United States Environmental Protection Agency
Region 1

Decision Document
Demolition Area 1 Groundwater Operable Unit

Camp Edwards
Massachusetts Military Reservation
Cape Cod, Massachusetts

November 1, 2006

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PART I: DECLARATION FOR THE SDWA DECISION DOCUMENT

A. SITE NAME

The subject site is the Demolition Area 1 (Demo 1) Groundwater Operable Unit (OU) within Camp Edwards at the Massachusetts Military Reservation (MMR) (Figure 1). The OU consists of the groundwater impacted by contaminants from the Demo 1 source area.

B. STATEMENT OF BASIS AND PURPOSE

This Decision Document presents the selected response action for the Demo 1 Groundwater OU. This selected response action was chosen in accordance with Section 1431(a) of the Safe Drinking Water Act (SDWA), 42 USC §300i(a), as amended, and with the Administrative Order concerning response actions issued there under, U.S. Environmental Protection Agency Region 1 (EPA) Administrative Order No. SDWA-1-2000-0014 (AO3). The Regional Administrator of EPA Region I has been delegated the authority to select the necessary response action pursuant to EPA Delegation No. 9-17 (1200-TN-350) dated May 11, 1994.

This decision is based on the Administrative Record, which has been developed in accordance with AO3 and with a previous EPA Administrative Order, SDWA 1-97-1019 (AO1), requiring investigation of contamination at the Training Ranges and Impact Area. This Administrative Record is available for review at the Impact Area Groundwater Study Program (IAGWSP) office, 1803 West Outer Road, Camp Edwards, MA. Documents included in the Administrative Record are listed in Appendix B.

C. ASSESSMENT OF THE SITE

On July 13, 1982, EPA determined that the Cape Cod Aquifer is the sole or principal source of drinking water for Cape Cod, Massachusetts, and that the Cape Cod Aquifer, if contaminated, would create a significant hazard to public health (47 Fed. Reg. 30282). Contaminants from the Training Ranges and Impact Area at MMR are present in and may enter and migrate in the Cape Cod Aquifer. The response action selected in this Decision Document is necessary to protect the Cape Cod aquifer, an underground source of drinking water on which the public currently relies and may in the future rely.

D. DESCRIPTION OF COMPREHENSIVE RESPONSE ACTION

This Decision Document sets forth the selected response action for the remediation of a plume of groundwater contamination at and emanating from the Demo 1 site (Figure 2).

In the Demo 1 Feasibility Study (AMEC 2005), seven contaminants of concern (COCs) were identified for groundwater at Demo 1. These included hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX), 2,4,6-trinitrotoluene (TNT), 2,4-dinitrotoluene (2,4-DNT), (4A-DNT), (2A-DNT), and perchlorate. After the development of the Feasibility Study, the completion of soil remedial actions in the Demo 1 source area, and the

start up of the Rapid Response Action pump and treat system for groundwater, maximum levels of the seven COCs in groundwater decreased within the Demo 1 plume. As of April 2006, only four of the original COCs remain in the aquifer above risk based or regulatory levels. These four are RDX, 2,4-DNT, TNT, and perchlorate (Table 1).

Specific COCs for groundwater at Demo 1 used to develop the comprehensive response action include the explosive compound RDX and the water-soluble salt perchlorate that is used as an oxidizer. Since the other two remaining COCs are limited in extent within the RDX and perchlorate plume, are at much lower concentrations, and are expected to be remediated well within the timeframes for RDX and perchlorate, modeling used for determining the feasibility of remediation alternatives and the selected response action was based on remediation of the RDX and perchlorate plumes. Detections of RDX in the Demo 1 plume have ranged from the detection limit of 0.25 parts per billion (ppb) to 370 ppb. Perchlorate detections have ranged from the detection limit of 0.35 ppb to 500 ppb.

The lifetime federal health advisory (HA) for RDX in drinking water is 2 ppb. There currently is no federal drinking water standard for perchlorate. However, the EPA has established an official reference dose for perchlorate of 0.0007 milligrams per kilogram per day (mg/kg/day). This translates to a Drinking Water Equivalent Level (DWEL) of 24.5 ppb, assuming all of the contaminant comes from drinking water. With a contaminant like perchlorate, individuals may be exposed through other sources such as food or breast milk. EPA previously issued interim guidance suggesting 4-18 ppb perchlorate as a provisional cleanup level (1999 and 2003). In addition, the Massachusetts Department of Environmental Protection (MassDEP) has promulgated a Massachusetts Maximum Contamination Level (MMCL) of 2 ppb.

The Demo 1 Plume will be remediated to restore the aquifer which has been designated a Sole Source Aquifer by the EPA and a Potentially Productive Aquifer by the MassDEP. This groundwater response action will remediate the contaminated groundwater containing RDX at concentrations greater than the 10^{-6} risk-based level, the concentration resulting in an increased lifetime cancer risk of one in a million, which currently is 0.6 ppb, and/or perchlorate greater than 2 ppb , by withdrawing groundwater from several extraction wells and treating that water to remove contaminants before recharging it to the aquifer (Figure 3). The selected response action is the third of three major actions at Demo 1. The first action was conducted as a Rapid Response Action (RRA) to remove contaminated soil from the source area of the Demo 1 plume. Soil was treated on-site by thermal desorption, which uses heat to separate contaminants from the soil and oxidize them. The second major action was a groundwater RRA intended to begin removal of contaminants from the aquifer and limit further migration of the plume while the comprehensive remedy could be selected and implemented. The groundwater RRA began operation during September 2004. The comprehensive remedy will build upon the groundwater RRA.

Groundwater modeling predicts this response action will prevent significant further migration of the plume and restore the impacted portion of the aquifer for use as a public water supply. The major components of this response action are:

- Extraction of 906 gallons of contaminated water per minute from the plume using five extraction wells
- Treatment of the groundwater to remove contaminants to below applicable federal and state drinking water standards and risk-based levels using granular activated carbon (GAC) and ion exchange resin (IX) (Figure 4 and Figure 5)
- Reinjection of the treated water back into the aquifer using four injection wells
- Natural attenuation of the leading edge of the plume to below applicable water-quality standards and risk-based levels over a reasonable period of time.
- Land Use Controls to eliminate the potential for ingestion of contaminated groundwater until the concentrations of Contaminants of Concern in the groundwater are at such a level to allow unrestricted use and exposure.
- Long-term monitoring through a network of approximately 103 groundwater monitoring well screens (Figure 2) to track the extent and movement of the plume during and after operation of the comprehensive remedy.
- A contingency response for additional active measures to be taken to control the plume if plume contaminants above applicable federal and state drinking standards or risk-based levels are found to migrate substantially further than anticipated. This contingency response would most likely include additional extraction and treatment of groundwater near the leading edge of the plume if actual or modeled data at a well transect west of North Pond exceeds applicable federal or state regulatory or risk-based levels for COCs.
- The additional active treatment system will likely consist of an extraction well pumping at 30 to 50 gpm and a portable treatment container, which will use GAC and/or ion exchange filters to clean the groundwater.

E. DETERMINATIONS

The comprehensive groundwater response action selected in this Decision Document will protect the public health from any endangerment which may be presented by the presence or potential entry of COCs into an underground source of drinking water from the Demo 1 source area.

The selected response action meets current applicable federal and state requirements.

As required by AO3, the selected alternative provides a level of protection to the aquifer underlying and downgradient of the Demo 1 source area commensurate with the aquifer's designation as a Sole Source Aquifer and a Potential Productive Aquifer that is protective of human health.

The selected response action includes a periodic review at frequencies not to exceed five years. At each periodic interval, the IAGWSP will provide to EPA and MassDEP sampling data, modeling data, and other relevant data. EPA and MassDEP will review this and any other relevant information to determine if additional measures are necessary for the protection of public health. This will include information acquired after the implementation or five-year period

(such as new regulatory requirements or changes in the environmental conditions of the site). In addition the remedy includes a detailed annual evaluation to determine if the contingency remedy is needed.

