



CURRENT ENVIRONMENTAL SOLUTIONS

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Six-Phase Heating™ DNAPL Remediation at SILRESIM Superfund Site

Client: USACE/EPA

Location: Lowell, Massachusetts

Duration: August - January, 2002

Supervising Engineer: William Heath

Project Mgr: Chris Thomas

Field Super: Rick Somosky

SITE

Current Environmental Solutions (CES™) was subcontracted by Tetra Tech-FW (TT-FW) to implement a Six Phase Heating (SPH) pilot study at the Silresim Superfund site in Lowell, MA under the auspices of the U.S. Army Corps of Engineers (USACE) and US Environmental Protection Agency (EPA). The subcontract was executed in July 2002, and actual site work took place between August 2002 and January 2003.

The subsurface soil and groundwater have been impacted by a variety of volatile and semi-volatile compounds, predominantly TCE, TCA and other chlorinated aliphatic and aromatic compounds. Both LNAPL and DNAPL were detected in the pilot area and in other areas surrounding the pilot site. The DNAPL compounds consisted of a wide variety of VOCs, SVOCs and PAHs. The LNAPL compounds consisted of aromatic compounds including BTEX and styrene. The contamination is a result of heavy industrial use since the 1900's, but the most significant cause of the contamination was due to operations of the Silresim Company solvent waste recovery facility that operated from 1971 through 1977. The Silresim Company declared bankruptcy in 1977 and abandoned approximately one million gallons of hazardous materials on site.

The pilot test area was located in an area known to have high levels of VOC contamination in soil and groundwater. The area of the one array pilot study was approximately 850 ft². The depth of treatment extended to 40 ft. bg. The subsurface consisted of silty sand from grade to 10 ft. bg. followed by a varved silty clay unit that extended to 40 ft. bg. Groundwater was found at 6 ft bg.



Silresim Site Layout

OBJECTIVE

The objectives of the study were to prove the efficacy of the SPH technology as a remedial alternative for mass removal of subsurface contaminants and to significantly reduce soil and groundwater concentrations in the heterogeneous low-permeability soils. Moreover, there specific challenges due the large mass-in-place, variety of contaminants, and buried metal objects. Before the project, the TT-FW Project Manager commented “If [Six-Phase Heating™] works on this site, it should pretty much work anywhere!”

TECHNOLOGY

SPH has emerged as the leading in-situ treatment technology for soil and groundwater remediation, especially in more difficult site conditions involving heterogeneous and low-permeability soils. It has proven to be an efficient, effective and rapid means of remediating soil contaminated with VOCs and SVOCs. The technique uses conventional polyphase electricity to resistively heat the soil and groundwater to the boiling point of water. This increases the volatility of contaminants thereby improving the efficiency of SVE. The heat also initiates VOC degradation through various pathways. Once steam is generated in situ, it acts as a carrier gas which strips out contaminants from the soil or groundwater. The steam is collected from the subsurface by an SVE process, and the contaminants are treated aboveground by conventional means such as activated carbon or catalytic oxidization.

APPLICATION

The ERH system was designed to heat and decontaminate soil and groundwater within the 850 ft² area from grade to 40 ft. bg., corresponding to a total treatment volume of soil and groundwater of approximately 1,250 yd³. The subsurface installation included 7 deep and 7 shallow vented electrodes, 4 horizontal vacuum extraction (HVE) wells, 4 thermocouple monitoring wells, and three clusters of groundwater monitoring wells. Process equipment included a 500 kW Six-Phase Heating™ Power Supply Unit (PSU), an electrolyte addition system, a steam condenser system, vapor phase granular activated carbon (VPGAC), and a water collection /transfer system for managing secondary wastewater.

Installation of the ERH system commenced in August 2002, and start-up began in early October 2002. Heating operations were completed over a three-month period ending early January 2003. Boiling temperatures were achieved after 5 weeks of operations, and this was consistent with CES's design modeling. Based on site characterization data, the VOC mass in the target treatment area was estimated between 600 to 800 lbs. yet operations field data and VPGAC loading indicated significantly higher mass had been removed by the SPH operation.

RESULTS

Overall, approximately 1,500 pounds of contaminants were removed during the test, and post test field screening estimated the remaining mass-in-place to be 13 lbs. Evidence of contaminant degradation in place in place was indicated by high levels of chloride ion in the groundwater. Shallow groundwater contamination located in the target treatment zone was reduced by greater than 99% (to 24 ft. bg.) and greater than 77% in deeper groundwater contamination. Total electrical energy input was approximately 286,200 kWh or 93% of the predicted value.

The SPH pilot test performed to design and proved extremely effective, despite the difficult challenges posed by the physical site conditions. During heating phases, temperature rises were recorded above 5°C per day. CES's proprietary electrode design was very efficient at coupling power to the soil, and there were no signs of any power degradation or electrode drying. The most interesting result, however, was that the SPH system removed more than double the estimated mass-in-place.