Evaluation of a Sustainable Cometabolic Biobarrier to Treat Large Dilute Chlorinated VOC Groundwater Plumes

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Background/Objectives. One of the greatest challenges remaining for remediating chlorinated volatile organic compounds (CVOCs) at numerous sites is the treatment and/or control of large dilute plumes. Current approaches to address this challenge are typically long term and have high capital, operation and maintenance costs. Cometabolism is showing significant promise in this area because organisms grow aerobically on a supplied substrate (e.g., propane or methane) rather than the trace contaminant, allowing good degradation kinetics, minimal impacts to aquifer geochemistry, and the ability to achieve part-per-trillion contaminant concentrations. The key objective of this ESTCP-funded project is to demonstrate effective in situ co-metabolic treatment of a large, dilute CVOC plume using an approach that is both environmentally sustainable and cost effective.

Approach/Activities. This project entails cometabolic biosparging using a line of sparge wells installed perpendicular to groundwater flow across the width of a large, dilute CVOC plume downgradient of Building 324 at the former Myrtle Beach Air Force Base in South Carolina. The groundwater plume, with *cis*-DCE and vinyl chloride concentrations in excess of federal MCLs, will be treated as it flows through a biologically active zone (i.e., bio-curtain) created by biosparging oxygen, an alkane gaseous substrate (propane), and a gaseous nutrient (ammonia). The biosparging system, process controls, and system monitoring equipment will be powered by an off-the-grid solar energy system. Oxygen, propane, and ammonia will be stored on site in cylinders, and configured to provide the appropriate delivery pressures and flows.

Results/Lessons Learned. Detailed site characterization activities conducted indicate that the downgradient portion of the plume is approximately 210 feet wide, 34 feet deep, and up to 15 feet thick. Laboratory treatability studies were performed with aquifer materials obtained during site characterization activities. These studies consisted of microcosms to determine the efficacy of oxygen and various alkane/alkene gases (propane, methane, ethene, and natural gas) to stimulate co-metabolic treatment of target CVOCs using indigenous microbial populations, and to determine if nutrient addition would be required/beneficial for this process. Results of these studies indicated that propane is likely to be the most effective cometabolic substrate for this site, and that nutrient addition will be required for effective treatment. Batch kinetic studies were also conducted with enrichment cultures derived from the microcosms to help inform design (particularly, substrate gas sparging frequency and duration) of the biosparging system to maximize treatment efficacy.

The preliminary biosparging system design includes 22 sparge wells screened across three vertical depth intervals. Sparging of the gases will be performed at a single well at a time, to minimize instantaneous flows required. For safety reasons, nitrogen purging will occur between the oxygen and propane/ammonia sparge cycles to prevent mixing of oxygen and the two flammable gases within the biosparging system and the sparge wells. System construction is scheduled to begin in late 2018, with system startup in early 2019. Results of the site characterization and laboratory treatability studies, as well as details of the final system design, system construction and early operational data will be presented.