F. SUPPORTING DATA

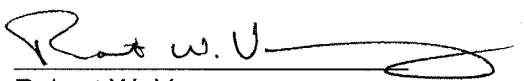
The following information is included in the Decision Summary section of this SDWA Decision Document. Additional information can be found in the Administrative Record for this Site.

- COCs and their respective concentrations;
- Baseline risk represented by the COCs;
- Cleanup levels established for COCs and the basis for the levels;
- Current and future land and groundwater use assumptions used in the baseline risk assessment and Decision Document;
- Land and groundwater use that will be available at the Site as a result of the selected response action;
- Decision factor(s) that led to selecting the comprehensive groundwater response action.

G. AUTHORIZING SIGNATURE

This Decision Document documents the selected response action for remediation of the MMR Demo 1 Groundwater OU. This response action was selected by EPA under the authority of the SDWA. MassDEP concurs in this decision.

U.S. Environmental Protection Agency

By:  Date: 11-1-06

Robert W. Varney
Regional Administrator
Region 1

PART II: THE DECISION SUMMARY

A. DEMO 1 SITE DESCRIPTION

Demo 1 is an approximately 7.4-acre site located on Camp Edwards approximately two miles northeast of the Otis Rotary in Bourne. Demo 1 is located north of Pocasset Forestdale Road and south of the Camp Edwards Impact Area, west of Turpentine Road and east of Frank Perkins Road. Demo 1 is located in a natural topographic depression, or kettle hole, that covers approximately one acre at its base, which is 45 feet (ft) below the surrounding grade. The Demo 1 source area exists largely within a perimeter road. However, investigations outside of Perimeter Road have not been completed. Four explosive and propellant compounds (RDX, TNT, 2,4-DNT, and perchlorate) have been detected in groundwater and are identified as the COCs in groundwater for the Demo 1 Groundwater OU. These contaminants are all directly related to past demolition, disposal and/or demolition training activities and have been detected in soil at Demo 1.

A more complete description of the Site can be found in Section 2.0 of the Groundwater Report Addendum (AMEC, 2004).

B. SITE HISTORY AND ENFORCEMENT ACTIVITIES

History of Site Activities

Demo 1 was used from the mid 1970s to the late 1980s for destruction of munitions and other items along with demolition training. These activities included the destruction of various types of ordnance using explosive charges of C4 (90% RDX and 10% inert materials), TNT, and detonation cord. The predominant explosive compounds used in demolition munitions are RDX, followed by TNT.

Perchlorate, a water-soluble salt used as an oxidizer, is a component of some munitions, rocket propellants, and pyrotechnics, and fireworks that were likely destroyed at Demo 1. Perchlorate (ClO_4^-) originates as a contaminant in the environment from the solid salts of ammonium, potassium, or sodium perchlorate.

RDX, TNT, and other explosives, and perchlorate resided on the soil surface at Demo 1 as particulates and residuals (chunks of C4, hand grenades, or flares) from the destruction activities or from the destroyed items. Regrading and filling activities following destruction and training events likely raised the elevation of the ground surface in the Demo 1 depression. Placing fill to create a smoother surface and to cover protruding objects increased the safety of subsequent military training activities. These regrading and/or filling activities resulted in distribution of contaminants to depths of approximately 8 ft below the ground surface prior to any RRA remediation activities.

A more detailed description of the Site history can be found in Section 2.0 of the Demo 1 Groundwater Report Addendum and Site Archive Search Report.

History of Investigations and Response Actions

The history of investigations and response actions conducted at Demo 1 is summarized in Appendix B – References.

History of SDWA Enforcement Activity

In February 1997, EPA Region 1 issued SDWA Administrative Order 1-97-1019 (AO1) requiring investigation of contamination at or emanating from the Training Ranges and Impact Area upon the sole source aquifer.

In May 1997, EPA issued SDWA Administrative Order 1-97-1030 (AO2), which prohibited all live firing of mortars and artillery, firing of lead from small arms, planned detonation of ordnance or explosives at or near the Training Ranges and Impact Area except for UXO activities, and certain other training related activities (Paragraph II.A.1)

In January 2000, EPA issued SDWA Administrative Order 1-2000-0014 (AO3) which required the IAGWSP to implement RRAs and remedial actions to abate the threat to public health presented by the contamination from past and present activities and sources at and emanating from the Training Ranges and Impact Area. The RRAs specifically required by AO3 addressed elevated concentrations of contaminants in soil and have been completed. The comprehensive remedial action component of AO3 requires that a Feasibility Study (FS), Remedial Design (RD) and Remedial Action (RA) be completed for several areas of concern, including the Demo 1 Groundwater OU.

C. COMMUNITY PARTICIPATION

Throughout the Site's history, the IAGWSP and EPA and MassDEP have kept the community and other interested parties apprised of Site activities at the Demo Area 1 site through informational meetings, fact sheets, press releases and public meetings. Below is a brief chronology of public outreach efforts.

The Impact Area Review Team (IART) is a citizen advisory committee that was established in 1997 under AO1. The IART's goal is to serve as a technical advisory resource and to allow the EPA and NGB to hear first hand the concern of the public related to the ongoing investigation and cleanup effort at Camp Edwards. The team meets regularly (usually the fourth Tuesday of each month) to hear updates and provide public input on the IAGWSP investigation and cleanup.

The IAGWSP also regularly briefs the Senior Management Board (SMB), which advises MMR organizations on environmental programs and policies. Members of the SMB include selectmen from the towns of Bourne, Falmouth, Mashpee, and Sandwich and representatives from the EPA, MassDEP, Massachusetts Department of Public Health, Massachusetts National Guard, the U.S. Coast Guard, and a representative from the Wampanoag Tribe.

In October 2001 the IAGWSP, EPA and MassDEP released a Public Involvement Plan outlining activities to address community concerns and to keep citizens informed about and involved in response activities.

From March 8, 2000, through the present, the IAGWSP regularly presented updates on the plan and execution of the Remedial Investigation, RRAs, and FS for Demo 1 Soil and Groundwater at the IART meetings. With respect to this Decision Document, the most important were:

- On April 26, 2005 an informational meeting, in Sandwich, MA, to describe the Supplemental Evaluation to the Revised Draft FS for Demo 1 Groundwater.
- On August 23, 2005 an informational meeting in Falmouth, MA to describe the Remedy Selection Plan (RSP) for Demo 1 Groundwater at which the IAGWSP gave a presentation on the RSP and the EPA presented its proposed remedy and answered questions from the IART. The IAGWSP notified the public of the August 23, 2005 public meeting and announced the public comment period in a display ad placed in the August 19, 2005, editions of *The Cape Cod Times* and *The Enterprise* newspapers, and display ads were placed in the September 9, 2005 editions of these same newspapers to announce the public hearing and as a reminder of the public comment period.
- From August 22, through September 19, 2005 a Public Comment Period on the RSP for Demo 1 Groundwater. The IAGWSP placed copies of the RSP for the Demo 1 Groundwater Plume in the IAGWSP's information repositories at the Bourne, Falmouth, Mashpee, and Sandwich, MA public libraries. The repository contains documents on the Demo 1 investigation and findings supporting selection of the Remedial Action including the FS for Demo 1 Groundwater and other relevant documents upon which EPA relied in selecting the proposed remedy. The RSP also was made available on the IAGWSP Web site, which also contains the supporting documents and which offered a means of submitting public comments on the RSP. In addition, the IAGWSP mailed copies of the RSP to IART members and distributed to individuals in attendance at the public meeting and public hearing.
- On September 13, 2005 a Public Information Session and Public Hearing on the RSP for Demo 1 Groundwater in Bourne, MA. The public information session, along with a presentation on the RSP and EPA's proposed remedy was held prior to the opening of the public hearing. Local residents and officials, news media representatives, representatives from EPA, MassDEP and the IAGWSP interested in site activities and cleanup decisions were invited to attended both meetings. Representatives from EPA, MassDEP and IAGWSP were available to answer questions. The IAGWSP notified the public of the September 13, 2005 information session and public hearing and reminded them about the public comment period in a display ad placed in the September 9, 2005 editions of *The Cape Cod Times* and *The Enterprise* newspapers. Comments received during the Public Comment Period for the RSP for Demo 1 Groundwater were compiled and answered in the Responsiveness Summary included in this document.

