

Assumptions Underlying the UCLs

- ▶ Each MI sample is representative of the average concentration in the segment
- ▶ The estimated mean for each segment has a normal distribution
 - Having a large number of soil increments in each MI sample increases the likelihood that the measurements of MI samples will be normally distributed. It is assumed that 25 increments per MI sample is sufficient to achieve normality, but additional increments are encouraged whenever practical and when adequate mixing of the increments can be achieved.
- ▶ For segments in which two MI samples are collected
 - each measurement is an estimate of the true average for the segment
 - the measurements are independent (no correlation)
- ▶ If more than one measurement for a MI sample is obtained, their arithmetic mean (rather than each measurement) is computed and input into VSP for that MI sample
- ▶ The true, unknown RSD is the same for all segments

 PNWD-SA-7032 / 41

It is also assumed that explosives constituents in surface soil are not resuspended and transported through the air to distinct isolated hot spots outside the boundary. That is it is assumed that the only way surface soil explosives constituents will breach the boundary is as a continuous plume across the boundary.

Power of the UCL test depends on magnitude of the difference in the true mean for the segment and the action level, the number of soil increments per MI sample, and the variability among MI samples in each segment. In contrast to most all other VSP modules, the RS VSP module does not ask the VSP user to specify the required power of the test. Hence, VSP presumes the user has verified previously that the number of increments and MI samples used is sufficient to achieve a sufficiently high power for the UCL test to reject H_0 when H_0 is false.

Hypothetical Case Study

- ▶ Suppose that surface soil samples are to be collected along the current (provisional) boundary of an active training range to determine if mean concentrations of RDX at the boundary exceed the action limit (4.4 ppm).
- ▶ If so, it will be necessary to determine if true mean concentrations greater than 4.4 ppm extend beyond the boundary, and if so, where along the boundary such contamination may exist.
- ▶ The goal would be to establish a new boundary beyond which there is high confidence that the action limit for the RDX mean (4.4 ppm) is not exceeded.

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PNWD-SA-7032 / 42

Hypothetical Case Study (continued)

- ▶ Suppose that movement of RDX in surface soil to adjacent off-range areas would be most likely to occur on the downhill portion of the range
- ▶ Assuming that assumption to be true, the project planning team decides to sample only the current boundary on the downhill side of the training range
- ▶ Suppose a DXF file of the training range has been saved in the VSP folder
- ▶ The DXF file is loaded into VSP by clicking **Map** on the VSP menu bar, then clicking **Load Map from file**, and double clicking the appropriate DXF file

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PNWD-SA-7032 / 43

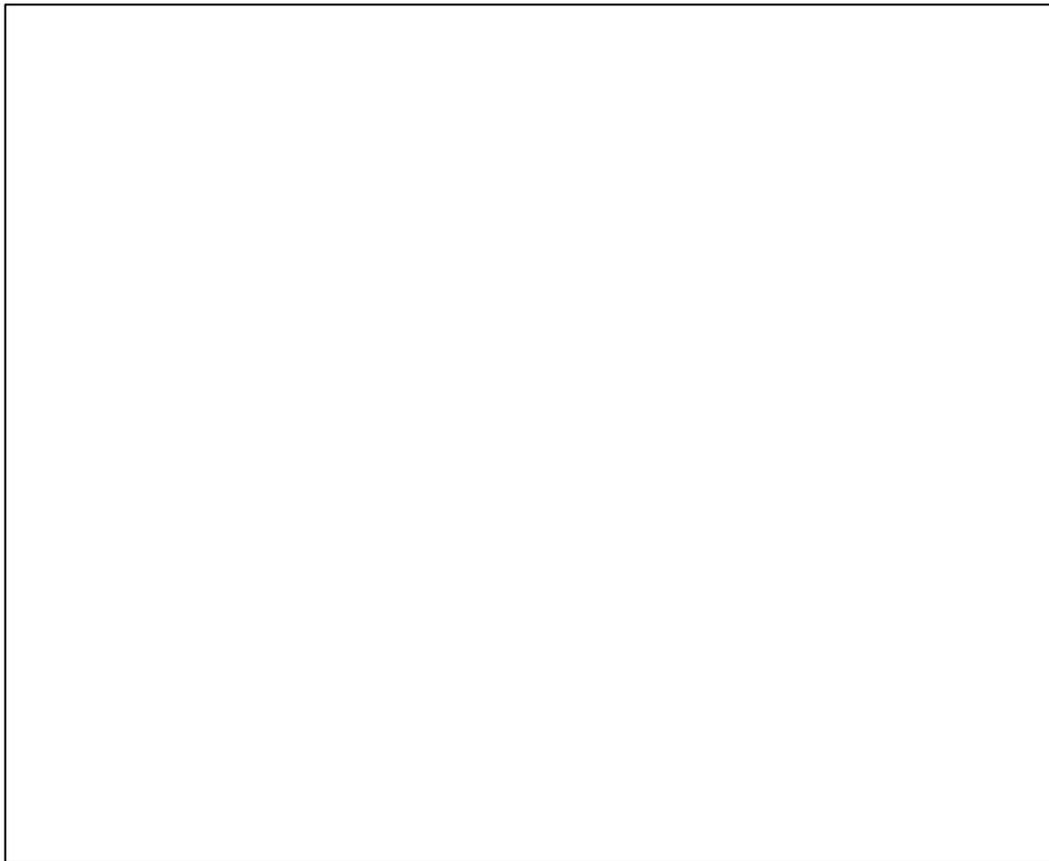
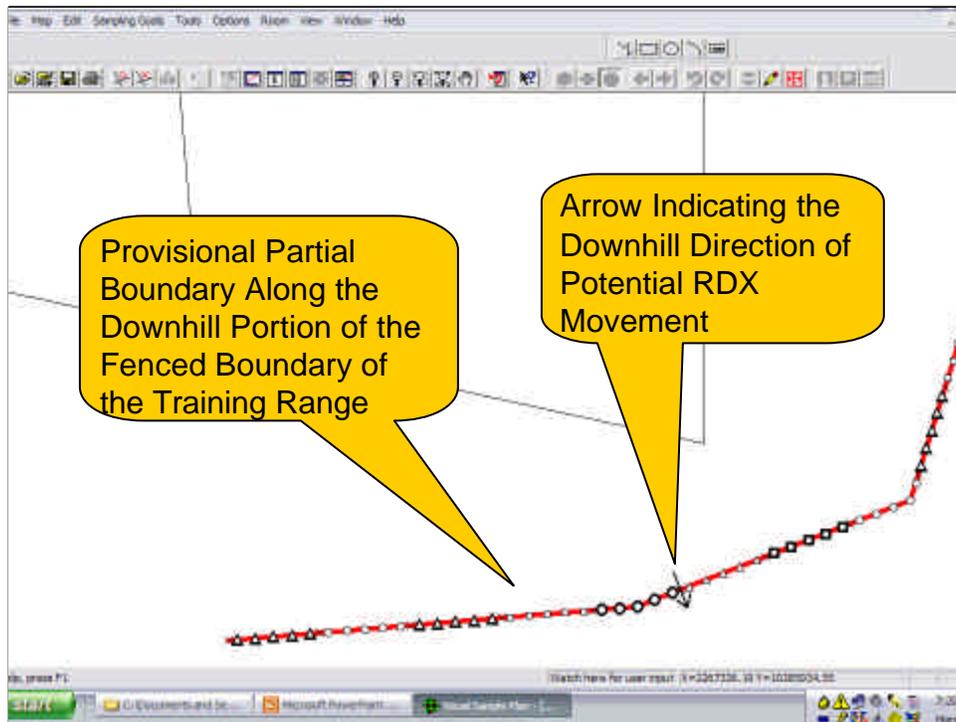
Hypothetical Case Study (continued)

