Impact Area Groundwater Study Program

Feasibility Study
Demo 1 Groundwater Operable Unit

Appendix E
Response to Comments Letter and Memorandum of Resolution

Camp Edwards
Massachusetts Military Reservation
Cape Cod, Massachusetts

August 19, 2005

Prepared for:

U.S. Army Corps of Engineers
New England District
Concord, Massachusetts
for
U.S. Army / National Guard Bureau
Impact Area Groundwater Study Program
Camp Edwards, Massachusetts

Prepared by:

AMEC Earth & Environmental, Inc
Westford, Massachusetts
Contract No. DAHA92-01-D-0006

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September 2, 2004

Mr. Len Pinaud
Massachusetts Dept. of Environmental Protection
20 Riverside Drive
Lakeville, MA 02347

Mr. Todd Borci
EPA – New England, Region 1
1 Congress Street, Suite 1100
Boston, MA 02114-2023

Dear Mr. Pinaud and Mr. Borci:

Re: Impact Area Groundwater Study Program (IAGWSP)
USEPA Region I Administrative Orders SDWA 1-97-1019 and 1-2000-0014
Response to Comments (RCL) on the Revised Draft Feasibility Study
Demo 1 Groundwater Operable Unit

On behalf of the Army/NGB IAGWSP and the U.S. Army Corps of Engineers (USACE), AMEC Earth & Environmental (AMEC) is pleased to provide the attached response to comments letter (RCL) for the above-referenced document. The Demo 1 Groundwater Feasibility Study was submitted on 05/20/04. Comments were received from EPA on 07/20/04 and responses are provided in Attachment 1. Comments were received from DEP on 08/02/04 and responses are provided in Attachment 2.

EPA's letter of 07/20/04, which included the comments on the Revised Draft FS as an attachment, indicates that EPA prefers Alternative 6 with specific modifications made to the conceptual design. Each of these conceptual design changes is discussed below.

Rerouting of Subsurface Piping

EPA requested that the piping for the downgradient well in Alternative 6 be modified by either rerouting the piping along Fredrikson, Estey and Pew Roads (outside the plume footprint) or incorporating a stand-alone system at Fredrikson Road to minimize natural resource impacts. The options proposed by EPA were originally considered during the preparation of the FS.

The major issue associated with the rerouting the piping along existing roads is added cost. The major difficulties with the stand-alone system are the power supply source and conceptual design of new discharge location(s). New discharge locations would add costs associated with additional injection wells and subsurface piping. At this point, significant modeling effort would be required to evaluate new potential discharge locations.

Based on these considerations, the IAGWSP has revised the piping route for Alternatives 3 and 6, as requested by EPA, to minimize natural resource impacts. This change results in an increase in capital cost of approximately $300,000 for Alternatives 3 and 6. The changes to the

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subsurface pipe routing, capital costs and reduced impact on natural resources will be reflected in the Final FS for Alternatives 3 and 6.

Wellfield Design Optimization

EPA also requested that the IAGWSP evaluate the use of only two extraction wells between the source area and Frank Perkins Road instead of the proposed three wells. EPA is correct in their evaluation that removal of one of the upgradient extraction wells would not reduce the systems capture efficiency. However, what would be compromised is the time required to achieve the remediation goals, which impacts operation, maintenance and monitoring costs.

The wellfield designs contained in the FS are optimized as part of the modeling algorithm to capture the distributions of perchlorate and RDX mass contained in the plume in an efficient timeframe to balance capital and operation, maintenance and monitoring costs. The wellfield design optimization and well pump rate "ceilings" assigned to each extraction well in no way limited the optimization. That is, the well pumping rates did not force the optimization to select three wells instead of two extraction wells. The three extraction wells at and upgradient of Frank Perkins Road are required to reduce the distance contamination must travel to be removed from the aquifer. If one of the extraction wells upgradient of Frank Perkins Road is removed, then the time to achieve the remediation goals will be extended.

To demonstrate this, a transport simulation was conducted in which the middle well of the three wells between the source area and Frank Perkins Road was removed and that well's extraction rate was assigned to the Frank Perkins Road well. The new design requires approximately five additional years to achieve the remediation goals. The operation, maintenance and monitoring costs for the additional five years significantly exceeds the capital costs for installation of the additional extraction well and piping. Therefore, no change is proposed to the wellfield design upgradient of Pew Road.

Recent Perchlorate Data

EPA indicated that they feel a leading edge extraction well is required based primarily on the recently obtained perchlorate results at and downgradient of Pew Road. The IAGWSP acknowledges that the recent perchlorate results are higher in concentration than the data used to conduct the FS modeling and that supplemental evaluations are warranted prior to selection of a remedy for the Demo 1 Groundwater Operable Unit. These supplemental evaluations are proposed to be conducted in support of remedy selection and should not impact the finalization of the FS. As agreed at the 9/11/03 FS scoping meeting, the wellfield designs conducted in the FS were based on the distribution of contaminants through 5/03, which was documented in the Draft Groundwater Report Addendum (7/22/03). Updating all data and incorporating it into a revised FS would require major revisions to the modeling runs, animations, and costing for all six alternatives. This would unduly delay the FS and therefore delay the selection and implementation of a comprehensive remedy by several months.

As discussed at our Remedy Selection Plan kickoff meeting conducted on 8/19/04, the IAGWSP has conducted an evaluation of the attenuation of the plume downgradient of Pew Road with no

leading edge extraction well using the recent perchlorate results received through 5/25/04. The estimated perchlorate mass for both the 2003 and 2004 data are presented in detail in the Response to EPA General Comment 4 (Attachment 1). Attachment 3 presents the new plume contours using 2004 data and Attachment 4 presents the longitudinal cross-section. The results of the evaluation indicate that the predicted timeframe to achieve remediation goals in the area downgradient of Pew Road is similar to those predicted for Alternative 5 in the FS and the mass captured under Alternative 5 for the 2003 and the 2004 data is also similar (Attachment 5).

As also discussed on 8/19/04, the IAGWSP recognizes that this evaluation doesn't consider the recent perchlorate detections found in profile samples collected at monitoring well MW-341 (D1P-24) located on Pew Road. Monitoring well results from MW-341 are expected to be received by 9/3/04 and results from the 8/04 groundwater sampling event for monitoring wells at and downgradient of Pew Road will be available shortly thereafter. Therefore, supplemental evaluations, including development of conservative hypothetical perchlorate distributions, are required to support remedy selection.

In a letter dated 8/26/04, EPA agreed that the IAGWSP should perform supplemental evaluations; including a sensitivity analysis to discern the perchlorate distribution at and downgradient of Pew Road that would be predicted to cause the plume to persist above remediation goals for an unacceptable duration as compared to incorporating a leading edge extraction well. In an email dated 8/30/04, EPA requested that the IAGWSP provide a summary of the proposed technical approach and schedule for these supplemental evaluations prior to discussing at a meeting and proceeding with the work. The IAGWSP plans to provide the approach and schedule for the supplemental evaluations next week.

Proposed Remedy

As indicated above, the IAGWSP agrees that supplemental evaluations based on new data are needed to support the remedy selection process. However, based on the evaluations conducted to date, the IAGWSP maintains that a leading edge extraction well is not appropriate based on the following considerations.

- Groundwater modeling predicts that the timeframe to achieve remediation goals is similar with or without the leading edge extraction well.
- A promulgated federal or state perchlorate cleanup standard is not available.
- Within the next two weeks, any further migration of significant contaminant concentrations past Pew Road will be stopped by the operation of the RRA ETR system at Pew Road.
- The estimated mass of perchlorate contained in the plume downgradient of Pew Road is only approximately 1% of the total perchlorate mass in the entire plume. This mass is predicted to attenuate to below detectable concentrations before posing any imminent risk under current and foreseeable aquifer use scenarios.
- Inclusion of the leading edge extraction well will increase the construction costs by over $2,000,000.
- Given the intermittent detections and trace level concentrations at the leading edge of the perchlorate plume, efficiently locating an extraction well at the leading edge is

difficult. Improper placement of the well based on these data could make any future remediation more difficult if this well is found to be necessary.
- Influent contaminant concentrations from a leading edge extraction well would likely not be detectable, which would significantly limit performance monitoring.

The IAGWSP continues to look at these issues and notes that, although the FS shows six alternatives, there is always an option to create a hybrid version of these proposed remedies during the Remedy Selection (i.e., Alternative 5 with a contingency for a downgradient well).

Please contact Ben Gregson or Paul Nixon of the IAGWSP, or Dave Margolis of the USACE, if there are any questions.

Sincerely,

Marc Grant, P.E.
Program Manager

Attachment 1:	Response to EPA Comments (07/20/04) on the Feasibility Study, Demo 1 Groundwater Operable Unit (05/20/04) [45 pages]
Attachment 2:	Response to DEP Comments (08/02/04) on the Feasibility Study, Demo 1 Groundwater Operable Unit (05/20/04) [4 pages]
Attachment 3:	Perchlorate Distribution in Groundwater as of 5/25/04
Attachment 4:	Perchlorate Cross-section A-A' as of 5/25/04
Attachment 5:	Perchlorate Mass Capture for Alternative 5 using 2003 and 2004 data

CC: Ben Gregson / Paul Nixon - IAGWSP
Dave Margolis / Scott Michalak – USACE
Gina Kaso – USACE
Mark Panni – MADEP
Bob Lim – EPA
Jane Dolan – EPA
Tom Frendak/Travis McCoun – AEC
Randall Nida – NGB

Attachment 1
Draft Responses to EPA Comments (7/20/04)
Revised Draft Feasibility Study (5/20/04)
Demo 1 Groundwater Operable Unit

EPA GENERAL COMMENTS

1. The document underplays the fact that the Demo 1 plume is located within a sole source aquifer (SSA). This must be corrected. In both the Executive Summary and the Background Section, the document should discuss the fact that Camp Edwards overlies the Sagamore Lens, the most productive part of the Cape Cod Aquifer, the only drinking water supply for Cape Cod; and that the Commonwealth of Massachusetts has designated Camp Edwards as a reserve for purposes of water supply and wildlife protection. The FS should indicate that various locations on and around Camp Edwards are being considered as replacement water supply sources for water supplies that have been contaminated as a result of other activities on Massachusetts Military Reservation.

The fact that Camp Edwards overlies a sole source aquifer, and its designation as a water supply reserve are mentioned multiple times in the document. The characterization of the Demo 1 groundwater plume and aquifer were described in detail in the Groundwater Report and the Groundwater Report Addendum. Although locations within Camp Edwards may be considered for the development of future water supplies, it should be noted that the DEP has already denied the use of the area around North Pond (downgradient of the Demo 1 plume) due to concerns for the drawdown of the water level in the pond. No changes to the text are proposed.

2. MILCON - This FS should include a discussion regarding the complications of building a permanent treatment facility (MILCON) at Frank Perkins Road for Alternatives 2 through 6. This discussion should be included in the Implementability section for each alternative.

Federal Fiscal law imposes limitations on the Army's ability to fund and construct facilites that qualify as "military construction" (MILCON) projects. The IAGWSP is working closely with the Army Environmental Center (AEC) and the Department of the Army Headquarters in an attempt to resolve potential MILCON issues related to the Demo 1 project. Meanwhile, other funding mechanisms are being explored.

The type and source of funding is not relevent to the scope of the FS. Therefore, no new text is proposed.

3. Perchlorate Treatment Technology - EPA will be closely monitoring influent concentrations and data from the performance of any stand alone or straight carbon portion of a larger system since we believe that straight carbon is not yet a proven technology for the treatment of perchlorate. In the event that data or any other information causes the EPA to require a change in treatment media to ion exchange or some other proven technology, the Army/Guard must comply with that request.

Comment noted. The performance of the Rapid Response Action (RRA) for Groundwater at Demo 1 will be evaluated. Specifically, GAC treatment efficiency will be evaluated for use in the comprehensive remedial action.

4. Calculating Mass Removal - When discussing the percentage of mass removal of contaminants for different alternatives, EPA believes that it is essential that the data be in a form that can be easily compared between alternatives. Thus, regardless of whether an alternative involves cleaning up to background (non-detect) or to risk based standards (RBCs) it is

essential that the basis for comparison be the same. The "denominator" in such a calculation should always be the volume of groundwater with contamination above non-detect. Therefore, Section 3.5 should clarify the approach for calculating mass in the active remediation alternatives. The document clearly should specify whether the total mass of the plume is based upon the mass of the plume to non-detect or the RBC boundary. In addition, EPA would like to know the estimated mass in the plume that is downgradient and outside of the capture of the Pew Road extraction well.

To set a baseline, EPA would like to see the document present he estimated mass for the following: mass to ND boundary; mass to ND boundary downgradient of Pew Road, between Pew and Frank Perkins, and upgradient of Frank Perkins; mass to RBC for RDX and perchlorate for the same segments.

All calculations of percent mass removal under the various alternatives are total mass present in the plume to the ND boundary as defined by analytical data collected through April 2003. The table below presents and compares the perchlorate mass and volume for each portion of the plume for the total (as presented in the FS) and that quantity in the perchlorate plume that is above 1 ug/L.

Location	Perchlorate to Non-Detect				Perchlorate to 1 ug/L			
	Mass (lbs)	%	Volume (gallons)	%	Mass (lbs)	%	Volume (gallons)	%
Upgradient of FPR	80.44	80.6	605,686,694	42.9	80.22	81.2	463,905,007	56
Between FPR and PR	18.46	18.5	595,035,870	42.2	18.12	18.3	346,344,570	42
Downgradient of PR	0.95	1.0	210,111,330	14.9	0.45	0.5	12,398,100	1.5
Total	99.85	100	1,410,833,894	100	98.80	100	822,647,677	100

Section 3.5 will be modified to include the following text and amended table below: "The analytical data collected for the Demo 1 plume were plotted spatially onto Figures 2-6 through 2-21, using data from May 2003. The plume shells were interpolated and rendered in three dimensions in the groundwater modeling process. 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 major treatment system components. The mass of perchlorate upgradient of Frank Perkins Road is 80.5 lbs; the mass of perchlorate between Frank Perkins Road and Pew Road is 18.5 lbs; and the mass of perchlorate downgradient of Pew Road is 1 lb.

COC	Estimated Volume		Estimated Mass	
	Liters	Gallons	Kilograms	Pounds
Perchlorate (Total)	5.5E09	1.5E09	45	100
Upgradient of FPR	--	--	36.5	80.5
Between FPR & Pew	--	--	8.4	18.5
Downgradient of Pew	--	--	0.45	1
RDX	1.2E09	3.2E08	30	67
TNT	4.7E07	1.2E07	0.06	0.13

The total mass of the perchlorate plume is 99.85 lbs, the mass of the plume downgradient of Pew Road is 1% of this or 0.95 lbs (this is a conservative estimate because this includes mass west of Pew Road that may be in the capture zone). The mass of perchlorate between Pew Road and Frank Perkins Road is 18.45 lbs or 18.5%. The mass of perchlorate upgradient of Frank Perkins Road is 80.44 lbs or 80%. The IAGWSP updated its calculation of plume mass with 2004 data and observed a slight shift of mass from upgradient of Frank Perkins Road (decreased from 80% to 76% of total) to the area between Frank Perkins and Pew Roads (increased from 18.5% to 23.5% of total). The area downgradient of Pew Road decreased very slightly to 0.9% from 1.0% (this is because the plume was redrawn in 2004 with a smaller downgradient area due to the non-detect at MW-252 in 2004). The total mass of the perchlorate plume according to 2004 estimates was 115 lbs. The difference in estimates is based on the process of interpolation between well screen data points at a given point in time. However, this variation is reasonable considering the large areal extent of data and the monitoring density available.

The mass of the perchlorate plume above the risk-based concentration (1 ug/L) is 98.8 lbs, the mass of the plume downgradient of Pew Road above the risk-based concentration is 0.45 lbs or 0.5%. The mass of perchlorate between Pew Road and Frank Perkins Road above the risk-based concentration is 18 lbs or 18.3 %. The mass of perchlorate upgradient of Frank Perkins Road above the risk-based concentration is 80 lbs or 81.2 %. The IAGWSP updated its calculation of plume mass with 2004 data and again, observed the slight shift of mass from upgradient of Frank Perkins Road (decreased from 81.2% to 76% of total above the risk-based concentration) to the area between Frank Perkins and Pew Roads (increased from 18.3% to 23% of total). The area downgradient of Pew Road above the risk-based concentration increased from 0.5% to 0.7% of the total mass. The total mass of the perchlorate plume above the risk-based concentration according to 2004 estimates was 114 lbs.

The total mass of the RDX plume is 66.9 lbs. The area upgradient of Frank Perkins Road accounts for 66.3 lbs or 99.1% of the plume mass. The total mass of RDX above the risk-based concentration is 66.8 lbs or 99.97%. The mass of RDX above the health advisory of 2 ug/L is 66.2 lbs or 99.87%.

5. Groundwater Downgradient of Pew Road - In discussing each alternative which does not include an extraction well downgradient of Pew Road, the FS should specifically include a statement that groundwater downgradient of Pew Road, which is currently above risk-based levels, would not be treated. Thus, groundwater west of Pew Road and on the base could not

be used for drinking water purposes. See also specific comments below referring back to this general comment.

A statement that indicates water in this area may be above risk-based levels during treatment will be added to the appropriate alternatives. However, each of these alternatives is expected to reduce the concentrations in the plume to below risk-based levels at the end of the specified treatment time. It is also important to note that development of water supply sources in this area (LRWS10-1) were denied by DEP in the past due to the proximity, and potential drawdown of the Pond.

6. Estimates to Achieve Restoration - There appears to be inconsistencies when evaluating the restoration timeframes for the plume particularly downgradient of Pew Road. For example, the Demo 1 FS Fact Sheet table presents estimates for restoration of groundwater from Perchlorate downgradient of Pew Road at greater than 50 years for Alternative 2, 15 years for Alternative 4, 20 years for Alternative 5 despite the fact that all these alternatives are similar and do not include a leading edge extraction well. In addition to mass capture, clarification should be provided on estimates to achieve restoration for the entire plume including the leading edge.

Estimates of time to achieve restoration are based on the maximum concentration within the entire plume inclusive of the leading edge. Despite the similarities in well location, the alternatives listed have different pumping rates and remedial objectives (e.g., risk-based, background levels) which, as expected, result in different times to achieve restoration. The restoration times that are provided are based on an evaluation through the entire plume. The areas upgradient of Pew Road dictate the time required to achieve restoration. The toe of the plume dissipates in approximately the same time for all the alternatives except for Alternative #1.

Alternative 2 entails pumping 220 gpm at Frank Perkins Road and 100 gpm at Pew Road in order to hydraulically contain, and gradually remove mass from, the plume. Alternative 4 entails pumping at a much higher rate of 1,417 gpm from five extraction wells along the plume axis which would reduce mass at a greater rate and reduce concentrations below risk-based levels in approximately 14 years. Alternative 5 entails pumping from five extraction wells at a moderate combined rate of 906 gpm in order to reduce concentrations below risk-based levels in 20 years. Since 99% of the perchlorate plume mass is upgradient of Pew Road, the presence or absence of a downgradient extraction well at Frederickson Road does not make a big difference in the mass removal.

7. Schedule - EPA does not agree with the schedule as contained in this document. EPA does agree with points raised by the Army/NGB to attempt to expedite this schedule, and will continue to cooperate on the schedule. In order to meet the expedited schedule, EPA reminds the Army/NGB that the Response to Comment Letter (RCL) is due from the Army/Guard by 20 August 2004. It is EPA's intention to finalize our schedule discussions at that time.

The IAGWSP proposed to expedite the FS/RD/RA process as prescribed by EPA in AO3 and represented by the schedule included in the FS. EPA participated in developing an expedited schedule but has not provided approval to go ahead with this approach. As stated in the cover letter attached to the Revised Draft FS, the schedule will be modified once EPA provides written comment and agreement.

EPA SPECIFIC COMMENTS

1. Page ES-1, Para. 5 - The discussion of the Remedial Action Objectives for the Demo 1 Plume in paragraph 5 should also incorporate the concepts contained in Section 3. I. (Objectives) of the AO3 SOW. In particular, the remedial alternatives should provide a level of protection to the aquifer that accounts for the fact that the Cape Cod Aquifer is a sole source aquifer, is susceptible to contamination, and that Camp Edwards overlies a productive part of the aquifer.

The remedial response objectives are described in detail in the FS in Section 4.1 Remedial Response Objectives. The first sentence of paragraph 5 provides a summary of the overall objective stated in the AO3 SOW as is appropriate for the executive summary.

2. Page ES-1, Para. 5 - The text should be rewritten to list two RAOs (rather than one overall and one specific). Hence the first sentence of this paragraph should be deleted and replaced with the following specific RAO:

"Restore groundwater to its beneficial use as a sole source aquifer within a time frame that is reasonable."

The language in the executive summary quotes AO3 directly.

EPA is directed to their comments on the Demo 1 Groundwater Operable Unit Draft Feasibility Study on 10/31/01:

EPA Specific Comment 23 (10/31/01) Page 28, Section 5.2, 2nd Paragraph – This entire paragraph should be rewritten as follows:

"The overall, primary Remedial Action Objective for the groundwater contamination found at Demo 1 is to protect the health of persons who are or may be users of the underlying sole source aquifer (Sagamore Lens of the Cape Cod Aquifer), and to protect and preserve the aquifer as a public drinking water supply, as required by AO3.

In addition, a secondary remedial action objective is to:

Prevent potential ingestion and ... Hazard Index."

The IAGWSP's response to EPA on 12/10/01 (RCL, MMR-4469):

"The requested change will be made in the Final FS. However, the Guard maintains that the primary objective does not comply with the specific requirements of AO3 (3.0, II, A, a.) regarding the definition of a Remedial Action Objective."

3. Page ES-1, Para. 5 - The RAO starting "Prevent potential ingestion and ..." must include a reference to state standards that are deemed substantive.

IAGWSP considers promulgated standards to be substantive, such as a Massachusetts Maximum Contaminant Level (MMCL). DEP has not yet promulgated a standard for perchlorate. The promulgated level for RDX is the Federal health advisory set at 2.0 ug/L in groundwater.

4. Page ES-2, First Full Para. - Insert the following at the end of this paragraph:

"According to this 2003 memorandum, the 1999 interim guidance remains the applicable guidance until supplanted by new guidance based on a finalized risk assessment."

The text will be changed to read:
"In January 2003, EPA (EPA, 2003) issued a memorandum re-affirming 1999 interim guidance that results in a provisional risk-based standard range from 4 to 18 µg/L for perchlorate. The range (4-18 µg/L) is considered to be protective based on recent, ongoing analyses and taking into account the most sensitive receptors, and therefore no additional adjustment for childhood exposure is needed. According to this 2003 memorandum, the 1999 interim guidance remains the applicable guidance until supplanted by new guidance based on a finalized risk assessment."

5. Page ES-2 - The text should briefly explain the ongoing soil RRA efforts.

The following text will be added after the fourth full paragraph on Page ES-2:
"The IAGWSP is also implementing a soil Rapid Response Action (RRA) at Demo 1. The purpose of the soil RRA is to remove munitions and ordnance and related contaminants from soils that were the source of the Demo 1 groundwater plume. The RRA includes excavation and thermal treatment of contaminated soil from the Demo 1 source area.

The objective of the RRA Plan for the Demo 1 Soil OU (AMEC, 2003b) is to reduce or eliminate potential risks to human health present at Demo 1 as a result of historic open burn and open detonation (OB/OD), disposal and demolition training activities. The soil RRA will eliminate the continuing source to groundwater contamination at Demo 1 associated with geophysical anomalies and contaminated soil.

The soil RRA Plan includes:

- *Removal of all geophysical anomalies within the perimeter road at Demo 1 (approximately 7.4 acres),*
- *Excavation of approximately 15,000 cubic yards of contaminated soil,*
- *Off-site disposal of "burn pit" materials,*
- *On-site treatment of the soil (15,000 cubic yards) via thermal treatment to remove COCs from the soil,*
- *Restoration of the site through reuse of treated soil determined to be acceptable.*

Anomaly removal began in mid- 2003 and soil excavation began in late 2003. Thermal treatment began in Winter 2004 and will be completed during Fall 2004. Treated soil meeting cleanup goals will be returned to the Demo 1 depression and final site restoration

will be completed."

6. Page ES-3, Alternatives 2 through 6 - a) Like Alternative 2, the text should clearly state that a permanent structure would be built for the Frank Perkins Road treatment system while use of mobile treatment systems are assumed for Pew Road treatment system.

The paragraph describing Alternative 2 on page ES-3 will have the following changes, starting in the penultimate sentence:
"…A permanent structure would be constructed to house the treatment system at Frank Perkins Road. The treatment system at Pew Road would continue to utilize the single mobile treatment container of the RRA treatment system using GAC media…"

The paragraph describing Alternative 3 on page ES-3 will have the following changes, starting in the penultimate sentence:

"…Similar to Alternative 2, a combination of IX resin and GAC media would be utilized to treat the extracted water at a permanent treatment structure at Frank Perkins Road. A fourth injection well would be added to recharge the treated water to the aquifer in the downgradient area. Treatment at Pew Road would be via three mobile treatment containers utilizing GAC media. This alternative also includes long-term groundwater monitoring and institutional controls."

The paragraph describing Alternative 4 on page ES-3 will have the following changes, starting in the penultimate sentence:

"…Similar to Alternative 3, a combination of IX resin and GAC media would be used to treat the extracted water at a permanent treatment structure at Frank Perkins Road and four injection wells would be used to recharge the treated water to the aquifer. Treatment at Pew Road would be via three mobile treatment containers utilizing GAC media. This alternative also includes long-term groundwater monitoring and institutional controls."

The paragraph describing Alternative 5 on page ES-3 will have the following changes, starting in the penultimate sentence:

"…Similar to Alternative 3, a combination of IX resin and GAC media would be used to treat the extracted water at a permanent treatment structure at Frank Perkins Road and four injection wells would be used to recharge the treated water to the aquifer. Treatment at Pew Road would be via one mobile treatment container utilizing GAC media. This alternative also includes long-term groundwater monitoring and institutional controls."

The paragraph describing Alternative 6 at the top of page ES-4 will have the following changes, starting in the penultimate sentence:

"…Similar to Alternative 3, a combination of IX resin and GAC media would be used to treat the extracted water at a permanent treatment structure at Frank Perkins Road and four injection wells would be used to recharge the treated water to the aquifer. Treatment at Pew Road would be via two mobile treatment containers utilizing GAC

media. This alternative also includes long-term groundwater monitoring and institutional controls."

b) These alternatives mislead the reader into assuming that ion exchange (IX) resin and granular activated carbon (GAC) will be used at both Frank Perkins Road and Pew Road. Like the previous comment, the text should clearly state that IX resin and GAC will be used at Frank Perkins Road and GAC will be used at Pew based on expected influent concentrations of explosives and perchlorate.

See responses above.

7. Page ES-3, Alternative 3 - Add "with one leading edge extraction well on Fredrikson Road" after "plume axis."

The text will be changed to read:
"Alternative 3 includes a total of four extraction wells (including the two existing groundwater RRA extraction wells) located along the plume axis with one leading edge extraction well on Fredrikson Road and pumping at a combined flow rate of 472 gpm."

8. Page ES-3, Alternative 6 - Add "with one leading edge extraction well on Fredrikson Road" after "plume axis."

The text will be changed to read:
"Alternative 6 includes a total of six extraction wells (including the two existing groundwater RRA extraction wells) located along the plume axis with one leading edge extraction well on Fredrikson Road and pumping at a combined flow rate of 981 gpm."

9. Page ES-4 - The evaluation criteria for the remedial alternatives should use the exact wording in the SOW for AO3. The first criterion should read "overall protection of human health and the environment, including prevention of the movements of contaminants into the aquifer and its preservation as a drinking water supply."

The text in the inset table on Page ES-4 will be changed to read:

Category	Criteria
Threshold	Overall protection of human health and the environment*, including prevention of the movement of contaminants into the aquifer and its preservation as a drinking water supply*
	Compliance with regulations
Primary Balancing	Long-term effectiveness and permanence
	Reduction of toxicity, mobility, and volume through treatment
	Short-term effectiveness
	Implementability
	Cost
Modifying	State Acceptance
	Community Acceptance

10. Page ES-5, Last Para. - Add the following to the end of this paragraph:

"The Remedy Selection Plan will be available for public review in conjunction with a public comment period on the preferred alternative."

The last paragraph will be changed to read:
"…The plan will summarize the description, analysis and comparison of all alternatives evaluated in the FS and describes the rationale for selecting the proposed remedial alternative. The Remedy Selection Plan will be available for public review in conjunction with a public comment period on the preferred alternative."

11. Page 3 - This FS needs to contain additional discussion of site history. Add a few sentences describing the time period that Demo 1 operated; the types of materials disposed of there; and the fact that both demolition and OED training occurred there. Please provide proposed text in the RCL.

The following text will be added as a new paragraph following paragraph 1 of Section 2.1:
"Demolition training and explosive ordnance disposal at Demo 1 included the destruction of various types of ordnance using explosive charges of C4, 2,4,6-trinitrotoluene (TNT), and detonation cord from the mid 1970's to the late 1980's. The predominant explosive compounds used in demolition munitions are hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) followed by TNT. Perchlorate has also been detected in groundwater. Perchlorate (ClO4-) originates as a contaminant in the environment from the solid salts of ammonium, potassium, or sodium perchlorate. Ammonium and potassium perchlorate are manufactured for use as the oxidizer component and primary ingredient in solid propellant for rockets, missiles, and fireworks, in addition to being used in some delay compositions, flares, signaling devices, other pyrotechnics, smokes, and tracers."

12. Page 16, Section 2.5.1 - Summarize the long term groundwater monitoring program in this sub-section.

The following text will replace the existing text in Section 2.5.1:
"The Long Term Groundwater Monitoring (LTGM) Plan was initiated in 1997 and substantially modified in 2000. Since that time, the LTGM Plan has been evaluated and revised accordingly in the first few months of each monitoring year. Throughout the period of LTGM Plan monitoring, numerous wells have been installed as part of the ongoing IAGWSP investigations. In order for a well to become "eligible" for LTGM the well must have undergone three discrete sampling events. Therefore, approximately every four months a number of recently installed wells become "eligible" for possible inclusion in the LTGM Plan. Any such additions are included prior to completion of the April, August, and December LTGM Plan events.

The objectives defined during the first years of the LTGM were documented in the Final Interim LTGM Plan in August 2000 (Ogden, 2000). The primary objective of the LTGM was to monitor the distribution of explosives in groundwater at and downgradient of sources identified during area-specific investigations (operable units [OUs]). This distribution data is gathered and maintained in order to gain relevant information about the plumes' size and migration in soil and groundwater in order to design a remediation

system for the Contaminants of Concern. The data generated were to be reviewed annually to identify the following:

- *Changes in the types of explosives detected in the groundwater;*
- *Increases or decreases in the aerial and vertical distribution of explosives in groundwater; and*
- *Pulsing of contaminants that may be attributed to seasonal variations in precipitation and leaching of explosives from source areas.*

A secondary objective was to monitor the aquifer to assess if additional, as yet undetected contamination is migrating off the Impact Area and Training Ranges. The final objective was to continue monitoring the quality of potable and non-potable water supply wells (Ogden, 2000).

Groundwater sampling will continue at Demo 1 in accordance with the System Performance and Environmental Impact Monitoring Plan (SPEIM). The objective of the SPEIM is to provide the necessary data to evaluate the ETR system performance of the RRA, the comprehensive remedial action, and to monitor contaminant migration.

13. Page 18, Section 2.6.1 - Provide a short description of the RRA progress, including the discovery of the DU round and the results of the soil tests around the location of the DU round.

The following text will be added before the last paragraph of Section 2.6.1:
"During excavation activities at Demo 1 in May 2004, a depleted uranium (DU) round was discovered. The item was put in a bag, the soil around it was removed and bagged. Radiation equipment was brought in to survey the soil from the area, and there were no detections above background. Soil samples were collected from in and outside the area where the item was found and they showed no detections of uranium above background. Also, two of the existing monitoring wells in the Demo 1 depression (MW-19 and MW-73) were sampled and analyzed for gross alpha and beta radiation and results from both wells were nondetect.

The Demo 1 Soil RRA completion is expected in the Fall of 2004. To date, the thermal treatment unit at Demo 1 has treated more than 15,000 tons of soil.

14. Page 19, 2nd Bullet - The text should note that explosives have recently been detected in groundwater at a monitoring well located at Pew Road.

The text will be changed to read:

- *"An ex-situ treatment process consisting of GAC media to remove low levels of perchlorate and explosives (explosive contaminants were recently detected in groundwater at Pew Road); and"*

15. Page 22, 1st full Para. - The text here states that low levels of perchlorate have been detected in MW74 and MW78, but these wells are not within the greater than nondetect plume shell shown on Figure 2-7. It appears that these wells should be within the pale yellow plume.

Monitoring well MW-78 is within the non-detect plume shell boundary on Figure 2-7. MW-74 is depicted in cross section as containing RDX (Figure 2-9). The nature of the detection on the other side of a clean well (MW-75) caused the interpretation, as shown.

16. Page 23, Last Para. - Please clarify if the conclusion in the last two sentences is supported by the more recent data since 5/03.

Figures 2-17 and 2-18 illustrate cross-sections E-E' and F-F' (upgradient of the power line), respectively, which depict perchlorate concentrations. Downgradient of Pew Road the perchlorate plume appears to be slightly higher in elevation on the south side of the plume (see Figures 2-18 and 2-19). The width of the perchlorate plume at Pew Road (cross-section F-F') is approximately 1,000 feet. At the power line, although detectable concentrations have been noted in the north and south wells, recently detections are limited to MW-258 to the north. This suggests that the overall width narrows to approximately 200 ft.

The most recent data since 5/03 supports the conclusion made in the last two sentences of this section. However, there is a duplicate sample for MW-252M3 with an estimated detection just above the detection limit. The leading edge of the plume in this area appears to be fluctuating and therefore, the last sentence of this section will be deleted and replaced with the following text: "Sporadic detections in MW-252M3 to the south indicate that the leading edge of the perchlorate plume in this area is diffuse and at barely detectable concentrations."

17. Page 27, Section 3.5 - Please clarify if the mass estimated is based upon the non-detect or RBC plume boundaries.

The mass estimates are based on the non-detect plume boundaries.

18. Page 30, Section 4.2, 2nd Para. - The text should be rewritten to list two RAOs (rather than one overall and one specific). Hence the first sentence of this paragraph should be deleted and replaced with the following specific RAO:

"Restore groundwater to its beneficial use as a sole source aquifer within a time frame that is reasonable."

See response to EPA Comment 2.

The following sentence, "The overall remedial action objective for groundwater at Demo 1 is to protect and restore a localized contaminated area within the sole source aquifer. " will be replaced with, "The remedial action objective for groundwater at Demo 1 is to restore groundwater to its beneficial use as a sole source aquifer within a time frame that is reasonable."

19. Page 31, Lines 1 & 2 - The text should briefly explain the basis for each of the values provided. The text should clarify that the lower of the two values (regulatory and risk based) was selected as the preliminary remediation goal.

The text will be changed to read:
"The agreed upon values to be used for the regulatory standards or risk-based

concentrations are as follows: 0.6 µg/L for RDX (risk-based), 1.0 µg/L for perchlorate (risk-based), and 2.0 µg/L for TNT (regulatory standard, health advisory). These values represent the lower of the regulatory or risk-based values for each compound and were selected as the preliminary remediation goals for the purposes of the FS. Table 4-1 presents the basis for these values and annotates their methods of derivations."

20. Page 34, First Partial Para. - The text should note that low levels of RDX have now been detected in groundwater at Pew Road. The fact that low levels of RDX may show up in the Pew Road system should be mentioned in the text.

The text will be changed to read:
"The Frank Perkins Road system is expected to treat low concentrations of perchlorate and explosives and the Pew Road system is expected to treat only very low levels of perchlorate. Since low levels of RDX were recently detected at Pew Road, there is a possibility that very low levels of explosives could be treated at Pew Road. However, based on the observed concentrations of RDX at Pew Road, detectable concentrations of RDX are not anticipated in the treatment influent. Regardless, GAC media would be able to treat any explosive compounds that may be in the influent."

21. Page 34, 3rd Para. - While GAC is slated to be used for the RRA system at Pew Road, the final selection of a treatment media for Pew Road will be determined based on the performance of the RRA system and the results of ongoing innovative technology studies. This information will provide additional information regarding the effectiveness, cost, etc. of various types of carbon and ion exchange resins which will be used to determine the appropriate media for the Pew Road system.

Agree – The IAGWSP plans to monitor GAC performance during the RRA and utilize the most efficient treatment method.

22. Page 36, Section 5.2 - Add "(RRA System)" after "Baseline" in the second bullet.

The bullet will be changed to read:
"*Alternative 2: Baseline (RRA System)"*

23. Page 37, Last Para., Last Sentence - See General Comment on calculating mass removal.

The text will be changed to read:
"These interpolations were then synthesized to form a three-dimensional plume shell image. Representations of the plume shells included all perchlorate and RDX data above their respective analytical detection limits."

24. Page 38, Section 6.1.2, Criteria #1, and Sections 6.2.3.1, 6.3.3.1, 6.4.3.1, 6.5.3.1, 6.6.3.1 and 6.7.3.1 - The evaluation criteria for the discussion of remedial alternatives should use the exact wording in the SOW for AO3. The first criterion is "overall protection of human health and the environment, including prevention of the movements of contaminants into the aquifer and its preservation as a drinking water supply." For each alternative, under the first criterion, the text should evaluate whether the alternative prevents movement of contaminants into the water supply and preserves the aquifer as a water supply. This means the entire

aquifer, including the portion underlying Camp Edwards, not just the off-base portion. If the NGB wants, the NGB may make a factual distinction between the on-base and off-base portions of the aquifer, but there must be no implication that it is acceptable under this criterion to allow contamination above cleanup levels on base as long as there is no contamination above cleanup levels off base. This is an example where the fact that AO3 was issued to protect a sole source aquifer, and the fact that the entire base is a water supply reserve under Massachusetts law, distinguishes this FS from the usual CERCLA FS.

The text in Section 6.1.2 will be changed to read:
"1. Overall protection of human health and the environment, including prevention of the movements of contaminants into the aquifer and its preservation as a drinking water supply"

Note that each alternative discusses the time to meet each respective cleanup objective (i.e., risk-based or background objective) in terms of the time to achieve this at ALL points in the aquifer – not just the off-base portion. None of the timeframes presented have a caveat concerning off-base aquifer quality versus on-base aquifer quality.

25. Page 41, Section 6.2.1.1 - The costs for this alternative should include decommissioning/ abandoning the extraction and reinjection wells that already exist.

The costs for decommissioning and abandonment of the extraction and reinjection wells are factored into the RRA costs and are unrelated to the costs of Alternative 1.

26. Page 41, Section 6.2.1.1, Bullet 2 - Clarify "periodic" by changing it to "annual" as is assumed in Appendix C.

Appendix C costs assume semi-annual monitoring for 50 years in Alternative 1. The text in bullet 2 will be changed to read "semi-annual", as is assumed in Appendix C.

27. Section 6.2.2.2 - For each alternative, the FS should also state that additional Institutional Controls may be required if the contaminants are not remediated to acceptable levels by 2052, the date the lease expires.

The text of the FS in Section 6.2.2.2 states that institutional controls would be established should the Army transfer its lease to another entity. An example of what sort of institutional control was presented but this does not represent the only institutional control available.

A sentence will be added to the end of Section 6.2.2.2 to indicate that additional institutional controls may be necessary:
"As long as the plume area is within the purview and control of the Army, groundwater use restrictions are not needed. The current lease agreement is in effect until 2052. However, should the Army transfer its lease to another entity, institutional controls would be established upon lease transfer. Institutional controls could include deed restrictions that would prohibit the placement of drinking water supply wells where their zone of contribution would intercept the Demo 1 groundwater plume. Additional institutional controls may be appropriate should the contaminants remain above acceptable levels by 2052."

28. Page 41, Section 6.2.2.1 - The text should note that the SPEIM Plan developed in conjunction with the RRA system would likely need to be revised for each alternative. The text should also clarify that the SPEIM Plan will establish a regular reporting requirement for the long-term monitoring effort. In the second sentence, suggest adding "and reporting" after "impacts," and change "monitored" to "conducted."

Section 6.2.2.1 will be changed to read:
"Long-term groundwater monitoring associated with the Demo 1 plume would continue using the same sampling and analytical protocols currently in use. Baseline monitoring and reporting of the site conditions and potential environmental impacts will be conducted according to the System Performance and Environmental Impact Monitoring (SPEIM) Plan for the RRA systems. The Draft SPEIM, was submitted to the EPA and DEP in June 2004, outlining all sampling associated with long-term groundwater monitoring for the RRA systems. The SPEIM Plan will be revised prior to implementation of a comprehensive remedy."

29. Page 41, Section 6.2.2.2 - EPA disagrees with the statements in this paragraph because we believe that Army control of the property under which the Demo 1 groundwater plume exists is not sufficient. The text does not take into consideration the possibility of an off-base water supply well which has a zone of contribution that intercepts the Demo 1 plume and where the Army does not have controls. Therefore, EPA reserves the right to require the Army to develop and implement institutional controls should any land use changes occur that may result in an exposure to the Demo 1 groundwater plume.

The Army believes that the existing level of land use controls is sufficient to preclude "imminent and substantial endangerment" to the health of present and future groundwater users as required under SDWA section 1431(a). However, the Army remains willing to discuss this matter further with EPA.

As long as the plume area is within the purview and control of the Army, groundwater use restrictions are not needed. The current lease agreement is in effect until 2052. However, should the Army transfer its lease to another entity, institutional controls could be established upon lease transfer. Institutional controls could include deed restrictions that would prohibit the placement of drinking water supply wells where their zone of contribution would intercept the Demo 1 groundwater plume. Additional institutional controls may be appropriate should the contaminants remain above acceptable levels by 2052.

30. Sections 6.2.3.1; 6.3.3.1; 6.5.3.1; 6.6.3.1 - Please incorporate General Comment on "Groundwater Downgradient of Pew Road" into these sections.

For Section 6.2.3.1, the text will read:
"Alternative 1 will not prevent the migration of the plume off Camp Edwards. Therefore, the areas downgradient of the Demo 1 source area would likely be impacted by groundwater above risk-based levels and be unavailable for groundwater source development. Short-term impacts would be limited. Vegetation will not be impacted because Alternative 1 simply entails long-term monitoring of groundwater, which is currently ongoing."

