FINAL
RECORD OF DECISION

AOC 50, Devens, Massachusetts
January 22, 2004

Tables

Figures

Appendices

ABB-ES	ABB Environmental Services, Inc.
AOC	Area of Contamination
ARAR	applicable or relevant and appropriate requirement
AWQC	Ambient Water Quality Criteria
bgs	below ground surface
BRAC	Base Closure and Realignment Act
BTEX	benzene, toluene, ethylbenzene, xylene
CAA	Clean Air Act
CAC	Citizens Advisory Committee
CCCs	Criterion Continuous Concentrations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Cis-1,2-DCE	cis 1,2-dichloroethene
CMC	Criterion Maximum Concentration
CMR	Code of Massachusetts Regulations
COC	chemical of concern
CPC	chemical of potential concern
CVOC	chlorinated volatile organic compound
CWA	Clean Water Act
cy	cubic yard(s)
1,1-DCE	1,1-dichloroethene
1,2-DCE	1,2-dichloroethene
1,2-DCP	1,2-dichloropropane
DNAPL	dense nonaqueous phase liquid
EPA	Environmental Protection Agency
EPC	exposure point concentration
ERA	ecological risk assessment
ERD	Enhanced Reductive Dechlorination
FFA	Federal Facilities Agreement
FOST	Finding of Suitability to Transfer
FS	Feasibility Study
ft	feet or foot
gpm	gallons per minute
HI	hazard index
HHRA	human health risk assessment
HLA	Harding Lawson Associates
HQ	Hazard quotients
IC	Institutional Controls
IRIS	Integrated Risk Information System
IRZ	*In-situ* Reactive Zones
IWS	In-well Stripping
LTMP	long-term monitoring plan
MAAF	Moore Army Airfield
MADEP	Massachusetts Department of Environmental Protection
MCL	Maximum Contaminant Level
MCLG	Maximum Containment Level Goals

MCP	Massachusetts Contingency Plan
mg/kg	milligrams per kilogram
MMCL	Massachusetts Maximum Contaminant Level
NAPL	nonaqueous phase liquid
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NIPDWR	National Interim Primary Drinking Water Regulation
NPL	National Priorities List
O&M	Operation and Maintenance
OPS	Operating Properly and Successfully
ORP	oxidation reduction potential
OSWER	Office of Solid Waste and Emergency Response
PCE	tetrachloroethene
pH	negative log of the hydrogen ion concentration
PID	photoionization detector
PP	Proposed Plan
RAB	Restoration Advisory Board
RAO	remedial action objectives
RAWP	Remedial Action Work Plan
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
R_f	retardation factor
RfD	reference dose
RFTA	Reserve Forces Training Area
RI	Remedial Investigation
RME	Reasonable maximum exposure
ROD	Record of Decision
SA	Study Area
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SI	Site Investigation
SMCL	Secondary Maximum Containment Level
SVE	soil vapor extraction
TBC	to be considered
TCE	trichloroethene
TPH	total petroleum hydrocarbons
TRC	Technical Review Committee
TSCA	Toxic Substances Control Act
μg/g	micrograms per gram
μg/Kg	micrograms per kilogram
μg/L	micrograms per liter
USEPA	U.S. Environmental Protection Agency
UST	underground storage tank
VC	vinyl chloride
VPGAC	vapor-phase granular activated carbon
VOC	volatile organic compound

ZVI	zero-valent iron

PART 1: THE DECLARATION

SITE NAME AND LOCATION

Area of Contamination 50
Devens Reserve Forces Training Area
Devens, Massachusetts
CERCLIS ID MA7210025154

STATEMENT OF PURPOSE AND BASIS

This decision document presents the U.S. Army's and U.S. Environmental Protection Agency (USEPA) selected remedial action alternative for Area of Contamination (AOC) 50 at the Devens Reserve Forces Training Area (RFTA) (formerly Fort Devens), Devens, Massachusetts (Figure 1). It was developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), 42 USC §§ 9601 et seq., as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) 40 CFR Part 300, et seq., as amended. The Chief Base Realignment and Closure Office (BRACO) and the Director of the Office of Site Remediation and Restoration, USEPA Region 1, have been delegated the authority to approve this Record of Decision (ROD).

This decision is based on the Administrative Record that has been developed in accordance with Section 113(k) of CERCLA. The Administrative Record is available for public review at the Devens BRAC Environmental Office, Devens, Massachusetts, and at the Ayer, Harvard, Lancaster, and Shirley Town Libraries. The Administrative Record Index (Appendix A) identifies each of the items considered during selection of the remedial action.

STATE CONCURRENCE

The Commonwealth of Massachusetts concurs with the selected remedy. Appendix B contains a copy of the Declaration of State Concurrence.

ASSESSMENT OF SITE

The response actions selected in this ROD are necessary to protect public health or welfare or environment from actual or threatened releases of hazardous substances to the environment.

DESCRIPTION OF THE SELECTED REMEDY

The selected remedy for AOC 50 is Alternative 6: Soil Vapor Extraction, Enhanced Reductive Dechlorination (with solubilized inorganic controls), In-Well Stripping/Aerobic Bioremediation, Monitoring, and Institutional Controls (IC). In addition, Geochemical additives and *In-situ* Chemical Oxidation are included as contingencies to address inorganics and volatile organic compounds, respectively, in the event that monitoring data indicate that implementation of these contingencies is warranted. This remedy is a comprehensive approach that addresses all current and potential future risks caused by groundwater contamination and mitigates residual soil contamination in the source area.

The AOC 50 Source Area comprises less than 2 acres and surrounds Buildings 3803 (the former parachute shop), 3840 (the former parachute shakeout tower), 3824 (a gazebo), and 3801 (the former 10th Special Forces airplane parachute simulation building). Sources of groundwater contamination within AOC 50 include two World War II fueling systems, a drywell, and the tetrachloroethene (PCE) drum storage area; these sources are collectively referred to as the Source Area (Figure 2). Other potential sources of contamination may include a former cesspool and floor drain associated with Buildings 3801 and 3840. Although these sources have been removed or taken out of commission, groundwater underlying AOC 50 contains elevated concentrations of volatile organic compounds (VOCs) most notably PCE.

Site investigations and a risk assessment indicate that soil does not pose an unacceptable risk and there are no complete exposure pathways to the groundwater plume at AOC 50 under the current land use. However, soil contamination in the Source Area is a continuing source of groundwater contamination and will therefore be mitigated. Exposure to contaminated groundwater would only occur if the land use changes or if groundwater associated with the AOC is used in the future. Based on the results of the human health risk assessment (HHRA), the following future site and groundwater uses are associated with health risks that exceed USEPA target cancer-risk ranges and non-cancer thresholds:

- Potable use of the groundwater associated with the Source Area and the Southwest Plume by a full-time commercial/industrial worker.
- Use of the groundwater associated with the Source Area in an "open" industrial process (e.g., washing and spraying) by a full-time commercial/industrial worker.
- Unrestricted potable use of the groundwater associated with the Source Area, and North and Southwest Plumes (e.g., consumption by residents).
- Construction and occupation of residential dwellings over the Source Area (vapor intrusion).

Based on the results of the screening-level ecological risk assessment (ERA), the following potential risks are associated with groundwater discharging to the Nashua River:

- Low risk predicted for benthic organisms under current conditions.
- Low to moderate risk predicted for benthic organisms under future conditions.

Risks for pelagic organisms were determined to be negligible under all scenarios.

The chemicals of potential concern (CPCs) contributing to potential future human health risk greater than the benchmarks of 1×10^{-6} or a hazard index of one at the site include PCE, trichloroethene (TCE), 1,1-dichloroethene (1,1-DCE), cis-1,2-dichloroethene (cis-1,2-DCE), vinyl chloride (VC), 1,2-dichloropropane, methylene chloride, 1,2-dichloroethane, benzene, arsenic, lead, nitrate, and manganese.

The key components of the selected remedy at AOC 50 consist of the following:

- Soil Vapor Extraction
- Enhanced Reductive Dechlorination (with solubilized inorganics controls)
- In-Well Stripping/Aerobic Bioremediation
- Geochemical Additives (contingency)
- *In-Situ* Chemical Oxidation (contingency)
- Monitoring
- Institutional Controls
    - Existing zoning that prohibits residential use
    - Other applicable regulations and institutional controls to restrict future groundwater use, manage storm-water recharge under development scenarios, manage construction so that it would not interfere with the remedy, and allow site access as outlined below
- Institutional Control Inspections
- Five-year Site Reviews

This remedy relies on existing property zoning, and access and land use control measures with the property owner to ensure the North Plume property remains in non-residential land use, groundwater pumping is restricted, the remedy is protected, and site access is available to the Army. The remedy relies on existing lease terms and future transfer deed restrictions to ensure that the Source Area property remains in non-residential land use, the groundwater is not ingested and groundwater vapors are not inhaled, groundwater pumping is restricted, storm-water recharge is adequately managed under development scenarios, the remedy is protected, and site access is available to the Army. The remedy relies on existing zoning and legal agreements to ensure that the Southwest Plume property remains in non-residential land use, groundwater pumping is restricted, master planning to adequately manage storm-water recharge under development scenarios, the remedy is protected, and site access is available to the Army. These restrictions shall be implemented, monitored, reported on, and enforced by the Army and shall be maintained until the concentration of hazardous substances in the soil and the groundwater beneath have been reduced to levels that allow for unlimited exposure and unrestricted use. If future land use at AOC 50 is inconsistent with these institutional controls, then the site exposure scenarios for human health and the environment would be re-evaluated to assess whether this response action remains appropriate. To the extent practical, remedial activities will be performed with minimal alteration and disturbance to the property. Long-term environmental monitoring will be implemented to assess the success of restoration activities and to monitor for attainment of groundwater cleanup levels.

STATUTORY DETERMINATIONS

The selected remedy for AOC 50 is protective of human health and the environment, attains federal and state environmental and facility siting requirements that are applicable to the remedial action (applicable or relevant and appropriate requirements), is cost effective, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. The NCP articulates nine evaluation criteria to be used in assessing the individual remedial alternative. The selected remedy was based on a comparison of the nine criteria and meets the goals of protecting human health and the environment, maintaining protection over time, and minimizing untreated waste. Because the remedy will result in hazardous substances, pollutants or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure during the period of operation of the remedy, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

DATA CERTIFICATION CHECKLIST

The following information is contained in the Decision Summary section of this Record of Decision. Additional information can be found in the Administrative Record file.

- Chemicals of concern and their respective concentrations
- Baseline risk represented by the chemicals of concern
- Cleanup levels established for chemicals of concern and the basis for those levels
- The process by which source materials constituting principal threats are addressed
- Current and reasonably anticipated future land use assumptions and the current and potential future beneficial uses of groundwater used in the baseline risk assessment
- Potential land and groundwater use that will be available at the site as a result of the selected remedy
- Estimated capital, annual operation and maintenance, and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected
- Key factors that led to selection of the remedy

AUTHORIZING SIGNATURES

The foregoing represents the selection of a remedial action by the U.S. Department of the Army and the U. S. Environmental Protection Agency, with the concurrence of the Commonwealth of Massachusetts Department of Environmental Protection (MADEP).

Concur and recommend for immediate implementation:

U.S. DEPARTMENT OF THE ARMY

(see next page)
Glynn D. Ryan
Chief, Atlanta Field Office
Department of the Army
Base Realignment and Closure

Date

(see next page)
Douglas S. Baker
COL, GS
Chief, Base Realignment
And Closure Office

Date

U.S. ENVIRONMENTAL PROTECTION AGENCY

Susan Studlien
Susan Studlien
~~Acting~~ Director
Office of Site Remediation and Restoration
Region 1

03/31/04
Date

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U.S. ENVIRONMENTAL PROTECTION AGENCY

Susan Studlien
Acting Director
Office of Site Remediation and Restoration
Region 1

Date

PART 2: THE DECISION SUMMARY

1.0 SITE NAME, LOCATION, AND DESCRIPTION

This Record of Decision (ROD) addresses past releases to soil and groundwater at Area of Contamination (AOC) 50 at Devens Reserve Forces Training Area (RFTA), Devens Massachusetts (Figure 1). The Devens RFTA, formerly Fort Devens, is located in the Towns of Ayer and Shirley (Middlesex County) and Harvard and Lancaster (Worcester County), approximately 35 miles northwest of Boston, Massachusetts. A Federal Facilities Agreement (FFA) between the U.S. Department of the Army and the U.S. Environmental Protection Agency (USEPA) establishes the Army as the lead agency for developing, implementing, and monitoring response actions at Devens RFTA in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). Fort Devens is identified by the CERCLIS ID number MA7210025154.

AOC 50 is located on the northeastern boundary of the former Moore Army Airfield (MAAF), within the former North Post portion of Devens RFTA, Ayer, Massachusetts. The AOC 50 Source Area (Figure 2) comprises less than 2 acres and includes Buildings 3803 (the former parachute shop), 3840 (the former parachute shakeout tower), 3824 (a gazebo), and 3801 (the former 10th Special Forces airplane parachute simulation building). Sources of groundwater contamination within AOC 50 include two World War II fueling systems, a drywell, and the tetrachloroethene (PCE) drum storage area; these sources are collectively referred to as the Source Area. Other potential sources of contamination may include a former cesspool and floor drain associated with Building 3840. Although these sources have been removed or taken out of commission, groundwater underlying AOC 50 contains elevated concentrations of volatile organic compounds (VOCs) most notably PCE. The primary area of groundwater contamination at AOC 50 is referred to as the Southwest Plume, which extends from the Source Area approximately 3,000-feet downgradient to the Nashua River.

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

This section provides a brief description of the historical land use at Devens RFTA, investigative and response history at AOC 50, and enforcement history.

2.1 LAND USE AND RESPONSE HISTORY

Fort Devens was established in 1917 as Camp Devens, a temporary training camp for soldiers from the New England area. In 1931, the camp became a permanent installation and was renamed Fort Devens. Throughout its history, Fort Devens served as a training and induction center for military personnel, and as a unit mobilization and demobilization site. All or portions of this function occurred during World Wars I and II, the Korean and Vietnam conflicts, and operations Desert Shield and Desert Storm.

Fort Devens was identified for cessation of operations and closure under Public Law 101-510, the Defense Base Closure and Realignment Act (BRAC) Act of 1990, and was officially closed in September

1996. Portions of the property formerly occupied by Fort Devens were retained by the Army for reserve forces training and renamed the Devens RFTA. Areas not retained as part of the Devens RFTA were transferred to new owners for reuse and redevelopment.

All but approximately 14 acres of the former MAAF (approximately 246 acres total) were transferred to Mass Development in 1997 for reuse. Currently, the airfield is closed to aircraft traffic and is used by the Massachusetts State Police for training and vehicle storage. The MAAF is zoned for Special Use II and Innovation and Technology Business. Under the Devens Reuse Plan (November 14, 1994), Special Use II and Innovation and Technology Business includes a broad range of industrial, light industrial, office, and research and development uses. There are currently no plans for development of the MAAF, although the area can be developed if interested parties are identified. The Devens RFTA retained approximately 9.1 acres of the former airfield for vehicle storage and maintenance and the 4.3 acre parcel which includes the AOC 50 Source Area.

Sources of contamination within AOC 50 include two World War II fueling systems, a drywell, the PCE drum storage area and cesspool. Each of these sources is briefly discussed below.

2.1.1 Fueling Systems

During World War II, two fueling systems were used in the area subsequently designated AOC 50; one system was used for fueling aircraft and trucks (System A), and the other for fueling trucks (System B). These systems were not used for refueling operations after the late 1940s (Biang, et al., 1992). The two separate fueling systems were filled by gasoline shipments on a Boston & Maine Railroad spur (which no longer exists) located adjacent to Fueling System B (Figure 2).

Releases of fuel associated with incidental spills at the former aircraft fuel pits, truck-fill stands, and railroad fuel-delivery points were considered possible sources of contamination. Because the systems were approximately 50 years old, the underground storage tanks (USTs) were also considered possible continuing sources of releases. The potential for migration of contaminated groundwater to the Nashua River was a concern. At the time of the initial Site Investigation (SI) in 1992 (ABB, 1993), several fueling-system components were still visible in their original locations.

Fort Devens removed all of these components in 1992. In addition, approximately 450 tons of contaminated soil was removed from under the water-separator, water-control pits, and three 25,000-gallon USTs. The excavation extended to a depth of approximately 18 ft below ground surface (bgs) due to the presence of water in the excavation. All excavations were backfilled to grade. Field screening results and post-excavation sample analyses are presented in the Remedial Investigation (RI) prepared by Harding Lawson Associates (HLA, 2000a).

2.1.2 Drywell, Tetrachloroethene Drum Storage Area, and Cesspool{ TC "1.4.1.2 Drywell and Tetrachloroethene Drum Storage Area" \f C \l "4" }

2.1.2.1 Drywell

In 1969, Building 3840 was constructed and attached, via an enclosed walkway, to Building 3803. In addition, two large sinks and a janitors' room were added to Building 3803. The design drawings for Building 3840 indicate that a floor drain was constructed in the center of the concrete floor. This floor drain, the additional sinks in Building 3803, and the roof drains for Building 3840 were piped to a drywell located approximately 20 ft northeast of Building 3840 (Figure 2). The concrete drywell was approximately 5 ft in diameter and 8 ft deep, with an open bottom and a cover on the top. This drywell received wash water, rainwater, and PCE waste associated with parachute cleaning activities.

