AEREOBIC COMETABOLIC BIOREMEDIATION

An emerging in-situ remediation technology to address groundwater impacted with 1,4-dioxane, aerobic cometabolic bioremediation, was investigated as a possible cleanup technology for this site. In aerobic cometabolic bioremediation, select indigenous microorganisms (methanotrophs) are stimulated by adding oxygen and a growth substrate to produce a class of contaminant-degrading enzymes, mono-oxygenases (MOs).

Several types of MOs have been shown to degrade 1,4-dioxane including methane mono-oxygenase (MMO), butane mono-oxygenase (BMO), propane mono-oxygenase (PMO), and toluene mono-oxygenase (TMO). Many indigenous soil bacteria possess the genetic coding to produce one or more of these enzymes, and are therefore capable of degrading 1,4-dioxane. The majority of these microorganisms degrade 1,4-dioxane cometabolically, meaning 1,4-dioxane is a secondary substrate that is fortuitously degraded as the MOs metabolize a primary target growth substrate (i.e., methane, propane, butane, etc.). Thus, adequate oxygen, nutrients, carbon and energy sources are required to facilitate aerobic cometabolic bioremediation of 1,4-dioxane.

The laboratory studies were conducted using soils and groundwater from the site to determine the applicability of this technology for in-situ degradation of 1,4-dioxane and chlorinated solvents. Three variables were assessed in the laboratory to optimize the performance of the field study:
1. Electron Donor/Growth Substrate: Methane, butane, and propane were assessed in microcosms studies.
2. Propane-Air-Cycle: Different duration cycles of propane and air were assessed to determine optimum exposure conditions to stimulate MO producing bacteria.
3. Nutrient Conditions: Different trace nutrient mixtures were added to microcosms to determine if nutrient conditions might affect the rate of growth.

Results from the studies indicated that methane, propane, and butane worked well to stimulate bioremediation for 1,4-dioxane. Furthermore, results showed that the addition of nitrogen, phosphorus, and molybdenum trace nutrients provided optimal microbial growth and degradation of the target contaminants.