The system proposed in Alternative 2 would reduce concentrations everywhere in the plume to background levels within 50 years for perchlorate and RDX, including downgradient of Pew Road and east of the Base boundary. The text included in Section 6.3.3.1 seems appropriate since groundwater supplies would not be developed while clean-up is ongoing.

The system proposed in Alternative 4 would reduce concentrations everywhere in the plume to below risk-based levels in approximately 10 years for perchlorate and RDX, including downgradient of Pew Road. Therefore, the text included in Section 6.5.3.1 seems appropriate since groundwater supplies would not be developed while clean-up is ongoing.

The system proposed in Alternative 5 would reduce concentrations everywhere in the plume to below risk-based levels in approximately 13 years for perchlorate and 14 years for RDX, including downgradient of Pew Road and east of the Base boundary. Therefore, the text included in Section 6.6.3.1 seems appropriate since groundwater supplies would not be developed while clean-up is ongoing. Alternatives with toe wells don't make the area downgradient of Pew Road useable for drinking water.

31. Page 42, Section 6.2.3.1 - Add the following as the first sentence of this section.

"Alternative 1 would not be protective of human health."

The text in Section 6.2.3.1 will be changed to read:
"Alternative 1 will not prevent the migration of the plume off Camp Edwards and would not be protective of human health if the aquifer in the area was used as a water supply. Therefore, the areas downgradient of the Demo 1 source area would likely be impacted by groundwater above risk-based levels and be unavailable for groundwater source development. Short-term impacts would be limited. Vegetation will not be impacted because Alternative 1 simply entails long-term monitoring of groundwater, which is currently ongoing."

32. Page 42, Section 6.2.3.1 - Revise the text to indicate that some ecological impacts could be expected with this alternative due to the need to install additional monitoring wells.

A sentence will be added to the text in Section 6.3.2.1:
"Alternative 1 will not prevent the migration of the plume off Camp Edwards and would not be protective of human health if the aquifer in the area was used as a water supply. Therefore, the areas downgradient of the Demo 1 source area would likely be impacted by groundwater above risk-based levels and be unavailable for groundwater source development. Short-term impacts would be limited. Vegetation will be minimally impacted because Alternative 1 simply entails long-term monitoring of groundwater, which is currently ongoing. As with all alternatives under consideration, additonal monitoring wells will be installed for long-term monitoring of the remedy and may cause some ecological impacts."

33. Page 42, Section 6.2.3.4 - Add a statement to this section indicating that with this alternative, groundwater in the area would not be available for drinking water purposes in the

future.

The text in Section 6.2.3.4 will be changed to read:
"No treatment would occur, therefore no reduction in toxicity, mobility, or volume would occur through treatment. With this alternative, groundwater in the area would not be available for drinking water purposes in the foreseeable future."

34. Page 42, Section 6.2.3.5 - The text should be revised to indicate that "minimal" as opposed to "no" impact would be expected under this alternative since the alternative does require the installation of a number of monitoring wells.

The text in Section 6.2.3.5 will be changed to indicate that minimal impact would be expected. The text will be changed to read:
"There would be little effect on the community from implementing Alternative 1 because no construction work would be involved. A site-specific health and safety plan (HASP) would be followed during long-term groundwater monitoring and personal protective equipment (PPE) would be used as necessary to prevent potential exposure to COCs. Minimal impact would occur to the environment as a result of this Alternative since long-term monitoring of groundwater would continue. The Minimal Action Alternative would not meet the Remedial Response or Action Objectives."

35. Page 42, Section 6.2.3.6 - Additional information must be included specifically related to the mechanism that the Army would use to restrict development of drinking water supplies in the areas impacted, or that would be impacted, by the plume.

The Army believes that the existing level of land use controls is sufficient to preclude "imminent and substantial endangermenet" to the health of present and future groundwater users as required under SDWA section 1431(a). However, the Army remains willing to discuss this matter further with EPA.

As long as the plume area is within the purview and control of the Army, groundwater use restrictions are not needed. The current lease agreement is in effect until 2052. However, should the Army transfer its lease to another entity, institutional controls could be established upon lease transfer. Institutional controls could include deed restrictions that would prohibit the placement of drinking water supply wells where their zone of contribution would intercept the Demo 1 groundwater plume. Additional institutional controls may be appropriate should the contaminants remain above acceptable levels by 2052.

36. Page 44, Section 6.3.1.2 - Although no concentration objective is set, please clarify if 50 years was the assumed operation period to develop the cost estimate by adding a bullet to the list of assumptions. Background is only mentioned once in Section 6.3.3.1.

Operation of the RRA system would have to continue for 50 years to reduce the RDX and perchlorate concentrations to background concentrations. The timeframe of 50 years was then used as an operational period for the cost estimate.

In order to clarify this section, a bullet will be added to Section 6.3.1.2 Assumptions:

- *"The treatment system would operate for a period of 50 years, at which time*

concentrations of perchlorate and RDX are expected to reach background levels."

37. Page 44, Section 6.3.1.2, 2nd Bullet - Include information regarding design assumptions that were used in relation to the IX system.

The following text will be added to the bulleted list in Section 6.3.1.2 Assumptions:

- *"The sizing of the IX system at Frank Perkins Road would be based on a minimum 3 foot bed depth and 6 gpm/sf. The sizing of the GAC vessels would be based on a 10 minute EBCT for the Frank Perkins Road location."*

38. Page 44, Section 6.3.2.1 - Add text here clarifying mass removal calculation as requested in general comment. In addition, add a brief discussion of the capture zone as illustrated by Figure A4-1.

The following text will be added after the last sentence of the first paragraph of Section 6.3.2.1:
"This graphic depicts the incremental mass percentage of each COC removed from the aquifer on a year-by-year basis, compared with initial conditions. Initial conditions are considered the basis on which the FS evaluations were performed (using 5/03 data). That is, a total mass for each COC was calculated based on all detections above the analytical detection limit. For each Alternative under evaluation, the quantity of mass removed per year was calculated and presented in graphical form against the mass estimated for time zero (i.e., positive mass shown at time zero reflects the mass removed after four years of RRA operation and at the initiation of the comprehensive remedy)."

39. Page 45, Section 6.3.2.2 - The text must clarify that whether or not the Pew Road system will remain the same will be contingent on information obtained during operation of the RRA system and the results of ongoing innovative technology studies regarding various treatment media.

The IAGWSP will monitor GAC performance during the RRA and implement the most cost effective solution in the comprehensive remedy.

40. Page 46, Section 6.3.2.4, Para. 2 - The text in the third sentence should note that the SPEIM Plan developed in conjunction with the RRA system would likely need to be revised for this alternative. The text should also clarify that the SPEIM Plan will establish a regular reporting requirement for the long-term monitoring effort. In the second sentence, suggest adding "and reporting" after "impacts," and change "monitored" to "conducted."

The text of the second and third sentence will be modified to read:
"Long-term groundwater monitoring associated with the Demo 1 plume would continue using the same sampling and analytical protocols currently in use. Baseline monitoring and reporting of the site conditions and potential environmental impacts will be conducted according to the System Performance and Environmental Impact Monitoring (SPEIM) Plan. The Draft SPEIM, submitted to the EPA and DEP in June 2004, outlined all sampling associated with system operation and maintenance for the RRA Systems. The SPEIM Plan will be revised prior to implementation of a comprehensive remedy.

The results of influent and effluent sampling of the treatment system will be used to estimate mass removal of contaminants and ensure compliance with discharge requirements."

41. Page 46, Section 6.3.2.4 - Clarify over what time frame 20 tons of GAC will be sent off-site for disposal.

As the section states, 20 tons of GAC will be sent off-site for disposal every nine months. The text will be changed to read:
"Every nine months, approximately 20 tons of GAC would be sent off-site for disposal and approximately 220 c.f. of IX resin would be incinerated after media change-outs for the Frank Perkins Road treatment system."

42. Page 46, Section 6.3.2.4, 2nd Para. - Add the following to the end of the last sentence of this paragraph:

"...and determine the need fo GAC/IX change-outs."

The text will be changed to read:
"The results of influent and effluent sampling of the treatment system will be used to estimate mass removal of contaminants, ensure compliance with discharge requirements and determine the need for GAC/IX change-outs."

43. Page 46, Section 6.3.2.5 - EPA disagrees with the statements in this paragraph because we believe that Army control of the property under which the Demo 1 groundwater plume exists is not sufficient. The text does not take into consideration the possibility of an off-base water supply well which has a zone of contribution that intercepts the Demo 1 plume and where the Army does not have controls. Therefore, EPA reserves the right to require the Army to develop and implement institutional controls should any land use changes occur that may result in an exposure to the Demo 1 groundwater plume.

The text of the FS in Section 6.3.2.5 states that institutional controls would be established should the Army transfer its lease to another entity. An example of what sort of institutional control was presented but this does not represent the only institutional control available.

A sentence will be added to the end of Section 6.3.2.5 to indicate that additional institutional controls may be necessary:
"As long as the plume area is within the purview and control of the Army, groundwater use restrictions are not needed. The current lease agreement is in effect until 2052. However, should the Army transfer its lease to another entity, institutional controls could be established upon lease transfer. Institutional controls could include deed restrictions that would prohibit the placement of drinking water supply wells where their zone of contribution would intercept the Demo 1 groundwater plume. Additional institutional controls may be appropriate should the contaminants remain above acceptable levels by 2052."

44. Sections 6.3.3.1; 6.4.3.1; 6.5.3.1; 6.6.3.1, 6.7.3.1 - Please incorporate General Comment on mass removal calculations into the discussion of the percentage of mass removal

in these sections.

Regardless of the target goals, mass removal is always comparable among all alternatives. See response to EPA General Comment 4 for more information.

The text in the first paragraph of Section 6.3.3.1 will be changed to read: "Alternative 2 will prevent the migration of the plume off Camp Edwards. Groundwater fate and transport modeling of Alternative 2 indicate that perchlorate and RDX concentrations would decrease to background levels within 50 years and the plume would not migrate off Camp Edwards. More than 80% of the total perchlorate mass and 67% of the total RDX mass would be removed from the aquifer after 10 years from implementation of the comprehensive remedy."

The text in the first paragraph of Section 6.4.3.1 will be changed to read: "This alternative would prevent the migration of the plume outside of MMR. Groundwater models indicate that background levels could be achieved in 27 years for RDX and 23 years for perchlorate. After 27 years of operation (i.e., completion of Alternative 3), all the mass is expected to be addressed since evaluation of the total plume mass is based on all concentrations above background."

The text in the first paragraph of Section 6.5.3.1 will be changed to read: "This alternative would aggressively remove contaminated groundwater from Demo 1, achieving risk-based levels in just over 10 years according to the groundwater model used for this FS. For perchlorate, target concentrations would be achieved in less than 10 years and would represent 98.9% of the total mass (98.8 lbs of perchlorate mass is above the risk-based standard compared with 99.85 lbs of perchlorate above the detection limit). For RDX, target concentrations would be achieved in just over 10 years; after 10 years of operation, an estimated 99.7% of the RDX mass would have been captured."

The text in the first paragraph of Section 6.6.3.1 will be changed to read: "This alternative would prevent the migration of the plume off-base and remove contaminant mass from the groundwater plume. Target concentrations would be achieved in less than 14 years for RDX and 13 years for perchlorate, according to the modeling performed for this FS. Achieving risk-based levels for perchlorate and RDX would result in removal of 98.9% of the perchlorate mass and 99.9% of the RDX mass."

The text in the first paragraph of Section 6.7.3.1 will be changed to read: "This alternative would prevent the migration of the plume off-base and remove contaminant mass from the groundwater plume. According to the groundwater model, background levels would be achieved in 16 years for RDX and 17 years for perchlorate. After 17 years of operation (i.e., completion of Alternative 6), all the mass is expected to be addressed since evaluation of the total plume mass is based on all concentrations above background."

45. Section 6.3.3.1 - The second sentence is garbled. Please correct if there should there be an "and" after "50 years."

The text will be changed to read:

"Groundwater fate and transport modeling of Alternative 2 indicate that perchlorate and RDX concentrations would decrease to background levels within 50 years and the plume would not migrate off Camp Edwards."

46. Page 47, Section 6.3.3.1 - Add the following to the beginning of this section:

"This alternative will protect human health by preventing ingestion of contaminated groundwater and restoring the aquifer."

Ingestion or the threat of ingestion of contaminated groundwater is not occurring at Demo 1. As such, there is no direct human health risk currently, unless a groundwater supply well were to be installed within the plume boundary or directly downgradient of the plume. The following text will be added to the beginning of Section 6.3.3.1: "This alternative will protect human health by restoring the aquifer."

47. Page 48, Section 6.3.3.5 - Replace "1" with "2" in the first sentence.

The text will be changed to read: "There would be little effect on the community from implementing Alternative 2 because the construction work would be conducted on Camp Edwards."

48. Page 48, Section 6.3.3.6, 4th Para., 2nd Sentence - Add "and reported" after "monitored." And add "the most-current version of the" to reflect the fact that monitoring for this alternative is estimated to be conducted for 50 years and the SPEIM plan is likely to be modified.

The second sentence of paragraph four of Section 6.3.3.6 will be changed to read: "Baseline monitoring of the site conditions and potential environmental impacts would be monitored and reported according to the most-current version of the SPEIM Plan, which will be submitted in June 2004 and will outline all sampling associated with system operation and maintenance."

49. Page 49, Section 6.3.3.6, 6th Para. - Provide information as to the mechanism to be used to prevent use of the development of drinking water supplies in the area.

A sentence will be added to the end of Section 6.3.3.6 to indicate that additional institutional controls may be necessary:

"As long as the plume area is within the purview and control of the Army, groundwater use restrictions are not needed. The current lease agreement is in effect until 2052. However, should the Army transfer its lease to another entity, institutional controls could be established upon lease transfer. Institutional controls could include deed restrictions that would prohibit the placement of drinking water supply wells where their zone of contribution would intercept the Demo 1 groundwater plume. Additional institutional controls may be appropriate should the contaminants remain above acceptable levels by 2052."

50. Page 50, Section 6.4.2.1, 2nd Para - Add text here clarifying mass removal calculations as requested in general comment. In addition, add a brief discussion of the capture zone as

illustrated by Figure A4-7.

Appropriate text will be added consistent with the response to General Comment 4: "All percentages are based on total mass in the plume to the ND contour". The capture zone geometry in Figure A4-7 will be briefly described in this section.

51. Page 50, Section 6.4.2.1, Pew Road Location - To be consistent with EPA comments on Alternative 6, text should reflect routing of piping along Fredrikson and Estey Roads.

The text will be changed to read:
"Groundwater extracted from the extraction wells west of Pew Road (EW-D1-2 and EW-D1-402) would be conveyed along Pew, Estey and Fredrickson Roads to a series of mobile treatment containers located on Pew Road. Based on the modeling results, a total of 208 gpm of groundwater would be pumped to this Pew Road location."

52. Page 52, Section 6.4.2.2 - Please clarify in the text the estimated time period that the Pew Road treatment system would operate. It appears from Appendix C that this time period will be less than six years as no full replacement is assumed.

Appendix C states that the RRA mobile treatment containers from Pew and Frank Perkins Roads will be utilized through Year 6 of the Comprehensive Remedy. Hence, zero dollars are associated with capital for the containers and a mobilization cost is estimated under capital. Under the operation and maintenance section of Appendix C, Alternative 3 Estimated Costs, Item B. Periodic Costs, Pew Road container replacements are itemized. New containers are assumed for Year 6 and Year 16. Note that the cost of three replacement containers are calculated and then a present worth analysis is applied to obtain the costs for Years 6 and 16.

53. Page 52, Section 6.4.2.4, Para. 2 - The text should also clarify that the SPEIM Plan will establish a regular reporting requirement for the long-term monitoring effort.

The second sentence of the second paragraph in Section 6.4.2.4 will read:
"The Draft SPEIM Plan for the RRA System, submitted to EPA and DEP in June 2004, would be updated to describe baseline monitoring of the site conditions and potential environmental impacts and outline all sampling associated with the system operation and maintenance for this alternative. The results of influent and effluent sampling of the treatment system would be used to estimate mass removal of contaminants to ensure compliance with discharge requirements and report conditions over the long-term per the SPEIM requirements."

54. Page 53, Section 6.4.2.4 - Add the following to the end of the last sentence of this paragraph:

"...and determine the need fo GAC/IX change-outs."

Assume the comment refers to the second paragraph of Section 6.4.2.4. The text will be further changed to read:
"The results of influent and effluent sampling of the treatment system would be used to estimate mass removal of contaminants, ensure compliance with discharge

requirements and determine the need for GAC/IX change-outs. The results would be reported over the long-term O&M of the system per the SPEIM requirements."

55. Page 53, 6.4.2.5 - EPA disagrees with the statements in this paragraph because we believe that Army control of the property under which the Demo 1 groundwater plume exists is not sufficient. The text does not take into consideration the possibility of an off-base water supply well which has a zone of contribution that intercepts the Demo 1 plume and where the Army does not have controls. Therefore, EPA reserves the right to require the Army to develop and implement institutional controls should any land use changes occur that may result in an exposure to the Demo 1 groundwater plume.

The text of the FS in Section 6.4.2.5 states that institutional controls would be established should the Army transfer its lease to another entity. An example of what sort of institutional control was presented but this does not represent the only institutional control available.

A sentence will be added to the end of Section 6.4.2.5 to indicate that additional institutional controls may be necessary:

"As long as the plume area is within the purview and control of the Army, groundwater use restrictions are not needed. The current lease agreement is in effect until 2052. However, should the Army transfer its lease to another entity, institutional controls could be established upon lease transfer. Institutional controls could include deed restrictions that would prohibit the placement of drinking water supply wells where their zone of contribution would intercept the Demo 1 groundwater plume. Additional institutional controls may be appropriate should the contaminants remain above acceptable levels by 2052."

56. Section 6.4.3.1 - In the discussion of short-term impacts, discuss how they might be minimized by installing piping along Estey Road and Frederickson Road, rather than constructing a road and piping across undisturbed vegetation; or alternatively, by installing a mobile treatment unit at EW-D1-402.

Alternative 3 will be modified in the final FS to show the piping for EW-D1-402 laid out along Pew, Estey and Frederickson Roads.

The text will be changed to read:
"Short-term impacts would be limited. Other than trenching along Pew, Estey and Frederickson Roads to EW-D1-402, minimal vegetation would be impacted by construction since the conceptual design focuses on using existing roadways and previously disturbed areas. Establishment and adherence to a site health and safety plan would limit the risk to construction workers. All contaminated media would be contained and disposed of in accordance with applicable regulations."

57. Page 53, Section 6.4.3.1 - Add the following to the beginning of this section:

"This alternative will protect human health by preventing ingestion of contaminated groundwater and restoring the aquifer."

Ingestion or the threat of ingestion of contaminated groundwater is not occurring at Demo 1. As such, there is no direct human health risk currently. The following text will be added to the beginning of Section 6.4.3.1:

"This alternative will protect human health by restoring the aquifer."

58. Page 54, Section 6.4.3.5 - To be consistent with EPA comments on Alternative 6, text should reflect routing of piping along Fredrikson and Estey Roads.

The third paragraph of Section 6.4.3.5 will be changed to read:
"To the extent feasible, previously disturbed areas have been utilized for the installation of wells, subsurface piping and treatment facilities to minimize impact on cultural and natural resources."

59. Page 55, Section 6.4.3.6 - Provide information as to the mechanism to be used to prevent use of the development of drinking water supplies in the area.

See response to EPA Comment 35.

60. Page 55, Section 6.4.3.7 - To be consistent with EPA comments on Alternative 6, costs should reflect routing of piping along Fredrikson and Estey Roads.

Section 6.4.3.7 will be changed to reflect an increase of costs related to additional piping along Pew, Estey, and Fredrikson Roads:
"The costs were estimated for Alternative 3 as follows:

- *Capital cost: $ 6,840,000;*
- *Present worth of O & M: $14,700,000; and*
- *Total present worth: $21,600,000."*

61. Page 56, Section 6.5, General - a) Alternative 4 is designed to risk based concentrations in approximately 10 years, however no time estimate is provided for the portion of the plume downgradient of Pew Road to reach RBCs. If this time is greater than 10 years, a brief statement should be added that the alternative is designed to capture the plume upgradient of Pew Road and the remainder is assumed to attenuate.

b) With respect to the conceptual wellfield design and flowrates, a significant amount of extraction (1010 gpm) and reinjection (1196 gpm) is located within the vicinity of Frank Perkins Road. Intuitively, it appears that EW-D1-1, EW-D1-502, and EW-D1-501 are operating at a far greater rate than needed to capture the plume upgradient of Frank Perkins Road. Please clarify if these wells were modeled at lower flowrates. If so, discuss why they were rejected in favor of these rates.

As stated in previous responses, the time to reach RBCs is approximately 10 years and is inclusive of the plume downgradient of Pew Road. Once the plume is cut off at Pew Road (accounting for 99% of the perchlorate plume mass), the toe of the plume attenuates to concentrations below risk-based levels in 10 years or less.

The design flow rates in the upgradient area are required to reach the 10 year cleanup

objectives required by AO3. It is not possible to efficiently capture the plume and meet the 10 year AO3 time criterion. The BRUTEFORCE code evaluated countless iterations in order to achieve the risk-based concentrations for both RDX and perchlorate WITHIN a ten-year timeframe.

62. Page 56, Section 6.5.2.1 - Add text here clarifying mass removal calculations as requested in general comment. In addition, add a brief discussion of the capture zone as illustrated by Figure A4-8.

Appropriate text will be added consistent with the response to General Comment 4: "All percentages are based on total mass in the plume to the ND contour". The capture zone geometry in Figure A4-8 will be briefly described in this section.

63. Page 58, Section 6.5.2.3, Frank Perkins Road Location - The reinjection flow rate proposed is very high. EPA recommends that the IAGWSP confer with AFCEE regarding the range of reinjection flow rates that are feasible for this site. It may be necessary to include additional reinjection wells to the conceptual design, thereby requiring revisions to the cost estimate.

IAGWSP conferred with AFCEE during conceptual design of the RRA and the evaluation in the FS. IAGWSP calculated the reinjection flow rates based on site-specific data.

64. Page 58, Section 6.5.2.4, Para. 2 - The text should also clarify that the SPEIM Plan will establish a regular reporting requirement for the long-term monitoring effort.

The text in the second paragraph of Section 6.5.2.4 will be changed to read:
"The Draft SPEIM Plan for the RRA System, submitted to EPA and DEP in June 2004, would be updated to describe baseline monitoring of the site conditions and potential environmental impacts and outline all sampling associated with the system operation and maintenance for this alternative. The results of influent and effluent sampling of the treatment system would be used to estimate mass removal of contaminants to ensure compliance with discharge requirements and report conditions over the long-term per the SPEIM requirements."

65. Page 58, Section 6.5.2.5 - EPA disagrees with the statements in this paragraph because we believe that Army control of the property under which the Demo 1 groundwater plume exists is not sufficient. The text does not take into consideration the possibility of an off-base water supply well which has a zone of contribution that intercepts the Demo 1 plume and where the Army does not have controls. Therefore, EPA reserves the right to require the Army to develop and implement institutional controls should any land use changes occur that may result in an exposure to the Demo 1 groundwater plume.

See response to EPA Comment 35.

66. Page 62, Section 6.6.1, 1st Para. - Figure cited should be "6-13" instead of "6-9" which is for the previous alternative.

The text will be changed to read:
"For Alternative 5, the groundwater would be extracted via five extraction wells, treated

at two treatment systems and then re-injected at four injection wells as indicated in Figure 6-13."

67. Page 62, Section 6.6.2.1, Para 2 - Add text here clarifying mass removal calculations as requested in general comment. In addition, add a brief discussion of the capture zone as illustrated by Figure A4-9.

Appropriate text will be added consistent with the response to General Comment 4: "All percentages are based on total mass in the plume to the ND contour". The capture zone geometry in Figure A4-9 will be briefly described in this section.

68. Page 63, Section 6.6.2.3, Frank Perkins Road Location - The reinjection flow rate proposed is very high. EPA recommends that the IAGWSP confer with AFCEE regarding the range of reinjection flow rates that are feasible for this site. It may be necessary to include additional reinjection wells to the conceptual design, thereby requiring revisions to the cost estimate.

IAGWSP conferred with AFCEE during conceptual design of the RRA and the evaluation in the FS. IAGWSP calculated the reinjection flow rates based on site-specific data.

69. Page 64, Section 6.6.2.4, Para 2 - The text should also clarify that the SPEIM Plan will establish a regular reporting requirement for the long-term monitoring effort.

The text in paragraph 2 of Section 6.6.2.4 will be changed to read:
"The SPEIM Plan for the RRA System, to be submitted to EPA and DEP in June 2004, would be updated to describe baseline monitoring of the site conditions and potential environmental impacts and outline all sampling associated with the system operation and maintenance for this alternative. The results of influent and effluent sampling of the treatment system would be used to estimate mass removal of contaminants to ensure compliance with discharge requirements and report conditions over the long-term per the SPEIM requirements."

70. Page 64, Section 6.6.2.6 - EPA disagrees with the statements in this paragraph because we believe that Army control of the property under which the Demo 1 groundwater plume exists is not sufficient. The text does not take into consideration the possibility of an off-base water supply well which has a zone of contribution that intercepts the Demo 1 plume and where the Army does not have controls. Therefore, EPA reserves the right to require the Army to develop and implement institutional controls should any land use changes occur that may result in an exposure to the Demo 1 groundwater plume.

See response to EPA Comment 35.

71. Page 65, Section 6.6.3.1 - Add the following to the beginning of this section:

"This alternative will protect human health by preventing ingestion of contaminated groundwater and restoring the aquifer."

Ingestion or the threat of ingestion of contaminated groundwater is not occurring at Demo 1. As such, there is no direct human health risk currently. The following text will

be added to the beginning of Section 6.6.3.1:

"This alternative will protect human health by restoring the aquifer."

72. Page 68, Section 6.7.2.1, Para 2 - Add text here clarifying mass removal calculations as requested in general comment. In addition, add a brief discussion of the capture zone as illustrated by Figure A4-10.

Appropriate text will be added consistent with the response to General Comment 4: "All percentages are based on total mass in the plume to the ND contour". The capture zone geometry in Figure A4-10 will be briefly described in this section.

73. Page 68, Section 6.7.2.1, Pew Road - Change "97" to "173."

The text stated that a total of 87 gpm will be pumped to each injection well, 173 gpm will be the amount pumped to the treatment facility on Pew Road. This typographical error will be corrected:
"Groundwater extracted from the extraction wells west of Pew Road (EW-D1-2 and EW-D1-604) would be conveyed to a treatment facility located on Pew Road. Based on the modeling results a total of 173 gpm of groundwater would be pumped to this location."

74. Page 70, Section 6.7.2.4, Para 2 - The text should also clarify that the SPEIM Plan will establish a regular reporting requirement for the long-term monitoring effort.

The text in paragraph 2 of Section 6.7.2.4 will be changed to read:
"The SPEIM Plan for the RRA System, to be submitted to EPA and DEP in June 2004, would be updated to describe baseline monitoring of the site conditions and potential environmental impacts and outline all sampling associated with the system operation and maintenance for this alternative. The results of influent and effluent sampling of the treatment system would be used to estimate mass removal of contaminants to ensure compliance with discharge requirements and report conditions over the long-term per the SPEIM requirements."

75. Section 6.7.3.1 - EPA contests the biased description of short-term impacts in Alternative 6 versus 3. Please explain why is the short-term impact of installing a well downgradient of Pew Road considered "limited" in Alternative 3, but discussed as "significant" with respect to Alternative 6. They should both be considered limited, if mitigation measures are taken. In the discussion of short-term impacts, discuss how they might be minimized by installing piping along Estey Road and Frederickson Road, rather than constructing a road and piping across undisturbed vegetation; or alternatively, by installing a mobile treatment unit at EW D-1-604.

The text in Section 6.4.3.1 should have mentioned the disturbance of vegetation to EW-D1-402. Note that this alternative does not have a well location midway between Frank Perkins and Pew Road as with Alternative 6.

The piping layouts for Alternatives 3 and 6 were changed in accordance with EPA comments to put the routes along existing roadways. Therefore, the impact associated with piping through undisturbed forest has been removed from the evaluation. (The

costs, however, have increased for both alternatives to account for the increase linear footage of piping used.)

76. Page 70, Section 6.7.3.1 - Add the following to the beginning of this section:

"This alternative will protect human health by preventing ingestion of contaminated groundwater and restoring the aquifer."

Ingestion or the threat of ingestion of contaminated groundwater is not occurring at Demo 1. As such, there is no direct human health risk currently. The following text will be added to the beginning of Section 6.7.3.1:

"This alternative will protect human health by restoring the aquifer."

77. Section 7.1 - Discuss the issue presented in General Comment on "Groundwater Downgradient of Pew Road," and present a comparison of the percentage of mass removal, taking into account the issue presented in the general comment on "Calculating Mass Removal."

Comparison of mass removal effectiveness for the various designs is presented in Tables 6-1 and also A4-1. All calculated percentages are based on total plume mass to the ND contour.

78. Page 75, Section 7.1 - The text must be revised to indicate that Alternative 1 is not protective of human health and the environment. This will make the text in this section consistent with information presented in Section 8.0.

The text in Section 7.1 will be changed to read:
"All alternatives, except Alternative 1, have the potential to protect human health and the environment. Alternative 4 would remediate the aquifer most quickly. Alternatives 3 through 6 would be more reliable than Alternative 1, which is a minimal action alternative and not protective of human health or the environment, or Alternative 2, which primarily acts as a hydraulic containment measure rather than focusing on relatively rapid mass removal."

79. Section 7.1 and 7.3 - As noted above, the text should compare how whether the alternative prevents movement of contaminants into the water supply and preserves the aquifer as a water supply. This means the entire aquifer, including the portion underlying Camp Edwards, not just the off-base portion. If the NGB wants, the NGB may make a factual distinction between the on-base and off-base portions of the aquifer, but there must be no implication that it is acceptable under this criterion to allow contamination above cleanup levels on base as long as there is no contamination above cleanup levels off base. This is an example where the fact that AO3 was issued to protect a sole source aquifer, and the fact that the entire base is a water supply reserve under Massachusetts law, distinguishes this FS from the usual CERCLA FS.

Note that each alternative discusses the time to meet each respective cleanup objective (i.e., risk-based or background objective) in terms of the time to achieve this at ALL points in the aquifer – not just the off-base portion or the portion within the plume as defined in 2003 terms. None of the timeframes presented have a caveat concerning off-

base aquifer quality versus on-base aquifer quality.

80. Page 76, Section 7.4 - Add a sentence stating that Alternatives 3 and 6 provide the greatest reduction of mobility because a leading edge extraction well is included in the wellfield design. In addition, this section should discuss the use of IX resin and GAC to treat perchlorate and explosives as these are part of the treatment technology train of groundwater extraction and treatment.

The following text will be added to the end of Section 7.4:
"Alternatives 3 and 6 reduce the mobility of 14% of the perchlorate plume volume which accounts for <1% of the total perchlorate plume mass."

The IAGWSP will monitor GAC performance during the RRA and implement the most cost effective solution in the comprehensive remedy.

81. Page 76, Section 7.7 - Include comparative analysis information regarding Alternatives 5 and 6.

The text in Section 7.7 will be changed to read:
"Alternative 1 has the lowest capital cost since it is a minimal action alternative. Alternative 2 has the next lowest capital cost. Operation and maintenance costs for Alternative 2 would be spread over 50 years of system operation. The cost of Alternative 2 does not factor in costs allocated for the RRA System. Alternative 3 has the next lowest capital cost. Operation and maintenance costs for Alternative 3 would be spread over 27 years of system operation. Alternatives 4 and 6 have the highest capital costs. Operation and maintenance of the system described in Alternative 4 would be spread over 11 years. Alternative 5 has a moderate total cost and achieves the remedial objectives within 14 years of operation."

82. Page 78, Section 8.0 - Insert text at the end of the first paragraph indicating the Remedy Selection Plan will be made available to the public and there will be a public comment period held in relation to the Preferred Alternative before the final remedy is selected.

Section 8.0 will be revised to read:
"This Revised Draft FS describes the development and detailed analysis of remedial action alternatives for groundwater at Demo 1. After resolution of comments on the Revised Draft FS and receipt of input from the public, a Remedy Selection Plan (RSP) will be developed that documents the proposed remedial action alternative. The RSP will be presented to the public and an opportunity for public comments has been worked into the schedule for the comprehensive remedy selction process."

83. Page 78, Section 8.1 - The conclusions section should be revised during comment resolution. For example, Bullet 3 may have to be revised if the restoration timeframe for the entire plume including the leading edge is the standard of comparison since Alternatives 2, 4, and 5 do not actively remediate this part of the Demo 1 plume. Additionally, EPA has comments with regard to the cost estimating for Alternative 6 that may challenge the conclusion that Alternative 5 is the most cost-effective.

As stated above, the timeframes presented in the FS for restoration are based on

compliance everywhere – both on- and off-base, within the current plume footprint and downgradient of the current plume footprint.

84. Page 78, Section 8.2 - The schedule information should be updated based on discussions between the IAGWSP, EPA and DEP.

The IAGWSP proposed an expedited schedule to the EPA and DEP but has not received concurrence. Schedule information will be updated based on the latest approved schedule at the time the FS is issued as a final document.

85. Table 4-1 - The following revisions to this table are necessary.

a) Add units under Risk Based Concentration (RBC) heading.

b) Perchlorate (EPA 1999) references should be combined into one line to read "Perchlorate (EPA 1999 - provisional RfD)"; the value presented in the Risk Based Concentration column should be "3.7 - 18"; the Proposed RBC or Regulatory Goal entry should be "4-18 EPA interim EPA policy".

c) Insert a new line for perchlorate to read: in COC heading "Perchlorate (EPA 2002 - draft)"; RBC entry - "1".

d) The footnotes summarizing the January 1999 information is incorrect. This memorandum puts forth a provisional RfD range = 0.0001 -0.0005 mg/kg/day. This range is the same for both children and adults.

Response to Comment 85(a): The change will be made.

Response to Comment 85(b): The reference in the table footnotes will be made as noted. The table will be corrected.

Response to Comment 85(c): In accordance with current EPA guidance (EPA 2003), pending NAS review of the 2002 external review draft, the reference dose(s) provided in the 1999 Interim Guidance are adequately protective of potential adverse effects, even to sensitive subpopulations. Consequently, any reference to the 2002 external review draft will not be added to this table due to outstanding uncertainties regarding the science presented in the 2002 document (W.H. Farland, Ph.D. A.M. Jarabek. October 27, 2003).

EPA's own memorandum to it's regional offices indicates that the 2002 document is not to be used until finalized (EPA Memo dated 22 Jan 2003 from Marianne Lamont Horinko to Assistant and Regional Administrators).

"…as an interim measure and in the absence of a finalized oral health risk benchmark for perchlorate, we are reaffirming the 1999 interim guidance… The 1999 Interim Guidance remains the applicable guidance until supplanted by new guidance based on a finalized risk assessment… Regardless of the authority under which perchlorate is addressed, the risks are the same. The guidance in this memorandum, therefore, is applicable to all OSWER programs."

AND

"In determining whether cleanup may be necessary and in setting appropriate cleanup levels, the regions should follow the 1999 Interim Guidance described in the first section of this memorandum. As stated there, when based on the provisional RfD range, the regions should continue to use the provisional cleanup levels for perchlorate in groundwater ranging from 4 to 18 parts per billion ppb with an added suggestion to carefully consider the lower end of the provisional range (as discussed earlier in this memorandum). Also, as noted earlier in this memorandum, the 4 to 18 ppb range is considered to be protective based on recent, ongoing analyses and taking into account the most sensitive receptors, and therefore no additional adjustment for childhood exposure is needed.

In selecting the appropriate cleanup level at specific sites, the regions should consider the factors that are typically addressed in setting groundwater cleanup levels, such as practicability, the reliability of exposure data, whether the groundwater is used as a source of drinking water, as well as other routes of exposure. Before a region, for site-specific reasons, chooses a cleanup level either below or above the 4 to 18 ppb range, it must consult with OSWER, ORD, and OW."

Response to Comment 85(d): The table has been revised as noted and referencing the 22 January 2003 Memorandum from Marianne Lamont Horinko to EPA Regions.

86. Figure 2-5 - Revise map so that it correctly depicts current data – i.e., the >4ppb plume shell extends downgradient of Pew Road, and the >1 ppb plume shell incorporates MW 225 and MW 231.

Per agreement with the Agencies in the 09/11/03 FS Scoping Meeting, data up to and including May 2003 was used in the plume development and modeling. As such, the plume shells will not be adjusted to reflect more current data, for the purposes of the FS.

87. Figure 2-6 - In the legend, describe what a dashed line means (in this case, is it the estimated extent of the perchlorate plume?).

A note describing the nature of dashed lines representing estimated data will be added to Figure 2-6 in the Final FS.

88. Figure 2-7 - Make consistent with text on Page 22. The text there states that low levels of perchlorate have been detected in MW74 and MW78, but these wells are not within the nondetect plume shell shown on Figure 2-7. It appears that these wells should be within the pale yellow plume.

Figure 2-7 represents RDX distribution in groundwater, not perchlorate.

89. Figures 2-12, 2-13, 2-17 and 2-19 - Update these figures to reflect more recent perchlorate detections above 4 ppb at MW 211, and the higher levels at MW 225 and 231. Also update other figures if they do not contain up-to-date data. pretty far off – see eg. App. A, figure

Per agreement with the Agencies in the 09/11/03 FS Scoping Meeting, data up to and including May 2003 was used in the conceptual site model. As such, the plume shells will not be adjusted to reflect more current data.

90. Table 6-1 - a) Please clarify why the % removed of Perchlorate mass after 10 years is less in Alternative 6 than Alternative 5 when Alternative 6 includes a leading edge extraction well.

Alternative 5 was optimized for mass removal. The optimization iteration routine never "placed" a well at the leading edge of the plume because this area represents less than ONE percent of the total mass of the plume. A note will be added to Table 6-1.

b) In Alternative 4, please clarify why no time estimate is provided for "Years to achieve background" whereas the Demo 1 FS Fact Sheet provides an estimate of 15 years.

As discussed in the 09/11/03 FS Scoping Meeting and as presented in AO3, the objectives for Alternative 4 were to optimize the well design to achieve "risk-based levels within 10 years". As such, the timeframe to get to background was calculated later and remains apart from the evaluation.

91. Figure 8-1 - This schedule should be updated based upon the latest schedule EPA and the NGB have developed to reach the Decision Document. The schedule for Remedial Design and Remedial Action should be appended to wherever the Decision Document is finalized.

The IAGWSP proposed an expedited schedule to the EPA and DEP but has not received concurrence. Schedule information will be updated based on the latest approved schedule at the time the FS is issued as a final document.

Appendix A

92. General - Add a table showing all reinjection well screen elevations.

A table will be added.

93. Capture Zones - Inspection of the capture zone figures for each alternative in Appendix A illustrate that captures zones, especially at Frank Perkins Road, fully capture the width of the Demo 1 plume upgradient of Frank Perkins Road, however capture zones upgradient of Pew Road differ. The text for each alternative should describe the capture zone that are illustrated by Figures A4-7 through A4-10 in Appendix A.

The shape and width of the capture zones vary based on the specific parameters of the pumping rates, extraction well and injection well locations, and screen elevations. As depicted, some of the capture zones may not encompass the whole width of the plume. However, the model projections for time to cleanup the plume accounts for particles that are captured and treated as well as particles that attenuate within a given timeframe. Appropriate descriptive text will be added.

94. Extraction and Reinjection Rates - Upon inspection of the Figures A4-8, A4-9, and A4-10, it appears that the high rates of extraction and reinjection are creating a greater degree of

dilution and recycling of water when compared to Figure A4-7, Alternative 3. That said, please discuss considerations given to different extraction rates and other configurations for reinjection (i.e., more reinjection wells).

The design methodology utilized is an iterative optimization process that systematically evaluates 100s of possible extraction well locations, combinations and pumping rates. The pumping designs presented are those that best meet a given set of performance criteria i.e. (10 years to risk-based levels) and the high extraction rates are required to meet the time criteria for cleanup. An unfortunate consequence is that the plume will collapse faster in some places and extraction efficiency will decline. In practice, during the operation and maintenance phase, the ETR system pumping rates will be optimized based on performance monitoring and individual wells which no longer extract detectable mass will be packed off or shutdown

Three of the four proposed reinjection wells are part of the RRA systems presently being constructed. Those locations were determined prior to development of the subregional model used in the FS design process. In order to balance reinjection along the south side of the plume at Pew Road, a fourth location was identified to the north resulting in two pairs of wells along Frank Perkins Road and Pew Road, respectively. A third pair of candidate injection locations were identified closer to the kettle depression in the event that modeling indicated additional extraction wells were required too distant to make practical use of the Frank Perkins Road treatment system and reinjection locations. No other reinjection scenarios were evaluated however the optimization methodology ensures that extraction rates are balanced by reinjection in each simulation iteration.

95. Page 4, Section 2.1 - The document should provide references to the various estimates of hydraulic properties provided (e.g., ratio of horizontal to vertical hydraulic conductivity, thickness of till layer, and depth of bedrock).

A reference to Masterson et al, 1998 will be added.

96. Page 5, Section 2.1 - The document should provide references to the ratio of horizontal to vertical hydraulic conductivity.

See response to EPA Comment 95.

97. Page 5, Section 2.3 - The document should provide information about the conductances chosen for the stream nodes and the elevation used for the drain.

As discussed in Section 1.0 of Appendix A, the design of AMEC regional model is directly derivative of the USGS regional model (as documented in Masterson et al, 1996, 1998, and 2000) in terms of grid structure and the majority of boundary conditions. Therefore, elevations and conductances of Drain, Stream, and General Head Boundary nodes are as determined by USGS and only modified as describe in this document where new data has become available or calibration considerations required a change.

98. Page 5, Section 2.3 - The document should indicate why the MODFLOW stream package was not used to simulate the streams instead of using the drain package.

