Methanotrophic Cometabolic Enhanced Natural Attenuation at a Confidential Southeastern Pennsylvania TCE Superfund Site

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Background/Objectives. The Baker | O'Brien & Gere Remediation Solutions Joint Venture (BAKER | OBG) is evaluating enhanced natural attenuation (ENA) for a trichloroethene (TCE) National Priorities List Site, located in southeastern Pennsylvania, which is regulated under CERCLA. TCE was discovered in the Site groundwater in 1985 and a pump and treat (P&T) groundwater remediation system was started up in 1995. The P&T system was shut down in 2009 to evaluate TCE rebound. In 2014, an attempt to change the remedy from P&T directly to monitored natural attenuation (MNA) was not successful, and ENA came under consideration to address the remaining TCE plume. Maximum TCE concentrations are now typically below 20 µg/L. In 2015, an explanation of significant difference (ESD) was issued for the Site which initiated the permanent shut down of the groundwater P&T system. BAKER | OBG was contracted in 2015 by the client to take over site management and move the project toward closure. The path to MNA began in March 2016 with a laboratory treatability study to understand the natural cometabolic TCE degradation process occurring at the Site, evaluate cometabolic biodegradation testing procedures, and develop an ENA conceptual design. Baseline geochemistry sampling data and microcosm study data confirmed that indigenous methanotrophic bacteria (MOB) capable of degrading TCE are naturally present at the site. The treatability testing results and geochemistry data were used to design a field pilot test.

Approach/Activities. The ENA pilot test included a focused low concentration methane and nutrient injection process designed to temporarily increase the available methane cometabolic substrate and stimulate the ongoing cometabolic degradation of TCE. Methane was selected as the cometabolite because of the natural MOB present at the Site. The amendment dilution water was extracted from existing onsite wells which exhibited the highest populations of the MOB and the soluble methane monooxygenase (sMMO) enzyme. Nutrients and sodium bicarbonate were added to the extracted groundwater via batch mix tanks, and the solution was then pumped through a methane infuser to the injection wells. Due to a history of vandalism at the Site, a remediation system trailer containing all required equipment was designed and built so that it could be brought to the Site each day and removed from the Site at the end of each day.

Injections were initiated in December 2017 and proceeded for 15 days through January 2018, with intermittent injection pauses due to holidays and extreme cold weather. System optimization was performed based on a continuous review of injection performance data and included the installation of two additional methane infusers and increased amendment dosages. The second 15-day injection period began in February and concluded on March. Injection process monitoring was conducted throughout the injection effort and post-injection groundwater performance monitoring was conducted in April, May, and June, along with a comprehensive groundwater and surface water monitoring event at the end of June 2018.

Results/Lessons Learned. The population of naturally occurring MOB increased from 2.1 to 553 cells/mL before the injection to as high as 297,000 cells/mL during the injection. Dissolved methane concentrations increased from non-detect (<1.5 µg/L) before the injection to as high as 430 µg/L during the pilot test. TCE concentrations decreased by approximately 20% during the 30-day test and then rebounded following the test. This presentation will summarize the

treatability testing, ENA system design and implementation, and post injection performance monitoring data (including field parameters, VOCs, methane, carbon dioxide, total MOB and sMMO). The presentation will also include the next steps for the Site, and the challenges, lessons learned, and solutions developed while implementing a fully mobile methanotrophic cometabolic injection system capable of complete mobilization and demobilization of the system every day in order to overcome the significant and frequent vandalism that occurs at the Site.