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Training
Initiatives and Partnerships
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TECHNOLOGY NEWS AND TRENDS

A newsletter about soil, sediment, and ground-water characterization and remediation technologies

July 2007

This issue of Technology News and Trends (TNT) looks back to find lessons learned from site characterization and remediation projects described in earlier issues of the newsletter. These site-specific updates encompass expanded field operations, the results of longer-term monitoring, techniques for system integration, and recent research on technical focus areas of the U.S. EPA's Office of Superfund Remediation and Technology Innovation.

ART System Performance Enhanced by Effective Site Assessment

The U.S. EPA's Region 7 office has used analytical data from small-diameter tree cores over the past eight years to identify shallow areas of soil and ground water with volatile organic compounds (VOCs) at the Riverfront Superfund site, located along the Missouri River in New Haven, MO. As an initial site assessment technique, tree-core analysis continues to significantly reduce the extent of analytical sampling (and associated costs)

CLU-IN Resources

The U.S. EPA Science Policy Council formed a cross-Agency workgroup in 2004 to examine potential environmental applications and implications of nanotechnology. The workgroup's findings were published earlier this year in the EPA Nanotechnology White Paper (EPA 100/B-07/001), now available on CLU-IN.

needed to identify contaminant source areas at
the Riverfront site and to facilitate cleanup design and implementation. Success of this simple and inexpensitve tool was demonstrated in 2004 at the site's operable unit 1 (OU1), where a tetrachloroethene (PCE) plume and source area in soil were discovered through tree coring and subsequently confirmed by traditional soil and ground-water sample analysis [November 2005 *TNT*].

In early 2005, results from the OU1 tree-coring analysis were used with portable gas-chromatograph (GC) analysis of soil borings to guide placement of an advanced remediation technology (ART) well for treating a vadose-zone hotspot adjacent to the river. An ART well provides the opportunity for treatment-system optimization by operating as a combined soil vapor extraction (SVE)/in-well aeration well using a single, continuous screen. System optimization also was achieved by down-sizing the 5-horsepower (hp) compressor to a 3-hp unit, while retaining the 3-hp blower and 0.5-hp well pump originally anticipated for the ART system. This 2-hp reduction in the total energy demand resulted in a 25% reduction in energy costs for system operation. Monitoring over the past two years showed a rapid decrease in hotspot PCE concentrations, suggesting that the well-defined contaminant characterization effectively optimized treatment-well placement and, in turn, will minimize treatment duration and cost.

The ART system consists of a single 6-in. diameter, 30-ft.-deep well with a 25-gpm recirculation pump at the leading edge of the contaminant plume. A small building 70 feet away houses a 10 ft^3/min air sparging unit and a 100 ft^3/min vacuum blower. A trench between the well and equipment shed contains the compressed air and vacuum return lines and the well pump's power cable. The system removes contaminated vapor from both contaminated soil and stripped ground water at a rate 100 ft^3/min. Water-table mounding and associated negative gradients promote subsurface recirculation of ground water through the soil formation and the treatment well casing.

As an ongoing partner in large-scale remediation of the site, the U.S. Geological Survey (USGS) installed nine monitoring wells prior to system startup. An existing residential well at OU1 is used to monitor the northwest edge of the plume. Analytical results of ground-water and vapor sampling in March 2007 indicate that the ART system has removed more than 1,000 lbs. of subsurface contaminants, primarily PCE (Figure 1). Ground water near the treatment well, which treats a portion of the total source area, shows a 98% reduction in PCE concentrations and a 97% decrease in concentrations of PCE breakdown products such as cis-dicholoroethene. A monitoring well approximately 100 feet downgradient of the treatment well (2-3 years travel-time distant) demonstrated a 63% decrease in PCE concentrations.

