Lessons Learned: Application of Phytoremediation in Place of Conventional Pump-and-Treat Approach at a Hydrocarbon-Impacted Site

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Background/Objectives. The site is located in California's San Joaquin Valley at an elevation of approximately 133 feet above mean sea level. Soil and groundwater at the site have been impacted by hydrocarbon releases related to bulk and retail fuel-distribution activities from 1946 until 2017. Investigation and remediation of the site began in 1988. An existing remediation system has employed groundwater and soil vapor extraction and treatment for over 10 years. Projected long-term energy and water usage for this conventional system were the impetus to develop a plan for the implementation of phytoremediation as an alternative means to achieve the necessary hydraulic control and degradation of hydrocarbons in soil and groundwater.

Approach/Activities. A multi-phase pilot study is in progress to assess the feasibility of enhancing, and potentially replacing, conventional remediation systems with a phytoremediation-based design. A Phase I test plot was installed in the spring of 2017, with planting of 274 immature, single-species hybrid poplar whips in 300-millimeter diameter boreholes over a 1,230-square meter grid. Phase II of the pilot study was initiated with the planting of 273 additional trees in the spring of 2018, consisting of multiple species of poplars and willows. Groundwater elevations were monitored continuously within, and outside of, the test plot to assess hydraulic containment developed via uptake of groundwater by poplar trees. Tree health was monitored via trunk diameter and tree height measurements, leaf appearance, and leaf tissue analysis. Soil and groundwater chemistry in the test plot were analyzed for factors that may affect tree health. In addition, a carbon dioxide (CO_2) flux survey was conducted using isotopic speciation of CO_2 emitted from the plot to assess phytoremediation effectiveness in enhancing the rate of hydrocarbon degradation.

Results/Lessons Learned. After nine months of growth of the Phase I plot, tree health ranged from trees over 4 meters tall with healthy leaf stock, to trees that were no longer viable. The observed mortality rate for Phase I was higher than anticipated. The tree health data collected during this 9-month period was assessed, and primary and secondary factors in tree mortality were identified. These include: length of aboveground whip exposure at initial planting, tree planting date, lack of irrigation, boron and salt concentrations within soil and groundwater, hydrocarbon concentrations in shallow soil beneath the test plot, and damage caused by poplar borers and rabbits. The selection and planting of trees for Phase II of the pilot study incorporated lessons learned from the analysis of the Phase I data. Early data collection from the Phase II plot suggests that the tree mortality factors identified in Phase I are being successfully mitigated as a result of modifications in the tree planting procedure, tree species selection, and timing of planting. Tree health parameters, groundwater elevation data, as well as CO_2 flux and isotopic analyses indicate that the mitigation measures implemented have resulted in a more effective phytoremediation remedial approach for the site.