Application of a Combined Biological, Chemical and Biogeochemical Treatment of a Trichloroethene Plume in Northern California

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Background/Objectives. Chlorinated ethenes (CEs) were detected in groundwater at a confidential site in northern California. Trichloroethene (TCE), cis-1,2-dichloroethene (DCE), and vinyl chloride (VC) were detected at concentrations up of to 6,500 µg/L, 2,800 µg/L and 530 µg/L, respectively. The affected aquifer is adjacent to a sensitive wetland and large estuary system. Groundwater flow rates are relatively high allowing for migration of the CEs which resulted in a CE plume over 2,000 feet long and 500 feet wide. Groundwater remediation was determined to be required to prevent migration of the CEs into the wetlands and the estuary system.

Approach/Activities. ERM designed and implemented a full-scale remediation system to simultaneously prevent continued down-gradient migration of the contaminants and to treat the high concentration portion of the plume. Contaminant migration was controlled by installation of permeable reaction barrier (PRB) on the down-gradient portion of the plume. The PRB was constructed by high-pressure injection of two reductive reagents; EHC® and Geoform® ER (Evonik Corporation). These reagents are injected as a slurry and combine biological and abiotic processes that synergistically degrade CEs. A biogeochemical process also is created that biologically sulfidizes the incorporated zero valent iron in situ thereby increasing the reactivity and longevity of the abiotic processes and extending the reactive zone of the PRB.

The high concentration area treatment was conducted by application of a completely soluble reagent that enhances both biological and biogeochemical treatment processes (Geoform® Soluble; Evonik). These reagents were applied using a groundwater extraction-amendment-injection (GEAI) system consisting of multiple extraction and injection wells located in the plume area. The reagent consists of an emulsified lecithin substrate, nutrients and additional reagents. These reagents enhance biologically mediated reductive dechlorination and simultaneously generate reactive iron-sulfide minerals. These biogenically formed minerals enhance the biological degradation process by creating an abiotic degradation pathway and by maintaining highly reducing conditions required for biologically mediated reductive dechlorination. In addition, the formation of reactive iron-sulfides inhibits the generation of methane. Both treatment areas were bioaugmented with the microbial consortium (SDC-9™; Aptim).

Results/Lessons Learned. The GEAI system was demonstrated to be highly effective for distribution of the biogeochemical reagents in the high-concentration plume. Complete biological reductive dechlorination of the CEs in the plume was confirmed by sequential dechlorination of the CEs and an increase in ethene in the treatment zone. Biogeochemical degradation of the CEs was confirmed by the non-stoichiometric production of daughter products following degradation of the TCE. The effectiveness of the PRB was confirmed by analyses of groundwater in wells placed up- and down-gradient of the PRB. This presentation will describe the biological, chemical and biogeochemical processes that were applied for reductive treatment of the CEs, the methods in which the reagents were applied and the results of post treatment monitoring in both the high-concentration plume and the PRB areas.