Lessons Learned from 25 Years of High Resolution Site Characterization

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Background/Objectives. High resolution site characterization (HRSC) broke into the mainstream of the remediation industry circa 2006 when the Groundwater Resource Association of California held the High Resolution Site Characterization and Monitoring. While researchers and practitioners had been conducting high resolution investigations since the late 1970s the techniques were used sparingly by the industry until direct sensing technologies like the membrane interface probe (MIP) and laser induced fluorescence (LIF) gained popularity in the early 2000s and the appellation HRSC appeared in the mid 2000s. Many practitioners equate HRSC and direct sensing, and direct sensing tools are an important part of HRSC but in and of themselves are insufficient for development of a complete conceptual site model and for making sound site management decisions. Best practice for HRSC is to use a wide variety of high resolution techniques to investigate the various critical aspects of subsurface contamination problems. Overreliance on single tools and approaches can lead to erroneous CSMs and poor management decisions and remedial designs

Approach/Activities. Early HRSC methods, such as those pioneered by John Cherry and colleagues at the University of Waterloo included very detailed groundwater sample, hydraulic head and hydraulic conductivity measurements, evaluation and analyses of soil cores and sediments, discharge of groundwater to surface water etc. Use of dynamic work strategies combine with a transect approach to investigation reduces uncertainty and improves understanding. In recent years tools have been combined into tool strings to provide more information than a single tool. Examples include the Waterloo^{APS} which combines injection logging and head measurement with sample collection; and the MiHPT which combines injection logging with the direct sensing MIP. In addition, strings now combine the Waterloo^{APS} with UVOST and electrical conductivity (Wenner array). Saturated soil core profiling is critical to understanding aquitard materials and mass distribution and a new cryocoring tool allows for very high resolution sampling and analyses of saturated aquifer materials. Important Processes in the hyporheic zone typically occur over very short spatial scales A new sediment tool collects very high resolution data of multiple types to help understand plume discharge to surface water bodies. These types of groundwater surface water interaction can be leveraged by using techniques such as forward looking infrared imaging and distributed temperature sensing to focus on concentrated discharge zones

Results/Lessons Learned. Failure to test key elements of a CSM, or testing the elements with tools not suited for the purpose can greatly hamper remediation. Often we take our hypotheses for granted and therefore are sabotaged when they turn out to not be true. An overreliance on a single screening tool appears to save time and money in the short term by is unlikely to lead to an adequate CSM or uncertainty reduction. The use of a variety of tools coupled with a dynamic and methodical approach (e.g., transects) incorporating both screening techniques and definitive techniques results in more complete CSMs and greatly reduced uncertainty. These approaches save money over the life cycle of the project by ensuring proper delineation of treatment zones, a better understanding of what treatment technologies will perform best and when treatment is either unnecessary or unlikely to work at all.