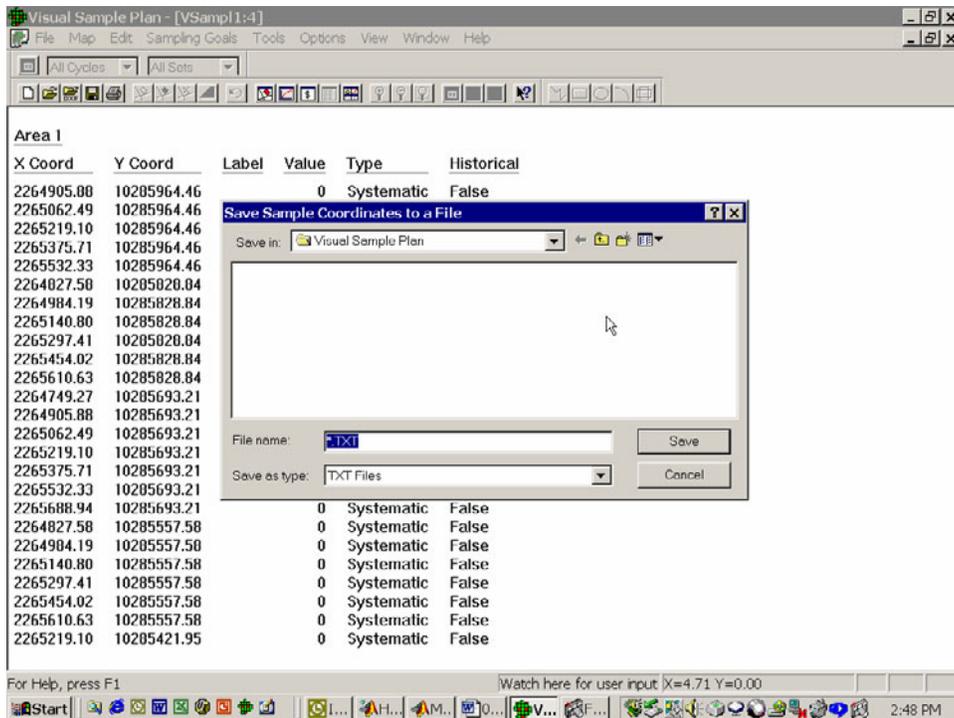


Figure 10. Coordinates view and Map→Sample Points→Export option

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Goal: To open a new project, to draw a rectangle with specific dimensions, and then to create a sampling design suitable for a one sample t-test.

- Close the current project using **File→Close Project**. Respond **No** to the query **Save changes to Vsampl1?**
- From the main menu, select **File→New Project**,
- Or click the **New** icon, 
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- Click the **Maximize** button (or double click title bar) to maximize initial window.
- Draw a one-acre field with overall dimensions of 165 feet x 264 feet = 43,560 square feet = 1 acre by doing the following:
 - Visual Sample Plan plots geometrical figures in an X-Y coordinate frame. For your one-acre field, it will be convenient to frame the field in your screen by changing the area portrayed on the screen. You can do this by setting the map extents for the figure you are about to draw. From the main menu select **Map→Set Map Extents**. A Map Extents dialog box will appear.
 - Using the dialog box, set map extents as follows:

Minimum X: **-100**
Maximum X: **300**

Minimum Y: **-100**
Maximum Y: **200**

Use default **Units**: Feet

Click **OK**. The dialog box now says **Sample Plan Phase 1**.

- From the main menu select **Map→Draw Rectangle** (the cursor changes to a flashing +).
- Note that the status bar at the bottom of the screen says **Enter corner point: X,Y**.

For Help, press F1 Enter corner point: X,Y X=253.33 Y=185.00



- Using the keyboard, type in the coordinates of one corner of the one-acre field. Type (*be sure to use a comma* between the numbers):
0,0 <Enter>
- The message on the status bar will change to **"Enter other corner: X, Y"**. Now type:
264, 165 <Enter>
The one-acre field will appear in the color yellow.
- From the main menu select **View→Zoom Out**. Notice the cursor has changed to a magnifying glass  and the icon that looks like a magnifying glass with a minus sign in it is selected. The **Zoom Out** icon  is in the center.
- Shrink the one-acre field by clicking on the map two times.
- Deselect the **Zoom Out** icon by clicking on it.

