FACT SHEET

REVISED INTERNAL DRAFT
BOUNDARY TREATMENT TECHNOLOGY EVALUATION

NASA AMES RESEARCH CENTER
MOFFETT FIELD, CALIFORNIA

INTRODUCTION

The National Aeronautics and Space Administration (NASA) Ames Research Center (ARC) is conducting a technology evaluation for addressing a chlorinated solvent plume migrating onto Ames. The goal of this evaluation is to develop a preferred voluntary protective action (VPA) to stop the migration of chlorinated solvents in the groundwater. These solvents are currently entering Ames property from the upgradient Orion Park Military Housing Area (OPHA) (see Figure 1).

Several investigations conducted by Ames have determined that the solvents discovered in Area of Investigation (AOI) 4 are migrating from OPHA. Records of trichloroethene (TCE) in monitoring wells at Ames have shown the presence of TCE as far back as 1991. Ames is proactively addressing the quality of groundwater flowing onto its property. Ames is voluntarily evaluating and plans to install a treatment technology to prevent the continued migration of contamination from OPHA into uncontaminated areas at Ames. This evaluation considers proven technologies and process options to effectively treat chlorinated solvents as they flow onto Ames, while avoiding hydraulic effects that could potentially accelerate groundwater flow and chemical transport across the boundary.

TREATMENT GOAL

This VPA is designed to treat dissolved chlorinated solvents, primarily TCE and 1,2-dichloroethene (1,2-DCE), in the A1 aquifer zone groundwater as they flow onto Ames. Investigations to date have identified an approximately 300-foot-wide portion of the boundary treatment area that contains a shallow sand channel deposit and coincides with the most concentrated part of the chlorinated solvent plume.

This VPA is intended to treat the bulk of the solvent plume by targeting this sand channel deposit. This 300-foot-wide portion of the boundary will hereafter be referred to as the boundary treatment zone.

The treatment goal for groundwater that passes through the boundary treatment zone is 0.5 microgram per liter (μg/L) for TCE and 6.0 μg/L for 1,2-DCE. The treatment goal is based on maximum containment levels (MCL) for 1,2-DCE and the revised toxicity value for TCE. The current MCL for TCE is 5 μg/L. The Environmental Protection Agency (EPA) is re-evaluating the MCL for TCE and will most likely decrease it in the future.

IDENTIFICATION AND SCREENING OF TECHNOLOGIES

The purpose of the planned VPA is to intercept and treat dissolved chlorinated solvents as they enter Ames from the OPHA. Developing appropriate treatment alternatives involves evaluation of technology types and process options that are most effective, implementable, and cost effective. Appropriate technology types were identified and evaluated on the basis of applicability to site-specific conditions.

DESCRIPTION OF SELECTED TECHNOLOGIES

Four technologies were chosen for consideration as alternatives to intercept and treat the solvent plume. The technologies are (1) Zero Valent Iron (ZVI) permeable reactive barrier (PRB), (2) in situ chemical oxidation, (3) in situ enhanced reductive dechlorination, (3a) direct injection of Hydrogen Released Compound (HRC) through boreholes, (3b) injection-extraction recirculation treatment with addition of lactate, and (4) an air sparge wall (see Table 1).

Alternative 1: Permeable Reactive Barriers (PRB)
PRBs are subsurface vertical treatment media that are designed to intercept and treat groundwater plumes. As opposed to impermeable barriers, such as slurry walls, PRBs are intended to direct or induce flow toward a reactive media, thus intercepting and treating the plume.

PRBs are considered to be a promising alternative to pump-and-treat systems because of the passive nature of the system. This technology is especially well suited for chlorinated hydrocarbons, such as TCE, which are likely to persist in groundwater for decades. Once installed, the system requires little or no maintenance for a number of years.

Alternative 2: In Situ Chemical Oxidation

In situ chemical oxidation involves the injection of chemical oxidants into soil and/or groundwater to oxidize and degrade contaminants. Chemical oxidation has been shown to degrade chlorinated hydrocarbons, polyaromatic hydrocarbons, and petroleum products. The three most commonly used oxidants for in situ chemical oxidation are hydrogen peroxide, potassium (or sodium) permanganate, and ozone.

