Integrated In-Well Air Stripping and In Situ Chemical Oxidation to Remediate a Large Dilute VOC Plume in a Deep Aquifer

Douglas Fisher, PE (douglas.fisher@amecfw.com), Donald Smallbeck, and Natalie Chrisman Lazarr, PE (Amec Foster Wheeler, Phoenix, Arizona, USA)
Stuart Pearson, PE (stuart.pearson@amecfw.com) (Amec Foster Wheeler, Portland, Maine, USA)

Background/Objectives. The Former Williams Air Force Base (AFB) located in Mesa, Arizona was an active Air Force (AF) base from 1941 through 1993. The Former Williams AFB was placed on the U.S. Environmental Protection Agency National Priorities List in 1989 following remedial investigations (RIs) that identified various sites impacted by historic hazardous substance releases. One of these sites is the Former Williams AFB Landfill 4 (LF004) which received wastes from 1941 to 1976. RIs identified two regions of contaminated soil vapor that are likely sources of contamination to two large dilute plumes of volatile organic compounds (VOCs) in groundwater: one contaminated with trichloroethene (TCE), in the vicinity of a former above ground storage tank (AST) located northeast of LF004, and the second contaminated with tetrachloroethene (PCE) in the southeast (SE) portion of LF004. The area underlying LF004 is characterized by a heterogeneous lithology of sands, gravels, silts/silty sands and clays, low natural oxidant demand (NOD) and a dynamic (rising) groundwater system. Project objectives include removal of the soil vapor plumes impacting groundwater and remediation of groundwater exceeding the maximum contaminant levels (MCLs) for TCE and PCE of 5 micrograms per liter (µg/L) each.

Approach/Activities. The soil vapor plumes were addressed with soil vapor extraction (SVE) to mitigate ongoing sources of VOC contamination to groundwater. In-well air stripping (IWAS) was implemented in the AST area to address the dissolved TCE plume. In situ chemical oxidation (ISCO) using sodium permanganate was implemented in conjunction with IWAS to improve remedial performance. Treatability testing suggested ISCO would be effective in this environment due to the low NOD in the aquifer. The PCE plume in the SE landfill area was addressed through batch ISCO injection at new remediation wells and existing monitoring wells. ISCO was enhanced using in-well recirculation at remediation wells; water was extracted from the lower screen of dual screen wells, amended with oxidant and injected into the upper screen of the well (screens were separated with an in-well packer). Groundwater recirculation was further enhanced by extracting groundwater from downgradient wells, amending it with oxidant and reinjecting it into upgradient wells.

Results/Lessons Learned. Results of soil vapor sampling indicate that SVE successfully remediated the soil vapor plumes in the AST and SE landfill areas. Although largely effective, the IWAS system alone left some groundwater in the AST area above the MCL of 5 µg/L, either due to lithologic conditions or because they were outside of the zone of influence of the IWAS system. Supplementing IWAS with ISCO effectively addressed areas with recalcitrant concentrations and reduced the remediation time frame. Adoption of the injection/recirculation approach effectively targeted portions of the aquifer that were difficult to reach due to heterogeneity and low permeability zones. ISCO was particularly efficient at LF004 due to the low NOD in the aquifer. The LF004 site has demonstrated how the use of multiple technologies, a flexible design, and observational modifications can overcome challenging site conditions and improve project outcomes.