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- From the main menu, select **Sampling Goals**→**Compare Average to Fixed Threshold**→**Data not required to be normally distributed**→**Systematic grid sampling (Wilcoxon signed ranks test) ...**
- A **True Mean vs. Action Level** dialog box will appear. Be sure that it contains the following values:
- **Choose:**
- **True Mean \geq Action Level** (Assume Site is Dirty).
- **False Rejection Rate (Alpha)** 5.0%
- **False Acceptance Rate (Beta)** 20.0%
- **Lower Bound of Gray Region** 9
- **Action Level** 10
- **Estimated Standard Deviation** 3
- Click **Apply**.

Note the bottom line in the dialog box in Figure 11: **Minimum Number of Samples in Survey Unit: 67**.

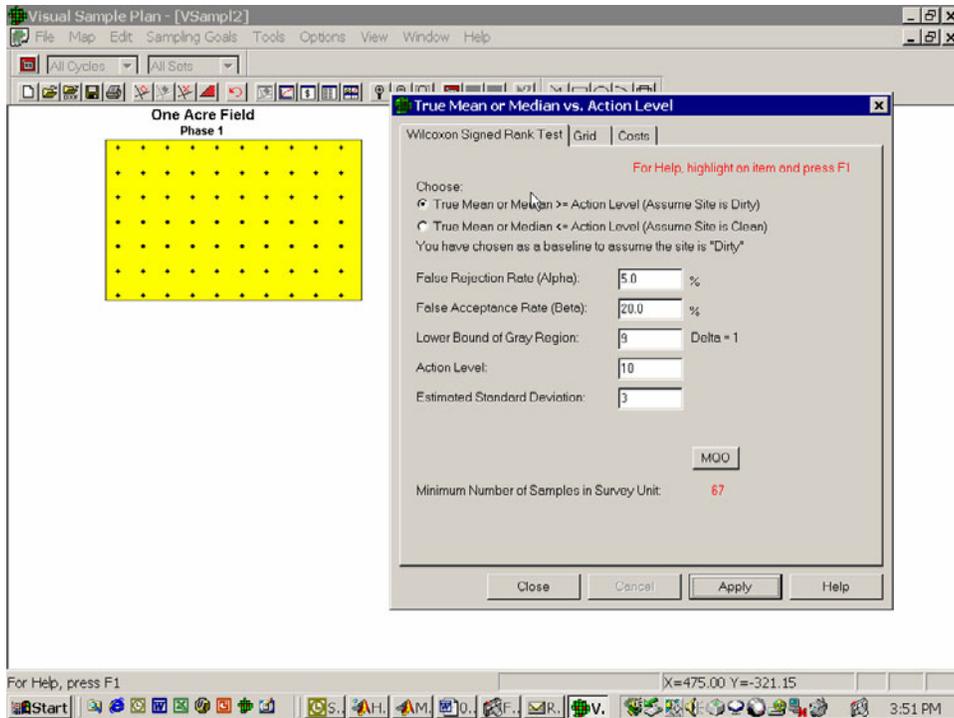


Figure 11. Minimum Number of Samples in Survey Unit: 67

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Goal: To see the impact of altering the width of the gray region.

To make your screen look like Figure 12 below:

- Change the **Lower Bound of Gray Region** from **9 to 8**. Note that Delta, the width of the gray region, has increased from 1 to 2 units.
- Click **Apply**.
- Note **Minimum Number of Samples in Survey Unit: 18**.

