Lessons Learned during DNAPL Source Zone Remediation

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Background/Objectives. As a result of a leaking underground storage system at a 17-acre site in Queens, New York, sorbed-phase chlorinated ethane DNAPL sources were discovered within a low permeable silt zone containing interbedded sand stringers. Following bench- and field-scale pilot testing programs, a full-scale bioremediation system was installed. Unfortunately, following system start-up, mobile-phase DNAPL was observed being captured by the treatment system. The presence of this mobile DNAPL was not identified during RI and represented a source far greater than originally anticipated during the remedial selection process. A supplemental RI was completed to delineate the DNAPL-bearing zone. Originally, it was estimated that the bioremediation system would operate for approximately three years, but the system has been operating for the last eight years. The bioremediation system was initially retrofitted with DNAPL knockouts to capture and mobile-phase DNAPL from being re-injected into the subsurface. Once the rate of captured DNAPL became asymptotic, a supplemental co-solvent flushing approach was implemented to address the significant DNAPL mass that remained.

Approach/Activities. To stimulate the indigenous microbial population capable of anaerobic reductive dechlorination processes, the bioremediation system extracts groundwater from a network of 48 extraction wells, amends the water stream with lactate and nutrients, and re-injects the water back into the subsurface via a network of 34 injection wells. The system was designed to treat the area where soil chlorinated VOC concentrations exceeded 500 ppm.

In 2012, during the supplemental co-solvent flushing remediation, a total of 15,000 gallons of 190-proof ethanol was directed into the subsurface and approximately 28,000 gallons of elutriate extracted via a dedicated network injection and extraction wells. As the ethanol concentrations increased in the treatment zone, the ethanol solubilized the DNAPL into solution, which was then pumped from the ground via the extraction wells.

Results/Lessons Learned. Over the course of eight years, the bioremediation system has been reconfigured four times to address changing site conditions, to more aggressively treat recalcitrant areas, or in one instance, to reverse course on a prior reconfiguration. Modeling completed as part of the design phase, depicted lactate distribution in the subsurface to fully occur within nine months; however, many areas still do not contain measureable concentrations of lactate (or its breakdown products). Certain areas have been observed to be highly biologically active, while other areas exhibited no biological activity at all. Through these reconfigurations, significant progress has been made, with the most recent reconfiguration deactivating approximately 50% of the system.

During implementation of the co-solvent flushing program, the complexity of the geology became evident. While some areas exhibited ethanol concentrations nearing 65%, other areas showed no appreciable ethanol increases, including a monitoring well less than two feet from an injection well. This resulted in multiple modifications to the injection/extraction approach to maximize DNAPL recovery. While the co-solvent flushing was deemed a success, based on mobile-phase DNAPL not being seen since, the program potentially would have been more successful if a greater understanding of the complex site geology had been obtained beforehand.