Containment of a 1,4-Dioxane Plume Using TreeWell® Phytoremediation Technologies

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Background/Objectives. The site is a large chemical production plant with operations that included the production of 1,4-dioxane. Historical activities resulted in elevated concentrations of 1,4-dioxane in groundwater at the site with concentrations as high as 1,500 mg/L in the downgradient groundwater plume. Groundwater monitoring results indicated the 1,4-dioxane plume was migrating towards a nearby surface water body. Therefore, a remedy to contain the plume and mitigate the potential for discharge to the nearby surface water body was needed while a source area remedy was being designed and implemented. However, typical containment alternatives are both labor and energy intensive and are unattractive when considering economic and sustainability considerations. Therefore, a more economic and sustainable nature based remedial alternative was desired.

Approach/Activities. It was determined that a remedial alternative utilizing a *TreeWell*® system would be an appropriate sustainable alternative for containing the 1,4-dioxane plume via pump and treat. The *TreeWell*® system was designed based on site hydrologic calculations, site lithology, and accounting for the space available for planting at an active chemical plant. The *TreeWell*® system was installed to target groundwater impacts from 5 to 11 meters below ground surface (m bgs). A total of 240 *TreeWell*® units were installed and planted with poplars. The *TreeWell*® system was designed and installed with the understanding that the trees would consume groundwater impacted with 1,4-dioxane and transpire the 1,4-dioxane to the atmosphere where it would ultimately be photodegraded in the atmosphere, thus preventing the 1,4-dioxane impacted groundwater from reaching the nearby surface water body.

Results/Lessons Learned. Groundwater monitoring results since the trees were planted in 2014 demonstrate that the *TreeWell*® units are actively drawing the groundwater plume into the phytoremediation area during the active growing season, thereby providing the desired containment. However, evaluations of the 1,4-dioxane mass being transpired by the trees indicated that less than 0.1% of the mass being drawn into the phytoremediation area was being transpired by into the atmosphere by the trees. Additional investigations proved that 1,4-dioxane-degrading activity is present in soil fromÂ within the *TreeWell*® units. The occurrence of 1,4-dioxane biodegradation was supported by detection of genes encoding for dioxane monooxygenase and aldehyde dehydrogenase, enzymes associated with biodegradation of 1,4-dioxane. The data from this site indicate the efficacy of a *TreeWell*® based alternative for addressing 1,4-dioxane in groundwater.