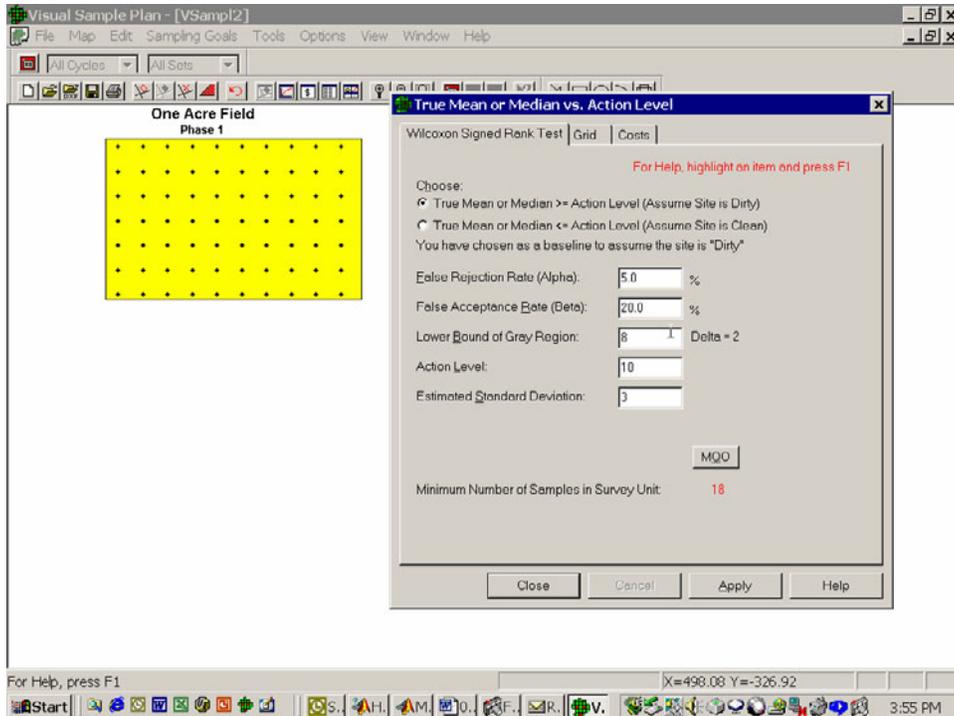


Figure 12. Dialog box with larger gray region

The dramatic decrease in sample size from 67 in the previous example to 18 in this example illustrates the important influence the width of the gray region has on sample size.

Close the dialog box.

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Goal: To demonstrate the effect of changing the hot-spot size on the number of samples required.

To make your screen look like Figure 13 below:

- From the main menu select **Sampling Goals**→**Locating a Hot Spot**→**Systematic grid sampling**→**Minimize number of samples ...** A dialog box will appear labeled **Find Hot Spot with Minimum Number of Samples**.
- Click the **Hot Spot** tab.
 - For **Shape (0.2 – 1.0)** enter **0.8**. (This command sets the assumed shape of the hot spot. A perfect circle has a shape of 1.0, a Shape = 0.8 ellipse has a minor-to-major axis ratio of 0.8.)
 - Enter **20.0** for the **Length of Semi-Major Axis** in Feet.
- Click the **Find Grid** tab within the dialog box and select **Triangular** as the **Grid Type**.
 - Enter **95%** for **Probability of Hit**.
 - Click **Apply**. Your screen will look similar to Figure 13, requiring 45 samples.

