TBA Remediation Approaches at Two Distinct Sites: One Large-Scale and One with Really High Concentrations

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Background/Objectives. The impacts of tertiary-butyl alcohol (TBA) in groundwater appear to be long lasting and widespread, compared to its parent compound methyl tert-butyl ether (MTBE) as well as other site chemicals of concern, as demonstrated at two distinctly different sites in California. One site is a complex, large-scale industrial petroleum facility with a TBA plume above action levels (12 µg/L) covering an area of up to 110 acres and extending to approximately 150 feet below ground surface. The other site is an active emergency response facility with TBA impacts from historical gasoline underground storage tanks (USTs) with concentrations up to 2,200,000 µg/L. The approach to remediation at these sites is similar from a technological perspective, but vastly different in logistics and scale.

Approach/Activities. At the petroleum facility, given the scale and complexity, a bench-scale treatability study was conducted using site soils and groundwater comparing in situ chemical oxidation (ISCO) using base-activated sodium persulfate (BASP) with several approaches to in situ aerobic bioremediation (ISAB), testing for direct metabolic (oxygen and diammonium phosphate ([DAP]), enhanced cometabolic (oxygen, DAP, and propane), and bioaugmented cometabolic bioremediation (oxygen, DAP, propane, and ENV425 [APTIM]). The selected remedy for the UST site was ISCO using BASP and a tight grid of direct-push injection points (5-foot centers) to target up to 50% of pore spaces in a predominant clay and elastic silt geology in the source area (20 to 35 ft bgs). Two injection events were performed (2019 and 2022) and a total of approximately 14,000 pounds of sodium persulfate, 2,800 gallons of 25% sodium hydroxide, and 17,000 gallons of solution were injected. Because of the elevated concentrations of TBA (and MTBE) released into the dissolved-phase, biosparging is also being implemented to enhance the source area remedy via ISAB.

Results/Lessons Learned. The treatability study for the large petroleum facility exhibited rapid and effective degradation of TBA by both ISCO and aerobic bioremediation technologies; however, the degradation was complete for all biological approaches by Day 25 of the study while the BASP ISCO treatment stalled after 18 days at approximately 70% reduction. The performance of the metabolic approach was surprising given that degradation does not appear to be occurring under natural conditions, which are not oxygen-limited. Therefore, the addition of oxygen and nutrients (DAP) is a viable and cost-effective solution to a large-scale and deep TBA plume at this site. Complete biodegradation of co-contaminant 1,2-dichloroethane (DCA) was exhibited for both cometabolic approaches between Day 25 and 65 of the study, corresponding to highly active propane-oxidizing bacteria as evidenced by propane consumption and propane monooxygenase enzymes. BASP ISCO achieved 70% reduction in the concentration of 1,2-DCA while the metabolic bioremedy achieved 40% reduction.

At the UST site, historical concentrations of MTBE and TBA indicate natural attenuation of several orders of magnitude and conversion of MTBE to TBA near the former source area. Following ISCO injections, order of magnitude increases were exhibited in short term and followed by concentration reductions over a few months. While that is a desired effect of ISCO, repeated rebound at monitoring wells located nearest the former UST suggest the presence of residual mass and continuous back diffusion out of the silts and clays. The uncertainty of how

many rounds of injections would be required to diminish the rebound led to consideration of physical removal and/or ISCO soil mixing.