Anaerobic and Aerobic Biostimulation and Bioaugmentation of Chlorinated Solvents and 1,4-Dioxane

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Background/Objectives. The purpose of the in situ bioremediation (ISB) systems was to promote either reductive dechlorination of chlorinated ethenes or oxidation of 1,4-dioxane in groundwater via biostimulation in combination with bioaugmentation. The plume contains elevated concentrations of various chlorinated volatile organic compounds (CVOCs): tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), and 1,1-dichloroethene, as well as 1,4-dioxane. For those areas that still contained high levels of PCE and TCE, enhanced reductive dechlorination was promoted via injection of carbon source amendments and a *Dehalococcoides* consortium. However, for those areas which transitioned to cis-1,2-DCE and VC and 1,4-dioxane, aerobic biodegradation of these contaminants was promoted via air sparging and bioaugmentation with *Pseudonocardia dioxanivorans* CB1190 (CB1190).

Approach/Activities. A series of injection wells was used in areas with elevated CVOCs and 1,4-dioxane to distribute the anaerobic and aerobic bioremediation amendments. The anaerobic amendments included quick release carbon substrate and emulsified oil substrate and the *Dehalococcoides* microbial consortium (BAC-9) to promote complete reductive dechlorination of the chlorinated ethenes. The aerobic bioremediation system involved air sparging along with the injection of CB1190, and nutrient medium (e.g., containing nitrogen, phosphorus, potassium and calcium to support growth of CB1190). A monitoring program was developed to evaluate the effectiveness of the treatment system, which included field parameters, CVOCs,1,4-dioxane, key microbial populations and genes, and geochemistry.

Results/Lessons Learned. Within one quarter after injecting the carbon substrates, an increase was observed in the total organic carbon (TOC) in the impacted monitoring wells. The increase in TOC corresponded to a significant decline in competing electron acceptors as well as a significant decrease in concentrations of PCE, TCE and cis-1,2-DCE in wells affected by biostimulation and bioaugmentation.

In the areas where aerobic biostimulation and bioaugmentation using CB1190 was applied, there was a major increase in dissolved oxygen and nutrients along with a significant increase in the CB1190 microbial population. This led to a significant reduction in cis-1,2-DCE, VC and 1,4-dioxane in the groundwater. This presentation will discuss how the distribution of the various amendments significantly impacted the biodegradation of the chlorinated ethenes and 1,4-dioxane in groundwater, and how advanced molecular tools were applied to monitor and evaluate the effectiveness of the biostimulation and bioaugmentation amendments.