Iterative Selection of Remedial Alternatives for Mixed Contaminants in Complex Geology

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Background/Objectives. Complex geology and contaminant properties have required a comprehensive review and adjustment of existing remedial activities at a former pesticide manufacturing facility, and current Superfund site, in Albany, Georgia. The Site is impacted with organochlorine pesticides (OCPs) coeluted within a light non-aqueous phase liquid (LNAPL) composed primarily of xylene and ethylbenzene. The original remedial technology was groundwater pump and treat (P&T), which operated from 1996 to 2003, at which time it was deactivated due to unsatisfactory mass removal. Suboptimal performance of P&T is attributable to complex geology, which consists of 20 to 35 feet of alternating low permeability clayey sands and sandy clays (residuum) overlying the Ocala Limestone, a highly porous and transmissive regional aquifer. The upper portion of the Ocala Limestone serves as the primary mass storage unit for contaminants. Specifically, a highly irregular and weathered transition zone is present directly beneath the residuum and contains many fractures, joints, and solution cavities. A smaller extent of contamination has also been observed beneath this zone as the geology grades into more competent limestone bedrock. Subsurface remediation is also challenging due to the conflicting physical/chemical properties of OCPs and the LNAPL. A remediation strategy capable of addressing these unique geologic and chemical characteristics was needed to progress the Site towards closure.

Approach/Activities. Remedial amendments containing labile organic carbon and either zero valent iron (ZVI) or ferrous iron/sulfate were initially evaluated using field pilot studies. The addition of organic carbon and ZVI was expected to abiotically reduce OCPs, while sulfate would be relied upon to serve as an electron acceptor for anaerobic biodegradation of the LNAPL constituents. A field pilot study of two amendments applied in two separate areas of the Site was conducted in 2019. The ZVI product (EHC®) was applied as a slurry, and the ferrous iron/sulfate product (Geoform™ Soluble) was applied as an aqueous solution. As expected, greater attenuation of OCPs was observed with EHC® slurry, and greater attenuation of xylenes was observed with Geoform™. Therefore, a substrate blend (GeoForm™ Extended Release, consisting of the components of EHC® and GeoForm™ Soluble) was bench tested to evaluate its effectiveness in degrading both OCPs and LNAPL constituents. The bench study showed successful degradation of OCPs but partitioning of xylenes from groundwater to soil was observed, versus degradation. Consequently, the use of these products was eliminated from further consideration and a stepwise remedial approach was considered. Due to the continued persistence of xylene and ethylbenzene, a field-scale air sparge/soil vapor extraction (AS/SVE) test was conducted to first address these elevated aromatic groundwater concentrations. Due to the location of the weathered limestone and residuum, strategic placement of both AS and SVE well screens were required to allow for the successful volatilization and capture of the xylene/ethylbenzene. Implementation of the AS/SVE pilot resulted in visual influence of air sparging and the extraction of significant contaminant mass by SVE.

Results/Lessons Learned. An iterative process of evaluating various technologies or amendments incorporated knowledge of site-specific geology and chemical-specific properties. A Focused Feasibility Study to facilitate a Record of Decision amendment presents a remedial approach that utilizes AS/SVE to eliminate LNAPL constituents. After AS/SVE, the aquifer conditions will be adjusted to stimulate the attenuation of OCPs using a reductive amendment.