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1995

EPA Superfund
Record of Decision:

DOVER AIR FORCE BASE
EPA ID: DE8570024010
OU 10
DOVER, DE
09/26/1995

Text:

RECORD OF DECISION
DECLARATION OF THE SELECTED INTERIM REMEDY

Site Name and Location

Target Area 2 of Area 6, West Management Unit, Dover Air Force Base, Ke County, Delaware.

Statement of Basis and Purpose

This Record of Decision (ROD) presents the selected interim remedial ac for Target Area 2, which was chosen in accordance with the requirements of th Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 U.S.C Section 9601 et seq., and, to the extent practicable, t National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CF Part 300. This decision prepared by the U.S. Air Force, the lead agency, as owner/operator of the Base is based on the Administrative Record for the Site Support was provided by the U.S. Environmental Protection Agency (EPA) Region III and the Delaware Department of Natural Resources and Environmental Contro (DNREC).

The State of Delaware and the U.S. Environmental Protection Agency concu with the selected interim remedy. The information supporting this interim re action decision is contained in the information repository for the Administra Record located at the Dover Public Library, Dover, Delaware.

Assessment of the Site

Four regions were identified in Area 6 where shallow groundwater contain combined concentrations of the chlorinated solvents trichloroethene, perchlor and 1,2-dichloroethene in excess of 1,000 æg/L. These regions were inferred the vicinity of the source areas for the chlorinated solvent plumes present i and were incorporated into areas for remediation termed Target Areas. This R addresses the interim remedy for Target Area 2. The maximum concentration of chlorinated volatile organic compounds in Target Area 2 groundwater was 17,93 æg/L. While a Risks Assessment was not performed specifically for Target Are risk associated with exposure to Area 6 groundwater under a hypothetical futu commercial/industrial land use scenario was 9 x 10-4.

Actual or threatened releases of hazardous substances from this Site, if addressed by implementing the interim response action selected in this ROD, m present a current or potential threat to public health, welfare, or the envir

Description of the Selected Interim Remedy

The selected interim remedy consists of in situ bioremediation of groundwa utilizing accelerated anaerobic biodegration. Accelerated anaerobic biodegra one of the bioremediation technologies being applied to the Target Areas to p the development of alternate and innovative treatment technologies as encoura under CERCLA. Performance of the interim remedy and compliance with applicab or relevant and appropriate requirements will be evaluated in the Final Basew ROD.

Statutory Determinations

The selected interim remedial action satisfies the remedial selection pr requirements of CERCLA and the NCP. The selected interim remedy provides the best balance of trade-offs among the nine criteria required to be evaluated u CERCLA. The selected interim action provides protection of human health and environment, complies with federal and state requirements that are legally ap or revelent and appropriate to the action, and is cost effective. This inter utilizes permanent solutions and alternative treatment technology to the maxi extent practicable, and satisfies the statutory preference for remedies that treatment that reduces toxicity, mobility, or volume as a principal element. Force understands that although this interim remedy may not achieve MCLs for certain contaminants, this interim action is only part of a total remedial ac Base that will be protective of the public health and welfare and of the envi when completed (CERCLA 121d, 42 U.S.C 9621.d).

19 SEP 1995	SEP 26 1995
CHARLES T. ROBERTSON, JR. Date Lieutenant General USAF Air Mobility Command Chairperson, Environmental Protection Committee	THOMAS C. VOLTAGGIO D Hazardous Waste Management Division Direct Environmental Protection Agency Region III

Target Area 2
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RECORD OF DECISION
FOR THE INTERIM REMEDY OF
TARGET AREA 2 OF AREA 6
WEST MANAGEMENT UNIT
DOVER AIR FORCE BASE, DOVER, DELAWARE

August 3, 1995

DECISION SUMMARY FOR THE RECORD OF DECISION
TARGET AREA 2 OF AREA 6
WEST MANAGEMENT UNIT

DOVER AIR FORCE BASE

INTRODUCTION

Dover Air Force Base (DAFB) recently completed a Focused Feasibility Study (FFS) conducted to address chlorinated solvent and pesticide source area contamination in Area 6 of Dover Air Force Base (DAFB), Delaware as an interi response. The FFS was undertaken as part of the U.S. Air Force's Installatio Restoration Program (IRP). The basis for the FFS was the Area 6 Remedial Investigation (RI) report dated July 1994, which characterized contamination evaluated potential risks to public health and the environment. The interim performed as the first phase of Feasibility Studies to be conducted on sites Management Unit, the management unit to which Area 6 belongs. The scope of t FFS was limited to the evaluation of alternatives for remediation of primary chlorinated solvent and pesticide source areas originating in the northern, u portion of the Area 6 region of investigation. The final remediation of sour if necessary, and non-source area contamination in Area 6 posing human health environmental risks will be addressed in the final Base-wide Feasibility Stud

This Record of Decision (ROD) addresses Target Area 2, which is one of t chlorinated solvent source areas evaluated in the FFS. This ROD summarizes t FSS, describes the remedial alternatives that were evaluated, identifies the alternative selected by DAFB, and explains the reasons for this selection. T Environmental Protection Agency (EPA) and the State Delaware concur with the interim remedy selected in this ROD.

