Heat-Enhanced Hydrolysis and Flash Sparging

Chris Thomas (cthomas@thermalrs.com) (TRS Group, Inc.) and Brad Morris (TRS Group, Inc.)

Background/Objectives. Electrical resistance heating (ERH) was performed at a Superfund site in Rockford, Illinois to remediate 1,1,1-trichloroethane (TCA), perchloroethylene (PCE) and fuels. The remediation focused on a source area located below and adjacent to a building, as well as the downgradient plume that extended below an asphalt parking lot and neighboring street. The maximum pre-ERH concentration of TCA in soil was 510,000 micrograms per kilogram (µg/kg) and the maximum concentration of PCE was 88 µg/kg although elevated detection limits for PCE existed in most areas due to fuels. The goal of the remediation was to reduce TCA concentrations in soil to less than 9,118 µg/kg with heat-enhanced hydrolysis while remediating PCE to less than 60 µg/kg through steam stripping. A fast-moving groundwater interval at the deep portion of the site presented known challenges to heating that needed to be addressed in the design.

Approach/Activities. A consultant conducted multiple investigations to produce a comprehensive site conceptual model. The model identified contaminated soil with heavy fuel impacts including a light non-aqueous phase liquid (LNAPL) layer at the top of the aquifer with TCA and PCE dissolved within the NAPL. The source area was also impacted with LNAPL throughout the vadose zone. Based on the horizontal and vertical profile of the contamination and site characteristics, the contamination was divided into three zones to address individual lithological conditions and varying depths. Total treatment area for the three areas was 8,500 ft^2 and a combined volume of 6,100 yd^3. The contamination depths varied from 2 to 37 ft bgs. Thirty-nine electrodes were installed inside and outside a building and below an active roadway. The system was designed with an over-sized power control unit (PCU) and targeted electrode design to deliver sufficient heating into the fast-moving groundwater interval.

Results/Lessons Learned. The ERH system operated for a total of 125 days. TCA was rapidly hydrolyzed to non-detect values as anticipated. The ERH system recovered approximately 5,700 pounds of VOCs from the soils through volatilization by steam stripping. An estimated 150 pounds of TCA was hydrolyzed in-situ. ERH removed the majority of fuels in the saturated zone, but heavy fuels located at the bottom of the treatment zone in the fast-moving aquifer were noted to still contain PCE concentrations that resulted in an exceedance of the 60 µg/kg value during soil sampling. To enhance steam stripping at the bottom depth of the treatment interval, air sparge wells were installed to address the residual PCE was identified. Introduction of air at depth resulting in a subsurface flashing effect that enhanced steam stripping in a targeted depth interval. A temporary increase in PCE concentrations and steam production were observed in the recovered vapors. The flash steam stripping was able to successfully remediate the residual PCE concentrations in a short period of time. All cleanup goals were successfully met for the site using a combination treatment of hydrolysis, steam stripping and flash sparging.