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Bioremediation Incorporated into Treatment Train Achieves Closure of an LNAPL Source Area

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Background/Objectives. An active power plant experienced a release of fuel oil to shallow soil and groundwater that threatened to impact an adjacent federally protected river in Maryland that feeds into the lower Chesapeake Bay. Light non-aqueous phase liquid (LNAPL) and elevated total petroleum hydrocarbons (TPH) were identified in the groundwater of the power plant area less than 100 feet from the river. The impacted area contains several subsurface utilities that would have made physical removal (dig and haul) of the soils in the impacted zone difficult also potentially impacting the river and would have required the shutdown of the plant during excavation. Previous remedial activities included limited physical removal (bailing) of LNAPL from two monitoring wells; however the state agency was requiring a more aggressive remedial approach to mitigate migration of the LNAPL to the river.

Approach/Activities. To better define the extent of the LNAPL three dimensionally, Laser induced fluorescence (LIF) was implemented that could provide a target for a more focused remedial strategy. A desk-top feasibility study was conducted and a minimally invasive remedial option was selected to address the LNAPL and dissolved phase hydrocarbons. The selected remedy was an in situ treatment train that included chemical oxidation, aerobic and anaerobic bioremediation, multi-phase extraction (MPE) and monitored natural attenuation (MNA). A blend of sodium persulfate and calcium peroxide was chosen based on the combined substrates ability to provide chemical oxidation as well as aerobic and anaerobic biodegradation of the TPH. A successful pilot test was conducted in December 2008, with full-scale implementation conducted from 2009 through 2011. Approximately 6,000 gallons of an 8% injection solution was injected into the subsurface (approximately 3,000 pounds of persulfate/peroxide) in three injection events between 2009 and 2011. Multi-phase extraction was implemented for approximately six months in 2012 to capture additional LNAPL that was liberated by the substrate injections outside of the treatment zone followed by natural attenuation monitoring from 2012 to 2014.

Results/Lessons Learned. LNAPL was initially measured at 1.2 feet at the source area monitoring well. Eighteen months after injections, LNAPL was measured at only 0.2 feet in the same monitoring well. Dissolved phase TPH-DRO had been detected at concentrations up to 6 mg/L prior to initiating the injection program. Concentrations in six of the seven performance monitoring points in and around the source area were non-detect for TPH-DRO in May 2011. Groundwater geochemistry was observed to be mildly reducing prior to injections (low dissolved oxygen and moderately negative oxidation reduction potential) then highly oxidizing immediately after injections (high DO, and strongly positive ORP) to strongly reducing four months after injections. An additional 24 gallons of LNAPL was removed by MPE (mobilized during the injections) that significantly reduced measured LNAPL in site groundwater that facilitated bioremediation and attenuation of the dissolved TPH. Two years (2012 to 2014) of monitoring for attenuation of the TPH showed no LNAPL observed in the monitoring wells or the adjacent river. The monitoring well data also indicated that the dissolved phase plume was stable, shrinking and no longer a threat to the adjacent river. MDE agreed to no further action for the Site based on the combined success of the in situ treatment train to significantly reduce LNAPL, the dissolved phase plume and mitigate migration to the adjacent river in the Spring of 2016.