In Situ Remediation of a Fractured Sedimentary Bedrock Groundwater and Overburden Impacted with TCE through Organic Carbon and Soluble Iron Injections: Pilot-Scale and Full-Scale Results

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Background/Objectives. The Site is underlain by bedrock consisting of the Passaic Formation of the Brunswick Group, which forms a steeply sloping bedrock ridge along the western edge of the Site. The Site operated as a sheet-fed printing business from 1969 to 1988. The operations consisted of photographing original artwork, transferring to an aluminum printing plate, and then attaching to a printing press which used ink and an alcohol/water mixture to transfer the plate image onto paper. Industrial wastewater was discharged into two wastewater removal systems located on the Site. Because of these operations, the overburden and shallow bedrock at the Site are impacted with trichloroethene (TCE). Bedrock underlying the Site is strictly sedimentary comprising of interbedded siltstone and sandstone. A pilot test was conducted in August 2012 to evaluate the enhanced in situ anaerobic biodegradation of TCE in the overburden and shallow bedrock. Based on the results observed at the pilot-scale, a full-scale remedy consisting of enhanced in-situ biotreatment is currently being implemented at the Site.

Approach/Activities. An in situ pilot test was conducted through the injection of electron donor 3-D Microemulsion™ (3DMe™) to enhance the reductive dechlorination of TCE. The electron donor was added through the injection points as two rows spaced at 15 feet, each row consisting of five points spaced at about 10 feet apart. Three injection points were constructed as wells and were used to inject into the shallow bedrock while seven injection points were installed using a direct-push drive for injection into the overburden. The injection wells are approximately 40 feet below ground surface (bgs) and screened from 20 to 40 feet interval. For the overburden injection, a direct-push rig was used to inject to a depth from 2 to 10 feet bgs. Approximately 120 pounds (lb) of 3DMe™ was delivered at each injection point along with a bromide tracer. Full-scale in situ treatment is in progress with EHC-Liquid® mixture (EHC-L) serving as an electron donor. Approximately 5,200 lb of the 25 percent strength EHC-L are designed for injections into the overburden distributed through 10 direct push points, while about 4,700 lb are designed for injections into the shallow bedrock distributed through the eight injection wells. *Dehalococcoides* sp. will be delivered along with the EHC-L.

Results/Lessons Learned. The 3DMe™ injections enhanced the native dechlorination activity in the shallow bedrock and overburden groundwater. This is based on the decline of TCE and the steady increase in the concentration of TCE daughter products, cis-1,2-dichloroethene (cis-1,2-DCE) and vinyl chloride (VC). The average molar ratio of (cis-1,2-DCE+VC) to TCE was approximately 20 times greater relative to the baseline pre-injection data, supporting the selection of in situ treatment as a viable option for the remedy. Further indications of contaminant degradation are suggested by the detections of ethene and ethane in majority of monitoring wells in bedrock and overburden, implying that TCE was being sequentially dechlorinated to innocuous byproduct, ethene. Further, reductive dechlorination was supported by groundwater geochemical shifts: microbial respiratory byproducts formation such as increase in concentration of dissolved manganese, production of dissolved methane and a decline in sulfate concentration. These results along with the full-scale treatment results, designed based on the pilot test, will be presented.