DNAPL REMEDIATION

At the Silresim Superfund Site

Client: US Army Corps of Engineers

Lowell, Massachusetts

October, 2002

Current Environmental Solutions (CES) was contracted under a prime contract with the US Army Corps of Engineers to perform a electrical resistance heating (ERH) remedy using Six Phase Heating (SPH) at the Silresim Superfund Site in Lowell, MA.

SITE

The site was located in an industrial area of Lowell, MA, and it covered an area of approximately 4.5 acres. The site and surrounding areas were used by industry since the early 1900's. First it was an oil and fuel storage depot, and from 1971 through 1977, it was the location of a chemical waste reclamation facility. The responsible party filed for bankruptcy in late 1977 and abandoned the facility, leaving approximately one million gallons of hazardous materials on site.

In 1982, the site was declared a Superfund Site and added to the National Priorities List (NPL). In 1995, a groundwater treatment system was installed to mitigate offsite migration of contaminants. In 1997, a soil vapor extraction (SVE) was installed over a portion of the site. The SVE system was able to remove 12 tons of contamination in two years; however, it was determined that SVE alone could not achieve the site remediation goals within an acceptable time frame. An evaluation of SVE enhancement technologies was performed and ERH/ SPH was selected as a viable option.

The subsurface geology consisted of multiple stratified units within the treatment zone which extended from ground surface to approximately 40 ft. below grade (bg). Fill and layers of fine sand existed from grade to approximately 10 ft. bgs. Below this, to 30 ft. bg, there was a clayey-silt layer, and beneath the clayey silt there was a layer of silty-fine sand.

The subsurface soil and groundwater at the site was impacted with volatile organic compounds (VOCs), such as Trichloroethene (TCE), 1,1,1- Trichloroethane (TCA), and other chlorinated aliphatic and aromatic compounds. In the SPH treatment zone, the highest levels of subsurface contamination existed at approximately 8 ft. bgs. Dense non-aqueous phase liquid (DNAPL) was detected in the treatment area and in surrounding areas. The SPH system was be used to remove VOCs through direct vaporization, in situ steam stripping and thermally enhanced biodegradation.

The main goal of the SPH pilot study was to lower the VOCs levels by greater than 99% from pretest levels. Another important goal was to maintain effective subsurface vapor capture and treatment with the SVE system.

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APPLICATION

The treatment system consisted of six electrodes in a hexagonal array with a seventh neutral electrode at the center. Three devices were installed in the treatment area to ensure the recovery of vapors and steam: horizontal wells, slotted deep electrodes screened from 10 to 40 ft. bg, and slotted shallow electrodes screened from 3-10 ft. bgs. The installation was not paved, so it was covered with an impermeable site cap as an additional safety measure to prevent fugitive emissions.

The shallow electrodes were be independently energized to heat the vadose zone which will result in increased permeability for the SVE system. Once the vadose zone was heated to boiling, the deep electrodes were be energized and operated in parallel with the shallow electrodes for the remainder of the treatment operation. After approximately one month of operation, the shallow vadose zone permeability was dramatically improved for SVE, and the 30 ft. bgs temperature was near 100 C. With shallow and deep electrode arrays operated simultaneously, the total power level was increased to 260 kW, with about 90% of the power directed into the saturated zone. The entire interval from 5 to 35 ft bgs were at boiling temperatures within 35 days of operations.

DNAPL within the treatment zone was be removed via direct vaporization during the first 40 days of operation. Further boiling induced steam stripping and thermal biodegradation of the remaining dissolved phase contaminants. Based on modeling calculations, CES anticipated that the remediation objectives will be achieved in roughly 70 days, or about 35 days following the achievement of boiling conditions throughout all of the vadose zone and most of the saturated zone. This prediction was confirmed in the field operations.

RESULTS

Operations commenced October 11, 2002 with power focused on the shallow electrodes. By October 25th, all systems were operating as designed, and almost 31,000 kW-hr were input to the subsurface The target power rate for the shallow electrode operation was 90 kW and the system was operating at 92 kW. The average subsurface temperature in the treatment zone reached 60 C by the end of October 2002, and the temperature in the shallow electrode area is raising at a rate of approximately 2 C per day. Final sampling by TT-FW and the USACE confirmed a 99% reduction in soil and groundwater concentrations.

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