As an aid to the reader, a glossary of the technical terms used in this ROD provided at the end of the summary.

PUBLIC PARTICIPATION

The Proposed Plan for this site was issued on June 16, 1995. The public comment period on the Plan was open through July 13, 1995. Documents compris the Administrative Record for the site were available at the Dover Public Lib The only comments received during the public period were from the Remediation Technologies Development Forum expressing support for the propose interim remedy.

SITE BACKGROUND

DAFB is located in Kent County, Delaware, 3.5 miles southeast of the city o Dover (Figure 1) and is bound to the southwest by the St. Jones River. DAFB comprises approximately 4,000 acres of land, including annexes, easements, an property (Figure 2). The surrounding area is primarily cropland and wetlands

DAFB began operation in December 1941. Since then, various military servic have operated out of DAFB. The present host organization is the 436th Airlif Its mission is to provide global airlift capability, including transport of c equipment, and relief supplies.

DAFB is the U.S. East Coast home terminal for the C-5 Galaxy aircraft. The Base also serves as the joint services port mortuary, designed to accept casu the event of war. The C-5 Galaxy, a cargo transport plane, is the largest ai the USAF, and DAFB is one of a few military bases at which hangars and runway designed to accommodate these planes.

The portion of DAFB addressed in this ROD is located within Area 6 of the West Management Unit. The West Management Unit is one of four Management Units into which the Base has been divided (Figure 3). Area 6 is the largest associated areas identifies in the West Management Unit. The Area 6 region o investigation extends approximately 8,400 feet from its northern most point n hardstand and Building 723 to its southern most point near the St. Jones Rive (Figure 4). The area north of U.S. Highway 113 contains the industrialized p

Target Area 2
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of the Area 6 region of investigation. The location addressed in this ROD fa this industrialized portion of Area 6.

DAFB is relatively flat, with elevations ranging from approximately 10 to 3 feet above mean sea level (MSL). The ground surface is covered almost entire buildings, concrete, and asphalt. Surface water runoff throughout the indust portion of Area 6 is controlled by an extensive storm drainage system. The s drains direct most runoff to either Pipe Elm Branch or the golf course tribut St. Jones River.

The Columbia Formation is the shallowest water-bearing unit and holds the water table aquifer. The Columbia Formation typically consists of fine to co grained sand with varying amounts of silt, clay, and gravel. Discontinous le gravel, silt and clay are also common. Generally, the upper portion of the C Formation is finer grained and contains more silt and clay lenses than the de portion. The water table is generally encountered at a depth of 10 to 12 fee ground surface (bgs) in the northern portion of Area 6 and shallows to within feet of the surface in the Base housing area the St. Jones River. The groundwater elevation or potentiometric surface of both the shallow and deep of the Columbia Aquifer range from approximately 13.5 feet MSL in the norther portion to less than 3 feet MSL near the St. Jones River. The thickness of t

Columbia Formation in Area 6 ranges from 28 to 64 feet.

Unconformably underlying the Columbia Formation is the upper unit of the Calvert Formation, which generally consists of gray to dark gray firm, dense clay, with thin laminations of silt and fine sand. This upper silt and clay in thickness from 15 to 21 feet in the northern portion of Area 6. The hydra conductivity of this unit range from 6.83 x 10-3 to 1.53 x 19-3 ft/day (2.41 x 10-7 cm/sec), which are three to five orders of magnitude lower than the ov Columbia Formation. These significantly lower hydraulic conductivities form to the vertical migration of constituents identified in the Columbia Aquifer. Underlying this confining unit is the upper sand unit of the Calvert Formatio

Frederica Aquifer. This aquifer averages 22 feet in thickness in the vicinit No constituents of concern were identified in the three Frederica monitoring installed in Area 6. Additionally, no production wells are installed the Fre Aquifer in the vicinity of DAFB.

