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1995

EPA Superfund
Record of Decision:

DOVER AIR FORCE BASE
EPA ID: DE8570024010
OU 05
DOVER, DE
08/03/1995

Text:

RECORD OF DECISION
DECLARATION OF THE SELECTED INTERIM REMEDY

Site Name and Location

Target Area 3 of Area 6, West Management Unit, Dover Air Force County, Delaware.

Statement of Basis Purpose

This Record of Decision (ROD) presents the selected interim rem for Target Area 3, which was chosen in accordance with the requiremen Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorizadon A 1986 (SARA) and, to the extent practicable, the National Oil and Haza Substances Pollution Contingency Plan (NCP), 40 CFR Part 300. This d prepared by the U.S. Air Force, the lead agency, as the owner/operato is based on the Administrative Record for the Site. Support was prov Environmental Protection Agency (EPA) Region III and the Delaware Dep of Natural Resources and Environmental Control (DNREC).

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

Assessment of the Site

Four regions were identified in Area 6 where shallow groundwate combined concentrations of the chlorinated solvents trithloroethene, and 1,2-dichloroethene in access of 1,000 æg/L. These regions were i the vicinity of the source areas for the chlorinated solvent plumes p and were incorporated into areas for remediation termed Target Areas. addresses the interim remedy for Target Area 3. The maximum concentr chlorinated volatile organic compounds in Target Area 3 groundwater w æg/L. While a Risk Assessment was not performed specifically for Tar risk associated with exposure to Area 6 groundwater under a hypotheti commercial/industrial use scenario was 9 x 10-4.

A soil gas survey was conducted in the vicinity of Building 719 the vadose zone source of chlorinated solvent contamination. Several solvent constituents were detected in soil gas samples. The maximum concentrations of the particularly notable chlorinated solvents ident trichloroethane (13,900 æg/L), 1,1-dichloroethane (385 æg/L), and cis

(>3,770 æg/L). These soil gas detections are a clear indication of v contamination near Building 719.

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

Description of the Selected Interim Remedy

The selected interim remedy consists of in situ bioremediation and soil utilizing co-metabolic bioventing and intrinsic bioremediati bioventing and intrinsic bioremediation are two of the bioremediation being applied to the Target Areas to promote the development of alter innovative treatment technologies as encouraged under CERCLA. Perfor the interim remedy and compliance with applicable or relevant and app requirements will be evaluated in the Final Basewide ROD.

Statutory Determinations

The selected interim remedial action satisfies the remedial sel requirements of CERCLA and the NCP. The selected interim remedy prov best balance of trade-offs among the nine criteria required to be eva CERCLA. The selected interim action provides protection of human hea environment, complies with federal and state requirements that are le or relevant and appropriate to the action, and is cost effective. Th utilizes permanent solutions and alternative treatment technology to extent practicable, and satisfies the statutory preference for remedi treatment that reduces toxicity, mobility, or volume as a principal e Force understands that although this interim remedy may not achieve M certain contaminants, this interim action is only part of a total rem Base that will be protective of the public health and welfare and of when completed (CERCLA 121d, 42 U.S.C. 9621.d).

CHARLES T. ROBERTSON, JR. Date	THOMAS C. VOLTAGGIO
Lieutenant General, USAF	Hazardous Waste Management
Air Mobility Command	Division Director
Chairperson, Environmental	Environmental Protection Agen
Protection Committee	Region III

Target Area 3

RECORD OF DECISION
FOR THE INTERIM REMEDY OF
TARGET AREA 3 OF AREA C
WEST MANAGEMENT UNIT
DOVER AIR FORCE BASE, DOVER, DELAWARE

August 3, 1995

DECISION SUMMARY FOR THE RECORD OF DECISION
TARGET AREA 3 OF AREA 6
WEST MANAGEMENT UNIT
DOVER AIR FORCE BASE

INTRODUCTION

Dover Air Force Base (DAFB) recently completed a Focused Feasibi (FFS) conducted to address chlorinated solvent and pesticide source a contamination in Area 6 of Dover Air Force Base (DAFB), Delaware as a response. The FFS was undertaken as part of the U.S. Air Force's Ins Restoration Program (IRP). The basis for the FFS was the Area 6 Reme Investigation (RI) report dated July 1994, which characterized contam evaluated potential risks to public health and the environment. The performed as the first phase of Feasibility Studies to be conducted o Management Unit, the management unit to which Area 6 belongs. The sc FFS was limited to the evaluation of alternatives for remediation of chlorinated solvent and pesticide source areas originating in the nor portion of the Area 6 region of investigation. The final remediation if necessary, and non-source area contamination in Area 6 posing huma environmental risks will be addressed in the final Base-wide Feasibil