- ▶ The partial boundary is drawn on the map by
 - ✦ clicking **Edit** on the VSP menu bar
 - ✦ clicking **Sample Areas > Define New Open-Type Sample Area**
 - ✦ selecting a color (say, red) from the color box that appears
 - ✦ clicking the left mouse button at locations (the boundary beginning point, points of changing direction along the boundary, and the boundary end point) on the map to define the partial boundary
 - ✦ clicking the right mouse button to create the boundary, then
 - ✦ clicking **Edit** on the VSP menu bar
 - ✦ clicking **Sample Areas > Flip Direction** to reverse the arrow that VSP placed on the boundary to indicate the downhill direction

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PNWD-SA-7032 / 44

Range Sustainability (VSP)



Hypothetical Case Study (Continued)

- ▶ Suppose the goal is to find any circular area (“hot spot”) on the partial boundary that is = 3 feet in diameter for which the mean concentration of RDX in surface soil is = 4.4 ppm
- ▶ Furthermore, suppose that the statistical testing process that uses the upper confidence limit (UCL) on the mean for a given boundary segment must have no more than a 1% chance (1 chance in a 100) of *incorrectly* indicating that the boundary in that segment does not need to be moved outward, that is, of failing to *correctly* indicate that the boundary needs to be moved outward
- ▶ In other words, it is required that $\alpha = 0.01$, i.e., that there must be $100(1-\alpha)\% = 99\%$ confidence in the decision not to move that particular boundary segment outward.

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The 99% confidence statement applies to the decision made *separately* for each individual segment. If in truth none of the k segments along the boundary have hot spots, then the overall confidence that *all* the k UCL tests will correctly indicate that none of the k boundary segments should be moved outward will be (assuming the k tests are independent)

$$\text{Overall Confidence} = 100(1 - \alpha)^k$$

For example, if $\alpha = 0.01$ for each of the k UCL tests, then

$$\text{Overall Confidence} = 100(1 - 0.01)^9 = 100(0.99)^9 = 91$$

that is, there is 91% confidence in the conclusion that none of the boundary segments need to be moved outward. Note that reducing α for each individual segment will increase the overall confidence level. For example, if α is set at 0.001 for each segment, then

$$\text{Overall Confidence} = 100(1 - 0.001)^9 = 100(0.999)^9 = 99$$

as desired. For additional discussion of this topic see page 305 in:

Millard, S.P. and N.K. Neerchal. 2001. *Environmental Statistics with S-Plus*, CRC Press, NY

Hypothetical Case Study (Continued)

- ▶ The requirements on the previous slide are entered into the VSP RS dialog box
- ▶ This box is accessed by clicking **Sampling Goals** on the VSP menu bar, then clicking **Establish Boundary of Contamination > Partial Boundary** as shown on the next slide.
- ▶ Click the **Apply** button after dialog box inputs are added.

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PNWD-SA-7032 / 47

Range Sustainability (VSP)

