**MULTI-INCREMENT TCE VADOSE ZONE INVESTIGATION**

ALAN D. HEWITT  
U.S. Army ERDC-CRREL  
72 Lyme Road  
Hanover, NH 03755  
(603) 646-4388  
Alan.D.Hewitt@erdc.usace.army.mil

CO-PERFORMERS: Susan Bigl (U.S. Army ERDC-CRREL); Charles A. Ramsey (EnviroStat, Inc.)

This study was conducted at a site where an underground tank positioned above a concrete pad was used to store TCE for 12 years. An odor of TCE was evident during excavations when the original tank, a replacement tank used for fuel oil, and the concrete pad were removed from the site. The extent of contamination was quantified a few years later, using over 500 discrete samples to define the zone with the highest concentrations (sometimes exceeding 1% wt/wt of TCE). The highly contaminated zone was a 3,000-m³ volume measuring 11 m by 22 m in surface area and 12 m deep.

In 2006, both multi-increment and discrete sampling strategies were used to estimate the average concentration and the three-dimensional distribution of TCE in the zone of interest. A total of 188 discrete and 41 multi-increment samples were obtained for the evaluation. Each discrete sample was an individual 5-g (3-cc) plug of soil. The majority of the multi-increment samples contained 40 of the 5-g soil plugs. The multiple increments were combined in two ways – within an individual borehole and within 0.6-m subsurface depth intervals.

Both sampling strategies established similar average TCE concentrations. However, the discrete sample average was heavily influence by a single sample with a concentration very different from the rest. More importantly, the discrete sampling strategy failed to identify two layers in a soil boring where the TCE concentrations exceed 1% w/w. This omission would lead to a gross underestimation of the contamination mass (volume with >1% TCE), which could trigger a false negative action, or the improper design and subsequent low cost estimation for remedial technologies. Additionally, this study identified large economical advantages to using the multi-increment sample strategy and combining the increments in two directions, which inherently establishes two independent values allowing for quality assurance data confirmation. Lastly, the multi-increment sampling also allows for a lot more increments (and sample mass) from the zone under investigation to be included in the analysis, for no additional cost other than that of the solvent. This sampling strategy is well suited for identifying the location of high concentrations of TCE and most likely many other volatile organic compounds in subsurface zones.