The primary advantage of the stream package over drain is in accounting for streamflow losses that could deplete the available water to sustain flow. However, the great majority of streams on Cape Cod are lower than the adjacent watertable and therefore only gain water. In gaining situations the Stream and Drain packages are computationally identical and therefore the Drain packages was selected for its greater ease of implementation.

99. Page 5, Section 2.3 - The document should indicate how the bedrock data were interpolated and the method used (Surfer®, kriging, inverse distance) and the relevant contouring controls used (e.g. number of nearest neighbors, grid size, weighting factors).

The text will be modified to include details of the conventional kriging process that was used within the Surfer software. A sentence will be added to the end of the second paragraph in Section 2.3:
"These bedrock contours were generated using Surfer® software, enabling a conventional kriging process."

100. Page 5, Section 2.3 - The document authors should identify the source of bedrock elevation data used including well data and geophysical information.

The text will be modified to state that the data is a combination of bedrock elevations from boreholes collected by and shared between USGS, Jacobs Engineering, and AMEC.

101. Page 5, Section 2.3 - The document authors should indicate how recharge was applied to developed properties containing impermeable parking lots, building roofs etc. that would preclude meaningful infiltration.

See response to EPA Comment 97. The recharge distribution in developed area was defined by USGS based on population density, water usage estimates and a baseline "natural" or ambient recharge rate. In that accounting, additional recharge was computed to represent septic return flow however no reduction in ambient recharge due to impervious surfaces was postulated. During the model calibration process only the baseline rate was adjusted.

102. Page 6, Section 2.3 - The DEMO model [page 14] indicates that recharge distribution should reflect vegetative cover and topography which account for a 30% variation in recharge across that model domain. It is unclear why the site-wide model did not consider these factors.

The purpose of the regional model in this FS is to provide lateral boundary conditions and initial hydraulic parameters for the more refined subregional model. From this starting point the subregional model was modified to reflect local data and features such as slug test results (which were not available at the time the regional model was being finalized), small ponds, the clay lens etc. With the refinements at the subregional level, a second phase of calibration was performed as discussed in Section 3 in which recharge adjustments were required to optimize the match to vertical plume trajectory.

103. Page 6, Section 2.3 - Provide a basis for a lesser recharge to the pond as compared to the surrounding model preferably a study identifying this relationship of lower recharge to ponds than to soil. In fact, since the model represents lakes as constant heads, the recharge is

meaningless, as recharge is actually controlled by the conductance and water table elevation rather than by recharge.

See response to EPA Comment 101. The recharge distribution and assumptions regarding ponds were originally developed by USGS. However, the comment incorrectly states the model represents lakes as constant heads when in fact they are represented as variable head cells with a very high hydraulic conductivity (50,000 ft/d) to induce a flat watertable. This approach allows for simulation of the dependence of pond levels on groundwater conditions and thereby allows pond levels to be calibration targets. The reduced recharge rate along pond surfaces is hypothesized by USGS based on the expectation of increased evaporation rates relative to the adjacent aquifer.

104. *Page 6, Section 2.3* - Please provide the basis for assigning ponds a conductance of 50,000 ft/d.

See response to EPA Comment 103.

105. Page 6, Section 2.3 - Please discuss the method for determining pond depths determined (e.g., bathymetric surveys) and provide references.

Pond bathymetries were not modified from the precursor USGS regional model.

106. Page 6, Section 2.3 - Please discuss whether or not the model account for industrial water well pumping. There are a number of large water withdrawals that do not appear to be included in the model. For example, the industrial water wells for the Mirant Canal Electricity Generating Plant.

The model does not account for the Mirant Canal industrial pumpage however, pumping rates for the 26 municipal wells defined in the precursor USGS regional model have been modified to reflect actual operational rates reported by the water suppliers in 2000. Further, no significant industrial pumping occurs anywhere near the Demo 1 area and therefore the model is considered accurate for the purpose presented in this document.

107. Page 6, Section 2.4 - The document should discuss historical and seasonal variation in water level and the impact of changes in pumping rate from nearby wells that may have had an impact on the plume trajectory over time. If plume orientation is the “best” calibration target, it would be very sensitive to changes in the water table caused by seasonal effects, dry or wet years and changes in pumping. The model appears to have been designed with a static set of boundary conditions that do not reflect any of these variations.

The regional model is a steady-state simulation of long-term average climate conditions. Transient flow modeling is considered both unnecessary and inappropriate when calibrating to plumes which have formed over many 10s of years in an area where horizontal flow direction is relatively stable (unlike the top-of-mound area). Data requirements would include long-term recharge history, long-term water level hydrographs at the site, pumping histories, and other information which is not readily available. Plumes are considered “best” calibration targets in a steady-state simulation of long-term average climate conditions precisely because they integrate seasonal and short-term climatic oscillations.

108. Page 7, Section 2.4 - The document should discuss whether there is any basis in the field geology to justify the elliptical zone of lower hydraulic conductivity. If the zone cannot be confirmed by geologic investigations then it may represent an error in the conceptual model.

The Buzzards Bay and Sandwich moraines are considered be a complex mixture of gravel, sand, silt, and clay lithologies generally having lower permeability and greater heterogeneity than the adjacent outwash areas. Therefore, a discrete zone of lower permeability is consistent with the conceptual model. While there is insufficient data from geologic borings to define the exact extent of the postulated zone its presence is indicated by two lines of evidence, 1) the higher than expected water levels observed in the so-called far field wells (MW-80 through MW-84) and the apparent trajectory of the Demo1 Perchlorate plume.

109. Page 9, Section 2.4.3 - Please discuss the approach for assigning hydraulic conductivity throughout the model. It appears that around pumping wells a machine algorithm selected the best fitting data but in areas remote from the pumping wells how was hydraulic conductivity assigned? Did the model take into account the size of the grid cell's impact on water levels in the wells through a Peaceman approximation or by other manner? If a correction was not applied then the model will tend to underpredict drawdown near the pumped well due to the model grid size exceeding the size of the well diameter and not accounting for well inefficiency.

The basic hydrogeologic framework and hydraulic properties were initially established by USGS based on a conceptual geologic model. Further adjustments have been made only where field data and /or model calibration considerations require.

As stated in the first paragraph on page 9, a grid cell size of one to two feet was used at pumping centers thereby eliminating the need for corrections to improve the accuracy of drawdown. Well inefficiencies were not considered.

110. Page 9, Section 2.4.3 - How did the model predicted hydraulic conductivities compare to field data other than these few pump tests such as slug tests, grain size analyses, geologic well log data and other sources for estimates of hydraulic conductivity at individual monitoring wells. How did it compare to long term remedial pumping data?

See response to EPA Comment 109. Relative to pump testing there is greater uncertainty associated with the listed methods and therefore such a comparison is not expected to provide significant insight into aquifer properties. In general, the simulated conductivities are consistent with published values for sands and gravels. Due to the coarse grid in the regional model local remedial systems are not actively simulated and therefore no such comparison can be performed.

111. Page 9, Section 2.4.3 - What was the relationship used between longitudinal to transverse hydraulic conductivity and what was the basis for the decision?

See response to EPA Comment 109. Due to the nature of glacial outwash deposits which lack fractures or organized directional fabric, no significant horizontal anisotropy is hypothesized by USGS or other hydrogeologists working on Cape Cod.

112. Page 9, Section 2.4.3 - What values of vertical hydraulic conductivity were used?

Vertical anisotropy ratios range from 3:1 to 100:1 depending on location and depth. Ratios originally hypothesized by USGS have largely been maintained except where pumping test interpretation suggested they be revised.

113. Page 9, Section 2.4.3 - How did the model deal with grid cells that contained to different types of lithology within the grid cell volume (e.g. sand and clay) within the same grid cell? Many models take the approach of simulating lithology with variable thickness grid cells that are aligned with specific lithologic layers to avoid this problem.

The hydrogeologic framework of western Cape Cod is postulated to consist of a very thick well-sorted deposit of sand and gravel formed by a proglacial delta. Distinct laterally correlatable layers are very rare. Therefore, the hydraulic conductivity assigned to the uniformly 10 foot thick layers is intended to represent the combined lithology in that interval.

114. Page 9, Section 2.4.3 - Provide references and justification for the storage coefficients used in the model.

The text will be revised to state the specific yield used is in the range reported by Jacobs (2000) and also as arrived at through calibration of a transient model for the SE Ranges (AMEC, 2003)

115. Page 10, Section 2.5 - Provide information about the anisotropy values used in the model

See responses to EPA Comments 111 and 112.

116. Page 10, Section 2.5 - Discuss any sensitivity analyses that were conducted. If sensitivity analyses were not conducted please explain why they were not conducted.

Sensitivity analyses were conducted on the final calibrated subregional model used for design predictions as presented in Section 4.6 .

117. Page 10, Section 2.5 - The document should include information about the MODFLOW solver used and the solver input values.

The text will be revised to state that the PCG2 solver employing the Modified Incomplete Cholesky method with a relaxation parameter of 0.95 and a convergence criteria of 0.00001 feet.

118. Page 10, Section 2.5 - The document should provide information about the mass balance results for the water budget calculated by MODFLOW and described whether the value was considered appropriate for this type of simulation.

The text will be revised to state that the model mass balance was less than $1x10^{-6}$ percent and is considered more than satisfactory.

119. Page 14, Section 3.3.2 - Please discuss the method for determining pond depths (i.e., bathymetry).

Because the ponds in question are very small and represented by only a few grid cells within the model, accurate representation of bathymetry was not possible. Average depths were estimated from site observations.

120. Page 14, Section 3.3.3 - Provide a basis for the various hydrologic parameters used.

After Freeze & Cherry (1979) hydraulic conductivity of glacial till and silty clays ranges from about 2 to 0.000001 ft/day. The value for the clay deposits at Demo 1 was selected in the upper portion of the range and adjusted through calibration.

121. Page 15, Section 3.3.3 - Why is the geometric mean listed as less than 100 ft/day. Provide the value.

The exact value will be provided.

122. Page 16, Section 3.4.2 - Provide references to surface water elevation measurements, were these one time estimates or averages or values for the calibration year, expand the discussion.

The text will be revised to state the surface elevation of Opening Pond was determined in early 2003 during installation and survey of shallow piezometers along the shoreline. Estimates for North Pond and Flax Pond were made using a photogrammetric analysis of high resolution airphotos and review of published topographic maps.

123. Page 17, Section 3.5.1 - The document should describe whether soil sampling data support their interpretation of the source area.

The text will be revised to state that sampling indicates perchlorate and RDX are present in the soil along the flanks of the kettle depression and therefore supports the interpretation.

124. Page 18, Section 3.5.2.2 - What is the basis for the selected dispersivities used in the model other than what was previously used. If larger transverse dispersivities were used then the source area would not need to be as wide.

The text will be revised to state the dispersivities selected were based on values published by Garabedian et al (1988) as utilized in previous modeling at Demo 1 (AMEC, 2001).

125. Page 18, Section 3.5.2.2 - Provide literature data to support that perchlorate should have no retardation in groundwater.

A reference to the text Perchlorate in the Environment (Urbansky ,2000) will be incorporated.

126. Page 18, Section 3.5.2.4 - The discussion of TNT biodegradation half-lives are unclear as the range of values provided was from one reference yet the value chosen was based on different references where a range of half-lives were not provided. Provide the range of values in the cited articles upon which the half-life values were selected and then indicate whether the value is conservative or not and its sensitivity to the results. Incidentally, the half-life chosen was certainly not in the "upper range of values" reported by Spanggord et al and Pennington.

The paragraph will be rephrased as follows: "In contrast to RDX and perchlorate, literature review indicated TNT biodegradation half-lives for conditions similar to MMR range from 0.125 days to 190 years (Spanggord et al. 1980; Meylan 1997; Townsend and Myers 1996; and Pennington et al. 2001). For all TNT transport simulations, a biodegradation half-life of 365 days was selected. Despite the uncertainty indicated by the broad range the selected value is considered conservative." Sensitivity of simulation results to TNT half-life is described in Section 4.6.

127. Page 20, Section 4.1 - Provide a reference for the risk based criteria.

Table 4-1 presents references for the risk-based criteria.

128. Page 27, Section 4.6 - The document should present a sensitivity analysis for the conductance of drain cells and constant head cell hydraulic conductivity at pond sites.

As no drain cells are simulated near the plume or extraction wells the sensitivity of design predictions to this boundary condition was considered irrelevent. As stated in a previous response, ponds are not simulated with constant heads but rather variable head with high hydraulic conductivity. The purpose of assigning very high hydraulic conductivity (50,000 ft/day) to ponds cells is to induce a flat watertable. Because this value is several orders of magnitude higher than the surrounding aquifer, aquifer head is expected to be highly insensitive to changes in this parameter.

129. Figure A2-2 - Please clarify the approach for characterizing lakes. In EPA's document copy, the lakes are light blue which does not match any of the legend color patterns.

The figure shows the ponds present within the model domain in light blue. These are not boundary conditions and therefore no legend color is assigned. The boundary conditions are accurately shown in red, green, and dark blue consistent with the legend. The figure will be revised to remove the pond polygons.

130. Figure A2-5 - The Demo 1 plume appears to be headed too far north instead of eventually discharging into the Rod & Gun Club pond. This probably indicates that the pond was not adequately modeled in terms of depth or permeability in the near vicinity.

The figure shows the particle tracks run within the regional model and, due to the coarse grid cell size, small ponds such as Rod & Gun Club cannot be simulated. Also, the particle tracks shown represent only the trajectory of the center of mass of the plume and thus do not represent the width of the plume that would pass under the pond.

131. Figure A2-7a through k - For these maps of hydraulic conductivity it would be helpful to show the field observed hydraulic conductivity at each of the monitoring well to compare the

simulated to observed values. These maps could be enlarged as plates if necessary (size C or D drawings).

The comment is noted, however, since monitoring well based hydraulic conductivities were not used in regional model development, the purpose and value of such maps is questionable.

132. Figure A2-11 - For the water table contour map it would be helpful to show the field observed water table elevations at each of the monitoring well to compare the simulated to observed values. These maps could be enlarged as plates if necessary (size C or D drawings)

The comment is noted, however, such a figure would be extremely challenging to produce such that the 1474 pairs of field observations and predicted values (as listed in Table A2-4) would be legible. Further, this figure would have limited value as the primary focus of this FS is development of the subregional model used for design predictions.

133. Figure A2-13 - Are there long term pump tests or periods when remedial pumping were ongoing at Demo 1 that could be used to calibrate the model? If so why were the testing data not used?

No data of this type is available.

134. Figure A3-2 - The north and south boundary of the interpreted extent of clay deposits is not well bounded. Perhaps additional soil borings should be installed to define such a key feature. In any case the authors should acknowledge the limited characterization of the unit and discuss the implications.

Text will be inserted acknowledging these limitations.

135. Figure A3-3 - The legend should have used a different color than white to define the perchlorate plume extent as it does not show-up on the figure.

The figure will be revised with a darker shade of pink.

136. Figure A3-4 - It is unclear how the 19" was specifically chosen other than as a calibration artifact. The authors reference topography and other factors that may justify the 19" band but are unclear how this specific value was chosen/calculated for such a broad swath.

The text will be revised to clarify the width of the swath was determined from maps and airphotos delineating the denser vegetative cover of the Buzzards Bay moraine upland. The value of recharge was arrived at through iterative trial and error simulations to improve the match to the observed vertical trajectory of the perchlorate plume. A 30% reduction from the baseline value of 27" resulted in the best match.

137. Figure A3-4 - It appears that the 27" of recharge was applied to the ponds which is different than was done for the larger model where surface water bodies were assigned lower values of recharge than the surrounding aquifer.

This is an acknowledged inconsistency between the regional and subregional modeling.

However, in contrast to those in the regional model these ponds are very small and net difference in cumulative recharge to the model domain would be similarly small.

138. Figure A3-5a through c -There are several orange objects just south of the Rod and Gun Club pond, what are these objects?

The orange object south of Rod & Gun Club pond in model layers 1-3 is an unnamed pond that, while inexplicably omitted from the state's GIS mapping (perhaps because it is classified as a wetland), is an equally significant a body of water.

139. Figure A3-5a through q - For these maps of hydraulic conductivity it would be helpful to show the field observed hydraulic conductivity at each of the monitoring well to compare the simulated to observed values. These maps could be enlarged as plates if necessary (size C or D drawings)

This comment is noted, however, as discussed in Section 3.3.3 geometric means of individual slug tests grouped within 3 vertical zones and 3 horizontal zones were the basis for adjusting hydraulic conductivities during subregional calibration rather than the individual test values.

140. Figure A3-5 – What is the basis for the blue triangle area that extends along Route 28 in the northern portion of the model. Do monitoring well hydraulic data or boring logs justify this variation? This zone is modeled as being very persistent and a deep penetrating feature.

This feature is the southern portion of the elliptical zone of lower hydraulic conductivity simulated in the regional model.

141. Figure A3-5n – There appears to be a green stripe running along Pew road. Was this a mistake in the model where one of the earlier hydraulic zones was not completely changed to the new value?

The comment correctly identifies this as an artifact of the trial-and-error parameter changes explored during calibration. As this anomalous feature is one or two 50 foot grid cells in width, no significant impact on model results is expected..

142. Figure A3-6 – Please specify the method for determining the depths of the ponds.

Based on field observations the pond depths were estimated for Opening Pond, North Pond, and Flax Pond at 15, 15, and 7 feet, respectively.

143. Figure A3-7 – Please provide the rationale for not aligning the model grid to the flow direction down the axis of the plume.

As shown in Figure A3-3 the model grid is aligned consistent with the plume axis. Further, the plume follows a path which curves gently from an initial trajectory south of west to one slightly north of west, and therefore, no single grid alignment will be ideal everywhere along the plume length.

144. Figure A3-7 – The simulated particle paths show that along the leading edge of the plume, especially on the southern side, the model under predicts the distance that the plume has migrated.

Though the particle tracking shown in this figure only provides a part of the analysis of plume fate & transport (dispersion is not considered), analytical data from the toe monitoring wells actually supports the interpretation that the north side of the plume has advanced farther downgradient.

145. Figure A3-8 – It is unclear why the plume would travel into the low conductivity unit unless it was forced to enter by strong vertical gradients. Not enough data was provided regarding simulated and observed vertical gradients and piezometric elevations in the deeper layers. Also it would be helpful to show the position of the monitoring wells that define the plume extent. It would be surprising for the plume not to try to migrate under or around the low conductivity zone instead of entering the unit.

Because recharge continually accretes to the watertable in the steady-state model, vertical downward gradients develop which drive flow downward across all layers, including the clay zones, irrespective of their permeability values, as required by conservation of mass and the fact that the materials are not considered completely impermeable. Observed vertical gradients in well clusters have historically been negligible or slightly downward, consistent with the interpretation that groundwater moves horizontally in a continuous fashion with regional flow toward the coast and vertically downward in an intermittent fashion following recharge events. The steady-state model simulates the net effect of these processes, resulting in continuous plunging trajectory (influenced by relative permeabilities).

While this figure only portrays particle tracks, the formal fate and transport modeling does show the plume preferentially migrates over the clay zone in the higher permeability shallow sediments. (see Figures A3-14a through A3-14h and also the animation sequences in Appendix A – Attachment 1). Monitoring well locations relative to the plume extent are shown on Figure A3-1.

146. Figure A3-9 – Provide information about calibration to water levels in deep wells as additional plots

It is not clear from the comment which wells are considered deep wells. All water levels available for the area are included in the plot and accompanying table (Table A3-2). In general, only very small vertical head differences were observed in well clusters and thus such plots would provide no new information.

147. Figure A3-11 - For the water table contour map it would be helpful to show the field observed water table elevations at each of the monitoring well to compare the simulated to observed values. These maps could be enlarged as plates if necessary (size C or D drawings)

The comment is noted, however, such a figure would be extremely challenging to produce such that the 1474 pairs of field observations and predicted values (as listed in Table A2-4) would be legible. Further, this figure would have limited value as the primary focus of this FS is development of the subregional model used for design predictions.

148. Figure A3-11 - The colors chosen for the plume outlines do not show up very well. Select a palette of colors that will

The figure will be consistent with other IAGWSP drawings.

149. Figure A3-12 - The wide source zone needs to be further justified through shallow soil contamination data. It is more likely that the broad source area is due to changing gradients and water elevations over time that caused a broad groundwater source area to form as opposed to the postulated broad surface source. The model would likely do much better if the historical changes in seasonal, wet and dry years and historical pumping variations were taken into account.

The comment does not consider the fact that the RDX plume is not as wide as perchlorate yet both plumes would have formed in the same aquifer conditions, subject to the same transient processes and dispersion. There is no other explanation available besides a difference in source footprint, unless aquifer conditions were radically different during a phase of loading which predates introduction of RDX. With respect to this possibility it should be noted that recent analytical detection of RDX at Pew Rd. now suggests that there is less of a difference in plume length than previously interpreted and therefore initial loading of RDX and perchlorate may have been closer in time.

With respect to the suggested application of transient modeling, please see the response to EPA Comment 107.

150. Figures A3-14a through h - The plume appears to be off-center. Again maybe it reflects that in earlier years the gradient was slightly different than today.

Comment noted.

151. Figure A3-14 - The plume drawings should indicate the number of years the model simulation lasted.

A note will be added indicating the simulation was run for approximately 55 years.

152. Figures A3-14j through l - There is no modeled concentration shown on the images, perhaps the colors used did not show up, otherwise, the model underpredicts these simulations.

The figures will be revised with bolder plume colors.

153. Figure A3-15a - The model tended to overpredict this scenario, perhaps the model is underestimating contaminant retardation.

The recent analytical detection of RDX at Pew Rd. now suggests that the plume is longer than previously interpreted and therefore this comment presents a moot point.

154. Figure A3-15g and h - The model tended to significantly underpredict the 100 to 500 ppb contour interval. Please explain.

The model does predict core plume concentrations above 100 ppb however these do not persist below model layer 6. In evaluating these comparison figures it should be noted that there is some uncertainty associated with the plume shells and the deepest screen in which concentrations above 100 ppb were detected spans an elevation from 11 to 1 ft ngvd (MW-76M1) which corresponds to model layer 6.

155. Figure A4-1 - a) Add reinjection rates to figure.

Appropriate labels will be added.

b) Show capture zones on figure similar to subsequent figures of other alternatives.

The capture zone particle tracks will be added, though they are already published as part of the RRA SPEIM document (also in review).

c) The difference in the perchlorate and RDX plume trajectories is likely due to the different period of contaminant loadings for the two contaminants. Since the model is static, it cannot allow for different flow paths from the same starting point. This appears to be a major problem for the model calibration. Please discuss planned efforts for model calibration.

This comment requires clarification as there is no difference in plume trajectory interpreted between RDX and perchlorate. There are only differences in width and length and both plumes appear asymmetric and slightly skewed to the north.

156. Figure A4-4 - Please discuss the approach for simulating Opening Pond in the model.

Please see responses to EPA Comments 104, 119, and 142.

157. Figure A4-4 - Please discuss the approach for model testing of changes in the position and length of the vertical recovery well screen length.

Extraction wells were screened along the present interpreted vertical thickness of the plume, in order to ensure its capture. The model was not used to test changes in screen position. During the operational phase of whichever remedy is selected, packers will be used to focus extraction on contaminated intervals as performance monitoring indicates plume thickness is being reduced.

158. Figure A4-10 - Please add the layer for the plume to allow for comparisons just like Figure A4-9.

The plume was inadvertently omitted and will be added.

159. Figure A4-13 - The sensitivity analysis using a decreased by 30% hydraulic conductivity data set appears to fit the plume trajectory much better. Why wasn't this simulation selected as the baseline?

Based on maximum concentrations in analytical data the center of mass of the perchlorate plume follows a curved path which passes closer to the northern end of the plume toe. The baseline calibrated simulation was determined as best matching this

trajectory and also monitoring well water levels.

160. Table A2-5 - The model tended to overpredict the elevation of Flax Pond which is why the plume probably diverts too far to the north instead of heading for the Rod & Gun Club pond and Flax Pond

The Flax Pond listed in this comparison of pond elevations to regional model predictions is not the same as the Flax pond in the Pocasset Village development west of the plume.

161. Table A2-5 - Where are the data for Opening Pond and the Rod & Gun Club Pond? Were the elevations provided for one point in time (please provide) or an average?

These ponds are too small to be simulated in the regional model.

162. Table A2-8 - Are the values shown for one point in time (please provide) or an average baseflow. Calibrating to a single event may not be representative.

The values are for single samples and are the best available data. Further, stream discharges are considered very low priority calibration targets due the transient nature of streamflow response inferred by the comment and also the uncertainty inherent in field measurement of discharge.

163. Table A4-1 - a) Please clarify why the % removed of Perchlorate mass after 10 years is less in Alternative 6 than Alternative 5 when Alternative 6 includes a leading edge extraction well.

b) In Alternative 4, please clarify why no time estimate is provided for "Years to achieve background" whereas the Demo 1 FS Fact Sheet provides an estimate of 15 years.

The slightly reduced (0.4%) capture efficiency after 10 years of operation is related to the stagnation zone that develops between the Pew Rd. well and the leading edge well downgradient. This stagnation zone results in slower groundwater velocities and therefore recovery of mass just downgradient of Pew Road. While the leading edge well captures additional mass the relative quantity is insignificant and less than the efficiency lost at Pew Road.

Alternative 4 is a risk-based design and not intended or presented as an alternative to reach background levels.

Appendix C

164. General - Additional detail and supporting information is needed to be provide verification of the cost estimates presented allowing an evaluation of the appropriateness of the proposed items. Most of the line item costs presented in Appendix C are shown as lump sum cost items with a note stating they are contractor quotes. This prevents completion of a detailed review and verification of the information presented. Items such as "Pre-Fab Metal Building" are presented as lump sum costs. However, it is not clear if this line item cost includes the installation of a foundation and floor or even delivery and erection of the structure.

Additional information in the form of contractor quotes will be attached as an Appendix to the Final FS.

165. General - The general specifications for equipment should be included to allow verification of pricing and appropriateness of the items identified. As one example, it is not clear what size air compressor would be purchased for the system at a cost of $13,000 for Alternatives 2 and 3, $26,000 for Alternative 4 and $20,000 for Alternatives 5 and 6.

General specifications for equipment will be attached as an Appendix to the Final FS.

166. Alt 6 vs. Alt 5 - a) Please clarify discrepancies between the costs for Alternative 5 and 6. Specifically, please clarify why an additional three years of pumping, likely at the toe well, runs another $5.6M. While it is assumed that the mobile treatment system has some capital cost and additional O&M, costs identified in other portions of the cost details add up to $5.6M.

There are no discrepancies between the costs for Alternative 5 and 6. Alternative 6 pumps an additional 75 gpm at the toe well and is dedicated to recovering less than ONE percent of the total mass. Three additional years of pumping for Alternative 6 is not only at the toe well, but at all wells because the system must work longer to achieve background (rather than risk-based levels).

b) In addition, EPA believes that the cost of piping for Alternative 5 and 6 should be closer. Alt. 6 was costed out with 10,580 feet ($1,428,300) of piping run, while Alt. 5 was costed out with only 5,095 feet ($687,625) of piping run. By EPA's measuring (i.e., piping run from EW-D1-604 to Pew Road), Alternative 6 only has 2,700 feet more piping than Alternative 5 Based on the information provided to us, the comparison should be slightly closer.

EPA's comment regarding Alternative 6 is a moot point since they requested that this Alternative be re-routed along roadways.

Appendix D

167. General - EPA is continuing our review of these tables and will provide comments, if any, in time for the draft Decision Document for Demo 1 Groundwater.

Comment noted.

Attachment 2
Draft Responses to EPA Comments (7/20/04)
Revised Draft Feasibility Study (5/20/04)
Demo 1 Groundwater Operable Unit

DEP GENERAL COMMENTS

1. The Army/NGB provides an evaluation in the Draft FS of several extraction wellfield designs and treatment technologies for the Demo-1 groundwater plume. A CD-ROM with animations of the various remedial alternatives is provided with the Draft FS. However, figures illustrating a time-RDX/perchlorate concentration series for each of the proposed remedial alternatives would also be very helpful to the Department's evaluation of the proposed remedial alternatives. Also, please provide a table indicating all of the wells considered and ultimately used in the development of the Demo-1 RDX/perchlorate plume shells with easting and northing coordinates, well elevation in feet mean sea level (MSL), the concentration of RDX and perchlorate used in plume shell development and the date the sample was obtained.

The requested information is presented in 3 dimensions in the animations attached to the FS.The quantity of maps that the DEP is requesting is sizable when one considers the number of model layers, time steps necessary to show each remedy's progress, and the number of alternatives under consideration.

A table with the wells utilized in plume shell development with the easting and northing coordinates, well elevations, and concentrations used will be provided in the Final FS.

2. Figure 2-12 of the Draft FS indicates that perchlorate concentrations in the vicinity of Pew Road are between 1 ppb and 4 ppb. The longitudinal cross section A-A' (Figure 2-13) indicates a maximum perchlorate concentration of 3.5 ug/L at Pew Road in the MW-211M2 wellscreen. However, this perchlorate concentration is from February 28, 2003. Since then, the perchlorate concentration in this wellscreen increased to 5.9 ug/L in June 20, 2003. More concerning to the Department is the steady increase in the perchlorate concentration in the deeper M1 wellscreen in MW-211 from non-detect in February 28, 2003 to a maximum concentration of 11 ug/L in May 21, 2004. It should also be noted that perchlorate concentrations of 11.3 ug/L and 4.3 ug/L were reported from borehole screening samples obtained from 180 feet and 190 feet, respectively during the installation of MW-211 in April 2002.

Based upon the most recent analytical data, the Demo-1 plume has significantly higher perchlorate concentrations at Pew Road than what is indicated in the figures provided in the Draft FS. It is likely that there is substantially greater perchlorate mass in the vicinity and downgradient of Pew Road than is being accounted for by the groundwater model. This will significantly impact the time estimated by the Army/NGB model for perchlorate to attenuate to background or risk-based concentrations in the groundwater downgradient of Pew Road. The Department recommends that the Army/NGB update the Demo-1 groundwater model with the most recent groundwater data to determine if concentration predictions for perchlorate downgradient of Pew Road are still valid.

The IAGWSP updated perchlorate plume shells with the most recent data, recalculated mass estimates and re-ran Alternatives 5 and 6. Significant findings include a slightly increased mass estimate (+15%) within the bounds of error given the areal extent and density of data collection points and no appreciable difference in the performance of the

proposed alternatives.

3. The Department cannot concur at this time with the Army/NGB proposal for the use of GAC for treatment of perchlorate in groundwater. The Department will provide comments regarding treatment technologies for perchlorate after review of the results of the Pew Road Pilot Test, currently due in September 2004 and the performance of the Rapid Response Action at Demolition Area 1.

Comment noted. The containerized treatment system has flexibility to accommodate different treatment media and that the Army will evaluate the performance of GAC for perchlorate treatment at Pew Road under the RRA Plan.

4. The Department has reviewed a letter from the U.S. EPA to the Impact Area Groundwater Study Program Office dated July 20, 2004 regarding EPA Comments on the Draft FS. The Department concurs with the proposed approach stated in the EPA letter to modify Alternative 6-Additional Alternative B to reduce costs and environmental impacts. In addition, the Department concurs with the General and Specific Comments contained within the attachment to the letter.

Comment noted.

DEP SPECIFIC COMMENTS

5. Page ES-1, Executive Summary and Page 1, Section 1.0, Introduction: The text states "**This Revised Draft Feasibility Study (FS) presents the evaluation of alternatives to remediate explosives and perchlorate contamination in groundwater at Demolition Area 1 (Demo 1) at Camp Edwards, pursuant to United States Environmental Protection Agency (EPA) Administrative Orders Safe Drinking Water Act (SDWA) 1-97-1019 (AO1) and 1-2000-0014 (AO3)**". Please revise the text to state "*This Revised Draft Feasibility Study (FS) presents the evaluation of alternatives to remediate explosives and perchlorate contamination in groundwater at Demolition Area 1 (Demo 1) at Camp Edwards, in accordance with United States Environmental Protection Agency (EPA) Administrative Orders Safe Drinking Water Act (SDWA) 1-97-1019 (AO1) and 1-2000-0014 (AO3) and the Massachusetts Contingency Plan (MCP)*".

See letter to DEP, dated 09/30/03. No change will be made to text.

6. Page 6, Section 2.4, Summary of Investigations and Reports: This section should include a reference to the Department letters dated June 18, 2003, July 15, 2003, and September 18, 2003 concerning the requirement for the Army/NGB to submit an Immediate Response Action (IRA) Plan to address a Condition of Substantial Release Migration (SRM) (as defined in section 40.0006 of the Massachusetts Contingency Plan), which exists at the Demo-1 groundwater plume due to the potential for the Demo 1 plume to migrate beyond the MMR boundary at more than 200 feet per year. This section should also include a brief description of the IRA Plan that was submitted by the NGB to the Department on July 8, 2003.

See letter to DEP, dated 09/30/03. No change will be made to text.

7. Page 20, Section 2.7.1, Explosive Compounds: The NGB indicates, "**Recent analytical results indicated that invalidated detections of RDX were measured at MW-210 and MW-211M1. While this extends the length of the RDX plume somewhat, this recent development does not affect the groundwater modeling or remedial system design completed to date**". Please provide an estimate on the current distribution of RDX in the groundwater based upon the recent detection at MW-211M1. It appears that this detection increases the distribution of RDX from approximately 4,600 feet downgradient of the Demo-1 source area by approximately 1,700 feet (i.e. ~ 6,300 ft.).

As noted in EPA Comment 153, the model was overpredicting RDX which was, at first considered conservative, is now appropriate in light of recent data. Therefore, the groundwater model is not affected. An update on the current RDX distribution (i.e., plume length) will be included in the FS text.

8. Page 26, Section 3.3, Movement of Contaminants in Groundwater: The NGB states, "**Based upon results through May 2003, the downgradient extent of the RDX plume is interpreted to reach MW-10, approximately 4,600 feet downgradient of the source, whereas the perchlorate plume is 9,200 feet long. However, RDX was recently detected at low concentrations (less than 1 ug/L) in monitoring wells MW-210M2 and MW-211M1**". Please revise the estimated downgradient extent of the RDX plume based upon these recent RDX detections in monitoring wells MW-210M2 and MW-211M1.

The downgradient extent of the RDX plume will be revised in the text only.

9. Page 68, Section 6.7.2.1, Groundwater Extraction: The NGB indicates, "**Groundwater extracted from the extraction wells west of Pew Road (EW-D1-1, EW-D1-601, EW-D1-604) would be conveyed to a treatment facility located on Pew Road. Based on the modeling results a total of 87 gpm of groundwater would be pumped to this location**". The Pew Road treatment system flow rate of 87 gpm does not agree with the Pew Road treatment system flow rate of 173 gpm referenced on page 69 of the Demo-1 FS. Please indicate what the correct flow rate is to the Pew Road treatment system for Alternative 6.

See response to EPA Comment 73.

10. Page 72, Section 6.7.3.7, Costs: The NGB indicates that the present worth of O & M for Alternative 6 is $16,700,000, while the present worth of O & M for Alternative 3 is $14,700,000. However, the predicted period of operation for Alternative 3 (27 years) is 10 years longer than the predicted period of operation for Alternative 6 (17 years). Please explain why the O & M costs for Alternative 6 are $2,000,000 greater than the O & M costs for Alternative 3.

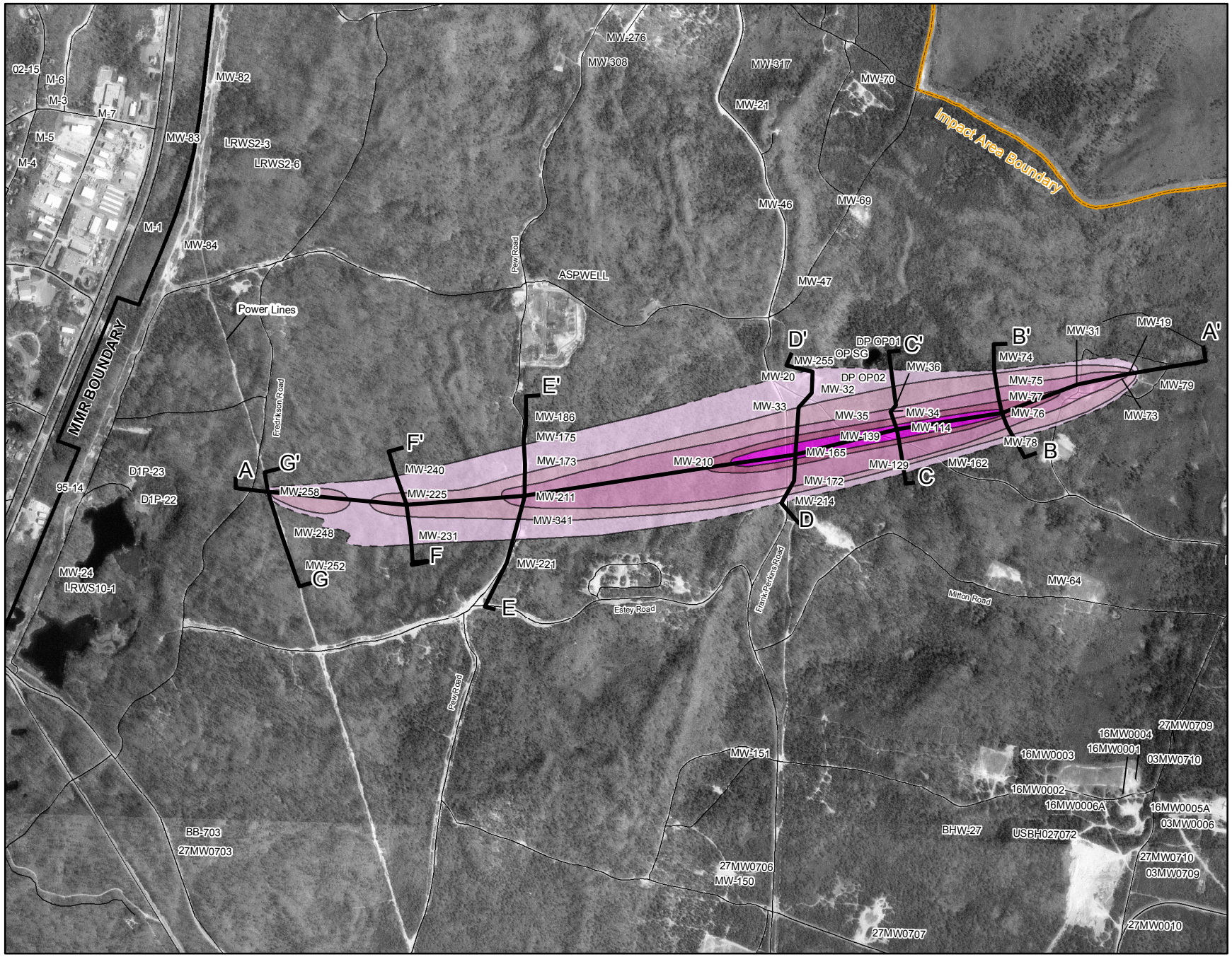
Annual treatment system costs for Alternative 6 are almost double those of Alternative 3 when looking at GAC and IX replacement costs. This is related to the higher pumping rates necessary for Alternative 6 and the subsequent increase in treatment media (e.g., GAC, IX)

that would be used. Over the project length of 17 years, this difference in O&M cost has a higher present worth than the 27 year O&M costs for Alternative 3.

11. Page 78, Section 8.1, Conclusions: Please provide a brief comparison of the remedial alternatives with respect to estimated times for achieving background concentrations in this section.

The following text will be added to Section 8.1 bulleted list:

- *Alternative 6 achieves background in the shortest timeframe (approximately 17 years).*



Impact Area Groundwater Study Program

LEGEND

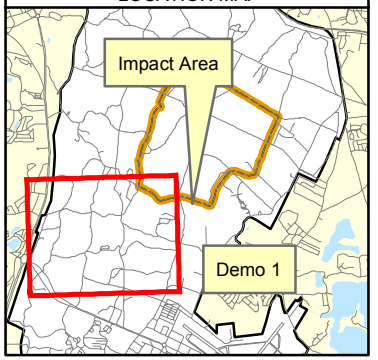
- Existing Monitoring Well
- Piezometer
- Staff Gauge

Perchlorate in Groundwater

- Greater than Non-Detect
- Greater than 1 ppb
- Greater than 4 ppb
- Greater than 18 ppb
- Greater than 100 ppb
- Impact Area Boundary
- MMR Boundary
- Roads
- Cross Section

Note: Plume shell illustrated is representative of widest observed at each transect cross-section Groundwater data through May 25, 2004.

