Long-Term Monitoring (1993-2007) of the Effect of Hybrid Poplar Trees on a Petroleum-Hydrocarbon Contaminated Ground-Water System

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Changes in ground-water levels and contaminant geochemistry were observed in a coal-tar contaminated shallow aquifer near Charleston, South Carolina, before and after the installation of a hybrid poplar tree grove. The grove was planted in the fall of 1998 as part of site remediation activities, and consisted of about 600, 6-ft rooted hybrid poplar cuttings. Monitoring wells, tree-tissue samples, and sap-flow monitoring were performed to evaluate the performance of the site.

Ground-water levels decreased about 3.5 ft across the planted and unplanted areas of the site between 1998 and late 2000 due to regional drought conditions in the Southeast. After 2001, however, decreases in ground-water levels in the *planted* area were about 1-ft deeper than measured in *unplanted* areas. Estimates of water flow through the 7-year old trees using sap-flow instruments indicate that the poplar trees are transpiring near 5 gallons of water per day per tree.

Long-term monitoring activities indicate that the hybrid poplars also have decreased ground-water contaminant concentrations in *planted* areas to a larger extent than observed in *unplanted* areas. The magnitude of the observed decrease in ground-water contaminant concentrations in the *planted* area is dependent upon the presence of absence of pockets of coal-tar Dense Non-Aqueous Phase Liquid (DNAPL) beneath the trees. In the planted areas *not* characterized by DNAPL, milligram per liter concentrations of benzene, toluene, and naphthalene in monitoring wells have decreased since 2000 by an average of 85%, 83%, and 82%, respectively. These areas exhibited a seasonal variation in dissolved-phase contaminant concentrations, with the lowest concentrations observed during spring/summer when transpiration rates and ground-water uptake by the hybrid poplar trees were measured to be at a maximum. Higher ground-water concentrations were observed during fall/winter after tree leaf-drop and decreased transpiration rates. Benzene, toluene, and naphthalene, as well as other coal-tar related PAH's, such as styrene, were detected in various tree tissues sampled during the summers when the concentrations in ground water were the lowest. In areas where DNAPL existed beneath the trees, concentrations of benzene, toluene, and naphthalene have decreased only an average of 32%, 55%, and 49%, respectively.

These data collected before, during, and after the installation of a hybrid poplar tree grove suggest that their affect on the ground-water hydrology and contaminant levels occurs on a seasonal basis at this site. There is a long-term trend in decreasing dissolved-phase contaminant concentrations in ground water beneath the trees in areas with no DNAPL present. Overall, these data stress the importance of the collection of long-term monitoring data to assess the effectiveness of planted hybrid poplar trees on ground-water hydrology and contaminant geochemistry in contaminated ground-water systems.

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