All draft and final reports related to the Demo 1 remedial investigation, work plans, RRAs, FS and RSP were made available through the Information Repository at the public libraries in Bourne, Falmouth, Mashpee and Sandwich, MA. These documents also were made available to the public through the IAGWSP Web site: groundwaterprogram.army.mil (formerly www.groundwaterprogram.org.) and the Administrative Record at 1803 West Outer Road, Camp Edwards, MA.

All IART meetings, public meetings, Public Comment Periods and Public Hearings related to the Demo 1 remedial investigation, work plans, RRAs, FS and RSP were advertised in *the Cape Cod Times* and the local edition of *the Enterprise* newspapers.

Media releases on presentations and Public Comment Periods for Demo 1 were distributed to *the Cape Cod Times* and other area media including newspapers, radio and television media. Media releases also were distributed to area reporters on the startup, progress and completion of the Demo 1 RRA work.

Fact sheets were published and distributed on the Demo 1 investigation, the plan for the RRAs, the start of RRA treatment, and the Revised Draft FS. General fact sheets related to the Demo 1 investigation including those on the IAGWSP investigations and findings and on related issues, such as the contaminants of concern, were also published and distributed.

IAGWSP, the EPA, and MassDEP also participated in general information sessions such as open houses, information sessions, and community meetings on the program including Demo 1.

D. SCOPE AND ROLE OF OPERABLE UNIT OR RESPONSE ACTION

The Demo 1 site was split into two operable units in 2000. The Soil OU and the Groundwater OU were established in the FS Work plan (AMEC, 2000). This allowed the two media to be evaluated on separate timelines, thereby expediting the remedy selection process.

Soil OU

The IAGWSP has completed soil and unexploded ordnance (UXO) work as an RRA at Demo 1. Approximately 27,000 tons of contaminated soil was excavated and either treated on-site or sent off-site for disposal. Upon completion of the RRA, no significant residual contamination remained in the soil within the perimeter road. A Completion of Work and Operable Unit Closure Report was issued in December 2005 to document that no further action relating to soil contamination is needed within the perimeter road at this time. However, investigations outside of Perimeter Road have not been completed.

Groundwater OU

Two groundwater extraction/treatment/reinjection (ETR) systems including extraction wells, piping, portable treatment units containing IX resin and GAC filtration media were installed at the Demo 1 Groundwater OU as a RRA measure. One system is located at Frank Perkins Road and the other is located at Pew Road (Figure 2A and 2B). The systems were started in September 2004 and have been removing contaminants and limiting the migration of explosives and perchlorate in Demo 1 groundwater.

A comprehensive response action, as described in this Decision Document, is planned for long-term treatment of Demo 1 groundwater. The selected response action addresses groundwater contamination at and emanating from the Demo 1 source area. The selected response action required by this decision document provides a design that groundwater modeling predicts will achieve a risk-based level of 0.6 ppb for RDX in 11 years while reducing perchlorate concentrations to less than 2 ppb within the same time frame. Background concentrations of

RDX and perchlorate would be reached within 19 years.

E. SITE CHARACTERISTICS

Site Geology

The geology of Western Cape Cod comprises glacial sediments deposited during the retreat of the Wisconsin stage of glaciation. Three extensive sedimentary units dominate the regional geology: the Buzzards Bay Moraine (BBM), the Sandwich Moraine (SM), and the Mashpee Pitted Plain (MPP). These moraines form hummocky ridges. The MPP, which consists of fine- to coarse-grained sands forming a broad outwash plain, lies south and east of the two moraines. Underlying the MPP are fine-grained, glaciolacustrine sediments and basal till at the base of the unconsolidated sediments. The Demo 1 depression is located within the MPP. The Demo 1 plume originates in the MPP, eventually flowing into the BBM (Figure 7).

In the area east of Frank Perkins Road, subsurface lithology is dominated by varying compositions of fine, medium and coarse sand with occasional gravels. Ground surface elevation in the MPP portion of the Demo 1 plume is relatively flat from the western edge of the kettle hole depression to the eastern edge of the moraine. West of Frank Perkins Road, the Demo 1 plume crosses into the BBM. As expected, the BBM is comprised of fine to coarse sand and gravel, with discontinuous and continuous clays and silts.

Site Hydrogeology

A single groundwater flow system underlies Western Cape Cod, including MMR. The Camp Edwards Impact Area lies over the Sagamore Lens, which is part of the Cape Cod aquifer. Groundwater flows radially in all directions from the apex of the Sagamore Lens, which is located to the southeast of the Impact Area. The aquifer system is unconfined (i.e., the water table is in equilibrium with atmospheric pressure and is recharged by infiltration from precipitation). Surface water runoff at MMR is minimal except on extreme slopes, due to the highly permeable nature of the sands and gravels underlying the area.

The ocean bounds the aquifer on three sides, with groundwater discharging into Nantucket Sound on the south, Buzzards Bay on the west, and Cape Cod Bay on the north. The Bass River in Yarmouth forms the eastern lateral aquifer boundary.

Surface water is present at MMR in a few ponds in kettle holes. The kettle hole ponds are land-surface depressions that extend below the water table. Where these kettle holes do not extend down to the water table, they are merely surface depressions, such as the Demo 1 depression. Larger and deeper ponds have greater effect on slope and direction of the regional water table near the pond. While horizontal groundwater flow is dominant in the aquifer system, vertical flow is important in areas near ponds.

Groundwater flow in the Demo 1 area is from north-northeast to south-southwest away from the groundwater mound to the north-northeast and toward the Bourne area to the south-southwest.

Movement of Contaminants in Groundwater

RDX (and other explosives compounds) and perchlorate were present in the soils at Demo 1. These compounds readily leach from soil to the groundwater, with perchlorate more readily dissolving than RDX. The majority of the source of explosives and perchlorate within the perimeter road has been removed through the soil RRA recently completed at Demo 1. No further impact to groundwater is expected after the dissolved contaminants in the partially saturated soil above the groundwater table are washed out.

Movement of RDX is slightly retarded in the soil and the aquifer due to limited sorption to soil particles. Therefore, RDX will generally move at a velocity slightly less than that of normal advective flow, while perchlorate will move generally at the same rate as the advective front. Longitudinal dispersion is a significant transport process for both perchlorate and RDX and a factor in natural attenuation.

The longitudinal and lateral extent of the perchlorate plume is larger than the RDX plume at Demo 1. The combination of higher solubility, higher dissolution rates, and lower sorption rates has allowed perchlorate to travel further in the groundwater regime and impact a larger portion of the aquifer. Based on results through June 2005, the downgradient extent of the RDX plume extends as far as MW-211, approximately 7,300 feet downgradient of the source, whereas the perchlorate plume is 10,000 feet long (Figure 2). [Note: RDX was detected in MW-225M3, which is located approximately 1,300 feet downgradient of MW-211, at concentrations of 0.33 ug/L and 1.6 ug/L in samples obtained in April and August 2005, respectively. Therefore, the RDX plume has advanced considerably downgradient of MW-211.] The widest downgradient width of the RDX plume is approximately 650 ft, whereas the widest extent of the perchlorate plume is approximately 1,000 ft, roughly two times the observed width of the RDX plume.

Estimate of the Contaminant Volume and Mass

The estimated volume and mass of the contaminant plumes for perchlorate RDX and TNT are presented below. The mass of perchlorate in three sections of the plume is broken down and presented relative to RRA treatment system components. The mass of perchlorate upgradient of Frank Perkins Road is 31.8 kilograms (kg); the mass of perchlorate between Frank Perkins Road and Pew Road is 9.7 kg; and the mass of perchlorate downgradient of Pew Road is less than 1 kg.

COC	Estimated Volume		Estimated Mass	
	Liters	Gallons	Kilograms	Pounds
Perchlorate (Total)	5.2 E09	1.4 E09	42.3	93.3
Upgradient of Frank Perkins Road	2.4 E09	6.4 E08	31.8	70.1
Between Frank Perkins Road & Pew Road	2.0 E09	5.2 E08	9.7	21.4
Downgradient of Pew Road	8.7 E08	2.3 E08	0.78	1.7
RDX (Total)	1.5 E09	4.0 E08	21	46.3
TNT (Total)	4.7 E07	1.2 E07	0.06	0.13

Current Exposure Pathways

No one is currently drinking contaminated water at Demo 1.