LOCATION MAP



NOTES & SOURCES

Basemap data from US Geological Survey 7 1/2 minute Topographic Maps. Source: MassGIS
Aerial photos: 1:5000 black & white digital orthophotos
Resolution: 0.5 meter; Date Flown: 1997; Source: MassGIS

TITLE

Perchlorate Distribution in Groundwater as of 05/25/04
Demo 1 Groundwater Operable Unit

0 1,000 Feet

N

AMEC Earth & Environmental, Inc.
Westford, Massachusetts

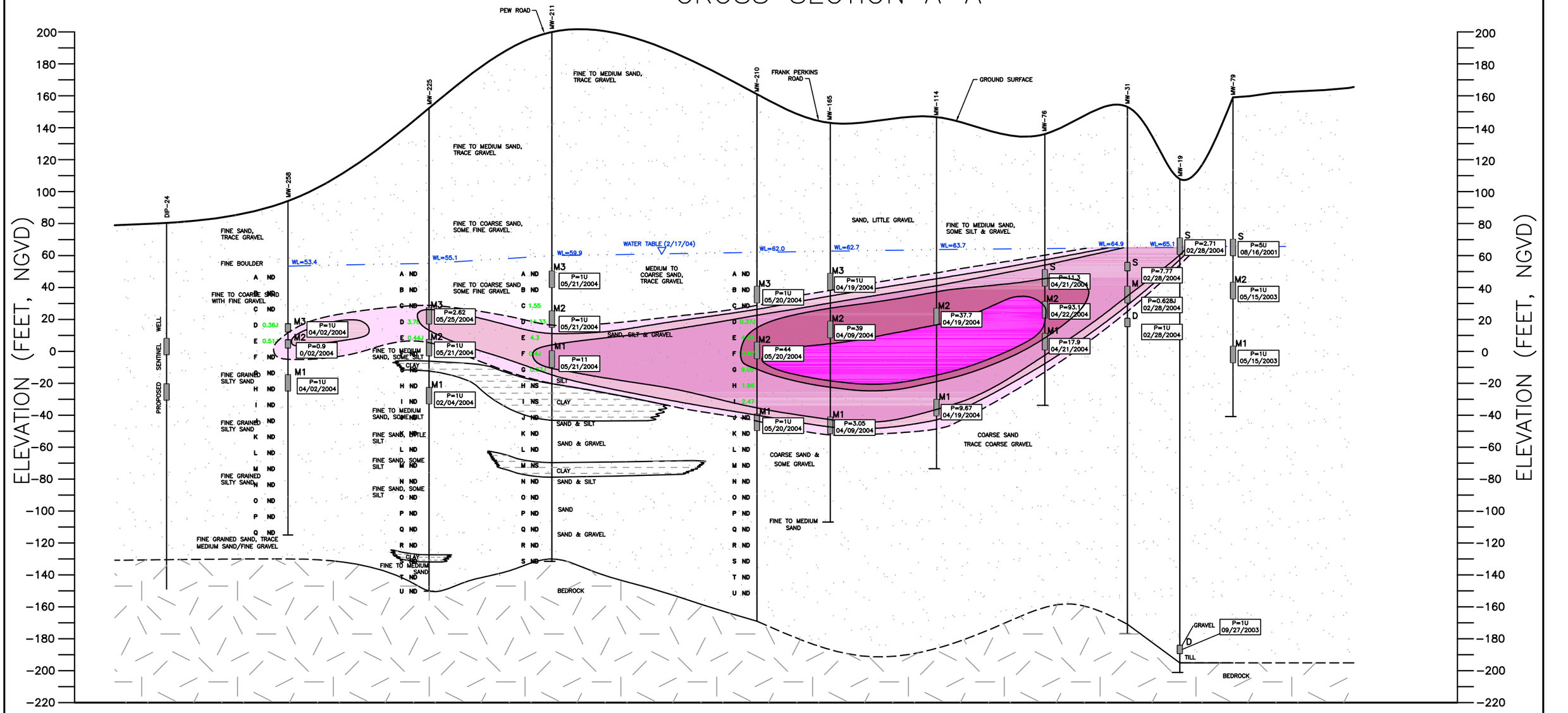
J:/mmr/ReportFigs2004/D313/D313_A-1.pdf
G:/MMR_COE/Work2004/D313/D313_A-1.mxd
August 24, 2004 DWN: JBB AP CHKD:

FIGURE
A-3

CROSS SECTION A–A'

A WEST

A' EAST



NOTES:

1. FOR ORIENTATION OF CROSS SECTION, SEE FIGURE 4–9 IN GROUNDWATER REPORT ADDENDUM.
2. GEOLOGIC CONDITION BETWEEN EXPLORATIONS ARE AN INTERPRETATION OF AVAILABLE DATA. ACTUAL CONDITIONS MAY VARY.
3. NGVD = NATIONAL GEODETIC VERTICAL DATUM
4. SAMPLE COLLECTION DATES FOR EACH MONITORING WELL IDENTIFIED ADJACENT TO OR BENEATH RESULTS FOR EACH WELL.
5. CONCENTRATIONS IN UG/L
6. * = UNVALIDATED DATA, D=DILUTION, J = ESTIMATED CONCENTRATION.
7. SCREENING CONCENTRATIONS WERE COLLECTED DURING DRILLING. ND = NON–DETECT, (<0.43 UG/L), 1U = NON–DETECT, (<0.43 UG/L), NS = NOT SAMPLED, 1.55 = PERCHLORATE DETECTED IN UG/L.

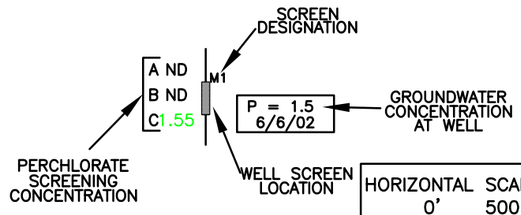
LEGEND

PERCHLORATE CONCENTRATIONS

- ND – 1.0 ug/l
- 1.0 ug/l – 4 ug/l
- 4 ug/l – 18 ug/l
- 18 ug/l – 100 ug/l
- > 100 ug/l

GEOLOGIC UNITS

- F–C SAND
- CLAY
- BEDROCK



HORIZONTAL SCALE: 1"=1000'
0' 500' 1000'
0' 30' 60'
VERTICAL SCALE: 1"=60'

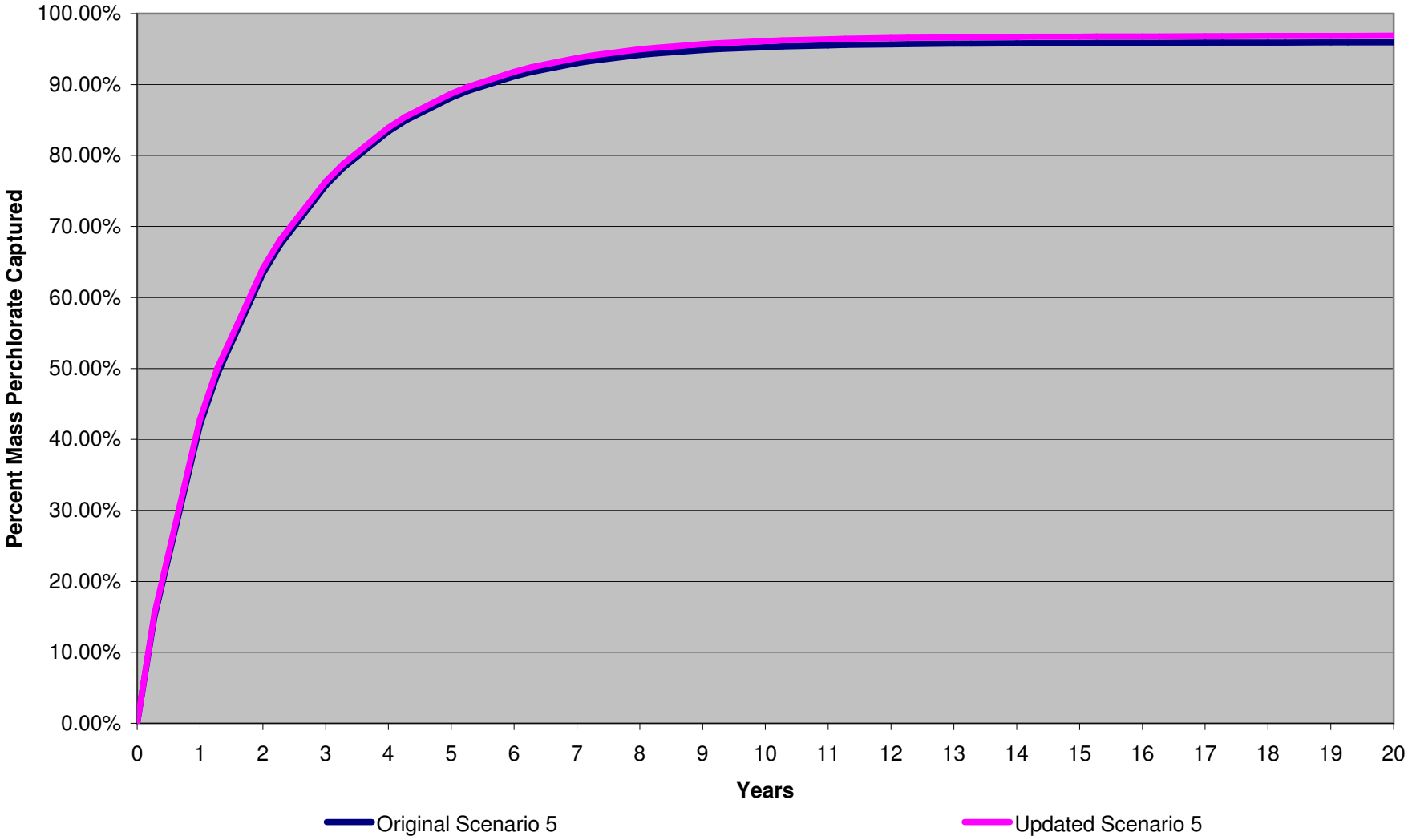
ATTACHMENT 4 DRAFT

CROSS SECTION A–A' PERCHLORATE DISTRIBUTION IN GROUNDWATER AS OF 5/25/04

REVISIONS	AMEC Project No: 2–7622–5018		
	DRAWN BY: RWB	DATE: 8/23/04	DRAWING NO.
	CHECKED BY: JJM		

FILE: J:\Demo 1\GW\DB\Analytical Plots\Plume Shells\PERC_AA.dwg BY: christopher.obaba DATE: 01 Sep 2004 - 11:06am

Attachment 5
Comparison of Original and Updated Scenario 5 Mass Capture



July 11, 2005

Ms. Lynne Jennings
EPA – New England, Region 1
1 Congress Street, Suite 1100
Boston, MA 02114-2023

Mr. Len Pinaud
Massachusetts Dept. of Environmental Protection
20 Riverside Drive
Lakeville, MA 02347

Dear Ms. Jennings and Mr. Pinaud:

Re: Impact Area Groundwater Study Program (IAGWSP)
USEPA Region I Administrative Orders SDWA 1-97-1019 and 1-2000-0014
Revised Memorandum of Resolution on the Revised Draft Feasibility Study, Technical Memorandum (TM) 01-17
Demo 1 Groundwater Operable Unit

On behalf of the Army/NGB IAGWSP and the U.S. Army Corps of Engineers (USACE), AMEC Earth & Environmental (AMEC) is pleased to provide the attached Revised Memorandum of Resolution (MOR) for the above-referenced document. The Revised Draft Feasibility Study (FS), Demo 1 Groundwater Operable Unit (OU) was submitted on 05/20/04. Comments were received from EPA on 07/20/04 and from MADEP on 08/02/04. The IAGWSP submitted a response to comments letter (RCL) to EPA and MADEP comments on 09/02/04.

A resolution meeting was conducted on 09/28/04 to discuss the responses to EPA and MADEP comments. Supplemental evaluations were conducted at EPA's request using updated plume and aquifer parameters. The IAGWSP submitted the MOR and Supplemental Evaluations summary on 04/05/05 and EPA comments were received on 04/19/05. EPA requested that the IAGWSP submit a revised MOR to address EPA comments. MADEP comments on the MOR and Supplemental Evaluations were received on 04/25/05. MADEP submitted two more comments on the feasibility Study via email on 05/06/05. The EPA submitted a revised table for Appendix D of the FS on 05/26/05.

This revised MOR includes the following attachments. The changes required by these attachments will be reflected in the Final Demo 1 Groundwater Feasibility Study:

- Attachment 1 – EPA (07/20/04) comments and the IAGWSP responses (09/02/04) and resolutions (revised as needed) for each comment included in the MOR dated 04/05/05;
- Attachment 2 – DEP (08/02/04) comments and the IAGWSP responses (09/02/04) and resolutions (revised as needed) for each comment included in the MOR dated 04/05/05;
- Attachment 3 – Updated Table 6-1 to be included in the Final FS;
- Attachment 4 – Map of Approved Wellhead Protection Areas (Zone II);
- Attachment 5 – Request by EPA (4/19/05) and proposed language to be included in the Final FS that references the Supplemental Evaluations;
- Attachment 6 – Response to DEP's comments provided on May 5, 2005;

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- Attachment 7 – Revised Appendix D for the Final FS as requested by EPA;
- Attachment 8 – EPA and DEP comments on the Supplemental Evaluations summary and IAGWSP responses; and
- Attachment 9 – Revised Executive Summary.

Please contact Paul Nixon of the IAGWSP if there are any questions.

Sincerely,

Marc Grant
Program Manager

cc. w/Atts:
Paul Nixon/Ben Gregson - IAGWSPO
Scott Michalak/Dave Margolis – USACE
Mark Panni – MADEP
Bob Lim - EPA
Tom Frendak – AEC
Randall Nida – NGB

Attachment 1

Attachment 1
EPA Comments, IAGWSP Responses and Resolutions
Revised Memorandum of Resolution
Revised Draft Feasibility Study
Demo 1 Groundwater Operable Unit

EPA General Comment 1 (08/02/04) The document underplays the fact that the Demo 1 plume is located within a sole source aquifer (SSA). This must be corrected. In both the Executive Summary and the Background Section, the document should discuss the fact that Camp Edwards overlies the Sagamore Lens, the most productive part of the Cape Cod Aquifer, the only drinking water supply for Cape Cod; and that the Commonwealth of Massachusetts has designated Camp Edwards as a reserve for purposes of water supply and wildlife protection. The FS should indicate that various locations on and around Camp Edwards are being considered as replacement water supply sources for water supplies that have been contaminated as a result of other activities on Massachusetts Military Reservation.

(9/02/04 Response)
The fact that Camp Edwards overlies a sole source aquifer, and its designation as a water supply reserve are mentioned multiple times in the document. The characterization of the Demo 1 groundwater plume and aquifer were described in detail in the Groundwater Report and the Groundwater Report Addendum. Although locations within Camp Edwards may be considered for the development of future water supplies, it should be noted that the DEP has already denied the use of the area around North Pond (downgradient of the Demo 1 plume) due to concerns for the drawdown of the water level in the pond. No changes to the text are proposed.

(09/28/04 CRM)
EPA disagreed with the IAGWSP's response. Detail is required in the FS.

Resolution
A revised Executive Summary is provided as Attachment 9 which includes our proposed revisions for the Final FS.

EPA General Comment 4 (08/02/04) Calculating Mass Removal - When discussing the percentage of mass removal of contaminants for different alternatives, EPA believes that it is essential that the data be in a form that can be easily compared between alternatives. Thus, regardless of whether an alternative involves cleaning up to background (non-detect) or to risk- based standards (RBCs) it is essential that the basis for comparison be the same. The "denominator" in such a calculation should always be the volume of groundwater with contamination above non-detect. Therefore, Section 3.5 should clarify the approach for calculating mass in the active remediation alternatives. The document clearly should specify whether the total mass of the plume is based upon the mass of the plume to non-detect or the RBC boundary. In addition, EPA would like to know the estimated mass in the plume that is downgradient and outside of the capture of the Pew Road extraction well.

To set a baseline, EPA would like to see the document present the estimated mass for the following: mass to ND boundary; mass to ND boundary downgradient of Pew Road, between Pew and Frank Perkins, and upgradient of Frank Perkins; mass to RBC for RDX and perchlorate for the same segments.

(9/02/04 Response)
All calculations of percent mass removal under the various alternatives are total mass present in the plume to the ND boundary as defined by analytical data collected through April 2003. The table below presents and compares the perchlorate mass and volume for each portion of the plume for the total (as presented in the FS) and that quantity in the perchlorate plume that is above 1 ug/L.

Location	Perchlorate to Non-Detect				Perchlorate to 1 ug/L			
	Mass (lbs)	%	Volume (gallons)	%	Mass (lbs)	%	Volume (gallons)	%
Upgradient of FPR	80.44	80.6	605,686,694	42.9	80.22	81.2	463,905,007	56
Between FPR and PR	18.46	18.5	595,035,870	42.2	18.12	18.3	346,344,570	42
Downgradient of PR	0.95	1.0	210,111,330	14.9	0.45	0.5	12,398,100	1.5
Total	99.85	100	1,410,833,894	100	98.80	100	822,647,677	100

Section 3.5 will be modified to include the following text and amended table below:

> *"The analytical data collected for the Demo 1 plume were plotted spatially onto Figures 2-6 through 2-21, using data from May 2003. The plume shells were interpolated and rendered in three dimensions in the groundwater modeling process. 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 major treatment system components. The mass of perchlorate upgradient of Frank Perkins Road is 80.5 lbs; the mass of perchlorate between Frank Perkins Road and Pew Road is 18.5 lbs; and the mass of perchlorate downgradient of Pew Road is 1 lb.*

COC	**Estimated Volume**		**Estimated Mass**	
	Liters	Gallons	Kilograms	Pounds
Perchlorate (Total)	5.5E09	1.5E09	45	100
Upgradient of FPR	--	--	36.5	80.5
Between FPR & Pew	--	--	8.4	18.5
Downgradient of Pew	--	--	0.45	1
RDX	1.2E09	3.2E08	30	67
TNT	4.7E07	1.2E07	0.06	0.13

> *The total mass of the perchlorate plume is 99.85 lbs, the mass of the plume downgradient of Pew Road is 1% of this or 0.95 lbs (this is a conservative estimate because this includes mass west of Pew Road that may be in the capture zone). The mass of perchlorate between Pew Road and Frank Perkins Road is 18.45 lbs or*

18.5%. The mass of perchlorate upgradient of Frank Perkins Road is 80.44 lbs or 80%. The IAGWSP updated its calculation of plume mass with 2004 data and observed a slight shift of mass from upgradient of Frank Perkins Road (decreased from 80% to 76% of total) to the area between Frank Perkins and Pew Roads (increased from 18.5% to 23.5% of total). The area downgradient of Pew Road decreased very slightly to 0.9% from 1.0% (this is because the plume was redrawn in 2004 with a smaller downgradient area due to the non-detect at MW-252 in 2004). The total mass of the perchlorate plume according to 2004 estimates was 115 lbs. The difference in estimates is based on the process of interpolation between well screen data points at a given point in time. However, this variation is reasonable considering the large areal extent of data and the monitoring density available.

The mass of the perchlorate plume above 1 ug/L is 98.8 lbs, the mass of the plume downgradient of Pew Road above the risk-based concentration is 0.45 lbs or 0.5%. The mass of perchlorate between Pew Road and Frank Perkins Road above the risk-based concentration is 18 lbs or 18.3%. The mass of perchlorate upgradient of Frank Perkins Road above the risk-based concentration is 80 lbs or 81.2 %. The IAGWSP updated its calculation of plume mass with 2004 data and again, observed the slight shift of mass from upgradient of Frank Perkins Road (decreased from 81.2% to 76% of total above the risk-based concentration) to the area between Frank Perkins and Pew Roads (increased from 18.3% to 23% of total). The area downgradient of Pew Road above the risk-based concentration increased from 0.5% to 0.7% of the total mass. The total mass of the perchlorate plume above the risk-based concentration according to 2004 estimates was 114 lbs.

The total mass of the RDX plume is 66.9 lbs. The area upgradient of Frank Perkins Road accounts for 66.3 lbs or 99.1% of the plume mass. The total mass of RDX above the risk-based concentration is 66.8 lbs or 99.97%. The mass of RDX above the health advisory of 2 ug/L is 66.2 lbs or 99.87%."

(09/28/04 CRM)
EPA requested that the mass and volume calculations be updated as part of the supplemental evaluations.

Resolution
The IAGWSP agreed to provide updated estimates of mass and volume of the plume as part of the Supplemental Evaluations (submitted 04/05/05) in support of remedy selection.

EPA General Comment 5 (08/02/04) Groundwater Downgradient of Pew Road - In discussing each alternative which does not include an extraction well downgradient of Pew Road, the FS should specifically include a statement that groundwater downgradient of Pew Road, which is currently above risk-based levels, would not be treated. Thus, groundwater west of Pew Road and on the base could not be used for drinking water purposes. See also specific comments below referring back to this general comment.

(9/02/04 Response)
A statement that indicates water in this area may be above risk-based levels during

treatment will be added to the appropriate alternatives. However, each of these alternatives is expected to reduce the concentrations in the plume to below risk-based levels at the end of the specified treatment time. It is also important to note that development of water supply sources in this area (LRWS10-1) were denied by DEP in the past due to the proximity, and potential drawdown of the Pond.

(09/28/04 CRM)
EPA requested that a distinction be made between passive and active treatment in the FS.

Resolution
See Specific Comment 30.

EPA General Comment 6 (08/02/04) Estimates to Achieve Restoration - There appears to be inconsistencies when evaluating the restoration timeframes for the plume particularly downgradient of Pew Road. For example, the Demo 1 FS Fact Sheet table presents estimates for restoration of groundwater from Perchlorate downgradient of Pew Road at greater than 50 years for Alternative 2, 15 years for Alternative 4, 20 years for Alternative 5 despite the fact that all these alternatives are similar and do not include a leading edge extraction well. In addition to mass capture, clarification should be provided on estimates to achieve restoration for the entire plume including the leading edge.

(9/02/04 Response)
Estimates of time to achieve restoration are based on the maximum concentration within the entire plume inclusive of the leading edge. Despite the similarities in well location, the alternatives listed have different pumping rates and remedial objectives (e.g., risk-based, background levels) which, as expected, result in different times to achieve restoration. The restoration times that are provided are based on an evaluation through the entire plume. The areas upgradient of Pew Road dictate the time required to achieve restoration. The toe of the plume dissipates in approximately the same time for all the alternatives except for Alternative #1.

Alternative 2 entails pumping 220 gpm at Frank Perkins Road and 100 gpm at Pew Road in order to hydraulically contain, and gradually remove mass from, the plume. Alternative 4 entails pumping at a much higher rate of 1,417 gpm from five extraction wells along the plume axis which would reduce mass at a greater rate and reduce concentrations below risk-based levels in approximately 14 years. Alternative 5 entails pumping from five extraction wells at a moderate combined rate of 906 gpm in order to reduce concentrations below risk-based levels in 20 years. Since 99% of the perchlorate plume mass is upgradient of Pew Road, the presence or absence of a downgradient extraction well at Frederickson Road does not make a big difference in the mass removal.

(09/28/04 CRM)
EPA requested that the time to achieve both risk-based and background concentrations for each of the alternatives under consideration be included.

Resolution
The IAGWSP agreed to add this information to Table 6-1 (see Attachment 3).

EPA General Comment 7 (08/02/04) Schedule - EPA does not agree with the schedule as contained in this document. EPA does agree with points raised by the Army/NGB to attempt to expedite this schedule, and will continue to cooperate on the schedule. In order to meet the expedited schedule, EPA reminds the Army/NGB that the Response to Comment Letter (RCL) is due from the Army/Guard by 20 August 2004. It is EPA's intention to finalize our schedule discussions at that time.

(9/02/04 Response)
The IAGWSP proposed to expedite the FS/RD/RA process as prescribed by EPA in AO3 and represented by the schedule included in the FS. EPA participated in developing an expedited schedule but has not provided approval to go ahead with this approach. As stated in the cover letter attached to the Revised Draft FS, the schedule will be modified once EPA provides written comment and agreement.

(09/28/04 CRM)
EPA and MADEP requested a revised schedule incorporating the proposed supplemental evaluations.

Resolution
The Supplemental Evaluation has been completed and the current schedule for follow-on activities was addressed in a letter to EPA dated June 15, 2005, and is contingent upon resolution of several policy issues. Once the Feasibility Study is finalized, the Remedy Selection Plan will be completed, followed by the Draft Decision Document and Responsiveness Summary.

EPA Specific Comment 1 (08/02/04) Page ES-1, Para. 5 - The discussion of the Remedial Action Objectives for the Demo 1 Plume in paragraph 5 should also incorporate the concepts contained in Section 3. I. (Objectives) of the AO3 SOW. In particular, the remedial alternatives should provide a level of protection to the aquifer that accounts for the fact that the Cape Cod Aquifer is a sole source aquifer, is susceptible to contamination, and that Camp Edwards overlies a productive part of the aquifer.

(9/02/04 Response)
The remedial response objectives are described in detail in the FS in Section 4.1 Remedial Response Objectives. The first sentence of paragraph 5 provides a summary of the overall objective stated in the AO3 SOW as is appropriate for the executive summary.

(09/28/04 CRM)
EPA requested that the executive summary provide additional detail.

Resolution
See the resolution to EPA General Comment 1.

EPA Specific Comment 3 (08/02/04) Page ES-1, Para. 5 - The RAO starting "Prevent potential ingestion and ..." must include a reference to state standards that are deemed substantive.

(9/02/04 Response)
IAGWSP considers promulgated standards to be substantive, such as a Massachusetts Maximum Contaminant Level (MMCL). DEP has not yet promulgated a standard for perchlorate. The promulgated level for RDX is the Federal health advisory set at 2.0 ug/L in groundwater.

(09/28/04 CRM)
EPA requested that the text explicitly state that the MMCLs were considered.

Resolution
After a thorough review of AO3, EPA and DEP comments on the issue back to October 2001, the MMR Installation Restoration Program's Remedial Action Objectives, and recent meetings between the Army, EPA, and DEP leadership, the following Remedial Action Objectives are proposed for both the Executive Summary and section 4.2 of the Feasibility Study:

> *"The Remedial Action Objectives for groundwater at Demo 1 are to protect the health of persons from contaminants in, or likely to enter, a sole source of drinking water; and to restore the useable groundwaters to their beneficial uses wherever practicable within a reasonable timeframe. The Sagamore Lens, part of the Cape Cod Aquifer, underlies Camp Edwards and is susceptable to contamination.*

See the resolution to EPA General Comment 1.

EPA Specific Comment 4 (08/02/04) Page ES-2, First Full Para. - Insert the following at the end of this paragraph:

"According to this 2003 memorandum, the 1999 interim guidance remains the applicable guidance until supplanted by new guidance based on a finalized risk assessment."

(9/02/04 Response)
The text will be changed to read:
"In January 2003, EPA (EPA, 2003) issued a memorandum re-affirming 1999 interim guidance that results in a provisional risk-based standard range from 4 to 18 μg/L for perchlorate. The range (4-18 μg/L) is considered to be protective based on recent, ongoing analyses and taking into account the most sensitive receptors, and therefore no additional adjustment for childhood exposure is needed. According to this 2003 memorandum, the 1999 interim guidance remains the applicable guidance until supplanted by new guidance based on a finalized risk assessment."

(09/28/04 CRM)
EPA requested that text quoted from the 2003 memorandum include the EPA suggestion to carefully consider the lower end of the range.

Resolution
See the resolution to EPA General Comment 1.

EPA Specific Comment 20 (08/02/04) Page 34, First Partial Para. - The text should note that low levels of RDX have now been detected in groundwater at Pew Road. The fact that low levels of RDX may show up in the Pew Road system should be mentioned in the text.

(9/02/04 Response)
The text will be changed to read:
"The Frank Perkins Road system is expected to treat low concentrations of perchlorate and explosives and the Pew Road system is expected to treat only very low levels of perchlorate. Since low levels of RDX were recently detected at Pew Road, there is a possibility that very low levels of explosives could be treated at Pew Road. However, based on the observed concentrations of RDX at Pew Road, detectable concentrations of RDX are not anticipated in the treatment influent. Regardless, GAC media would be able to treat any explosive compounds that may be in the influent."

(09/28/04 CRM)
EPA requested that the language "very low" levels be substituted with "low" levels. A concentration range may be added.

Resolution
Since detectable concentrations of explosives have been measured in influent at Pew Road since the text was originally written, the third sentence will be deleted. The following text is proposed.

> *"The Frank Perkins Road and Pew Road systems are expected to treat low concentrations of perchlorate and explosives."*

EPA Specific Comment 21 (08/02/04) Page 34, 3rd Para. - While GAC is slated to be used for the RRA system at Pew Road, the final selection of a treatment media for Pew Road will be determined based on the performance of the RRA system and the results of ongoing innovative technology studies. This information will provide additional information regarding the effectiveness, cost, etc. of various types of carbon and ion exchange resins which will be used to determine the appropriate media for the Pew Road system.

(9/02/04 Response)
Agree – The IAGWSP plans to monitor GAC performance during the RRA and utilize the most efficient treatment method.

(09/28/04 CRM)
EPA suggested that the IAGWSP should state that they will propose the most efficient treatment method to the regulatory agencies at the time of design.

Resolution
The following revised text is proposed:

> *For the Pew Road system, a mobile treatment container system will be utilized. The most efficient treatment media will be proposed to the agencies based on an*

evaluation of the ongoing RRA system performance.

EPA Specific Comment 27 (08/02/04) Section 6.2.2.2 - For each alternative, the FS should also state that additional Institutional Controls may be required if the contaminants are not remediated to acceptable levels by 2052, the date the lease expires.

(9/02/04 Response)
The text of the FS in Section 6.2.2.2 states that institutional controls would be established should the Army transfer its lease to another entity. An example of what sort of institutional control was presented but this does not represent the only institutional control available.

A sentence will be added to the end of Section 6.2.2.2 to indicate that additional institutional controls may be necessary:

"As long as the plume area is within the purview and control of the Army, groundwater use restrictions are not needed. The current lease agreement is in effect until 2052. However, should the Army transfer its lease to another entity, institutional controls would be established upon lease transfer. Institutional controls could include deed restrictions that would prohibit the placement of drinking water supply wells where their zone of contribution would intercept the Demo 1 groundwater plume. Additional institutional controls may be appropriate should the contaminants remain above acceptable levels by 2052."

(09/28/04 CRM)
EPA was not satisfied with the land use control language proposed in the Revised Draft FS. It was decided that Army and EPA legal counsel and technical staff would work together to develop appropriate land use controls.

Resolution
The following language will be included in the text for Alternatives 2-6 of the Feasibility Study:

> *"Under this alternative, land use controls would be implemented where appropriate to minimize potential risk of exposure to contaminated groundwater from the Demo 1 plume. These land use controls can be considered in three categories – (i) those that relate to property that is under the control of the Army through the existing lease between the Commonwealth of Massachusetts and the US Army (i.e. on-post administrative controls), (ii) those that relate to property that is not under the control of the Army (i.e. off-post institutional controls), and (iii) those that relate to the Post after the lease with the Army has expired (i.e. post-lease institutional controls). See Appendix G for more details regarding DOD and Army proposals for land use controls.*

The following language will be added to a new appendix, Appendix G, in the Feasibility Study:

> *DOD and Army policies describe various types of land use controls that are implementable to prevent exposure to contaminants and provide that such land use controls be documented as part of the project's remedial design and decision*

documents.

A. In accordance with applicable DOD and Army policies, the Army will take the following actions to identify, implement, and document on-post administrative controls:

1) As soon as practical after completion of the Feasibility Study - Demo 1 Groundwater OU, the IAGWSP, EPA, DEP, and appropriate National Guard representatives will convene a meeting to discuss on-post administrative control options and to finalize specific on-post administrative procedures.

2) The Army's commitment to institute on-post administrative controls and the process for identifying such controls will be set forth in the Remedy Selection Plan (RSP).

3) The Decision Document will identify and describe the administrative controls to be adopted after review and approval by EPA, in consultation with the Environmental Management Commission and will state the performance objectives applicable to the administrative controls. The Decision Document will also contain a summary of the following:

i) a description of the relevant risk(s) necessitating the administrative controls;
ii) a description of risk exposure assumptions and reasonably anticipated land uses;
iii) a description of the administrative controls' performance objectives;
iv) a summary of specific administrative control implementation actions;
v) a description of the area covered by the administrative controls;
vi) the anticipated duration of the administrative controls;
vii) a process for review and modification of administrative controls if the administrative controls do not adequately protect against risks to human health.

4) The Army, the Massachusetts National Guard, or any other entity in control of the on-post areas which require administrative controls shall enter into a Memorandum of Understanding with the EPA (and MADEP, as necessary) to ensure that the necessary administrative controls shall be implemented within six months following the Decision Document. The MOU shall also set forth a program to monitor the effectiveness of the institutional controls, and a process under which EPA can enforce the implementation, monitoring, maintenance, and modification of the institutional controls, if necessary.

5) The System Performance and Ecological Impact Monitoring Plan (SPEIM Plan) will include a detailed description of the on-post administrative controls to be used, the area covered by the administrative controls, and a process of quality assurance to facilitate and document consistent long-term adherence to the administrative controls.

6) The annual SPEIM Reports will be submitted to EPA and will include an

update of the administrative controls' status and the area currently covered by the administrative controls. The SPEIM Reports will continue to include the annual administrative control updates until such time that contaminant concentrations in the on-post portion of the aquifer no longer exceed applicable drinking water standards or applicable health-based levels or until EPA approves a request to discontinue on-post administrative control implementation.

6) The administrative controls described in the Decision Document and SPEIM Plan will be incorporated into the Camp Edwards Base Master Plan and the Camp Edwards Groundwater Protection Plan.

B. In accordance with applicable DOD and Army policies, the Army will take the following actions to assess the need for and, if necessary, identify, implement, and document off-post institutional controls:

1) The Army will install groundwater monitoring wells at the post boundary capable of detecting off-post migration of contaminants from the Demo 1 plume. The Army has also conducted extensive modeling to determine the present and future shape and movement of the Demo 1 plume. At the present time, the existing wells have detected no evidence of off-post contaminant migration and the modeling results indicate that such migration is highly unlikely to occur in the future. The Army will regularly monitor groundwater quality at the base boundary and will provide monitoring results to EPA and DEP in accordance with the SPEIM Plan.

2) If the groundwater sampling and modeling results indicate a reasonable likelihood that off-post groundwater contaminant concentrations will exceed applicable drinking water standards, the Army will propose for EPA and DEP consideration specific institutional controls sufficient to eliminate the pathway for exposure to the contaminated groundwater supplies. EPA shall have the right to review and approve the proposed institutional controls after consultation with the MADEP and local authorities.

3) The annual SPEIM Reports will include a summary of the monitoring results and an updated analysis of the likelihood of off-post contaminant migration. EPA may require SPEIM reports on a more frequent basis than annually if deemed necessary.

4) If the process set forth in paragraphs B.1 and B.2 above necessitates the adoption of off-post institutional controls, the annual SPEIM Reports will also include an update of the institutional controls' status and the area currently covered by the institutional controls. The SPEIM Reports will continue to include the annual institutional control updates until such time that contaminant concentrations associated with the Demo 1 plume in the off-post portion of the aquifer no longer exceed applicable drinking water standards or health-based levels or until EPA approves a request to discontinue off-post institutional control implementation.

5) If the process set forth in paragraphs B.1 and B.2 above necessitates the adoption of off-post institutional controls, the Army will submit to EPA a proposed amendment to the Decision Document containing a detailed description of the institutional controls, the area affected by the institutional controls, and a process of quality assurance to facilitate consistent long-term adherence to the institutional controls. EPA shall have the right to review and approve the proposed institutional controls after consulting with the MADEP and local authorities. The Decision Document will identify and describe the institutional controls to be adopted and will state the performance objectives applicable to the institutional controls. The Decision Document will also contain a summary of the following:

- *i) a description of the relevant risk(s) necessitating the institutional controls;*
- *ii) a description of risk exposure assumptions and reasonably anticipated land uses;*
- *iii) a description of the institutional controls' performance objectives;*
- *iv) a summary of specific institutional control implementation actions and a schedule for implementation;*
- *v) a description of the area covered by the institutional controls;*
- *vi) the anticipated duration of the institutional controls;*
- *vii) a program to monitor the effectiveness of the institutional controls, and a process under which EPA can enforce the implementation, monitoring, maintenance, and modification of the institutional controls, if necessary.*

6) It is anticipated that the quality assurance process described in paragraph B.5 above will involve the participation of several off-post entities including but not limited to the DEP Division of Water Supply (as the approving authority for all public water supply development), the Bourne Water District, and the Bourne Board of Health.

C. The Army has conducted extensive modeling to predict the future shape and movement of the Demo 1 plume. At the present time, the modeling results indicate that persistance of the plume beyond the term of the Army's lease is highly unlikely to occur. If cleanup goals are not met when the lease with the Army expires, then the Army will take the following actions to assess the need for institutional controls after post closure:

1) The Army will continue to regularly monitor groundwater quality and will provide monitoring results to EPA and DEP in accordance with the SPEIM Plan. The annual SPEIM Reports will include a summary of the monitoring results and an updated analysis of the likelihood of contaminant remaining after termination of the lease. EPA may require SPEIM reports on a more frequent basis than annually if deemed necessary.

2) If the groundwater sampling and modeling results indicate a reasonable likelihood that groundwater contaminant concentrations will exceed applicable drinking water standards or health-based levels after the Army's lease expires,

the Army will propose for EPA and DEP consideration specific institutional controls sufficient to eliminate the pathway for exposure to the contaminated groundwater supplies. EPA shall have the right to review and approve the proposed institutional controls, after consultation with the DEP and local authorities.

3) If the process set forth in paragraphs C.1 and C.2 above necessitates the adoption of institutional controls after the cessation of the lease, the annual SPEIM Reports will also include an update of the institutional controls' status and the area currently covered by the institutional controls. The SPEIM Reports will continue to include the annual institutional control updates until such time that contaminant concentrations associated with the Demo 1 plume in the aquifer no longer exceed applicable drinking water standards or health-based levels or until EPA approves a request to discontinue institutional control implementation.

4) If the process set forth in paragraphs C.1 and C.2 above necessitates the adoption of institutional controls after cessation of the lease, the Army will submit to EPA a proposed amendment to the Decision Document containing a detailed description of the institutional controls, the area affected by the institutional controls, and a process of quality assurance to facilitate consistent long-term adherence to the institutional controls. EPA shall have the right to review and approve the proposed institutional controls after consultation with DEP and local authorities. The Decision Document will identify and describe the institutional controls to be adopted and will state the performance objectives applicable to the institutional controls. The Decision Document will also contain a summary of the following:

- *i) a description of the relevant risk(s) necessitating the institutional controls;*
- *ii) a description of risk exposure assumptions and reasonably anticipated land uses;*
- *iii) a description of the institutional controls' performance objectives;*
- *iv) a summary of specific institutional control implementation actions and a schedule for implementation;*
- *v) a description of the area covered by the institutional controls;*
- *vi) the anticipated duration of the institutional controls;*
- *vii) a program to monitor the effectiveness of the institutional controls, and a process under which EPA can enforce the implementation, monitoring, maintenance, and modification of the institutional controls, if necessary.*

5) It is anticipated that the quality assurance process described in paragraph C.4 above will involve the participation of several off-post entities including but not limited to the DEP Division of Water Supply (as the approving authority for all public water supply development), the Bourne Water District, and the Bourne Board of Health.

The Decision Document, the SPEIM Plan, and any amendments, appendices, or attachments thereto will be deemed incorporated into, and made an enforceable part of, Administrative Order for Response Action SDWA-1-2000-0014 ("AO3")."

EPA Specific Comment 30 (08/02/04) Sections 6.2.3.1; 6.3.3.1; 6.5.3.1; 6.6.3.1 - Please incorporate General Comment on "Groundwater Downgradient of Pew Road" into these sections.

(9/02/04 Response)
For Section 6.2.3.1, the text will read:
"Alternative 1 will not prevent the migration of the plume off Camp Edwards. Therefore, the areas downgradient of the Demo 1 source area would likely be impacted by groundwater above risk-based levels and be unavailable for groundwater source development. Short-term impacts would be limited. Vegetation will not be impacted because Alternative 1 simply entails long-term monitoring of groundwater, which is currently ongoing."

The system proposed in Alternative 2 would reduce concentrations everywhere in the plume to background levels within 50 years for perchlorate and RDX, including downgradient of Pew Road and east of the Base boundary. The text included in Section 6.3.3.1 seems appropriate since groundwater supplies would not be developed while clean-up is ongoing.

The system proposed in Alternative 4 would reduce concentrations everywhere in the plume to below risk-based levels in approximately 10 years for perchlorate and RDX, including downgradient of Pew Road. Therefore, the text included in Section 6.5.3.1 seems appropriate since groundwater supplies would not be developed while clean-up is ongoing.

The system proposed in Alternative 5 would reduce concentrations everywhere in the plume to below risk-based levels in approximately 13 years for perchlorate and 14 years for RDX, including downgradient of Pew Road and east of the Base boundary. Therefore, the text included in Section 6.6.3.1 seems appropriate since groundwater supplies would not be developed while clean-up is ongoing. Alternatives with toe wells don't make the area downgradient of Pew Road useable for drinking water.

(09/28/04 CRM)
Where no active remediation is proposed downgradient of Pew Road, the IAGWSP should explicitly state that passive remediation of the plume is planned. EPA suggests using the following language: "Contamination downgradient of Pew Road will disperse within *x* years based on the transport model predictions."

Resolution
Specific times to degradation will be provided as part of the supplemental evaluation. The following language will be added to the respective sections to indicate that passive remediation is proposed:

> *"The system proposed in Alternative 2 would reduce concentrations everywhere in the plume to background levels within 50 years for perchlorate and RDX, including passive remediation downgradient of Pew Road and east of the Base boundary based on the transport model predictions."*
>
> *"The system proposed in Alternative 4 would reduce concentrations everywhere in the plume to below risk-based levels in approximately 10 years for perchlorate and RDX, including passive remediation downgradient of Pew Road and east of the*

Base boundary based on the transport model predictions. "

"The system proposed in Alternative 5 would reduce concentrations everywhere in the plume to below risk-based levels in approximately 13 years for perchlorate and 14 years for RDX, including passive remediation downgradient of Pew Road and east of the Base boundary based on the transport model predictions. "

EPA Specific Comment 31 (08/02/04) Page 42, Section 6.2.3.1 - Add the following as the first sentence of this section.

(9/02/04 Response)
"Alternative 1 would not be protective of human health."

The text in Section 6.2.3.1 will be changed to read:
"Alternative 1 will not prevent the migration of the plume off Camp Edwards and would not be protective of human health if the aquifer in the area was used as a water supply. Therefore, the areas downgradient of the Demo 1 source area would likely be impacted by groundwater above risk-based levels and be unavailable for groundwater source development. Short-term impacts would be limited. Vegetation will not be impacted because Alternative 1 simply entails long-term monitoring of groundwater, which is currently ongoing."

(09/28/04 CRM)
EPA requested that "off Camp Edwards" be removed from the proposed response.

Resolution
The IAGWSP proposes the following revised text:
"Alternative 1 would not prevent the migration of the plume and may not be protective of human health if the aquifer were to be used as a water supply. The areas downgradient of the Demo 1 source area would likely be impacted by groundwater above risk-based levels and be unavailable for groundwater source development. Short-term impacts would be limited. Some limited vegetated areas could be impacted for the installation of additional monitoring wells. Otherwise, ecological impacts would be minimal because Alternative 1 simply entails long-term monitoring of groundwater, which is currently ongoing."

EPA Specific Comment 32 (08/02/04) Page 42, Section 6.2.3.1 - Revise the text to indicate that some ecological impacts could be expected with this alternative due to the need to install additional monitoring wells.

