DOD Treatability Study Documents Successful Carbon Tetrachloride Remediation using HRC®

Contaminant Concentrations Reduced by 99% Within One Year

Project Highlights

- Treatability study demonstrated effective reduction of carbon tetrachloride and benzene contamination
- Combined application of HRC® and HRC Primer® reduced carbon tetrachloride concentrations to below cleanup goal within one year
- Influx of additional carbon tetrachloride contamination to the site was buffered by enhanced anaerobic bioremediation

Project Summary

Historic operations at a Department of Defense site in Maryland resulted in soil and groundwater contamination with carbon tetrachloride, benzene, and chloroform at concentrations of 274 µg/L, 178 µg/L, and 21 µg/L, respectively. Monitoring at the site revealed decreasing trends in contaminant concentrations as a result of natural attenuation. However, the site was on a redevelopment 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 enhanced 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. Although benzene is commonly degraded under aerobic conditions, the destruction of the contaminant has also been known to occur under anaerobic conditions.[1]

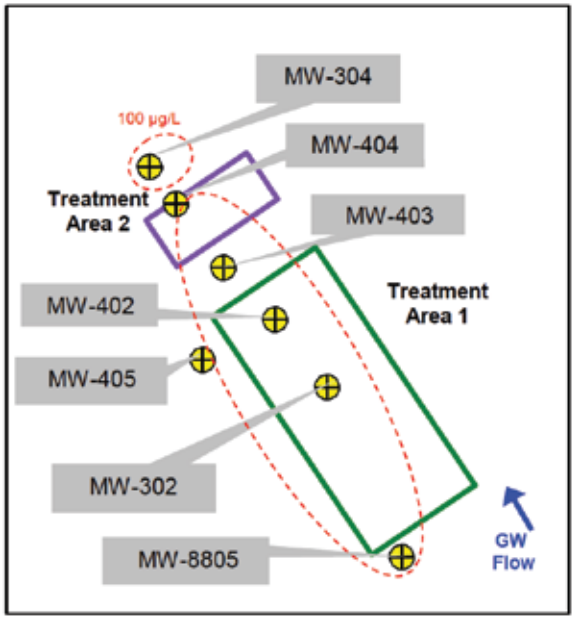
A mixture of HRC and HRC Primer was applied to the contaminated site to establish optimal reducing conditions in groundwater and thereby enhance the process of reductive dechlorination. Direct-push injections were applied in a grid pattern within the two treatment areas shown in Figure 1. Groundwater monitoring was conducted in and around the treatment areas to evaluate the distribution and treatment effectiveness of HRC.

Technology Description

HRC is an engineered, hydrogen release compound designed specifically for enhanced, *in situ* anaerobic bioremediation of chlorinated compounds in groundwater or highly saturated soils.

HRC Primer is derivative of the standard Hydrogen Release Compound (HRC) product and is designed to provide a controlled but fast release of hydrogen to assist in initiating anaerobic biodegradation.