The drywell near Building 3840 and associated piping were removed for the Army by Roy F. Weston Corporation between November and December 1996 (Weston 1997). The resulting excavation was approximately 9.5-ft deep and covered an area approximately 21 feet (ft) by 30 ft, equating to approximately 225 cubic yards (cy) of soil (in-place). Details regarding the removal activities are documented in a September 1997 report titled *Removal Action Report; Dry Well, Cesspool, and Fuel Oil Underground Storage Tank; Area of Contamination (AOC) 50, Moore Army Air Field, Devens, MA* (Weston, 1997).

In addition to the removal of the drywell, a 750-gallon fuel storage UST associated with the Building 3840 heating system was also removed. In connection with the tank removal, approximately 787 gallons of oil, water, and residual sludge were recovered from the tank and approximately 25 cy of contaminated soil were excavated. Solid and liquid wastes generated during removal of the drywell and fuel storage UST were taken off-site for proper treatment and disposal.

2.1.2.2 Tetrachloroethene Drum Storage Area

A PCE drum storage area east of Building 3801 was identified during field investigation activities completed in 1992. Historical records and interviews with former Fort Devens personnel indicate this area was used to store single drum quantities of PCE (HLA, 2000a). The PCE was used by Army personnel in Buildings 3803 and 3840 for spot cleaning of parachutes. Parachute cleaning was performed only as needed to maintain the integrity of the parachute material. Unused PCE was either reused or may have been washed down into the drywell system associated with Buildings 3803 and 3840. This information was supported by a review of the historic hazardous waste manifests, which did not include the removal of waste chlorinated solvents from AOC 50 (Mott, 1997). The use of this area for drum storage was discontinued in 1992. The length of time or total number of drums stored in this area of AOC 50 is unknown.

Based on the results of various field investigations, PCE was detected in vadose zone soils beneath the former drum storage area and was likely contributing to PCE impacts in groundwater. An interim removal action for PCE-contaminated soil at the former drum storage area was planned and implemented as a source-control measure while additional investigation activities were conducted across the site. An *in-situ* soil vapor extraction (SVE) system was installed adjacent to the former drum storage area in December 1993 and January 1994. Five soil vapor extraction wells (SVE-1 through SVE-5) were installed, one in the center of the presumed PCE source and four on the periphery (Figure 2).

Operation of the SVE system began in February 1994 and continued through July 1996. Operation & Maintenance (O&M) data collected between February 1994 and July 1996 indicated that approximately 240 pounds (approximately 18 gallons) of PCE were successfully recovered in the vapor phase. Details regarding the installation, operation, and performance of the SVE system between February 1994 and July 1996 are documented in a November 1996 report titled *Summary Report, SVE Monitoring, AOC 50* (ABB, 1996a).

The SVE system was operated again for brief periods in December 1998, May and June 1999, and October and November 1999. The brief periods of SVE system operation after the 1996 shut down were conducted to evaluate the concentration of PCE in the soil vapor, under equilibrium conditions. In general, recovered vapor concentrations were either below the detection limits of a photoionization detector (PID), or after a brief peak observed when the system was restarted, quickly attenuated within minutes. No appreciable mass of PCE was recovered during the brief periods of SVE operation between 1998 and 1999.

2.1.2.3 Cesspool

A cesspool associated with the bathroom in Building 3803 was identified on the site drawings; it appears to be the only septic system structure for either building. The concrete and rubble cesspool was approximately 10 ft in diameter and 9 ft deep with an open bottom and a cover on the top. The drywell and cesspool were investigated as potential contaminant sources for the various volatile contaminants, including PCE detected in soil and groundwater during previous investigations.

The cesspool was removed concurrent with the drywell and UST associated with Building 3840. During the cesspool removal activities, a total of 25 cy of soil, sludge, and concrete were excavated and taken offsite for treatment and disposal.

2.2 ENFORCEMENT HISTORY

On December 21, 1989, Fort Devens was placed on the National Priorities List (NPL) under CERCLA as amended by the Superfund Amendments and Reauthorization Act (SARA) to evaluate and implement response actions to clean up past releases of hazardous substances, pollutants, and contaminants. An FFA to establish a procedural framework for ensuring that appropriate response actions are implemented at Fort Devens was developed and signed by the Army and the USEPA Region I on May 13, 1991, and finalized on November 15, 1991. AOC 50 is considered a sub-site to the entire installation.

In 1996, the Army initiated an RI for AOC 50. The RI report was issued in January 2000. The purpose of the RI was to determine the nature and extent of contamination at the AOC, assess human health and ecological risks, and provide a basis for conducting a Feasibility Study (FS).

An FS that evaluated remedial action alternatives for cleanup of groundwater was issued in December 2002. The FS identified and screened nine remedial alternatives and provides a detailed analysis of these remedial alternatives to allow decision-makers to select a remedy for cleanup of AOC 50.

In January 2003, the Proposed Plan (PP) detailing the Army's preferred remedial alternatives for AOC 50 was issued for public comment. Technical comments presented during the public comment period are included in the Administrative Record. Appendix C of this ROD, the Responsiveness Summary, contains a summary of these comments and the Army's responses, and describes how these comments affected the remedy selection.

3.0 COMMUNITY PARTICIPATION

The Army has held regular and frequent informational meetings, issued fact sheets and press releases, and held public meetings to keep the community and other interested parties informed of activities at AOC 50. Community interest in AOC 50 was high throughout this process through the issuance of the PP.

In February 1992, the Army released a community relations plan that outlined a program to address community concerns and keep citizens informed about and involved in remedial activities at Fort Devens. As part of this plan, the Army established a Technical Review Committee (TRC) in early 1992. The TRC, as required by SARA Section 211 and Army Regulation 200-1, included representatives from USEPA, U.S. Army Environmental Center, Devens RFTA, Massachusetts Department of Environmental Protection (MADEP), local officials, and the community. Until January 1994, when it was replaced by the Restoration Advisory Board (RAB), the committee generally met quarterly to review and provide technical comments on schedules, work plans, work products, and proposed activities for the study areas (SAs) and AOCs at Devens RFTA. The RI, FS, and PP reports, and other related support documents were all submitted to the RAB for their review and comment.

The Army, as part of its commitment to involve the affected communities, forms a RAB when an installation closure involves transfer of property to the community. The Fort Devens RAB was formed in February 1994 to add members of the Citizen's Advisory Committee (CAC) to the TRC. The CAC had been established previously to address Massachusetts Environmental Policy Act/Environmental Assessment issues concerning the reuse of property at Devens RFTA. The RAB consists of representatives from the Army, USEPA Region I, MADEP, local governments and citizens of the local communities. It meets monthly and provides advice to the installation and regulatory agencies on the Devens RFTA cleanup programs. Specific responsibilities include: addressing cleanup issues such as land use and cleanup goals, reviewing plans and documents, identifying proposed requirements and priorities, and conducting regular meetings that are open to the public.

On January 20, 2003, the Army issued the PP, to provide the public with an explanation of the Army's proposal for remedial action at AOC 50. The PP also described the opportunities for public participation and provided details on the upcoming public comment period and public meeting.

On January 22, 2003, the Army published a public notice announcing the PP, the date for a public information meeting, and the start and end dates of a 30-day public comment period in the Harvard Post and papers of the Nashoba Publishing Company (Groton Landmark, Harvard Hillside, Pepperell Free Press, The Public Spirit, Ayer, Shirley Oracle, and Townsend Times). The Army also made the PP available to the public at the public information repositories at the Ayer Public Library, the Hazen Memorial Library in Shirley, the Harvard Public Library, and the Lancaster Public Library, or by request from the Devens BRAC Environmental Office.

From January 23 through February 20, 2003, the Army held a 30-day public comment period to accept public comments on the Proposed Plan. On January 30, 2003, the Army held an informal public information meeting at Devens RFTA to present the Army's Proposed Plan to the public and to provide the opportunity for open discussion concerning the PP.

On February 7, 2003, the Army published a public notice announcing the PP, the date for a public hearing in the Harvard Post and papers of the Nashoba Publishing Company (Groton Landmark, Harvard Hillside, Pepperell Free Press, The Public Spirit, Ayer, Shirley Oracle, and Townsend Times). On February 19, 2003, the Army held a Public Hearing to present the PP and accept formal verbal or written comments from the public. A transcript of this hearing, formal public comments, and the Army's response to comments are included in the attached Responsiveness Summary (see Appendix C). A written request to extend the comment period for the PP from February 20, 2003 to March 7, 2003 was accepted by the BRAC office on February 20, 2003.

All supporting documentation for the decision regarding AOC 50 is contained in the Administrative Record for review. The Administrative Record is a collection of all the documents considered by the Army in choosing the plan of action for AOC 50. The Administrative Record is available for public review at the Devens BRAC Environmental Office and at the Town Repositories. An index to the Administrative Record is available at the BRAC Environmental Office located at 30 Quebec Street, Devens, Massachusetts and the index is provided as Appendix A.

4.0 SCOPE AND ROLE OF THE RESPONSE ACTION

This ROD documents the selection of the remedial action proposed for control of site risk at AOC 50. Implementation of Alternative 6 (Soil Vapor Extraction, Enhanced Reductive Dechlorination, In-Well Stripping/ Aerobic Bioremediation, Iron Injection [contingency], *In-Situ* Chemical Oxidation [contingency], Monitoring, Institutional Controls) at AOC 50 will protect possible future commercial/industrial workers and unrestricted use (residents) from exposure to groundwater via ingestion and/or inhalation. Specifically, implementation of Alternative 6 in the following specific areas will:

<u>Source Area</u>

- Protect potential residential and commercial/industrial receptors from ingesting contaminated groundwater;
- Protect commercial/industrial workers from inhaling vapors released from groundwater used as "open" process water;

- Prevent potential construction/occupation of residential dwellings and inhalation of vapors released from contaminated groundwater to indoor air;

Southwest Plume

- Protect potential residential and commercial/industrial receptors from ingesting contaminated groundwater;
- Prevent low to moderate potential ecological effects to benthic organisms; and

North Plume

- Protect potential residential receptors from ingesting contaminated groundwater.

5.0 SUMMARY OF SITE CHARACTERISTICS

The following subsections summarize the nature and distribution of contamination presented in the AOC 50 RI report (HLA, 2000a), FS report (ARCADIS, 2002a), and 2001 Groundwater Sampling Report (ARCADIS, 2002b)

5.1 AOC 50 CONTAMINANT CHARACTERIZATION

Contaminated media at AOC 50 previously included surface and subsurface soil and groundwater; however, because of removal actions that took place between 1992 and 1999, groundwater is considered the medium of concern. The nature and extent of contamination is described in detail in the final RI report and is summarized in the FS report and in the following subsections.

5.1.1 Soil Characterization

Soil contamination at AOC 50 can be divided into two types: 1) petroleum hydrocarbons found in vadose zone soils near the former Fueling System B, and 2) PCE and related compounds in soils above and below the water table in the former drywell and drum storage areas.

5.1.1.1 Fuel-Related Compounds

During the 1992 Site Investigation, soil was collected from 6 borings for laboratory analysis that revealed total petroleum hydrocarbon (TPH) concentrations ranging from less than 27.7 milligrams per kilogram (mg/kg) in a surface sample (near the former truck stand) to 162 mg/kg 15-ft bgs south of the former Fueling System B. Xylenes, ethylbenzene, and toluene were detected in soil samples taken from the Fueling System B excavations in December 1992. A soil boring installed in the middle of the former Fueling System B UST grave during the 1996 RI detected benzene concentrations in soil ranging from 0.0046 mg/kg at 18 to 22 ft bgs to 0.020 mg/kg at 10 ft bgs. In this boring, ethylbenzene concentrations ranged from 0.0022 mg/kg at 15 ft bgs to 0.0083 mg/kg at 18 ft bgs, toluene concentrations ranged from 0.0087 mg/kg at 15 ft bgs to 0.020 mg/kg at 18 ft bgs, and xylenes concentrations ranged from 0.0083 mg/kg at 20 ft bgs to 0.071 mg/kg at 10 ft bgs. During a 1994 Phase II Site Investigation, only soil from 4 ft bgs in one boring located in the former PCE drum storage area contained benzene, which was detected at a concentration of 0.002 mg/kg.

Two soil/sludge samples were collected from the bottom of the drywell in 1996 and field laboratory results indicated there were no detectable levels of benzene, toluene, ethylbenzene, and xylene (BTEX). A nearby soil boring, contained toluene at 0.0043 mg/kg in the 9-foot soil sample. During the 1998 Benzene and Ethylene Dibromide Assessments (HLA, 2000b), soil samples collected near the dry well and downgradient of the Source Area were analyzed for BTEX. No detectable levels of BTEX were found.

5.1.1.2 PCE and Related Compounds

The highest levels of PCE at AOC 50 were detected in soil samples collected in 1993 beneath the Former Drum storage area. The highest concentration was 3,000 µg/g in a 7-foot deep sample. This same boring, as well as others in the vicinity, confirmed the limited spatial presence of PCE in soil both above and below the water table (to a depth of approximately 40 ft bgs) in that area. The SVE system operated between 1994 and 1999 significantly reduced PCE levels in vadose soils in that area, as evidenced by low residual concentrations in soil vapor collected by the SVE system.

Field analytical results for subsurface soil samples collected from borings used to assess the former drywell indicated that PCE and/or cis-1,2-DCE was present in the soil from the approximate bottom of the former drywell to refusal of the borings (i.e., at the top of the glacial till). Concentrations of PCE in soil were as high as 5.5 micrograms per kilogram (µg/kg) at 9-foot bgs and 3.2 µg/kg 50-foot bgs. The drywell and associated impacted soil (approximately 225 cy) were removed in 1996.

PCE was also detected in the one soil boring drilled adjacent to the former cesspool that was associated with the lavatory in Building 3803. Concentrations were low and ranged from an estimated concentration of 0.0044 µg/kg in the 20-ft bgs soil sample to 0.011 µg/kg in the 25-ft bgs soil sample. The former cesspool and approximately 25 cy of soil, sludge and concrete were removed in 1996.

The results from the field and off-site laboratory soil samples indicate that soil contamination in the Source Area at AOC 50 appears to be in the saturated zone from approximately 30 ft bgs to 67 ft bgs below and to approximately 60 ft downgradient of the former drywell. This assessment is based on the analytical data collected from soil borings completed in this area of this site. The field and off-site laboratory results of the soil samples collected from the soil boring completed at the former drum storage area, and the area between the former drum storage area and the former drywell, indicate that the PCE contamination in soil is limited to the saturated zone from 12 to 35 ft bgs.

5.1.2 Groundwater Characterization

Groundwater contamination at AOC 50 can be divided into two types: 1) petroleum hydrocarbons and 2) PCE and related compounds found throughout the Site.

Based on the October 2001 site-wide groundwater sampling event performed by ARCADIS (2002b), the AOC 50 groundwater plume contains concentrations of PCE, trichloroethene (TCE), 1,2-dichloroethene (1,2-DCE), and 1,2-dichloropropane (1,2-DCP) above their Maximum Contaminant Levels (MCLs). The laboratory analytical results for the October 2001 groundwater samples at AOC 50 indicate that samples collected from 35 of the 51 monitoring wells did not contain PCE at a concentration above the laboratory method detection limit. The VOC analytical results indicate that groundwater samples from 16 monitoring wells contained PCE at concentrations above the 5 micrograms per liter (μg/L) MCL. The highest concentration of PCE detected in a groundwater sample in October 2001 was 4,300 μg/L. PCE concentrations were generally consistent with previous sampling rounds. In October 2001, there were four exceedances of the TCE MCL (5 μg/L), two exceedances of the cis-1,2-DCE MCL (70 μg/L), and one exceedance of the 1,2-DCP MCL (5 μg/L). In October 2001, benzene and toluene were detected in a limited number of groundwater samples collected across the site including areas adjacent to and downgradient of former USTs; however, the concentrations of benzene and toluene were below their respective MCLs in all cases. More recent data from 2002 confirms previous analytical data and new well data provides additional plume delineation, but also indicates that PCE concentrations in the Source Area have been detected at greater than 30,000 μg/L. The extent of VOCs in groundwater can generally be delineated by the PCE 5 μg/L contour line as shown on Figure 3.

5.2 CONCEPTUAL SITE MODEL

Based on the site history, geology, hydrogeology, surface water hydrology, and contaminant distribution, a conceptual site model was developed for AOC 50 and is outlined in the FS (ARCADIS, 2002a). Field investigation activities indicate that PCE is the primary constituent of concern. The original source of PCE in groundwater is believed to be the former drywell and former drum storage area. This area is considered the Source Area. The Army discontinued drum storage of PCE in 1992 and removed the drywell (and related soils) in 1996. PCE released from these two areas would migrate vertically through the vadose zone to the aquifer.

Dissolved phase PCE has been detected in groundwater at very low concentrations (less than 10 ug/L) north of Route 2A (North Plume) and at elevated concentrations (greater than 1,000 ug/L) southwest of the Source Area (Southwest Plume). Known activities at the site indicate that limited amounts of PCE as product were released to the drywell and to the ground surface near the drum storage area. The releases would be expected to dissipate through dissolution by infiltration to groundwater. Adsorption of aqueous phase contaminants onto soil occurs as a function of equilibrium partitioning as the groundwater plume migrates with the natural groundwater flow direction. The higher silt content of soils in the Source Area provides for higher adsorptive capacity and slower groundwater flow rates in the Source Area.