Area 6 is defined by the association of chlorinated solvents in groundwater forming a plume in the Columbia Aquifer. Several separate potential sources identified in the Area 6 RI that may have contributed to the chlorinated solv contamination. These potential sources include some of the twelve IRP sites the Area 6 groundwater flow regime shown in Figure 4. Additionally, various and hangars where solvents are used may also be sources. The shop activities solvent use is common include painting or paint stripping, aircraft and vehic maintenance, and plating or welding. The northern most point of chlorinated contamination is the aircraft maintenance area located north of Atlantic Stre chlorinated solvent plumes extend approximately 4,600 feet south into Base Ho

The Area 6 RI identifed four regions where shallow groundwater (i.e., the t ten feet of the Columbia Aquifer) contained combined concentrations of the chlorinated solvents trichloroethene (TCE), perchloroethene (PCE), and 1,2-dichloroethene (DCE) in excess of 1,000 æg/L. These regions were inferred to the vicinity of the source areas for the chlorinated solvent plumes that are Area 6. The groundwater data suggested that primary source areas reside in t vicinity of the following reference points, which were incorporated into area remediation termed Target Areas:

Paint Washout Area m(Site SS59) located along the eastern portion of t open storage yard. (Target Area 1)

Civil Engineering (CE) Shops Area including Building 607 (Carpentry Shop), Building 608 and 609 (Material Control/Supply Offices), Building 615 (Interior and Exterior Electrical Shop, Power Production, Paint Shop, and Sheet Metal Shop), and Building 650 (Sign Shop). (Target Area 2)

Target Area 2
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Building 719 housing the Jet Engine Repair Shop. (Target Area 3)

Buildings 715 and 716 housing the ISO-Dock and an engine storage facility, respectively. (Target Area 4)

The four Target Areas that have been identified are shown in Figure 5. Eac Target Area incorporates one of the primary suspected source areas and the significantly impacted portions of the shallow and deep groundwater plumes as with the respective source area. Plume maps of total chlorinated VOCs in sha and deep groundwater are shown in Figures 6 and 7, respectively. The Target are the regions of chlorinated solvent groundwater contamination that were ev in the FFS.

TARGET AREA/SOURCE AREA CHARACTERISTICS

The following section described the physical and chemical characteristics o Target Area 2, which is addressed in this Record of Decision.

Target Area 2 is located to the east of Target Area 1, originating in the v of the CE Shops and extending south about 1,500 feet. Historically, a vehicl maintenance facility also reportedly resided in the vicinity of the CE shops, another potential source of the contamination. Target Area 2 is elliptically and is approximately 13.1 acres in size. Expanded scale maps of the chlorina solvent plumes residing in the shallow and deep portions of the aquifer withi Area 2 are shown in Figures 8 and 9, respectively. The maximum concentration total chlorinated VOCs in Target Area 2 groundwater was found in the deep Columbia at a concentration of 17,930 æg/L. This detection was made approxim 600 feet downgradient of the CE Shops, and indicates a rapid downward migrati chlorinated constituents in the aquifer in this location.

SUMMARY OF SITE RISKS.

The full Risk Assessment (RA) for Area 6 can be found in the final Area 6 R report dated July 1994. The purpose of the RA is to determine whether exposu site-related contaminants could adversely affect human health and the environ

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The focus of the baseline RA is on the possible human health and environmenta effects that could occur under current or potential future use conditions in that the contamination is not remediated. The risk is expressed as lifetime cancer risk (LECR) for carcinogens, and hazard quotient (HQ) for noncarcinoge For example, and LECR of 1 x 10-6 represents one additional case of cancer in million exposed population, whereas a hazard quotient above one presents a li of noncarcinogenic health effects in exposed populations.

The baseline RA focused on potential pathways by which maintenance and construction workers could be exposed to contaminated materials in Area 6. T workers' exposure to groundwater and soil have been evaluated under a regular maintenance scenario; a future contruction scenario; and a hypothetical futur groundwater use from the Columbia Aquifer under a commercial/industrial scena Although a specific Target Area 2 RA has not been performed, the risk calcula Area 6 Remedial Investigation from the hypothetical future exposure to ground within Area 6 had an LECR of 9 x 10-4, which exceeds the 1 x 10-4 to 1 x 10-6 used to evaluate the need for remediation. In addition to the overall Area 6 Target Area 2 constituents of concern have been compared to the risk-based sc concentrations (RBSCs) developed for the commercial/industrial scenario at DA identify the chlorinated solvents that present a risk-based concern.

The possibility exists for exposure of workers to hazardous substances in s during excavation activities. Source areas identified during excavation will protection as per health and safety protocols. All workers performing excava at DAFB will be health and safety trained for work at CERLA sites.

Based on the direction of groundwater flow, the Area 6 plume extends in a southerly direction towards the St. Jones River. There are no surface water points within Area 6 between the Target Area and the river. Presently, the A

is confined within the Base property and has not reached the St. Jones River.

The future use of groundwater from the Columbia Aquifer by the Base personn quite unlikely and hypothetical. This hypothetical future groundwater use as

groundwater from the Columbia Aquifer will be used for drinking and showering by Base personnel under a commercial/industrial scenario. The RBSCs were com with the maximum detected concentrations of chlorinated solvents in Target Ar (Table 1). Concentrations of five of the six detected chlorinated solvents--dichloroethane, 1,1-dichloroethene, 1,2-dichloroethene, perchloroethene, and trichloroethene--in Target Area 2 exceed their corresponding RBSCs in groundw The concentrations of the other detected compound, 1,1-dichloroethane, was be RBSC.