This Record of Decision (ROD) addresses Target Area 3, which is chlorinated solvent source areas evaluated in the FFS. This ROD summ FFS, describes the remedial alternatives that were evaluated, identif alternative selected by DAFB, and explains the reasons for this selec Environmental Protection Agency (EPA) and the State of Delaware concu interim remedy selected in this ROD.

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

PUBLIC PARTICIPATION

The Proposed Plan for this site was issued on June 16, 1995. Th comment period on the Plan was open through July 31, 1995. Documents the Administrative Record for the site were available at the Dover Pu The only comments received during the public comment period were from Remediation Technologies Development Forum expressing support for the interim remedy.

SITE BACKGROUND

DAFB is located in Kent County, Delaware, 3.5 miles southeast of Dover (Figure 1) and is bounded to the southwest by the St. Jones Riv comprises approximately 4,000 acres of land, including annexes, easem propery (Figure 2). The surrounding area is primarily cropland and w

DAFB began operation in December 1941. Since then, various mili have operated out of DAFB. The present host organization is the 436t Its mission is to provide global airlift capability, including transp equipment, and relief supplies.

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

The portion of DAFB addressed in this ROD is located within Area West Management Unit. The West Management Unit is one of four Manage

Units into which the Base has been divided (Figure 3). Area 6 is the associated areas identified in the West Management Unit. The Area 6 investigation extends approximately 8,400 feet from its northern most hardstand and Building 723 to its southern most point near the St. Jo (Figure 4). The area north of U.S. Highway 113 contains the industri

Target Area 3

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of the Area 6 region of investigation. The location addressed in thi this industrialized portion of Area 6.

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

The Columbia Formation is the shallowest water-bearing unit and water table aquifer. The Columbia Formation typically consists of fi grained sand with varying amounts of silt, clay, and gravel. Discont gravel, silt and clay are also common. Generally, the upper portion Formation is finer grained and contains more silt and clay lenses tha

portion. The water table is generally encountered at a depth of 10 t ground surface (bgs) in the northern portion of Area 6 and shallows t feet of the surface in the Base housing area near the St. Jones River groundwater elevation or potentiometric surface of both the shallow a of the Columbia Aquifer range from approximately 13.5 feet MSL in the portion to less than 3 feet MSL near the St. Jones River. The thickn Columbia Formation in Area 6 ranges from 28 to 64 feet.

Unconformably underlying the Columbia Formation is the upper uni Calvert Formation, which generally consists of gray to dark gray firm clay, with thin laminations of silt and fine sand. This upper silt a in thickness from 15 to 21 feet in the northern portion of Area 6. T conductivity of this unit range from 6.83 x 10-3 to 1.53 x 19-3 ft/da x 10-7 cm/sec), which are three to five orders of magnitude lower tha Columbia Formation. These significantly lower hydraulic conductiviti to the vertical migration of constituents identified in the Columbia Underlying this confining unit is the upper sand unit of the Calvert

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

Area 6 is defined by the association of chlorinated solvents in forming a plume in the Columbia Aquifer. Several separate potential identified in the Area 6 RI that may have contributed to the chlorina contamination. These potential sources include some of the twelve IR the Area 6 groundwater flow regime shown in Figure 4. Additionally,

and hangars where solvents are used may also be sources. The shop ac solvent use is common include painting or paint stripping, aircraft a maintenance, and plating or welding. The northern most point of chlo contamination is the aircraft maintenance area located north of Atlan chlorinated solvent plumes extend approximately 4,600 feet south into

The Area 6 RI identified four regions where shallow groundwater ten feet of the Columbia Aquifer) contained combined concentrations o chlorinated solvents trichloroethene (TCE), perchloroethene (PCE), an dichloroethene (DCE) in excess of 1,000 æg/L. These regions were inf the vicinity of the source areas for the chlorinated solvent plumes t Area 6. The groundwater data suggested that primary source areas res vicinity of the following reference points, which were incorporated i remediation termed Target Areas:

Paint Washout Area (Site SS59) located along the eastern po open storage yard. (Target Area 1)

Civil Engineering (CE) Shops Area including Building 607 (C Shop), Buildings 608 and 609 (Material Control/Supply Offic 615 (Interior and Exterior Electrical Shop, Power Productio and Sheet Metal Shop), and Building 650 (Sign Shop). (Targ

Building 719 housing the Jet Engine Repair Shop. (Target A

Target Area 3

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

The four Target Areas that have been identified are shown in Fig Target Area incorporates one of the primary suspected source areas an significantly impacted portions of the shallow and deep groundwater p

with the respective source area. Plume maps of total chlorinated VOC and deep groundwater are shown in Figures 6 and 7, respectively. The are the regions of chlorinated solvent groundwater contamination that in the FFS.

TARGET AREA/SOURCE AREA CHARACTERISTICS

The following section describes the physical and chemical charac Target Area 3, which is addressed in this Proposed Plan.

Target Area 3 is located north of Target Area 1, originating nea and extending south about 800 feet where it joins Target Area 1. Bui Jet Engine Repair Shop - once contained large dip tanks of TCE. The of TCE from the dip tanks is a suspected source of the contamination. suspected source is two former underground storage tanks (USTs) that in 1992 from the northeast side of Building 719. The USTs were conne building's drain system and collected waste oils and spent solvents u Target Area 3 is elliptically shaped and is approximately 3.7 acres i scale maps of the chlorinated solvent plumes residing in the shallow of the aquifer within Target Area 3 are shown in Figures 8 and 9, res maximum concentration of total chlorinated VOCs in Target Area 3 grou found in the shallow Columbia at a concentration of 21,310 æg/L in th source location near Building 719. Migration of the plume appears to occurred through the deeper portion of the aquifer.

A soil gas survey was conducted in March 1995 in the vicinity of to better define the vadose zone source of chlorinated solvent contam

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chlorinated solvent constituents were detected in soil gas samples. detected concentrations of the particularly notable chlorinated solve include 1,1,1-trichloroethane (13,900 æg/L), 1,1-dichloroethane (385 cis-1,2-dichloroethene (>3,770 æg/L). These soil gas detections are of vadose zone contamination near Building 719.

SUMMARY OF SITE RISKS

The full Risk Assessment (RA) for Area 6 can be found in the fin report dated July 1994. The purpose of the RA is to determine whethe site-related contaminants could adversely affect human health and the The focus of the baseline RA is on the possible human health and envi effects that could occur under current or potential future use condit that the contamination is not remediated. The risk is expressed as l cancer risk (LECR) for carcinogens, and hazard quotient (HQ) for nonc For example, an LECR of 1 x 10-6 represents one additional case of ca million exposed population, wheresas a hazard quotient above one pres of noncarcinogenic health effects in exposed populations.

The baseline RA focused on potential pathways by which maintenan construction workers could be exposed to contaminated materials in Ar

workers' exposure to groundwater and soil have been evaluated under a maintenance scenario; a future construction scenario; and a hypotheti groundwater use from the Columbia Aquifer under a commercial/industri Although a specific Target Area 3 RA has not been performed, the risk the Area 6 Remedial Investigation from the hypothetical future exposu groundwater within Area 6 had an LECR of 9 x 10-4, which exceeds the x 10-6 risk range used to evaluate the need for remediation. In addi Area 6 risk the Target Area 3 constituents of concern have been compa risk-based screening concentrations (RBSCs) approved by EPA for the c industrial scenario at DAFB to identify the chlorinated solvents that based concern.

Target Area 3

The possibility exists for exposure of workers to hazardous subs during excavation activities. Source areas identified during excavat worker protection as per health and safety protocols. All workers pe excavation work at DAFB will be health and safety trained for work at

Based on the direction of groundwater flow, the Area 6 plume ext southerly direction towards the St. Jones River. There are no surfac points within Area 6 between the Target Area and the river. Presentl plume is confined within the Base property, and has not reached the S

The future use of groundwater from the Columbia Aquifer by Base is quite unlikely and hypothetical. This hypothetical future groundw that groundwater from the Columbia Aquifer will be used for drinking purposes by Base personnel under a commercial/industrial scenario. T compared with the maximum detected concentrations of chlorinated solv

Area 3 (Table 1). Concentrations of three of the five detected chlor 1,2-dichloroethene, perchloroethene, and trichloroethene-in Target Ar their corresponding RBSCs in groundwater. The concentrations of the detected compounds, 1,1-dichloroethane and 1,1,1-trithloroethane, wer corresponding RBSCs.

