Combining Biotic and Abiotic Treatment Processes to Overcome Challenges of a Mixed Chlorinated Solvent Plume

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Background/Objectives. The site is a former chemical manufacturing facility in California. The area associated with this full-scale treatment contains a commingled plume of chlorinated volatile organic compounds (CVOCs) (principally trichloroethene [TCE], carbon tetrachloride [CT), chloroform [CF], and 1,2-dichloroethane [1,2-DCA]) in shallow groundwater across approximately one acre.

Approach/Activities. Due to reported inhibitory effect of the presence of CT and CF on TCE degradation, the initial approach to address these commingled impacts in the shallow groundwater included direct push injection of zero valent iron (ZVI) at 0.18 percent weight per weight (w/w) and emulsified lecithin substrate (ELS) at an aquifer concentration of 1,000 milligrams per liter (mg/L) to stimulate abiotic and biotic dechlorination processes. Bioaugmentation in the form of a *Dehalococcoides (*DHC) containing inoculate was directly added into the injection reagent to ensure a robust dechlorinating microbial population within the impacted zone. Performance monitoring results over the next four months indicated CF and 1,2-DCA concentrations persisted in localized areas. In addition, in situ total organic carbon (TOC) and microbial target species concentrations were significantly lower than mass loading calculations predicted. The recalcitrant areas and low TOC concentrations were attributed to inefficiencies in distribution of the substrates and biological inhibition.

To improve dechlorination results an iterative approach was used to incorporate design changes for the second and third round of injections, which were implemented approximately six months and 12 months, respectively, after the start of the initial round. In addition, the inhibitory effects of CF and CT on TCE degradation performance monitoring results suggested chlorinated methane (CM) degradation was inhibited in the presence of chlorinated ethenes. Therefore, to address inhibitory effects of a commingled chlorinated plume during the second and third round of direct push injections a novel approach of bioaugmenting with both CM (MCD-1) and CE (DHC) degrading cultures was applied. In addition, the second round of injections included ZVI at 0.19 percent w/w in target areas and an ELS target aquifer TOC concentration of 3,000 mg/L. The third round of injections included GeoForm®, a slow release carbon substrate mixed with ferrous sulfate, and ELS at a target aquifer TOC concentration of 5,000 mg/L.

Results/Lessons Learned. Microbial and chemical results collected over the last 16 months indicate in situ biological and chemical treatment reduced concentrations of TCE and CF by on average 91% and 95%, respectively, in groundwater. Biological dechlorination required reducing conditions and sufficient TOC concentrations. Chemical results in two target monitoring wells indicate that 1,2-DCA biodegradation was also inhibited in the presence of a commingled plume of CVOCs when chlorinated ethene concentrations were above 1.0 mg/L. Furthermore, it was noted that TCE degradation is inhibited in the presence of CF at concentrations above 0.8 mg/L. Microbial data suggest CVOC biodegradation was occurring despite low concentrations of DHC, indicating concentrations of *Dehalobacter spp, Dehalobacter DCM,* and *Dehalobium chlorocoercia,* found in bioaugmented inoculate MCD-1, may be driving CVOC biodegradation. This presentation will describe the effectiveness of CM degrading cultures in combination with DHC, TOC, and ZVI in treating a commingled CVOC plume.