DOD Treatability Study Documents Successful Carbon Tetrachloride Remediation using HRC®

CASE SUMMARY
Air Force Base, Maryland

Historic operations at a Department of Defense site in Maryland produced soil and groundwater contamination. The principle contaminants included carbon tetrachloride, benzene and chloroform at concentrations of 274 parts per billion (ppb), 178 ppb, and 21 ppb, respectively. Historical monitoring at the site revealed decreasing trends in contaminant concentrations as a result of natural attenuation via anaerobic bioremediation. However, the site was on a re-development schedule and monitored natural attenuation was deemed to be too slow and costly. The Air Force, in conjunction with the Comprehensive Environmental Response, Compensation, and Liability (CERCLA) Partnering Team, agreed to perform a treatability study to observe the effectiveness of using enhanced or accelerated anaerobic bioremediation to reduce the contaminants. A focus was placed on the biodegradation of carbon tetrachloride due to its highly recalcitrant nature; if it could be treated so could the other constituents, such as benzene.1

1In the presence of certain microbes, Dechloromonas strain RCB and strain JJ, benzene can be degraded anaerobically (Author. “Anaerobic Benzene Oxidation Coupled to Nitrile Reduction in Pure Culture by Two Strains of Dechloromonas.” Nature June 28, 2001: 1039-1043.)

REMEDIAITION APPROACH

The remediation objective was to show effective enhanced natural attenuation and anaerobically reduce concentrations of carbon tetrachloride and benzene. Although benzene is commonly degraded aerobically, the destruction of the contaminant has occurred under anaerobic conditions. A mixture of HRC® and HRC Primer®, a less viscous version of HRC, was applied to overcome potentially high oxidation-reduction potential conditions in groundwater and enhance the process of reductive dechlorination. Direct-push injections were applied within the treatment areas as seen in Figure 1. Groundwater monitoring was conducted in and around the treatment areas to evaluate the distribution and treatment effectiveness of HRC.

Subsurface Details
- Soil Type: Sand and Gravel
- Depth to Groundwater: 5-12 feet
- Treatment Area #1: 28,125 ft²
- Treatment Area #2: 5,625 ft²
- Treatment Thickness: 15-18 feet

Application Details
- Application Type: Two Grid Injections
- Injection Spacing: 12.5 feet
- Application Rate:
  - HRC: 3 lbs/ft
  - HRC Primer: 2 lbs/ft
- Quantity Applied:
  - HRC: 6,570 lbs
  - HRC Primer: 4,410 lbs
- Product Cost: $50,560

Figure 1. Carbon Tetrachloride Isoconcentration and Well Location Map
RESULTS

**Carbon Tetrachloride**
Sampling results three months after the HRC/HRC Primer injection revealed carbon tetrachloride reductions from 87% - 99% within the treatment areas. Downgradient wells MW-403 and MW-304 were also affected by HRC with carbon tetrachloride concentrations declining below the MCL of 5 ppb. Continued reduction was observed over the following year and the treatment resulted in concentrations below the cleanup goal in 5 of the 6 HRC affected wells.

Concentrations of carbon tetrachloride upgradient of the HRC injection areas were observed in well MW-8805 (Graph 1). A continuous increase was observed as concentrations rose from 11 to 150 ppb. It can be assumed that the influx observed in MW-8805 also occurred at nearby wells within the treatment areas. No increase in contamination occurred within the HRC treated wells indicating the effective treatment of resident and influx carbon tetrachloride.

**Benzene**
Baseline benzene concentrations exceeded 150 ppb. A reducing trend was established shortly after the HRC/HRC Primer injection and concentrations declined over the following 18 months. A benzene reduction of 56% - 98% was observed and concentrations are expected to reach the cleanup goal of 5 ppb as HRC continues to be effective in the subsurface.

**Chloroform**
Initial chloroform concentrations were above 20 ppb. Six months post-HRC application, 3 out of the 6 HRC treated wells sampled below the MCL of 0.15 ppb. Within 12 months, the cleanup goal was reached in all wells except MW-403 (2.3 ppb).

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