In addition to partitioning into the aqueous (dissolved) and adsorbed phases, the possibility exists for chlorinated solvents such as PCE to remain in a non-aqueous or free phase depending on a number of factors including the amount and duration of material released and the fraction of organic carbon in the soils. Since free phase chlorinated solvents, including PCE, are typically more dense than water, the non-aqueous phase of PCE and other chlorinated solvents are collectively referred to as dense non-aqueous phase liquid (DNAPLs). The presence of a free or DNAPL phase is important to consider when planning a groundwater remediation program because this phase can present a large portion of the mass of contamination (as compared to the dissolved phase) and also presents a source of ongoing dissolved impacts. As outlined in the FS (ARCADIS, 2002a Section 2.5.1), existing analytical data from the Source

Area do not suggest that a DNAPL exists at the site. Numerous soil borings, soil samples, and screening groundwater samples have been collected in various locations within the Source Area and the concentrations of PCE in these samples are generally lower than would be associated with DNAPL. The length of the PCE plume (over 2,000 ft) and the historic presence of milligram per liter concentrations of PCE in three monitoring wells in the Source Area indicate that adsorbed (residual) PCE is present below the water table in the Source Area.

The distribution of PCE and other VOCs follows the hydraulic gradients at the site. The bulk of the dissolved contaminant plume moves away from the Source Area and migrates with groundwater to the southwest. The contaminant plume has traveled with groundwater downward from the Source Area through the glacio-fluvial deposits to the till. The downward hydraulic gradients in this area were demonstrated by water elevation measurements in well pairs in the Source Area. Groundwater monitoring data indicate that a minor northward component of flow may have been present during a limited period (as evidenced by the extremely limited extent and low concentration of PCE in the North Plume).

The average groundwater velocity is estimated to be approximately 0.58 ft/day (212 ft per year [ft/yr]). The groundwater flow direction is generally southwest across the site. The contaminant plume has migrated with groundwater southwestward to the Nashua River. Based on the estimated groundwater velocity and a minimum retardation factor (R_f) of 2 for PCE, a maximum of 28 years was required for the PCE to reach the river. Although the groundwater plume discharges to the Nashua River, the concentrations of contaminants in the river would be significantly lower due to mixing. Groundwater modeling was used to predict future concentrations of VOCs in the Nashua River for various remedial scenarios. A discussion of the modeling is provided in the FS report (ARCADIS, 2002a).

Review of historical groundwater monitoring data for the plume at AOC 50 suggests that overall concentrations of PCE are stable or declining. These results are expected, given the following factors:

- The assumed age of the plume (30+ years);
- The fact that PCE usage was discontinued at the site more than 10 years ago;
- The remediation activities completed to date, including excavation of impacted soils and operation of the SVE system, removed a continuing source of soil contamination in the Source Area.

6.0 CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES

AOC 50 is currently defined by three distinct areas; the Source Area, Southwest Plume, and North Plume. These areas are shown on Figure 3. The Army currently leases the area designated as the Source Area to Mass Development. The buildings on this property are included in the lease but are generally inactive. The Army intends to convey this property to Mass Development once a determination is made that the remedy is operating properly and successfully (OPS) and a Finding of Suitability to Transfer (FOST) is issued by the Army. Appropriate Land Use Controls and CERCLA Right of Access will be incorporated into the conveyance.

The Army, Mass Development and the Fish and Wildlife Service own portions of the area overlying the Southwest Plume. The Army retained approximately 9.1 acres of the former airfield for vehicle storage and maintenance but transferred a large portion of the property to Mass Development in 1997 for reuse. The Fish and Wildlife Refuge located adjacent to the Nashua River is generally forested and heavily vegetated with steep terrain and limited access. The Refuge abuts the Nashua River and there are currently no known plans to develop this area. The area owned by Mass Development has several buildings and a former airfield. Currently, the airfield is closed to aircraft traffic and is used by the Massachusetts State Police for training and vehicle storage. Under the Devens Reuse Plan (November 14, 1994), the area is zoned for Special Use II and Innovation and Technology Business, which includes a broad range of industrial, light industrial, office, and research and development uses. There are currently no plans for development of the MAAF, although the area can be developed if interested parties are identified.

The Merrimack Warehouse Realty Co., Inc. owns the area overlying the North Plume. The property is zoned commercial and is developed with a building used for the manufacture of windshield washer fluid and as a storage facility. A fire pond is also located on the property and would be used for fire suppression should it be necessary.

Groundwater beneath AOC 50 (Source Area, Southwest Plume, and North Plume) is not used as a drinking water or industrial water source and the entire area is on publicly supplied water and sewer. Future residential use of land at AOC 50 is not likely based on zoning restrictions; the Army will not use the land for residential use, the Devens Reuse Plan does not include residential development of land in the vicinity of AOC 50, and the privately owned land (North Plume) is not zoned for residential use. Since the aquifer underlying portions of the AOC 50 site are classified as high and medium yielding aquifers, there is the potential to use this resource in the future. The institutional controls that will ensure the objectives of prohibiting residential use and restricting groundwater use (and protecting the remedial system) for each area of the plume are discussed in Section 12 of this ROD.

7.0 SUMMARY OF SITE RISKS

As part of the RI, HLA prepared a baseline risk assessment to estimate the probability and magnitude of potential adverse human health and environmental effects from exposure to contaminants associated with the Site, assuming no remedial action was taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. The public health risk assessment followed a four step process: 1) hazard identification, which identified those hazardous substances which, given the specifics of the site were of significant concern; 2) exposure assessment, which identified actual or potential exposure pathways, characterized the potentially exposed populations, and determined the extent of possible exposure; 3) toxicity assessment, which considered the types and magnitude of adverse health effects associated with exposure to hazardous substances, and 4) risk characterization and uncertainty analysis, which integrated the three earlier steps to summarize the potential and actual risks posed by hazardous substances at the site, including carcinogenic and noncarcinogenic risks and a discussion of the uncertainty in the risk estimates. A summary of those aspects of the human health risk assessment that support the need for remedial action is discussed below, followed by a summary of the screening-level ecological risk assessment.

7.1 HUMAN-HEALTH RISK ASSESSMENT

Out of 29 chemicals detected at the Site, 18 were selected for evaluation in the human health risk assessment as chemicals of potential concern. The chemicals of potential concern were selected to represent potential site related hazards based on toxicity, concentration, frequency of detection, and mobility and persistence in the environment and can be found in Tables 9-4 through 9-7 of the RI. From these, the FS identified those chemicals that pose significant future risks; these are referred to as the chemicals of concern (COCs) and are summarized in Table 1.

Consistent with the National Contingency Plan, COCs are defined as those chemicals that were found to pose cancer risks greater than 1×10^{-6} or hazard quotients (HQs) greater than 1. In addition, the criteria for designating COCs have been expanded as follows:

- Chemicals detected at maximum concentrations greater than their Maximum Contaminant Level (MCL), or state groundwater quality standard are designated as COCs, even if the risks that they contribute are not significant. Such chemicals include; 1,2-dichloroethane, iron, methylene chloride, and 1,2-dichloropropane.
- Arsenic is designated as a COC because it may be solubilized by the remediation technology, even though it is not predicted to pose significant risks under baseline conditions.
- Benzene, which also is not predicted to pose significant risks under baseline conditions, is designated as a COC at the request of the Massachusetts Department of Environmental Protection due to past releases.
- Although the HLA risk assessment identified total-1,2-dichloroethylene as a significant contributor of risk, data collected after the completion of the RI (i.e., groundwater samples collected and analyzed in October 2001 and February 2002) demonstrate that cis-1,2-dichloroethylene is the primary isomer present and that trans-1,2-dichloroethylene is present at concentrations well below the MCL. Therefore, neither trans-1,2-dichloroethylene nor 1,2-dichloroethylene (total) is identified as a COC. However, cis-1,2-dichloroethylene is identified as a COC.
- During the RI, groundwater samples were analyzed for nitrate and nitrite (as nitrogen) and the risk assessment identified the combination nitrate/nitrite as a COC, based on the conservative assumption that all nitrogen in groundwater is present as nitrite. Post-RI groundwater samples were analyzed for both nitrate and nitrite individually; nitrite was not detected. Therefore, nitrate is included as a COC, while nitrite is not.
- Lead is included as a COC due to its potential to pose ecological risks, as detailed in Section 7.2. The maximum concentration of lead detected in groundwater has never exceeded the human health-based National Interim Primary Drinking Water Regulation (NIPDWR) of 15 μg/L.
- Although C19-C36 aliphatics were detected in two samples (at concentrations of 270 ug/L and 120 ug/L), they are excluded from the list of COCs because the detected concentrations are more than an order of magnitude below Massachusetts' GW-1 standard of 5,000 ug/L.

- Chloride is not designated as a COC, even though it was detected at concentrations above the secondary MCL because secondary MCLs are not enforceable as interim cleanup levels and because there is insufficient toxicity data available to allow calculation of a risk-based concentration for chloride.

The following chemicals are the final COCs for AOC 50: arsenic, benzene, 1,2-dichloroethane, 1,1-DCE, cis-1,2-DCE, 1,2-DCP, iron, lead, manganese, methylene chloride, nitrate, PCE, TCE, and VC.

Table 1 contains the exposure point concentrations (EPCs) used to evaluate the reasonable maximum exposure scenario (RME) in the baseline risk assessment for the COCs. This table reflects the EPCs applied in the HLA risk assessment prepared for the RI, namely the maximum detected concentrations. The use of maximum concentrations to characterize exposures that occur over many years is a conservative practice that likely overestimates actual long-term exposures. In the RI, three portions of the plume (the Source Area, the Southwest plume, and the North plume) were evaluated individually; these distinctions were subsequently dropped in the FS and groundwater was evaluated as a single plume. Because this section of the ROD summarizes the risk assessment as it was presented in the RI, Table 1 differentiates between the three portions of the plume. Estimates of average or central tendency EPCs for the COCs and all chemicals of potential concern can be found in Tables 9-4 through 9-7 of the HLA RI.

Potential human health effects were estimated through the development of several hypothetical exposure pathways. These pathways were developed to reflect the potential for exposure to hazardous substances based on the present uses, potential future uses, and location of the Site. The majority of the land associated with AOC 50 is now owned by the Mass Development; however, the Source Area is still owned by the U.S. Army. The airfield is no longer used for aviation purposes, but is instead presently used by the Massachusetts State Police for driver training. There are no groundwater supply wells on these properties; the area is supplied with municipal water from a remote source. The Devens Reuse Plan designates the airfield for future "special use"; this use primarily includes commercial/ industrial development and does not include residential development. Land between the airstrip and the Nashua River is wooded, and slopes steeply toward the Nashua River and is owned by the U.S. Fish and Wildlife Service. A commercially developed property currently overlies the North Plume. The land on the west side of the Nashua River includes a portion of the U.S. Fish and Wildlife Refuge and Mass Development's Devens Waste Water Treatment Facility and Environmental Business Zone. The future use of the land on both sides of the Nashua River is expected to remain unchanged.

The following is a brief summary of only those exposure pathways that were found to present significant risks. A more thorough description of all exposure pathways evaluated in the risk assessment can be found on pages 9-11 through 9-14 of the HLA RI. Under RME assumptions, significant risks were predicted to be associated with potable water ingestion and volatile inhalation by future commercial/industrial workers, as well as with potable water ingestion by future adult and child residents. No current exposure pathways are complete because the groundwater is not currently used for municipal or industrial purposes and because groundwater under occupied buildings is at a sufficient depth to limit exposure.

The commercial/industrial scenario assumed that future adult workers would use the groundwater both as process water and as their only source of water for consumption during work hours. It was assumed that indoor air would be impacted by both vapor intrusion and by volatilization during use of process water (i.e., spraying). Workers were assumed to contact COCs 250 days per year (i.e., five days per week for 50 weeks) over a period of 25 years. Workers were assumed to drink one liter of impacted groundwater per day and to work indoors eight hours per day. The risk assessment assumed that workers conduct spraying and related activities four hours per day. They were assumed to wear normal protective equipment (e.g., gloves, waterproof gear), which would prevent dermal contact with impacted groundwater. Indoor air concentrations associated with the migration of volatile COCs from groundwater were estimated using the Johnson and Ettinger (1991) model.

Future residents were assumed to include children (ages one through six) and adults, who use groundwater as their only source of household water. It was assumed that residents would be exposed 350 days per year over a 30-year period (with 6 years as a child and 24 years as an adult). Adults were assumed to drink 2.3 liters of impacted groundwater per day, while children were assumed to drink 1.5 liters per day. Inhalation risks were assumed to be approximately equal to VOC ingestion risks for residential exposures to groundwater.

Excess lifetime cancer risks were determined for each exposure pathway by multiplying a daily intake level by the chemical specific cancer slope factor. Cancer slope factors have been developed by EPA from epidemiological or animal studies to reflect a conservative "upper bound" of the risk posed by potentially carcinogenic compounds. That is, the true risk is unlikely to be greater than the risk predicted. The resulting risk estimates are expressed in scientific notation as a probability (e.g. 1×10^{-6} for 1/1,000,000) and indicate (using this example), that an average individual is not likely to have greater that a one in a million chance of developing cancer over 70 years as a result of site-related exposure (as defined) to the compound at the stated concentration. All risks estimated represent an "excess lifetime cancer risk" - or the additional cancer risk on top of that which we all face from other causes such as cigarette smoke or exposure to ultraviolet radiation from the sun. The chance of an individual developing cancer from all other (non-site related) causes has been estimated to be as high as one in three. EPA's generally acceptable risk range for site related exposure is 10^{-4} to 10^{-6}. Current EPA practice considers carcinogenic risks to be additive when assessing exposure to a mixture of hazardous substances.

Table 2 provides a summary of the cancer toxicity data relevant to the COCs. The cancer toxicity data presented in Table 2 reflect the state-of-the-science at the time that the RI was prepared and are the basis for subsequent risk calculations developed in the HLA risk assessment. EPA has modified several of the cancer slope factors for COCs since the time that the RI was prepared. The cancer slope factor for VC was revised in 2000, such that the updated value is less stringent than that used in the HLA risk assessment. In 2002, 1,1-dichloroethylene was reclassified as a group C carcinogen (possible human carcinogen) and the Integrated Risk Information System (IRIS) concluded that it is not applicable to derive cancer toxicity values for this compound due to equivocal evidence of carcinogenicity and insufficient weight-of-evidence. The cancer slope factor for benzene was also revised in 2000, such that the updated value is more stringent than that used in the HLA risk assessment. In addition, the cancer slope factors for PCE and TCE are currently under review by EPA. Although revised values for PCE and TCE have not yet been verified or published by IRIS, proposed values are more stringent than those used in the HLA risk assessment. Risks were not recalculated in the ROD to reflect changes in the toxicity values for these chemicals, because, as noted below, such updates would not change either: a) the conclusions of the risk assessment (i.e., PCE will drive cancer risks, regardless of which cancer slope factor is used) or b) the interim cleanup levels (which are based on applicable or relevant and appropriate requirements (ARARs) for all of the carcinogenic COCs).

In assessing the potential for adverse effects other than cancer, an HQ is calculated by dividing the daily intake level by the reference dose (RfD). RfDs have been developed by EPA and they represent a level to which an individual may be exposed that is not expected to result in any deleterious effect. RfDs are derived from epidemiological or animal studies and incorporate uncertainty factors to help ensure that adverse health effects will not occur. An HQ ≤ 1 indicates that a receptor's dose of a single chemical is less than the RfD, and that toxic noncarcinogenic effects from that chemical are unlikely. The Hazard Index (HI) is generated by adding the HQs for all COCs that affect the same target organ (e.g., liver) within or across those media to which the same individual may reasonably be exposed. An HI ≤ 1 indicates that toxic noncarcinogenic effects are unlikely.

Table 3 summarizes the noncarcinogenic toxicity data relevant to the COCs. The noncancer toxicity data presented in Table 3 again reflect the state-of-the-science at the time that the RI was prepared and are the basis for subsequent noncancer risk calculations developed in the HLA risk assessment. EPA has modified several of the reference doses for COCs since the time that the RI as prepared. For example, noncancer toxicity values for benzene, cis-1,2-dichloroethylene, 1,1-dichloroethylene, and manganese have been revised, such that the updated values are less stringent than those used in the HLA risk assessment. Toxicity information for nitrite is presented Table 3, consistent with the HLA risk assessment. As discussed above, subsequent sampling demonstrated that only nitrate is present. Nitrate is less toxic than nitrite. The noncancer toxicity values for PCE and TCE are currently under review by EPA; proposed values are more stringent than those used in the HLA risk assessment. In addition, IRIS issued noncancer toxicity values for VC in 2000, such that noncancer hazards can now be quantified for this chemical. Again, hazards were not recalculated in the ROD to reflect recent changes in the noncancer toxicity values, because such updates would not change either a) the conclusions of the risk assessment (i.e., PCE will drive noncancer risks, regardless of which RfD is used) or b) the interim cleanup levels (which are based on ARARs for all COCs).

