In Situ Bioremediation of the Source Zone for Chlorinated Solvents in Groundwater: Successes and Challenges

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Background/Objectives. The purpose of the source zone study was to evaluate the potential for biostimulation and bioaugmentation as an in situ bioremediation approach for chlorinated solvents in groundwater at a site in Southern California. Elevated concentrations of chlorinated volatile organic compounds (cVOCs): tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), and 1,1-dichloroethene are present in groundwater at total concentrations up to 100 milligrams per liter (mg/L). A natural attenuation evaluation indicated that reductive dechlorination was occurring, but at a rate that was not promoting complete reductive dechlorination to ethene. To further the evaluation, bench-scale testing was performed to evaluate the potential effectiveness of various amendments on the biodegradation of cVOCs. The results of the bench-scale study indicated that the combination of the Dehalococcoides consortium with a sodium lactate amendment demonstrated evidence of complete reductive dechlorination of cVOCs. The bench-scale study also indicated that if vinyl chloride (VC) accumulates in groundwater, it would be appropriate to include an EOS® amendment to support the rate of degradation to ethene over a longer time period.

Approach/Activities. A pair of recirculation wells was installed to promote further migration of the injected carbon substrates into groundwater. Following an initial lactate injection via the paired recirculation wells and when aquifer groundwater reached favorable conditions, the Dehalococcoides consortium was injected into groundwater. Several months after the bioaugmentation injection, the total organic carbon (TOC) levels decreased, and the slow release carbon substrate, EOS®, was injected into groundwater using the recirculation wells. A detailed monitoring program, which included an evaluation of physical, chemical, geochemical, and microbiological parameters, was conducted to assess the effectiveness of the in situ bioremediation pilot study over time.

Results/Lessons Learned. This presentation will summarize the field results of the biostimulation via lactate injection, bioaugmentation injection using Dehalococcoides, biostimulation via the injection of EOS®, and the challenges of the distribution of amendments via recirculation in a relatively flat groundwater table. The initial lactate injection led to reducing conditions in groundwater and a significant increase in the TOC. Following the bioaugmentation injection, the Dehalococcoides population increased by three to five orders of magnitude in the pilot-study wells closest to the injection wells, which corresponded to elevated levels of volatile fatty acids in downgradient pilot-study monitoring wells. A decrease in TCE and an increase in cis-1,2-DCE and VC was also observed, and the ethene concentrations increased by several orders of magnitude in groundwater. Greater distribution of the amendments was observed during the biostimulation, as a results of recirculation with larger volumes of chase water, which led to a larger zone of reductive dechlorination. The summary will address how the amendments impacted the chlorinated solvent concentrations, microbial community, and chemistry of the groundwater in the area surrounding the recirculation wells and wells outside the pilot study area and what are the key parameters to monitor to determine the success of the bioremediation system.