(9/02/04 Response)
A sentence will be added to the text in Section 6.3.2.1:
"Alternative 1 will not prevent the migration of the plume off Camp Edwards and would not be protective of human health if the aquifer in the area was used as a water supply. Therefore, the areas downgradient of the Demo 1 source area would likely be impacted by groundwater above risk-based levels and be unavailable for groundwater source development. Short-term impacts would be limited. Vegetation will be minimally impacted because Alternative 1 simply entails long-term monitoring of groundwater, which is currently ongoing. As with all alternatives under consideration, additonal monitoring wells will be

installed for long-term monitoring of the remedy and may cause some ecological impacts."

(09/28/04 CRM)
EPA requested that "off Camp Edwards" be removed from the proposed response.

Resolution
The text proposed in resolution to Comment 31 above addresses this comment.

EPA Specific Comment 85 (08/02/04) Table 4-1 - The following revisions to this table are necessary.

a. Add units under Risk-Based Concentration (RBC) heading.

b. Perchlorate (EPA 1999) references should be combined into one line to read "Perchlorate (EPA 1999 - provisional RfD)"; the value presented in the Risk-Based Concentration column should be "3.7 - 18"; the Proposed RBC or Regulatory Goal entry should be "4-18 EPA interim EPA policy".

c. Insert a new line for perchlorate to read: in COC heading "Perchlorate (EPA 2002 - draft)"; RBC entry - "1".

d. The footnotes summarizing the January 1999 information is incorrect. This memorandum puts forth a provisional RfD range = 0.0001 -0.0005 mg/kg/day. This range is the same for both children and adults.

(9/02/04 Response)
Response to Comment 85(a): The change will be made.

Response to Comment 85(b): The reference in the table footnotes will be made as noted. The table will be corrected.

Response to Comment 85(c): In accordance with current EPA guidance (EPA 2003), pending NAS review of the 2002 external review draft, the reference dose(s) provided in the 1999 Interim Guidance are adequately protective of potential adverse effects, even to sensitive subpopulations. Consequently, any reference to the 2002 external review draft will not be added to this table due to outstanding uncertainties regarding the science presented in the 2002 document (W.H. Farland, Ph.D. A.M. Jarabek. October 27, 2003).

EPA's own memorandum to it's regional offices indicates that the 2002 document is not to be used until finalized (EPA Memo dated 22 Jan 2003 from Marianne Lamont Horinko to Assistant and Regional Administrators).

"…as an interim measure and in the absence of a finalized oral health risk benchmark for perchlorate, we are reaffirming the 1999 interim guidance… The 1999 Interim Guidance remains the applicable guidance until supplanted by new guidance based on a finalized risk assessment… Regardless of the authority under which perchlorate is addressed, the risks are the same. The guidance in this memorandum, therefore, is applicable to all OSWER programs."

AND

"In determining whether cleanup may be necessary and in setting appropriate cleanup levels, the regions should follow the 1999 Interim Guidance described in the first section of this memorandum. As stated there, when based on the provisional RfD range, the regions should continue to use the provisional cleanup levels for perchlorate in groundwater ranging from 4 to 18 parts per billion ppb with an added suggestion to carefully consider the lower end of the provisional range (as discussed earlier in this memorandum). Also, as noted earlier in this memorandum, the 4 to 18 ppb range is considered to be protective based on recent, ongoing analyses and taking into account the most sensitive receptors, and therefore no additional adjustment for childhood exposure is needed.

In selecting the appropriate cleanup level at specific sites, the regions should consider the factors that are typically addressed in setting groundwater cleanup levels, such as practicability, the reliability of exposure data, whether the groundwater is used as a source of drinking water, as well as other routes of exposure. Before a region, for site-specific reasons, chooses a cleanup level either below or above the 4 to 18 ppb range, it must consult with OSWER, ORD, and OW."

Response to Comment 85(d): The table has been revised as noted and referencing the 22 January 2003 Memorandum from Marianne Lamont Horinko to EPA Regions.

(09/28/04 CRM)
EPA requested a footnote be added to Table 4-1 that states that an alternate federal perchlorate number is addressed in a document currently under review.

Resolution
The following will be added to the table:

> *"On February 18, 2005, EPA established an official reference dose (RFD) of 0.0007 mg/kg/day for perchlorate. EPA's reference dose translates to a DWEL of approximately 24.5 μg/L."*

EPA Specific Comment 86 (08/02/04) Figure 2-5 - Revise map so that it correctly depicts current data – i.e., the >4ppb plume shell extends downgradient of Pew Road, and the >1 ppb plume shell incorporates MW-225 and MW-231.

(9/02/04 Response)
Per agreement with the Agencies in the 09/11/03 FS Scoping Meeting, data up to and including May 2003 was used in the plume development and modeling. As such, the plume shells will not be adjusted to reflect more current data, for the purposes of the FS.

Resolution
The Supplemental Evaluation summary to be included as an appendix in the Final FS will include the plume data through November 2004 and assess the impact of the newer plume delineation on Alternatives 5 and 6.

EPA Specific Comment 89 (08/02/04) Figures 2-12, 2-13, 2-17 and 2-19 - Update these figures to reflect more recent perchlorate detections above 4 ppb at MW-211, and the higher levels at MW-225 and 231. Also update other figures if they do not contain up-to-date data. pretty far off – see eg. App. A, figure

(9/02/04 Response)
Per agreement with the Agencies in the 09/11/03 FS Scoping Meeting, data up to and including May 2003 was used in the conceptual site model. As such, the plume shells will not be adjusted to reflect more current data.

(09/28/04 CRM for Comment 86 and 89)
EPA indicated that they would further evaluate whether figues should be updated prior to finalization of the FS.

Resolution
The IAGWSP proposed that the FS be finalized based on data collected through May 2003 as previously agreed and that the new data be incorporated in the supplemental evaluations (submitted 04/05/05) to be provided as an appendix to the Final FS as a stand-alone evaluation.

EPA Specific Comment 94 (08/02/04) Extraction and Reinjection Rates - Upon inspection of the Figures A4-8, A4-9, and A4-10, it appears that the high rates of extraction and reinjection are creating a greater degree of dilution and recycling of water when compared to Figure A4-7, Alternative 3. That said, please discuss considerations given to different extraction rates and other configurations for reinjection (i.e., more reinjection wells).

(9/02/04 Response)
The design methodology utilized is an iterative optimization process that systematically evaluates 100s of possible extraction well locations, combinations and pumping rates. The pumping designs presented are those that best meet a given set of performance criteria i.e. (10 years to risk-based levels) and the high extraction rates are required to meet the time criteria for cleanup. An unfortunate consequence is that the plume will collapse faster in some places and extraction efficiency will decline. In practice, during the operation and maintenance phase, the ETR system pumping rates will be optimized based on performance monitoring and individual wells which no longer extract detectable mass will be packed off or shutdown

Three of the four proposed reinjection wells are part of the RRA systems presently being constructed. Those locations were determined prior to development of the subregional model used in the FS design process. In order to balance reinjection along the south side of the plume at Pew Road, a fourth location was identified to the north resulting in two pairs of wells along Frank Perkins Road and Pew Road, respectively. A third pair of candidate injection locations were identified closer to the kettle depression in the event that modeling indicated additional extraction wells were required too distant to make practical use of the Frank Perkins Road treatment system and reinjection locations. No other reinjection

scenarios were evaluated however the optimization methodology ensures that extraction rates are balanced by reinjection in each simulation iteration.

(09/28/04 CRM)
EPA requested that the response provided be included in the text of Appendix A.

Resolution
The IAGWSP agreed to include the text presented in the RCL in Appendix A of the FS.

EPA Specific Comment 119 (08/02/04) Page 14, Section 3.3.2 - Please discuss the method for determining pond depths (i.e., bathymetry).

(9/02/04 Response)
Because the ponds in question are very small and represented by only a few grid cells within the model, accurate representation of bathymetry was not possible. Average depths were estimated from site observations.

(09/28/04 CRM)
EPA requested that bathymetric detail on the Pond be provided.

Resolution
The IAGWSP agreed to measure the pond depth and include that information in the supplemental evaluations. We have measured the depth of the north pond and found it to be approximately 4 feet at its deepest point and 1.5 feet average depth. The south pond was measured to be approximately 1 foot at its deepest point and an average depth of 0.5 feet. For the purposes of the model revisions, average depths of 3 feet for north pond and 2 feet for south pond were used.

EPA Specific Comment 166 (08/02/04) Alt 6 vs. Alt 5 –
a) Please clarify discrepancies between the costs for Alternative 5 and 6. Specifically, please clarify why an additional three years of pumping, likely at the toe well, runs another $5.6M. While it is assumed that the mobile treatment system has some capital cost and additional O&M, costs identified in other portions of the cost details add up to $5.6M.

(9/02/04 Response)
There are no discrepancies between the costs for Alternative 5 and 6. Alternative 6 pumps an additional 75 gpm at the toe well and is dedicated to recovering less than ONE percent of the total mass. Three additional years of pumping for Alternative 6 is not only at the toe well, but at all wells because the system must work longer to achieve background (rather than risk-based levels).

b) In addition, EPA believes that the cost of piping for Alternative 5 and 6 should be closer. Alt. 6 was costed out with 10,580 feet ($1,428,300) of piping run, while Alt. 5 was costed out with only 5,095 feet ($687,625) of piping run. By EPA's measuring (i.e., piping run from EW-D1-604 to Pew Road), Alternative 6 only has 2,700 feet more piping than Alternative 5 Based on the information provided to us, the comparison should be slightly closer.

(9/02/04 Response)
EPA's comment regarding Alternative 6 is a moot point since they requested that this Alternative be re-routed along roadways.

(09/28/04 CRM)
EPA requested that cost information to achieve both risk-based and background concentrations for Alternatives 5 and 6 be included.

(4/05/05 Resolution)
The IAGWSP will provide the additonal cost information as part of the Supplemental Evaluations.

Attachment 2

Attachment 2
MADEP Comments, IAGWSP Responses and Resolutions
Revised Memorandum of Resolution
Revised Draft Feasibility Study
Demo 1 Groundwater Operable Unit

MADEP General Comment 1 (8/02/04) The Army/NGB provides an evaluation in the Draft FS of several extraction wellfield designs and treatment technologies for the Demo-1 groundwater plume. A CD-ROM with animations of the various remedial alternatives is provided with the Draft FS. However, figures illustrating a time-RDX/perchlorate concentration series for each of the proposed remedial alternatives would also be very helpful to the Department's evaluation of the proposed remedial alternatives. Also, please provide a table indicating all of the wells considered and ultimately used in the development of the Demo 1 RDX/perchlorate plume shells with easting and northing coordinates, well elevation in feet mean sea level (MSL), the concentration of RDX and perchlorate used in plume shell development and the date the sample was obtained.

(9/02/04 Response)
The requested information is presented in 3 dimensions in the animations attached to the FS.The quantity of maps that the DEP is requesting is sizable when one considers the number of model layers, time steps necessary to show each remedy's progress, and the number of alternatives under consideration.

A table with the wells utilized in plume shell development with the easting and northing coordinates, well elevations, and concentrations used will be provided in the Final FS.

(09/28/04 CRM)
MADEP requested time-series figures from the animated plume sequences provided on CD ROM with the FS document.

Resolution
Selected time-series figures were provided in the Supplemental Evaluations.

MADEP Comment 3 (08/02/04) The Department cannot concur at this time with the Army/NGB proposal for the use of GAC for treatment of perchlorate in groundwater. The Department will provide comments regarding treatment technologies for perchlorate after review of the results of the Pew Road Pilot Test, currently due in September 2004 and the performance of the Rapid Response Action at Demolition Area 1.

(9/02/04 Response)
Comment noted. The containerized treatment system has flexibility to accommodate different treatment media and the Army will evaluate the performance of GAC for perchlorate treatment at Pew Road under the RRA Plan.

(09/28/04 CRM)
MADEP asked about date for issuance of the Innovative Technology Evaluation (ITE) Groundwater Pilot Report.

Resolution
This report was finalized on November 29, 2004.

MADEP Comment 6 (08/02/04) Page 6, Section 2.4, Summary of Investigations and Reports: This section should include a reference to the Department letters dated June 18, 2003, July 15,

2003, and September 18, 2003 concerning the requirement for the Army/NGB to submit an Immediate Response Action (IRA) Plan to address a Condition of Substantial Release Migration (SRM) (as defined in section 40.0006 of the Massachusetts Contingency Plan), which exists at the Demo 1 groundwater plume due to the potential for the Demo 1 plume to migrate beyond the MMR boundary at more than 200 feet per year. This section should also include a brief description of the IRA Plan that was submitted by the NGB to the Department on July 8, 2003.

(9/02/04 Response)
See letter to DEP, dated 09/30/03. No change will be made to text.

(09/28/04 CRM)
MADEP disagreed with the IAGWSP response which declined to include language concerning the MADEP's assertion of SRM conditions and the necessity of completing an IRA.

Resolution
The IAGWSP agreed to include language documenting the exchange of viewpoints between MADEP and IAGWSP. The IRA Plan that was submitted to the MADEP is no longer relevant to the comprehensive remedies being evaluated in the FS since it is not expected to be acted upon given the current status of the Demo 1 remedial action. The following text is proposed for inclusion in the FS:

> *"MADEP issued a letter to the IAGWSP stating that a Condition of Substantial Release Migration was met at the Demo 1 Groundwater Operable Unit (OU) and that an Immediate Response Action (IRA) was required. A Draft Rapid Response Action (RRA) Plan was submitted on 07/08/03 for the Groundwater Operable Unit. A letter to MADEP explaining the IAGWSP position was sent to MADEP on 09/30/03. The MADEP responded to that letter on 10/28/03. They did not concur. The IAGWSP and MADEP have both expressed a desire to work together to ensure an effective response to the Demo 1 groundwater plume while acknowledging their varying points of view."*

MADEP Comment 11 (08/02/04) Page 78, Section 8.1, Conclusions: Please provide a brief comparison of the remedial alternatives with respect to estimated times for achieving background concentrations in this section.

(9/02/04 Response)
The following text will be added to Section 8.1 bulleted list:
- *Alternative 6 achieves background in the shortest timeframe (approximately 17 years).*

(09/28/04 CRM)
MADEP requested that the time to achieve both background and risk-based levels be stated.

Resolution
The IAGWSP will revise the text in Section 8 and Table 6-1 (Attachment 2) to include the time to achieve both background and risk-based levels for all alternatives but notes that

each alternative used different concentration goals during optimization. The text will be changed to read:

- *"Alternative 4 would achieve the risk-based concentrations in the shortest timeframe (approximately 10 years). Background concentrations would be reached in 15 years with this alternative.*

- *Alternative 5 is estimated to be the most cost-effective in comparison with other alternatives and would achieve risk-based concentrations within the plume in approximately 14 years. Background concentrations would be reached in 20 years.*

- *Alternative 6 is estimated to achieve risk-based concentrations within the plume in approximately 14 years. Background concentrations would be reached in approximately 17 years."*

Attachment 3

Table 6-1
Comparison of Effectiveness of Design Alternatives
Final Feasibility Study
Demo 1 Groundwater Operable Unit

				Design Details			Perchlorate Remediation			RDX Remediation		
Alternative Number	Design Alternative	Concentration Objectives	Time Objective (years)	Number of Extraction Wells	Total Extraction Rate (gpm)	Number of Injection Wells	Years to achieve RBC	Years to achieve* Background	% Mass Removed after 10 Years	Years to achieve RBC	Years to achieve Background	% Mass Removed after 10 Years
2	Baseline (RRA System)	-	-	2	320	3	36	35/>50	80.2	36	50	67.5
3	Background	Background	30	4	472	4	23	23/21	92.7	23	27	92.1
4	10 Year	Risk-based	10	5	1417	4	10	15	98.3	11	15	99.7
5	Additional Alternative A	Risk-based	<20	5	906	4	13	15/20	98.3	14	16	98.8
6	Additional Alternative B	Background	<20	6	981	4	14	15/17	97.9	14	16	99.0

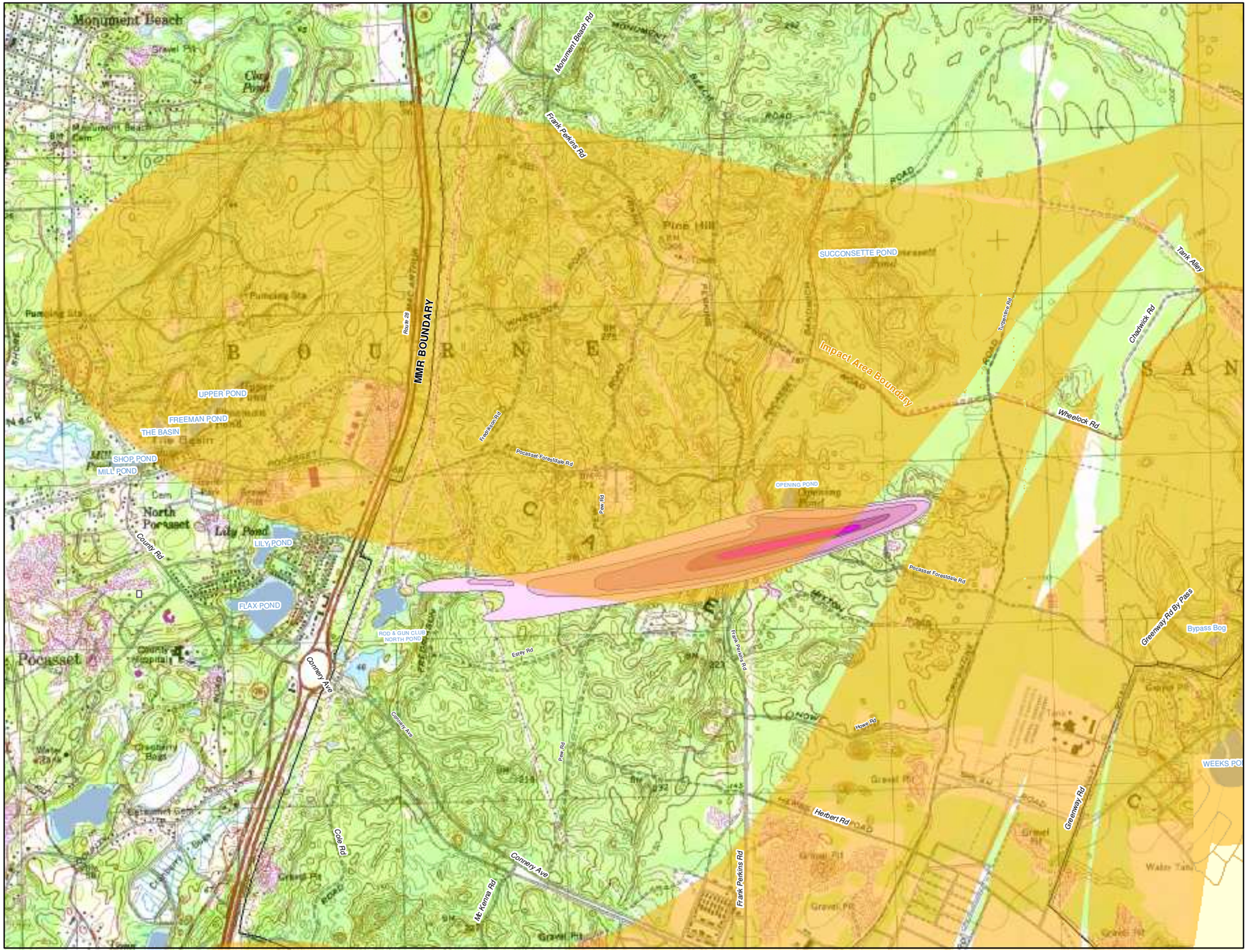
* upgradient/downgradient of Pew Road

Note: all percentages reflect cumulative mass removed including 4 years of RRA operation prior to startup of selected alternative

RBC = Risk-Based Concentrations

gpm = gallons per minute

Attachment 4



Impact Area Groundwater Study Program

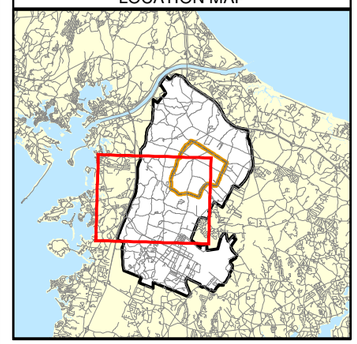
LEGEND

Approved Wellhead Protection Areas (Zone II)

Perchlorate Concentrations (Revised 11/17/04)

- ND-1
- 1-4
- 4-18
- 18-100
- >100

LOCATION MAP



NOTES & SOURCES

Map Coordinates: NAD 83, UTM, Zone 19N, Meters
Basemap data from US Geological Survey 7 1/2 minute Topographic Map Source: MassGIS

TITLE

Approved Wellhead Protection Areas (Zone II) Monument Beach

Final Feasibility Study
Demo 1 Groundwater Operable Unit

0 2,000 Feet

N

DRAFT

AMEC Earth and Environmental, Inc.
Westford, Massachusetts

J:/mmr/ReportFigs2005/D9501/D9501_Fig2-3a.pdf
G:/MMR_COE/Work2005/D9501/D9501_Fig2-3a.mxd
June 9, 2005 DWN: JBB ABF CHKD: BD

FIGURE
2-3a

Attachment 5

Attachment 5
EPA Request 04/19/05
Revised Memorandum of Resolution
Revised Draft Feasibility Study
Demo 1 Groundwater Operable Unit

EPA General Comment (04/19/05) EPA requests that the Executive Summary (page ES-5) be revised to reference the supplemental evaluation because this new appendix to the Feasibility Study supports the selected remedy using the more recent groundwater data. The last bullet in Section 8.1, Conclusions, should also reference the supplemental evaluation.

Response
See the resolution to EPA General Comment 1 in Attachment 1 above.

The following language is proposed for insertion as the second paragraph in the Executive Summary:

> *"This report has incorporated comments from EPA and DEP and was based on data available in May 2003. However, this final report has appended the Supplemental Evaluations, completed 04/05/05, which examined the performance of Alternatives 5 and 6 under conditions through November 2004 and with an updated model (see Appendix F). After re-running these two alternatives, the relative performance is consistent with the results presented in the body of the FS. This executive summary incorporates the final results of both the Revised Draft FS and the Supplemental Evaluations."*

The following language is proposed as a replacement for the last paragraph of the Executive Summary:

> *"The next step to selecting a comprehensive remedy for the Demo 1 Groundwater Operable Unit is the preparation of the Draft Remedy Selection Plan. The Draft Remedy Selection Plan will document the proposed remedial action alternative. The plan will summarize the description, analysis and comparison of all alternatives evaluated in the FS and describes the rationale for selecting the proposed remedial alternative."*

The last bullet in the list provided in Section 8.1 will be revised as follows:

- *Alternative 5 is estimated to be the most cost-effective in comparison with other alternatives and would achieve risk-based concentrations within the plume in approximately 14 years. Considering the data presented in the supplemental evaluations presented in Appendix F, it appears that as few as 11 years may be needed to reach risk-based concentrations.*

Attachment 6

Attachment 6
Response to DEP Comments 05/05/05
Revised Memorandum of Resolution
Revised Draft Feasibility Study
Demo 1 Groundwater Operable Unit

MADEP Comment #1 provided on May 5, 2005: The FS does not document that an evaluation of the feasibility of approaching or achieving background for each alternative, considered within the Feasibility Study/Remedy Selection process, is a substantive requirement, as agreed by the Army in a letter to the Department dated September 30, 2003. Please reference MGL c. 21E §3A, 310 CMR 40.0850 and 310 CMR 40.0860 in Appendix D, "Summary of Regulatory Considerations" to the FS. Please also reference the Department's Remedy Selection Plan General Comment #2, dated 4 May 2005 for further information. Please revise the FS.

Response

Alternatives 3 and 6 in the FS were developed with the goal of reaching background concentrations. Alternatives 4 and 5 were developed with the goal of reaching risk-based concentrations. However, each of these four alternatives is capable of reaching either risk-based concentrations or background. As summarized in Table 6-1 of the FS (and the revised Table 6-1 presented in this MOR as Attachment 3, the only difference is in the additional years of operation necessary to achieve background. The following language will be added to the FS:

> *"At the request of the MADEP, an evaluation was conducted to determine whether the alternatives could approach or achieve background concentrations. It was determined that while the time to achieve this varied, as shown on Table 6-1, Alternatives 3, 4, 5, and 6 were all able to achieve background concentrations."*

2. Please include the DEP approved Zone II for the Bourne Water District Monument Beach Wellfield, and any other applicable DEP approved Zone II, on each figure in the FS where a 'Zone of Contribution' is depicted.

The IAGWSP suggests that a more efficient approach would be to add a single figure to the Final FS showing the DEP approved Zone IIs in relation to the Demo 1 plume. The new figure will be added to the FS as Figure 2-3a. A copy of the figure is provided as Attachment 4 to this MOR. The figure will be referenced in Section 2.3 of the text as follows:

> *"The MADEP approved Zone IIs for the Bourne Water District Monument Beach Wellfield and other public water supplies in the vicinity of the Demo 1 plume are presented in Figure 2-3a. A Zone II is a wellhead protection area that has been determined by hydrogeological modeling and approved by the MADEP."*

Attachment 7

Table D-1
Summary of Potential Regulatory Considerations
Alternatives 1 through 6
Final Feasibility Study
Demo 1 Groundwater Operable Unit

AUTHORITY/TYPE	PROVISION	SYNOPSIS	ACTION TO BE TAKEN IN CONSIDERATION
Federal/Action Specific	SDWA MCLs, 40 CFR 141.61 – 141.63	The EPA has promulgated SDWA MCLs (40 CFR 141-143) that are enforceable standards for public drinking water supplies. The standards protect drinking water quality by limiting the levels of specific contaminants that can adversely affect public health.	Cleanup goals for the alternatives in the FS considered federal MCLs.
State/Action Specific	MA Drinking Water Regulations, 310 CMR 22.00	These standards establish Massachusetts MCLs (MMCLs) for public drinking water systems (310 CMR 22.00 et. seq.).	Cleanup goals for the alternatives in the FS considered Massachusetts MCLs (MMCLs)

Table D-1
Summary of Potential Regulatory Considerations
Alternatives 1 through 6
Final Feasibility Study
Demo 1 Groundwater Operable Unit

AUTHORITY/TYPE	PROVISION	SYNOPSIS	ACTION TO BE TAKEN IN CONSIDERATION
Federal/Action Specific	SDWA 47 FR 30282 Sole Source Aquifer	Pursuant to Section 1424(e) of the Safe Drinking Water Act, the EPA has 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. As a result of this determination, no commitment for Federal financial assistance (through a grant, contract, loan guarantee, or otherwise) may be entered into for any project which the Administrator determines may contaminate such aquifer through a recharge zone so as to create a significant hazard to public health, but a commitment for Federal financial assistance may, if authorized under another provision of law, be entered into to plan or design the project to assure that it will not so contaminate the aquifer. (47 FR 30282, Tuesday July 13, 1982)	Groundwater will be treated in accordance with Federal/State Drinking Water Standards before recharge so that implementation of any remedy would not contaminate the aquifer through a recharge zone.

Table D-1
Summary of Potential Regulatory Considerations
Alternatives 1 through 6
Final Feasibility Study
Demo 1 Groundwater Operable Unit

AUTHORITY/TYPE	PROVISION	SYNOPSIS	ACTION TO BE TAKEN IN CONSIDERATION
Federal/Action Specific	Resource Conservation and Recovery Act (RCRA) [40 CFR 261; 40 CFR 262.34]	Resource Conservation and Recovery Act (RCRA) regulations at 40 CFR 261.24 identify the concentrations of contaminants that make a waste material a RCRA-characteristic hazardous waste for toxicity. 2,4-DNT is the only COC that has a Toxicity Characteristic Leaching Procedure (TCLP) limit, i.e., 130 μg/l. .	Spent activated carbon and other solid waste sent offsite for disposal will be analyzed, and if the results exceed the standards in §261.24, or otherwise constitute hazardous wastes, the material will be treated and/or disposed of offsite in a RCRA-permitted treatment storage and disposal facility. Hazardous wastes will be identified at the point of generation , and will be accumulated in accordance with requirements of 40 CFR 262.34(a) on-site for no greater than 90 days without a RCRA permit. If hazardous wastes are accumulated for greater than 90 days a RCRA permit would be required.
Federal/Action Specific	RCRA Land Disposal Restrictions [40 CFR 268]	These regulations restrict the disposal of any treatment wastes classified as hazardous waste.	Hazardous wastes generated from the treatment process, if any, may require treatment before offsite land disposal.
State/Action Specific	Solid Waste Management Regulations (RCRA Subtitle D), 310 CMR 19.000 et seq.	If a waste is determined to be a solid waste, it must be managed in accordance with the state regulations at 310 CMR 19.000 et seq.	Any solid wastes generated and determined to be non-hazardous will be managed in accordance with these regulations and disposed of appropriately.
State/Action Specific	Hazardous Waste Operations and Emergency Response, 29 CFR 1910.120	These regulations describe training, monitoring, planning, and other activities to protect the health of workers performing hazardous waste operations.	These worker protection standards would be followed to protect the health of workers if any primary or secondary wastes are determined to be RCRA characteristically hazardous.

Table D-1
Summary of Potential Regulatory Considerations
Alternatives 1 through 6
Final Feasibility Study
Demo 1 Groundwater Operable Unit

AUTHORITY/TYPE	PROVISION	SYNOPSIS	ACTION TO BE TAKEN IN CONSIDERATION
Federal/Action Specific	Underground Injection Control Program [40 CFR 114, 146, 147, 1000]	Underground Injection Control Program (40 CFR 114, 146, 147, 1000) regulations outline minimum program and performance standards for underground injection wells and prohibit any injection that may cause a violation of any primary drinking water regulation in the aquifer. Infiltration galleries fall within the broad definition of Class V wells. These regulations are administered by the State. See description of State regulations below.	Extracted groundwater will be treated to levels at or below federal and state primary drinking water standards (where they exist) to ensure that discharges to the aquifer will not cause any violation of these standards in the aquifer. The substantive components of the Massachusetts Contingency Plan, 310 CMR 40.0040, Management Procedures for Remedial Wastewater and Remedial Additives will be adequately addressed as part of the planned approach for operation and maintenance of the treatment systems.
Federal/Action Specific	RCRA Section 3020	EPA guidance concerning the "Applicability of RCRA Section 3020 to In Situ Treatment of Ground Water" (EPA 2000) could also pertain to this remedial action component. The extracted groundwater would not be a listed or characteristic hazardous waste, therefore this regulatory interpretation would not be legally applicable. It could, however, be relevant and appropriate to groundwater recharge.	Requirements will be taken into account in regulating discharge of treated groundwater.

Table D-1
Summary of Potential Regulatory Considerations
Alternatives 1 through 6
Final Feasibility Study
Demo 1 Groundwater Operable Unit

AUTHORITY/TYPE	PROVISION	SYNOPSIS	ACTION TO BE TAKEN IN CONSIDERATION
Federal/Action Specific	National Environmental Policy Act of 1969 (NEPA; 42 USC 4321 et seq.) and CEQ Regulations (4 CFR 1500-1508)	"EPA believes that NGB is not required to follow NEPA procedures, as long as the NGB's actions are conducted in accordance with the administrative order, because of the provision in the CEQ regulations exempting enforcement actions from NEPA." (USEPA, 1 March 01) The Environmental Standard Operating Procedures (ESOP) Manual (AMEC, August 2001) establishes a standard procedure for identifying and minimizing impacts to environmental resources through siting of structures, careful installation, and scheduling of construction work. This procedure was developed in consideration of the National Environmental Policy Act (NEPA; 42 USC 4321 et seq.); Council on Environmental Quality (CEQ) Regulations Implementing the Procedural Provisions of NEPA (40 CFR 1500-1508); and Army Regulation (AR) 200-2.	As applicable, a Record of Action for remedial actions will be prepared for review by the Natural Heritage and Endangered Species Program, State Historic Preservation Office and Tribal Historic Preservation Office.

Table D-1
Summary of Potential Regulatory Considerations
Alternatives 1 through 6
Final Feasibility Study
Demo 1 Groundwater Operable Unit

AUTHORITY/TYPE	PROVISION	SYNOPSIS	ACTION TO BE TAKEN IN CONSIDERATION
State/ Chemical Specific	Massachusetts Air Pollution Control Regulations [310 CMR 6.00 – 7.00]	Construction activities could trigger Massachusetts Air Pollution Control Regulations (310 CMR 6.00 – 7.00). These regulations set emission limits necessary to attain ambient air quality standards for fugitive emissions, dust and particulates.	Engineering controls, such as dust suppression, would be used as necessary to comply with these regulations for fugitive emissions, dust, and particulate emissions during site construction activities.
State/Action Specific, Chemical Specific	310 CMR 40.0040 Construction and operation of a groundwater treatment plant	Regulations establish management procedures for remedial wastewater as well as the construction, installation, change, operation and maintenance of treatment works for Remedial Wastewater. Treatment works shall be inspected and the inspections documented. Treatment works shall be protected from vandalism and measures shall be taken to prevent system failure, contaminant pass through, interference, by-pass, upset, and other events likely to result in a discharge of oil and/or hazardous material to the environment.	The substantive components of the Massachusetts Contingency Plan, 310 CMR 40.0040, Management Procedures for Remedial Wastewater and Remedial Additives will be adequately addressed as part of the planned approach for operation and maintenance of the treatment systems.

Table D-1
Summary of Potential Regulatory Considerations
Alternatives 1 through 6
Final Feasibility Study
Demo 1 Groundwater Operable Unit

AUTHORITY/TYPE	PROVISION	SYNOPSIS	ACTION TO BE TAKEN IN CONSIDERATION
State/Action Specific, Chemical Specific	Discharge of Groundwater 310 CMR 40.0045	Regulations restrict remedial wastewater discharge to the ground surface or subsurface and/or groundwater. Such a discharge should not erode or impair the functioning of the surficial and subsurface soils, infiltrate underground utilities, building interiors or subsurface structures, result in groundwater mounding within two feet of the ground surface, or result in flooding or breakout to the ground surface. The concentrations of all pollutants discharged must be below the Massachusetts Groundwater Quality Standards established by 314 CMR 6.0. The concentrations must also be below the applicable Reportable Concentrations established by 310 CMR 40.0300 and 40.1600.	The substantive components of the Massachusetts Contingency Plan, 310 CMR 40.0040, Management Procedures for Remedial Wastewater and Remedial Additives will be adequately addressed as part of the planned approach for operation and maintenance of the treatment systems. The detailed plan for monitoring, inspecting and reporting on the performance of the extraction, treatment and recharge systems will be presented in the System Performance and Ecological Impact Monitoring (SPEIM) Plan, which will be submitted to the MADEP for review.

Table D-1
Summary of Potential Regulatory Considerations
Alternatives 1 through 6
Final Feasibility Study
Demo 1 Groundwater Operable Unit

AUTHORITY/TYPE	PROVISION	SYNOPSIS	ACTION TO BE TAKEN IN CONSIDERATION
State/Action Specific	Discharge of Groundwater 310 CMR 40.0300 and 310 CMR 40.1600	The MCP contains special provisions for the discharge of groundwater containing very low levels of oil or hazardous material. Groundwater containing oil and/or hazardous material in concentrations less than the applicable release notification threshold established by 310 CMR 40.0300 and 40.1600, can be discharged to the ground subsurface and/or groundwater only when following appropriate guidelines.	The substantive components of the Massachusetts Contingency Plan, 310 CMR 40.0040, Management Procedures for Remedial Wastewater and Remedial Additives will be adequately addressed as part of the planned approach for operation and maintenance of the treatment systems. The detailed plan for monitoring, inspecting and reporting on the performance of the extraction, treatment and recharge systems will be presented in the System Performance and Ecological Impact Monitoring (SPEIM) Plan, which will be submitted to the MADEP for review.

Table D-1
Summary of Potential Regulatory Considerations
Alternatives 1 through 6
Final Feasibility Study
Demo 1 Groundwater Operable Unit

AUTHORITY/TYPE	PROVISION	SYNOPSIS	ACTION TO BE TAKEN IN CONSIDERATION
State/Action Specific	Groundwater Discharge Regulations [314 CMR 5.00]	Recharge of effluent from some treatment works requires a permit under Groundwater Discharge Regulations at 314 CMR 5.00 unless the exemption allowing for actions taken in compliance with MGL C. 21E and regulations at 40 CMR 40.00 applies. The effluent discharged must not exceed any Massachusetts Groundwater Quality Standards and effluent limitations in 314 CMR 6.0. The MADEP has determined that effluent from the Demo 1 treatment system is “conditionally exempt” from obtaining the permit provided that the applicable or relevant provisions of the MCP 310 CMR 40 are complied with (as per letter from MADEP dated 13 February 2004). .	The substantive components of the Massachusetts Contingency Plan, 310 CMR 40.0040, Management Procedures for Remedial Wastewater and Remedial Additives will be adequately addressed as part of the planned approach for operation and maintenance of the treatment systems. Treated effluent which is recharged to the aquifer will not exceed Massachusetts groundwater quality standards. The detailed plan for monitoring, inspecting and reporting on the performance of the extraction, treatment and recharge systems will be presented in the System Performance and Ecological Impact Monitoring (SPEIM) Plan, which will be submitted to the MADEP for review.

Table D-1
Summary of Potential Regulatory Considerations
Alternatives 1 through 6
Final Feasibility Study
Demo 1 Groundwater Operable Unit

AUTHORITY/TYPE	PROVISION	SYNOPSIS	ACTION TO BE TAKEN IN CONSIDERATION
State/Action Specific	Underground Injection Control [310 CMR 27.00]	Regulates any underground injection of hazardous wastes, of fluids used for extraction of minerals, oil, and energy and of certain other fluids with the potential to contaminate groundwater in order to protect underground sources of drinking water.	The substantive components of the Massachusetts Contingency Plan, 310 CMR 40.0040, Management Procedures for Remedial Wastewater and Remedial Additives will be adequately addressed as part of the planned approach for operation and maintenance of the treatment systems. The detailed plan for monitoring, inspecting and reporting on the performance of the extraction, treatment and recharge systems will be presented in the System Performance and Ecological Impact Monitoring (SPEIM) Plan, which will be submitted to the MADEP for review.

Attachment 8

Attachment 8
EPA and MADEP Comments on Supplemental Evaluations
Revised Memorandum of Resolution
Revised Draft Feasibility Study
Demo 1 Groundwater Operable Unit

EPA Comment 1 (04/19/05) Page F-6, Section 3.0, 2nd and 3rd Paragraph: Please discuss why the images showing the plume at +10, +15, and +17 years in Figure F3-2 and F3-3 shows Perchlorate persisting in the area around EW-D1-603 while the text and tables present the conclusion that cleanup to 1 ppb is achieved.

Response

Figures F3-2 and F3-3 (and also F3-4) portray maximum predicted concentrations within the 3-dimensional subsurface groundwater simulation projected onto the map plane. The maximum concentration is projected irrespective of depth. In the case of Demo 1 (and elsewhere on MMR) varying types of soil are present including both highly permeable sand and gravel aquifer materials and poorly permeable silts and clays that constitute an aquitard of limited local extent. The presence of this aquitard is influencing the vertical movement of the plume, essentially preventing downward migration that would result from the prevailing downward hydraulic gradients. On figures F3-2 and F-3-3, the estimated lateral extent of the interpreted aquitard is indicated with a dashed brown line.

In the groundwater flow simulation the aquitard is assigned a hydraulic conductivity of 0.5 feet/day, roughly 2-3 orders of magnitude lower than the surrounding aquifer materials but still permeable to water (and therefore to contaminant mass). This value is based on published values for silts and clays and is also consistent with values assigned to similar bodies elsewhere on MMR. While the aquitard is likely to be less conductive than assumed, it is standard modeling practice to account for potential heterogeneities and discontinuities (i.e. sandy zones) by using a conservative (slightly higher) value. As a consequence of this slight permeability and the downward gradients induced by recharge accretion at the water table, water and plume mass moves vertically downward where the plume is mapped to be directly above and adjacent to the clay. Once in the clay, groundwater velocity declines significantly and the plume mass stagnates. Because the unit is so poorly permeable, plume mass cannot be pumped out by extraction wells.

The concentrations don't change appreciably after 10 years. The 2-d plan view figures (prepared at the Agencies request) cannot distinguish between what is inside the aquitard and what may be above or below it. Their practical value is limited to comparing the lateral extent of contamination over time, particularly downgradient of the clay aquitard.

The 3-d animations (as shown during the Supplemental Evaluations presentation and included in the FS) are a better representation of concentrations at any point in the aquifer and aquitard. It is from this 3-d perspective that time-to-cleanup within the aquifer materials was evaluated, the results of which are compiled in Table F3-1. Table F3-1 indicates that the time required to achieve 1 ppb of perchlorate throughout the productive parts of the aquifer is predicted to be 11 years. The concentrations predicted to linger in the aquitard were not included because that is not a productive part of the aquifer. Note that the model accounts for seepage of contaminant mass out of the aquitard so contaminant concentrations shown downgradient of the clay layer on the 2-d figures are also conservatively predicted (i.e. probably higher than what will actually occur) although the impact is quite small.

The following text will be inserted into the document;

"The perchlorate concentrations portrayed within the dashed brown line on Figures F3-2 and F3-3 for year 2017 and after represent plume mass which the model predicts will stagnate within the clay zone. Because this portion of the aquifer is not productive due to low permeability, it has not been included in the estimated timeframes for remediation of the plume as summarized in Table F3-1."

EPA Comment 2 (04/19/05) Figure F3-3: See above comment on Section 3.0. Please clarify why it appears that the Perchlorate plume in Figure F3-3 persists longer than the estimated years to achieve clean up in Table F3-1.

Response
See response to Comment 1 above.

EPA Comment 3 (04/19/05) Table 6-1 and Table F3-1: Please clarify why Table 6-1 of the FS (as revised for the MOR) and Table F3-1 are different.

Response
One of the important model updates described in the Supplemental Evaluation documentation is the reduction of effective porosity from 39% to 35%. Groundwater transport velocity is linearly related to this parameter and therefore time-of-travel (and corresponding time-to-cleanup) estimates decrease by 10% due to that change alone.

Several other model updates were also implemented (in addition to the plume revision) and therefore Table F3-1 represents the most accurate prediction of system performance for the 5 and 6 well designs.

The supplemental evaluation confirmed the predictions of relative performance put forth for Alternatives 5 and 6 in the original FS. In order to compare Alternatives 1 through 6 on an equivalent basis it was determined best to present the original results in the final FS as compiled in Table 6-1 and to consider the revised timeframes for Alternatives 5 and 6 in the Remedy Selection Plan only.