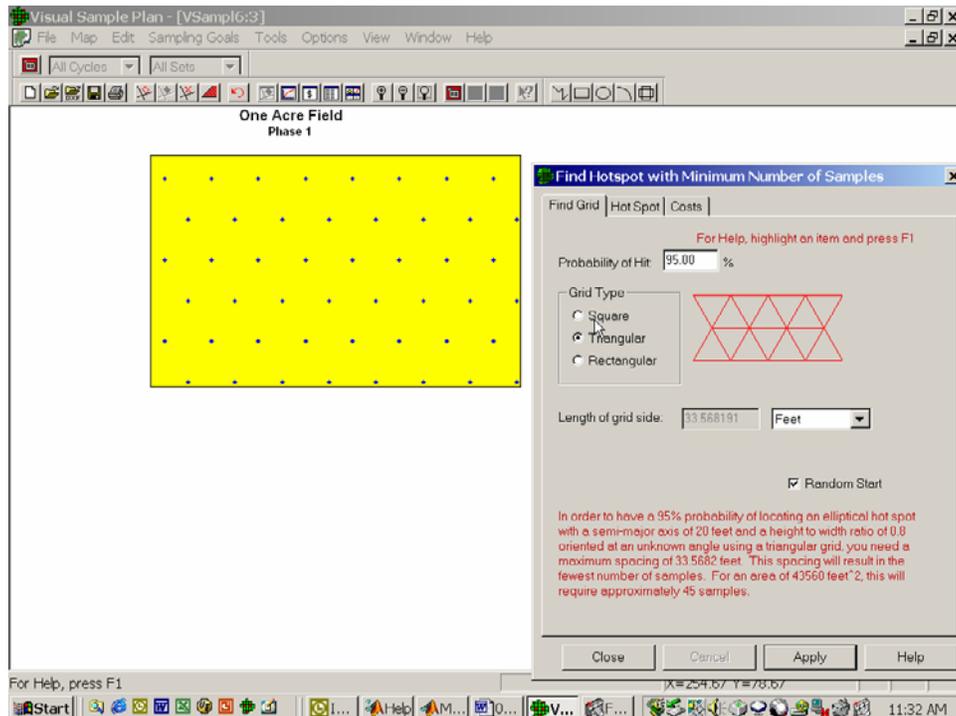


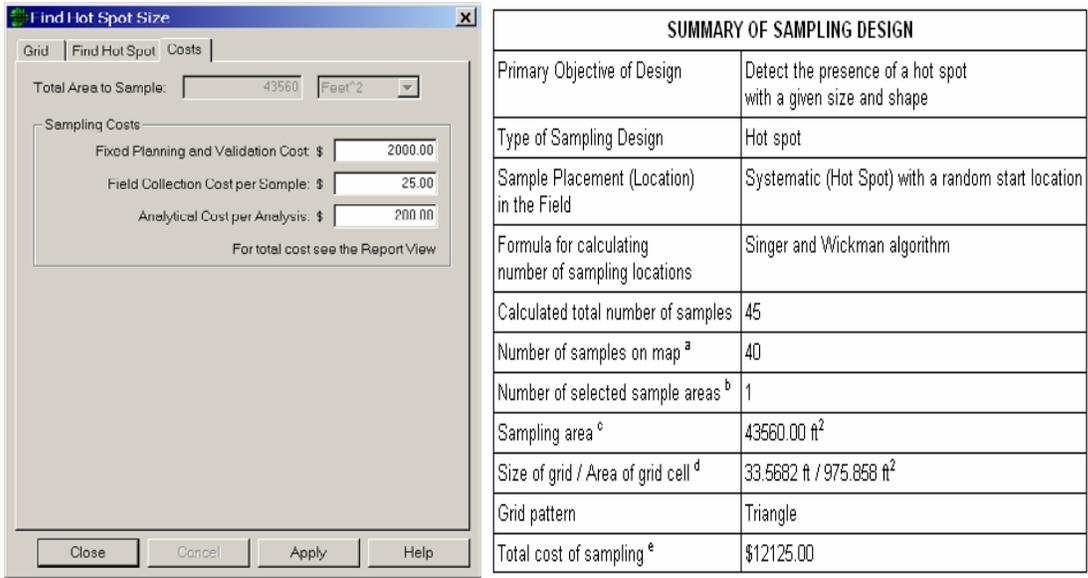
Figure 13. Hot-spot sampling design

- Click the Close button on the Find Hot Spot with Minimum Number of Samples dialog box.

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Goal: To illustrate how to get sampling cost information with hot-spot sampling.

- From the main menu select **Window**→**Quad Window**.
- **Maximize** the report view in the lower, left corner of the screen.
- From the main menu select **Sampling Goals**→**Locating a Hot Spot**→**Systematic grid sampling**→**Minimize hot spot size ...** A dialog box will appear labeled **Find Hot Spot Size**.
- Click the **Costs** tab and enter the following values:
 - Fixed Planning and Validation Cost **\$2000.00**
 - Field Collection Cost per Sample **\$25.00**
 - Analytical Cost per Analysis **\$200.00**
- Click **Apply**. Click **Apply** several times. Note the **SUMMARY OF SAMPLING DESIGN** table (see Figure 14); the entry “Number of samples on map” varies slightly with the calculated number, depending on the starting point of the sampling grid.
- Note the “Total cost of sampling” is listed as **\$12125.00**, based on the calculated number of samples.
- You can scroll the report window and see a large amount of information relating to the current sampling design.
- Click the **Close** button on the **Find Hot Spot Size** dialog box.



SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Detect the presence of a hot spot with a given size and shape
Type of Sampling Design	Hot spot
Sample Placement (Location) in the Field	Systematic (Hot Spot) with a random start location
Formula for calculating number of sampling locations	Singer and Wickman algorithm
Calculated total number of samples	45
Number of samples on map ^a	40
Number of selected sample areas ^b	1
Sampling area ^c	43560.00 ft ²
Size of grid / Area of grid cell ^d	33.5682 ft / 975.858 ft ²
Grid pattern	Triangle
Total cost of sampling ^e	\$12125.00

Figure 14. Hot-spot sampling example

Return to the **Quad Window** by clicking on the maximize button.



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Goal: To develop a sampling plan with a limited budget.

To make your screen look like Figure 15 below:

- From the main menu select **Sampling Goals**→**Locating a Hot Spot**→**Systematic grid sampling**→**Predetermined fixed cost ...**
- From the **Find Cost** tab, enter the **Total Cost** as **\$10000.00**
- Verify that the **Grid Type** is still **Triangular**.
- The inputs under the **Hot Spot** and **Costs** tabs should default to the values you just set previously on pages 16 & 17. For example, the **Length of Semi-Major Axis** should still be 20.0 ft.
- Click **Apply**. Note (in the enlarged report window in the lower left-hand window of the **Quad Window**) that by fixing the total survey cost and the sample cost, we have reduced the number of samples to 35. However, the probability of hitting a hot spot has been reduced to about 80% (see Figure 15).

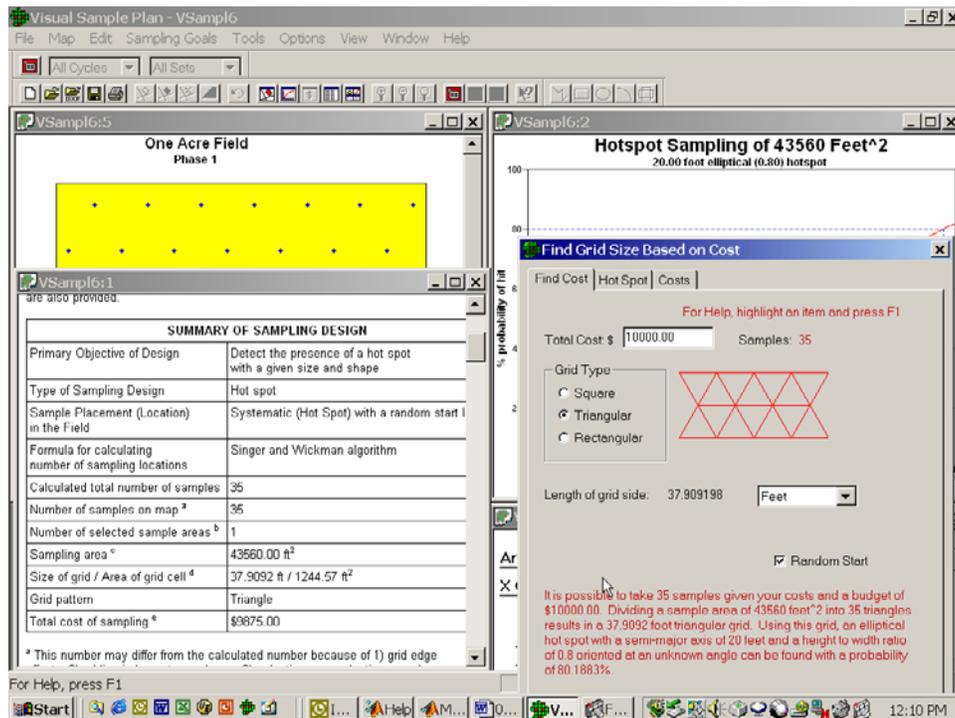


Figure 15. Hot-spot sampling option, “Predetermined Fixed Cost”

Although the sampling cost has been reduced to within the goal of \$10,000, the 80% chance of detecting a hot spot may not meet our objectives. The next exercise will illustrate how to use the graph to compare sampling cost to the probability of hot-spot detection.

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Goal: To see the graph view with probability of finding a hot spot vs. sampling cost.

