Enhanced Bioremediation of Contaminated Groundwater at Berkeley Lab, Using Hydrogen-Release Compound®

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RESEARCH OBJECTIVES

The U.S. Department of Energy is actively pursuing innovative, cost-effective methods of remediating contaminated groundwater at its facilities, including Berkeley Lab. The accidental release of solvents used at Berkeley Lab decades ago resulted in contamination of underlying groundwater at several onsite locations. Several groundwater cleanup technologies have been deployed to address the contamination, including conventional groundwater extraction and treatment, soil washing, chemical oxidation, thermally enhanced dual vapor and groundwater extraction, natural attenuation, and enhanced bioremediation. Among these, enhanced bioremediation is a particularly promising, innovative cleanup technology that reduces contaminant levels below regulatory standards in a relatively short period of time.

APPROACH

Indigenous bacteria found in groundwater are known to biodegrade chlorinated solvents, leading to the natural attenuation of groundwater contaminant plumes. Unfortunately, natural attenuation can be a relatively slow process, potentially taking decades to reduce contaminant levels below cleanup requirements. Therefore, supplements that promote bacteria growth can be added to the groundwater to help enhance natural bioremediation and expedite cleanup. This technique is referred to as enhanced bioremediation.

An *in situ* pilot study performed at Berkeley Lab's Building 71B successfully demonstrated rapid biodegradation of chlorinated solvents, within nine months of injecting concentrated glycerol tripolylactate ester into contaminated groundwater. Gycerol tripolylactate (sold under the trade name Hydrogen Release Compound, HRC®) is a commercially available, dense, viscous liquid that is highly soluble in water. Full-scale treatment of the contaminated area, located beneath and downgradient of the building, is currently under way using dilute HRC®. Groundwater is mixed with HRC® and heated in an aboveground bioreactor to stimulate quick bacterial growth, then injected into a drainfield located within the footprint of the building at the source. An existing groundwater pump and treat system, located downgradient from the source, hydraulically controls the plume and supplies water to the drainfield, thus distributing HRC® throughout the contaminated area.

ACCOMPLISHMENTS

Dissolved oxygen and oxidation-reduction potentials rapidly decreased in groundwater within three weeks of HRC® injection. This rapid decrease indicates that reducing conditions favoring anaerobic biodegradation of solvents quickly developed after introducing HRC®. More importantly, total contaminant levels in groundwater decreased throughout the winter months, in contrast to normal trends when concentrations increased because of winter recharge and rising water table conditions (Figure 1).

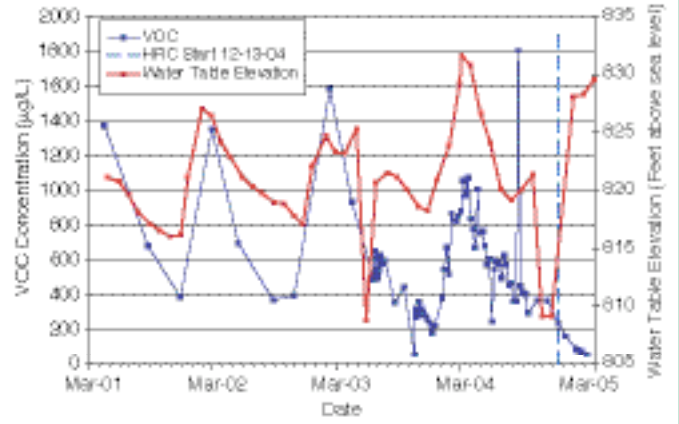

Figure 1. Total VOC concentrations increase every year when the water table beneath Building 71B rises because of winter rains. This trend ended after injecting HRC®.

SIGNIFICANCE OF FINDINGS

HRC® is typically applied by direct injection of the concentrated product into the subsurface, using a dense network of direct push or conventionally drilled borings. The size and depth of the plume, which controls the number of borings and amount of HRC® applied, can have a significant impact on remediation costs. Our study shows that HRC® can be successfully incorporated into an existing conventional groundwater extraction system by injecting it into the subsurface in its dilute form. Additional time is needed to study our approach to assess whether biofouling by bacteria will reduce the permeability of the drainfield, production well, or porous material, rendering our approach ineffective. However, few viable alternatives are available that can be used to treat contaminated soils beneath an existing structure, as with HRC®.

ACKNOWLEDGMENTS

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