EPA Comment 4 (04/19/05) Figure F3-1: a) Add pipelines along Fredrikson Rd between the treatment facility and the reinjection well (IW-D1-5). b) Please clarify why reinjection well was placed to the north of the Fredrikson Road treatment facility rather than the south.

Response
A pipeline will be added to Fredrickson Road between the treatment facility and reinjection well IW-D1-5.

Reinjection well locations are placed so as to have minimal impact on the plume trajectory. The reinjection well location was placed to the north of the treatment facility because the distance from MW-258 was shorter than it would be by placing the reinjection well beyond the possible trajectory of the plume south of MW-252.

Attachment 8
EPA and MADEP Comments on Supplemental Evaluations
Revised Memorandum of Resolution
Revised Draft Feasibility Study
Demo 1 Groundwater Operable Unit

MADEP General Comment 1 (04/25/05) - The Department requests that the specific remedial action objective for the Demolition Area-1 groundwater operable unit as referenced on page 30 of the Draft FS be modified as follows (please insert underlined text); *"Prevent potential ingestion and inhalation of water containing COCs (RDX, HMX, 2,4-DNT, 2A-DNT, 4A DNT, TNT and perchlorate) in excess of background levels (to the extent technically feasible), federal maximum contaminant levels (MCLs), State MCLs, Health Advisories, State Health Advisories, Drinking Water Equivalent Levels (DWELs), or an unacceptable excess lifetime cancer risk or non-cancer Hazard Index*."

Response
Please see response to EPA's General Comment 1 in Attachment 1 of this MOR.

MADEP General Comment 2 (04/25/05) The Department is not in agreement with the Army/NGB model predictions generated for the Supplemental Evaluation. The Army/NGB indicates on page F-2, **"The objective of the sensitivity analysis is to evaluate a hypothetical perchlorate mass distribution at and downgradient of Pew Road to assess the level of confidence that the portion of the perchlorate plume that is not captured by the Pew Road extraction well will naturally attenuate to acceptable levels within a reasonable timeframe."** Areas where the Department is in disagreement with the Army/NGB are identified in the specific comments section of this letter. The Department suggests that in order to proceed with finalizing the Draft FS, the agencies agree to disagree regarding the model-predictions for Alternative 5 and 6.

Response
The IAGWSP agrees with MADEP that it is in the best interest of the project to move forward with the understanding that the DEP and the IAGWSP are not in complete agreement at this time on the likely fate of the plume. Please note that the text quoted in the MADEP's comment is from the hypothetical situation used to test the sensitivity of the predictions to higher concentrations than what have been demonstrated to actually exist in the plume. That hypothetical case is not intended to portray the actual fate of the plume as we currently understand it.

MADEP Specific Comment 2 (04/25/05) Page F-7, Section 3.0: Attachment 1: Supplemental Evaluations – Final Feasibility Study: The text states **"The relative effect of the 5 and 6 well systems on plume migration can be interpreted by comparing Figures F3-2 and F3-3. The plume extent at startup in 2007 is shown in both figures to be approximately 100 feet east of the northern tip of North Pond. In Figure F3-3 the maximum plume advance is shown at +15 years to be approximately 150 feet west of the northern tip of North Pond (and remains under the ponds extent). Therefore, the plume advances an additional 250 feet into a portion of the aquifer that is precluded from development as a water supply due to the presence of the pond. "**. This model outcome is not credible to the Department. The Department anticipates that the portion of the Demo 1 plume downgradient of the extraction system at Pew Road will continue to advance with minimal attenuation and at a rate comparable to the advective velocity of the groundwater without a leading edge extraction well and that North Pond will exert minimal, if any, hydraulic influence upon the plume due the shallowness and limited volume of groundwater discharging to North Pond. There are numerous examples (i.e. Ashumet Valley, CS-10, FS-28, etc.) of Massachusetts Military Reservation (MMR) plumes that underflow much larger and deeper ponds than North Pond.

The MMR CS-23 plume provides a comparable analogy to the Demo 1/North Pond interaction where the top of the CS-23 plume is approximately 40 feet below the groundwater table (comparable to the depth of the perchlorate contamination in Demo 1 monitoring well MW-258) as it approaches Osborne Pond. Cross-sections E-E' (Figure 3-7) and F-F' (Figure 3-8) provided in the *Final Chemical Spill-23 Remedial Investigation* dated March 2005 indicate that the CS-23 plume underflows Osborne Pond, which is comparable in size and depth to North Pond, without any discernible impact upon the flow trajectory of the CS-23 plume.

In addition, the Department notes that Figure F3-3 indicates that the maximum downgradient extent of the 1-4 ug/L model-computed perchlorate concentration by startup year 2007 terminates approximately 500 feet upgradient of Fredrikson Road. However, perchlorate concentrations greater than 1 ug/L are already being observed at MW-258 located just upgradient of Fredrikson Road. The December 2004 sampling results at MW-258 reported perchlorate concentrations of 0.47J ug/L, 1.62 ug/L and 1.01 ug/L for the M1, M2 and M3 well screens, respectively. Therefore, the model does not accurately reflect the distribution of perchlorate mass already known to be downgradient of Pew Road. Perchlorate concentrations have increased in all three well screens at MW-258 since it was installed in early 2003. This conclusively demonstrates the ability of perchlorate concentrations in the 1-4 ug/L concentration range to substantially migrate in the aquifer with minimal natural attenuation.

Lastly, the Department recommends that the portion of the highlighted text that reads **"…into a portion of the aquifer that is precluded from development as a water supply due to the presence of the pond."** be eliminated. The determination of whether a portion of the aquifer is useable is made solely by the Department and the local Water District. The pond is located in a region of the aquifer that is considered to be potentially productive by the Department.

Response

The IAGWSP agrees that the pond should be expected to have minimal impact on the plumes horizontal trajectory. The attenuation of the plume, although slightly impacted by predicted vertical gradients beneath the pond, is achieved mostly through dispersion and dilution as it moves horizontally with the flow of the groundwater.

The 1 ppb contour referenced in paragraph 3 of the MADEP's comment is currently mapped but is predicted to dissipate to levels below 1 ppb by 2007, the first year shown on the referenced figure. That is why the figure and the current understanding of the plume are different.

In response to paragraph #4 of the MADEP comment – while development of a water supply well close to North Pond is theoretically possible, the associated drawdown and resulting ecological impact on the area around the pond makes this an unlikely area for development as a water supply. However, at DEP's request, the text will be deleted.

MADEP Specific Comment 3 (04/25/05) Page F-8, Section 4.0 -Attachment 1: Supplemental Evaluations – Final Feasibility Study:

The text indicates, **"The implementation of a 6th well would:**

- **Reduce further downgradient migration of perchlorate by ~250 feet:**

- **Reduce time to achieve 0.35 ug/L downgradient of Pew Road by two years:**
- **Capture 1% more of the total perchlorate mass; and**
- **Result in a maximum perchlorate influent concentration of 0.4 ug/L, which will only exceed the 0.35 ug/L for the initial four years of operation of the 6th well"**.

The Department notes that the stated performance of a 6th extraction well at Fredrikson Road is a model-prediction only and is not based upon empirical evidence. The Department is not confident in the model-predictions for the performance of a 6th extraction well due to the reasons provided in specific comment #2. Perchlorate concentrations greater than 1 ug/L are already being observed in the vicinity of Fredrikson Road (i.e. MW-258). Therefore, the Department anticipates that without active treatment of the leading edge, the Demo 1 plume downgradient of Pew Road will continue to migrate at a rate comparable to the advective velocity of the groundwater with minimal attenuation. The Department also anticipates (based upon the December 2004 sampling results at MW-258) that there would be higher perchlorate influent concentrations in the 6th extraction well and the extraction well would capture more than 1% of the total perchlorate mass in the Demo-1 plume.

Response

While the model is only a prediction, it is based on empirical evidence from the monitoring wells throughout Demo 1. The dispersion rates, groundwater velocities, hydraulic conductivities and other important parameters are all derived from empirical data. The model is the best tool available for predicting fate and transport of the plume, but it remains just a prediction. There are likely to be some areas where migration of the plume is underpredicted, and areas where migration is overpredicted. On the whole, we expect the plume behavior to be similar to the modeled prediction. The model will be updated throughout the operation of the ETR systems through the SPEIM program.

Attachment 9

Attachment 9
Revised Executive Summary
Revised Memorandum of Resolution
Revised Draft Feasibility Study
Demo 1 Groundwater Operable Unit

This Final Feasibility Study (FS) presents the evaluation of alternatives to remediate explosives and perchlorate contamination in groundwater at Demolition Area 1 (Demo 1) at Camp Edwards, pursuant to United States Environmental Protection Agency (EPA) Administrative Orders Safe Drinking Water Act (SDWA) I-97-1019 (AO1) and 1-2000-0014 (AO3).

This report has incorporated comments from EPA and DEP and was based on data available in May 2003. However, this final report has appended the Supplemental Evaluations, completed 04/05/05, which examined the performance of Alternatives 5 and 6 under conditions through November 2004 and with an updated model (see Appendix F). After re-running these two alternatives, the relative performance is consistent with the results presented in the body of the FS. This executive summary incorporates the final results of both the Revised Draft FS and the Supplemental Evaluations.

Demo 1 is located north of Pocasset Forestdale Road and south of the Impact Area at Camp Edwards, west of Turpentine Road and east of Frank Perkins Road. The site 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. Explosive ordnance disposal and demolition training at Demo 1 from the mid 1970's to the late 1980's included the destruction of various types of ordnance and fireworks using explosive charges of C4, a plastic explosive; 2,4,6-trinitrotoluene (TNT), and detonation cord. The predominant explosive compounds used in demolition munitions are hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) followed by TNT. A major component of rockets and fireworks is perchlorate (ClO_4^-).

Seven explosive and propellant compounds (RDX, TNT, octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine [HMX], 2-amino-4,6-dinitrololuene [2A-DNT], 4-amino-2,6-dinitrotoluene [4A-DNT], 2,4-dinitrotoluene [2,4-DNT] and perchlorate have been consistently detected in groundwater and are identified as the contaminants of concern (COCs) in groundwater for the Demo 1 Groundwater Operable Unit. These contaminants are all directly related to past demolition and disposal activities and have been detected in soil at Demo 1.

RDX and TNT have been detected in groundwater at Demo 1 at maximum concentrations of 370 micrograms per liter (μg/L) and 16 μg/L, respectively. Perchlorate has been detected in groundwater at Demo 1 at a maximum concentration of 500 μg/L. The measured extent of the perchlorate plume is approximately 9,400 feet long and 1,000 feet wide, and the measured extent of the RDX plume is approximately 7,300 feet long and 500 feet wide. The RDX plume and all other COC plumes are contained within the perchlorate plume.

The Remedial Action Objectives for groundwater at Demo 1 are to protect the health of persons from contaminants in, or likely to enter, a sole source of drinking water; and to restore the useable groundwaters to their beneficial uses wherever practicable within a reasonable timeframe. The Sagamore Lens, part of the Cape Cod aquifer, underlies Camp Edwards and is susceptible to contamination.

The EPA Lifetime Health Advisory for RDX and TNT in drinking water is 2 μg/L. There is no Federal Maximum Contaminant Level or EPA Lifetime Health Advisory for perchlorate.

Attachment 9
Revised Executive Summary
Revised Memorandum of Resolution
Revised Draft Feasibility Study
Demo 1 Groundwater Operable Unit

In January 2003, EPA issued a memorandum re-affirming 1999 interim guidance that results in a provisional risk-based cleanup range from 4 to 18 μg/L for perchlorate. The range (4-18 μg/L) is considered to be protective based on recent, ongoing analyses and taking into account the most sensitive receptors, and therefore no additional adjustment for childhood exposure is needed. In the absence of a finalized oral health risk benchmark for perchlorate, but in light of ongoing assessment activities by EPA, states and other interested parties, EPA re-affirmed this guidance with an added suggestion to carefully consider the low end of the provisional range. According to this 2003 memorandum, the 1999 interim guidance remains the applicable guidance until supplanted by new guidance based on a finalized risk assessment.

In February 2005, EPA established an official reference dose (RfD) of 0.0007 mg/kg/day of perchlorate. A reference dose is a scientific estimate of a daily exposure level that is not expected to cause adverse health effects in humans. EPA's new RfD translates to a Drinking Water Equivalent Level (DWEL) of 24.5 μg/L. A Drinking Water Equivalent Level, which assumes that all of a contaminant comes from drinking water, is the concentration of a contaminant in drinking water that will have no adverse effect with a margin of safety. Because there is a margin of safety built into the RfD and the DWEL, exposures above the DWEL are not necessarily considered unsafe. EPA plans to issue guidance based on the new RfD.

In April 2002, the Massachusetts Department of Environmental Protection (DEP) issued a 'Massachusetts Interim Drinking Water Advice for Perchlorate' to the Bourne Water District in response to the low concentrations of perchlorate detected in groundwater samples collected from wells within the Monument Beach Well Field. The DEP recommended that "pregnant women, infants, children up to the age of twelve, and individuals with hypothyroidism avoid drinking water containing concentrations of perchlorate exceeding 1 μg/L". This guidance, along with information on statewide perchlorate testing, was sent to all state water suppliers in January 2004 with instructions that testing would begin in April 2004. In addition, the DEP published a draft cleanup standard of 1 μg/L for comment in November 2004.

In September 2004, the IAGWSP implemented a groundwater Rapid Response Action (RRA) at Demo 1. The purpose of the groundwater RRA is to begin removing contamination in the plume while continuing to evaluate the feasibility of comprehensive remedial actions and determining a comprehensive remedial action. The RRA includes extraction and treatment of contaminated groundwater from two areas within the plume: one near Frank Perkins Road and another at Pew Road, between Estey and Pocasset Forestdale Roads.

A wide range of potential remedial technologies and process options were identified and screened based upon their potential ability to remediate the COCs. Process options were then combined into remedial alternatives that represented a range of treatment options. The evaluation conducted in the Draft FS (AMEC, 2001d) formed the basis for the selection of the extraction, treatment and recharge (ETR) components for the groundwater RRA Plan. Because the groundwater RRA is in operation prior to implementation of the comprehensive remedial action, the groundwater RRA ETR components are incorporated, where feasible, into each of the comprehensive remedial alternatives.

The IAGWSP is also implementing a Soil Rapid Response Action (RRA) at Demo 1. The purpose of the Soil RRA is to remove munitions and ordnance and related contaminants from

soils that were the source of the Demo 1 groundwater plume. The RRA includes excavation and thermal treatment of contaminated soil from the Demo 1 source area.

The objective of the RRA Plan for the Demo 1 Soil OU (AMEC, 2003b) is to reduce or eliminate potential risks to human health present at Demo 1 as a result of historic open burn, open detonation, disposal and demolition training activities. The Soil RRA will eliminate the continuing source to groundwater contamination at Demo 1 associated with geophysical anomalies and contaminated soil.

The Soil RRA Plan includes:

- Removal of geophysical anomalies within the perimeter road at Demo 1 (approximately 7.4 acres),
- Excavation of approximately 16,000 cubic yards of contaminated soil,
- Off-site disposal of "burn pit" materials,
- On-site treatment of the soil (16,000 cubic yards) via thermal treatment to remove COCs from the soil,
- Restoration of the site through reuse of treated soil determined to be acceptable.

Anomaly removal began in mid-2003 and soil excavation began in late 2003. Thermal treatment began in Winter 2004 and was completed during Summer 2005. Treated soil meeting cleanup goals will be returned to the Demo 1 depression and final site restoration will be completed.

The six comprehensive remedial alternatives developed for the Demo 1 Groundwater Operable unit include:

- Alternative 1 – Minimal Action. Alternative 1 provides a minimal action alternative for comparison with other alternatives. This alternative includes institutional controls and long-term monitoring only.

- Alternative 2 – Baseline. Alternative 2 provides a baseline alternative for comparison with other alternatives based on the continued operation of the groundwater RRA ETR systems. According to groundwater modeling performed during this FS, Alternative 2 would achieve risk-based concentrations for the COCs in 36 years. Alternative 2 would entail pumping groundwater at a total flow rate of approximately 320 gallons per minute (gpm) from two locations, treatment via ion exchange (IX) resin to remove perchlorate and granular activated carbon (GAC) media to remove explosive compounds, and recharge of treated water via three injection wells. It would also include construction of a permanent structure to house the treatment system at Frank Perkins Road, long-term groundwater monitoring and institutional controls. The treatment system at Pew Road would continue to utilize the single mobile treatment container of the RRA treatment system using GAC media.

- Alternative 3 - Background. Alternative 3 is designed to provide an alternative that would be expected to achieve risk-based concentrations for the COCs within 23 years and background concentrations within 27 years according to groundwater modeling

performed during this FS. Alternative 3 includes a total of four extraction wells (including the two existing groundwater RRA extraction wells) located along the plume axis with one leading edge extraction well on Fredrikson Road and pumping at a combined flow rate of 472 gpm. Similar to Alternative 2, a combination of IX resin and GAC media would be utilized to treat the extracted water at a permanent treatment structure at Frank Perkins Road. A fourth injection well would be added to recharge the treated water to the aquifer in the downgradient area. Treatment at Pew Road would be via three mobile treatment containers utilizing GAC media. This alternative also includes long-term groundwater monitoring and institutional controls.

- Alternative 4 - 10 Year. Alternative 4 includes a total of five extraction wells (including the two existing groundwater RRA extraction wells) located along the plume axis and pumping at a combined flow rate of 1,417 gpm. This alternative is the most aggressive cleanup scenario evaluated in this FS. According to groundwater modeling performed during this FS Alternative 4 is designed to achieve risk-based levels for the COCs within 10 years and background concentrations within 15 years. Similar to Alternative 3, a combination of IX resin and GAC media would be used to treat the extracted water at a permanent treatment structure at Frank Perkins Road and four injection wells would be used to recharge the treated water to the aquifer. Treatment at Pew Road would be via three mobile treatment containers utilizing GAC media. This alternative also includes long-term groundwater monitoring and institutional controls.

- Alternative 5 - Additional Alternative A. Alternative 5 includes a total of five extraction wells (including the two existing groundwater RRA extraction wells) located along the plume axis and pumping at a combined flow rate of 906 gpm. This alternative would be expected to achieve risk-based levels for the COCs within 11 years and background concentrations within 19 years, according to the Supplemental Evaluations (Appendix F). Similar to Alternative 3, Alternative 5 would also use a combination of IX resin and GAC media to treat the extracted water at a permanent treatment structure at Frank Perkins Road and four injection wells would be used to recharge the treated water to the aquifer. Treatment at Pew Road would be via one mobile treatment container utilizing GAC media. This alternative also includes long-term groundwater monitoring and institutional controls.

- Alternative 6 - Additional Alternative B. Alternative 6 includes a total of six extraction wells (including the two existing groundwater RRA extraction wells) located along the plume axis with one leading edge extraction well on Fredrikson Road and pumping at a combined flow rate of 981 gpm. Alternative 6 would be expected to achieve risk-based levels for the COCs within approximately 11 years and background concentrations within 17 years, according to groundwater modeling performed during the Supplemental Evaluations (Appendix F). Similar to Alternative 3, a combination of IX resin and GAC media would be used to treat the extracted water at a permanent treatment structure at Frank Perkins Road and four injection wells would be used to recharge the treated water to the aquifer. Treatment at Pew Road would be via two mobile treatment containers utilizing GAC media. This alternative also includes long-term groundwater monitoring and institutional controls.

Each of these remedial alternatives was evaluated in detail according to the threshold and primary balancing criteria identified below. The modifying criteria identified below will be assessed based upon input from DEP and the public.

Category	Criteria
Threshold	Overall protection of human health and the environment, including prevention of the movement of contaminants into the aquifer and its preservation as a drinking water supply
	Compliance with regulations
Primary Balancing	Long-term effectiveness and permanence
	Reduction of toxicity, mobility, and volume through treatment
	Short-term effectiveness
	Implementability
	Cost
Modifying	State Acceptance
	Community Acceptance

Following the detailed analysis, the six comprehensive remedial alternatives were compared. The comparison highlighted the relative advantages and disadvantages of the alternatives with respect to the seven threshold and primary balancing criteria. A summary of the comparative analysis follows.

Alternatives 3 through 6 all have the potential to protect human health and restore the aquifer to beneficial use, but vary in the time required to achieve these objectives. Alternative 1 provides no active remediation and hence, is the least protective of human health and the aquifer. Alternative 2 would protect human health, but would not restore the aquifer as quickly as the other alternatives. Alternative 3 is predicted to achieve risk-based levels within 23 years and Alternative 4 is predicted to remediate the aquifer to risk-based levels within 10 years. Alternatives 5 and 6 are predicted to reach risk-based levels in 14 and 13 years, respectively, according to original model predictions. Additional modeling, summarized in the Supplemental Evaluations (Appendix F) predicts that Alternatives 5 and 6 would achieve risk-based levels within 11 years.

The long-term effectiveness and permanence of the alternatives are similar, but as indicated above, the time to reduce COCs to risk-based concentrations would be obtained most quickly by Alternative 4 followed by Alternatives 5 and 6. All alternatives, except the minimal action alternative, would reduce the toxicity, mobility, and volume of contaminated groundwater through similar treatment. However, Alternatives 3 through 6 would be most effective at actively reducing toxicity, mobility and volume. Alternative 1 would not actively reduce the toxicity, mobility and volume.

The short-term effectiveness criterion considers the ability of the alternative to protect the community and on-site workers during implementation of the remedy and the impact to the environment as a result of the action. Alternative 4 would have the least short-term impact in terms of impact to community and on-site workers because the remedy would be complete in 10 years followed by Alternatives 5, 6, 3 and 2. Alternatives 1 and 2 would have the least environmental impact based on vegetation clearance followed by Alternatives 3, 5, 4, and 6.

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All six alternatives can be implemented. Alternative 1 is the easiest to implement followed by Alternatives 2, 5, 3, 4, and 6. The estimated costs of the Alternatives are presented below:

Alternative	Estimated Costs		
	Capital	Present Worth of O&M	Total Present Worth
1	$ 1,550,000	$ 1,300,000	$ 2,850,000
2	$ 3,640,000	$ 11,400,000	$ 15,000,000
3	$ 5,620,000	$ 14,700,000	$ 20,300,000
4	$ 10,200,000	$ 15,500,000	$ 25,700,000
5*	$ 8,340,000	$ 12,700,000	$ 21,000,000
6*	$ 9,860,000	$ 16,700,000	$ 26,600,000

*Based on additional modeling, summarized in the Supplemental Evaluations (Appendix F) the estimated costs for Alternatives 5 and 6 would be revised as follows:

Alternative	Estimated Costs		
	Capital	Present Worth of O&M	Total Present Worth
5*	$ 8,300,000	$ 10,600,000	$ 18,900,000
6*	$ 9,900,000	$ 12,200,000	$ 22,100,000

Alternative 1 provides the lowest cost because it is a minimal action scenario, involving long-term groundwater monitoring and institutional controls. Alternative 2 provides the next lowest cost, in part because this alternative uses the existing extraction wells and piping of the groundwater RRA ETR system. The total present worth cost of Alternatives 3 and 5 are similar, and Alternatives 4 and 6 are higher due to additional flow rate, extraction wells and/or pumping duration. The following table summarizes the main features of each alternative under consideration in the Revised Draft FS.

Alternative	Concentration Objectives	Number of Extraction Wells	Total Extraction Rate	Years to Achieve RBC*	Years to Achieve Background **	Estimated Cost (millions)
1	-	0	0	-	-	$ 2.9
2	-	2	320	36	50	$ 15.0
3	Risk-based	4	472	23	27	$ 20.3
4	Risk-based	5	1417	11	15	$ 25.7
5++	Risk-based	5	906	14	15/20+	$ 21.0
6++	Risk-based	6	981	14	15/17+	$ 26.6

*Years to achieve risk-based concentration for most recalcitrant COC modeled
**Years to achieve background concentration for most recalcitrant COC modeled.
+upgradient/downgradient of Pew Road

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Revised Executive Summary
Revised Memorandum of Resolution
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Demo 1 Groundwater Operable Unit

[++]Based on additional modeling, summarized in the Supplemental Evaluations (Appendix F) the main features for Alternatives 5 and 6 would be revised as follows:

Alternative	Concentration Objectives	Number of Extraction Wells	Total Extraction Rate	Years to Achieve RBC*	Years to Achieve Background **	Estimated Cost (millions)
5	Risk-based	5	906	11/9[+]	12/19[+]	$ 18.9
6	Risk-based	6	1006	11/9[+]	12/17[+]	$ 22.1

*Years to achieve risk-based concentration for most recalcitrant COC modeled
**Years to achieve background concentration for most recalcitrant COC modeled
[+]upgradient/downgradient of Pew Road

The next step to selecting a comprehensive remedy for the Demo 1 Groundwater Operable Unit is the preparation of the Draft Remedy Selection Plan. The Draft Remedy Selection Plan will document the proposed remedial action alternative. The plan will summarize the description, analysis and comparison of all alternatives evaluated in the FS and describe the rationale for selecting the proposed remedial alternative. The Remedy Selection Plan will be available for public review in conjunction with a public comment period on the preferred alternative.

August 10, 2005

Mr. Len Pinaud
Massachusetts Dept. of Environmental Protection
20 Riverside Drive
Lakeville, MA 02347 Email / US MAIL

Ms. Lynne Jennings Email / US MAIL
EPA – New England, Region 1
1 Congress Street, Suite 1100
Boston, MA 02114-2023

Dear Mr. Pinaud and Ms. Jennings:

Re: Impact Area Groundwater Study Program (IAGWSP)
USEPA Region I Administrative Orders SDWA 1-97-1019 and 1-2000-0014
Response to EPA Comments (08/09/05) on the Revised Memorandum of Resolution (07/11/05) to the Revised Draft System Feasibility Study, Technical Memorandum (TM) 01-17, Demo 1 Groundwater Operable Unit

On behalf of the Army/NGB IAGWSP and the U.S. Army Corps of Engineers (USACE), AMEC Earth & Environmental (AMEC) is pleased to provide the attached responses to EPA comments for the above-referenced document. The Revised Draft Feasibility Study (FS), Demo 1 Groundwater Operable Unit (OU) was submitted on 05/20/04. Comments were received from EPA on 07/20/04 and from MADEP on 08/02/04. The IAGWSP submitted a response to comments letter (RCL) to EPA and MADEP comments on 09/02/04.

A resolution meeting was conducted on 09/28/04 to discuss the responses to EPA and MADEP comments on the FS. Supplemental evaluations were conducted at EPA's request using updated plume and aquifer parameters. The IAGWSP submitted the MOR and Supplemental Evaluations summary on 04/05/05 and EPA comments were received on 04/19/05. EPA requested that the IAGWSP submit a revised MOR to address EPA comments. MADEP comments on the MOR and Supplemental Evaluations were received on 04/25/05. MADEP submitted two more comments on the Feasibility Study via email on 05/06/05. The EPA submitted a revised table for Appendix D of the FS on 05/26/05. The IAGWSP submitted a revised Memorandum of Resolution (MOR2) on 07/11/05. Comments were received from the EPA on 07/29/05 requesting changes to make the FS consistent with the Draft Remedy Selection Plan (RSP).

The IAGWSP accepts the changes to the remedial action objectives, recommended in the 08/09/05 letter, and provides the attached (see Attachment 1) responses to EPA comments on the MOR dated 07/11/05. If you have any questions, please contact Paul Nixon at (508) 968-5620.

Sincerely,

Marc Grant, P.E.
Program Manager

MMR-9710 (Demo 1 GW FS RMOR RTC 081005).doc

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	Gina Kaso – USACE	Email
	Bob Lim – EPA	Email
	Desiree Moyer – EPA	Email & US Mail
	Mark Panni / Elliot Jacobs / Ellie Grillo – DEP	Email
	Tom Frendak/Travis McCoun – AEC	Email
	Randall Nida – NGB	Email

Attachment 1
Responses to EPA Comments (08/09/05)
Revised Memorandum of Resolution
Revised Draft Feasibility Study
Demo 1 Groundwater Operable Unit

General Comment #1 **–** The new revision to the executive summary (Attachment 9) **still** does not mention that the Cape Cod Aquifer has been designated as a sole source aquifer. See comments below on Attachment 9. In addition, the third paragraph should mention that Camp Edwards was designated in 2002 by the Massachusetts legislature as the Upper Cape Water Supply Reserve dedicated to the natural resource purposes of water supply and wildlife habitat protection.

Resolution: *The suggested text will be added to the executive summary.*

Specific Comment #1 – EPA disagrees with the resolution. Insert RAOs as agreed to in the Remedy Selection Plan.

Resolution: *The RAOs from the Remedy Selection Plan will be copied to the Final FS verbatim.*

Specific Comment #3 – EPA disagrees with the resolution. Insert RAOs as agreed to in the Remedy Selection Plan.

Resolution: *The RAOs from the Remedy Selection Plan will be copied to the Final FS verbatim.*

EPA Specific Comment #27 – To be consistent with the RSP comments, in the 1st proposed text, add “On-post land use controls will be established by the Army, Massachusetts National Guard, and any other entity in control of the on-base areas in a Memorandum of Understanding (MOU) with the EPA (and MADEP, as necessary) within six months following the Decision Document. The MOU shall also provide for a program to monitor the effectiveness of the institutional controls, and a process under which EPA can enforce the implementation, monitoring, maintenance, and modification of the institutional controls, if necessary.” For Appendix G proposed changes, further clarification that institutional controls are not necessarily an exclusive remedy for off-base contamination or post-lease on-base contamination is required. Therefore, in section B(2) of the new Appendix G, at the end of the first sentence, add "in addition to any remedial action that may be necessary." Similarly, in Section C(2), at the end of the first sentence, add "in addition to any remedial action that may be necessary."

Resolution: *The requested text is already in Appendix G. It will be copied to the land use control section of the text describing each alternative.*

EPA Specific Comment #30 – Change "passive remediation" to "natural attenuation."

Resolution: *The text will be changed as suggested.*

EPA Specific Comment #85 – EPA has not issued national guidance on implementing the reference dose. To be consistent with the RSP comment after “24.5 ug/L,” add “assuming all of the contaminant comes from drinking water.”

Resolution: *The text will be changed as suggested.*

Attachment 7, Table D-1:

Page 2 - In synopsis section discussing **sole source aquifer**, delete the second sentence. The remediation is not a commitment for federal assistance (rather it is a federal action) and therefore the sentence is not relevant.

Resolution: *The text will be deleted as suggested.*

Page 6 - In "action to be taken" section discussing state regulations regarding **construction and operation of a groundwater treatment plant,** what does "additives will be adequately addressed" mean. Rewrite and clarify.

Resolution: *The word "Additives" is part of the title of the regulation, "Management Procedures for Remedial Wastewater and Remedial Additives". No additives are proposed in any of the alternatives considered in the FS. The remedial wastewater part of the regulation is potentially applicable.*

Page 10 - In synopsis section of **State UIC regulations**, delete existing synopsis, and substitute the following language which was taken from the J2 North RRA workplan: "These regulations prohibit injection of fluid containing any pollutant into underground sources of drinking water where such pollutant will or is likely to cause a violation of any state drinking water standard or adversely affect the health of persons."

Resolution: *The text will be changed as suggested.*

Page 10 - In "action to be taken" section of **State UIC regulations**, what does "additives will be adequately addressed" mean. Rewrite and clarify.

Resolution: *The word "Additives" is part of the title of the regulation, "Management Procedures for Remedial Wastewater and Remedial Additives". No additives are proposed in any of the alternatives considered in the FS. The remedial wastewater part of the regulation is potentially applicable.*

Page 10 - In "action to be taken" section of **State UIC regulations,** include the following language taken from the J2 North RRA workplan: "Extracted groundwater will be treated to levels at or below federal and state primary drinking water standards (i.e. MCLs) to ensure that discharges to the receiving aquifer will not cause any violations of these standards in the aquifer."

Resolution: *The text will be changed as suggested.*

Page 10 - Add sections regarding CWA NPDES Stormwater Discharge Requirements and MA Stormwater Discharge Requirements, as was done in the J2 North RRA workplan of 4/26/05.

Resolution: *The text will be added from the J2 North RRA Plan as suggested.*

Attachment 9, Revised Executive Summary

Page 1 of 7, 3rd Paragraph - The executive summary must mention that the Cape Cod Aquifer has been designated as a sole source aquifer. In addition, the third paragraph should mention that Camp Edwards was designated in 2002 by the Massachusetts legislature as the Upper Cape Water Supply Reserve dedicated to the natural resource purposes of water supply and wildlife habitat protection.

Resolution: *The text will be added as suggested.*

Page 1 of 7, 6th Paragraph – Insert RAOs as agreed to in the Remedy Selection Plan.

Resolution: *The text will be added as suggested.*

Pages 6 and 7 of 7 – Double-check values in tables to be consistent with Remedy Selection Plan.

Resolution: *The tables will be checked and revised as necessary to be consistent with the Final RSP.*

11 August 2005

Mr. Kent Gonser
Impact Area Groundwater Study Program Office
PB 565/567 West Outer Road
Camp Edwards, MA 02542

Re: *Response to EPA Comments (08/09/05) on the Revised Memorandum of Resolution (07/11/05) to the Revised Draft System Feasibility Study, Technical Memorandum (TM) 01-17, Demo 1 Groundwater Operable Unit*

Dear Mr. Gonser:

EPA has reviewed the above referenced letter entitled *Response to EPA Comments (08/09/05) on the Revised Memorandum of Resolution (07/11/05) to the Revised Draft System Feasibility Study, Technical Memorandum (TM) 01-17, Demo 1 Groundwater Operable Unit* dated 10 August 2005. EPA finds the resolutions to be acceptable and requests that the IAGWSP finalize the feasibility study document with all the changes prior to the start of the public comment period for the *Remedy Selection Plan for the Demolition Area 1 Groundwater Plume.* If you have any questions, please do not hesitate to call Robert Lim at (617) 918-1392 or me at (617) 918-1210.

Sincerely,

Lynne A. Jennings
MMR Team Leader

cc: Paul Nixon/IAGWSP
Marc Grant/AMEC
Len Pinaud/ MA DEP
Robert Lim/EPA
Bill Walsh-Rogalski/EPA
Margery Adams/EPA

Impact Area Groundwater Study Program

Feasibility Study
Demo 1 Groundwater Operable Unit

Appendix F
Supplemental Evaluations

Camp Edwards
Massachusetts Military Reservation
Cape Cod, Massachusetts

August 19, 2005

Prepared for:

U.S. Army Corps of Engineers
New England District
Concord, Massachusetts
for
U.S. Army / National Guard Bureau
Impact Area Groundwater Study Program
Camp Edwards, Massachusetts

Prepared by:

AMEC Earth & Environmental, Inc
Westford, Massachusetts
Contract No. DAHA92-01-D-0006

IMPACT AREA GROUNDWATER STUDY PROGRAM

Feasibility Study
Demo 1 Groundwater Operable Unit

Appendix F
Supplemental Evaluations

Camp Edwards
Massachusetts Military Reservation
Cape Cod, Massachusetts

August 19, 2005

Prepared for:

U.S. Army Corps of Engineers
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Concord, Massachusetts

U.S. Army / National Guard Bureau
Impact Area Groundwater Study Program
Camp Edwards, Massachusetts

Prepared by:

AMEC Earth & Environmental, Inc.
Westford, Massachusetts

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1.0 INTRODUCTION

The Revised Draft Feasibility Study (FS), Demo 1 Groundwater Operable Unit (OU) was submitted on 05/20/04. Comments were received from EPA on 07/20/04 and from MADEP on 08/02/04. The IAGWSP submitted a response to comments letter (RCL) to EPA and MADEP comments on 09/02/04.

A comment resolution meeting was conducted on 09/28/04 to discuss the responses to EPA and MADEP comments. EPA comments that were raised in the cover letter to their 07/20/04 comments on the Revised Draft FS were also discussed.

The EPA comments on the Revised Draft FS requested that the evaluation of alternatives account for increased concentrations of perchlorate and RDX at Pew Road, detected after modeling efforts for the FS were completed. In a letter dated 08/26/04, EPA requested that the IAGWSP should perform "supplemental evaluations" in support of selecting a comprehensive remedy for the Demo 1 Groundwater Operable Unit.

The content and scope of the Supplemental Evaluations were outlined in email correspondence from EPA, dated 8/26/04. The letter detailed the scope of the supplemental evaluations, which included an update of the plume shells, a re-run of Alternatives 5 and 6 to determine if these remained protective given higher detected contaminant concentrations, and a re-run of the sensitivity analysis with hypothetical increased contaminant concentrations. The scope details were further discussed among the IAGWSP, EPA and DEP at a meeting on 11/04/04.

The IAGWSP agreed to update the plume shells using the data collected through November 2004 and assess the impact on the effectiveness of Alternatives 5 and 6. This supplemental evaluation was agreed to be submitted in support of the remedy selection process. The IAGWSP, EPA and MADEP agreed to provide the Supplemental Evaluations as an appendix (Appendix F) to the Final FS for the Demo 1 Groundwater Operable Unit (OU).

1.1 Objectives

The overall objective of the supplemental evaluations is to incorporate increased contaminant concentrations in the plume conceptualization and re-evaluate the relative system performance for the 5 and 6 well solutions (FS Alternatives 5 and 6, respectively). The specific objectives of the supplemental evaluations are to:

- Update the plume shells presented in the Revised Draft FS using the most recent data available through November 2004;
- Update the groundwater flow model consistent with the final RRA construction details and the current proposed comprehensive system start date;
- Re-run the fate and transport model with the updates to the plume; and
- Evaluate the new results for the 5 and 6 well solutions to determine if they are consistent with the relative performance presented in the Revised Draft FS.

The objective of the sensitivity analysis is to evaluate a hypothetical perchlorate mass distribution at and downgradient of Pew Road to assess the level of confidence that the portion of the perchlorate plume that is not captured by the Pew Road extraction well will naturally attenuate to acceptable levels within a reasonable timeframe.

Section 2 presents the methodology used for the re-evaluation and the sensitivity analysis. The details regarding the model and plume revisions are presented in Section 3. Section 4 presents the results and Section 5 summarizes the conclusions of the Supplemental Evaluations.

2.0 METHODOLOGY

The supplemental evaluations consisted of several discrete activities. The itemized procedure for the model and plume updates, data re-evaluation, and sensitivity analysis was as follows:

1. Update model based on actual RRA system operation time and as-built well construction
2. Compile data from August groundwater monitoring round and new monitoring well installations (i.e., MW-341 and MW-352), through November 2004
3. Revise perchlorate and RDX plan view and cross-sections
4. Delineate 3-d plume shells
5. Import 3-d plume shells into RRA model
6. Run RRA model to establish updated initial conditions for design runs
7. Run Alternatives 5 and 6 with updated initial conditions starting in Early 2007
8. Analyze, document, and QA Results
9. Develop hypothetical mass distribution with 5 times higher concentrations
10. Run RRA model to establish hypothetical initial conditions for design runs
11. Run Alternative 5 with hypothetical initial conditions
12. Analyze, document, and QA Results

2.1 Model Revisions

When modeling activities for the FS commenced in Spring 2003, the groundwater RRA system was in the design stages. Modifications were made to the RRA system during design and installation. As a result, the model presented in the FS used the best assumptions at the time but some of those parameters were changed.

During installation of extraction well D1-EW-2, the elevation and thickness of the clay unit mapped at Pew Road was determined to be different than what was observed at other locations along Pew Road. As a result, the screen elevation of the extraction well was changed in the field so that the bottom of the well screen would be set at the top of the clay unit. This vertical shift in the extraction well screened interval was incorporated into the model revision used in the supplemental evaluation.

As requested by EPA and DEP and documented in the project note dated November 2003, the design pumping rate of extraction well D1-EW-1 at Frank Perkins Road was changed from 200 gpm to 220 gpm. It has operated at 220 gpm since start-up in September 2004. The FS modeling assumed that this well would operate at 200 gpm.

The effective porosity used in the subregional model for the Demo 1 FS was 39%. This was based on a site-specific study conducted by the USGS at MMR. In the transport calibration phase of the FS modeling effort in 2003, 39% porosity appeared to be a reasonable value based on the interpreted plume length and source timing. However, since that time the plume has been reinterpreted to extend nearly 1000 feet farther downgradient. This suggested that the transport velocity of the plume might be higher than earlier predicted in the FS modeling and effective porosity should be reduced. Recent model calibration efforts at other areas of MMR

have assumed an effective porosity of 35% and this value was incorporated into the Demo 1 model.

An estimate was made for the duration of RRA system operation prior to a comprehensive remedial action start-up. A 4-year operational period of the RRA was used in the original FS modeling. Based on current information, it appears that a comprehensive remedy could be operational by Spring 2007 and the total operational time of the RRA system has therefore been reduced to 2.5 years.

A comment received on the FS modeling from EPA was that pond bathymetry was not accurately known but rather assumed in the model. The IAGWSP agreed to measure the pond depth of north and south ponds west of Fredrikson Road and input these data into the model. Based on the field survey in mid 2004, the depth of the north pond was found to be approximately 4 feet at its deepest point and 1.5 feet average depth. The south pond was measured to be approximately 1 foot at its deepest point and an average depth of 0.5 feet. Field observations indicated this was below average pond levels by about 1 foot and therefore, for the purposes of the model revisions, average depths of 3 feet for north pond and 2 feet for south pond were used.

2.2 Plume Revisions

The IAGWSP prepared updated plume shells, which incorporated analytical data received through November 2004 and provided them to EPA and DEP for review. Approval was received on 12/9/04. The updated perchlorate plume shell is presented in Figure F2-1. The major difference between the May 2003 and November 2004 plume shells is the 1 and 4 µg/L contour lines' extension downgradient of Pew Road. These contours are now also wider at Pew Road.

The RDX plume shell was also updated through November 2004 and is presented in Figure F2-2. As expected, the RDX plume is shown to have migrated downgradient with time. The highest concentrations within the plume have also migrated downgradient. The leading edge was interpolated based on travel time after the first detection of RDX at MW-211 (Pew Road) and an assumed groundwater velocity of 1 foot per day.