- Enlarge the graph to fill the screen by clicking on its **Maximize** button. There is no need to close the dialog box at this point, but you may want to drag it off to one side.
- From the main menu select **Options**→**Graph**→**Display Cost**. Note that the X-axis variable has changed from “Number of Samples using a triangular grid” to “Sampling Cost using a triangular grid”. Also note that by moving the black line along the red curve, one can see the sampling cost (x) for a probability of hit (y) in the status box near the lower-right corner of the screen.

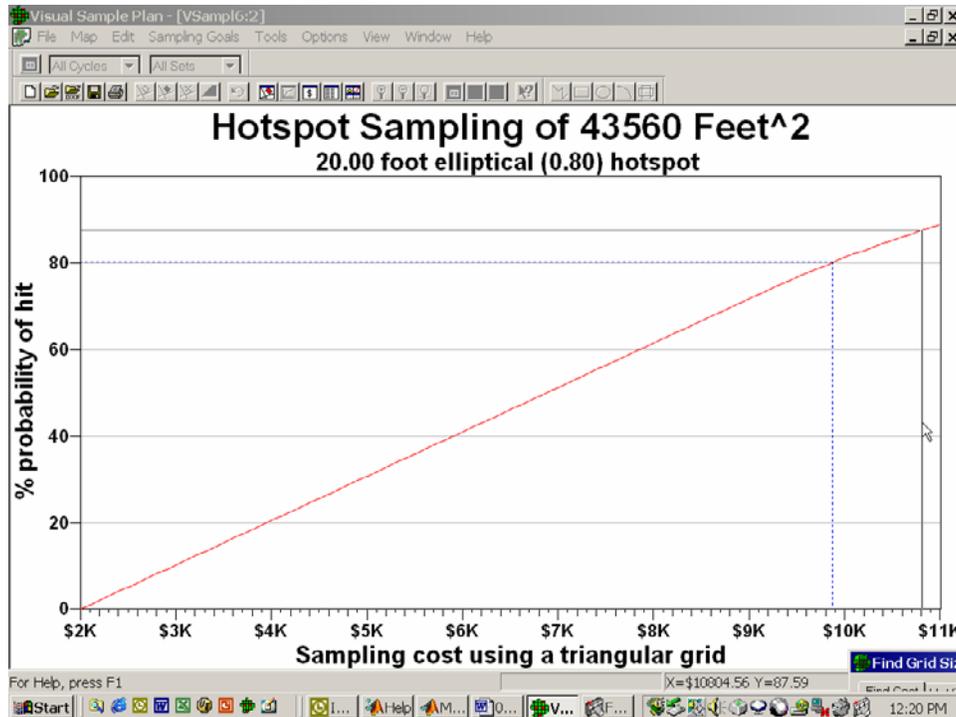


Figure 16. Hot-spot sampling example showing sampling cost on X-axis

In Figure 16, the status box shows that the cursor is at a sampling cost of \$10,804.56 vs. a probability of hot-spot detection of 87.59%. Move the cursor and note the changes in the status box.

The dotted blue line goes vertically from the sampling cost that came within our budget of \$10,000 (approximately \$10,000 is actually selected by VSP) and then horizontally to the corresponding hot-spot detection probability of 80%.

For more information on the hot-spot problem, see *Statistical Methods for Environmental Pollution Monitoring* (Gilbert 1987, pp. 119-131).

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Goal: To find the largest circular area that could be missed by a given systematic grid sampling design.

To make your screen look like Figure 17 below:

- Click the **Close** button in the **Find Grid Size Based on Cost** dialog box.
- Select the map view using **View→Map**.
- From the main menu select **Tools→Largest Unsampled Spot→**F**ind...**
- Enter an **Accuracy** of **1.0** feet.
- Leave the two check boxes at their default values.
- Click **OK**. A dialog box will appear indicating that the largest potential circular area has a radius of about 22 Feet and an area of about 1,500 Feet². These values will vary depending on the current grid.
- Click **OK** to close the box giving the Radius and Area information.