Actual or threatened releases of hazardous substances from this Site, if no addressed by the selected alternative or one of the other active measures con present a current or potential threat to public health, welfare, or the envir

REMEDIAL ACTION OBJECTIVE

Within the groundwater in Target Area 2, the interim Remedial Action Object (RAO) is to reduce the concentration of each ethyl-based chlorinared volatile compound (VOC) by 90 percent. The ethyl-based chlorinated VOCs include PCE, 1,1-DCE, 1,2-DCE, vinyl chloride, 1,1,1-trichloroethane, 1,1-dichloroethane, dichloroethane. The listed VOCs include primary contaminants and their commo breakdown products. Because these constituents are considered to be the most 90 percent reduction interim RAO is applied to each of these compounds indivi rather than to the aggregate concentration of all the chlorinated VOCs. For consistency, the 90-percent reduction model was based upon the RCRA Post-Clos Permit (Reference No. DE8570024010, Permit No. HW05A05) for Site WP21 of DAFB

which is a unit that adjoins Target Area 3 to the west.

The maximum concentrations of the detected chlorinated solvent compounds in Target Area 2 are summarized in Table 2, along with the compound and Target A specific interim RAO. Table 2 also included interim RAO concentrations for s compounds that have not yet been detected in the Target Area. These select c are chemical degradation products of some of the currently detected chlorinat constituents. Thus, reducing the concentration of detected compounds at the

Table 1

Maximum Concentration Detected of Ethyl-Based Chlorinated Volatiles in Target Area 2, and Corresponding Risk-Based Screening Concentration

Target Area 2

Compound	Maximum Detected	RBSC
1,1-Dichloroethane	5	1,300
1,2-Dichloroethane	150	0.29
1,1-Dichloroethene	5	0.12
1,2-Dichloroethene	2,600	84
Perchloroethene	710	4
Trichloroethene	15,000	4

Concentrations reported in units of æg/L.
RBSC - Risk-Based Screening Concentration for Commercial/Industrial scenario Base. The RBSCs are based on a lifetime cancer risk of 1 x 10-6 or a haz whichever is lower.

Table 2

Maximum Concentration Detected of Ethyl-Based Chlorinated Volatiles in Target Area 2, and Corresponding Compound and Target Area Specific Interim Remdial Action Objectives.

Target Area 2

Compound	Maximum Detected	Interim RAO
1,1-Dichloroethane	5	__(d)
1,2-Dichloroethane	150	15
1,1-Dichloroethene	5	7(a)
1,2-Dichloroethene	2,600	260
Perchloroethene	710	71
1,1,1-Trichloroethane	ND	200(b)
Trichloroethene	15,000	1,500
Vinyl chloride	ND	2(c)

Concentrations reported in units of æg/L.
ND - Not Detected
RAO - Remedial Action Objective
(a) - Maximum Contaminant Level for 1,1-Dichloroethene
(b) - Maximum Contaminant Level for 1,1,1-Trichloroethane
(c) - Maximum Contaminant Level for Vinyl chloride
(d) - Maximum Level has not been established for 1,1-Dichloroethane.

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producing other chlorinated VOC degradation products will not itself be suffi

satsify the interim RAO. Note that if a ten-fold reduction from the maximum concentration detected of a compound is below that compound's MCL, the MCL is as the interim RAO.

The issues of final cleanup levels and attainment of ARARs will be addresse the Final Basewide Record of Decision. The remedial action selected for this part of the remedial action which will be selected in a Final Basewide ROD.

SUMMARY OF ALTERNATIVES

Engineering technologies applicable to remediating the contaminated media w screened according to their effectiveness and implementability. Those techno were determined to be the most applicable were then developed into remedial a The following remedial alternatives are numbered to correspond to the alterna described in the FFS report.

Alternative 1--No Action.

Alternative 2--Collection, Ex Situ Treatment, and Surface Water Disc of Groundwater; and Performance of Soil Vapor Extraction in Chlorina Solvent Source Areas if Necessary.

Alternative 3--In Situ Groundwater Treatment Using Air Sparging and Density-Driven Convection Technologies Combined With Soil Vapor Extraction.

Alternative 4--In Situ Bioremediation of Groundwater Utilizing Accel Anaerobic Biodegradation.

The four remedial alternatives that were evaluated in detail are described In addition, the capital, annual operation and maintenance (O&M), and present of each alternative are provided.

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Alternative 1

Target Area 2

Capital Cost	$000
Annual O&M Cost	$000
Present Worth	$000

The no action alternative is evaluated in order to establish a baseline for comparison against other alternatives. Under this alternative, no efforts ar

to reduce the groundwater concentrations of chlorinated solvents in the Targe

Alternative 2

Target Area 2

Capital Cost	$500,000
Annual O&M Cost	$94,000(a)
Present Worth	$980,000(b)

(a)First year O&M cost. Refer to text.
(b)Assumes 10 years of operation.

