

## Enhanced Degradation of TCE on a Superfund Site Using Endophyte-Assisted Poplar Tree Phytoremediation

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**Background/Objectives.** Trichloroethylene (TCE) is a widespread environmental pollutant common in groundwater plumes associated with industrial manufacturing areas. We had previously isolated and characterized a natural bacterial endophyte, *Enterobacter* sp. strain PDN3, of poplar trees, that rapidly metabolizes TCE, releasing chloride ion. Our objectives were to test the performance this poplar endophyte on a TCE-contaminated Superfund field site.

**Approach/Activities.** A three-year field trial of endophyte-assisted phytoremediation was conducted on the Middlefield-Ellis-Whisman Superfund Study Area TCE plume in the Silicon Valley of California. Parameters measured were effects on tree growth, TCE content inside trees, soil chloride, upgradient and down gradient groundwater VOC levels.

**Results/Lessons Learned.** The results from this study (recently published in ES&T <http://pubs.acs.org/doi/abs/10.1021/acs.est.7b01504> ) showed that the inoculated poplar trees exhibited increased growth and reduced TCE phytotoxic effects with a 32% increase in trunk diameter compared to mock-inoculated control poplar trees. The inoculated trees excreted 50% more chloride ion into the rhizosphere, indicative of increased TCE metabolism *in planta*. Data from tree core analysis of the tree tissues provided further supporting evidence of the enhanced rate of degradation of the chlorinated solvents in the inoculated trees. Test well groundwater analyses demonstrated a marked decrease in concentration of TCE and its derivatives from the tree-associated groundwater plume. The concentration of TCE decreased from 300 µg/L upstream of the planted area to less than 5 µg/L downstream of the planted area. TCE derivatives were similarly removed with cis-1,2-dichloroethene decreasing from 160 µg/L to less than 5 µg/L and trans-1,2-dichloroethene decreasing from 3.1 µg/L to less than 0.5 µg/L downstream of the planted trees. 1,1-dichloroethene and vinyl chloride both decreased from 6.8 and 0.77 µg/L, respectively, to below the reporting limit of 0.5 µg/L providing strong evidence of the ability of the endophytic inoculated trees to effectively remove TCE from affected groundwater. The combination of native pollutant-degrading endophytic bacteria and fast-growing poplar tree systems offers a readily deployable, cost-effective approach for the degradation of TCE, and may help mitigate potential transfer up the food chain, volatilization to the atmosphere, as well as direct phyto-toxic impacts to plants used in this type of phytoremediation.