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Rapid Reduction of Chlorinated Solvents Using Combined Bioaugmented Enhanced Reductive Dechlorination and In Situ Chemical Reduction Approaches

Keith M. Gaskill (kgaskill@enviroforensics.com) (EnviroForensics, Indianapolis, IN, USA)
Doug Davis (DDavis@regenesis.com) (Regenesis, Columbus, OH, USA)

Background/Objectives. Following a source soil removal by excavation, the combined use of in bioaugmented enhanced reductive dechlorination (ERD) and in situ chemical reduction (ISCR) was used to treat dissolved phase chlorinated solvents in groundwater emanating from former dry cleaning operations at a project site in central Indiana. This polytechnology approach has led to very rapid biotransformation of chlorinated solvents with the parent contaminant, tetrachloroethene (PCE), at concentrations exceeding 6,900 ppb having been virtually eliminated within 4 months of application at all impacted well locations.

Approach/Activities. A combination of remedial technologies were applied concurrently during a single mobilization over three weeks using a direct push drilling and injection system into the shallow subsurface. These technologies included: 1) a micellar-suspension electron donor to provide a long-term source (approximately 3 years) of hydrogen; 2) a colloidal dual-valent iron substrate which was mixed directly with the electron donor; and, 3) a bioaugmentation microbial consortium containing an active culture of Dehalococcoides. Approximately 20,033 gallons of these substrates were used to treat a silty sand saturated zone volume of 252,000 ft^3 resulting in an estimated effective pore volume displacement of only 7%. 82 Injection locations were utilized and assigned within 5 zones. Each zone had a calculated volume of each injectant based on the geochemistry and contaminant concentration. The mobile nature of these substrates allowed for sufficient coverage within the target treatment zones to allow for rapid degradation of the chlorinated solvents following the initial pumping displacement.

Results/Lessons Learned. The study has demonstrated that the synergistic effects of ERD and ISCR chlorinated solvent degradation processes allow for a significant increase in degradation rates, and therefore savings in long term monitoring, than if one or the other of these approaches were used on its own. The combination of technologies has also proven to be a cost effective method of remediation with total implementation costs not exceeding $200,000. The study has also demonstrated that a relatively small volume pore displacement is all that is required to achieve these high rates of reduction.