Alternative 2 consists of groundwater extraction, groundwater pretreatment metals, groundwater treatments using air stripping for removal of chlorinated carbon adsorption for removal of residual contaminants, and surface water dis treated groundwater; performance of soil vapor extraction (SVE) in the shallo solvent source areas if determined to be necessary during remedial design; an of the offgases from the air stripper and, if implemented, the SVE system.

A total of three extraction wells are estimated to be installed in Target A cost estimating purposes only, to extract contaminated groundwater at a combi pumping rate of approximately 35 gallons per minute. If this alternative is selected for this interim response, then the exact number of wells and their

be determined during the remedial design. Extracted groundwater will be pret metals to reduce the concentrations of iron and manganese. Metals pretreatme the possibility of iron and manganese fouling subsequent treatment systems as ensure compliance with surface water discharge standards for metals.

Pretreated groundwater will then be pumped to the top of a low profile, thr air stripper that will transfer over 95 percent of the VOCs dissolved in the to the air stream. The air stream containing the VOCs will then exit the air

where it will be treated using carbon adsorption prior to release to the atmo Routine air sampling at a frequency determined during remedial design will be to ensure compliance with air emission standards.

Treated groundwater exiting the air stripper will be pumped to a liquid pha carbon adsorption unit to reduce the concentration to residual contaminants t comply with the surface water discharge standards prior to release to the gol tributary of the St. Jones River. Semi-annual water samples, assumed for cos purpose only, will be collected to ensure compliance with discharge standards sampling frequency will be determined during the remedial design.

Vadose zone chlorinated solvent contamination is present in the Target Area location where significant shallow groundwater contamination has been identif address this potential source, performance of SVE in a limited size area has included with this alternative. A total of two SVE wells are estimated to be remediate the source area presumed to be present. Soil sources would be expe remediated in less thawn 2 years with SVE treatment; 2 years of operation is costing purposes. If SVE is implemented, vapor collected by the SVE system w treated for organic constituents by vapor phase carbon units prior to being r atmosphere. The necessity of performing SVE will be determined during the re design.

Groundwater monitoring will be performed to monitor the progress of groundw remediation. In addition, existing land use restrictions associated with the operation of DAFB will be enforced throughout the course of remediation to pr

unauthorized extraction and use of the contaminated groundwater from the Colu Aquifer.

The time required to achieve the interim RAO is estimated to be in the rang

5 to 10 years, provided no free phase solvents are present in the aquifer. I solvents are present, the time required to achieve the interim RAO may be ext 30 years or more. The present worth cost of this alternative ($980,000) is c based on an assumed 10 year operation.

Alternative 3

Target Area 2

Capital Cost	$1,150,000
Annual O&M Cost	$140,000(a)
Present Worth	$1,900,000(b)

(a)First year O&M cost. Refer to text.
(b)Assumes 6 years of operation.

Alternative 3 consists of the in situ treatment of groundwater using a comb of air sparging (AS) and density-driven convection (DDC) technologies, combin SVE over the entire areas where in situ groundwater treatment is performed; a adsorption treatment of the offgases from the SVE system.

For in situ treatment at Target Area 2, 97 SVE wells, 31 AS wells, and 46 D wells are estimated to be required for cost estimating purposes only. If thi ultimately selected for this interim response, then the exact number of wells placement will be determined during the remedial design. AS will be used in soil is highly permeable and free of clay. DDC will be used in areas where s clay layers are present. The SVE system operates in tandem with the AS/DDC s to capture volatile contaminants stripped from the saturated zone. Vapor pha adsorption treatment units will be used to remove extracted VOCs from the air prior to release to atmosphere. Entrained water will be separated by knockou

sent to liquid phase carbon adsorption units to reduce contaminant concentrat

acceptable for discharge.

Groundwater monitoring will be performed to monitor the groundwater remedia progress and plume migration. In addition, existing land use restrictions as the military operation of DAFB will be enforced throughout the course of reme prevent unauthorized extraction and use of the contaminated groundwater from Columbia Aquifer.

The time required to achieve the interim RAO is estimated to be between 4 a 13 years, with 6 years being the estimate used for costing purposes. The pre cost is estimated to be $1,900,000. The remediation time estimates are based rate data from the AS/SVE pilot study performed at Site WP-21.

Alternative 4

	Target Area 2
Capital Cost	$230,000
Annual O&M Cost	$40,000(a)
Present Worth	$350,000

(a)First Year O&M cost.

Alternative 4 consists of in situ bioremediation of groundwater utilizing a anaerobic biodegradation in Target Area 2. Accelerated anaerobic biodegradat of the bioremediation technologies being applied to the Target Areas to promo development of alternate and innovative treatment technologies as encouraged CERLA.

