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ITRC's Bioremediation of Chlorinated Ethenes: DNAPL Source Zones--Fractured Rock Applications

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Background/Objectives. The Interstate Technology & Regulatory Council's (ITRC) Bioremediation of DNAPLs (BioDNAPL) Team developed technical and regulatory guidance to support the use of in situ bioremediation (ISB) as a treatment option for subsurface dense non-aqueous-phase liquids (DNAPLs), particularly those associated with chlorinated ethenes. Chlorinated solvents were once widely used throughout a number of industries, leading to numerous environmental contamination problems. DNAPLs, primarily those containing chlorinated ethenes, pose one of the most widespread and prominent types of contamination associated with Superfund sites. This guidance focuses on chlorinated ethene DNAPL source zones in the saturated subsurface, where the DNAPL acts as a reservoir that sustains a contaminant plume in groundwater.

Approach/Activities. The objective of this guidance is to provide a systematic understanding of the technical and related regulatory considerations for ISB of chlorinated ethene DNAPL source zones. It is based on scientifically sound and credible evidence supporting the safe and cost-effective application of ISB of DNAPL source areas. The guidance provides the reader with information related to site characterization requirements, application and design criteria, process monitoring, and process optimization. While the guidance is not exclusive to fractured rock sites, the principles presented in the guidance can readily be applied to applications of ISB in fractured rock settings.

Results/Lessons Learned. ISB of DNAPL technology has two main components: (1) enhanced dissolution and/or desorption of non-aqueous- and/or sorbed-phase contaminant mass and (2) biological degradation to non-chlorinated, nontoxic end products. The ability of ISB technology to enhance the dissolution and desorption of non-aqueous phase contaminants to the aqueous phase, where they can be degraded by the microbial population, is what makes the ISB technology applicable to DNAPL source zones. This typically results in faster remediation compared to traditional technologies that are limited by the NAPL dissolution rate (i.e., groundwater extraction). When applying ISB in a fractured rock setting, it is critical to understand the distribution of the DNAPL relative to the geology, specifically the fracture network. Diffusion from DNAPL into the matrix can also occur, which can provide another source of contamination that can sustain plumes for decades even when DNAPL is depleted. Additional detailed discussion of the advantages and limitations of enhanced ISB technology is found within the guidance. It is the expectation of the ITRC BioDNAPL Team that this guidance will accelerate technology transfer to and among the states, as well as those charged with site remediation. In addition to the ITRC BioDNAPL guidance document, a new document is under preparation whose topic is characterization and remediation at fractured rock sites. Principles of this document related to ISB will also be presented.