Only cancer risks and noncancer hazards associated with exposure pathways deemed relevant to the remedy being proposed are presented in this ROD. In particular, the Region 1 Model ROD specifies that this discussion only include pathways contributing cancer risks equal to or greater than 10^{-4} and noncancer hazards equal to or greater than 1. Readers are referred to Tables 9-23 and 9-24 of the HLA RI for a more comprehensive risk summary of all exposure pathways evaluated for all chemicals of potential concern and for estimates of the central tendency cancer risk and noncancer hazard. Table 4 depicts the cancer risks and noncancer hazards developed in the HLA risk assessment for future commercial/industrial workers and residents, corresponding to the RME scenarios.

Significant cancer risks are predicted for future commercial/industrial workers via potable water ingestion and volatile inhalation at the Source Area and via potable water ingestion at the Southwest plume. Significant noncancer hazards are predicted for future commercial/industrial workers via potable water ingestion at the Source Area plume.

Significant cancer risks are predicted for future residents via potable water ingestion and volatile inhalation at the Source Area, as well as via potable water ingestion at both the Southwest plume and the North plume. Significant noncancer hazards are predicted for future child and adult residents via potable water ingestion at all three plumes. Maximal cancer risks are predicted for adult residential exposure via potable water ingestion, whereas maximum noncancer hazards are predicted for child residential exposure via potable water ingestion.

The human health risk assessment was conducted in a manner that ensures a conservative and health-protective result. In reality, the likelihood of health effects occurring depends upon a number of uncertain factors, such as: a) whether people actually will be exposed to maximum concentrations on a continuous and long-term basis; b) the manner in which the site is developed in the future; c) whether the groundwater is used for potable or nonpotable purposes; d) the frequency with which people contact the groundwater; and e) the duration of time spent living or working at the site. If actual exposures are less than those assumed in the human health risk assessment, then actual risks will likely be lower than those predicted by the human health risk assessment. The predicted health effects also depend upon assumptions regarding the toxicity of COCs. Toxicity values are developed by the EPA with the objective of ensuring that they are conservative and health protective. Some of the toxicity values used in the human health risk assessment are provisional, meaning that they have not undergone formal peer-review and verification by EPA. Others have been updated since the HLA risk assessment was issued. Some of those updated values are more stringent than those used in the risk assessment, while others are less stringent. Regardless of these changes in the toxicity values, however, the conclusions of the risk assessment would not change if updated toxicity values were used. That is, PCE will be the major risk driver at AOC 50 regardless of the toxicity values applied to it and the other COCs. Hence, conclusions regarding the need for remediation at the site would not change, regardless of the status of the toxicity values.

7.2 SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT SUMMARY

The ERA contained in the HLA RI (2000a) provides a qualitative screening-level evaluation of potential risks to ecological receptors posed by chemicals of potential concern (CPCs) detected in groundwater from the Southwest Plume and Source Area. The ERA was updated in the Feasibility Study (ARCADIS, 2002a) to incorporate additional groundwater modeling information, but remains a screening-level assessment.

The only complete pathway through which ecological receptors could contact CPCs is through the migration of the plume to the Nashua River, discharge of CPCs into the river, and diffusion of the CPCs through sediment and porewater and into the surface water. Therefore, the potentially exposed receptors include aquatic organisms (pelagic and benthic) that inhabit the Nashua River. Pelagic organisms are defined as those that live within the water column, while the benthic organisms are defined as those that inhabit sediment (including porewater).

Groundwater monitoring and modeling data were used as surrogates for estimating exposure to benthic and pelagic organisms. Maximum and average concentrations of chemicals in groundwater during the last three years (in the Southwest Plume) were used to estimate chemical concentrations in the surface water and sediment (including porewater). A site-specific dilution factor of 237 was used to estimate current chemical concentrations in the Nashua River surface water. This dilution factor was derived using the groundwater flux and the lowest 7-day average flow in a 10-year period for the Nashua River.

Future chlorinated volatile organic compounds (CVOC) concentrations in the surface water and sediment (including porewater) were derived using the solute transport model developed in the FS. All other CPCs are estimated based on average and maximum concentrations observed in groundwater at the Site during the last three years. A dilution factor of 237 was used to estimate current chemical concentrations in the Nashua River surface water.

Predicted current and future surface water concentrations are well below screening-level ecological effects benchmarks for all CPCs, indicating that pelagic organisms are unlikely to be adversely impacted by CPCs in the Nashua River. Estimated concentrations of a limited number of CPCs in porewater exceed screening-level ecological effects benchmarks, indicating a potential for low to moderate hazards to benthic organisms.

These findings are summarized in Table 5, which presents hazard quotients (HQs) based on both average and maximum concentrations of CPCs in porewater and surface water. HQs are calculated as the ratio of predicted surface water and porewater concentrations (for pelagic and benthic organisms, respectively) to screening-level ecological effects benchmarks. For CPCs sharing similar mechanisms of action, HQs based on average concentrations are summed to yield hazard indices (HIs). HQs and HIs greater than one indicate the potential for adverse ecological effects, wherein HQs and HIs between one and ten are designated as low potential effects, HQs and HIs between 10 and 100 are designated as moderate potential effects, and HQs and HIs greater than 100 are designated as high potential effects.

7.3 BASIS FOR RESPONSE ACTION

The baseline human health risk assessment revealed that workers and residents potentially exposed to COCs in groundwater via potable water ingestion and vapor inhalation may present unacceptable human health risks (i.e., cancer risks greater than 10^{-4} and noncancer hazard indices greater than 1). In addition, the screening-level ecological risk assessment indicated significant but low ecological risks (hazard quotients for benthic organisms greater than 1 indicating low potential risk). Therefore, actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment. Groundwater will be the focus of remedial actions.

8.0 PRINCIPAL THREAT WASTES

The NCP establishes an expectation that treatment will be used to address the principal threats at a site wherever practical, whereas engineering controls, such as containment, may be used for wastes that pose a relatively low long-term threat or where treatment is impractical. The concept of principal threat and low-level threat wastes is applied on a site-specific basis when characterizing source material. Source material is defined as material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, surface water, air, or acts as a source for direct exposure. Contaminated groundwater generally is not considered to be source material, although non-aqueous phase liquids (NAPLs) and DNAPL may be.

Principal threat wastes are those source materials considered to be highly toxic or highly mobile which cannot be reliably contained or that would present a significant risk to human health or the environment should exposure occur. The manner in which principal threats are addressed generally will determine whether the statutory preference for treatment as a principal element is satisfied. Although USEPA has not established a threshold level of toxicity/risk to identify a principal threat waste; toxicity and mobility must combine to pose a potential risk several orders of magnitude greater than is acceptable under current or reasonably expected future land use, given realistic exposure scenarios. Further, characterizing a waste as a principal threat does not necessarily mean that the waste poses the primary risk at a site. Examples of source materials that generally constitute principal threats include liquid wastes in drums, lagoons, or tanks; NAPLs floating on or under groundwater; soil, sediment, sludge, or debris containing high concentrations of mobile or potentially mobile contaminants; buried non-liquid wastes; and soil containing significant concentrations of highly toxic material.

Low-level threat wastes are those source materials that generally can be readily contained and that would present only a low risk in the event of a release or exposure. Examples of wastes generally considered to constitute low-level threats include soil containing contaminants that are relatively immobile in air or groundwater (i.e., non-liquid, low volatility, low leachability) in the specific environmental setting and soil containing contaminants at concentrations associated with noncancer hazards near or less than one and cancer risks near or less than the acceptable cancer risk range.

At AOC 50, the fueling system components were removed in 1992, the drywell and cesspool removal actions were performed in 1996, and the SVE system was run in the drum storage area between 1994 and 1999. No waste drums, tanks, or impoundments, or areas of high toxicity/concentration/mobility soil contamination are known to remain at AOC 50. Based on this assessment, the Army concludes that there is a low principal threat for groundwater in the Source Area at the site that will need to be remediated; however, under current land uses and with land use controls in place to limit potential future uses, the threat is minimal at AOC 50.

9.0 GENERAL STATUTORY REQUIREMENTS AND REMEDIAL ACTION OBJECTIVES

Under its legal authorities, the Army's primary responsibility at Superfund sites is to undertake remedial actions that are protective of human health and the environment. In addition, Section 121 of CERCLA establishes several other statutory requirements and preferences, including the following:

- a requirement that the remedial action, when complete, must attain all federal and more stringent state environmental requirements, standards, criteria, or limitations that are applicable or relevant and appropriate to the action, unless a waiver is invoked;
- a requirement that a remedial action be cost-effective and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and
- a preference for remedies in which treatment permanently and significantly reduces the toxicity, mobility, or volume of hazardous substances as a principal element.

9.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Applicable or relevant and appropriate requirements (ARARs) are federal or more stringent state environmental laws that are applicable or relevant and appropriate to the hazardous substances or circumstances at a site. Inherent in the interpretation of ARARs is the assumption that protection of human health and the environment is ensured.

The NCP defines two ARAR components: (1) applicable requirements, and (2) relevant and appropriate requirements. These definitions are discussed in the following paragraphs.

Applicable Requirements. Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance that have jurisdiction at a site. An example of an applicable requirement is the use of the Safe Drinking Water Act (SDWA) MCLs for groundwater identified as a potential drinking water supply.

Relevant and Appropriate Requirements. Relevant and appropriate requirements are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a site, address problems or situations sufficiently similar to those encountered at the site that their use is well-suited to the particular site. For example, MCLs would be relevant and appropriate requirements at a site where hazardous substances could enter groundwater classified as a current or future drinking water source. When a requirement is found to be relevant and appropriate, it is complied with to the same degree as if it were applicable.

Requirements under federal or state law may be either applicable or relevant and appropriate to CERCLA clean-up actions, but not both. However, requirements must be both relevant and appropriate for compliance to be necessary. CERCLA on-site remedial response actions must only comply with the substantive requirements of an ARAR and not the administrative requirements to obtain federal, state, or local permits [CERCLA §121(e)]. The CERCLA program has its own set of administrative procedures that ensure proper implementation of CERCLA. The application of additional or conflicting administrative requirements could delay or confuse the implementation of a remedial action (USEPA, 1988). Off-site actions need only comply with applicable requirements, not relevant and appropriate requirements.

Off-site actions must comply fully with both substantive and administrative requirements.

Substantive requirements pertain directly to the actions or conditions at a site, while administrative requirements facilitate their implementation. To ensure that CERCLA response actions proceed as rapidly as possible, USEPA has reaffirmed this position in the current NCP. The NCP defines on-site as "the areal extent of contamination and all areas in very close proximity to the contamination necessary for implementation of the response action." The FFA provides additional guidance on the applicability of permitting requirements to response actions at Devens (USEPA, 1991). USEPA recognizes that certain administrative requirements, such as consultation with state agencies and reporting, are accomplished through the state involvement and public participation requirements of the NCP.

In the absence of federal- or state-promulgated regulations, there are many criteria, advisories, and guidance values that are not legally binding, but may serve as useful guidance for remedial actions. These are not potential ARARs, but are to-be-considered (TBC) guidance. These guidelines or advisory criteria should be identified if used to develop clean-up goals or if they provide important information needed to properly design or perform a remedial action. The two categories of TBC guidance are (1) technical information on how to perform or evaluate remedial or response actions; and (2) regulatory policy or proposed regulations.

Because of their site-specific nature, identification of ARARs requires evaluation of federal, state, and local environmental and health regulations regarding chemicals of concern, site characteristics, and proposed remedial alternatives. ARARs that pertain to the remedial response can be classified into three categories: chemical-, location-, and action-specific. The following subsections provide an overview of these ARARs categories.

9.1.1 Chemical-Specific ARARs

Chemical-specific ARARs generally involve health- or risk-based numerical values or methodologies that establish site-specific acceptable chemical concentrations or amounts. They govern the extent of site remediation by providing either actual clean-up levels, or the basis for calculating such values. The HHRA at AOC 50 identified potential human health risks from groundwater contamination under assumed future use scenarios. The screening-level ERA identified potential ecological risks from discharge of contaminated groundwater to Nashua River porewater. Human health and ecological risks from exposure to other media (soil and surface water) were found to be within acceptable levels. A key consideration in the assessment of groundwater chemical-specific ARARs for AOC 50 is the fact that groundwater at Fort Devens was assigned to Class I under Massachusetts regulations. Such groundwaters are designated as a potential source of potable water supply. Chemical-specific ARARs for groundwater at AOC 50 include federal drinking water MCLs promulgated under the SDWA, Massachusetts Groundwater Quality Standards, and Massachusetts MCLs (MMCLs) promulgated as part of the Massachusetts Drinking Water Standards and Guidelines.

The National Primary Drinking Water Regulations establish MCLs and Maximum Contaminant Level Goals (MCLGs) for several common organic and inorganic contaminants (USEPA, 2000). MCLs specify the maximum permissible concentrations of contaminants in public drinking water supplies. MCLs are federally enforceable standards based in part on health effects and on the availability and cost of treatment techniques. MCLGs specify the maximum concentration at which no known or anticipated adverse effect on humans will occur. MCLGs are non-enforceable health-based goals set equal to or lower than MCLs. The National Secondary Drinking Water Regulations establish secondary MCLs (SMCLs), which are nonenforceable standards for drinking water contaminants that affect the aesthetic qualities relating to public acceptance of drinking water. A National Interim Primary Drinking Water Regulation has been established for lead, at a concentration of 15 ug/L.

The Massachusetts Drinking Water Standards and Guidelines list MMCLs that apply to water delivered to any user of a public water supply system as defined in 310 CMR 22.00. Private residential wells are not subject to the requirements of 310 CMR 22.00; however, the standards are often used to evaluate private residential contamination, especially in CERCLA activities. The regulation contains Secondary MMCLs similar to the SMCLs of the federal SDWA.

Under Section 304(a) of the Clean Water Act, USEPA develops and publishes chemical-specific criteria for ambient surface water quality based on environmental and human health effects (USEPA, 1999). These Ambient Water Quality Criteria (AWQC) include Criterion Maximum Concentrations (CMC) and Criterion Continuous Concentrations (CCCs) for protection of freshwater and saltwater biota, as well as criteria for protection of human health for consumption of: a) water and organisms and b) organisms only. AWQC are generally applicable to surface water bodies of the United States. USEPA recommends that States and Tribes use the AWQC as guidance in adopting surface water quality standards.

314 CMR 6.07(2) specifies "for purposes of determining compliance with 314 CMR 6.06(1)(aa) for toxic pollutants in Class I and Class II ground waters, the Department shall use Health Advisories which have been adopted by the Department or USEPA. Generally, the level of a toxic pollutant which may result in one additional incident of cancer in 100,000 given a lifetime exposure (10^{-5} Excess Lifetime Cancer Risk) will be used in determining compliance with 314 CMR 6.06(1)(aa)." Risk-based values based on assumptions and toxicity values provided in the Final Human Health Risk Assessment (HLA, 2000a) were calculated for carcinogenic chemicals to meet this ARAR. However, 314 CMR 6.07(3) does not specifically address the criteria for determining compliance with 314 CMR 6.06(1)(aa) for non-carcinogenic chemicals. Therefore, it is assumed that the groundwater criteria will be USEPA's Lifetime Health Advisory, which is based on non-carcinogenic health effects. Note that the minimum criteria for arsenic is 50 µg/L as specific in 314 CMR 6.06(1)(c).

Massachusetts surface water quality standards are established under 314 CMR 4.00 and apply to any discharge to surface waters in the Commonwealth from any source. These standards designate the most sensitive uses for which the various waters of the Commonwealth shall be enhanced, maintained and protected; prescribe the minimum water quality criteria required to sustain the designated uses; and contain regulations necessary to achieve the designated uses and maintain existing water quality.

Table 6 presents federal and Commonwealth of Massachusetts requirements that may be chemical-specific ARARs for groundwater at AOC 50.

9.1.2 Location-Specific ARARs

Location-specific ARARs represent restrictions placed on the concentration of hazardous substances or the conduct of activities because of the location or characteristics of a site. These ARARs set restrictions relative to the presence of specific natural or manmade features or potentially affected resources at a disposal or clean-up site. Features and resources that can trigger location-specific ARARs include the following:

- seismic faults;
- caves, salt domes, salt beds, and underground mines;
- floodplains, wetlands, and water bodies;
- sensitive ecosystems or habitats;
- wilderness areas, wildlife refuges, wildlife resources, and scenic rivers;
- rare, threatened, or endangered species; or
- archaeological resources and historic sites.

None of the triggers listed above are known to exist at AOC 50; however, groundwater contamination extends to the Nashua River southwest of the site. If remedial actions are undertaken at or near these wetlands or river areas, several ARARs may be triggered. Table 6 summarizes the location-specific federal and state requirements that may pertain to remedial actions at AOC 50. Identification and evaluation of location-specific ARARs is an iterative task, necessary throughout the remedial response process.

9.1.3 Action-Specific ARARs

Action-specific ARARs set controls or restrictions on particular kinds of activities related to the management of hazardous waste. Action-specific ARARs involve design, implementation, and performance requirements that are generally technology- or activity-based. Selection of a particular remedial action at a site may invoke appropriate action-specific ARARs that may specify particular performance standards or technologies, as well as specific environmental levels for discharged or residual chemicals. Action-specific ARARs may be established under the Resource Conservation and Recovery Act (RCRA), the Clean Air Act (CAA), the Clean Water Act (CWA), the SDWA, the Toxic Substances Control Act (TSCA), and other laws.

Table 6 presents federal and Commonwealth of Massachusetts requirements that may be action-specific ARARs related to the selected remedial alternative for groundwater at AOC 50.