The chlorinated solvent groundwater plume in Target Area 2 will be remediat using accelerated anaerobic biodegradation technology. The native microorgan population that is intrinsically biodegrading the chlorinated solvent constit stimulated through the addition of an easily co-metabolized food source and e nutrients such as yeast extract. The food and nutrients will be delivered by with extracted groundwater and then injecting the enriched groundwater back i

aquifer. Groundwater injection will be performed in compliance with Delaware Regulations Governing Construction of Water Wells (DRGCWW), Section 3.15. Approximately nine extraction and nine injection wells are estimated to be re Target Area 2 for cost estimating purposes only. If this alternative is ulti for this interim response, then the exact number of wells and their placement determined during the remedial design. A pilot-scale version of this system installed and studied by the Remediation Technologies Development Forum (RTDF which is a consortium of partners from industry, government, and academia wor develop more effective and less costly remedial treatment technologies. Prel performance data indicate the technology should work well at this location. design data are expected to be available by December 1995.

The bioremediation process utilized is not expected to generate degradation products that can migrate beyond the Base boundary. Groundwater monitoring w performed to monitor the groundwater remediation progress and downgradient wa quality to ensure the offbase plume migration does not occur. In addition, e use restrictions associated with the military operation of DAFB will be enfor throughout the course of remediation to prevent unauthorized extraction and u contaminated groundwater from the Columbia Aquifer.

The time required to achieve the interim RAO in Target Area 2 using the accelerated anaerobic bioremediation technology will be evaluated during the but at this time the goal is estimated to be achieved within 2 years for cost

EVALUATION OF ALTERNATIVES

The selected alternative for remediating the contamination in the Target Ar Alternative 4 (bioremediation). Based on current information, this alternati

best balance of trade-offs among the alternatives with respect to the nine cr required to be evaluated under CERCLA. This section profiles the performance selected alternative against the nine criteria and explains how it compares t alternatives under consideration.

Overall Protection of Human Health and the Environment

The overall protectiveness criterion is a composite of other evaluation cri especially short-term effectiveness, long-term effectiveness, and compliance Alternativess 1, 2, 3 and 4 are all considered to be protective of human heal period of implementation because of the existence of land use restrictions th unauthorized extraction or use of contaminated groundwater in the Target Area preventing human exposure.

Alternative 1 (no action) is not considered effective because no provisions to monitor the Target Area plum to evaluate compliance with the interim RAO. Alternatives 2 (pump and treat), 3 (air sparging), and 4 (bioremediation) wil interim RAOs and are considered effective.

Compliance With ARARs

The interim RAOs that have been set for chlorinated solvent constituents in groundwater will allow for the resultant concentration of several of these co exceed their federal Maximum Contaminant Levels (MCLs). MCLs, as provided fo CERCLA 121 (d)(2)(A)(ii), are relevant and appropriate requirements for any actions expected to be taken as a result of the Base-wide investigation.

Offsite contaminant migration, even for interim actions, requires that a nu other ARARs be considered. The principal ARARs that pertain to the offsite m of contaminants are the Delaware regulations implementing the Federal Clean A Clean Water Act. These regulations are the Delaware Regulations Governing th

of Air Pollution (DRGCAP 1 through 3, 21, and 24), the Delaware Water Polluti Control Regulations (DWPCR 1 through 6), the Delaware Industrial Waste Efflue Limitations (DWPCR 8), and the Delaware surface Water Quality Standard (DSWQS through 9,11 and 12). The above referenced regulations regarding emissions o organic compounds to the atmosphere will be complied with in Alternatives 2 a ensure that acceptable levels of emissions are met. Alternative 2 will requi to surface water. The above referenced regulations regarding surface water d define limits of acceptable chemical concentrations for wastewater, and attai

limits will be a requirement for this alternative. For Alternative 4, there migration or releases of contaminants. The underground injection of recircu groundwater, which is an essential component of Alternative 4, will be perfor compliance with Delaware Regulations Governing the Construction of Water Well (DRGCWW, Section 3.15). Alternatives 2 and 3 both meet all previously identi regulations that pertain to the offsite movements of contaminants.

Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence criterion primarily considers th magnitude of residual risk that would remain after the implementation of an a and the adequacy and reliability of the control instituted. All the alternat for the long-term protection of human health through the existing land use re However, reliance upon land use restrictions is not considered a permanent re

Under Alternative 1 (no action), the chlorinated solvent contamination in groundwater will not be monitored. Therefore, the adequacy and reliability o alternative cannot be established.