Actual or threatened releases of hazardous substances from this addressed by the selected alternative or one of the other active meas may present a current or potential threat to public health, welfare,

REMEDIAL ACTION OBJECTIVE

Within the soils of Target Area 3, the interim Remedial Action O (RAO) is to reduce the concentration of each ethyl-based chlorinated compound (VOC) by 90 percent. The ethyl-based chlorinated VOCs inclu TCE, 1,1-DCE, 1,2-DCE, vinyl chloride, 1,1,1-trichloroethane, 1,1-dic 1,2-dichloroethane. These VOCs are considered to be the most toxic a the 90 percent reduction interim RAO is applied to each of these comp

Target Area 3

TABLE 2

Maximum Concentration Detected of Ethyl-Based Chlorinated Volatiles in Target Area 3, and Corresponding Compound and Target Area Specific Interim Remedial Action Objectives

	Target Area 3	
	Maximum	Interim
Compound	Detected	RAO
1,1-Dichloroethane	3	-(d)
1,2-Dichloroethane	ND	5(e)
1,1-Dichloroethene	ND	7(a)
1,2-Dichloroethene	2,300	230
Perchloroethene	1,000	100
1,1,1-Trichloroethane	9	200(b)

Trichloroethene	19,000	1,900
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 Contaminant Level has not been established for 1,1-Dichloroet
(e) - Maximum Contaminant Level for 1,2-Dichloroethane.

individually rather than to the aggregate concentration of all the ch For reasons of consistency, the 90-percent reduction model was based Post-Closure Permit (Reference No. DE8570024010, Pemit No. HW05A05) f WP21 of DAFB, which is a unit that adjoins Target Area 3 to the west.

The maximum concentrations of the detected chlorinated solvent c in Target Area 3 are summarized in Table 2, along with the compound a Area specific interim RAO. Table 2 also includes interim RAO concent some select compounds that have not yet been detected in the Target A select compounds are chemical degradation products of some of the cur chlorinated solvent constituents. Thus, reducing the concentration o compounds at the expense of producing other chlorinated VOC degradati will not itself be sufficient to satisfy the interim RAO. Note that reduction from the maximum concentration detected of a compound is be compound's MCL, the MCL is used as the interim RAO.

The issues of final cleanup levels and attainment of ARARs will b in the Final Basewide Record of Decision. The remedial action select is only part of the remedial action which will be selected in a Final

SUMMARY OF ALTERNATIVES

Engineering technologies applicable to remediating the contamina were screened according to their effectiveness and implementability. technologies that were determined to be the most applicable were then remedial alternatives. The following remedial alternatives are numbe correspond to the alternatives described in the FFS report.

Alternative 1-No Action.

Alternative 2-Collection, Ex Situ Treatment, and Surface W of Groundwater, and Performance of Soil Vapor Extraction i Solvent Source Areas if Necessary.

Alternative 3-In Situ Groundwater Treatment Using Air Spar Density-Driven Convection Technologies Combined With Soil

Target Area 3

TABLE 1

Maximum Concentration Detected of Ethyl-Based Chlorinated Volatiles in Target Area 3, and Corresponding Risk-Based Screening Concentrations

Target Area 3

Compound	Maximum Detected	RBSC
1,1-Dichloroethane	3	1,300
1,2-Dichloroethene	2,300	84
Perchloroethene	1,000	4
1,1,1-Trichloroethane	9	2,200
Trichloroehtene	19,000	4

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

Alternative 4-In Situ Bioremediation of Groundwater and So

Intrinsic Bioremediation and Co-Metabolic Bioventing Techn

The four remedial alternatives that were evaluated in detail are below. In addition, the capital, annual operation and maintenance (O present worth costs of each alternative are provided.

Alternative 1

	Target Area 3
Capital Cost	$000
Annual O&M Cost	$000
Present Worth	$000

The no action alternative is evaluated in order to establish a b comparison against other alternatives. Under this alternative, no ef undertaken to reduce the groundwater concentrations of chlorinated solve Target Area.

