



Project Case History

Full Scale Remediation of Trichloroethene and Benzene, Toluene, Ethyl Benzene, Xylene (BTEX) in Soil Using Six Phase Soil Heating - Niagara Falls, NY

This was the second full-scale implementation of Six Phase Soil Heating.

Contracting: Fixed Price Per Task

Contaminants Treated: Trichloroethene (TCE), Benzene, Toluene, Ethyl Benzene, Xylene (BTEX)

Technology Applied: Six-Phase Soil Heating (SPSH)

Geology: Sediments, glacial till, bedrock

Hydrology: Groundwater at 8 feet below ground surface (bgs)

Hydraulic Conductivity: 3×10^{-4} cm/sec

Treatment Area & Volume: 12,100 square feet & 4,480 cubic yards

Treatment Interval: ground surface to 10 feet bgs.

Beginning Contaminant Levels: 63.5 kilograms of TCE

Cleanup Levels Achieved: 20 kg TCE or >68% reduction 700

Remediation Time Period: July - October 1996

Project Reference: U.S. Air Force Reserve, Montgomery Watson

Six Phase Soil Heating (SPSH) was used for remediation of soil impacted by trichloroethene (TCE), TCE daughter compounds and Benzene, Toluene, Ethyl Benzene and Xylene (BTEX) at the Former Fire Training Area No. 1 at Niagara Falls International Airport Air Reserve Station, Niagara Falls, New York. Members of the TRS professional staff completed this project while working for a former company.

The site geology is characterized by a relatively thin overburden of lacustrine sediments and glacial till on top of fractured dolostone bedrock. The upper overburden is a 4 to 8 foot thick layer of stratified lacustrine sediments consisting primarily of clay and silty clay. Beneath the sediments and resting directly on the bedrock is a layer of glacial till. Groundwater is encountered at about 8 feet bgs. The hydraulic conductivity is 3×10^{-4} cm/sec.

The maximum concentration of TCE in soil was 14,000 $\mu\text{g}/\text{kg}$. The treatment area measured 110 feet by 110 feet with a treatment depth interval of 0 to 10 feet bgs. The resulting remediation volume was 4,480 cubic yards. The initial TCE mass estimate in the treatment area was 9 kilograms.

The purpose of this project was to reduce VOC concentrations in the saturated and unsaturated zones to reduce future groundwater contamination. The low permeability soil at this site precluded the

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use of conventional technologies including SVE or air sparging. The SPSH remediation technology was selected based on its potential ability to perform well in a low permeability matrix in both saturated and unsaturated conditions.

A total of 29 electrodes were installed and arranged in hexagonal arrays, 40 feet in diameter. One additional electrode/vent was installed in the center of the four arrays. This central vent was constructed in the same manner as the electrodes and manifolded separately within the SVE system. A surface plenum made of high-density polyethylene (HDPE) was constructed to provide a vapor seal.

Combining Technologies for Increased Contaminant Reduction over a Larger Area at Reduced Price

TRS implements heat-enhanced biodegradation by raising subsurface temperatures to enhance biodegradation of contaminant source areas and dissolved contaminant plumes.

ERH electrodes are used to introduce biological or chemical amendments to enhance the degradation of contaminant source areas and dissolved contaminant plumes. The combination of technologies can achieve lower cleanup goals at reduced cost in a larger treatment area.

Eleven Temperature Monitoring Points (TMPs) were installed with thermocouples at 2 and 6 feet bgs. Pressure monitoring was also conducted to ensure the SVE system maintained negative subsurface pressure. The SVE system operated at a vacuum of 5 to 8 inches of water and flow rates of 247 to 253 standard cubic feet per minute (SCFM).

The SPSH system operated from August 27 to September 25, 1996. Ambient soil temperatures were 13 to 21 degrees C. During SPSH operations subsurface temperatures increased between 75 and 90 degrees C. During the remediation 336,000 kW-hrs of electricity were used.

A total of 11,220 gallons of condensate were generated during the project. Less than 10 grams of TCE were removed in the condensate. The estimated TCE mass recovered to the surface during operations was 59.7 kilograms for total VOCs (43.5 kg TCE) and 4.6 kilograms for total BTEX compounds.

The mass of TCE removed from the site is more than four times the initial TCE mass estimate. The initial mass estimate that was based on Focused RI sampling conducted in 1993, apparently underestimated the TCE mass because sampling did not detect the accumulated TCE on the bedrock surface at the site.

The analysis of post treatment sampling, which provided an increased level of site characterization, indicates that approximately 20 kg of TCE are still present at the site. Based on the 43.5 kg of TCE removed, and the estimated residual TCE mass of 20 kg, the initial TCE mass that was present prior to the SPSH remediation appears to have been approximately 63.5 kg. Based on this initial TCE mass estimate the SPSH remediation recovered more than 68% of the TCE from Site 10.