Potential Exposure Pathways

The development of water supply wells and consumption of groundwater resources in the area downgradient of Demo 1 is a potential future exposure pathway. Camp Edwards, including the Demo 1 OU has been set aside as drinking water supply reserve by the Massachusetts Legislature.

F. CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

The site is currently used for military training and is located in an area designated as a water and wildlife preserve by Chapter 47 of the Acts of 2002 (Effective March 5, 2002 'An Act Relative to the Environmental Protection of the Massachusetts Military Reservation'). The site overlays a sole source aquifer which is a valued water supply to the Cape. The Land Use Controls (described in Section L below) will prevent the installation of on-base water wells that could provide a pathway for ingestion of drinking water that contains COCs in concentrations that exceed applicable drinking water standards. It is anticipated that all land affected by the on-base Land Use Controls described herein will remain under the control and direction of government military agencies and will continue to be used for military training and support purposes.

G. SUMMARY OF SITE RISKS

The baseline risk assessments revealed that there are no presently existing exposure routes for human receptors, and no one is currently drinking groundwater contaminated by Demo 1. However a potential future exposure pathway is through the development and consumption of groundwater resources in the area downgradient of Demo 1. The Demo 1 Plume will be remediated to restore the aquifer which has been designated a Sole Source Aquifer by the EPA and a Potentially Productive Aquifer by the MassDEP. Since groundwater contamination in this area is above a federal health advisory, this contamination may present an unacceptable human health risk to persons exposed to such compounds in the future.

H. REMEDIATION ACTION OBJECTIVES

Based on preliminary information relating to types of contaminants, environmental media of concern, and potential exposure pathways, response action objectives were developed to aid in the development and screening of alternatives. These objectives were developed to mitigate and prevent existing and future risks to human health. The response action objectives for the selected response action for Demo 1 are to restore the useable groundwater to its beneficial use within a reasonable timeframe; to provide a level of protection in the aquifer that takes into account that the Cape Cod aquifer, including the Sagamore Lens, is a sole source aquifer that is susceptible to contamination; and to prevent potential ingestion, inhalation and dermal contact with groundwater containing COCs (RDX, 2,4-DNT, TNT and perchlorate) in excess of federal maximum contaminant levels (MCLs), HAs, drinking water equivalent levels (DWELs), applicable

state standards, and/or an unacceptable excess lifetime cancer risk or non-cancer Hazard Index (Table 1).

In addition, the remedy will also prevent any migration of contaminants above regulatory or risk-based levels beyond the vicinity of the well transect that will include monitoring wells D1P-30, D1P-31 and D1P-32, which are to be installed as close as possible to the western edge of North Pond. The trigger for additional action will be activated if actual or modeled data at the above well transect exceeds federal or state regulatory or risk-based levels for COCs.

I. DEVELOPMENT AND SCREENING OF ALTERNATIVES

Remedial Alternatives were developed that considered the following objectives: provide an appropriate level of protection to the aquifer underlying the Training Ranges and Impact Area; evaluate and address the short-term and long-term potential for human exposure; and consider the potential threat to human health if the remedial alternative proposed were to fail.

The FS developed a range of alternatives that included the following:

- A no action alternative to serve as a baseline for alternative comparisons.
- An alternative that, throughout the entire groundwater plume, reduces the contaminant concentrations to background conditions;
- An alternative that, throughout the entire groundwater plume, reduces the contaminant concentrations to levels that meet or exceed the requirement governing public protection inherent in all MCLs, health advisories, DWELS, other relevant standards, results in a Hazard Index of 1 or less, and a cumulative 10^{-6} excess cancer risk and the non-cancer Hazard Risk of one as rapidly as possible and in less than 10 years.
- A limited number of remedial alternatives that attain site-specific remediation levels within different restoration time periods utilizing one or more different technologies if they offer the potential for comparable or superior performance or implementability; fewer or lesser adverse impacts than others available approached; or lower costs for similar levels of performance than demonstrated treatment technologies.

The FS screened the alternatives based on the short and long term aspects of the following three criteria:

- Effectiveness. This criterion focuses on the degree to which an alternative restores and protects the sole source aquifer underlying the Training Ranges and Impact Area as a future water supply; as well as the degree to which an alternative reduces toxicity, mobility, or volume through treatment; minimizes residual risks and affords long term protection; complies with Regulations, and minimizes short-term impacts. It also focuses on how quickly the alternative

achieves protection with a minimum of short term impact in comparison to how quickly the protection shall be achieved.

- Implementability. This criterion focuses on the technical feasibility and availability of the technologies that each alternative would employ and the administrative feasibility of implementing the alternative.
- Cost. This criterion focuses on the costs of installation and any long-term costs to operate and maintain the alternatives.

Upon completion of this screening, three remedial technologies were retained for further evaluation in the Final FS. They are Fluidized Bed Reactors, IX filtration, and GAC filtration. The Final FS determined that IX filtration for perchlorate removal and GAC filtration for explosives removal best met the three criteria and would be retained for detailed analysis. All 5 alternatives considered in the FS that employed active groundwater treatment used combinations of those technologies as the proposed remedial technologies.

J. DESCRIPTION OF ALTERNATIVES

The FS developed and evaluated five alternatives that attain site-specific remediation levels for RDX and perchlorate within different time frames and a no action alternative (Table 2). The development and evaluation were focused on RDX and perchlorate because all of the other COCs are limited in extent within the RDX plume, are at much lower concentrations, and are expected to be remediated well within the timeframes for RDX. The alternatives analyzed for the Site include:

- Alternative 1 - An alternative with no active remediation.
- Alternative 2 – An alternative based on the existing RRA extraction, treatment and reinjection (ETR) system,
- Alternatives 3 through 6 – ETR systems with different well field configurations and pumping scenarios.

All six alternatives include long-term monitoring and implementation of land use controls, which will remain in effect until the aquifer is restored. The active treatment systems will all use GAC and IX, as appropriate, to remove contaminants.

In order to account for changes in plume geometry since the evaluation in the FS, Alternative 5 and Alternative 6 were selected for re-evaluation under updated plume conditions. The results were reported in the FS Appendix F – Supplemental Evaluations. These alternatives were selected for updating because they represent the average of the range of alternatives with regard to total flow rate, years to achieve remedial goals, and cost. It also provided an opportunity to assess the sensitivity of contaminant migration at the toe of the plume to natural dispersion versus active remediation. The groundwater model was updated and the two alternatives were compared to determine changes in plume migration, years required to achieve remedial goals, and costs.

The six alternatives include:

Alternative 1 Minimal Action
Alternative 1 is a minimal action alternative with no active remediation. This alternative calls for:

- Shut-down of the two RRA ETR systems located at Frank Perkins Road and Pew Road.
- Installation of six additional monitoring wells for long-term monitoring of the groundwater plume.
- Long-term monitoring at 12 monitoring wells.
- The total cost (present worth) for Alternative 1, estimated over 50 years, is $ 2,850,000.

Alternative 2 - Baseline
Alternative 2 provides a baseline alternative that makes use of the RRA systems currently in place as a comprehensive response action. Groundwater modeling predicts that this alternative would restore groundwater to risk-based concentrations for COCs within 36 years and achieve background concentrations within 50 years. This alternative includes:

- Continued operation of the two RRA extraction, treatment and reinjection systems.
- Natural attenuation of the leading edge of the plume downgradient of Pew Road.
- Extraction of groundwater at the total pumping rate of 320 gpm.
- Recharge of the treated groundwater into the aquifer using three injection wells.
- The total cost for Alternative 2 is estimated to be $ 15,000,000.