Alternative 3: In Situ Enhanced Reductive Dechlorination

Alternative 3 is enhanced reductive dechlorination through the addition of electron donors to the affected media. It can be implemented as a barrier technology by (1) direct injection of amendments through cased or uncased boreholes, or (2) injection of amendments through a recirculating well system. Alternative 3A will be direct injection of HRC through direct push boreholes, and Alternative 3B will be recirculating the well treatment system with the addition of lactate.

Alternative 4: Air Sparge Barrier Trench and Soil Vapor Extraction (SVE)

Air sparging is an in situ technology in which air is injected into the saturated zone below or within the chemical plume through a system of injection wells. The injected air flows vertically and horizontally in channels through the soil column. As air rises through the formation, it volatilizes chlorinated hydrocarbons adsorbed to soils and dissolved in groundwater. Although the primary treatment mechanism of air sparging is volatilization, the increase of oxygen in the subsurface can also enhance aerobic biodegradation.

Air sparging is a common and well-proven technology that is generally implemented to treat an entire area of chemicals, where sparging wells are installed as an array that spans the chemical plume. Air sparging can, however, be implemented as a barrier trench technology by installing sparge wells in a line perpendicular to groundwater flow. As groundwater flows through the air sparge barrier trench, chemicals are volatilized, collected by the SVE wells, and treated groundwater flows downgradient of the barrier. SVE is almost always used with air sparging. SVE is required to remove vapors volatilized by sparging. SVE removes vapors and treats extracted air before discharge to the atmosphere.

DETAILED ANALYSIS OF ALTERNATIVES

The purpose of the detailed analysis of alternatives is to better define the design characteristics of the alternatives, analyze the alternatives against evaluation criteria, and compare the alternatives against each other.

Evaluation criteria used in this technology evaluation are modeled after EPA's guidance for conducting feasibility studies under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (EPA 1998). The six criteria used to evaluate each alternative are: (1) Treatment effectiveness and overall protectiveness of human health and the environment, (2) Regulatory compliance, (3) Long-term effectiveness and permanence, (4) Short-term effectiveness, (5) Implementability, and (6) Cost.

All alternatives provide overall protection to human health and the environment and comply with state and federal regulations. The major differences among these alternatives are implementability, treatment effectiveness, regulatory compliance and cost.

PREFERRED ALTERNATIVE

Based on the effectiveness, implementability, and cost criteria presented, Alternatives 2, 3A and 3B appear to be less suited than Alternatives 1 and 4 to this particular application over a projected 30-year period.

Alternatives 1 and 4 appear to be better suited for the goal of this VPA considering the long timeframe that may be required for this action. Furthermore, Alternative 1 is preferable to Alternative 4 because of Ames' preference to minimize the long-term Operation and Maintenance (O & M) effort. Alternative 1, therefore, is the preferred alternative for the VPA.