EPA requested that the perchlorate and RDX contaminant mass estimates be updated in the supplemental evaluation. For comparison, EPA also requested that the contaminant mass be calculated for discrete areas within the plume, upgradient (east) of Frank Perkins Road, between Frank Perkins Road and Pew Road and downgradient (west) of Pew Road. The plume mass and volume was calculated based on the new plume shells and compared to initial estimates in Table F2-1.

The mass estimates conducted in 2003 were completed using an effective porosity of 39% while the updated mass estimates utilized an effective porosity of 35%. From Table F2-1, 81% of the plume mass and 43% of the plume volume was estimated to be located east of Frank Perkins Road using the 2003 data. Another 18% of the plume mass and 42% of the plume volume was predicted to be located between Frank Perkins and Pew Roads based on the 2003 data. Based on the data presented in the FS, 99% of the plume mass was located upgradient of Pew Road.

The updated information suggests that the center of mass of the plume has shifted downgradient, as expected, over time. Using the updated data, 75% of the plume mass and 46% of the plume volume are predicted to be east of Frank Perkins Road. Another 23% of the plume mass and 37% of the plume volume was predicted to be located between Frank Perkins and Pew Roads. Based on the updated data evaluation using 2004 data, 98% of the mass was located upgradient of Pew Road. The percentage of perchlorate mass downgradient of Pew Road doubled from 0.9% in 2003 to 1.8% in 2004. Since the RRA System was turned on in September 2004 and it is expected to hydraulically capture the plume at Pew Road, minimal migration of mass past Pew Road is expected in the future.

No further migration of RDX past Pew Road is expected due to the operation of the Pew Road extraction system.

2.3 Sensitivity Analysis

The objective of the sensitivity analysis was to assess the level of confidence that the portion of the perchlorate plume that is not captured by the Pew Road extraction well will naturally attenuate to acceptable levels in a reasonable timeframe and within an acceptable distance.

Steps 9-12 constitute the sensitivity analysis that was conducted using the revised plume shells. Hypothetical mass distributions were developed from the revised plume shells by increasing the concentrations by a factor of 5 within the current extent of the plume. This was done to evaluate a hypothetical scenario with elevated contaminant concentrations for comparison with the actual concentrations and is not expected to be a realistic scenario based on all available groundwater data.

As with the revised shells, the hypothetical distribution was run in the model through a 2.5-year period of RRA system operation followed by implementation of the 5 well system starting in early 2007. An evaluation of the system performance and the timeframe to achieve remediation goals was completed for the hypothetical perchlorate distributions.

3.0 RESULTS

The two dimensional, plan view interpretations of the RDX and perchlorate plumes are presented in Figure F3-1. Also shown in this figure is an update of the treatment system configuration for the 6 well system, based on comments from EPA on the Revised Draft FS (Appendix E). The water extracted by the sixth well, EW-D1-604, would be treated by a stand-alone containerized treatment system on Fredrikson Road and the treated water would be discharged to a single injection well located to the north of the plume on Fredrikson Road. This layout eliminates the subsurface water piping that was originally laid out in a straight line from the sixth well on Fredrikson Road to the Pew Road treatment system. Since power would be required to operate the treatment system at Fredrikson Road, electrical trenching has been routed along roadways, as requested by EPA comments, and is presented in Figure F3-1.

The updated plume characterizations were used in the revised model (see Section 2.1) and run for 2.5 years under the RRA system conditions. Then, using that plume distribution for year 2007, the 6 well system conditions were run. Figure F3-2 presents a time series of model output showing plan view projections of maximum perchlorate distributions at 0, 5, 10, 15, and 17 years for the 6 well system. After 9 years of pumping, the perchlorate concentrations within the plume in the upgradient area are expected to be below 1 µg/L. With an additional 2 years of pumping (11 years total) the perchlorate concentrations in the downgradient area are reduced to below 1 µg/L. At 17 years from start-up, the model predicts that perchlorate concentrations are reduced below 0.35 µg/L everywhere in the aquifer with the one exception being the residual perchlorate mass that stagnates within the clay layer. As discussed in Appendix A of the FS this phenomenon is a consequence of the modeling technique used to represent the clay zone and is not expected to be a significant occurrence in the field.

Similarly, the plume distribution at year 2007 was used as a starting point for running the 5 well system conditions. Figure F3-3 presents a time series of model output showing perchlorate concentrations at 0, 5, 10, 15, and 17 years for the 5 well scenario. After approximately 9 years of pumping, the perchlorate concentrations within the plume in the upgradient area are expected to be below 1 µg/L. With an additional 2 years of pumping (11 years total) the remaining perchlorate in the downgradient area is reduced below 1 µg/L. In 19 years from start-up of the comprehensive remedy, perchlorate is reduced to below 0.35 µg/L in both the upgradient and downgradient areas. Again, the model predicts that there is a small percentage of perchlorate mass that remains within the clay layer between Frank Perkins and Pew Road, as shown in Figure F3-3.

The perchlorate concentrations portrayed within the dashed brown line on Figures F3-2 and F3-3 for year 2017 and after represent plume mass which the model predicts will stagnate within the clay zone. Because this portion of the aquifer is not productive due to low permeability, it has not been included in the estimated timeframes for remediation of the plume as summarized in Table F3-1.

Figure F3-4 presents the model output for RDX using the 5 well system at 0, 5, and 10 years. After 11 years of the 5 well system operation, the RDX concentrations are reduced below 0.6

µg/L. With 13 years of 5 well system operation, the RDX concentrations are reduced below 0.25 µg/L. RDX migration would appear the same for the six-well system so the figure has not been presented in a separate figure.

Figure F3-5 presents the mass capture effectiveness for each system over time. With operation of the RRA systems, approximately 34% of perchlorate mass is removed by 2007, when the comprehensive remedy is scheduled to start-up. At approximately 10 total years of operation, 95% of the perchlorate mass is expected to be removed for both the 5 and 6 well systems. After 12 years, the 6 well system is predicted to capture approximately 1% more of the total perchlorate plume mass than the 5 well system. Beyond 12 years of operation for both systems, the rate of further mass removal is negligible.

Predictions of influent contaminant concentrations for the 6th well are presented in Figure F3-6. The maximum predicted influent concentration is 0.4 µg/L and influent concentrations are not expected to be detectable after 5 years of system operation. With influent concentrations projected to be below the detection limit, mass removal will not be quantifiable.

Table F3-1 presents a comparison between the times to achieve clean up goals with the 5 and 6 well systems. The 5 well system would operate at a total flow rate of approximately 906 gpm and, in 11 years, would reduce perchlorate and RDX concentrations to 1 and 0.6 µg/L levels, respectively. After 19 years (only 13 years of operation followed by 6 years post-operation monitoring), the 5 well system would reach 0.35 µg/L for perchlorate. In contrast, the 6 well system would operate at 1,006 gpm and would reduce perchlorate and RDX concentrations to 1 and 0.6 µg/L, respectively, in 11 years. After 17 years of operation, perchlorate would be reduced to below 0.35 µg/L for the 6 well system.

The relative effect of the 5 and 6 well systems on plume migration can be interpreted by comparing Figures F3-2 and F3-3. The plume extent at startup in 2007 is shown in both figures to be approximately 100 feet east of the northern tip of North Pond. In Figure F3-3 the maximum plume advance is shown at +15 years to be approximately 150 feet west of the northern tip of North Pond (and remains under the ponds extent). Therefore, the plume advances an additional 250 feet.

The present value costs for the 5 and 6 wells systems to achieve the 1 µg/L and 0.35 µg/L objectives for perchlorate are presented in Table F3-2. Both the 5 and 6 well systems require 11 years of system operation to meet the 1 µg/L objective. The present value cost to operate the 5 well system for 11 years is $18.9 million dollars, whereas the 6th well would add $2.8 million (total present value of $22.1 million for the 6 well system). To achieve the 0.35 µg/L objective, the 5 well system requires 13 years of well operation followed by six years of groundwater monitoring for a cost of $20.3 million. The 6 well system achieves the 0.35 µg/L objective after 13 years of operation of all six wells followed by an additional four years of operation of the 6th well for a total of 17 years at a cost of $23.9 million.

Figure F3-7 presents the results of the sensitivity analysis for the hypothetical plume-mass distribution. This model output for the 5 well system presents the results of the current plume interpretation multiplied by a factor of five. In this hypothetical scenario, perchlorate is predicted

to migrate off-base at a concentration not greater than 1 µg/L. For the area downgradient of Pew Road, slightly more than 30 years would be required before the plume attenuates below 0.35 µg/L.

4.0 SUMMARY

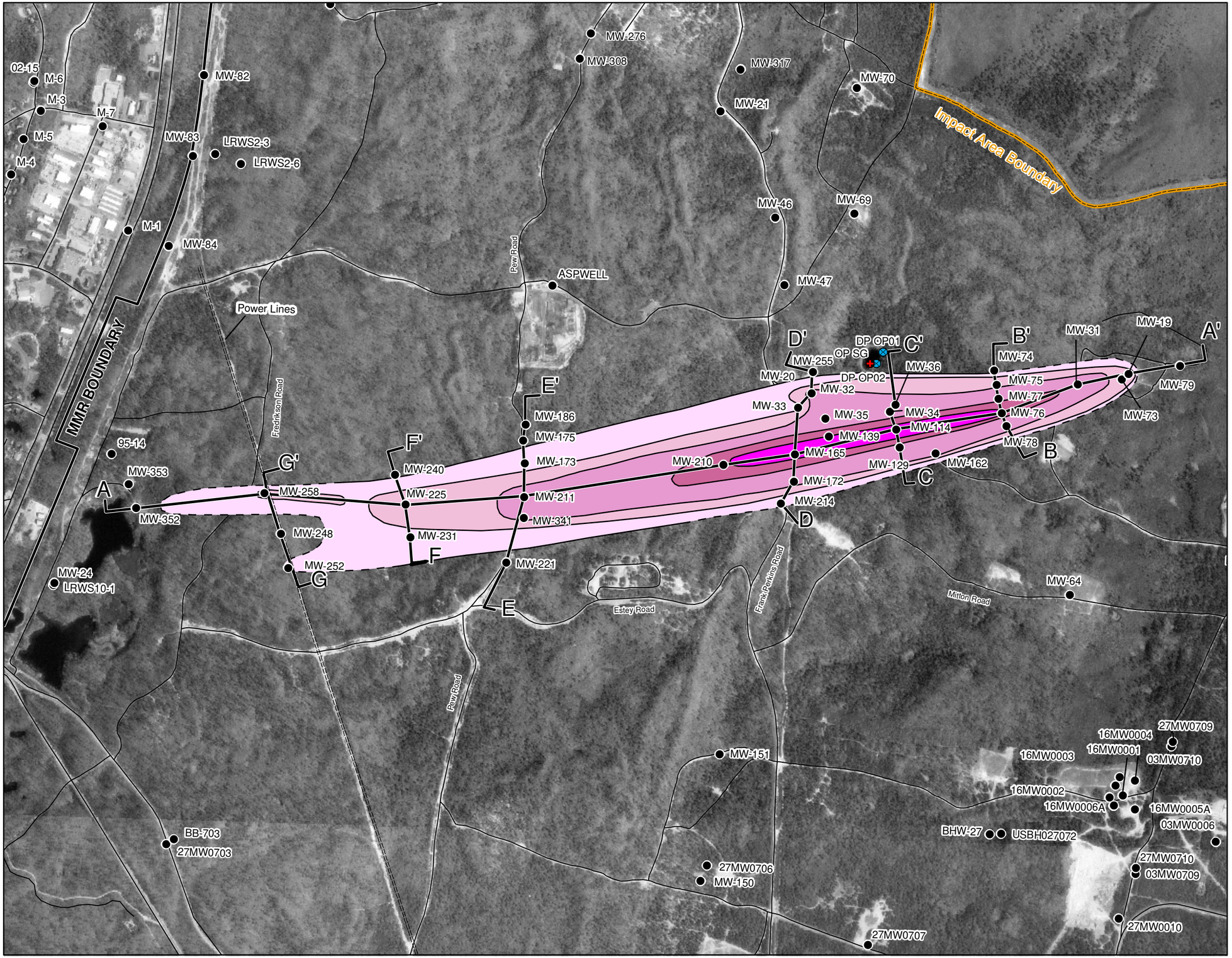
The supplemental evaluations of the 5 and 6 well systems presented in this Appendix utilized updated groundwater monitoring data and a revised numerical model. The results indicate that the relative performance of the 5 and 6 well systems under the revised conditions is consistent with the performance presented in the Revised Draft FS.

The implementation of the 6th well would:

- Reduce further downgradient migration of perchlorate by ~250 feet;
- Reduce time to achieve 0.35 µg/L downgradient of Pew Road by two years;
- Capture 1% more of the total perchlorate mass; and
- Result in a maximum predicted perchlorate influent concentration of 0.4 µg/L, which will only exceed the 0.35 µg/L for the initial four years of operation of the 6th well

In terms of costs, the 6 well system would add approximately $3.2 million and $3.6 million, respectively, to achieve the 1 µg/L and 0.35 µg/L objectives for perchlorate. This is approximately 17% more than the 5-well system.

The supplemental evaluations confirm that the performance of Alternatives 5 and 6 as presented in the Revised Draft FS remain appropriate by the latest plume interpretations and model revisions.



Impact Area Groundwater Study Program

LEGEND

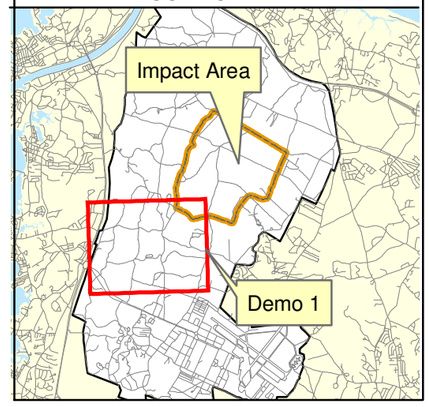
- Existing Monitoring Well
- Piezometer
- Staff Gauge

Perchlorate in Groundwater

- Greater than Non-Detect
- Greater than 1 ppb
- Greater than 4 ppb
- Greater than 18 ppb
- Greater than 100 ppb
- Impact Area Boundary
- MMR Boundary
- Roads
- Cross Section (A – A')

Note: Plume shell illustrated is representative of widest observed at each transect cross-section Groundwater data through November 3, 2004.

LOCATION MAP



NOTES & SOURCES

Basemap data from US Geological Survey 7 1/2 minute Topographic Maps. Source: MassGIS
Aerial photos: 1:5000 black & white digital orthophotos
Resolution: 0.5 meter; Date Flown: 1997; Source: MassGIS

TITLE

Perchlorate Distribution in Groundwater
as of 11/03/04
Supplemental Evaluations to
Support Remedy Selection
Demo 1 Groundwater Operable Unit

0 1,000 Feet

N

AMEC Earth & Environmental, Inc.
Westford, Massachusetts

J:/mmr/ReportFigs2005/D9487/D9487_FigF2-1.pdf
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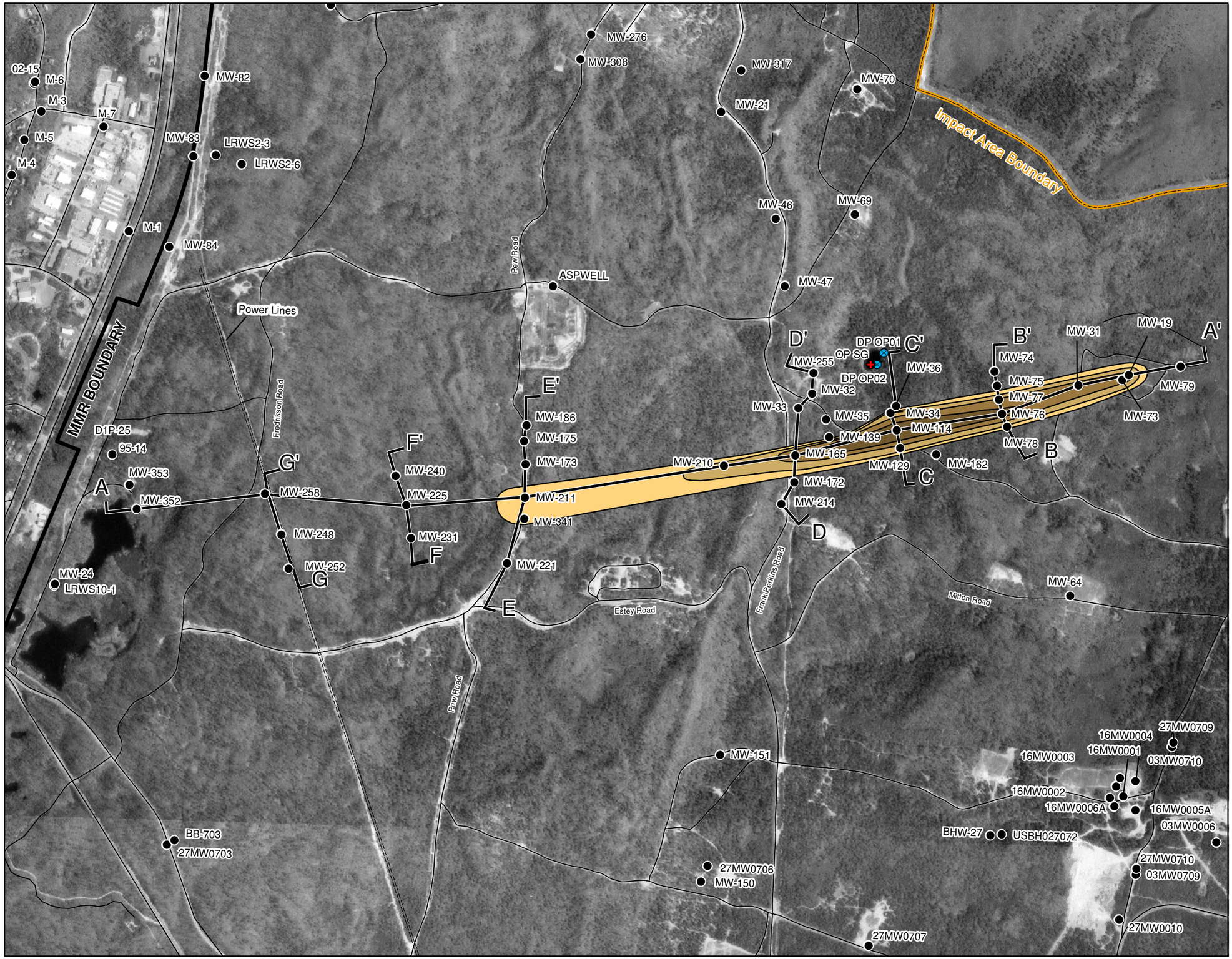
April 4, 2005 DWN: JBB AP JPB CHKD: JM

FIGURE
F2-1



Impact Area Groundwater Study Program

LEGEND

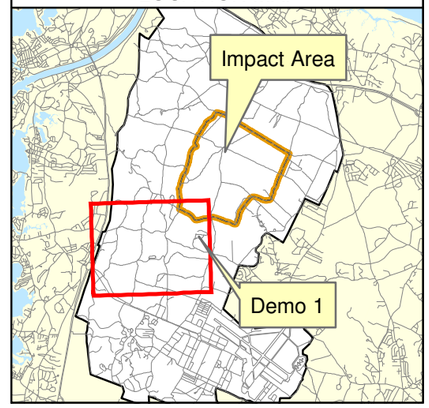
- Existing Monitoring Well
- Piezometer
- Staff Gauge

RDX in Groundwater

- Greater than Non-Detect and less than 2 ppb
- Greater than 2 ppb and less than 10 ppb
- Greater than 10 ppb and less than 100 ppb
- Greater than 100 ppb
- Impact Area Boundary
- MMR Boundary
- Roads
- Cross Section

Note: Plume shell illustrated is representative of widest observed at each transect cross-section Groundwater data through November 3, 2004.

LOCATION MAP



NOTES & SOURCES

Basemap data from US Geological Survey 7 1/2 minute Topographic Maps. Source: MassGIS
Aerial photos: 1:5000 black & white digital orthophotos
Resolution: 0.5 meter; Date Flown: 1997; Source: MassGIS

TITLE

RDX Distribution in Groundwater
as of 11/03/04
Supplemental Evaluations to
Support Remedy Selection
Demo 1 Groundwater Operable Unit

0 1,000 Feet

N

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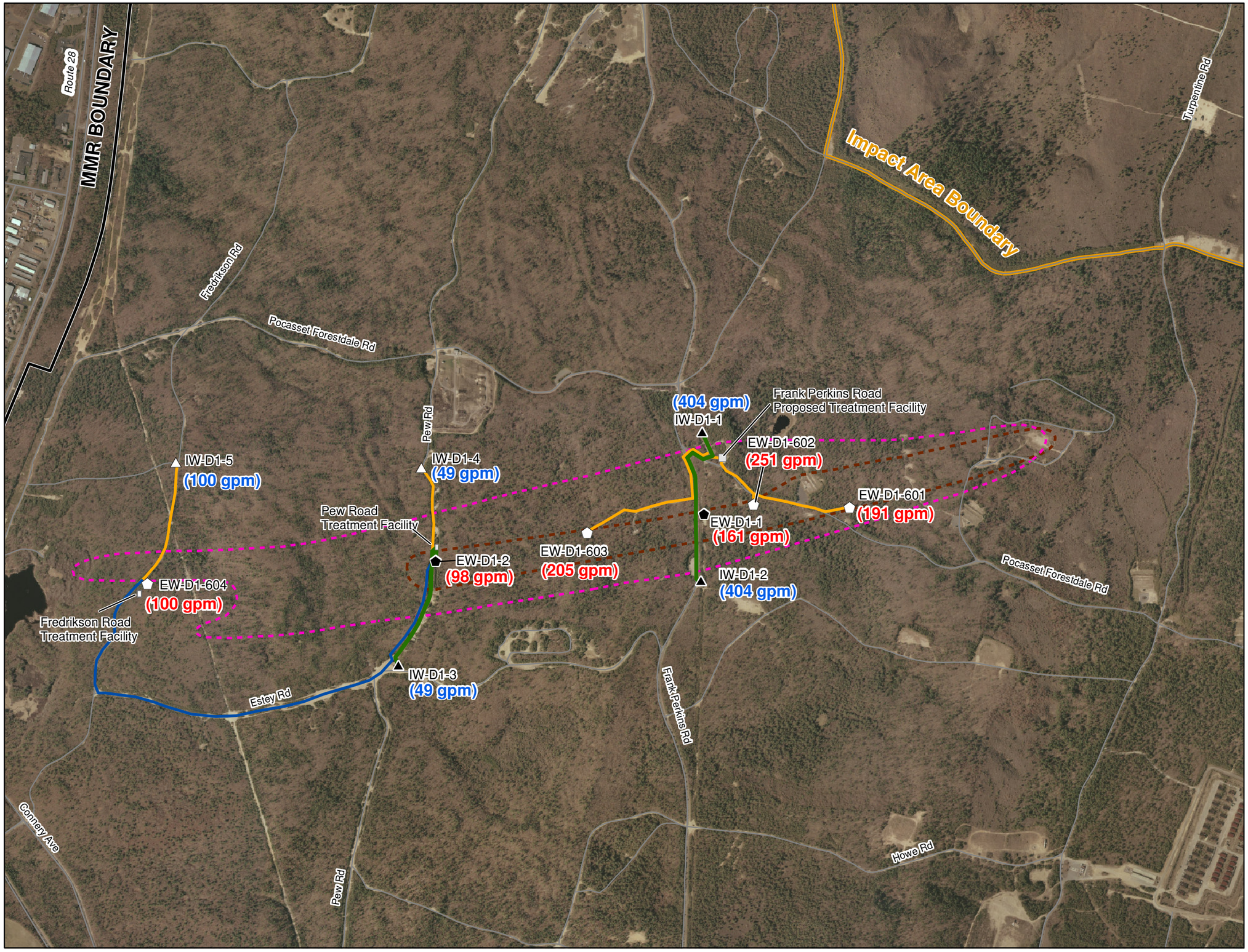
April 4, 2005 DWN: JBB AP JPB CHKD: JM

FIGURE

F2-2

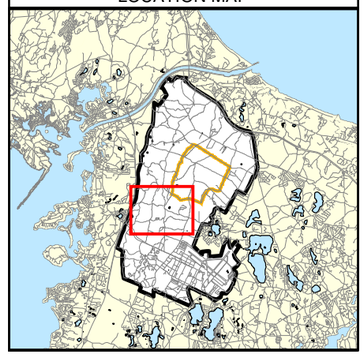


Impact Area Groundwater Study Program

LEGEND

- Existing Extraction Well
- Existing Injection Well
- Proposed Extraction Well
- Proposed Injection Well
- Extent of Perchlorate Plume (Revised 11/17/04)
- Extent of RDX Plume (Revised 11/17/04)
- Existing Piping Locations
- Proposed Piping Locations
- Proposed Subsurface Electric Supply
- (100) Extraction Rate (gallons per minute)
- (100) Injection Rate (gallons per minute)

LOCATION MAP



NOTES & SOURCES

Map Coordinates: NAD 83, UTM, Zone 19N, Meters
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Topographic Map Source: MassGIS
Aerial Photos: 1:2400 color digital orthophotos
Resolution: 0.3 meter; Date Flown: 2002;
Source: EarthData International of Maryland

TITLE

Alternative 6 -
Additional Alternative B
Conceptual Layout
Remedial Design Work Plan
Demo 1 Groundwater Operable Unit

0 1,000 Feet

N

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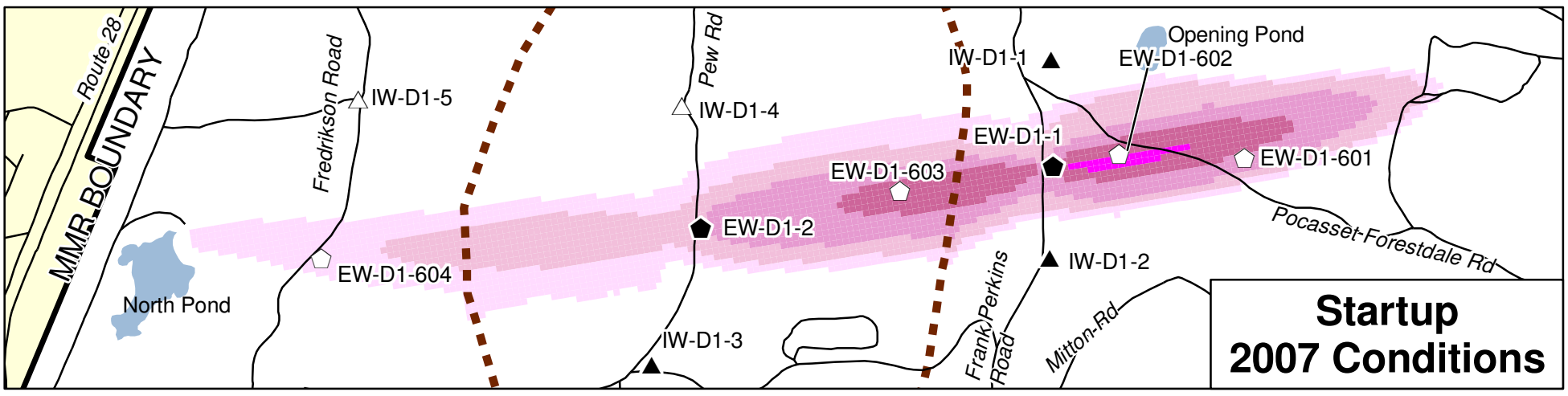
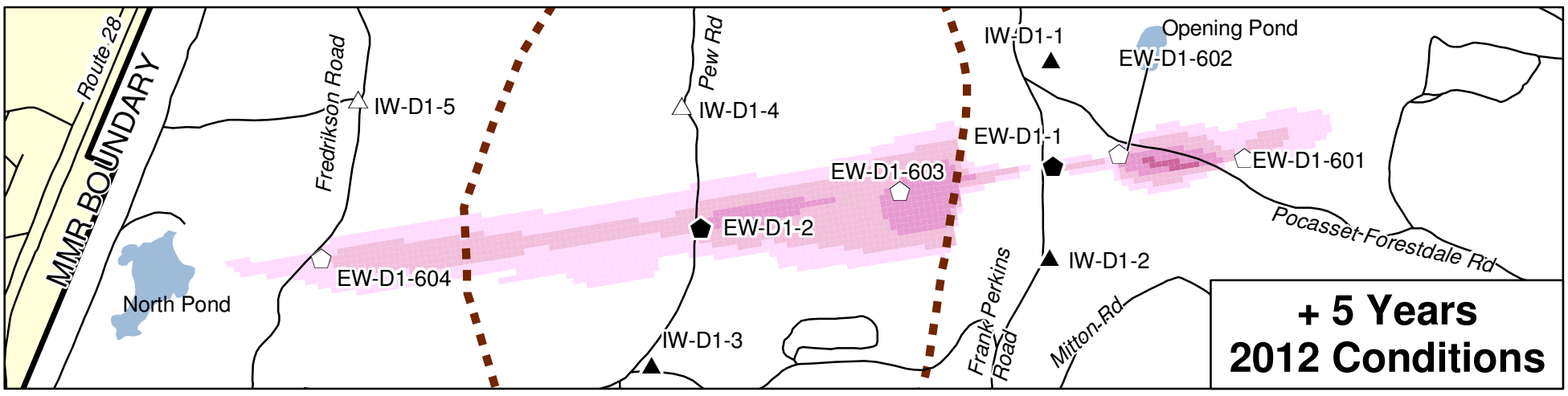
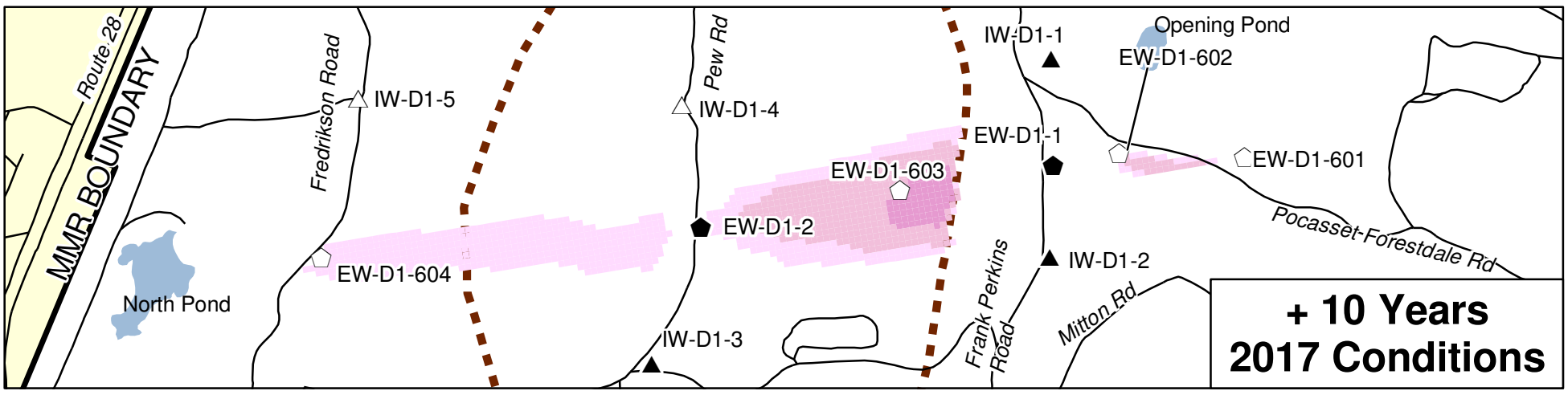
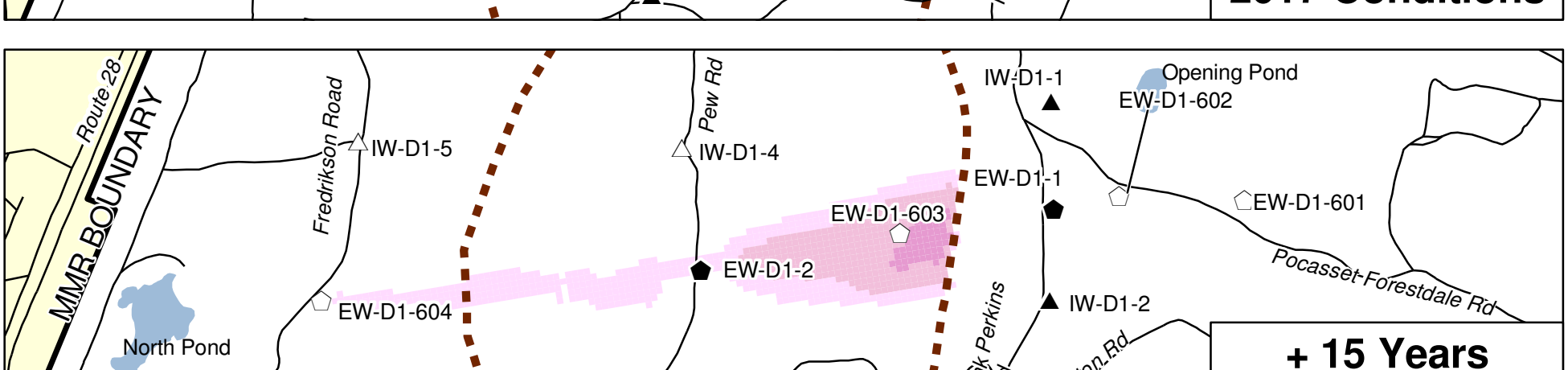
April 4, 2005 DWN: JBB AP JPB CHKD: JM

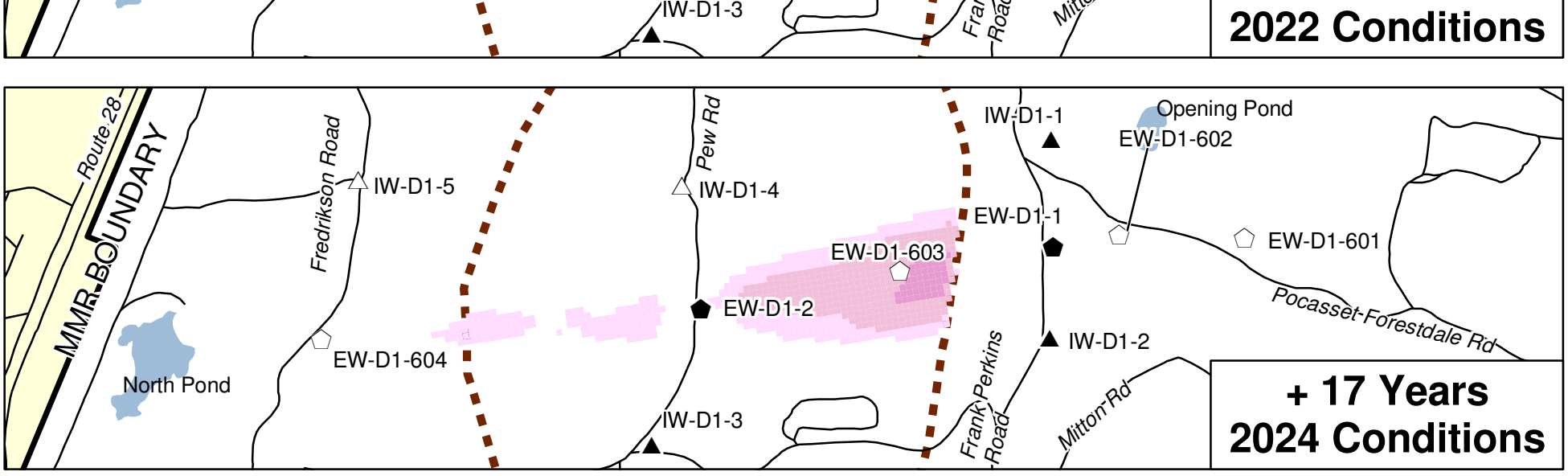
FIGURE
F3-1











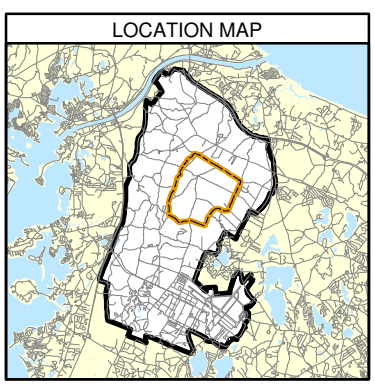
LEGEND

- Proposed Extraction Well
- Proposed Injection Well
- Existing Extraction Well
- Existing Injection Well
- Extent of Clay Zone

Model Computed Perchlorate Concentrations

- Non Detect to less than 1 ppb
- 1 - < 4 ppb
- 4 - < 18 ppb
- 18 - < 100 ppb
- Greater than or equal to 100 pbb

LOCATION MAP



N

0 1,250 Feet

NOTES & SOURCES
Map Coordinates: NAD 83, UTM, Zone 19N, Meters
Basemap data from US Geological Survey 7 1/2 minute
Topographic Map Source: MassGIS

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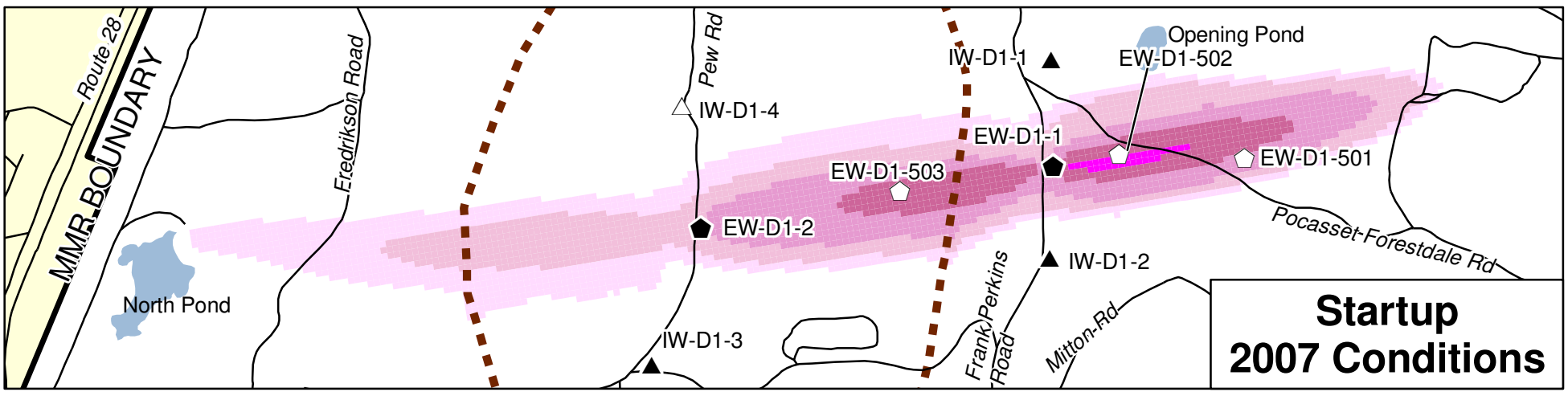
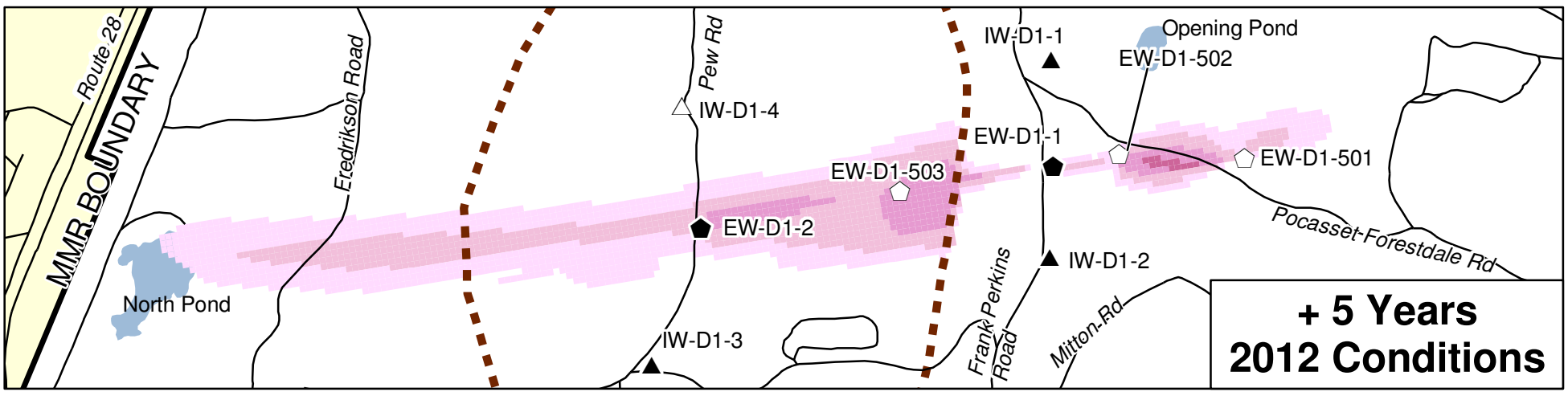
April 4, 2005 DWN: JBB CHKD: CA

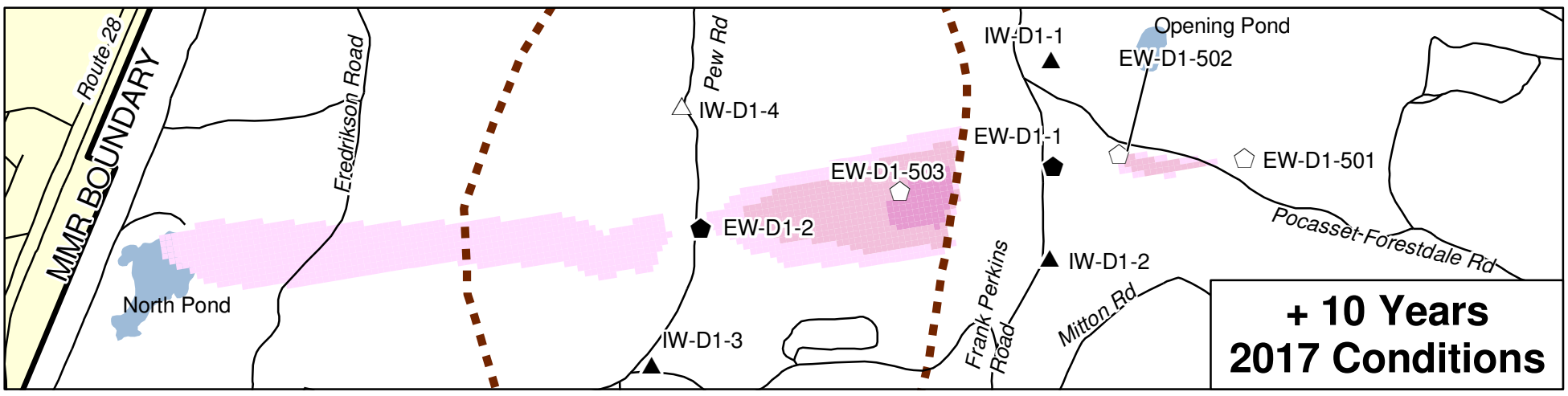
Simulated Perchlorate Distribution
During Operation of 6 Well System
Based on 12/04 Plumeshell
Remedy Selection Plan
Demo 1 Groundwater Operable Unit