Alternative 3 – Background
Alternative 3 is predicted by groundwater modeling to achieve risk-based concentrations for COCs in less than 23 years and background concentrations in less than 27 years. Alternative 3 would include:

- Continued operation of the two RRA extraction, treatment and reinjection systems.
- Installation of two additional extraction wells.
- Extraction of groundwater from the four wells at a total pumping rate of 472 gpm.
- Natural attenuation of the leading edge of the plume downgradient of Pew Road.
- Recharge of treated groundwater into the aquifer using a total of four injection wells (three from RRA systems plus one new well).
- The total cost for Alternative 3 is estimated to be $ 21,100,000.

Alternative 4 - 10 Year
Alternative 4 is predicted to achieve risk-based concentrations for COCs within approximately 11 years and background concentrations within 15 years. This alternative calls for:

- Continued operation of the two RRA extraction, treatment and reinjection systems.
- Installation of three additional extraction wells.
- Extraction of groundwater from the five wells at a total pumping rate of 1,417 gpm.
- Natural attenuation of the leading edge of the plume downgradient of Pew Road.

- Recharge of the treated groundwater into the aquifer using a total of four injection wells (three RRA wells plus one new well).
- The total cost for Alternative 4 is estimated to be $ 25,700,000.

Alternative 5 - Additional Alternative A (5-well system)
Alternative 5 provides a design that groundwater modeling predicts would achieve risk-based concentrations for the COCs within approximately 11 years and background concentrations within 19 years. This alternative calls for:

- Continued operation of the two RRA extraction, treatment and reinjection systems.
- Installation of three additional extraction wells.
- Extraction of groundwater from five extraction wells at a total pumping rate of 906 gpm.
- Natural attenuation of the leading edge of the plume downgradient of Pew Road.
- Recharge of the treated groundwater into the aquifer using a total of four injection wells (three RRA wells, plus one new well).
- The total cost for Alternative 5 was estimated in the FS to be $ 21,000,000 and later revised by the Supplemental Evaluations to $18,900,000.

Alternative 6 - Additional Alternative B (6-well system)
Alternative 6 provides a design that groundwater modeling predicts would restore groundwater to risk-based concentrations for the COCs within 11 years and background concentrations in approximately 17 years. This alternative includes:

- Continued operation of the two RRA extraction, treatment and reinjection systems.
- Installation of four additional extraction wells.
- Extraction of groundwater at a total pumping rate of 1,006 gpm.
- Recharge of the treated groundwater into the aquifer using a total of four injection wells (three RRA wells plus one new well).
- A new portable treatment unit near Frederickson Road to house treatment equipment including GAC and potentially IX filters.
- The total cost for Alternative 6 was estimated in the FS to be $ 26,600,000 and later revised by the Supplemental Evaluations to $23,900,000.

For all of the remedial alternatives evaluated (except Alternative 1), it is assumed that the RRA System would operate for the four year timeframe during construction and system startup. For each alternative (except Alternative 1), extraction wells are located throughout the plume to enable the greatest capture of mass possible. A more detailed presentation of each alternative is found in Section 6.0 of the FS.

K. SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

A detailed analysis was performed on the alternatives using nine evaluation criteria in order to select a comprehensive response action for groundwater at Demo 1. These criteria are divided into threshold, balancing, and modifying criteria and are given different weights accordingly. Although this decision is being made under the SDWA, these criteria provide a useful framework

for evaluating response alternatives. The threshold criteria include the protection of public health and compliance with regulations (Table 3). These criteria must be met by the remedy. The balancing criteria include the long-term effectiveness and permanence, reduction of toxicity, mobility or volume through treatment, short-term effectiveness, implementability, and cost. Modifying criteria include state and community acceptance of the selection of the remedy. These criteria were modeled on those used under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) and the National Contingency Plan (NCP).

In this decision under Section 1431(a) of the SDWA, the agency is using these criteria, not strictly in accordance with CERCLA and the NCP but as a way to evaluate and balance a number of relevant factors. The remedy selected through this process is one determined to be necessary to protect the health of persons from contaminants that are present in or likely to enter an underground source of drinking water and that is otherwise in accordance with law, as reflected in the first two criteria. It also reflects the EPA's determination of the appropriate balance of other environmental concerns as reflected by the other criteria. The following is a summary of the nine evaluation criteria:

- Overall protection of human health and the environment including preservation of the aquifer as a public drinking water supply. This addresses whether or not a response action provides adequate protection and describes how risks posed through each pathway are eliminated, reduced or controlled through treatment, engineering controls, or institutional controls. This includes prevention of the movement of contaminants into and through the aquifer and its preservation as a public drinking water supply.

- Compliance with state and federal requirements addresses whether or not a response action will meet all applicable federal and state requirements.

- Long-term effectiveness and permanence addresses the criteria that are utilized to assess alternatives for the long-term effectiveness and permanence they afford, along with the degree of certainty that they will prove successful.

- Reduction of toxicity, mobility, or volume through treatment addresses the degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume, including how treatment is used to address the principal threats posed by the Site.

- Short-term effectiveness addresses the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the installation and implementation period, until cleanup goals are achieved.

- Implementability addresses the technical and administrative feasibility of a response action, including the availability of materials and services needed to implement a particular option.

- Cost includes estimated capital and Operation and Maintenance (O&M) costs, as well as present-worth cost analysis.

- State acceptance addresses the State's position and key concerns related to the preferred alternative.

- Community acceptance addresses the public's general response to the proposed remedy.

Below is a comparison of the strength and weakness each alternative presented in the FS with respect to the nine criteria:

Overall Protection of Human Health and the Aquifer
Alternative 1 provides the least protection of human health and the aquifer because the plume is not prevented from further migration by extraction and treatment, and concentrations of explosives and perchlorate will persist in the aquifer for the longest time period. Alternatives 2 through 5 differ in their degrees of protectiveness in that some achieve cleanup levels more quickly. Alternative 6 is the most protective in that it achieves background levels sooner and actively remediates contamination downgradient of Pew Road, halting further migration of the plume. Alternatives 2 through 6 all protect human health by limiting the further migration of the plume and reducing contaminant concentrations although some will achieve this protection in a shorter timeframe. Alternatives 4, 5 and 6 provide protection in similar timeframes that are substantially faster than Alternatives 2 and 3. Alternative 5 achieves similar results through active remediation of the upgradient portions of the plume and natural attenuation of the leading edge of the plume.

Compliance with State and Federal Requirements
If no remedy is implemented, groundwater contamination would attenuate over a lengthy period of time (greater than 50 years) to health based standards but this is not protective of the aquifer. Alternative 1 is such a remedy. Alternatives 2 through 6 achieve federal and state health-based standards and background in differing periods of time. Alternatives 4, 5 and 6 achieve background and health-based levels in a reasonable period of time.

A summary of federal and state regulations that are potentially applicable to the response action is provided in Table 3.

Long-Term Effectiveness and Permanence
Alternative 1 is the least effective alternative in that time to achieve background is longer and results in the most significant degradation of the aquifer. Alternatives 4, 5, and 6 all provide for effective and permanent remediation for the portion of the plume that is captured by extraction wells although some will achieve protective levels in shorter timeframes. Alternatives 4 and 5 include natural attenuation (including dilution and dispersion) of the downgradient portion of the plume while Alternative 6 would actively restore the aquifer downgradient of Pew Road limiting further migration of the plume.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1 does not reduce the toxicity, mobility, or volume of contaminated groundwater through treatment because it relies on natural processes of dilution. Alternatives 2 through 6 vary in their rate of reduction of the total mass and volume of contamination due to differences in the number of extraction wells, their placement and pumping rates. Alternatives 2 through 5 do not reduce toxicity, mobility or volume through treatment in the portion of the plume where natural attenuation will occur. Alternative 6 reduces toxicity, mobility and volume of the plume the quickest because it includes an extraction well near the leading edge of the plume. Based on modeling, it is estimated that the leading edge would migrate only approximately 250 ft further in Alternative 5 than in Alternative 6.

