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Bench-Scale Performance of Partitioning Electron Donors for TCE DNAPL Bioremediation

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The Source Area Bioremediation (SABRE) project is an international collaboration whose objective is to evaluate enhanced anaerobic bioremediation for the treatment of chlorinated ethene source areas containing dense, non-aqueous phase liquids (DNAPL). This research effort focuses on a pilot-scale demonstration of enhanced bioremediation at a trichloroethene (TCE) DNAPL field site in the UK, that includes a significant program of laboratory and modeling studies. Given the project's emphasis on enhanced rates of DNAPL removal, the use of water-soluble electron donors that partition into DNAPL (e.g., n-butyl acetate and emulsified soybean oil, SRS) is of particular interest. This presentation discusses column studies designed to scale up results of microcosm studies, provide critical data for the design of the field demonstration, and produce high-quality experimental data suitable for numerical model calibration.

Although n-butyl acetate will be evaluated, SRS is the primary focus of the study because of its superior performance in the microcosm study. One-dimensional columns packed with site soil and flushed with a groundwater media will be used to address three primary research objectives: 1) **Effects of partitioning electron donors on bioenhanced mass transfer** - assess the impact of electron donor type (on the mass removal of DNAPL) under biotic conditions. These studies will also be used to determine if reductive dechlorination is inhibited by the presence of pure phase TCE and if the partitioning electron donors allow the dehalogenating bacteria to inhabit areas close to the DNAPL and increase TCE removal rates. Mass transfer enhancement factors for each electron donor will be determined; 2) **Factors influencing partitioning electron donor transport** - assess the transport properties of SRS and its interaction with TCE DNAPL and soil. Phenomena to be studied include partitioning of aqueous TCE into the emulsion and of emulsion into TCE DNAPL, sorption of electron donor onto soil, and potential for mobilization and redistribution of DNAPL phase. Data generated by this study will be used to develop partitioning electron donor dosing strategies (i.e., frequency, concentration) for the pilot study ; and 3) **Effect of sulfate on dechlorination of aqueous phase TCE** Characterize the ability of the partitioning electron donor to support aqueous TCE dechlorination in the presence and absence of sulfate and document the behavior of pH, sulfate reduction, electron donors, TCE dechlorination and dechlorinated daughter products in a continuous flow system. Data will be used to model behavior of the plume in the downgradient zone where DNAPL is not expected to be present.

The experimental data generated by the column studies will be complemented by a comprehensive numerical multicomponent transport model which incorporates the appropriate reaction pathways and kinetics. Successful model calibration will facilitate design of the pilot study and allow meaningful comparisons of alternative electron donor delivery strategies. Column studies are currently underway.