Remedial Action Using HRC under a State Dry Cleaning Program

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Abstract: Hydrogen Release Compound (HRC™) was introduced into the subsurface at a former dry cleaning site in April 2000 under the Florida Department of Environmental Protection (FDEP) Dry Cleaning Solvent Cleanup Program (DCSP). The site, located in Jacksonville, Duval County, Florida, has three distinct aquifer zones, all of which are impacted by tetrachloroethene (PCE) and its degradation components at levels well above regulatory cleanup criteria. Tetrachloroethene is used in the dry cleaning industry as a degreaser and waterless cleanser for garments. Its use has resulted in its accidental release into groundwater systems by improper disposal practices. The FDEP Dry Cleaning Solvent Cleanup Program provides a fund administered by the Department for the assessment and cleanup of dry cleaning sites. The source for the cleanup fund is a tax on dry cleaning solvents, both PCE and petroleum-based solvents.

Because of the expense and long-term operation and maintenance associated with *ex situ* groundwater treatment systems, *in situ* remedies were explored to remediate the approximate 16,000 square foot contaminant plume. Hydrogen Release Compound was selected because it is a low-cost, passive, effective technology for optimizing degradation rates of chlorinated hydrocarbons dissolved in groundwater.

Since completion of HRC injection in June 2000, quarterly monitoring has been conducted at the site. The data show that the reductive dechlorination process is occurring within the aquifer at a much more rapid pace than would occur under natural, non-induced conditions. As total dichloroethene (DCE) and vinyl chloride (VC) continue to accumulate as a result of the anaerobic degradation process, future actions may warrant implementing some type of aerobic bioremediation process.

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The former dry cleaner in this study occupied the north end of a shopping plaza in south central Jacksonville, Florida and was in operation from 1956 to 1995. There are no other dry cleaning facilities in the site vicinity. Two aquifer systems of interest underlie the site area; the Floridan aquifer system, which is the primary source of potable water in Duval County; and the surficial aquifer system that includes a shallow-rock aquifer that is an important secondary source of potable groundwater in some areas. Shallow groundwater occurs in a zone of sand grading to a clayey sand in the upper 30 feet of the surficial aquifer. Groundwater occurs at a depth of one to six feet below land surface (bls) depending upon rainfall. The groundwater flow direction in the surficial aquifer zone is to the east-southeast. A surficial aquifer hydraulic conductivity of 0.31 feet per day in the shallow zone and 0.23 feet per day in the deeper zone was calculated from rising head slug tests performed in July 1997 using five monitoring wells.

Hydrogen Release Compound is a proprietary, environmentally safe, food quality, polylactate ester specially formulated for slow release of lactic acid upon hydration. It is a semi-solid material that remains in place and generates highly diffusible hydrogen slowly over time. The continuous hydrogen source provided by the HRC can reduce dissolved phase chlorinated hydrocarbons by greatly enhancing the reductive dechlorination process.

The application of HRC was designed to treat an area encompassing approximately 17,000 square feet to a vertical depth of 25 to 30 feet. Dissolved chlorinated hydrocarbon contamination does not extend beyond a depth of 30 feet bls because of a thick clay layer present at that depth. HRC was injected across a total of 192 points through 2-inch outer-diameter pipe rods using Geoprobe direct push technology. Sixteen injections were completed to 30-feet bls, and 159 to 25-feet bls. Five pounds of HRC were injected per foot of vertical saturated zone. A total of 22,000 pounds of HRC was used overall. The remediation effort took approximately 25 days to complete.

Site monitoring began one month following HRC injection. The site has a total of 30 monitoring wells that tap three distinct intervals of the surficial aquifer, upgradient, downgradient, and within the contaminant plume. Eleven monitoring wells monitor the shallow zone of the aquifer (10 to 12 feet bls); ten wells monitor the intermediate zone (20 to 22 feet bls); and nine wells monitor the deep zone (30 to 32 feet bls). The dissolved-phase chlorinated hydrocarbon contamination is concentrated in the intermediate zone of the aquifer, where total hydrocarbon concentrations prior to HRC injection were greater than 40,000 ug/l.

Approximately seven months since injections with HRC, dissolved-phase chlorinated hydrocarbon concentrations are significantly lower. Vinyl chloride is the main contaminant of concern remaining in the shallow aquifer zone. Only one shallow monitoring well still shows levels of DCE above cleanup standards, and just six wells have detectable levels of VC above regulatory standards.

Hydrocarbon contamination in the intermediate zone of the aquifer remains high, though concentrations have noticeably decreased since the remedial action was undertaken. Like the shallow aquifer zone, the deep zone is free of both PCE and TCE, and VC is present in just four monitoring wells at levels above regulatory standards. Table 1 presents a degradation summary of the baseline data and the site data to present.

Table 1: Chlorinated hydrocarbon degradation summary

Aquifer Zone	*# Wells Detected*		*Contaminant of Concern*	*Detection Range (ug/l)*	
	Baseline 4/00	*2/01*		*Baseline 4/00*	*2/01*
Shallow	1	0	PCE	935	0
Intermediate	4	1	PCE	18 - 635	595
Deep	1	0	PCE	470	0
Shallow	3	0	TCE	13 - 1,510	0
Intermediate	6	4	TCE	43 - 12,700	14 - 1,340
Deep	1	0	TCE	755	0
Shallow	3	1	DCE	265 - 10,855	280
Intermediate	6	6	DCE	275 - 24,650	260 - 23,070
Deep	3	0	DCE	74 - 781	0
Shallow	6	6	VC	5 - 6,900	3 - 415
Intermediate	9	8	VC	19 - 6,770	120 - 8,730
Deep	4	4	VC	23 - 150	6 - 310

Monitoring of the remedial progress will continue until concentrations of PCE, TCE and DCE are below the primary regulatory standards of 3 ug/l and 70 ug/l respectively. Degradation of the VC to the primary regulatory standard of 1 ug/l may require implementation of an aerobic bioremediation process to replenish the aquifer with oxygen. Aerobic degradation of VC has been reported to proceed up to 10 times as quickly as anaerobic reductive dechlorination. Aerobic technologies presently being considered include oxygen release compound (ORC) and nutrient enhanced biosparging.

References

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