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Overcoming a Vexing Problem of Remediation at Sites with Complex Geology: Field Demonstrations of EK-Enhanced In Situ Remediation

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Background/Objectives. A common challenge to achieving remediation goals at sites with complex geology is contaminant mass stored in low-permeability (low-K) materials acting as long term sources. The main limitation of enhanced in situ remediation using conventional hydraulic-based techniques is the inability to effectively deliver the required amendments to the target area and/or formation. This presentation will discuss field-scale demonstrations of an electrokinetic-enhanced (EK-enhanced) in situ remediation technology that represents a cost-effective solution for this vexing problem. The mechanism of EK transport of ionic compounds is relatively independent of the hydraulic property of geologic matrix, and, thus, can achieve effective and uniform amendment delivery to and through a target area in the subsurface. Field implementations and performance results of multiple projects demonstrating various EK applications for in situ bioremediation (EK-BIO™) and in-situ activated persulfate remediation (EK-TAP™) at sites of heterogeneous, low-K materials will be presented.

Approach/Activities. Tetrachloroethene (PCE) from a source area at Naval Air Station Jacksonville (NAS JAX) had migrated vertically across a shallow sandy unit into the underlying clay unit. A network of 9 electrode wells and associated supply wells and monitoring wells were installed in the treatment area (approximately 35 ft by 35 ft) targeting the contaminant mass in clay at depths of approximately 19 to 24 ft. An EK-BIO™ control system was installed and operated to provide a constant direct current (DC) to electrodes and supply amendments (lactate and carbonate buffer solutions) to the target treatment area. A complete phase of system operation and rigorous performance monitoring has been concluded to demonstrate this technology. At a site in Louisiana, a network of 5 electrodes was installed to target chlorinated ethanes stored in layered marsh materials. An EK-TAP™ control system was installed and operated at this site to distribute persulfate by DC at the target depth of 42 ft, and subsequently heat-activate the distributed persulfate by alternating current (AC) to maximize treatment efficiency. With a design that uses the same electrodes and system infrastructure for both persulfate distribution and heat activation, the EK-TAP™ approach represents an innovative and cost-effective solution for complex site geology.

Results/Lessons Learned. The EK-BIO™ system at NAS JAX only required fairly low electrical energy (~30V) to supply a target constant current (~8A) to the electrodes. The performance monitoring data collected 5 months following amendment delivery and bioaugmentation showed the project had met the demonstration objectives with >80% of PCE decrease with substantial increases of dissolved ethene, >100x increases of *Dehalococcoides*, Dehalobacter, and vinyl chloride reductase (vcrA) genes, and >78% decrease of PCE concentrations specifically in clay. The effects of EK were evident when comparing the conditions within the pilot test area to those of background wells and soil samples. Given the impressive performance, the project has been funded for extended operation to further demonstrate the full potential of this technology, and those results will also be presented. The EK-TAP™ system at the Louisiana site has been in full operation since June 2016. A constant DC of 3A with a resultant voltage of 29V has been applied to distribute persulfate. The heat-activation phase is expected to be completed in 2016. The performance monitoring data will be discussed in this presentation.