9.1.4 Massachusetts Contingency Plan

The NCP provides that CERCLA on-site response actions must comply with ARARs to the extent they are substantive (i.e., pertain directly to actions or conditions in the environment), but do not need to comply with those that are administrative (i.e., mechanisms that facilitate the implementation of the substantive requirements).

The provisions of the Massachusetts Contingency Plan (MCP), 310 CMR 40.0000 (MADEP, 1997) are mostly administrative in nature and, therefore, do not have to be complied with in connection with the response actions selected for AOC 50. Further, the MCP contains a specific provision (310 CMR 40.0111) for deferring application of the MCP at CERCLA sites. As stated in the MCP, response actions at CERCLA sites are deemed adequately regulated for purposes of compliance with the MCP, provided the MADEP concurs in the CERCLA ROD.

9.2 CLEANUP LEVELS

The Remedial Action Objectives (RAOs) are site-specific clean-up objectives established for protecting human health and the environment. The RAOs may be qualitative (e.g., to prevent exposure to contaminated groundwater) or quantitative (e.g., to specify the maximum contaminant concentration in groundwater). The RAOs for protection of human and ecological receptors should indicate a contaminant level and an exposure route, rather than a contaminant level alone, because protectiveness may be achieved by reducing exposure as well as by reducing contaminant concentrations (USEPA, 1988). For AOC 50, RAOs were developed based on the results of the HHRA and ERA (summarized in Sections 2.8.1 and 2.8.2 of the FS, respectively) and based on ARARs. The qualitative RAOs are presented below:

- Minimize, stabilize or eliminate further migration of the groundwater contaminant plume within AOC 50 (containment); and
- Reduce the concentration of chemicals of concern (COCs) in groundwater to the chemical-specific interim cleanup levels, within a reasonable timeframe (aquifer restoration). The chemical-specific interim cleanup levels are defined in the following sections.

9.2.1 Interim Groundwater Cleanup Levels

Interim groundwater cleanup levels have been established for all COCs, which in most cases is based on ARARs. Because the aquifer under the Site is a Class I aquifer, which is a potential source of drinking water, MCLs established under the Safe Drinking Water Act and any more stringent state groundwater quality standards are ARARs. Table 7 summarizes the interim cleanup levels for all of the COCs in groundwater as well as risks and hazards associated with interim cleanup levels.

Risks and hazards associated with interim cleanup levels were calculated for the single scenario with the maximal exposures, namely residential exposures to groundwater via drinking water under RME exposure assumptions. Cancer risks were calculated for adults, whereas noncancer hazards were calculated for children, again because the age groups maximize exposures. Default RME assumptions were derived from the EPA's (1997) *Exposure Factors Handbook*. In particular, the water ingestion rates for adults and children were assumed to be 2.3 L/day and 1.5 L/day, respectively. An exposure frequency of 350 days/year was applied to both age groups. The exposure duration for adults and children were assumed to be 30 years and 6 years, respectively. Inhalation risks were assumed to be approximately equal to VOC ingestion risks for residential exposures to groundwater.

Primary MCLs have not been established for iron and manganese. Alternative interim groundwater cleanup levels are presented for these two COCs. Since the secondary MCLs for iron and manganese are based on aesthetic considerations, rather than protection of health, it is most appropriate to employ risk-based concentrations as the interim groundwater cleanup levels for these two inorganic compounds. This practice is consistent with the cleanup level implemented for manganese in the Final Five Year Review for Shepley's Hill Landfill at Devens (U.S. Army Corps of Engineers 1998). Risk-based concentrations are derived in Table 8 for iron and manganese, based on default exposure assumptions for child residents (i.e., the most highly exposed and susceptible receptor), published reference doses, and a target hazard index of one.

Periodic assessments of the protection afforded by remedial actions will be made as the remedy is being implemented and at the completion of the remedial action. A risk assessment will be performed on residual groundwater contamination once the interim groundwater cleanup levels identified in the ROD and newly promulgated ARARs and modified ARARs have been achieved for a period of two consecutive years. The purpose of the risk assessment of residual contamination will be to determine whether the remedial action is protective. The risk assessment of residual contamination will follow EPA procedures and will assess the cumulative carcinogenic and noncarcinogenic risks posed by all COCs in groundwater via potable water ingestion and vapor inhalation. If, after review of the risk assessment, EPA determines that the remedial action is not protective, the remedial action shall continue until either protective levels are achieved, and are not exceeded for a period of two consecutive years, or until the remedy is otherwise deemed protective or is modified. These protective residual levels shall constitute the final cleanup levels for this ROD and shall be considered performance standards for this remedial action.

Interim groundwater cleanup levels identified in the ROD and newly promulgated ARARs and modified ARARs which call into question the protectiveness of the remedy and the protective levels determined as a consequence of the risk assessment of residual contamination, must be met at the completion of the remedial action at the points of compliance. At this Site, interim cleanup levels must be met throughout the contaminated groundwater plume, which extends from the North Plume and Source Area along Route 2A to the Southwest Plume and the Nashua River. The boundary of this plume is shown on Figure 3. Attainment of interim groundwater cleanup levels will be determined through a long-term monitoring program that will be implemented as part of this ROD and are expected to be achieved within 27 years after implementation of the full-scale remedy.

9.2.2 Porewater Cleanup Levels

Interim cleanup levels have been established for porewater for COCs that pose an ecological hazard quotient for benthic invertebrates greater than 1, including 1,2-dichloroethylene, lead, manganese, and tetrachloroethylene. Interim cleanup levels for porewater have been set based on chronic freshwater ambient water quality criteria (USEPA 2002), final chronic values (MDEQ 2002), and chronic Tier II values (Suter 1996) (in descending order of preference). These concentrations reflect levels reported in the scientific literature to be without deleterious effect on aquatic organisms. Because these interim cleanup levels are specific to porewater, the point of compliance may be either; a) groundwater located as close as is practical to the Nashua River and downgradient of the In-well Stripping remedy or b) the porewater within the uppermost six inches of sediment of the Nashua River. Interim cleanup levels for porewater are presented in Table 9. These porewater cleanup levels must be met at the completion of the remedial action at the points of compliance. They are consistent with ARARs for surface water, attain EPA's risk management goals for remedial action, and are protective of the environment.

10.0 DESCRIPTION OF ALTERNATIVES

CERCLA and the NCP set forth the process by which remedial actions are evaluated and selected. In accordance with these requirements, the Army developed a range of remedial alternatives for AOC 50. Section 4.0 of the FS (ARCADIS 2002a) identified and screened a number of groundwater treatment technologies and process options based on probable effectiveness and implementability. In Section 5.0 of the FS (ARCADIS 2002a), the technologies and process options retained during the technology evaluation and screening were assembled into a number of logical remedial alternatives, which were then compared to one another with respect to effectiveness, implementability, and cost to eliminate impractical alternatives or alternatives with significantly higher costs (i.e., order of magnitude differences). A detailed analysis of each remedial alternative developed for groundwater at AOC 50 is presented in Section 6.0 of the FS report (ARCADIS 2002a).

The following section provides a narrative summary description of each of the remedial alternatives evaluated for AOC 50.

10.1 DESCRIPTION OF ALTERNATIVES FOR AOC 50

10.1.1 Alternative 1: No Action

The No Action alternative includes no remedial action components to reduce, control, or monitor potential human health or ecological risks associated with site groundwater. The No Action alternative was developed, as required by the NCP, to provide a baseline alternative for comparison purposes.

Estimated Time for Groundwater Cleanup:	48 years
Estimated Capital Cost:	$0
Estimated Annual Operation and Maintenance Cost:	$0
Estimated Total Cost (net present worth*):	$0

10.1.2 Alternative 2: Soil Vapor Extraction, Monitored Natural Attenuation, Institutional Controls

The alternative combines the use of SVE to remove residual, adsorbed phase CVOCs potentially present in the vadose zone soils in the Source Area with natural attenuation mechanisms for groundwater (e.g., dilution, dispersion, volatilization, abiotic transformation, biodegradation), groundwater monitoring, and institutional controls in the form of groundwater/land use restrictions. Implementation of Alternative 2 involves the following specific components:

Pre-Design Investigation. Additional field investigations will be conducted at AOC 50 to determine the best locations for placement of additional monitoring wells. New monitoring wells will be installed to better delineate groundwater impacts (both vertically and horizontally, as warranted) and to facilitate natural attenuation monitoring. Additional SVE wells will be installed in the Source Area to supplement the existing SVE well network. For the purposes of the FS evaluation, it was estimated that five new monitoring wells and three new SVE wells would be installed at the site. The exact number, locations, and completion details of the new monitoring and SVE wells will be specified in the Remedial Design.

SVE System. The existing SVE system at AOC 50 would be refurbished for use in this alternative. Vacuum would be applied to the SVE wells using a regenerative blower, and recovered vapors would be treated using vapor-phased granular activated carbon (VPGAC) prior to being discharged to the atmosphere, if required. It was assumed that the SVE system would be operated for the first 3 years of the remedy duration.

Monitoring. Long-term monitoring will be performed to confirm that COC concentrations are eventually reduced to remedial goals. During the initial phases of implementation, monitoring will be conducted at more frequent intervals. As the progress of the remedy is established, monitoring frequency will be reduced. Samples would be analyzed for VOCs, dissolved metals (arsenic, iron, and manganese), redox couples (nitrate/nitrite, sulfate/sulfide, and carbon dioxide/methane), dissolved gases (oxygen, ethane, and ethene), and various field parameters [e.g., oxidation reduction potential (ORP), negative log of the hydrogen ion concentration (pH), hardness, conductivity turbidity, and temperature]. The sampling frequency, locations, analytes, and procedures will be outlined in a long-term monitoring plan (LTMP) and submitted to the USEPA and MADEP for review and approval prior to implementation.

Institutional Controls and Inspections. Institutional controls will be implemented to restrict land and groundwater use at the site. This will be accomplished through existing zoning and other applicable regulations and /or institutional controls.

A LTMP will also be prepared for the site and it will identify the monitoring and maintenance requirements as well as the frequency of the inspections.

Five-Year Site Reviews. Under CERCLA 121c, any remedial action that results in contaminants remaining on-site at concentrations greater than those allowing unrestricted use must be reviewed at least every five years by the lead agency. During five-year site reviews, an assessment is made of whether the implemented remedy continues to be protective of human health and the environment or whether the implementation of additional remedial action is appropriate.

Consistent with guidance in Office of Solid Waste and Emergency Response (OSWER) Directive 9355.7-02A, the USEPA has recommended that five-year reviews for Devens RFTA sites be performed simultaneously and reported in a single document. The last five-year site review for Devens RFTA site was performed in 2000 (HLA, 2000a). However, the remedy is targeted for implementation in the summer of 2004.

Estimated Time for Groundwater Cleanup:	48 years
Estimated Capital Cost:	$330,000
Estimated Annual Operation and Maintenance Cost:	$120,000 to 630,000

Estimated Total Cost (net present worth*): $4,200,000

*Present worth based on 3.9 percent discount rate and environmental monitoring, institutional controls inspections, and five-year reviews for 48 years.

10.1.3 Alternative 3: Soil Vapor Extraction, Groundwater Extraction, *Ex-Situ* Treatment by Air Stripping and Carbon Adsorption, Surface Water Discharge, Monitoring, Institutional Controls

This alternative involves the use of SVE to remove adsorbed phase PCE potentially present in vadose zone soils in the Source Area, along with extraction of groundwater throughout the plume to establish hydraulic control and remove COC mass. Recovered groundwater will be treated with a combination of air stripping (with off-gas controls, as required) and carbon adsorption. Treated groundwater will be discharged to the Nashua River. Alternative 3 will include groundwater monitoring and institutional controls in the form of groundwater/land use restrictions and will consist of the following specific components:

Pre-Design Investigation. Additional field investigations will be conducted at AOC 50 to determine the best locations for placement of additional monitoring wells and to support the Remedial Design. In addition, pumping tests will be conducted in two areas of the site to support design of the groundwater pump-and-treat system.

Additional Groundwater Monitoring and SVE Wells. New monitoring wells will be installed to better delineate groundwater impacts (both vertically and horizontally, as warranted) and to facilitate groundwater monitoring. Additional SVE wells will be installed in the Source Area to supplement the existing SVE well network. For the purposes of the FS evaluation, it was estimated that five new monitoring wells and three new SVE wells would be installed at the site. The exact number, locations, and completion details of the new monitoring and SVE wells will be specified in the Remedial Design.

SVE System. The existing SVE system at AOC 50 would be refurbished for use in this alternative. Vacuum would be applied to the SVE wells using a regenerative blower, and recovered vapors would be treated using VPGAC prior to being discharged to the atmosphere, if required. It was assumed that the SVE system would be operated for the first 3 years of the remedy duration.

Groundwater Extraction System. Based on groundwater modeling, approximately nine extraction wells operating at a total (cumulative) continuous pumping rate of approximately 45 gallons per minute (gpm) will capture contaminated groundwater above remedial goals throughout the bulk of the plume. The 45 gpm pumping rate was selected based on the groundwater recharge and flux in the area requiring remediation and includes a small safety factor (approximately 5 gpm). Modeling simulations were performed for two conceptual groundwater extraction designs – one each with five wells and nine wells. As with the new monitoring and SVE wells, the exact locations and completion details of the extraction wells will be specified in the Remedial Design.

Groundwater Treatment System. A groundwater treatment system will be constructed to treat extracted groundwater prior to its discharge to the Nashua River. The Henry's Law constant for PCE and the other

VOCs present in Site groundwater are relatively high, indicating that they will readily partition from the dissolved phase into the vapor phase. They also have relatively high organic carbon partitioning coefficients (Koc values), indicating that they have an affinity for adsorption to organic carbon. Consequently, extracted groundwater will be treated to meet the applicable surface water discharge criteria using a shallow-tray air stripper for primary treatment, with a carbon adsorption polish. Pre-treatment will consist of equalization and filtration to remove solids. Volatiles in the air stripper off-gas will be treated using VPGAC prior to being discharged to the atmosphere, if required.

Surface Water Discharge. Following treatment, the extracted groundwater will be discharged to the Nashua River at the southwestern end of the airfield. Treated groundwater will be discharged immediately above the water's edge into a newly constructed riprap outfall. Limited disruption to the wetlands is anticipated. However, wetlands restoration and monitoring will be implemented upon completion of the remedy.

Monitoring. Long-term monitoring will be performed to confirm that COC concentrations are eventually reduced to remedial goals. During the initial phases of implementation, monitoring will be conducted at more frequent intervals. As the progress of the remedy is established, monitoring frequency will be reduced. Samples would be analyzed for VOCs, dissolved metals (arsenic, iron, and manganese), redox couples (nitrate/nitrite, sulfate/sulfide, and carbon dioxide/methane), dissolved gases (oxygen, ethane, and ethene), and various field parameters (e.g., ORP, pH, hardness, conductivity turbidity, and temperature). The sampling frequency, locations, analytes, and procedures will be outlined in a LTMP and submitted to the USEPA and MADEP for review and approval prior to implementation.

Institutional Controls and Inspections. Similar to Alternative 2, institutional controls will be implemented to restrict land and groundwater use at the site. This will be accomplished through existing zoning restrictions and other applicable regulations and/or institutional controls.

Five-Year Site Reviews. Under CERCLA 121c, any remedial action that results in COCs remaining on-site at concentrations greater than those allowing unrestricted use must be reviewed at least every 5 years by the lead agency. During five-year site reviews, an assessment is made of whether the implemented remedy continues to be protective of human health and the environment or whether the implementation of additional remedial action is appropriate. Details regarding the five-year site reviews at AOC 50 were previously discussed as part of Alternative 2.

Estimated Time for Groundwater Cleanup:	25 years
Estimated Capital Cost:	$2,000,000
Estimated Annual Operation and Maintenance Cost:	$380,000 to 950,000
Estimated Total Cost (net present worth*):	$9,600,000

*Present worth based on 3.9 percent discount rate and environmental monitoring, institutional controls inspections, and five-year reviews for 25 years.

10.1.4 Alternative 4: Soil Vapor Extraction, In-Well Stripping, Monitoring, Institutional Controls

This alternative involves the use of SVE to remove adsorbed phase PCE potentially present in vadose zone soils in the Source Area along with the installation of in-well stripping (IWS) circulation wells in a series of transects across the groundwater plume. Groundwater treatment will occur within the circulation wells (*in situ*) and will involve the physical process of air stripping to remove VOC mass. This process will enhance the ability of natural attenuation mechanisms to reduce concentrations of VOCs and other site-related COCs to remedial goals throughout the remaining portions of the site. Alternative 4 includes monitoring and institutional controls in the form of groundwater/land-use restrictions, and consists of the following specific components:

Pre-Design Investigation. Additional field investigations will be conducted at AOC 50 to determine the best locations for placement of additional monitoring wells and to support the Remedial Design.

Additional Groundwater Monitoring and SVE Wells. New monitoring wells will be installed to better delineate groundwater impacts (both vertically and horizontally, as warranted) and to facilitate groundwater monitoring. Additional SVE wells will be installed in the Source Area to supplement the existing SVE well network. It was estimated that five new monitoring wells and three new SVE wells will be installed at the site. The exact number, locations, and completion details of the new monitoring and SVE wells will be specified in the Remedial Design.