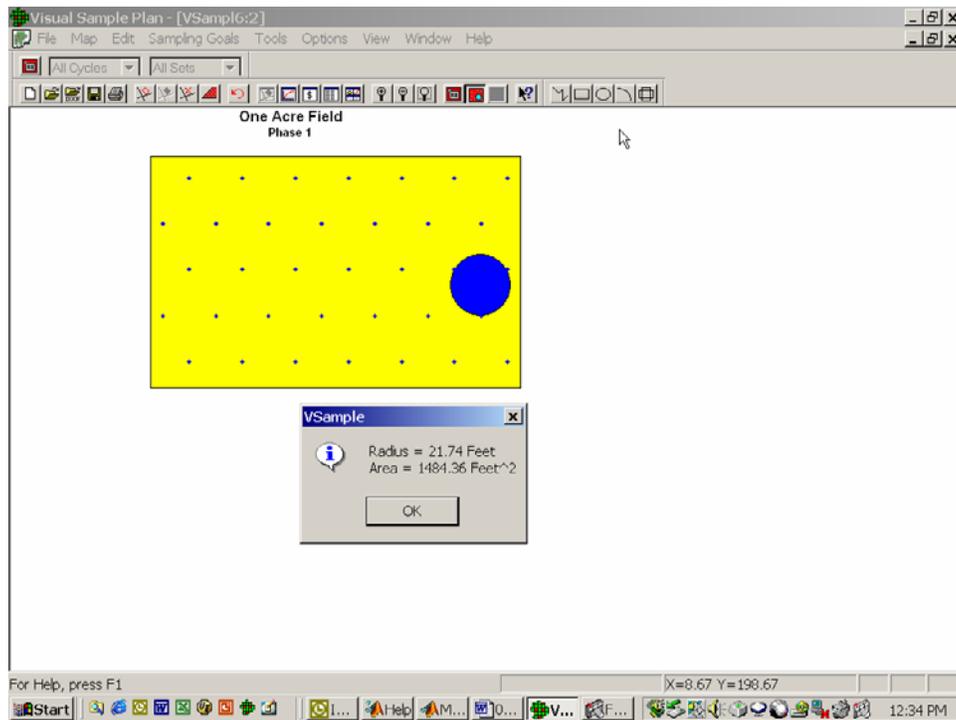


Figure 17. Largest potential unsampled circular area

The colored circle is the largest circle of contaminant that could be missed with the current sampling design. Note that no probability is associated with this tool. It simply finds the largest circle that fits between the current sampling locations.

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Goal: To stratify a one-acre field for more efficient sampling.

To make your screen look like Figure 18 below:

- Close the project using **File→Close Project**. Respond **No** to the query **Save changes to VSAMPL2?** (Visual Sample Plan automatically numbers your projects as you open them. Thus you may have a VSAMPL3 or more at this point.)
- (Note: Visual Sample Plan supports a stratified random sampling design for determining the global average for a number of strata. However, our goal here is to divide a site into a number of smaller areas, each of which will be individually examined. The following example illustrates this subdivision approach.)
- From the main menu select **File→New Project**.
- Click the **Maximize** button (or double click title bar) to maximize initial window.
- From the main menu select **Map→Set Map Extents**. Set map extents as follows:
Minimum X: **-100** Minimum Y: **-100**
Maximum X: **300** Maximum Y: **200**
Use default **Units**: Feet
Click **OK**
- Divide the one-acre field into two subsections as follows:
 - From the main menu select **Map→Draw Rectangle**.
 - Using the keyboard, enter the coordinates of opposite corners of the first rectangular subsection (note that these entered coordinates appear in the status bar at the bottom of the screen): First type (note commas):
0,0 <enter>
then
75,165 <enter>
 - Set the color of this subsection to dark blue using main menu option **Edit→Sample Areas→Change Colors**.
 - **Deselect** this subsection by left-clicking on it.
 - Start the second stratum by selecting **Map→Draw Rectangle**.
 - Using the keyboard, enter the coordinates of opposite corners of the second rectangular subsection (note that these entered coordinates appear in the bar at the bottom of the screen): First type (note commas):
75,0 <enter>
then
264,165 <enter>
 - Set the color of this subsection to light green using main menu option **Edit→Sample Areas→Change Colors**.
 - Turn on the blue color as Strata #1 by left-clicking on it.
 - You should now have a sampling area divided into two subsections. Each subsection, strata, can now be treated separately.
- The next sampling design will only apply to the right subsection in green. (Be sure the left subsection in blue is *not* selected by left-clicking on it if necessary.)

