Evaluation and Implementation of Horizontal Biosparging for Expedited Remediation of Petroleum Hydrocarbons

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Background/Objectives. Soil and groundwater at the facility were impacted from at least two documented jet fuel releases and other site activities. Active remediation was required across multiple target areas. Unconsolidated sediments consisting primarily of silty sands with areas of gravel and sand mixture with gravels underlain by glacial till ranged in thicknesses from 20 feet to more than 60 feet, providing a porous media for migration of petroleum LNAPL and dissolved constituents in groundwater. Previous remedial efforts including vertical bioventing provided partial remediation of the impacted areas but were unsuccessful in achieving remediation goals. Challenging site conditions required that the remedy not impact ongoing facility operations as well as upcoming redevelopment efforts. The first objective of the presentation is to discuss why biosparging was selected as the most cost-effective method to remediate the residual impacted areas within the desired timeframe. The second objective of the presentation is to detail how horizontal remediation well design principles were used to optimize removal of the petroleum hydrocarbons found in groundwater, adsorbed to soil below the water table, and within the capillary fringe.

Approach/Activities. The basis for design of the horizontal biosparge wells was to maximize oxygen distribution in the shallow aquifer without adversely impacting any of the various daily operations activities taking place at the site. Five horizontal biosparge wells with between 200 feet to 300 feet of screen were installed with horizontal directional drilling methods at target depths ranging from 24 feet below land surface (bls) to 39 feet bls. The horizontal wells screens were engineered using design software to produce a site-specific custom-engineered design to provide the desired air flow rates and air distribution. Ambient air was supplied to the horizontal wells via 25-horsepower rotary claw blowers capable of at least 150 to 225 cubic feet per minute. Performance criteria was monitored throughout the operation of the biosparge system.

Results/Lessons Learned. The effectiveness of the biosparging system in remediating the petroleum related contamination at the site was indicated by comparing the dissolved oxygen (DO) levels in groundwater as well as various soil gas measurements to the baseline measurements. The measured increase in DO served as a clear predictor of enhanced aerobic degradation of the petroleum related contamination. As a result of the aerobic degradation, soil gas measurements indicated decreased O_2 and increased CO_2 measurements. Subsequent sampling data and biosparging measurements indicate that biodegradation occurred at monitoring locations at least 120 feet from the horizontal wells. Within biosparging areas, decreased depth to water and increased DO measurements were recorded along with increased total volatile hydrogen (TVH) and decreased O_2 measurements. The outcomes produced by the remediation system underscored the importance of various elements of the design phase such as well layout design, well screen design, flow balancing, and well development technique selection. Additional lessons learned during the operation of the system also extended to operation optimization techniques as well as how the glacial till lithology impacted the performance of the biosparge system. Within 3 years of operation of the horizontal biosparge system, groundwater sampling results indicated no volatile organic compound (VOC) concentrations above the regulatory Groundwater Standards. The success of this project

resulted in the implementation of similar horizontal biosparging systems at similar facilities across the country.