SVE System. The existing SVE system at AOC 50 will be refurbished for use in this alternative. Vacuum will be applied to the SVE wells using a regenerative blower, and recovered vapors will be treated using VPGAC prior to being discharged to the atmosphere, if required. It was assumed that the SVE system will be operated for the first 3 years of the remedy.

IWS System. Approximately 25 groundwater circulation wells will be installed in a series of transects oriented perpendicular to groundwater flow. At each transect, the inlet (lower) screen interval of the circulation well will be positioned to intercept the zone of highest VOC concentrations, with the recharge (upper) screen interval positioned at the upper limit of the impacted zone (to prevent cross-contamination of unexpected zones). As with the new monitoring and SVE wells, the exact locations, spacing, and completion details of the circulation wells/transects will be specified in the Remedial Design. These details will be based on the results of a pilot-scale demonstration of circulation well/IWS technology to be performed as part of the Remedial Design. Each circulation well will be connected to a vapor recovery and treatment system via underground PVC piping.

Monitoring. Long-term monitoring will be performed to allow comparison of site conditions to remedial goals. During the initial phases of implementation, monitoring will be conducted at more frequent intervals. As the progress of the remedy is established, the monitoring frequency will be reduced. Samples will be analyzed for VOCs, dissolved metals (arsenic, iron, and manganese), redox couples (nitrate/nitrite, sulfate/sulfide, and carbon dioxide/methane), dissolved gases (oxygen, ethane, and ethene), and various field parameters (e.g., ORP, pH, hardness, conductivity turbidity, and temperature). The sampling frequency, locations, analytes, and procedures will be outlined in a LTMP and submitted to the USEPA and MADEP for review and approval prior to implementation.

Institutional Controls and Inspections. Institutional controls will be implemented to restrict land and groundwater use at the site. This will be accomplished through existing zoning restrictions and other applicable regulations and/or institutional controls.

Five-Year Site Reviews. Under CERCLA 121c, any remedial action that results in COCs remaining on-site at concentrations greater than those allowing unrestricted use must be reviewed at least every 5 years by the lead agency. During five-year site reviews, an assessment is made of whether the implemented remedy continues to be protective of human health and the environment or whether the implementation of additional remedial action is appropriate. Details regarding the five-year site reviews at AOC 50 were previously discussed as part of Alternative 2.

Estimated Time for Groundwater Cleanup:	30 years
Estimated Capital Cost:	$2,500,000
Estimated Annual Operation and Maintenance Cost:	$380,000 to 1,000,000
Estimated Total Cost (net present worth*):	$10,700,000

*Present worth based on 3.9 percent discount rate and environmental monitoring, institutional controls inspections, and five-year reviews for 30 years.

10.1.5 Alternative 5: Soil Vapor Extraction, Enhanced Reductive Dechlorination, Monitoring, Institutional Controls

This alternative involves the use of SVE to remove adsorbed phase PCE potentially present in vadose zone soils in the Source Area along with the installation of a series of enhanced reductive dechlorination (ERD) injection well transects across the groundwater plume. These wells will be used to deliver a source of excess organic carbon to the subsurface, stimulating microbial activity and resulting in the formation of anaerobic and reducing *in-situ* reactive zones (IRZs) downgradient of each transect. Within the IRZs, *in- situ* degradation of the primary COC in groundwater (PCE) and its resultant daughter products will be significantly enhanced, as evidenced by the results of the ERD pilot testing. The ERD application will drive adsorbed phase PCE mass into the dissolved phase, making it available for treatment and accessing the residual mass that often hinders physical mass removal techniques such as groundwater extraction.

This process will significantly reduce COC mass within the areas targeted by the ERD transects, greatly enhancing the ability of natural attenuation mechanisms to reduce COC concentrations to remedial goals throughout the remaining portions of the plume. Alternative 5 includes monitoring and institutional controls in the form of groundwater/land use restrictions, and consists of the following specific components:

Pre-Design Investigation. Additional field investigations will be conducted at AOC 50 to determine the best locations for placement of additional monitoring wells and to support the Remedial Design.

Additional Groundwater Monitoring and SVE Wells. New monitoring wells will be installed to better delineate groundwater impacts (both vertically and horizontally, as warranted) and to facilitate groundwater monitoring. Additional SVE wells will be installed in the Source Area to supplement the existing SVE well network. It was estimated that five new monitoring wells and three new SVE wells will be installed at the site. The exact number, locations, and completion details of the new monitoring and SVE wells will be specified in the Remedial Design.

SVE System. The existing SVE system at AOC 50 will be refurbished for use in this alternative. Vacuum will be applied to the SVE wells using a regenerative blower, and recovered vapors will be treated using VPGAC prior to being discharged to the atmosphere, if required. It was assumed that the SVE system will be operated for the first 3 years of the remedy.

ERD Implementation. Approximately 45 ERD injection wells will be used in a series of five transects oriented perpendicular to groundwater flow (5 wells have already been installed as part of the ERD pilot test (ARCADIS, 2001). The ERD injection wells will be used to inject a dilute solution of molasses (or other carbohydrate) and potable water into the formation to drive the groundwater environment to anaerobic and reducing conditions. The screen intervals of the injection wells will be positioned to intercept the zone of highest VOC concentrations at each transect. As with the new monitoring and SVE wells, the exact locations, spacing, and completion details of the injection wells/transects will be specified in the Remedial Design. These details will be based on the results of the pilot-scale demonstration of ERD technology initiated at AOC 50 in December 2001.

For the purposes of the FS, it was assumed that regular injection events will be completed manually using a batch process. It is assumed for costing purposes, that 100 gallons of a 10 percent molasses solution will be injected into each ERD well monthly for two years, and quarterly thereafter.

Monitoring. Long-term monitoring will be performed to allow comparison of site conditions to remedial goals. During the initial phases of implementation, monitoring will be conducted at more frequent intervals. As the progress of the remedy is established, the monitoring frequency will be reduced. Samples will be analyzed for VOCs, dissolved metals (arsenic, iron, and manganese), redox couples (nitrate/nitrite, sulfate/sulfide, and carbon dioxide/methane), dissolved gases (oxygen, ethane, and ethene), and various field parameters (e.g., ORP, pH, hardness, conductivity turbidity, and temperature). The sampling frequency, locations, analytes, and procedures will be outlined in a LTMP and submitted to the USEPA and MADEP for review and approval prior to implementation.

Institutional Controls and Inspections. Institutional controls will be implemented to restrict land and groundwater use at the site. This will be accomplished through existing zoning restrictions and other applicable regulations and/or institutional controls.

Five-Year Site Reviews. Under CERCLA 121c, any remedial action that results in COCs remaining on-site at concentrations greater than those allowing unrestricted use must be reviewed at least every 5 years by the lead agency. During five-year site reviews, an assessment is made of whether the implemented remedy continues to be protective of human health and the environment or whether the implementation of additional remedial action is appropriate. Details regarding the five-year site reviews at AOC 50 were previously discussed as part of Alternative 2.

Estimated Time for Groundwater Cleanup:	26 years
Estimated Capital Cost:	$1,100,000
Estimated Annual Operation and Maintenance Cost:	$190,000 to 800,000
Estimated Total Cost (net present worth*):	$5,700,000

*Present worth based on 3.7 percent discount rate and environmental monitoring, institutional controls inspections, and five-year reviews for 26 years.

10.1.6 Alternative 6: Soil Vapor Extraction, Enhanced Reductive Dechlorination, In-Well Stripping/Aerobic Bioremediation, Monitoring, Institutional Controls

This alternative involves the use of SVE to remove adsorbed phase PCE potentially present in vadose zone soils in the Source Area, along with the installation of a series of ERD injection well transects across the groundwater plume. In addition, a single transect of groundwater circulation/IWS wells will be installed across the downgradient edge of the Southwest Plume, upgradient of the Nashua River.

The ERD wells will be used to deliver a source of excess organic carbon to the subsurface, stimulating microbial activity and resulting in the formation of anaerobic and reducing IRZs downgradient of each transect. Within the IRZs, *in-situ* degradation of the primary COC in groundwater (PCE) and its resultant daughter products will be significantly enhanced as evidenced by the results of the ERD pilot testing. The ERD application will drive adsorbed phase PCE mass into the dissolved phase, making it available for treatment and accessing the residual mass that often hinders physical mass removal techniques such as groundwater extraction.

The downgradient positioning of a circulation well transect will allow direct *in-situ* treatment of groundwater using the physical process of air stripping to remove VOC mass. The circulation well transect will also oxygenate the groundwater. This will enhance the aerobic degradation of PCE transformation products (such as cis-1,2-DCE and VC) in the unlikely event that these daughter products are not degraded anaerobically in the ERD application zones. Groundwater aeration will also create a zone of oxidizing conditions (high ORP) that will promote oxidation and immobilization of dissolved metals (such as arsenic, iron, and manganese) in the unlikely event that these metals migrate away from the zones of reduced groundwater created by the ERD application. The combination of these processes will significantly reduce COC mass within the area targeted by the ERD and circulation well transects. In addition, following completion of the ERD remedy, long term monitoring will establish whether adjustments to aquifer chemistry or application of an alternative technology is warranted to expedite re-precipitation of inorganic compounds. Alternative 6 includes monitoring and institutional controls in the form of groundwater/land use restrictions, and consists of the following specific components:

<u>Pre-Design Investigation</u>. Additional field investigations will be conducted at AOC 50 to determine the

best locations for placement of additional monitoring wells and to support the Remedial Design.

Additional Groundwater Monitoring and SVE Wells. New monitoring wells will be installed to better delineate groundwater impacts (both vertically and horizontally, as warranted) and to facilitate groundwater monitoring. Additional SVE wells will be installed in the Source Area to supplement the existing SVE well network. It was estimated that five new monitoring wells and three new SVE wells will be installed at the site. The exact number, locations, and completion details of the new monitoring and SVE wells will be specified in the Remedial Design.

SVE System. The existing SVE system at AOC 50 will be refurbished for use in this alternative. Vacuum will be applied to the SVE wells using a regenerative blower, and recovered vapors will be treated using VPGAC prior to being discharged to the atmosphere, if required. It was assumed that the SVE system will be operated for the first 3 years of the remedy.

ERD Implementation. The implementation of ERD technology for Alternative 6 will be identical to that described for Alternative 5.

Circulation Well Transect. Alternative 6 will involve the installation of groundwater circulation/ IWS wells in a single transect oriented perpendicular to groundwater flow at the downgradient edge of the Southwest Plume, just upgradient of the Nashua River. The number of wells required to adequately treat the residual plume and aerate the solubilized inorganics will be determined in the Remedial Design. The implementation of this technology for Alternative 6 will be identical to that described for Alternative 4.

Monitoring. Long-term monitoring will be performed to allow comparison of site conditions to remedial goals. During the initial phases of implementation, monitoring will be conducted at more frequent intervals. As the progress of the remedy is established, the monitoring frequency will be reduced. Samples will be analyzed for VOCs, dissolved metals (arsenic, iron, and manganese), redox couples (nitrate/nitrite, sulfate/sulfide, and carbon dioxide/methane), dissolved gases (oxygen, ethane, and ethene), and various field parameters (e.g., ORP, pH, hardness, conductivity turbidity, and temperature). The sampling frequency, locations, analytes, and procedures will be outlined in a LTMP and submitted to the USEPA and MADEP for review and approval prior to implementation.

Institutional Controls and Inspections. Institutional controls will be implemented to restrict land and groundwater use at the site. This will be accomplished through existing zoning restrictions and other applicable regulations and/or institutional controls.

Five-Year Site Reviews. Under CERCLA 121c, any remedial action that results in COCs remaining on-site at concentrations greater than those allowing unrestricted use must be reviewed at least every 5 years by the lead agency. During five-year site reviews, an assessment is made of whether the implemented remedy continues to be protective of human health and the environment or whether the implementation of additional remedial action is appropriate. Details regarding the five-year site reviews at AOC 50 were previously discussed as part of Alternative 2.

Estimated Time for Groundwater Cleanup:	27 years
Estimated Capital Cost:	$1,700,000
Estimated Annual Operation and Maintenance Cost:	$300,000 to 940,000
Estimated Total Cost (net present worth*):	$8,200,000

*Present worth based on 3.8 percent discount rate and environmental monitoring, institutional controls inspections, and five-year reviews for 27 years.

10.1.7 Alternative 7: Soil Vapor Extraction, Enhanced Reductive Dechlorination, Zero-Valent Iron, In-Well Stripping/Aerobic Bioremediation, Monitoring, Institutional Controls

This alternative involves the technologies presented in Alternative 6. The only difference between Alternatives 7 and 6 is the application of zero-valent iron (ZVI) in the form of nano-scale particles in the Source Area to further enhance PCE degradation rates in a limited area once the anaerobic and reducing IRZs are formed. Similar to Alternative 6, this alternative includes monitoring and institutional controls in the form of groundwater/land use restrictions, and consists of the following specific components:

Pre-Design Investigation. Additional field investigations will be conducted at AOC 50 to determine the best locations for placement of additional monitoring wells and to support the Remedial Design.

Additional Groundwater Monitoring and SVE Wells. New monitoring wells will be installed to better delineate groundwater impacts (both vertically and horizontally, as warranted) and to facilitate groundwater monitoring. Additional SVE wells will be installed in the Source Area to supplement the existing SVE well network. It was estimated that five new monitoring wells and three new SVE wells will be installed at the site. The exact number, locations, and completion details of the new monitoring and SVE wells will be specified in the Remedial Design.

SVE System. The existing SVE system at AOC 50 will be refurbished for use in this alternative. Vacuum will be applied to the SVE wells using a regenerative blower, and recovered vapors will be treated using VPGAC prior to being discharged to the atmosphere, if required. It was assumed that the SVE system will be operated for the first 3 years of the remedy.

ERD Implementation. The implementation of ERD technology for Alternative 7 will be identical to that described for Alternative 5.

Circulation Well Transect. Alternative 7 will involve the installation of from two to four groundwater circulation/ IWS wells in a single transect oriented perpendicular to groundwater flow at the downgradient edge of the Southwest Plume, just upgradient of the Nashua River. The implementation of this technology for Alternative 7 will be identical to that described for Alternative 4.

Zero-Valent Iron Application. Where further enhancement of reductive dechlorination in the Source Area is desired, ZVI will be delivered to the targeted portion of the formation as a slurry using direct-push technology. It is assumed that approximately 75 pounds of ZVI will be introduced into a localized portion of the Source Area only, in a single application.

Monitoring. Long-term monitoring will be performed to allow comparison of site conditions to remedial goals. During the initial phases of implementation, monitoring will be conducted at more frequent intervals. As the progress of the remedy is established, the monitoring frequency will be reduced. Samples will be analyzed for VOCs, dissolved metals (arsenic, iron, and manganese), redox couples (nitrate/nitrite, sulfate/sulfide, and carbon dioxide/methane), dissolved gases (oxygen, ethane, and ethene), and various field parameters (e.g., ORP, pH, hardness, conductivity turbidity, and temperature). The sampling frequency, locations, analytes, and procedures will be outlined in a LTMP and submitted to the USEPA and MADEP for review and approval prior to implementation.

Institutional Controls and Inspections. Institutional controls will be implemented to restrict land and groundwater use at the site. This will be accomplished through existing zoning restrictions and other applicable regulations and/or institutional controls.

Five-Year Site Reviews. Under CERCLA 121c, any remedial action that results in COCs remaining on-site at concentrations greater than those allowing unrestricted use must be reviewed at least every 5 years by the lead agency. During five-year site reviews, an assessment is made of whether the implemented remedy continues to be protective of human health and the environment or whether the implementation of additional remedial action is appropriate. Details regarding the five-year site reviews at AOC 50 were previously discussed as part of Alternative 2.

Estimated Time for Groundwater Cleanup:	23 years
Estimated Capital Cost:	$1,700,000
Estimated Annual Operation and Maintenance Cost:	$290,000 to 940,000
Estimated Total Cost (net present worth*):	$7,800,000

*Present worth based on 3.6 percent discount rate and environmental monitoring, institutional controls inspections, and five-year reviews for 23 years.

10.1.8 Alternative 8: Soil Vapor Extraction, Chemical Oxidation, In-Well Stripping, Monitoring, Institutional Controls

This alternative involves the use of SVE to remove adsorbed phase PCE potentially present in vadose zone soils in the Source Area, chemical oxidation to treat adsorbed and dissolved phase impacts in groundwater in the Source Area, and a series of IWS circulation well transects to treat the groundwater plume. Groundwater treatment via the IWS circulation well transects will occur within the circulation wells (*in situ*), and will involve the physical process of air stripping to remove VOC mass. This process will enhance the ability of natural attenuation mechanisms reduce the concentrations of VOCs and other site-related COCs to remedial goals throughout the remaining portions of the site. Alternative 8 also includes monitoring and institutional controls in the form of groundwater/land use restrictions, and consists of the following specific components:

Pre-Design Investigation. Additional field investigations will be conducted at AOC 50 to determine the best locations for placement of additional monitoring wells and to support the Remedial Design.

Additional Groundwater Monitoring and SVE Wells. New monitoring wells will be installed to better delineate groundwater impacts (both vertically and horizontally, as warranted) and to facilitate groundwater monitoring. Additional SVE wells will be installed in the Source Area to supplement the existing SVE well network. It was estimated that five new monitoring wells and three new SVE wells will be installed at the site. The exact number, locations, and completion details of the new monitoring and SVE wells will be specified in the Remedial Design.