Alternative 2

	Target Area 3
Capital Cost	$330,000
Annual O&M Cost	$64,000(a)
Present Worth	$660,000(b)

(a)Frst year O&M cost. Refer to text.
(a)Based on 10 years of operation.

Alternative 2 consists of groundwater extraction, groundwater pr metals, groundwater treatment using air stripping for removal of chlo and carbon adsorption for removal of residual contaminants, and surfa discharge of treated groundwater; performance of soil vapor extractio

shallow chlorinated solvent source areas if determined to be necessary d design; and treatment of the offgases from the air stripper and, if i SVE system.

A total of two extraction wells are estimated to be installed in for cost estimating purposes only, to extract contaminated groundwate pumping rate of approximately 20 gallons per minute. If this alterna selected for this interim response, then the exact number of wells an will be determined during the remedial design. Extracted groundwater pretreated for metals to reduce the concentrations of iron and mangan pretreatment reduces the possibility of iron and manganese fouling su treatment systems as well as ensuring compliance with surface water d standards for metals.

Pretreated groundwater will then be pumped to the top of a low p tray air stripper that will transfer over 95 percent of the VOCs diss groundwater to the air stream. The air stream containing the VOCs wi air stripper unit where it will be treated using carbon adsorption pr the atmosphere. Routine air sampling at a frequency determined durin design will be performed to ensure compliance with air emission stand

Treated groundwater the air stripper will be pumped to a liquid carbon adsorption unit to reduce the concentration of residual contam that comply with the surface water discharge standards prior to relea course tributary of the St. Jones River. Semi-annual water samples, estimating purposes only, will be collected to ensure compliance with standards. Annual sampling frequency will be determined during the r

Vadose zone chlorinated solvent contamination is present in the Tar the location where significant shallow groundwatcr contamination has To address this source, performance of SVE in a limited sized area ha with this alternative. A total of two SVE wells are estimated to be remediate the source areas presumed to be present. Soil sources woul

Target Area 3

to be remediated in less than 2 years with SVE treatment; 2 years of assumed for costing purposes. If SVE is implemented, vapor collected system would be treated for organic constituents by vapor phase carbo being released to the atmosphere. The necessity of performing SVE wi determined during the remedial design.

Groundwater monitoring will be performed to monitor the progress groundwater remediation. In addition, existing land use restrictions the military operation of DAFB will be enforced through out the cours to prevent unauthorized extraction and use of the contaminated ground Columbia Aquifer.

The time required to achieve the interim RAO is estimated to be of 5 to 10 years, provided no free phase solvents are present in the phase solvents are present, the time required to achieve the interim extended to 30 years or more. The present worth cost of this alterna is calculated based on an assumed 10 year operation.

Alternative 3

	Target Area 3
Capital Cost	$330,000
Annual O&M Cost	$40,000(a)

Present Worth	$540,0000(b)

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

Alternative 3 consists of the in situ treatment of groundwater u combination of air sparging (AS) and density driven convection (DDC) combined with SVE over the entire areas where in situ groundwater tre performed; and carbon adsorption treatment of the offgases from the S

Target Area 3

For in situ treatment at Target Area 3, 30 SVE wells, 14 AS well wells are estimated to be required for cost estimating purposes only. is ultimately selected for this interim response, then the exact numb their placement will be determined during the remedial design. AS wi areas where soil is highly permeable and free of clay. DDC will be u where significant clay layers are present. The SVE system operates i the AS/DDC system to capture volatile contaminants stripped from the zone. Vapor phase carbon adsorption treatment units will be used to extracted VOCs from the air stream prior to release to atmosphere. E will be separated by knockout pots and sent to liquid phase carbon ad to reduce contaminant concentration to levels acceptable for discharg

Groundwater monitoring will be performed to monitor the groundwa remediation progress and plume migration. In addition, existing land associated with the military operation of DAFB will be enforced throu course of remediation to prevent unauthorized extraction and use of t groundwater from the Columbia Aquifer.

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

and 13 years, with 6 years being the estimate used for costing purpos worth cost is estimated to be $1,000,000. The remediation time estim on removal rate data from the AS/SVE pilot study performed at Site WP

Alternative 4

	Target Area 3
Capital Cost	$80,000
Annual O&M Cost	$50,000(a)
Present Worth	$170,000(b)

(a)First year O&M cost. Refer to text.
(b)Net cost to government.