Short-Term Effectiveness

Alternative 4 would reach risk-based cleanup goals or background concentrations most quickly. Alternatives 5 and 6 also reach the objectives quickly and in similar timeframes but have significantly lower flow rates, less cost, and less stress on the aquifer than Alternative 4. Alternatives 4, 5 and 6 would reach the cleanup goals most quickly, providing the greatest short-term effectiveness. Alternatives 2 and 3 would provide the least short-term effectiveness. Alternatives 2 and 3 would achieve background levels in greater than 50- and 27-year time frames, respectively, providing the least short-term effectiveness. Alternative 1 would not achieve background conditions within the aquifer in the time period used in the analysis. Alternative 6 would have the most construction activities since additional pipelines are required for the leading edge extraction well. Alternatives 4 and 5 with each having five extraction wells and associated piping would have the next greatest impact on natural resources but these impacts are minimized by construction on existing road and power line corridors.

None of the alternatives are expected to have significant short-term impacts on the community since the construction activities, if any, would be restricted to Camp Edwards. Alternative 1 would have the least short-term impact on the community since it involves no further action, except for the long-term groundwater monitoring and institutional controls.

Implementability

All alternatives can be implemented and rely upon proven technologies. Alternatives 1 and 2 are the most easily implemented alternatives because Alternative 2 relies on the existing treatment systems which were installed as part of the RRA, and Alternative 1 relies on existing monitoring wells. Alternatives 3 through 6 can be implemented, and can be effectively operated and monitored. The treatment technologies of groundwater extraction and treatment with GAC and IX in Alternatives 2 through 6 are reliable technologies.

Cost

Alternative 1 has the lowest cost (Table 2) but does not meet other important criteria. Alternative 2 has the lowest total cost (capital cost plus continuing operation costs) of the remaining alternatives (Alternatives 2 through 6). Alternative 5 has the next lowest total cost. Alternatives 4 and 6 have the highest total costs. In general, there is a trade off between cost and time required to achieve the remedial action goals. Alternative 5 seems to be a reasonable trade off between total costs and achieving the remedial goals in a reasonable timeframe.

Typically, to shorten duration, higher flow rates are needed and this increases both capital and yearly operating costs, as well as environmental impact. After a point, the costs of increasing flow rates increase more quickly with less benefit. Alternative 5 provides a system that balances cost and duration while providing flexibility to optimize operations in the future.

State Acceptance
This criterion is continually evaluated as the MassDEP participates in all aspects of the evaluation and selection of a remedy. The MassDEP's official concurrence is set forth in Appendix A

Community Acceptance
Comments were received from three members of the public as part of the public comment period on the RSP. Based on the comments received on the RSP, the public is generally supportive of Enhanced Alternative 5 (see Part III, the Responsiveness Summary).

L. THE SELECTED RESPONSE ACTION

Alternative 5 as presented in the Feasibility Study provides for a groundwater extraction system with five wells (Figure 3) with treatment to risk-based levels. This alternative provides the best balance of the criteria used to evaluate cleanup alternatives. It achieves cleanup goals in a reasonable timeframe. However, to strengthen this alternative, EPA has selected an Enhanced Alternative 5. This Enhanced Alternative 5 includes the groundwater extraction design provided in Alternative 5 and adds a significant feature - a contingency to add additional extraction wells if the plume is found to migrate further than expected as discussed in paragraph three below.

This feature of Enhanced Alternative 5 relates to the capture of the plume downgradient of Pew Road. The IAGWSP has presented information in its Supplemental Evaluation that under Alternative 5 a small section of the plume would migrate an additional 250 ft west and thereafter disperse to background levels. Because this assessment is based on projected conditions from modeling results, it contains uncertainties. So as to be protective of human health and the aquifer, EPA's Enhanced Alternative 5 would create a contingency for additional action.

If EPA determines, based on monitoring data or revised modeling by the IAGWSP or EPA, that plume migration is substantially different than predicted by the modeling conducted in the Feasibility Study, the IAGWSP will conduct a detailed analysis to determine, as accurately as possible, the current and projected future plume location. If groundwater modeling suggests that contamination above applicable federal or state regulatory or risk-based levels for COCs will likely migrate past the well transect that will include wells D1P-30, D1P-31, and D1P-32, (which are to be installed as close as possible to the western edge of North Pond) (Figure 3), an additional active groundwater treatment system will be designed and built within 12 months prior to the plume arrival date, and operated to prevent migration beyond the vicinity of the well transect.

The additional active treatment system will likely consist of an extraction well pumping at 30 to 50 gpm and a portable treatment container, similar to the unit located at Pew Road, which will use GAC and/or ion exchange filters to clean the groundwater.

In the Enhanced Alternative 5, the IAGWSP, as part of its annual monitoring reporting, will conduct a detailed annual assessment of plume migration west of Fredrikson Road.
EPA believes that this Enhanced Alternative 5 is reasonable when compared to Alternative 6 because it provides similar benefits at significantly less cost. Thus, the proposed remedy for the Demo 1 Groundwater Plume is Enhanced Alternative 5, which includes:

- Groundwater extraction at a total flow rate of 906 gpm from five extraction wells, three of which will be new construction;
- Treatment of water at two treatment facilities with construction of a permanent treatment building at Frank Perkins Road;
- Recharge of treated water via four injection wells;
- Monitoring for the entire plume including the leading edge downgradient of Pew Road; and
- Contingency for additional active treatment in the area downgradient of Pew Road.

Groundwater Extraction, Treatment, and Recharge to the Aquifer
The primary cleanup goals for groundwater at Demo 1 are to restore the useable groundwater to its beneficial use within a reasonable timeframe; to provide a level of protection in the aquifer that takes into account that the Cape Cod aquifer, including the Sagamore Lens, is a sole source aquifer that is susceptible to contamination; and to prevent potential ingestion and inhalation of groundwater containing COCs (RDX, 2,4-DNT, TNT, and perchlorate) in excess of federal maximum contaminant levels, Health Advisories, DWELs, applicable State standards or an unacceptable excess lifetime cancer risk or non-cancer Hazard Index.

In addition, the Enhanced Alternative 5 will also prevent any migration of contaminants above regulatory or risk-based levels beyond the vicinity of the well transect that will include monitoring wells D1P-30, D1P-31, and D1P-32, which are to be installed as close as possible to the western edge of North Pond. The trigger for additional action will be activated if actual or modeled data at the above well transect exceeds federal or state regulatory or risk-based levels for COCs.

The proposed remedy is expected to achieve a risk-based level of 0.6 ppb for RDX in 11 years while reducing perchlorate concentrations to less than 2 ppb within the same time frame (Table 2).

Cleanup Levels
The cleanup level for RDX is the 10^{-6} risk-based level, currently 0.6 ppb. The cleanup level for perchlorate is 2 ppb. The cleanup level for TNT is 2 ppb. The cleanup level for 2,4-DNT is 0.25 ppb. Table 1 provides a complete summary of cleanup levels.

Frank Perkins Road
Groundwater extracted from eastern extraction wells (EW-D1-1, EW-D1-501, EW-D1-502, EW-D1-503) would be pumped to a treatment facility at the Frank Perkins Road location (Figure 3). Based on the modeling results, a total of 808 gpm would be conveyed to this treatment facility. Groundwater would be treated by a combination of IX and GAC (Figure 4). Groundwater treated at the Frank Perkins Road system would be recharged to the aquifer via the existing injection wells IW-D1-1 and IW-D1-2. The flow would typically be split equally between the two injection wells, or 404 gpm each.

Pew Road
Groundwater extracted from the extraction well at Pew Road (EW-D1-2) would be conveyed to a treatment facility located on Pew Road (Figure 3). Based on the modeling results a total of 98 gpm of groundwater would be pumped to this location. A treatment container system, like those being used for the RRA, would be used at Pew Road. The treatment system would consist of GAC (Figure 5) with the addition of IX media if necessary. Groundwater treated via the Pew Road system would be recharged to the aquifer via the existing injection well IW-D1-3 and one new injection well IW-D1-4. The flow would typically be split equally between the two injection wells, or 49 gpm each.

Operation and Maintenance
O&M of the extraction, treatment and recharge systems will be routinely conducted to ensure effective operation of the remedy.

Plume Monitoring
During the period that the treatment systems are remediating the aquifer, the IAGWSP will monitor the contaminant plume in accordance with an approved performance monitoring plan.