SVE System. The existing SVE system at AOC 50 will be refurbished for use in this alternative. Vacuum will be applied to the SVE wells using a regenerative blower, and recovered vapors will be treated using VPGAC prior to being discharged to the atmosphere, if required. It was assumed that the SVE system will be operated for the first 3 years of the remedy.

Chemical Oxidation. Chemical oxidation will be implemented in the Source Area. A dilute solution of $KMnO_4$ consisting of potable water and raw granular potassium permanganate will be injected through a series of re-useable injection points. For the purposes of the FS, it was estimated that 10 injection points will be installed in the Source Area. The exact number, locations, and completion details of the injection points will be specified in the Remedial Design. The total amount of $KMnO_4$ required to successfully overcome the matrix demand (the naturally occurring organic material in the Site soil) and subsequently destroy the targeted COCs will be determined through completion of a bench-scale treatability study. It is preliminarily estimated that 10,000 pounds of $KMnO_4$ will be required.

IWS System. Approximately 20 groundwater circulation wells will be installed in a series of five transects oriented perpendicular to groundwater flow. At each transect, the inlet (lower) screen interval of the circulation wells will be positioned to intercept the zone of highest VOC concentrations, with the recharge (upper) screen interval positioned at the upper limit of the impacted zone (to prevent cross-contamination of unimpacted zones). As with the new monitoring wells, the exact locations, spacing, and completion details of the circulation wells/transects will be specified in the Remedial Design.

Monitoring. Long-term monitoring will be performed to allow comparison of site conditions to remedial goals. During the initial phases of implementation, monitoring will be conducted at more frequent intervals. As the progress of the remedy is established, the monitoring frequency will be reduced. Samples will be analyzed for VOCs, dissolved metals (arsenic, iron, and manganese), redox couples (nitrate/nitrite, sulfate/sulfide, and carbon dioxide/methane), dissolved gases (oxygen, ethane, and ethene), and various field parameters (e.g., ORP, pH, hardness, conductivity turbidity, and temperature). The sampling frequency, locations, analytes, and procedures will be outlined in a LTMP and submitted to the USEPA and MADEP for review and approval prior to implementation.

Institutional Controls and Inspections. Institutional controls will be implemented to restrict land and groundwater use at the site. This will be accomplished through existing zoning restrictions and other applicable regulations and/or institutional controls.

Five-Year Site Reviews. Under CERCLA 121c, any remedial action that results in COCs remaining on-site at concentrations greater than those allowing unrestricted use must be reviewed at least every 5 years by the lead agency. During five-year site reviews, an assessment is made of whether the implemented remedy continues to be protective of human health and the environment or whether the implementation of additional remedial action is appropriate. Details regarding the five-year site reviews at AOC 50 were previously discussed as part of Alternative 2.

Estimated Time for Groundwater Cleanup:	29 years
Estimated Capital Cost:	$2,600,000
Estimated Annual Operation and Maintenance Cost:	$380,000 to 1,200,000
Estimated Total Cost (net present worth*):	$11,100,000

*Present worth based on 3.9 percent discount rate and environmental monitoring, institutional controls inspections, and five-year reviews for 29 years.

10.1.9 Alternative 9: Soil Vapor Extraction, Enhanced Reductive Dechlorination, Groundwater Extraction, Ex-Situ Treatment by Air Stripping and Carbon Adsorption, Surface Water Discharge, Monitoring, Institutional Controls

Alternative 9 is similar to Alternative 6 with the exception that groundwater extraction will occur at the downgradient edge of the Southwest Plume rather than along a longitudinal transect of groundwater circulation/ IWS wells. The downgradient positioning of a groundwater extraction well will remove CVOC mass, provide hydraulic control, and will capture PCE transformation products in the unlikely event that CVOC daughter products were not degraded anaerobically via the ERD application. The recovered groundwater will be treated *ex-situ* using a combination of air stripping (primary) and carbon adsorption (secondary) to remove dissolved-phase VOC mass. Treated water will be discharged to the Nashua River.

The combination of these processes will significantly reduce COC mass within the areas targeted by the ERD transects and the extraction well. Alternative 9 will include monitoring and institutional controls in the form of groundwater/land use restrictions, and will consist of the following specific components:

Pre-Design Investigation. Additional field investigations will be conducted at AOC 50 to determine the best locations for placement of additional monitoring wells and to support the Remedial Design.

Additional Groundwater Monitoring and SVE Wells. New monitoring wells will be installed to better delineate groundwater impacts (both vertically and horizontally, as warranted) and to facilitate groundwater monitoring. Additional SVE wells will be installed in the Source Area to supplement the existing SVE well network. It was estimated that five new monitoring wells and three new SVE wells will be installed at the site. The exact number, locations, and completion details of the new monitoring and SVE wells will be specified in the Remedial Design.

SVE System. The existing SVE system at AOC 50 will be refurbished for use in this alternative. Vacuum will be applied to the SVE wells using a regenerative blower, and recovered vapors will be treated using VPGAC prior to being discharged to the atmosphere, if required. It was assumed that the SVE system will be operated for the first 3 years of the remedy.

ERD Implementation. The implementation of ERD technology for Alternative 9 will be identical to that described for Alternative 5, 6, and 7.

Groundwater Extraction System. Based on groundwater modeling, a single extraction well operating at a total continuous pumping rate of approximately 45 gpm will capture contaminated groundwater at the downgradient edge of the plume. As with the new monitoring and SVE wells, the exact location and completion details of this well will be specified in the Remedial Design.

Groundwater Treatment and Surface Water Discharge System. A groundwater treatment and surface water discharge system identical to that described for Alternative 3 will be constructed to handle the extracted groundwater.

Monitoring. Long-term monitoring will be performed to allow comparison of site conditions to remedial goals. During the initial phases of implementation, monitoring will be conducted at more frequent intervals. As the progress of the remedy is established, the monitoring frequency will be reduced. Samples will be analyzed for VOCs, dissolved metals (arsenic, iron, and manganese), redox couples (nitrate/nitrite, sulfate/sulfide, and carbon dioxide/methane), dissolved gases (oxygen, ethane, and ethene), and various field parameters (e.g., ORP, pH, hardness, conductivity turbidity, and temperature). The sampling frequency, locations, analytes, and procedures will be outlined in a LTMP and submitted to the USEPA and MADEP for review and approval prior to implementation.

Institutional Controls and Inspections. Institutional controls will be implemented to restrict land and groundwater use at the site. This will be accomplished through existing zoning restrictions and other applicable regulations and/or institutional controls.

Five-Year Site Reviews. Under CERCLA 121c, any remedial action that results in COCs remaining on-site at concentrations greater than those allowing unrestricted use must be reviewed at least every 5 years by the lead agency. During five-year site reviews, an assessment is made of whether the implemented remedy continues to be protective of human health and the environment or whether the implementation of additional remedial action is appropriate. Details regarding the five-year site reviews at AOC 50 were previously discussed as part of Alternative 2.

Estimated Time for Groundwater Cleanup:	24 years
Estimated Capital Cost:	$1,800,000
Estimated Annual Operation and Maintenance Cost:	$460,000 to 1,100,000
Estimated Total Cost (net present worth*):	$10,500,000

*Present worth based on 3.7 percent discount rate and environmental monitoring, institutional controls inspections, and five-year reviews for 24 years.

11.0 SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

Section 121(b)(1) of CERCLA presents several factors that, at a minimum, the Army is required to consider in its assessment of remedial action alternatives. Building upon these specific statutory mandates, the NCP articulates nine evaluation criteria to be used in assessing the individual remedial alternatives. The nine criteria are used to select a remedy that meets the goals of protecting human health and the environment, maintaining protection over time, and minimizing untreated waste. Section 6.0 of the FS report (ARCADIS 2002a) provides a detailed analysis of the alternatives using the first seven of the nine evaluation criteria.

Definitions of the nine criteria are provided below:

11.1 THRESHOLD CRITERIA

The two threshold criteria described below must be met in order for an alternative to be eligible for selection in accordance with the NCP.

- Overall Protection of Human Health and the Environment This criterion assesses whether a remedy will protect human health and the environment. This includes an assessment of how human health and environmental risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.
- Compliance with Applicable or Relevant and Appropriate Requirements This criterion assesses whether a remedy complies with all federal and state environmental and facility-siting laws and requirements that apply or are relevant and appropriate to the conditions and cleanup options at a specific site. If an alternative cannot meet an ARAR, the analysis of the alternative must provide the rationale for invoking a statutory waiver.

11.2 PRIMARY BALANCING CRITERIA

The following five criteria are used to compare and evaluate the elements of alternatives that meet the threshold criteria.

- Long- Term Effectiveness and Permanence This criterion assesses the effectiveness of the alternative in protecting human health and the environment after response objectives have been met. In addition, it includes consideration of the magnitude of residual risks and the adequacy and reliability of controls.
- Reduction of Toxicity, Mobility, or Volume Through Treatment This criterion evaluates the effectiveness of treatment processes used to reduce toxicity, mobility, or volume of hazardous substances. It also considers the degree to which treatment is irreversible, and the type and quantity of residuals remaining after treatment. SARA emphasizes that, whenever possible, a remedy should be selected that uses treatment to permanently reduce the toxicity of contaminants at the site, the spread of contaminants away from the source of contamination, and the volume or amount of contamination at the site.
- Short-Term Effectiveness This criterion evaluates the effectiveness of the alternative in protecting human health and the environment during the construction and implementation of a remedy until response objectives have been met. It considers the protection of the community, workers, and the environment during implementation of remedial actions.

- Implementability This criterion assesses the technical and administrative feasibility of an alternative and availability of required goods and services. Technical feasibility considers the ability to construct and operate a technology and its reliability, the ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of a remedy. Administrative feasibility considers the ability to obtain approvals from other parties or agencies and extent of required coordination with other parties or agencies.
- Cost This criterion evaluates the capital and operation and maintenance costs of each alternative.

11.3 MODIFYING CRITERIA

The modifying criteria are used in the final evaluation of remedial alternatives, generally after the Army has received public comments on the FS and PP.

- State Acceptance This criterion considers the state's preferences among or concerns about the alternatives, including comments on ARARs or the proposed use of waivers.

- Community Acceptance This criterion considers the community's preferences among or concerns about the alternatives.

Following the detailed analysis of each individual alternative, the Army performed a comparative analysis, focusing on the relative performance of each alternative with respect to the nine evaluation criteria. The purpose of the comparative analysis was to identify the advantages and disadvantages of the alternatives relative to one another and to aid in the eventual selection of a remedial alternative for groundwater at AOC 50. Section 6 of the FS report (ARCADIS 2002a) presents the detailed analysis if each remedial alternative developed for groundwater at AOC 50, Subsections 6.1 through 6.9 present the comparison of the different alternatives for AOC 50, and Subsection 6.10 presents the comparative analysis of the alternatives.

11.4 SUMMARY COMPARISON OF ALTERNATIVES

The comparison of alternatives is summarized in the attached table (Table 10) and briefly discussed below.

Remedial Alternative 1 does not satisfy the seven evaluation criteria and has an excessive remedial duration. Remedial Alternatives 2 and 4 have remedial durations equal to or greater than 30 years. Although Alternative 2 is relatively low cost ($4.2 MM), the remedial duration of 48 years is the highest of the alternatives evaluated. In addition to the excessive remedial duration of Alternative 4, the cost of this alternative is greater than $10 MM. The costs for Alternatives 3, 8, and 9 are excessive, ranging from $9.6 to $11.1MM. The relatively shorter remedial time frames for Alternatives 3 (25 years) and 9 (24 years) do not outweigh the higher costs.

The three most cost-effective and efficient alternatives are Alternatives 5, 6, and 7. The combination of remedial technologies comprising Alternative 5 forms the basis for Alternatives 6 and 7, which progressively incorporate two additional technologies: IWS and ZVI. Of these three, Alternatives 5 and 7 represent the least expensive and shortest alternatives, respectively. A further comparison of Alternatives 5 and 7 indicates that Alternative 7 would require approximately 10 percent less time to meet the remedial action objectives than Alternative 5; however, the cost of Alternative 7 is 35 percent more than Alternative 5. Alternative 6 has a comparable cleanup time frame to Alternative 5, but is also approximately 37% more costly than Alternative 5; however, Alternative 6 does provide an additional remedial component that is further protective of the Nashua River.

Alternative 7 differs from Alternative 6 in that it adds ZVI to the remedy in the Source Area. The introduction of ZVI to the subsurface creates technical difficulties not apparent in Alternative 6, as it is an emerging technology. Furthermore, the concentrations and areal extent of VOCs detected in the Source Area are not as substantial as originally presented based on recent groundwater analytical data. Therefore the apparent lower cost and shorter clean-up time for Alternative 7 are not likely and do not outweigh the benefits of Alternative 6.

12.0 THE SELECTED REMEDY

The selected remedy for AOC 50 is Alternative 6: Soil Vapor Extraction, Enhanced Reductive Dechlorination (with solubilized inorganics controls), In-Well Stripping/Aerobic Bioremediation, Monitoring, and Institutional Controls. The following sections summarize the selection rationale and a description of remedial components, cost, and expected outcome for Alternative 6. Changes in the selected remedies may occur as a result of new information and data collected during the design of the alternative. Major changes will be documented in the form of a memorandum in the Administrative Record, an Explanation of Significant Differences, or an amendment to this Record of Decision, as appropriate.

12.1 SUMMARY OF THE RATIONALE FOR SELECTION OF ALTERNATIVE 6

Alternative 6 provides the best balance among the candidate alternatives for AOC 50. Alternative 6 is protective of human health under current and anticipated future land use scenarios. Existing and proposed institutional controls will prevent unrestricted use. Alternative 6 is also protective of the environment, attains ARARs, offers long-term and short-term effectiveness, and is readily implementable at a reasonable cost.

12.1.1 Description of Alternative 6

Alternative 6 includes multiple components to reduce potential human-health and ecological risks associated with groundwater at AOC 50. The principal components of Alternative 6 consist of the following:

- Soil Vapor Extraction (SVE) in the Source Area;
- Enhanced Reductive Dechlorination (ERD) throughout the site (with solubilized inorganic controls;
- In-Well Stripping (IWS) along the downgradient portion of the Southwest Plume;
- Chemical Oxidation in the North Plume (contingency);

- Iron injection downgradient of the last ERD transect (contingency);
- Long-term monitoring;
- Institutional Controls; and,
- Five-Year Site Reviews

A description of the components of Remedial Alternative 6 and other related activities is provided below.

Pre-Design Investigation Activities – Over the past 12 months, the Army has undertaken extensive field investigation at AOC 50 to further assess the nature and extent of PCE impacts at AOC 50. A pilot test of the ERD technology was completed between December 2001 and July 2002, the results of which were documented in a report incorporated into the Final FS. Additional investigation activities will be conducted to support the remedial design (RD). This will include collection and analysis of groundwater and soil samples, installation and testing of IWS, and the installation of additional permanent SVE and monitoring wells, as necessary. A work plan will be submitted for review prior to initiating additional investigation activities.

Application of SVE in the Source Area – Based on the results of pre-design investigation to be performed, the existing SVE system formerly operated in the Source Area at AOC 50 will be refurbished for use in the preferred alternative. The system will apply vacuum to wells completed within the unsaturated soils, capturing VOC mass in the vapor phase as soil gases are withdrawn. The soil gases extracted from the subsurface will be treated, as needed with activated carbon prior to being discharged to the atmosphere. Operation of the SVE system in the Source Area will provide indirect remediation of groundwater impacts, if recoverable CVOC mass is present. Specifically, the capture of adsorbed phase mass potentially present in the vadose zone soils will be removed as a continuing source for groundwater contamination. Additional SVE wells will be installed if necessary, in the Source Area to supplement the existing SVE well network.

Enhanced Reductive Dechlorination (ERD) Implementation – This technology is implemented *in-situ* by stimulating microbial activity and significantly increasing rates of CVOC degradation. The microbial activity is stimulated through the injection of an organic carbon substrate. The areas in which this substrate is delivered become anaerobic and reducing due to the uptake of available electron acceptors to support respiration of the microbes, providing the environment required for the ERD process to take place. The preferred remedy will involve the installation of multiple injection wells in a series of transects oriented perpendicular to the direction of groundwater flow. A dilute solution of potable water and the organic carbon substrate (molasses or other) will be periodically injected into the formation through these wells to drive the groundwater environment to anaerobic and reducing conditions. The exact locations, spacing, and completion details of the injection wells/transects will be specified in the RD. To optimize the design and further reduce the remedy duration, the design will reflect the most up to date groundwater quality data and flow modeling.

Solubilized Inorganics Controls

As outlined in the Final FS (ARCADIS 2002a) and confirmed during the ERD pilot test, inorganics including iron, manganese and arsenic are solubilized within the reducing zones created by ERD technology. Inorganics solubilized within the reducing IRZs are not expected to migrate beyond the boundary of reducing conditions, and are not expected to persist once the prevailing aerobic groundwater environment is restored. Outside of the zone of reducing conditions (i.e., under the naturally aerobic conditions present in the groundwater at AOC 50) the inorganic constituents will be oxidized and subsequently immobilized through precipitation and/or adsorption. However, it is recognized that a subsequent phase of remediation will be implemented should groundwater monitoring indicate that the inorganics have not attained remediation goals.