Target Area 3

Alternative 4 consists of in situ bioremediation of groundwater co-metabolic bioventing and intrinsic bioremediation in Target Area 3 bioventing and intrinsic bioremediation are two of the bioremediation being applied to the Target Areas to promote the development of alter innovative treatment technologies as encouraged under CERCLA.

The distribution of chlorinated solvent constituents in groundwa downgradient of the Target Areas indicates that intrinsic bioremediat active. The degradation rates and reaction mechanisms associated wit bioremediation processes occurring in Target Area 3 will be studied o period by the Remediation Technologies Development Forum (RTDF), whic consortium of partners from industry, govermnent, and academia workin more effective and less costly remedial treatment technologies. Intr bioremediation is a passive remediation technology; that is it does n installation of any extraction or physical/chemical treatment systems remediation of the aquifer. Instead, this technology relies on the i

microorganisms to biologically degrade organic contaminants. Althoug technology is passive, it should not be confused with the no action a Establishing the efficacy of intrinsic bioremediation requires that a characterization be made, which includes sampling, testing, modeling, microbial activity and biotransformation rates. The RTDF study will whether intrinsic bioremediation holds promise as a long-term remedy contaminants present. Monitoring of the Target Area 3 groundwater pl conducted from an estimated six monitoring wells for cost estimating the study and rate measurement of the intrinsic bioremediation proces monitoring period will extend until the final FS and ROD is completed estimated to be within a period of 5 years for costing purposes.

The vadose zone chlorinated solvent contamination present in Tar near Building 719 will be remediated in situ using co-metabolic biove combined mixture of air and an organic substrate such as propane will the vadose zone to promote the biodegradation of the solvents present

Target Area 3

microorganisms. An SVE system will also be installed to allow materi be conducted and to prevent vapors from entering the building.

The bioremediation process utilized is not expected to generate products that can migrate beyond the Base boundary. Groundwater moni be performed to monitor the groundwater remediation progress and down water quality to ensure that offbase plume migration does not occur. existing land use restrictions associated with the military operation enforced throughout the course of remediation to prevent unauthorized use of the contaminated groundwater from the Columbia Aquifer.

The time required to achieve the interim RAO will vary with the bioremediation technology. Intrinsic bioremediation rates for Target evaluated during the RTDF study. The co-metabolic bioventing initiat Area 3 is estimated to be completed within 2 years. The present wort alternative is estimated to be $170,000.

EVALUATION OF ALTERNATIVES

The selected alternative for remediating the contamination in th is Alternative 4 (bioremediation). Based on current information, thi provides the best balance of trade-offs among the alternatives with r criteria that are required to be evaluated under CERCLA. This sectio performance of the selected alternative against the nine criteria and compares to the other alternatives under consideration.

Overall Protection of Human Health and the Environment

The overall protectiveness criterion is a composite of other eva especially short-term effectiveness, long-term effectiveness, and com ARARs. Alternatives 1, 2, 3, and 4 are all considered to be protecti health during their period of implementation because of the existence restrictions that prohibit the unauthorized extraction or use of cont groundwater in the Target Areas, thereby preventing human exposure.

Target Area 3

Alternative 1 (no action) is not considered effective because no made to monitor the Target Area plume to evaluate compliance with the RAO. Alternatives 2 (pump and treat), 3 (air sparging), and 4 (biore all meet the interim RAOs and are considered effective.

Compliance With ARARs

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

Offsite contaminant migration, even for interim actions, require of other ARARs be considered. The principal ARARs that pertain to th movement of contaminants are the Delaware regulations implementing th Clean Air Act and Clean Water Act. These regulations are the Delawar Governing the Control of Air Pollution (DRGCAP 1 through 3, 21 and 24 Delaware Water Pollution Control Regulations (DWPCR 1 through 6), the Industrial Waste Effluent Limitations (SWPCR 8), and the Delaware Sur Quality Standards (DSWQS 1 through 9, 11 and 12). The above referenc regulations regarding emissions of volatile organic compounds to the be complied with in Alternatives 2, 3, and 4 to ensure that acceptabl emissions are met. Alternative 2 will require discharge to surface w referenced regulations regarding surface water discharge define limit chemical concentrations for wastewater, and attainment of these limit requirement for this alternative. Alternatives 2, 3, and 4 meet all regulations that pertain to the offsite movement of contaminants.

Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence criterion primarily c magnitude of residual risk that would remain after the implementation

alternative, and the adequacy and reliability of the controls institu alternatives provide for the long-term protection of human health thr and use restrictions. However, reliance upon land use restrictions i a permanent remedy.

Under Alternative 1 (no action), the chlorinated solvent contami groundwater will not be monitored. Therefore, the adquacy and reliab alternative cannot be established.

Alternatives 2 (pump and treat), 3 (air sparging), and 4 (biorem all result in significant reductions of chlorinated solvent concentra Area. If any one of these treatment alternatives is selected, that s operated until the interim RAO is achieved. Hence, no more than 10 p maximum observed concentration of each ethyl-based chlorinated solven in the Target Area. The magnitude of residual contamination remainin Area is a function of the time the treatment alternative is operated continue. Continued operation of the treatment system beyond the poi interim RAO is reached may allow further reductions in contaminant le achieved. Performance of the interim remedy and compliance with ARAR 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 b implementation of Alternative 1. The three action alternatives inclu which are capable of significantly reducing the toxicity of groundwat Area.

The groundwater extraction system proposed under Alternative 2 w hydraulic control over the plume, thereby limiting the mobility of co from the Target Area. The air sparging in situ treatment technology Alternative 3 operates by increasing the mobility of contaminants. T mobility may result in some spreading of contamination beyond the eff these alternatives during the course of contaminant removal; however,

Target Area 3

volume of the contaminants will be reduced. The groundwater bioremediat technology proposed under Alternative 4 will have no impact on contam The toxicity profile of the groundwater may shift somewhat during the process, as vinyl chloride is generated during the degradation of the ethyl-based compounds. However, because little vinyl chloride has be the groundwater thus far, the evidence suggests that vinyl chloride i to carbon dioxide, water, and chloride ion under the aerobic conditio downgradient of the Target Areas.

Short-Term Effectiveness

Alternative 1 (no action) includes no remedial actions. Therefo be no short-term impacts on community or worker health or the environ construction activities. However, because Alternative 1 will not mon with the interim RAOs established for this project, it is considered

Alternatives 2 (pump and treat), 3 (air sparging) and 4 (bioreme all be effective in reducing groundwater contaminant concentrations i Area. None of these alternatives are expected to have significant im or public health or the environment. Alternative 2 is estimated to b

meeting the interim RAO within a 5 to 10 year time frame. However, a believed present, isolated pockets of DNAPLs in the aquifer could cau frame to increase to 30 years or more.

The presence of DNAPLs will also affect the length of time requi the interim RAO under Alternative 3, though to a lesser extent than w presence on Alternative 2. There are two reasons for this. First, t more air sparging/density-driven convection wells under Alternative 3 would be extraction wells under Alternative 2. Thus, the chance of l remediation well near a pocket of free product is much greater under Secondly, the in situ remediation is a more aggressive remediation pr and treat. High mass transfer rates from water to air would be achie physical in situ treatment technologies lowering the concentration of

the plume. Lowered groundwater concentrations would increase the dri solubilization of free product in order to maintain equilibrinm. The meet the interim RAO under Alternative 3 is estimated to be between 4

Alternative 4 is estimated to be capable of achieving the interi Target Area 3, though 50 years or more may be required relying upon i bioremediation. As with the other action alternatives, these time fr extended if DNAPLs are present. A DNAPL would present a continuing s contaminants to the aquifer as the DNAPL constituents were solubilize groundwater. This transfer of constituents from free phase to dissol occur through the physical processes of desorption and liquid-liquid These equilibrium-driven processes typically occur slowly because of surface area of DNAPL in contact with the groundwater in comparison t volume. The solubilization rate of DNAPLs would likely be slower tha

degradation of the dissolved constituents. Thus, the solubilization likely be the rate-limiting step. The co-metabolic bioventing treatm 3 will be accomplished within approximately 2 years.

Implementability

Three main factors are considered under this criterion: technic administrative feasibility, and availability of services and material alternatives are administratively feasible and the required services readily available. Hence, the comparison will focus on the technical alternatives.