Alternatives 2 (pump and treat), 3 (air sparging), and 4 (bioremediation) w

result in significant reductions of chlorinated solvent concentrations in the
If any one of these treatment alternatives is selected, that system will be o
interim RAO is achieved. Hence, no more than 10 percent of the maximum obser
concentration of each ethyl-based chlorinated solvent will remain in the Targ
magnitude of residual contamination remaining in the Target Area is a functio
the treatment alternative is operated or allowed to continue. Continued oper
treatment system beyond the point at which the interim RAO is reached may all
reductions in contaminant levels to be achieved. Performance of the interim
compliance with ARARs will be evaluated in the final Base-wide FS and ROD.

Reduction of Toxicity, Mobility, and Volume

No reduction of toxicity, mobility, or volume will be achieved by the
implementation of Alternative 1. The three action alternatives include compo
are capable of significantly reducing the toxicity of groundwater in the Targ

The groundwater extraction system proposed under Alternative 2 will establi
hydraulic control over the plume, thereby limiting the mobility of contaminan
the Target Area. The air sparging in situ treatment technology included in A
operates by increasing the mobility of contaminants. This increased mobility
in some spreading of contamination beyond the effective zones of these altern
the course of contaminant removal; however, the overall volume of the contami
be reduced. The bioremediation technology proposed under Alternative 4 will
impact on contaminant mobility. The toxicity profile of the groundwater may
somewhat during the biodegradation process, as vinyl chloride is generated du
degradation of the more chlorinated ethyl-based compounds. However, because
chloride has been detected in the groundwater thus far, the evidence suggests
chloride is rapidly degraded to carbon dioxide, water, and chloride ion under

conditions found downgradient of the Target Areas.

Short-Term Effectiveness

Alternative 1 (no action) includes no remedial actions. Therefore, there w short-term impacts on community or worker health or the environment from cons activities. However, because Alternative 1 will not monitor compliance with RAOs established for this project, it is considered to be ineffective.

Alternatives 2 (pump and treat), 3 (air sparging), and 4 (bioremediation) w be effective in reducing groundwater contaminant concentrations in the Target None of these alternatives are expected to have significant impacts on worker health or the environment. Alternative 2 is estimated to be capable of meeti RAO within a 5 to 10 year time frame. However, although not believed present pockets of DNAPLs in the aquifer could cause this time frame to increase to 3 more.

The presence of DNAPLs will also affect the length of time required to achi interim RAO under Alternative 3, though to a lesser extent than will their pr Alternative 2. There are two reasons for this. First, there would be many m sparging/density-driven convection wells under Alternative 3 than there would

extraction wells under Alternative 2. Thus, the chance of locating a remedia a pocket of free product is much greater under Alternative 3. Secondly, the remediation is a more aggressive remediation process than pump and treat. Hi transfer rates from water to air would be achieved with the physical in situ technologies lowering the concentration of solvents within the plume. Lowere groundwater concentrations would increase the driving force for solubilizatio product in order to maintain equilibrium. The time required to meet the inte

under Alternative 3 is estimated to be between 4 and 13 years.

Alternative 4 is estimated to be capable of achieving the interim RAO in Ta Area 2 within approximately 2 years using accelerated anaerobic bioremediatio the other action alternatives, these time frames may be extended if DNAPLs ar A DNAPL would present a continuing source of contaminants to the aquifer as t DNAPL constituents were solubilized in the groundwater. This transfer of con from free phase to dissoved phase would occur through the physical processes desorption and liquid-liquid partitioning. These equilibrium-driven processe occur slowly because of the relatively low surface area of DNAPL in contact w groundwater in comparison to DNAPL volume. The solubilization rate of DNAPLs likely be slower than the rate of degradation of the dissolved constituents. solubilization of DNAPLs would likely be the rate-limiting step.

Implementability

Three main factors are considered under this criterion: technical feasibil administrative feasibility, and availability of services and materials. All are administratively feasible and the required services and materials are rea Hence, the comparison will focus on the technical feasibility of the alternat

Alternative 1 (no action) has no technical feasibility considerations. Alt 2 (pump and treat), 3 (air sparging), and 4 (bioremediation) have technical f concerns associated with them. These concerns are related to the highly deve character of the Target Area and the the numerous space contraints that are p However, of the three action alternatives, Alternative 4 will be least diffic implement. Alternative 4 requires the installation of approximately 18 groun

injection/extraction wells in Target Area 2 plus the ancillary piping and sup equipment. The alternative 4 system is considered slightly easier to install

Alternative 2 system, which includes only seven groundwater extraction, SVE, inlet wells, but a more extensive piping network. Both Alternative 2 and 4 a considered much less complicated to install than Alternative 3, which consist sparge, DDC, and SVE wells, more expansive piping and numerous treatment stat Overall, Alternative 4 is judged to be the most easily implemented action alt Cost