After the ERD remedy is completed within sections of the plume and injection transects are phased out (which is expected to be approximately 10 to 15 years based on the groundwater modeling prepared in the FS), the inorganic data collected during the long-term monitoring will be evaluated to assess that adequate restoration of natural aerobic conditions and re-precipitation of inorganics have been achieved. If warranted, the re-precipitation of inorganics will be expedited through manipulation of aquifer chemistry or application of more effective treatment technologies along the length of the plume utilizing existing ERD injection wells as transects are phased out following the treatment of VOCs.

<u>IWS/Circulation Well Transect</u> - Alternative 6 will involve the installation of groundwater circulation/ IWS wells in the downgradient portion of the Southwest Plume, upgradient of the Nashua River. The inlet (lower) screen interval of the circulation well(s) will be positioned to intercept the zone of highest CVOC concentrations, with the recharge (upper) screen interval positioned at the upper limit of the impacted zone (to prevent cross-contamination of unimpacted zones). The lower screen will also intercept the zone of highest potential solubilized inorganics should this condition present itself. The IWS will create aerobic conditions conducive to the precipitation of solubilized inorganics. As with the new monitoring wells, the exact location, spacing, and completion details of the circulation wells will be specified in the RD.

<u>Sentinel Groundwater Monitoring Wells</u> – Monitoring wells will be placed in strategic locations between the Nashua River and the most downgradient ERD injection transect to serve as sentinel wells. The sentinel well network will consist of a series of wells installed approximately 400 ft from the most downgradient ERD injection transect. These wells will be located laterally and vertically across the plume to monitor the possible presence of solubilized inorganics beyond the expected extent of the reducing conditions created by the ERD application and trigger the inorganics contingency for the treatment of solubilized inorganics as discussed below. The number of wells required to adequately monitor the residual plume and solubilized inorganics will be determined in the Remedial Design.

<u>Monitoring</u> – Long-term monitoring will be performed to evaluate performance of the remedy and to confirm that COC concentrations are reduced to remediation goals. During the initial phases of implementation, monitoring will be conducted more frequently. As the progress of the remedy is established, monitoring frequency will be reduced. Samples will primarily be analyzed for VOCs, with additional analyses including dissolved metals (arsenic, iron, and manganese), nitrate, redox couples (sulfate/sulfide, and carbon dioxide/methane), and dissolved gases (e.g. oxygen, ethane, and ethene). Field parameters (e.g., ORP, pH, conductivity, turbidity, and temperature) will also be collected during sampling. Details of the monitoring will be outlined in a LTMP.

Institutional Controls – (ICs) will be implemented in each area of the plume (i.e. North, Source Area, and Southwest), shown on Figure 3, through formal negotiations during the preparation of the RAWP and RD with the different entities that own the properties overlying these areas. ICs are necessary to restrict land and groundwater use at the site to prevent unacceptable risk for the duration of the remedy. The ICs will be implemented in each area as shown on Figure 3. The ICs RD shall be prepared as the IC portion of the RD/RAWP. Within 90-days of the ROD signature, the Army shall prepare and submit to the USEPA for review and approval, an IC RD/RAWP that will contain implementation and maintenance actions including periodic inspections. The Army shall implement, monitor, report on, and enforce the ICs according to the RD/RAWP.

North Plume

The IC objectives in the North Plume include;

- protecting potential residential receptors from ingesting contaminated groundwater
- restricting groundwater pumping to avoid drawing the contaminated groundwater from the Source Area
- limiting construction over the contaminated groundwater that would interfere with the operation of the remedy
- providing access to the site for monitoring/remediation

The IC for this portion of the plume will include existing property zoning (commercial/industrial) and permits to ensure the property remains commercial/industrial with no residential use or development. In addition, the Army will negotiate necessary access and land-use control measures with the property owners to prevent exposure to groundwater and protect the remedy. These ICs shall be maintained until the hazardous substances in the soil and groundwater beneath have been reduced to levels that allow for unlimited exposure and unrestricted use. The expected duration of the IC is expected to be less than 10 years. The Army will implement, monitor, report on, and enforce these restrictions. The ICs would cover the North Plume Area as shown on Figure 3.

Source Area

The IC objectives in the Source Area include;

- protecting potential residential and commercial/industrial receptors from ingesting contaminated groundwater,
- protecting commercial/industrial workers from inhaling vapors released from groundwater used as "open" process water,
- preventing potential construction/occupation of residential dwellings, elementary and secondary schools, and child care facilities and inhalation of vapors released from groundwater to indoor air
- restricting groundwater pumping and storm-water recharge to avoid drawing the contaminated groundwater from the Source Area
- limiting construction in specified areas over the contaminated groundwater that would interfere with the operation of the remedy
- providing access to the site for monitoring/remediation

The ICs for this portion of the plume will include existing zoning and lease terms between the Army and

Mass Development that address these objectives. In addition, specific restrictions will also be incorporated into the Transfer deed prior to conveyance of the property to Mass Development. These restrictions would be implemented, monitored, reported on, and enforced by the Army and shall be maintained until the concentration of hazardous substances in the soil and groundwater beneath have been reduced to levels that allow for unlimited exposure and unrestricted use. The expected duration of the ICs could be up to 10 years. The ICs would cover the Source Area as shown on Figure 3.

Southwest Plume

The IC objectives in the Southwest Plume include;

- protecting potential residential and commercial/industrial receptors from ingesting contaminated groundwater
- restricting groundwater pumping and storm-water recharge to avoid drawing the contaminated groundwater away from the limits of the plume
- limiting construction in specified areas over the contaminated groundwater that would interfere with the operation of the remedy
- providing access to the site for monitoring/remediation

The ICs for this portion of the plume will include restricting the use of the property through existing zoning (Special Use II and Innovation and Technology Business for Mass Development and Open Space and Recreation for the Fish and Wildlife property) and restrict the potable use of groundwater through legal agreements with the parties involved. In addition, the legal agreements will restrict the construction of structures that would interfere with the operation of the remedy and provide for Army access to the properties during the operation of the remedy. The legal agreements will also include language to restrict the use of groundwater adjacent to the area of the IC. Legal agreements between the Army, Mass Development (incorporated in Devens Enterprise Commission's the Unified Permit) and the Fish and Wildlife Service, with oversight by the Devens Enterprise Commission will ensure that the ICs are in place. These ICs shall be implemented, monitored, reported on, and enforced by the Army and shall be maintained until the concentration of hazardous substances in the soil and groundwater beneath have been reduced to levels that allow for unlimited exposure and unrestricted use. The Army may transfer these responsibilities to another party by contract or through other means, but remains ultimately responsible for remedy integrity. The expected duration of the ICs could be up to 27 years. The ICs would cover the Southwest Plume as shown on Figure 3.

The implementation actions for the ICs listed above will be presented in the RD/RAWP. Details regarding the ICs may need to be adjusted periodically based on site conditions and other factors.

<u>5-Year Site Reviews</u> – Under CERCLA 121c, any remedial action that results in contaminants remaining on-site at concentrations greater than those allowing unrestricted use must be reviewed at least once every 5 years. During 5-year site reviews, an assessment is made of whether the implemented remedy continues to be protective of human health and the environment or whether the implementation of additional remedial action is appropriate. Restoration Advisory Board (RAB) meetings will be held coincident with these 5-year site reviews to keep the public informed of site status including its general condition, remaining contaminant concentrations, and protectiveness of the remedial action. RAB meetings will

also continue to be held on a regular basis to update the community on the progress of the remedial design and implementation.

Contingencies –

North Plume – As outlined in the FS, the primary method of groundwater remediation for the low levels of CVOCs observed in the North Plume area will be the application of ERD in the AOC 50 Source Area. The application of ERD will reduce the concentrations of CVOCs in the Source Area, thus limiting the potential for possible future migration of CVOCs off-site to the north. PCE was detected at a concentration of 11 ug/L (which represents a general downward trend since 1999) in the groundwater sample collected from Monitoring Well G6M-96-24B in January 2004. This is currently the only well in the North Plume to have detectable concentrations of PCE. The proposed contingency remedy associated with the North Plume will consist of two components:

Monitoring Program - Selected monitoring wells in the North Plume will be monitored for the presence of CVOCs and inorganics when ERD is implemented in the Source Area. The long-term monitoring plan will identify wells and frequency of sampling.

Remedy Implementation - In the event that PCE or its daughter products exceed their respective MCLs in the North Plume one year after ERD implementation in the Source Area, a direct application of *in-situ* chemical oxidation will be utilized to treat the CVOCs in the North Plume. The use of *in-situ* chemical oxidation is proposed over ERD application due to the concerns regarding potential inorganic solubilization related to ERD application. The treatments would continue periodically (i.e., annually), if needed based on groundwater monitoring results.

Inorganics - As outlined in the Final FS (ARCADIS 2002a), inorganics such as iron, manganese or arsenic can be solubilized within the reducing zones created by ERD technology. Inorganics solubilized within the reducing IRZs are not expected to migrate beyond the boundary of reducing conditions, and are not expected to persist once the prevailing aerobic groundwater environment is restored either naturally or via aeration by circulation wells. Outside of the zone of reducing conditions (i.e., under the naturally aerobic conditions present in the groundwater at AOC 50) and in the area of the circulation wells, it is expected the inorganic constituents will be oxidized and subsequently immobilized through precipitation and/or adsorption. Despite this expectation, it is recognized that a contingency must be available should groundwater monitoring indicate that there is an iron deficiency in the circulation treatment area (i.e., towards the Nashua River) that may preclude the effective immobilization of dissolved arsenic as it is recognized that arsenic solubility is strongly controlled by the presence of iron. The proposed contingency remedy associated with inorganics will consist of two components:

Monitoring Program - The monitoring of the sentinel wells will be conducted on a regular basis to detect a deficiency of iron in the system and allow time for Remedy Implementation. The specific details of the monitoring program associated with the contingency remedy will be outlined fully in the long-term monitoring plan.

Remedy Implementation –Adjustments to the chemistry of the groundwater approaching the IWS system will be made as deemed necessary to facilitate the re-precipitation of arsenic to less mobile forms. Such adjustments may include but are not limited to the addition of ferrous iron. Geochemical adjustments would be performed on an as-needed basis to maintain the necessary aquifer conditions. Field parameter measurements and inorganic groundwater samples will be collected on a periodic basis to confirm the desired conditions, and the monitoring of the sentinel well network will be maintained to assure the success of the contingency remedy.

12.1.2 Summary of Costs for Alternative 6

Table 11 contains a summary of estimated costs for implementing Alternative 6. The estimate is based on the best available information regarding the anticipated scope of the remedial alternative; however, changes in cost elements may occur as a result of new information and data collected during design of the alternative. This is an engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost. The detailed cost backup, including capital cost, operation and maintenance costs, and sources of cost information, is presented in Table 12. Additional detail on the cost estimate is provided in the FS (ARCADIS 2002a).

12.1.3 Expected Outcome of Alternative 6

The primary expected outcomes of the selected remedy are that: a) the groundwater at the site (including the Source Area, the Southwest plume, and the North plume) will no longer present an unacceptable risk to future workers or residents via potable water ingestion and inhalation; b) the site will be suitable for unrestricted land use; and c) groundwater will be suitable for potable purposes. Approximately 27 years are estimated as the amount of time necessary to achieve the goals consistent with unrestricted land use and potable use of groundwater for the entire site. Portions of the site (e.g. North Plume) may achieve the goals in a shorter period of time. Abating the unacceptable risk to benthic invertebrates via direct contact from discharge of groundwater to porewater of the Nashua River is also an expected outcome of the selected remedy. The low to moderate potential ecological effects will be mitigated by the remedy and goals consistent with long-term protection of benthic invertebrates. Another expected outcome of the selected remedy is that redevelopment in specified areas will be able to proceed once the remedy is Operating Properly and Successfully.

13.0 STATUTORY DETERMINATIONS

Under CERCLA and the NCP, the Army and USEPA must select remedies that are protective of human health and the environment, attain ARARs (unless a statutory waiver is justified), are cost effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of wastes as a principal element and a bias against off-site disposal of untreated wastes. The following subsections discuss how the selected remedies meet these statutory requirements.

13.1 STATUTORY DETERMINATIONS FOR REMEDIAL ALTERNATIVE 6

The selected remedy for AOC 50 is consistent with CERCLA and, to the extent practicable, the NCP. The selected remedy is protective of human health and the environment, attains ARARs, and is cost-effective. The selected remedy utilizes alternative treatment technologies and resource recovery technologies to the maximum extent practicable for this site. In addition, the selected remedy also satisfies the statutory preference for treatment that permanently and significantly reduces the toxicity, mobility, or volume of hazardous substances as a principal element.

13.1.1 The Selected Remedy is Protective of Human Health and the Environment

The selected remedy for AOC 50, Remedial Alternative 6, will protect human health and the environment by eliminating, reducing, or controlling exposures to human and environmental receptors through engineering and institutional controls. More specifically, human exposure to groundwater will be limited through in-situ groundwater treatment and through establishment of institutional controls to limit exposure to groundwater in the Source Area, North Plume, and Southwest Plume.

The selected remedy will reduce potential human-health and ecological risk levels for groundwater and sediment (porewater) exposure to protective ARARs levels (i.e., the remedy will attain ARARs). In addition, implementation of the selected remedy will not pose any unacceptable short-term risks or cause any cross-media impacts.

13.1.2 The Selected Remedy Attains Applicable or Relevant and Appropriate Requirements

The selected remedy for AOC 50 will attain all applicable or relevant and appropriate federal and state requirements. No waivers are required. ARARs for AOC 50 were identified and discussed in the FS (Sections 3.0 and 6.0) and Table 6 of this Record of Decision summarizes the ARARs for the selected remedy, including the regulatory citation, a brief summary of the requirement, and how it will be attained.

13.1.3 The Selected Remedial Action is Cost-Effective

The selected remedy is cost-effective because the remedy's costs are proportional to its overall effectiveness. This determination was made by evaluating the overall effectiveness of those alternatives that satisfied the threshold criteria (i.e., that are protective of human health and the environment and attain all federal and any more stringent state ARARs, or as appropriate, waive ARARs). Overall effectiveness was evaluated by assessing three of the five balancing criteria: long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness, in combination. The overall effectiveness of each alternative then was compared to the alternative's costs to determine cost-effectiveness. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs and hence represents a reasonable value for the money to be spent.

The estimated costs of this remedial alternative are:

Estimated Capital Cost:	$1,700,000
Estimated Operation and Maintenance Cost (Present Worth*):	$6,500,000
Estimated Total Cost:	$8,200,000

*Present worth based on 3.8 percent discount rate, for 27 years (Table 13).

13.1.4 The Selected Remedy Utilizes Permanent Solutions and Alternative Treatment or Resource Recovery Technologies to the Maximum Extent Practicable

After the Army identified those alternatives that attain or, as appropriate, waive ARARs and that are protective of human health and the environment, the Army determined which alternative made use of permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. This determination was made by deciding which one of the identified alternatives provides the best balance of tradeoffs among alternatives in terms of: (1) long-term effectiveness and permanence; (2) reduction of toxicity, mobility, or volume through treatment; (3) short-term effectiveness; (4) implementability; and (5) cost. The balancing test emphasized long-term effectiveness and permanence and the reduction of toxicity, mobility, or volume through treatment, and considered the preference for treatment as a principal element, the bias against offsite land disposal of untreated waste, and community and state acceptance. The Army believes the selected remedy provides the best balance of tradeoffs among the alternatives that are protective and attain ARARs.

13.1.5 The Selected Remedy Satisfies the Preference for Treatment as a Principal Element

The principal element of the selected remedy is *in-situ* treatment of contaminated groundwater by ERD and IWS. This element, in conjunction with previous removal actions, will complete addressing the primary threat at AOC 50 which is groundwater contamination.

13.1.6 Five-Year Review Requirements

Because AOC 50 has contaminants remaining on-site above concentrations that allow for unrestricted use and unrestricted exposure, a statutory review will be performed within five years after initiation of remedial action to assess whether the remedy remains or will remain protective of human health and the environment. Subsequent five-year reviews will be performed as long as hazardous substances, pollutants, or contaminants remain on-site above concentrations that allow for unrestricted exposure and unlimited use.

The five-year reviews may be discontinued when no hazardous substances, pollutants, or contaminants remain at AOC 50 above concentrations that allow for unrestricted use and unrestricted exposure. This determination will be made after a five-year review documents that contaminants are at acceptable levels.

14.0 DOCUMENTATION OF SIGNIFICANT CHANGES

The Army released a Proposed Plan for remedial action at AOC 50 in January 2003. The Proposed Plan identified Alternative 6: Soil Vapor Extraction, Enhanced Reductive Dechlorination, In-Well Stripping/Aerobic Bioremediation, Monitoring, and Institutional Controls as the preferred alternative for AOC 50. During the public comment period, the Army received comments requesting a reevaluation of technologies that were previously screened out in the FS. In response to these comments, a review of the technologies was made and there have been no significant changes to the preferred alternative for AOC 50, presented in the Proposed Plan and this ROD.

15.0 STATE ROLE

The Commonwealth of Massachusetts Department of Environmental Protection has reviewed the various alternatives and has indicated its support for the selected remedy. The Commonwealth has reviewed the RI and FS reports to determine if the selected remedy is in compliance with applicable or relevant and appropriate Commonwealth environmental and facility siting laws and regulations. A copy of the letter of concurrence from the Commonwealth of Massachusetts is attached as Appendix B.

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