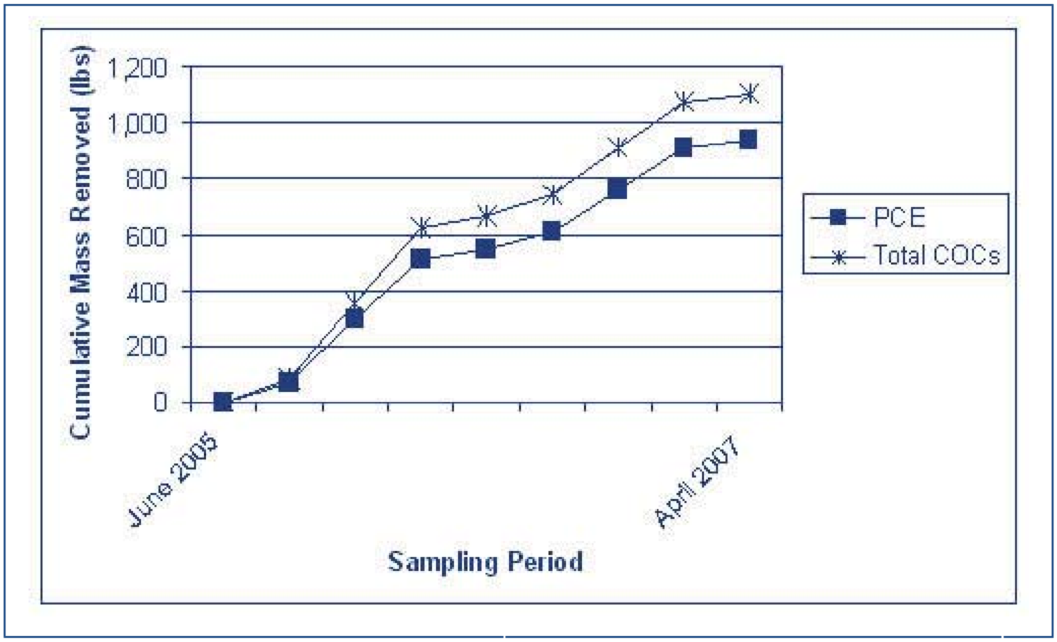

Figure 1. To date, the Riverfront OU1 ART system has removed approximately 83% of the source-area VOCs.

Performance evaluation includes monitoring the system's tolerance to changes in ground-water and surface-water levels and the effectiveness of the selected screened intervals of the wells (12-44 below ground surface [bgs]). Air sparge turbulence in the treatment well casing prevents direct measurement of water levels in the treatment well. In addition, ground-water levels below 27 feet stop the ART well pump from operating, preventing collection of samples directly from the treatment well. Consequently, samples are collected from a deep piezometer. No signs of well screen clogging have been observed, and results suggest that treatment rates are relatively unaffected by changes in water table elevation. The ART pump portion of the remedy can operate with ground-water levels at least as low as 26.8 ft bgs, although with some reduction in capacity.

Comparison of results from multiple sampling events suggests that SVE-induced off-gassing and ground-water fluctuations likely caused the upward and downward variability in VOC concentrations displayed in some deep ground-water samples. Also, seasonal variations in the river's elevation and oxygen levels caused variations in analytical results from downgradient monitoring wells. One drum of activated carbon was used to treat system vapor until analytical sampling confirmed that emissions were below Missouri air standards.

Installation costs for the ART well, associated aboveground equipment, and monitoring wells totaled approximately $140,000. Project capital costs are estimated to be one-tenth of that for capping and sheet-pile containment of the source area, the least expensive alternative remedy.

Semi-annual sampling of the well network and treatment vapor, as well as annual sampling of selected locations of the river, will continue over the next three years. The remedy's five-year review in 2009 will include detailed analysis of the impact of water levels on the ART system's performance and on monitoring well results. Ground-water analyses indicate that 60-95 % of the PCE plume naturally degrades prior to entry into the Missouri River; travel time for OU1 ground water migrating to the river is estimated to be 12-17 years.

A time-critical removal involving in-situ chemical oxidation recently was initiated to treat contaminated soil and shallow ground water at Riverfront's OU4, a residential area where tree-coring analysis unexpectedly identified PCE-contaminated soil. Initial injections of sodium permanganate were completed in May, and a second round is scheduled to occur by early fall. More information on tree coring as a site characterization and remediation planning tool is available in EPA's new *User's Guide: Tree Coring to Examine Subsurface Volatile Organic Compounds,* available on CLU-IN (www.cluin.org).

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