Air Sparging as an Adaptive and Effective Plume Management Approach at Large DNAPL Sites

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Background/Objectives. Cleaning and facility operations in support of launch operations resulted in releases of trichloroethene (TCE) at the Converter Compressor Building (CCB) and Former Drum Disposal Area (FDSA) sites at National Aeronautics Space Administration (NASA) Kennedy Space Center (KSC), Florida. TCE source areas were identified via a high-resolution direct-push technology (DPT) investigation. Treatment areas with concentrations greater than the Florida Natural Attenuation Default Concentration (NADC) (TCE – 300 µg/L) totaled more than 11 acres to a maximum depth of approximately 55 feet. Although highly heterogeneous, the interbedded high permeability zones at KSC are amenable to air sparging; therefore, aggressive air sparging systems were proposed, designed, and implemented at both sites. The objective of this abstract is to discuss the use of large-scale air sparging implementations as a plume management tool for cost effective and efficient treatment of large plume footprints. The presentation will summarize the design of a robust and flexible air sparging system and present adaptive operational protocols used to expedite the success of these techniques at dense non-aqueous-phase liquids (DNAPL) sites with TCE concentrations up to 191,000 µg/L.

Approach/Activities. During screening of remedial alternatives, it was determined that air sparging would be the most effective remedial technology for reaching project goals despite the presence of extremely high TCE concentrations. Operation of the air sparging systems at CCB and FDSA began in 2014 and included four treatment areas: CCB Hot Spots 1, 2 and 5 (4.4 acres), CCB Hot Spots 3 and 4 (3.0 acres), FDSA (3.7 acres), and a lower concentration area at CCB (less than 0.5 acre with a maximum vinyl chloride concentration of 570 µg/L). A total of 510 air sparging wells were installed in the four treatment areas at depths ranging from 25 to 50 feet below land surface. To increase treatment efficiency, the wells were spaced using a variable density approach based on concentration. For example, 35-foot grid spacing was used in dilute plume areas (i.e. between 300 and 11,000 µg/L), compared to a distance of 10 feet in areas of suspected DNAPL. A centralized air sparging system provided air to all wells, which allowed a phased approach for implementation and concurrent treatment of multiple sites, resulting in simplified operation and reduced cost. An adaptive operational process was used to quickly make adjustments to the system based on evaluation of groundwater sampling results and system operational data. Changes included optimizing pulsing scenarios, phasing out operation of clean zones, and manipulating injection flow and pressure in recalcitrant areas.

Results/Lessons Learned. The project successfully met the performance objectives of treating TCE and degradation products to concentrations less than the NADCs within one year of implementation. Treatment in each of the areas continued beyond the first year of operations for further reduction of contaminant concentrations. After the second year, concentrations were reduced to less than GCTLs in 67% of the treatment areas. Post-active remediation monitoring of these areas has indicated minimal rebounding. The maximum TCE baseline concentrations at each plume of 12,000, 47,000, 146,000, and 191,000 µg/L were reduced to 6, 32, 91, and 110 µg/L, respectively. The success of this project and the significant concentration reductions were predicated on high-resolution investigation results and aggressive and flexible air sparging design and operation. This project demonstrated that air sparging can be effective at sites with contaminant concentrations greater than 15% of saturation.