Alternative 1 (no action) has no technical feasibility considera Alternatives 2 (pump and treat), 3 (air sparging), and 4 (bioremediat technical feasibility concerns associated with them. These concerns highly developed character of the Target Area and the numerous space that are present. However, of the three action alternatives, Alterna least difficult to implement. Alternative 4 requires the installatio four air injection/SVE wells plus equipment to support the bioventing

Alternative 4 system is easier to install than the Alternative 2 syst six groundwater extraction and air injection/SVE wells and a more ext network. Both Alternatives 2 and 4 are considered much less complica than Alternative 3, which consists of 51 air sparge, DDC, and SVE wel expansive piping and numerous treatment stations. Overall Alternativ to be the most easily implemented action alternative.

COST

No direct costs are associated with the implementation of Altern action). The capital cost of Alternative 4 (bioremediation) is $80,0 cost of Alternatives 2 (pump and treat) and 3 (air sparging) are both $330,000.

The O&M cost of Alternative 2 will initially be $64,000 per year to $40,000 per year after 2 years of operation when SVE operations ar The O&M cost of Alternative 3 will be almost $40,000 the first year, several thousand dollars per year thereafter as the carbon consumptio with the SVE system's offgas treatment units decreases. The O&M cost Alternative 4 will be approximately $50,000 per year for the first 2 decrease to $30,000 per year after completion of the co-metabolic bio treatment. Additionally, the first several years of monitoring will performed by the RTDF as part of their intrinsic bioremediation pilot to the government.

The present worth cost of the alternatives will depend upon the operated. The present worth costs of Alternative 2 under operating s and 30 years are $540,000, $660,000, and $880,000 respectively. The costs of Alternative 3 under operating scenarios of 4, 6, and 13 year $490,000, $540,000, and $660,000. The present worth cost of Alternat government assuming 2 years of operation of the co-metabolic bioventi 3 years of monitoring in Target Area 3 following 2 years of monitorin is $170,000. Thus, Alternative 4 has the lowest present worth cost.

Target Area 3

State Acceptance

The State of Delaware concurs with the selected interim remedy f Area 3.

Community Acceptance

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

CONCLUSION

Based on the evaluation of the alternatives using the nine crite 4 (bioremediation) is preferred. Alternative 4 is protective of huma environment, complies with all ARARs, represents a permanent remedy t groundwater toxicity, provides the greatest ease of implementation, a cost effective action alternative.

The selected alternative utilizes permanent solutions and altern technologies to the maximum extent practicable. This interim action negatively impact the ability to implement a final action if it is re remedy will be selected in the final Base-wide ROD.

Actual or threatened releases of hazardous substances from this addressed by the selected alternative, may present a current or poten public health, welfare, or the environment.

Target Area 3

GLOSSARY AND ACRONYMS

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

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

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

ARARs - Applicable or Relevant and Appropriate Requirements. Criteri by federal and state statute and regulations that must be considered evaluation of remedial alternatives.

Biodegradation - The breakdown of organic constituents by microorgani complex compounds.

Capital Cost - Cost incurred for the construction and startup of a fa

CERCLA - Comprehensive Environmental Response, Compensation, and Liabili Act. Federal law creating the Superfund program.

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

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

EPA - U.S. Environmental Protection Agency.

Ex Situ - Performed above ground.

FS - Feasibility Study. Study undertaken to evaluate remedial altern

FFS - Focused Feasibility Study.

Groundwater - Subsurface water residing in a zone of saturation.

Target Area 3

GLOSSARY (cont'd)

HQ - Hazard Quotient. An indicator of the noncarcinogenic health ris with 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 thro of surface water to groundwater.

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

O&M Cost - Annual cost incurred for operation and maintenance of a fa

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

Plume - A recognizable distribution of constituents in groundwater.

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

RBSC - Risk Based Screening Concentration. A chemical-specific conce to preliminarily assess whether exposure to a chemical poses a potent risk.

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

RCRA - Resource Conservation and Recovery Act.

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

RTDF - Remediation Technologies Development Forum.

Soil Vapor Extraction (SVE) - An in situ physical treatment process t withdraw VOCs from subsurface soil residing above the groundwater tab

Target Area 3

GLOSSARY (cont'd)

Vadose Zone - Soil zone above the water table.

VOCs - Volatile organic compounds.

Target Area 3