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- From the main menu select **Sampling Goals**→**Compare Average to Fixed Threshold**→**Can assume data will be normally distributed**→**Systematic grid sampling ...**
- A **True Mean vs. Action Level** dialog box will appear.
 - Select the **Grid** tab and select **Triangular** grid type and **Random Start**
 - Select the **One-Sample t-test** tab. Be sure that it contains the following values:
 - **Choose:**
 - **True Mean \geq Action Level** (Assume Site is Dirty).
 - **False Rejection Rate (Alpha)** 5.0%
 - **False Acceptance Rate (Beta)** 10.0%
 - **Lower Bound of Gray Region** 5
 - **Action Level** 6
 - **Estimated Standard Deviation** 1.2
 - Click **Apply**. This should leave a sparse triangular sampling grid with 14 points in the right-hand subsection.
- Left-click within the right-hand, green subsection to deselect it (remove color).
- Left-click within the left-hand, blue subsection to select it. The selected sampling area should now be colored blue.
- Be sure that the variables are set to the following values, noting that the standard deviation is now **2.4**, i.e., twice as large as above:
 - **False Rejection Rate (Alpha)** 5.0%
 - **False Acceptance Rate (Beta)** 20.0%
 - **Lower Bound of the Gray Region** 5
 - **Action Level** 6
 - **Estimated Standard Deviation** 2.4
- Click **Apply**. This should create a denser triangular sampling grid in the blue subsection, with 37 sample points.
- Left-click in the right-hand subsection to display it as well. Your screen should now closely resemble Figure 18.

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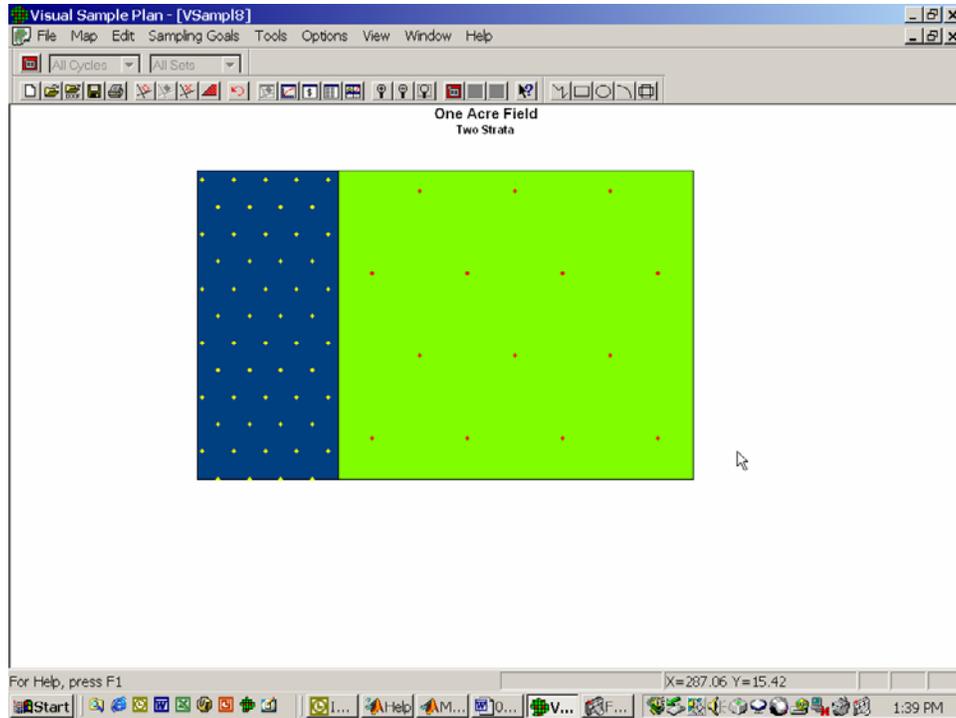


Figure 18. Example of subdivided sampling area

- Close the project using **File**→**C**lose Project. Respond **N**o to the query **S**ave changes to Vsampl3?

Visual Sample Plan Training Course
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