Biological Degradation and Chemical Reduction to Reduce DNAPL and Dissolved COCs to Turn off an Extraction System

Robert E. Mayer, Jr. (robert.mayer@aptim.com) (APTIM, Knoxville, Tennessee, USA)
Paul Bauer, Evan Schlegel, and Kevin Cronin (APTIM, Pittsburgh, Pennsylvania, USA)

Background/Objectives. Groundwater remediation has been conducted at a site near Niagara Falls, New York where volatile organic compounds (VOC) have been detected. The site had been an active research, testing, and manufacturing facility since 1940. A neutralization pond, formerly used for the treatment of waste fluids, was closed in 1987 and the piping was rerouted. Soils at the neutralization pond were excavated to bedrock, however, the presence of DNAPL and dissolved levels of VOCs have been detected in uppermost bedrock strata. The DNAPL plume has extended to near 750 feet downgradient of the pond and the dissolved phase VOC plume extends approximately 4,000 feet downgradient. The primary contaminants of concern (COCs) observed in groundwater are trichloroethene (TCE), methylene chloride, cis-1,2-dichloroethene (DCE), and vinyl chloride (VC). The original groundwater remedy included two groundwater recovery systems, one on-site and one off-site to address dissolved VOC impacts. A bioremediation pilot study began in 2017 and two supplemental injections have also been conducted to prevent the onsite recovery system from being restarted.

Approach/Activities. The groundwater treatment pilot study began in December 2017, using the carbon source 3D Microemulsion (3DMe®), the ferrous iron chemical reducing solution (CRS®), and the bioaugmentation culture SDC-9™. This study determined that this approach could reduce site contaminant concentrations and provided injection data for supplemental injections. In October 2019, a more robust bioremediation and chemical reduction treatment was conducted in a focused area where the highest concentrations of CVOCs have been detected. During this supplemental injection, CRS®, sulfonated micro scale ZVI (S-MicroZVI), 3DME®, and SDC-9™ were injected into the groundwater. This injection further reduced contaminate mass and VOC concentrations farther downgradient. In November 2021, a second focused injection was conducted where DNAPL levels were observed, using S-MicroZVI to abiotically reduce concentrations near the former neutralization pond. In the areas of lower contaminant concentrations, 3DME® and the two microbial cultures SDC-9™ and MDB-1™ were injected into the groundwater to degrade VOCs and methylene chloride.

Results/Lessons Learned. At an injection well located in the center of the former neutralization pond, TCE concentrations have decreased from 5,400 µg/L to 20 µg/L during the most recent sampling event. At a well located within the influence of the injections, TCE has decreased from 18,000 µg/L to 460 J µg/L in March 2022, the lowest level observed at this well. At this well cis-1,2-DCE has remained stable, however VC and ethene have increased, indicating that complete degradation is occurring. COCs have also decreased to below the groundwater standards at wells closer to the leading edge of the plume, for the first time. These reductions have allowed the on-site extraction system to remain shut down and prevented the treatment of approximately 9 million gallons of groundwater. Additional sampling will be used to evaluate the effectiveness of the bioremediation and chemical reduction treatment of groundwater contaminants and the possibility of a formal shutdown of the on-site groundwater extraction system.