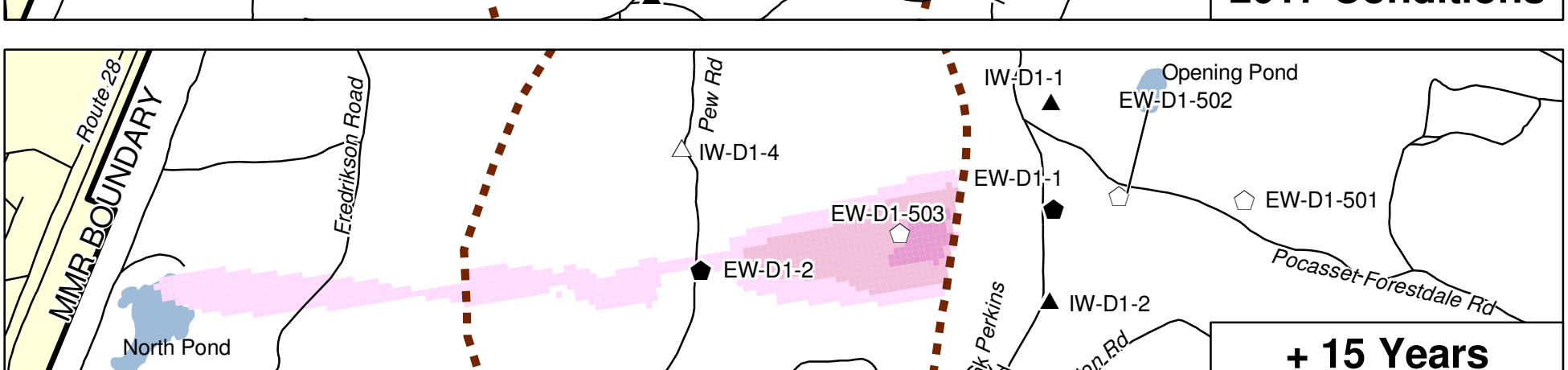
FIGURE
F3-2

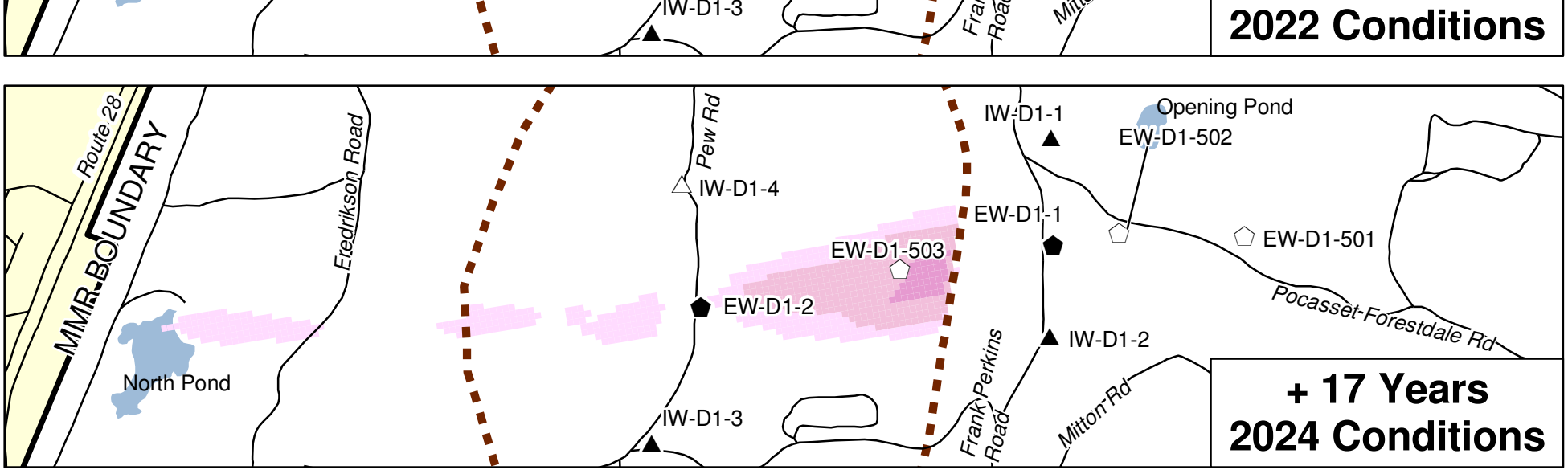
Impact Area
Groundwater Study Program











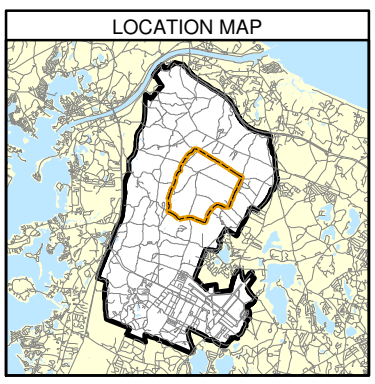
LEGEND

- Proposed Extraction Well
- Proposed Injection Well
- Existing Extraction Well
- Existing Injection Well
- Extent of Clay Zone

Model Computed Perchlorate Concentrations

- Non Detect to less than 1 ppb
- 1 - < 4 ppb
- 4 - < 18 ppb
- 18 - < 100 ppb
- Greater than or equal to 100 pbb

LOCATION MAP



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0 1,250 Feet

NOTES & SOURCES
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Topographic Map Source: MassGIS

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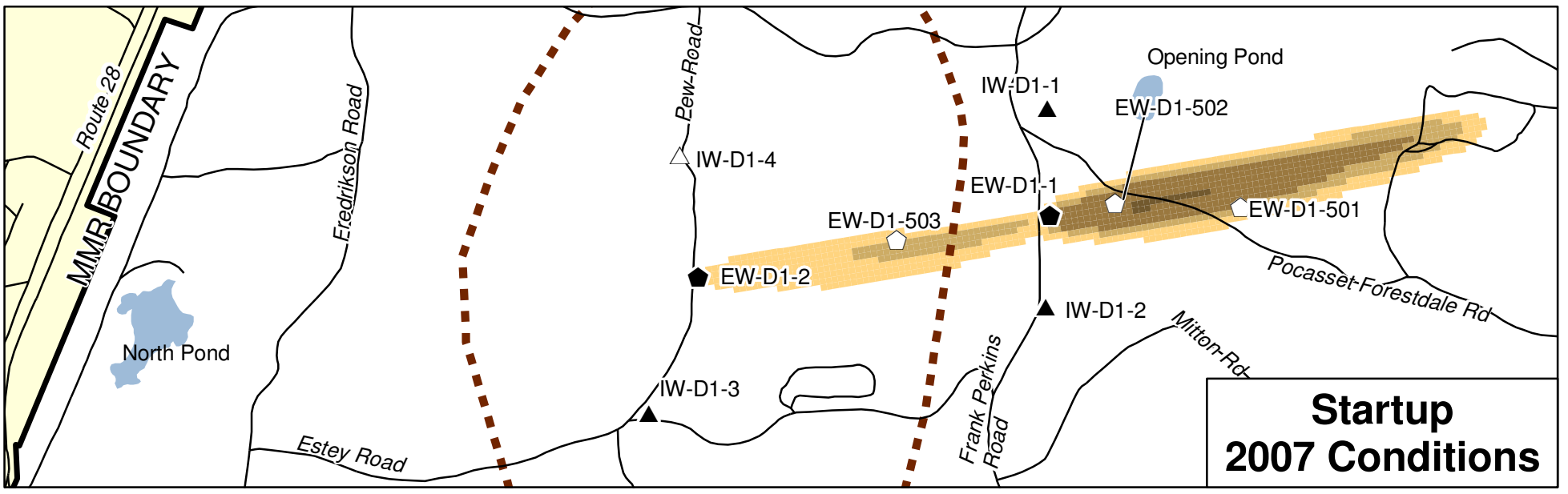
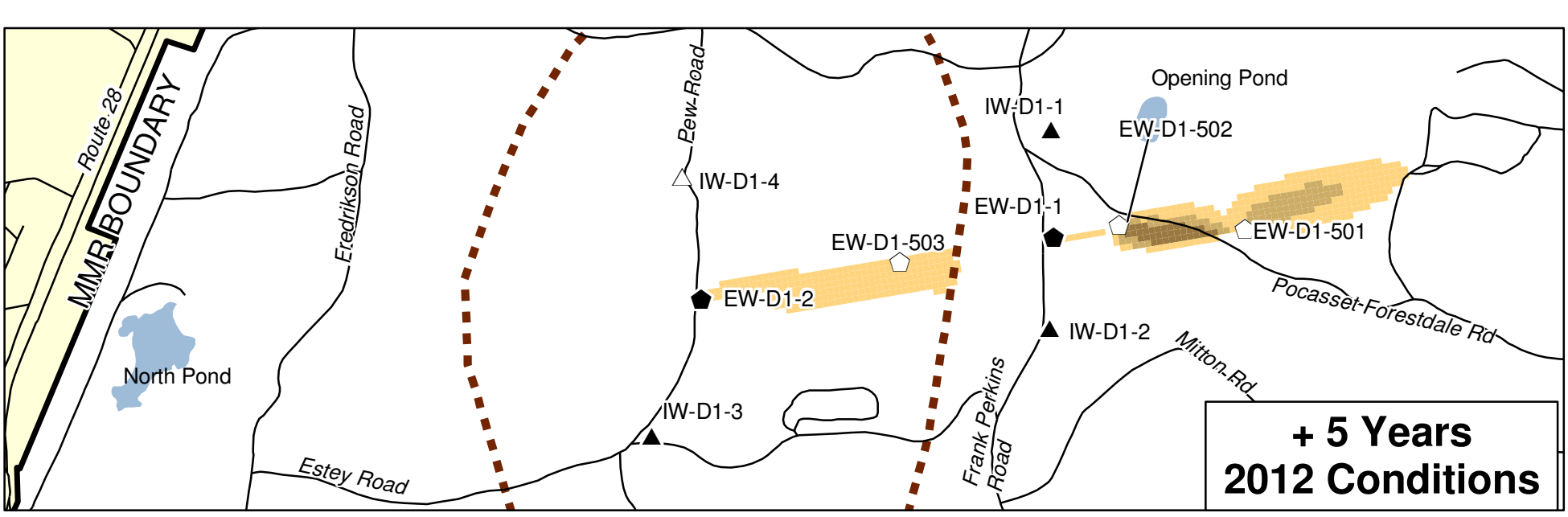
April 4, 2005 DWN: JBB CHKD: CA

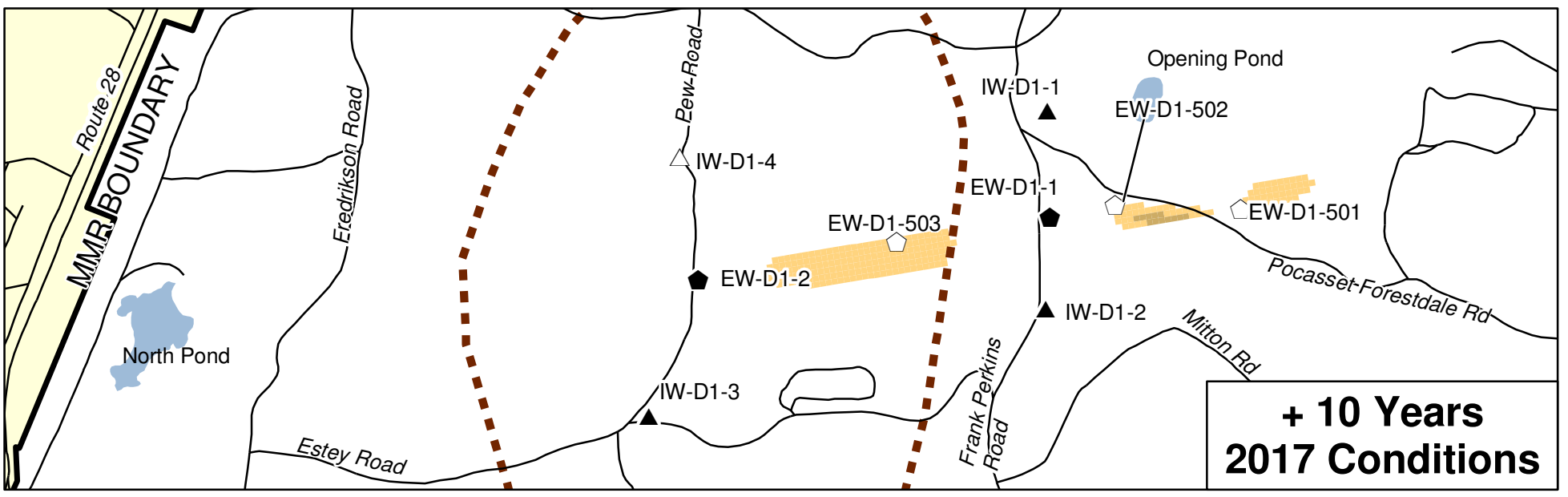
Simulated Perchlorate Distribution
During Operation of 5 Well System
Based on 12/04 Plumeshell
Remedy Selection Plan
Demo 1 Groundwater Operable Unit

FIGURE
F3-3

Impact Area
Groundwater Study Program







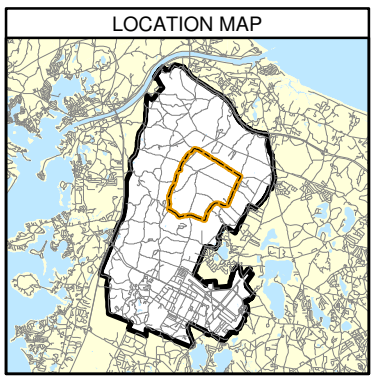
LEGEND

- Proposed Extraction Well
- Proposed Injection Well
- Existing Extraction Well
- Existing Injection Well
- Extent of Clay Zone

Model Computed RDX Concentrations

- Non Detect to less than 2 ppb
- 2 - < 10 ppb
- 10 - < 100 ppb
- Greater than or equal to 100 ppb

LOCATION MAP



N

0 1,250 Feet

NOTES & SOURCES
Map Coordinates: NAD 83, UTM, Zone 19N, Meters
Basemap data from US Geological Survey 7 1/2 minute
Topographic Map Source: MassGIS

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J:/mmr/ReportFigs2005/D9487/D9487_FigF3-4.pdf
G:/MMR_COE/Work2005/D9487/D9487_FigF3-4.mxd
April 4, 2005 DWN: JBB CHKD: CA

Simulated RDX Distribution
During Operation of 5 Well System
Based on 12/04 Plumeshell
Remedy Selection Plan
Demo 1 Groundwater Operable Unit

FIGURE
F3-4

Impact Area
Groundwater Study Program

Figure F3-5
Comparison of Mass Capture Effectiveness
Supplemental Evaluation – Final Feasibility Study
Demo 1 Groundwater Operable Unit

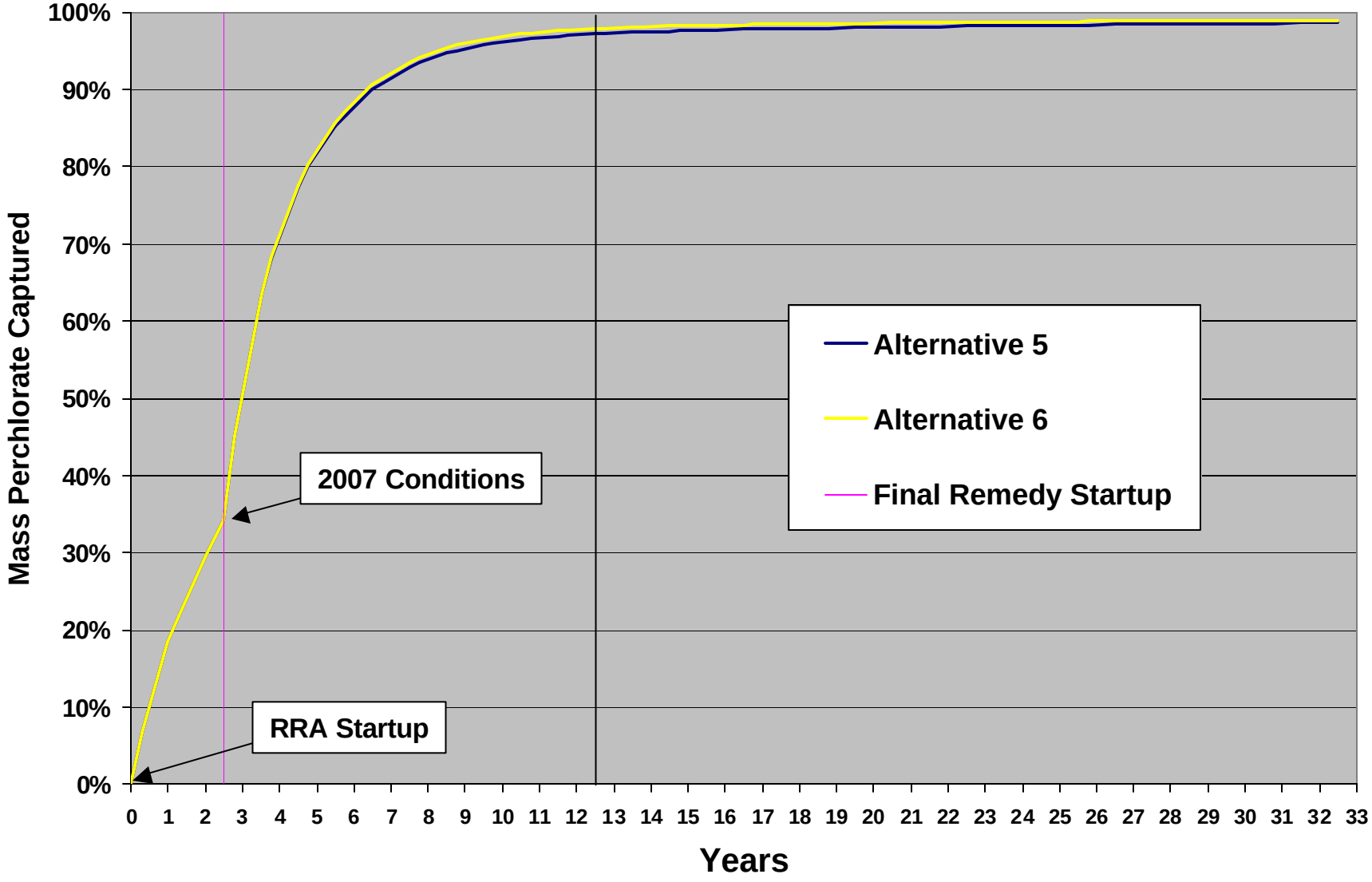
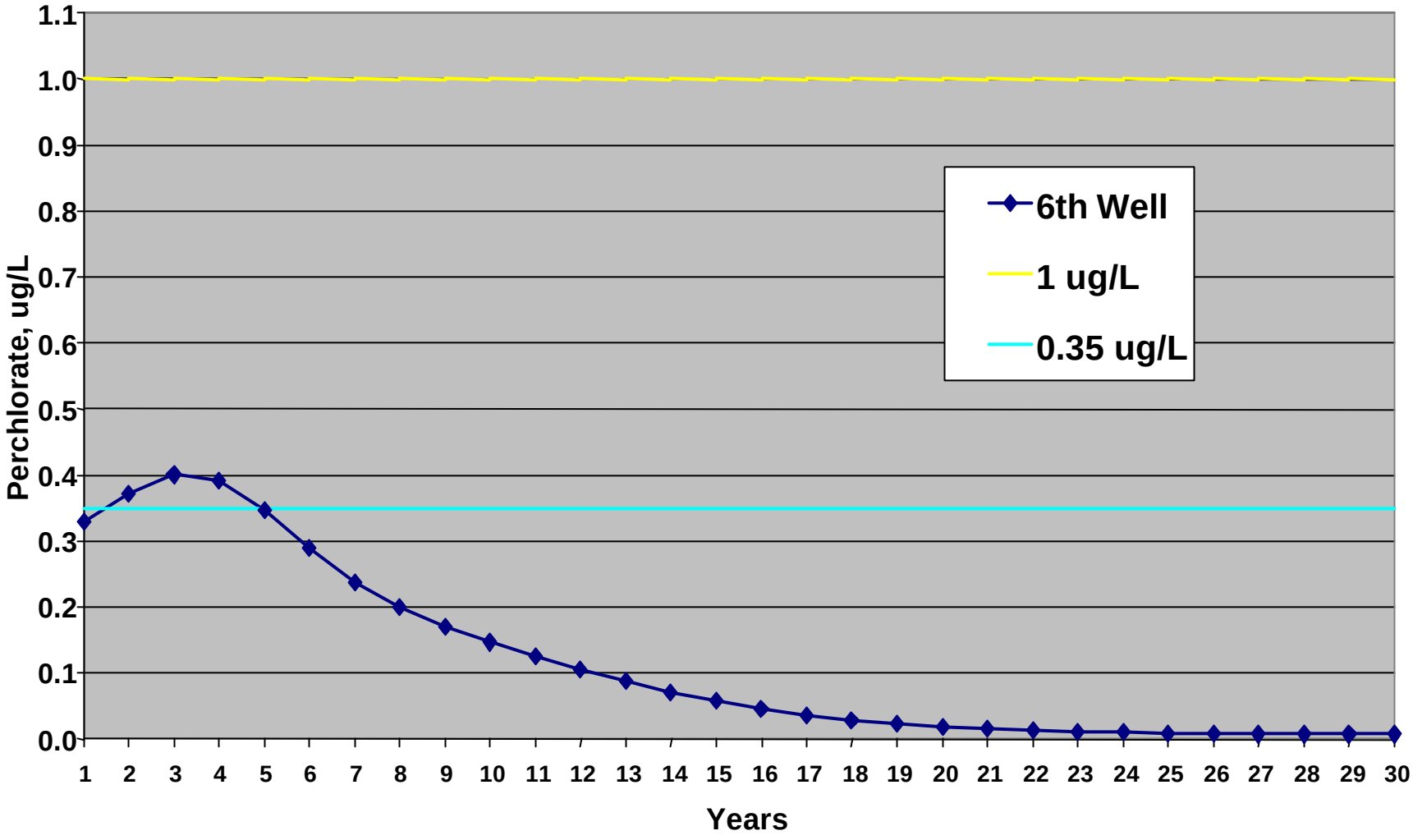
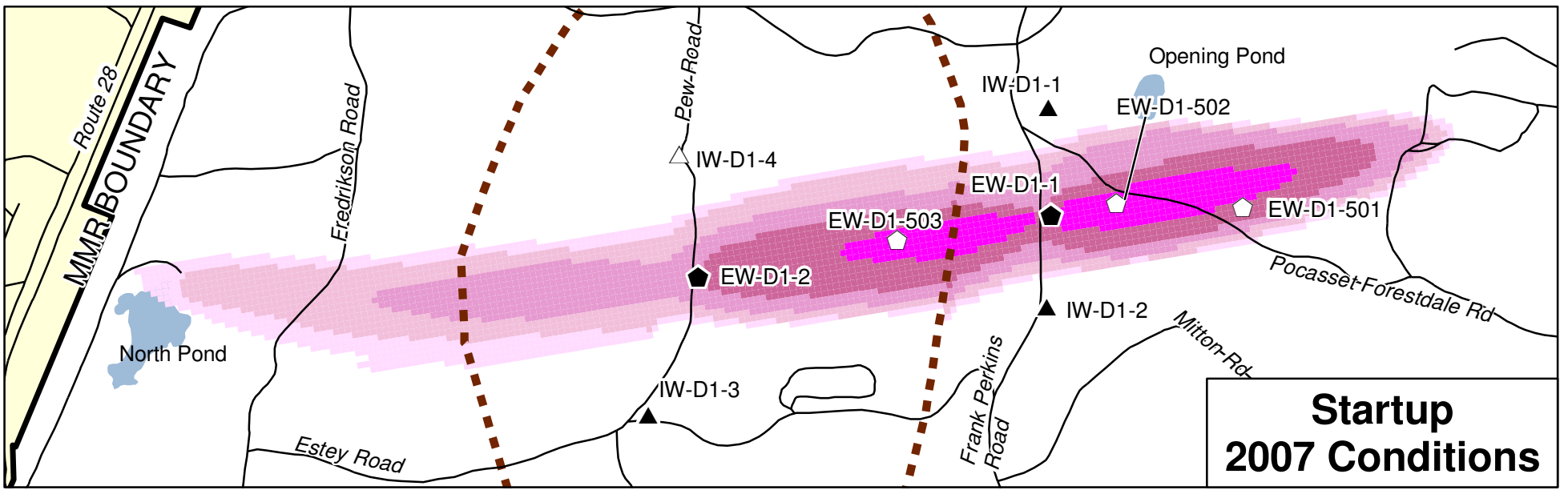
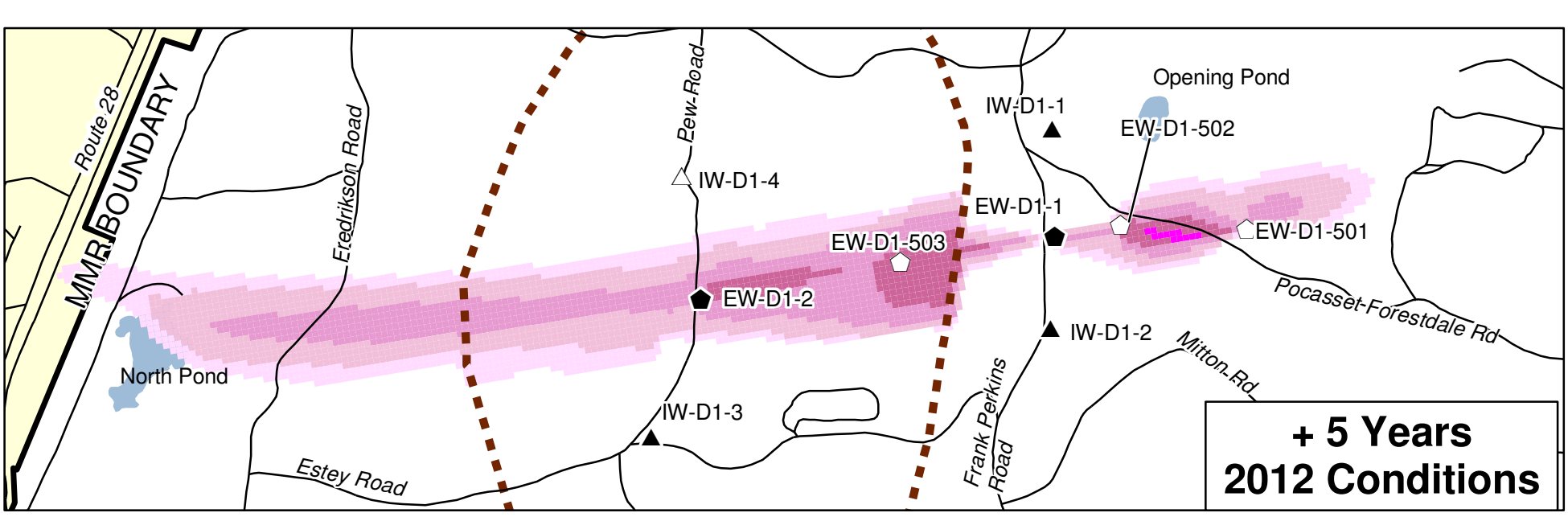
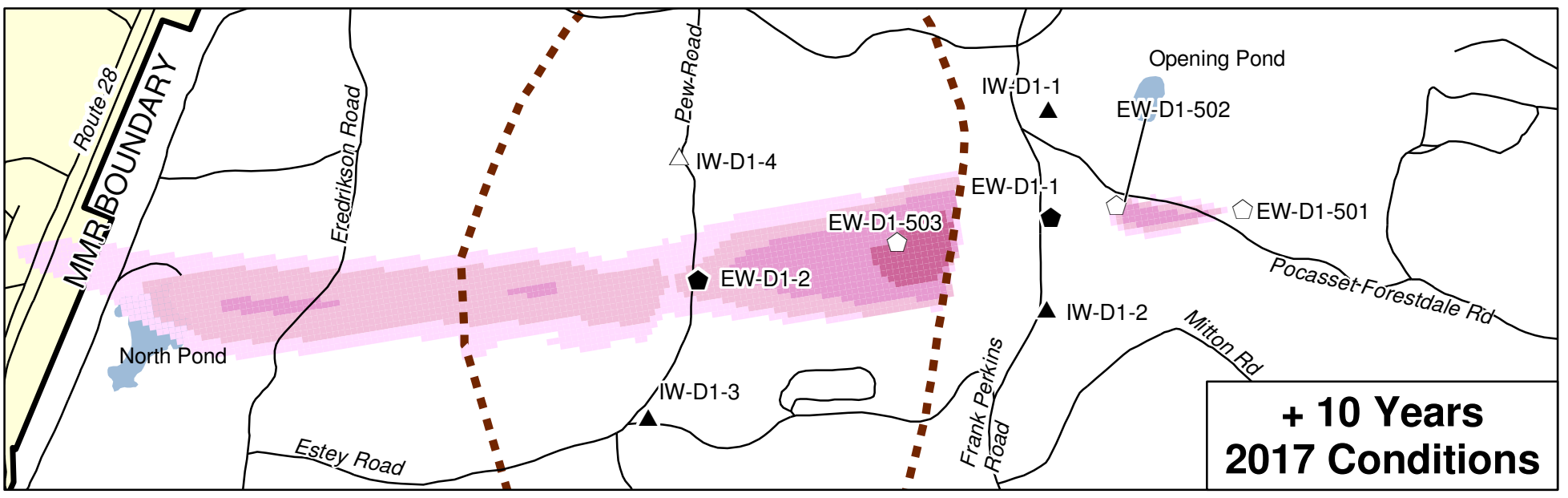


Figure F3-6
Influent Concentrations at 6th Well
Supplemental Evaluation – Final Feasibility Study
Demo 1 Groundwater Operable Unit









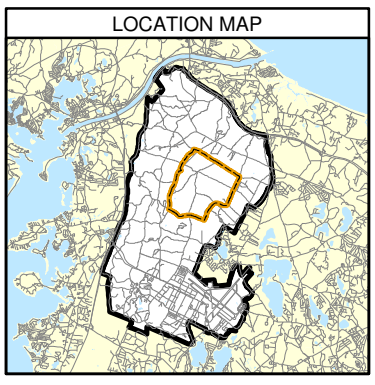
LEGEND

- Proposed Extraction Well
- Proposed Injection Well
- Existing Extraction Well
- Existing Injection Well
- Extent of Clay Zone

Model Computed Perchlorate Concentrations

- Non Detect to less than 1 ppb
- 1 - < 4 ppb
- 4 - < 18 ppb
- 18 - < 100 ppb
- Greater than or equal to 100 ppb

LOCATION MAP



N

0 1,250 Feet

NOTES & SOURCES
Map Coordinates: NAD 83, UTM, Zone 19N, Meters
Basemap data from US Geological Survey 7 1/2 minute
Topographic Map Source: MassGIS

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J:/mmr/ReportFigs2005/D9487/D9487_FigF3-7.pdf
G:/MMR_COE/Work2005/D9487/D9487_FigF3-7.mxd
April 4, 2005 DWN: JBB CHKD: CA

Simulated Perchlorate Distribution
During Operation of 5 Well System
Based on 5x 12/04 Plumeshell
Remedy Selection Plan
Demo 1 Groundwater Operable Unit

FIGURE
F3-7

Impact Area
Groundwater Study Program

Table F3-1
Comparison of Revised Alternatives
Supplemental Evaluations - Final Feasibility Study
Demo 1 Groundwater Operable Unit

Simulation	Design Details			Perchlorate Remediation		RDX Remediation	
Design Alternative	Number of Extraction Wells	Total Extraction Rate (gpm)	Number of Injection Wells	Years to achieve* 1 ug/L	Years to achieve* 0.35 ug/L	Years to achieve 0.6 ug/L	Years to achieve 0.25 ug/L
5 Well System	5	906	4	11/**9**	12/**19**	11	13
6 Well System	6	1006	5	11/**9**	12/**17**	11	13

* upgradient/downgradient of Pew Rd.

[1] Background (MDL) = 0.35 ug/L

[2] Background (MDL) = 0.25 ug/L

Table F3-2
Comparison of Revised Costs
Supplemental Evaluations - Final Feasibility Study
Demo 1 Groundwater Operable Unit

	0.35 ug/L Objective				1 ug/L Objective			
	Duration	**Capital Cost**	**O & M Cost**	**Total**	**Duration**	**Capital Cost**	**O & M Cost**	**Total**
5 Well System	13 yrs	8.3	12	20.3	11 yrs	8.3	10.6	18.9
6 Well System	17 yrs	9.9	14	23.9	11 yrs	9.9	12.2	22.1
Difference		1.6	2	**3.6**		1.6	1.6	**3.2**

Note: All costs in Millions

Impact Area Groundwater Study Program

Feasibility Study
Demo 1 Groundwater Operable Unit

Appendix G
Land Use Controls

Camp Edwards
Massachusetts Military Reservation
Cape Cod, Massachusetts

August 19, 2005

Prepared for:

U.S. Army Corps of Engineers
New England District
Concord, Massachusetts
for
U.S. Army / National Guard Bureau
Impact Area Groundwater Study Program
Camp Edwards, Massachusetts

Prepared by:

AMEC Earth & Environmental, Inc
Westford, Massachusetts
Contract No. DAHA92-01-D-0006

IMPACT AREA GROUNDWATER STUDY PROGRAM

Feasibility Study
Demo 1 Groundwater Operable Unit

Appendix G
Land Use Controls

Camp Edwards
Massachusetts Military Reservation
Cape Cod, Massachusetts

August 19, 2005

Prepared for:

U.S. Army Corps of Engineers
New England District
Concord, Massachusetts

U.S. Army / National Guard Bureau
Impact Area Groundwater Study Program
Camp Edwards, Massachusetts

Prepared by:

AMEC Earth & Environmental, Inc.
Westford, Massachusetts

LAND USE CONTROLS

DOD and Army policies describe various types of land use controls that are implementable to prevent exposure to contaminants and provide that such land use controls be documented as part of the project's remedial design and decision documents.

A. In accordance with applicable DOD and Army policies, the Army will take the following actions to identify, implement, and document on-post administrative controls:

1) As soon as practical after completion of the Feasibility Study – Demo 1 Groundwater OU, the IAGWSP, EPA, DEP, and appropriate National Guard representatives will convene a meeting to discuss on-post administrative control options and to finalize specific on-post administrative procedures.

2) The Army's commitment to institute on-post administrative controls and the process for identifying such controls will be set forth in the Remedy Selection Plan (RSP).

3) The Decision Document will identify and describe the administrative controls to be adopted and will state the performance objectives applicable to the administrative controls. The Decision Document will also contain a summary of the following:

   i. A description of the relevant risk(s) necessitating the administrative controls;
   ii. A description of risk exposure assumptions and reasonably anticipated land uses;
   iii. A description of the administrative controls' performance objectives;
   iv. A summary of specific administrative control implementation actions;
   v. A description of the area covered by the administrative controls;
   vi. The anticipated duration of the administrative controls.

4) The System Performance and Ecological Impact Monitoring Plan (SPEIM Plan) will include a detailed description of the on-post administrative controls to be used, the area covered by the administrative controls, and a process of quality assurance to facilitate and document consistent long-term adherence to the administrative controls.

5) The annual SPEIM Reports will include an update of the administrative controls' status and the area currently covered by the administrative controls. The SPEIM Reports will continue to include the annual administrative control updates until such time that contaminant concentrations in the on-post portion of the aquifer no longer exceed applicable drinking water standard or until EPA approves a request to discontinue on-post administrative control implementation.

6) The administrative controls described in the Decision Document and SPEIM Plan will be incorporated into the Camp Edwards Base Master Plan and the Camp Edwards Groundwater Protection Plan.

B. In accordance with applicable DOD and Army policies, the Army will take the following actions to assess the need for and, if necessary, identify, implement, and document off-post institutional controls:

1) The Army will install groundwater monitoring wells at the post boundary capable of detecting off-Base migration of contaminants from the Demo 1 plume. The Army has also conducted extensive modeling to determine the present and future shape and movement of the Demo 1 plume. At the present time, the existing wells have detected no evidence of off-post contaminant migration and the modeling results indicate that such migration is highly unlikely to occur in the future. The Army will regularly monitor groundwater quality at the base boundary and will provide monitoring results to EPA and DEP in accordance with the SPEIM Plan.

2) If the groundwater sampling and modeling results indicate a reasonable likelihood that off-post groundwater contaminant concentrations will exceed applicable drinking water standards, the Army will propose for EPA and DEP consideration specific institutional controls sufficient to eliminate the pathway for end-user exposure to the contaminated groundwater supplies.

3) The annual SPEIM Reports will include a summary of the monitoring results and an updated analysis of the likelihood of off-post contaminant migration.

4) If the process set forth in paragraphs B.1 and B.2 above necessitates the adoption of off-post institutional controls, the annual SPEIM Reports will also include an update of the institutional controls' status and the area currently covered by the institutional controls. The SPEIM Reports will continue to include the annual institutional control updates until such time that contaminant concentrations associated with Demo 1 plume in the off-post portion of the aquifer no longer exceed applicable drinking water standards or until EPA approves a request to discontinue off-post institutional control implementation.

5) If the process set forth in paragraphs B.1 and B.2 above necessitates the adoption of off-post institutional controls, the Army will submit to EPA a proposed amendment to the Decision Document containing a detailed description of the institutional controls, the area affected by the institutional controls, and a process of quality assurance to facilitate consistent long-term adherence to the institutional controls. EPA shall have the right to review and approve the proposed institutional controls after consulting with the MADEP and local authorities. The Decision Document will identify and describe the institutional controls to be adopted and will state the performance objectives applicable to the institutional controls. The Decision Document will also contain a summary of the following:

i. a description of the relevant risk(s) necessitating the institutional controls;
ii. a description of risk exposure assumptions and reasonably anticipated land uses;
iii. a description of the institutional controls' performance objectives;
iv. a summary of specific institutional control implementation actions and a schedule for implementation;
v. a description of the area covered by the institutional controls;
vi. the anticipated duration of the institutional controls;
vii. a program to monitor the effectiveness of the institutional controls, and a process under which EPA can enforce the implementation, monitoring, maintenance, and modification of the institutional controls, if necessary.

6) It is anticipated that the quality assurance process described in paragraph B.5 above will involve the participation of several off-post entities including but not limited to the DEP Division of Water Supply (as the approving authority for all public water supply development), the Bourne Water District, and the Bourne Board of Health.

C. The Army has conducted extensive modeling to predict the future shape and movement of the Demo 1 plume. At the present time, the modeling results indicate that persistence of the plume beyond the term of the Army's lease is highly unlikely to occur. If cleanup goals are not met when the lease with the Army expires, then the Army will take the following actions to assess the need for and, if necessary, identify, implement, and document institutional controls after Post closure:

1) The Army will continue to regularly monitor groundwater quality and will provide monitoring results to EPA and DEP in accordance with the SPEIM Plan. The annual SPEIM Reports will include a summary of the monitoring results and an updated analysis of the likelihood of contaminant remaining after termination of the lease. EPA may require SPEIM reports on a more frequent basis than annually if deemed necessary.

2) If the groundwater sampling and modeling results indicate a reasonable likelihood that groundwater contaminant concentrations will exceed applicable drinking water standards or health-based levels after the Army's lease expires, the Army will propose for EPA and MADEP consideration specific institutional controls sufficient to eliminate the pathway for exposure to the contaminated groundwater supplies. EPA shall have the right to review and approve the proposed institutional controls, after consultation with the MADEP and local authorities.

3) If the process set forth in paragraphs C.1 and C.2 above necessitates the adoption of institutional controls after the cessation of the lease, the annual SPEIM Reports will also include an update of the institutional controls' status and the area currently covered by the institutional controls. The SPEIM Reports will continue to include the annual institutional control updates until such time that

contaminant concentrations associated with the Demo 1 plume in the aquifer no longer exceed applicable drinking water standards or health-based levels or until EPA approves a request to discontinue institutional control implementation.

4) If the process set forth in paragraphs C.1 and C.2 above necessitates the adoption of institutional controls after cessation of the lease, the Army will submit to EPA a proposed amendment to the Decision Document containing a detailed description of the institutional controls, the area affected by the institutional controls, and a process of quality assurance to facilitate consistent long-term adherence to the institutional controls. EPA shall have the right to review and approve the proposed institutional controls after consultation with MADEP and local authorities. The Decision Document will identify and describe the institutional controls to be adopted and will state the performance objectives applicable to the institutional controls. The Decision Document will also contain a summary of the following:

    i. A description of the relevant risk(s) necessitating the institutional controls;
    ii. A description of risk exposure assumptions and reasonably anticipated land uses;
    iii. A description of the institutional controls' performance objectives;
    iv. A summary of specific institutional control implementation actions and a schedule for implementation;
    v. A description of the area covered by the institutional controls;
    vi. The anticipated duration of the institutional controls;
    vii. A program to monitor the effectiveness of the institutional controls, and a process under which EPA can enforce the implementation, monitoring, maintenance, and modification of the institutional controls, if necessary.

5) It is anticipated that the quality assurance process described in paragraph C.4 above will involve the participation of several off-post entities including but not limited to the DEP Division of Water Supply (as the approving authority for all public water supply development), the Bourne Water District, and the Bourne Board of Health.

The Decision Document, the SPEIM Plan, and any amendments, appendices, or attachments thereto will be deemed incorporated into, and made an enforceable part of, Administrative Order for Response Action SDWA-1-2000-0014 ("AO3").