CONTACT INFORMATION AND COMMENTS

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TABLE 1: COMPARATIVE ANAYLSIS OF ALTERNATIVES

CRITERION	Alternative 1: Permeable Reactive Trench (PRB)	Alternative 2: Chemical Oxidation	Alternative 3: Enhanced Reductive Dechlorination		Alternative 4: Air Sparge Trench and Soil Vapor Extraction (SVE)
			3A: Array of Injection Points	3B: Recirculation Zone	
Overall Protectiveness & Treatment Effectiveness	Protective because TCE & 1,2-DCE would be reduced to ethane, which is non-toxic. Effectiveness depends on adequate contact between iron and groundwater.	Protective because TCE & 1,2-DCE would be reduced to ethane, which is non-toxic. Recirculation improves performance by improving contact between chemicals and oxidant.	Protective because TCE & 1,2-DCE would be reduced to ethane, which is non-toxic. HRC injection is a well-established technology with treatment efficiencies as high as 100%, but effectiveness is site specific.	Protective because TCE & 1,2-DCE would be reduced to ethane, which is non-toxic. Effectiveness is improved through implementation of a recirculation zone, because the treatment zone would be contained and monitored until treatment goals are achieved.	Protective because TCE & 1,2-DCE would be removed from the groundwater through volatilization and treated in the vapor phase to nontoxic levels. A pilot test would be recommended to confirm effectiveness of the trench.
Regulatory Compliance	Meets applicable statutes and regulations.	Meets most applicable statutes & regulations. The recirculation of groundwater & permanganate could trigger issues with the SWRCB that would need to be resolved.	Meets applicable statutes and regulations.	Meets most applicable statutes & regulations. The recirculation of groundwater & lactate could trigger issues with the SWRCB that would need to be resolved.	Meets applicable statutes and regulations.
Long-Term Effectiveness & Permanence	The system would require almost no routine maintenance during operation, but may have to be replaced or regenerated at least once during the 30-year operating period.	Oxidant recirculation would operate as long as required. Injection wells would be monitored and cleaned periodically to remove precipitates.	HRC injection would last for 3 years and, thereaftere, require injections every third year. Assuming injections continue, chlorinated hydrocarbons that flow through the barrier would be treated.	Maintenance to remove occasional biofouling of wells and occasional alterations in amendments and doses would be regularly required.	An air sparge trench would require blower maintenance and operation & maintenance of the vapor treatment system. Chlorinated hydrocarbons that pass through the barrier would be treated.
Short-Term Effectiveness	After installation, the PRB will begin treating chemicals immediately. Once installed, the limited operation & maintenance required will protect workers from exposure.	Construction would last 3 months. Caution must be used when handling solid or liquid oxidant or when operating the system.	Construction would last 2 months. Treatment of TCE and 1,2-DCE would be expected a few months after installation.	Construction would last about 3 months. TCE and 1,2-DCE would be contained immediately, and treatment would be expected after a few months of operation.	Continuous trenching techniques will last about 2 months & will limit the amount of IDW produced. About 440 cy of contaminated soil would be excavated to install the trench & would require disposal.
Implementability	Continuous trenching is commonly used for installation of PRBs. Requires no external equipment or controls and no routine maintenance.	The installation of injection & extraction wells involves commonly used drill techniques. A sophisticated control system is required.	HRC injection is straightforward; however, amendment addition type, frequency and amount may require evaluation over time based on monitoring results.	A sophisticated control system is required. Extensive monitoring would be required for the first year to monitor system effectiveness.	An air sparge trench would require specialized trenching & horizontal well screen design. Monitoring & other O&M requirements would be minimal.
Cost	Capital cost is $1,640,000; annual O&M cost is $70,000	Capital cost is $1,440,000; annual O&M cost is $150,000	Capital cost is $750,000; annual O&M cost is $110,000	Capital cost is $1,130,000; annual O&M cost is $150,000	Capital cost is $970,000; annual O&M cost is $100,000

ACRONYMS

1,2-DCE	1,2-Dichlorothylene
AOI	Area of Investigation
cy	Cubic yard
DCE	Dichloroethene
EPA	Environmental Protection Agency
HRC	Hydrogen Released Compound
IDW	Investigation-derived Waste
O&M	Operation & Maintenance
MCL	Maximum containment levels
OPHA	Orion Park Military Housing Area
PRB	Permeable reactive barrier
SVE	Soil Vapor Extraction
SWRCB	State Water Resource Board
TCE	Trichloroethene
ZVI	Zero valent iron

PUBLIC REVIEW SCHEDULE

The Revised Internal Draft Bound: Draft Treatment Technology Evaluation document will be available from July 15 to August 29, 2003.

COPIES OF THE DRAFT DOCUMENT

Copies of the Revised Internal Draft Bound: Draft Treatment Technology Evaluation are available at:

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FIGURE 1: ORION PARK HOUSING AREA AND SOLVENT PLUME