A Comparison of Cost and Performance between Permeability Enhancement Technology and Conventional Injection Techniques at Low-Permeability Sites

Nathan Smith (SmithNT@cdmsmith.com), Kent Sorenson, Dung Nguyen, and Ryan Wymore (CDM Smith, Denver, Colorado, USA)

Background/Objectives. Effective amendment delivery at low-permeability sites remains one of the most challenging obstacles in the remediation industry, and significant costs are often incurred while obtaining limited progress in contaminant reduction. Permeability enhancement technology (i.e., environmental fracturing) has been shown capable of improving amendment delivery and treatment effectiveness at many sites where conventional injection techniques are ineffective. However, there is a lack of documented cost and performance assessment of permeability enhancement technology, especially relative to conventional injection techniques. ESTCP project ER-201430 was funded to compare commercially available permeability enhancement technologies at three sites with differing lithologies, contaminant profiles, and remedial objectives, and to provide written guidance for future applications. In addition, the project included evaluation of cost effectiveness of permeability enhancement in comparison to conventional technologies that were previously used at the sites, as well as monitoring techniques for permeability enhancement. This presentation will provide a comparison of the short-term and overall project cost as well as performance between permeability enhancement technology and conventional injection techniques.

Approach/Activities. Three DoD sites with challenging lithologies (silty clay/weathered shale, weathered sandstone, and glacial till) were selected for demonstration of the permeability enhancement technology. Site contamination had previously been addressed using conventional injection techniques such as in-well or direct-push injection with limited success. For the cost evaluation, the Bountiful/Woods Cross Superfund Site was also incorporated, as the site used conventional injection followed by permeability enhancement to address high concentrations within low permeability zones (silts and clays). Implementation costs for all permeability enhancement applications were tracked, and estimated costs for completion of the prior conventional approaches were developed (with the exception of the Bountiful/Woods Cross site, where actual costs were known). The actual remedial progress obtained by conventional techniques and permeability enhancement based upon percent mass reduction was used to normalize the cost evaluation. Specifically, site contaminant data were used to interpolate plumes before and after the remedial application. Then, the reduction in total mass achieved by conventional injection and permeability enhancement was calculated, and the percent reduction obtained by each approach was used to normalize the evaluation (i.e., cost per unit mass per unit time was calculated to compare performance).

Results/Lessons Learned. In all cases, permeability enhancement resulted in more substantial reduction of contaminants, and more cost-effective remediation for the sites is projected in the long-term when compared to conventional injection techniques. Comparison using the percent reduction approach indicated that costs for permeability enhancement were 50 to 80 percent less than that of the conventional technology previously used. Primary cost drivers for permeability enhancement technology, as well as demonstrated monitoring techniques, will also be shared to enable future users to make informed decisions when considering use of permeability enhancement at their sites. Some of the most important cost drivers were found to be site geology and target depth, mobilization charges, and remedial amendments utilized.