Contingency for Additional Remedial Actions
The portion of the plume already downgradient of Pew Road is expected to dissipate through natural dispersion. If EPA determines, based on monitoring well data or revised modeling, that plume migration is substantially different than predicted by the modeling conducted in the Supplemental Evaluations (Appendix D of the Final Feasibility Study), the IAGWSP will conduct a detailed analysis to determine, as accurately as possible, the current and projected future plume location.

Two sentinel well fences will be used to monitor the downgradient extent and dissipation of the Demo 1 plume (Figure 2). The first fence consists of existing well clusters MW-352 and MW-353 (upgradient fence). Both of these wells are located northeast of North Pond in the expected trajectory of the plume. Contamination has not yet been detected in these wells, however it is expected that the plume will eventually reach these wells. The second sentinel well fence will include well clusters D1P-30, 31 and 32 (downgradient fence). The elevation of the well screens and the north-south position of the downgradient fence will be based on the detection(s) at the upgradient fence. The wells in the downgradient fence will be placed as close as practical to the western side of North Pond (Figure 2).

All sentinel wells will be sampled and analyzed three times per year for perchlorate through the ongoing system performance monitoring program. The groundwater model will be updated yearly through the system performance monitoring program. The groundwater travel time between the upgradient and downgradient fences is expected to be 1.5 to 3 years. The model will also be used to determine the proper locations of the downgradient fence, both horizontally and vertically.

If groundwater modeling predicts that contamination above applicable federal or state regulatory or risk-based levels for COCs will likely migrate past the well transect that will include wells D1P-30, D1P-31, and D1P-32 an additional active groundwater treatment system will be designed and built within 12 months prior to the plume arrival date, and operated to prevent migration beyond the vicinity of the well transect. The location and elevation of the extraction well screen for this treatment system will be determined based on the location and elevation of COCs detected in the downgradient sentinel well fence. North Pond may have significant influence on the horizontal and vertical trajectory of the plume. Therefore, the proper location of the extraction well can not be determined until the leading edge of the plume is detected in the downgradient fence.

The contingency treatment system will likely consist of an extraction well pumping at 30 to 50 gpm and a portable treatment container, similar to the unit currently located at Pew Road, which will use GAC and/or IX units to clean the groundwater. Treated water will be returned to the aquifer. The objective of this system would be to prevent the migration of COCs above applicable federal and state standards or risk-based levels beyond the vicinity of the downgradient fence.

System Operation and Shutdown

Performance Monitoring

During the period that the treatment systems are remediating the aquifer to applicable drinking water standards or risk-based cleanup levels the IAGWSP will monitor the contaminant plumes in accordance with a system performance monitoring plan approved by EPA in consultation with MassDEP. The performance monitoring program will collect data for evaluating whether the system is performing as designed; the potential for short-term health effects due to exposures during active remediation; and when the selected remedy will attain the remediation goals set forth in this document.

Residual Risk Assessment

Before the treatment system is shut off, the IAGWSP will conduct, pursuant to a workplan approved by EPA in consultation with MassDEP, a residual risk assessment to determine if COCs remaining in the aquifer pose unacceptable human health risks. The IAGWSP will continue to operate the system and will undertake additional measures as necessary to achieve acceptable risks.

Feasibility Analysis

In light of uncertainties and limitations that may exist concerning current capabilities to estimate potential exposures and to quantify potential health risks associated with Demo 1 groundwater contamination, the IAGWSP will evaluate additional quantitative risk reduction elements (e.g. continued groundwater treatment to contaminant levels approaching or achieving background). Once acceptable risk levels have been achieved, the IAGWSP will evaluate, considering the factors set forth in MassDEP guidance, the technical and economic feasibility of conducting additional remediation activities to approach or achieve background concentrations.

Land Use Controls

The contaminated groundwater from the Demo 1 site currently poses an unacceptable risk to human health if used for drinking water purposes. The Demo 1 site is located on base approximately 2 miles east of the boundary with the Town of Bourne. The plume of contaminated groundwater extends approximately 10,000 feet west, is about 1,000 feet wide and covers an area of the aquifer 100 feet deep. No groundwater contamination associated with the plume has or is expected to migrate beyond the Camp Edwards boundary in concentrations that exceed applicable water quality standards or risk-based levels. Therefore, administrative and/or legal controls that minimize the potential for human exposure to groundwater contamination by limiting land or resource use, known as "land use controls" (LUCs), must be established for the on-base area of concern to avoid the risk of human exposure to contaminated groundwater from the Demo 1 site. These LUCs are needed on-base until the groundwater contamination from the Demo 1 site no longer poses an unacceptable risk.

The performance objectives of the LUCs are:

- Prevent access to or use of the Demo 1 site contaminated groundwater until the groundwater no longer poses an unacceptable risk.
- Maintain the integrity of the current or future remedial or monitoring system such as treatment systems and monitoring wells.

The LUCs will encompass the area including the Demo 1 site contaminated groundwater (indicated on Figure 2 in this Decision Document) and surrounding areas to prevent a risk from exposure to contaminated groundwater. The on-base area of concern is controlled and operated by the Massachusetts National Guard (MANG) in conjunction with the United States Army (Army), which leases this land from the Commonwealth of Massachusetts. It is expected that these entities will operate and lease, respectively, the area of concern and the surrounding area for the duration of this Decision Document. As a result, the Army will coordinate with the Commonwealth of Massachusetts as it fulfills its responsibility to establish, monitor, maintain and report on the LUCs for this site.

Each LUC will be maintained until either: (1) the concentrations of Contaminants of Concern in the groundwater are at such a level to allow unrestricted use and exposure, or (2) the Army, with the prior approval of EPA, modifies or terminates the LUC in question.

The Army is responsible for ensuring that the following two LUCs are established, monitored, maintained, reported on and enforced as part of this final remedy to ensure protection of human health in accordance with SDWA § 1431(a) for the duration of this final remedy selected in this Decision Document. In the event that the Commonwealth of Massachusetts fails to enforce the first LUC, the Army will act in accordance with the third to last paragraph in this section.

1. Existing LUCs prevent the inadvertent creation of a large potable water supply well. The Massachusetts Department of Environmental Protection (MassDEP) administers a permitting process for any new drinking water supply wells in Massachusetts that propose to service more than 25 customers or exceed a withdrawal rate of 100,000 gallons per day. This permitting process, which serves to regulate the use of Demo 1 site contaminated groundwater for any withdrawals of groundwater for drinking water purposes, constitutes a LUC for this final remedy.

2. The Dig Safe program implemented in Massachusetts provides an added layer of protection to prevent the installation of water supply wells in the Demo 1 site area and to protect monitoring wells and treatment system's infrastructure. This program requires, by law, anyone conducting digging activities (e.g., well drilling) to request clearance through the Dig Safe network. The MANG Air National Guard 102nd Fighter Wing at the Otis Air National Guard Base (Air Guard) is a member utility of Dig Safe. The Camp Edwards Training Range and Impact Area, including the area encompassed by the Demo 1 site and plume, falls within the geographical area identified by the Air Guard as a notification region within the Dig Safe program. Through the Dig Safe process, the Air Guard will be electronically notified at least 72 hours prior to any digging within this area. The notification will include the name of the party contemplating, and the nature of, the digging activity. Upon receiving Dig Safe notification of any proposed digging activity on Camp Edwards (which includes the Training Range and Impact Area and the Demo 1 site area), the Air Guard will promptly transmit the Dig Safe notification information to the MANG MMR Environmental & Readiness Center (E&RC). The E&RC will review each notification and, if the digging activity is intended to provide a previously unknown water supply well, the E&RC will immediately notify the project sponsor (of the well drilling), the EPA, and the MassDEP in order to curtail the digging activity. If the Dig Safe notification indicates proposed work near monitoring wells or treatment system infrastructure, the E&RC (or its designee) will mark its components to prevent damage due to excavation. The extent of the Air Guard's and E&RC's enforcement of this LUC does not address off-base parties failing to file a Dig Safe request.

Additionally, the Army is responsible for ensuring that the following LUC is established, monitored, maintained, reported on and enforced as part of this final remedy to ensure protection of human health in accordance with SDWA § 1431(a) for the duration of the final remedy selected in this Decision Document.

