Rapid Site Closure of a Large Gas Plant Using In Situ Bioremediation Technology in Low-Permeability Soil and Fractured Bedrock

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Background/Objectives. Natural gas condensate and other natural gas liquids released to the subsurface from a large gas-processing plant generated a petroleum hydrocarbon plume approximately 30 acres in area. The affected matrix was complex and included low permeability, residual clays overlying shallow, fractured limestone bedrock. Solute concentrations indicative of light, non-aqueous phase liquid (LNAPL) were observed at depths as shallow as 4 feet below ground surface. Undulating surface topography with paleochannels (incised, erosional features) and a relatively steep groundwater gradient caused a dissolved-phase plume of benzene, toluene, ethybenzene, and xylenes (BTEX) to extend more than 1/4-mile downhill from the source.

Approach/Activities. The initial Remedial Action Plan prepared by a predecessor and submitted to the Railroad Commission of Texas (RRC) was to install soil-vapor extraction and groundwater recovery and treatment systems to achieve site cleanup. Instead, an in situ BOS 200® injection program was implemented to expedite remediation for a pending property sale. BOS 200® is a granular, activated carbon injectate inoculated with cultured microbes (consortia of facultative microorganisms), electron acceptors (nitrate and sulfate), and nutrients (phosphorus and nitrogen) designed to quickly biodegrade BTEX compounds.

Subtle facies changes in overlying, low-permeability soil and thin bedding planes and complex fractures in highly weathered bedrock resulted in solute concentrations that varied by orders of magnitude in distances of only several millimeters. The first step was to conduct a high-resolution, quantitative-data assessment to characterize plume strength and geometry. The outcome was an accurate conceptual site model used to: 1) apply (continuous) soil and groundwater data to design a discrete remedial design; 2) inject BOS 200®; 3) complete confirmatory/performance borings to observe remedy distribution and evaluate if “the target was hit” (or adjust subsequent injections, accordingly); 4) analyze corresponding groundwater samples; and 5) calculate mass reduction. This sequence was repeated until cleanup goals were met in a subject area.

The site was subdivided into six regions, based on constituent concentrations. Treatment was implemented in three phases over a 15-month period. Approximately 4,800 injections were completed at 1,230 locations throughout the 30-acre plume. The remedy consisted of 185,875 pounds of carbon slurry, 5,650 pounds of supplemental sulfate (gypsum), and 352 gallons of microbes.

Results/Lessons Learned. The project was a success because of the effectiveness of the BOS 200® and the quantity and quality of data gathered to demonstrate treatment performance. The primary petroleum constituent, benzene, was reduced from concentrations of over 70,000 micrograms per liter (µg/L), i.e., LNAPL, to less than 1 µg/L. Following 24 months of post-treatment groundwater monitoring, a No Further Action determination was issued for the site by the RRC.