No direct costs are associated with the implementation of Alternative 1 (no Of the action alternatives, the capital cost of Alternative 4 (bioremediation which is significantly lower than the $500,000 capital cost of Alternative 2 treat) and the $1,150,000 capital cost of Alternative 3 (air sparging). The capital costs of Alternative 4 represent the net expenditures required by the to implement the alternative. Some of the required capital costs will assume expended by the RTDF in setting up their treatability study in the Target Are

The O&M cost of Alternative 2 will initially be $94,000 per year, but will to $60,000 per year after 2 years of operation when SVE operations are discon The O&M cost of Alternative 3 will be almost $140,000 the first year, but wil several thousand dollars per year thereafter as the carbon consumption rate a the SVE system's offgass treatment units decreases. The O&M costs of Alterna be approximately $40,000 per year for operating and monitoring the accelerate biodegradation system in Target Area 2. After shut-down of the system, groun monitoring will be performed at an annual cost of approximately $10,000 per y

The present worth cost of the alternatives will depend upon the time they a operated. The present worth costs of Alternative 2 under operating scenario and 30 years are $810,000, $980,000, and $1,300,000, respectively. The prese costs of Alternative 3 under operating scenarios of 4, 6, and 13 years, respe $1,710,000, $1,900,000, and $2,340,000. The present worth cost of Alternativ assuming 2 years of operation in Target Area 2 followed by 3 years of groundw

monitoring is $350,000. Thus, Alternative 4 will have the lowest present wor

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State Acceptance

The State of Delaware concurs with the selected interim remedy for Target A

Community Acceptance

The only comments received during the public comment period were from the RTDF expressing support for the proposed remedy. No community opposition to proposed remedy was noted.

CONCLUSION

Based on the evaluation of the alternatives using the nine criteria, Altern (bioremediation) is preferred. Alternative 4 is protective of human health a environment, complies with all ARARs, presents a permanent remedy that reduce groundwater toxicity, provides the greatest ease of implementation, and is th effective action alternative.

The selected alternative utilizes permanent solutions and alternative treat technologies to the maximum extent practicable. This interim action will not impact the ability to implement a final action, if it is required. The final selected in the final Base-wide ROD.

Actual or threatened releases of hazardous substances from this Site, if no addressed by the selected alternative, may present a current or potential thr health, welfare, or the environment.

GLOSSARY AND ACRONYMS

Air Sparging - Underground injection of air into saturated soil and groundwat in the in situ air stripping of volatile constituents.

Air Stripping - Transfer of volatile constituents from water to air by induce between air and water streams.

Aquifer - A geologic formation capable of yielding water to wells and springs

ARARs - Applicable or Relevant and Appropriate Requirements. Criteria set fo federal and state statute and regulations that must be considered in the of remedial alternatives.

Biodegradation - The breakdown of organic constituents by microorganisms into complex compounds.

Capital Cost - Cost incurred for the construction and startup of a facility.

CERCLA - Comprehensive Environmental Response, Compensation, and Liability Ac Federal law creating the Superfund program.

Dense Non-Aqueous Phase Liquid (DNAPL) - An organic liquid with a low water solubility and density greater than that of water. DNAPLs retain their p and chemical properties when in contact with water and tend to sink in an when released to groundwater.

Density-Driven Convection - Modified in ground air sparging system which indu flow pattern in the vicinity of the sparging well.

EPA - U.S. Environmental Protection Agency.

Ex Situ - Performed above ground.

RS - Feasibility Study. Study undertaken to evaluate remedial alternatives.

FFS - Focused Feasibility Study.

Groundwater - Subsurface water residing in a zone of saturation.

GLOSSARY (Cont'd)

HQ - Hazard Quotient. An indicator of the noncarcinogenic health risk associ exposure to a chemical.

In Situ - In the original location (in the ground for this report).

IRP - The U.S. Air Force Installation Restoration Program.

Leach - The solubilization and transport of constituents in soil through the surface water to groundwater.

LECR - Lifetime Excess Cancer Risk. The probability of the carcinogenic heal associated with exposure to the chemicals of concern.

O&M Cost - Annual cost incurred for operation and maintenace of a facility.

Maximum Contaminant Levels (MCLs) - Federal drinking water standards.

Plume - A recognizable distribution of constituents in groundwater.

Potentiometric Surface - An imaginary surface that represents the static head groundwater and is defined by the level to which water will rise.

RBSC - Risk Based Screening Concentration. A chemical-specific concentration preliminarily assess whether exposure to a chemical poses a potential hea

RAO - Remedial Action Objective. Cleanup goal established for the remediatio

RCRA - Resource Conservation and Recovery Act.

ROD - Record of Decision. A legal document issued by the lead governmental a selecting the remedy to be implemented at a CERCLA site.

RTDF - Remediation Technologies Development Forum.

Soil Vapor Extraction (SVE) - An in sity physical treatment process to volati withdraw VOCs from subsurface soil residing above the groundwater table.

Vadose Zone - Soild zone above the water table.

VOCs - Volatile organic compounds.