Evaluation of Factors that Influence the Long-Term Success or Failure of Chlorinated Solvent Source Zone Bioremediation

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Background/Objectives. The objective of this project was to assess the long-term effectiveness of past microbial treatment approaches for remediating source areas of chlorinated solvent-contaminated aquifers. Source areas of chlorinated volatile organic compounds (cVOCs) in groundwater create and perpetuate dilute groundwater plumes that subsequently pose risks to downgradient receptors for decades or centuries. Although bioremediation has been applied to treat many contaminant source areas, the long-term success of this approach, factors that differentiate successful from unsuccessful treatment applications, and the ongoing costs of site stewardship, have not been thoroughly assessed.

Approach/Activities. Five different previously treated cVOC sites were evaluated using field measurements of contaminant flux, molecular biological tools (MBTs) to document the existence and abundance of key degradative microorganisms and genes, and compound-specific stable isotope analysis (CSIA) to determine whether cVOC biodegradation was ongoing. In addition, a large database was created using individual well data from 15 different sites in order to evaluate the critical biological, geological, geochemical, and treatment factors impacting remediation success or failure. Various statistical approaches were used to analyze and interpret data including classification and regression tree (CART) analysis.

Results/Lessons Learned. The project findings suggest that source area remediation has the potential for long-term effectiveness, with persistence of key dechlorinating organisms for at least several years after bioaugmentation/biostimulation at some sites, and evidence of continued cVOC degradation based on CSIA and mass flux measurements. Some of the critical factors influencing long-term treatment success include sulfate and methane levels, percent fines in the aquifer matrix, hydraulic conductivity, and initial *Dehalococcoides* abundances, among others. This ESTCP-funded project provides an approach to estimate the effectiveness of past remedial efforts using emerging molecular and analytical tools, and a better understanding of factors critical to the success or failure of long-term site stewardship based on bioremediation.