1. For the on-base area of concern, a prohibition on new drinking water wells serving 25 or fewer customers has been established and placed on file with the planning and

facilities offices for the Massachusetts Air and Army National Guard and United States Coast Guard (major tenants at the MMR). The prohibition will be applied to future land use planning per Air National Guard Instruction (ANGI) 32-1003, Facilities Board, Army National Guard Regulation 210-20, Real Property Development Planning for the Army National Guard, and Commandant Instruction Manual 11010.14, Shore Facility Project development Manual (See Appendix D).

2. For the on-base area of concern, the Air National Guard has administrative processes and procedures that require approval for all projects involving construction or digging/subsurface soil disturbance, currently set forth in ANGI 32-1001, Operations Management. This procedure is a requirement of the Army National Guard and the United States Coast Guard by the Air National Guard through Installation Support Agreements. The Air National Guard requires a completed AF Form 103, Base Civil Engineer work Clearance Request (also known as the base digging permit), prior to allowing any construction, digging, or subsurface soil disturbance activity. All such permits are forwarded to the Installation Restoration Program for concurrence before issuance. An AF Form 103 will not be processed without a Dig Safe permit number (see next paragraph).

Monitoring of the environmental use restrictions and controls will be conducted annually by the Army. The monitoring results will be included in a separate report or as a section of another environmental report, if appropriate, and provided to the USEPA and MassDEP for informational purposes. The annual monitoring reports will be used in preparation of the Five Year Review to evaluate the effectiveness of the final remedy.

The annual monitoring report, submitted to the regulatory agencies by the Army, will evaluate the status of the LUCs and how any LUC deficiencies or inconsistent uses have been addressed. The annual evaluation will address (i) whether the use restrictions and controls referenced above were effectively communicated; (ii) whether the operator, owner and state and local agencies were notified of the use restrictions and controls affecting the property; and (iii) whether use of the property has conformed with such restrictions and controls and, in the event of any violations, summarize what actions have been taken to address the violations. The annual monitoring reports will be used in preparation of the five-year review to evaluate the effectiveness of the final remedy.

The Army may transfer various operational responsibilities for LUCs (i.e., monitoring) to other parties through agreements. However, the Army acknowledges its ultimate liability under SDWA § 1431(a) for remedy integrity.

The Army shall notify EPA and MassDEP 45 days in advance of any proposed land use changes that would be inconsistent with the LUC objectives or the final remedy. If the Army discovers a proposed or ongoing activity that would be or is inconsistent with the LUC objectives or use restrictions, or any other action (or failure to act) that may interfere with the effectiveness of the LUCs, it will address this activity or action as soon as practicable, but in no case will the process be initiated later than ten (10) days after the Army becomes aware of this breach. The Army will notify EPA and MassDEP as soon as practicable but no later than ten (10) days after

the discovery of any activity that is inconsistent with the LUC objectives or use restrictions, or any other action that may interfere with the effectiveness of the LUCs. The Army will notify EPA and MassDEP regarding how the Army has addressed or will address the breach within ten (10) days of sending EPA and MassDEP notification of the breach.

The Army will provide notice to the EPA and MassDEP at least six (6) months prior to relinquishing the lease covering the Demo 1 site so the EPA and MassDEP can be involved in discussion to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective LUCs. If it is not possible for the Army to notify the EPA and MassDEP at lease six (6) months prior to any transfer or sale, then the Army will notify the EPA and MassDEP as soon as possible, but no later than 60 days prior to the transfer or sale of any property subject to LUCs.

The Army shall not modify or terminate LUCs, implementation actions, or modify land use without approval by the EPA in conjunction with MassDEP. The Army, in coordination with other agencies using or controlling the Demo 1 site, shall seek prior concurrence before taking any anticipated action that may disrupt the effectiveness of the LUCs or any action that may alter or negate the need for LUCs.

Modifications

The performance of the system will be continuously evaluated through the system performance monitoring program. This will include evaluation of system parameters and flow rates to insure that the system continues to achieve project goals as efficiently as possible. Optimization changes will be documented in the periodic system performance monitoring reports.

Any significant changes to the response action described in this Decision Document will be documented in a technical memorandum in the Administrative Record for the Site. If EPA, in consultation with the state, believes that fundamental changes to the response action are necessary, EPA will issue a proposed revised decision document and accept public comment on it before issuing a final revised decision document.

Expected Outcomes of the Selected Response

The primary cleanup goals for groundwater at Demo 1 are to restore the useable groundwater to its beneficial use within a reasonable timeframe; to provide a level of protection in the aquifer that takes into account that the Cape Cod aquifer, including the Sagamore Lens, is a sole source aquifer that is susceptible to contamination; and to prevent potential ingestion, dermal contact, and inhalation of groundwater containing COCs in excess of federal maximum contaminant levels, health advisories, DWELs, applicable state standards or an unacceptable excess lifetime cancer risk or non-cancer Hazard Index. The proposed remedy is expected to achieve a risk-based level of 0.6 ppb for RDX in 11 years while reducing perchlorate concentrations to less than 2 ppb within the same time frame (Table 2).

There are currently no federal MCLs for any of the COCs so other federal or state standards or guidelines were used to establish cleanup levels (Table 1). For RDX the DWEL is 100 ppb. The lifetime HA is 2.0 ppb, and the concentration resulting in an increased incremental lifetime cancer risk of one in a million is 0.6 ppb. The cleanup standard for RDX was thus established at

the cancer risk level, currently at 0.6 ppb. For TNT, the DWEL is 20 ppb, the HA is 2.0 and the lifetime cancer risk for one in a million is 2.2 ppb. The cleanup standard for TNT was thus established at 2.0 ppb. For 2,4-DNT, the DWEL is 70 ppb and there is no lifetime HA, the 10^{-6} lifetime cancer risk for one in a million is 0.1 ppb. Due to analytical method limits, the cleanup standard was established at 0.25 ppb. In February 2005, EPA established a reference dose for perchlorate which equates to a DWEL of 24.5 ppb. The DWEL assumes that all of the contaminant comes from drinking water. With a contaminant like perchlorate, individuals may be exposed through other sources, such as food or breast milk. The State has promulgated a Massachusetts Maximum Contamination Level (MCLL) of 2 ppb. The cleanup standard for perchlorate was thus established at 2 ppb.

In addition, the Enhanced Alternative 5 will also prevent migration of COCs above applicable drinking water quality standards or risk-based levels beyond the vicinity of the well transect that will include monitoring wells D1P-30, D1P-31, and D1P-32. The trigger for additional action will be activated if actual groundwater concentrations or concentrations predicted by the model at this well transect exceed applicable federal or state standards or risk-based levels for COCs.

Five-Year Reviews

In addition to continuing evaluation of the treatment system by submission of annual reports on system performance and ecological impact monitoring, the IAGWSP shall review this groundwater remedy every five years. The purpose of the review is to revisit the appropriateness of the remedy in providing adequate protection of human health. The scope of the review shall include, but is not limited to the following questions: is the remedy operating as designed; have any of the cleanup standards changed since finalization of this Decision Document; and is there any new information that would warrant updating the remedy. If appropriate, additional actions may be required as a result of these reviews.

M. DETERMINATIONS

The groundwater response action selected for implementation at Demo 1 is consistent with the SDWA Section 1431(a), 42 USC §300i(a), as amended and with AO3.

The selected response action is protective of human health, will comply with applicable federal and state requirements, standards, MCLs, health advisories, and DWELS. The response action will adequately protect human health and the sole source aquifer which constitutes a current and potential drinking water supply by eliminating, reducing, or controlling exposures to potential human receptors at the site through treatment and institutional controls.

N. DOCUMENTATION OF NO SIGNIFICANT CHANGES

EPA presented a RSP for Enhanced Alternative 5 for the groundwater remedy at Demo 1 on August 22, 2005. The proposed alternative includes groundwater extraction, treatment and recharge. EPA reviewed all written and verbal comments submitted during the public comment period. It was determined that no significant changes to the response action, as originally

identified in the RSP, were necessary.

O. STATE ROLE

The MassDEP has reviewed the various alternatives and has concurred with the selected response action. See Appendix A.