Figure 1. Carbon Tetrachloride Isoconcentration and Well Location Map



Site Details

Site Type: Air Force Base

Contaminant of Concern: Carbon tetrachloride, Chloroform, Benzene

Concentration:
Carbon tetrachloride-274 µg/L
Chloroform-178 µg/L
Benzene-21 µg/L

Remediation Approach: Enhanced Anaerobic Bioremediation

Soil Type: Sand and Gravel

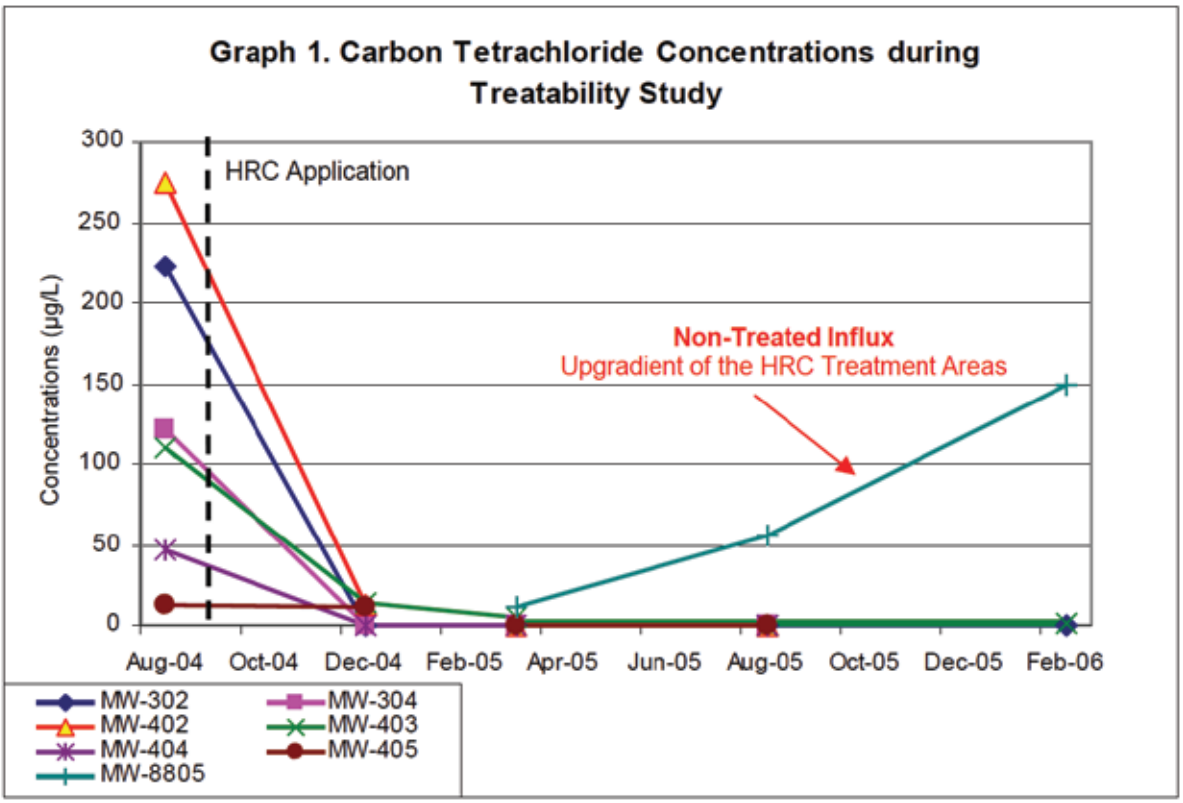
Technology Used: HRC HYDROGEN RELEASE COMPOUND

[1] In the presence of certain microbes, Dechloromonas strain RCB and strain JJ, Benzene can be degraded anaerobically (Coates, J. D., Chakraborty, R., Lack, J. G., O'Connor, S. M., Cole, K. A., Bender, K. S., Achenback, L. A. "Anaerobic Benzene Oxidation Coupled to Nitrate Reduction in Pure Culture by Two Strains of Dechloromonas." Nature June 28, 2001: 1039-1043.)

Results

Carbon Tetrachloride Reduced up to 99% After 3 Months

Sampling results three months after the HRC/HRC Primer injection revealed carbon tetrachloride reductions of 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 maximum contaminant level (MCL) of 5 µg/L. Continued reductions in the HRC-affected wells were observed over the following year, with levels dropping below the cleanup goal in 5 of the 6 wells. (Graph 1).



During the same sampling period, a continuous increase in the concentration of carbon tetrachloride was observed in well MW-8805 upgradient of the treatment areas. This increase is indicative of an influx of additional contamination to the area, which is assumed to have also occurred within the nearby treatment areas. Importantly, the contaminant levels within the HRC-affected wells remained below 5 µg/L during this period, indicating the effective treatment of both resident and influx carbon tetrachloride.

Benzene Concentrations Declined Up To 98%

Baseline benzene concentrations exceeded 150 µg/L prior to the treatability study. Reducing conditions were established shortly after the HRC/HRC Primer injection, and concentrations declined 56% - 98% over the following 18 months. Concentrations are expected to reach the cleanup goal of 5 µg/L as HRC continues to be effective in the subsurface.

Chloroform Concentrations Reduced to Cleanup Standards

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

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