Project

Team shows effectiveness of small-footprint groundwater remediation technology–

Higher than 95%

contaminant degradation

10 times

rate of impacted water flow in our previous test

Approx. 35%

cost savings vs. conventional pump-and-treat approach

Summary

- The U.S. Department of Defense (DOD) wanted to find a cheaper, more efficient solution for remediating large, deep, dilute groundwater plumes.–
- Backed by competitive DOD funding, Haley & Aldrich honed an existing remediation approach to shrink the aboveground footprint of the installation needed to perform the work.–
- This technology involves a new approach to achieve an effective 1,4-dioxane treatment through a belowground bioreactor and, at the same time, to reduce bioclogging.-
- A field test at a DOD site in Arizona successfully demonstrated the feasibility of this small-footprint treatment technology for large, deep, dilute groundwater plumes that can save costs and minimize site access constraints on groundwater cleanup.-

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Client challenge

Military and industrial sites around the world face problems with legacy contamination from commingled plumes containing 1,4-dioxane and chlorinated volatile organic compounds (CVOCs). 1,4-dioxane resists treatment through conventional remediation methods, such as granulated activated carbon (GAC) adsorption and air stripping, which can readily remove most CVOCs.–

The challenges multiply when the contaminants are found in large, deep, dilute plumes of groundwater. In dilute plumes, because of the lower concentration of contaminants, it's more difficult to ignite the chemical reactions that degrade them. It is also more difficult to access the plume and design an effective treatment system that is not prohibitively large and expensive, especially when the plume reaches a heavily populated residential community.–

In other words, remediating these plumes pushes the limits of existing technology. The U.S. Department of Defense (DOD) wanted to find a better solution — one that would efficiently resolve contamination that originated from DOD sites without disrupting the community around them. The DOD also wanted a technology that would not take up excessive space with piping and an aboveground treatment complex.–

The DOD called for proposals to develop a new technology via its Environmental Security Technology Certification Program. Haley & Aldrich's Applied Research Program, which has a proven track record on DOD-funded environmental research projects, won the highly competitive opportunity. After a successful proof-of-concept trial at an Air Force site, we planned to field-test our technology on a larger scale at a DOD site in Arizona.-

Our approach

The Haley & Aldrich team drew on previous research into remediating 1,4-dioxane and CVOCs through recirculation-based aerobic cometabolic biodegradation. This approach uses a microbial agent to treat contaminants, recirculating groundwater through a belowground bioreactor for 1,4-dioxane treatment and an aboveground GAC unit to treat some CVOCs (such as 1,1-dichlorethene, trichloroethene and 1,1,1-trichlorethane) that may not be readily treated by the belowground bioreactor.–

We wanted to show that we could save time and money and deploy this method with a smaller footprint — without, of course, making it less effective. To be successful, we would need to control the extent of bioclogging (microbial growth that clogs up the injection well and reduces water flow for treatment). We would also need to move some of the treatment process (primarily for 1,4-dioxane) belowground, which would both shrink the aboveground footprint and save time and money.–

At the Arizona site, we tested our approach on a dilute plume that measured about half a mile wide and 150 feet deep. We used an angled extraction-injection well pair to recirculate contaminated groundwater. First, several recalcitrant CVOCs were removed when extracted groundwater passed through a sized-down aboveground GAC unit. Then, the system introduced propane and oxygen to the recirculated groundwater and reinjected it back into the plume — a step that promoted aerobic cometabolic bacteria to degrade 1,4-dioxane belowground. To counteract bioclogging, we fine-tuned how much propane and oxygen were fed to aerobic cometabolic bacteria and injected a substance to slow microbial growth.–

After 270 days of system treatment operation and performance optimization, the test proved successful — our technology demonstrated a faster water flow rate than that of our previous test and achieved approximately 99% removal for CVOCs and 96% for 1,4-dioxane. The results show the promise of this approach for solving some of our most difficult groundwater contamination challenges.

Value delivered

- Increased the water flow rate by about 10 times the rate of our previous test, lending insights into how we can continue to speed up and scale up treatment-
- Achieved more than 95% contaminant degradation, beating our goal of 90%-
- Demonstrated the feasibility of a small-footprint treatment technology for large, deep, dilute groundwater plumes, which can save costs and minimize site access constraints on groundwater cleanup
- Reduced remediation cost by approximately 35% compared to a conventional pump-and-treat system for a hypothetical remediation scenario-
- Added to scientific and engineering understanding of remediation practices by publishing ajournal article that reviews the lessons learned from this and similar field tests. We're also developing an open-source design tool that will help people know whether they want to adopt this technology.-

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