Bench- and Pilot-Scale Studies: Worthwhile Tools in Optimizing Thermal Remediation Approaches

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Background/Objectives. TerraTherm has developed bench-scale testing procedures to evaluate the effectiveness of different in situ thermal approaches in a laboratory setting. Results are used to fine tune the remedial design/approach, and gather information that may affect the performance of the full-scale thermal system. A comprehensive bench scale study, followed by a pilot scale field implementation, was performed for a site at a former chemical manufacturing facility. Primary constituents of concern (COCs) at the site include 1,2-dichloroethane (1,2-DCA), 1,4-dioxane, 2-chloroethanol, bis(2-chloroethoxy)methane (BCEM), and bis(2-chloroethyl)ether (BCEE). From a chemical standpoint, this site differed a lot from other sites treated previously, justifying significant testing. The large scale of the proposed full-scale system was a factor for performing the field pilot test, so the spacing between wells can be optimized.

Approach/Activities. A complex bench scale study was performed, investigating static rates of BCEM/BCEE degradation in a closed system, as well as the removal efficiency of three different thermal treatment options (thermal conductive heating (TCH), steam enhanced extraction (SEE), and hot water flushing at temperatures below boiling). Hydrolysis products were identified in the static system and were found to be consistent with literature. Thermal treatment effluent samples (condensates) were found to be extremely corrosive, which prompted the desire to conduct a corrosion test in the pilot phase. The treatability study was followed with a SEE pilot test which was executed over an operating period of 26 days. The SEE technology was used to study the steam injection and subsurface steam propagation at the Site and the ability to heat the Pilot Test volume to the boiling point of water from 10 to 70 feet below ground surface (ft bgs) with a combination of steam injection and liquid extraction. A corrosion test was performed in the pilot study to evaluate candidate materials for wells, manifold pipes and the effluent treatment system components.

Results/Lessons Learned. Rates of in situ thermal hydrolysis of the contaminants of concern were confirmed in the bench scale study. Based on the pilot test results, portions of the site were found to be less permeable than expected, leading to a tighter well spacing in low-permeability areas of the site proposed for full-scale. Follow up recommendations for data gaps were recommended to further optimize the site operations. Results of the corrosion tests allowed cost effective decisions to be made for well design and construction. Operational details and lessons learned from both the bench scale study and the pilot test study will be presented, and put in context with the design and cost implications for full scale in situ thermal remediation implementation.