Advanced Electron Donor and High Volume Application for Treatment of TCE and DCE in an Atlantic Coastal Plain Aquifer

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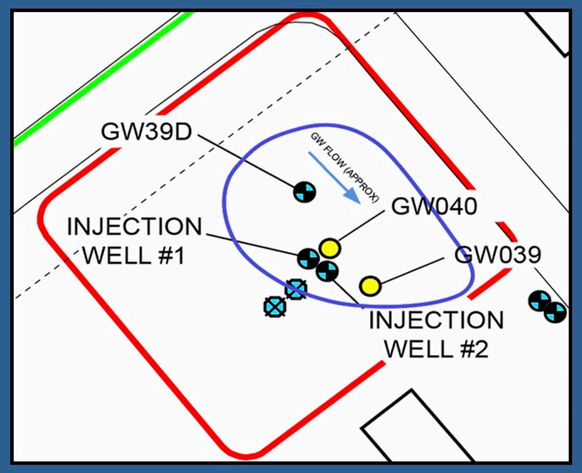

Figure 1. Site Map with Injection Well Locations

Background

Solid Waste Management Unit (SWMU) 166 is located at the Charleston Naval Complex Annex in Charleston, South Carolina. The area includes a former automotive service rack which resulted as a source for groundwater contamination. Based on various site investigations, a chlorinated solvent plume consisting primarily of trichloroethene (TCE) was found beneath the site extending 800 feet downgradient. Concentrations had reached 80 milligrams per liter (mg/L) TCE and 59 mg/L cis-1,2-dichloroethene (DCE) within the silty-sand matrix. In order to expedite overall site cleanup, source excavation activities were performed. Chemical oxidation and colloidal zero valent iron were performed at the source but failed to reduce concentrations of TCE. The potential presence of dense non-aqueous phase liquid (DNAPL) was observed following the remedial efforts. In order to provide further treatment of the plume, including the source area, the Base Cleanup Team evaluated the effectiveness of using in-situ biodegradation with the application of 3-D Microemulsion™.

In-Situ Enhanced Anaerobic Bioremediation

In May 2006, the application of 3-D Microemulsion™ was performed using 2 injection wells installed 10 feet apart (Figure 1). To observe contaminant reduction, 2 monitoring wells, GW040 and GW039, were sampled over the next 8 months. Well GW040 is located 10 feet downgradient of the injection wells in the immediate vicinity of the suspected DNAPL area. Well GW039, installed 2 months after the injection, is located 20 feet downgradient of the injection wells.

Figure 2. 3-D Microemulsion™ Concentrate

Figure 3. 3-D Microemulsion™ Application

In May, a total of 1,500 pounds 3-D Microemulsion™ concentrate was mixed with water at a ratio of 12:1 (water:3-D Microemulsion™) to create a microemulsion material. The microemulsion was mixed in batches and circulated through a centrifugal pump for approximately 10 minutes until a consistent, milky microemulsion was created. A total of 960 gallons of the microemulsion material was injected into GW040 and 911 gallons were injected into GW039 at a rate of 5-10 gallons per minute.

3-D Microemulsion™ Performance

Elevated total organic carbon (TOC) and metabolic acids generally have demonstrated increasing trends since the 3-D Microemulsion™ application. Subsurface distribution and transport have been indicated by elevated TOC and metabolic acids in downgradient well GW039 beginning approximately 6 months after the injection.

Within 30 days, reducing conditions at GW040 decreased rapidly as the oxidation reduction potential (ORP) reached -300 mV. ORP continued to decline and reached a low of -362 mV 9 months after injection. At GW039, ORP decreased to -300 mV within 6 months and has remained low. Sulfate-reducing conditions were achieved less than 2.5 months after the application and persisted at 8.5 months post-injection.

Concentration trends for TCE and DCE in GW040 have remained relatively flat (Table 1), indicating that source contamination loading into the aqueous phase by desorption and/or NAPL dissolution has been accelerated by the enhanced anaerobic conditions. During this time, ethene/ethane concentrations in GW040 have increased by more than 140 times from 0.158 mg/L at baseline to 2.50 mg/L at the 10-month sampling interval. In downgradient well GW039, TCE concentrations have decreased 83%, DCE has shown a characteristic increase/decrease pattern, and VC has been detected at 216 ug/L approximately 8.5 months after the 3-D Microemulsion™ application.

Table 1. Chlorinated Solvent Concentrations in GW040 (ug/L)

	April '06	July '06	Oct '06	Jan '07	Mar '07
TCE	28,200	25,000	31,000	29,600	NS
DCE	56,500	67,400	76,200	56,700	NS
VC	ND	ND	ND	14	NS
Ethene/Ethane	158	Not measured	568	292	2495

Table 2. Chlorinated Solvent Concentrations in GW039 (ug/L)

	July '06	Aug '06	Oct '06	Jan '07
TCE	Installed	271	109	47
DCE		300	1,020	317
VC		5	20	216
Ethene/Ethane		ND	ND	ND

Enhanced reductive dechlorination is expected to continue near GW040 and downgradient well GW039 over the next 2 sampling events. It is likely that TCE and cis-DCE concentrations will decline while VC and ethene/ethane levels increase.

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