# Implementation of a Hybrid Poplar Phytoremediation Program for TCE at an Arid, Fractured Bedrock Site

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**Background/Objectives.** Several areas within a former industrial facility in Southern California are being remediated for volatile organic compounds (VOCs), predominantly trichloroethene (TCE) in groundwater. In one area, recent concentrations range from approximately 1,400 micrograms per liter (µg/L) to 24,000 µg/L, exceeding cleanup levels. In this area, the plume is well-defined, bounded to the north, east and west. Groundwater flows slowly to the south towards an ephemeral stream. Geochemical indicators (e.g., dissolved oxygen, oxidation-reduction potential, presence of methane, and elevated cis-1,2-dichloroethene and vinyl chloride concentrations) suggest that natural attenuation processes are occurring in the vicinity of the ephemeral stream. Due to the subsurface conditions in this area (low permeability alluvium/degraded bedrock overlying fractured bedrock), remedial technologies used elsewhere at the site were not feasible, and phytoremediation was identified as the remedial alternative. Pilot studies (field and bench-scale) were conducted to assist in development of a full-scale phytoremediation design.

**Approach/Activities.** A field study was conducted to evaluate the presence of TCE in tree tissue, and qualitative relationships, if any, with nearby groundwater. The study included collection of 20 tree core samples, and analysis of headspace concentrations of VOCs from the tree tissue. Groundwater from monitoring wells near the cored trees was also analyzed for VOCs. The results of the field study confirmed that TCE was present in most of the trees sampled at the site, and correlated well with observed groundwater concentrations.
A bench-scale study was conducted to evaluate growth rates of candidate tree species, and assess tolerance to high salinity soils at the site. Two hybrid poplars were selected, and trees were installed in March 2016. This presentation summarizes the installation methods and irrigation design, and provides the results of the first two years of growth, including tree tissue and groundwater sampling results to evaluate changes in groundwater geochemistry, VOC concentrations, and biodegradation conditions.

**Results/Lessons Learned.** A variety of challenges have resulted in modifications to the phytoremediation system in the first year, including varied irrigation needs in different areas of the plantation; mortality (drought/pests/unknown factors); pest management (aphids, ground animals); inconsistent tree establishment; and poor irrigation water quality. Ramboll Environ has worked with an outside vendor to obtain advice and assist with tree establishment and progress monitoring, and to address these challenges during the first two years of tree growth. Current growth success demonstrates that despite obvious hurdles, this remediation technology can be feasible in an arid, fractured rock environment.