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Air Force Center for
Engineering and the Environment

Final Record of Decision for Ashumet Valley Groundwater

March 2009

Prepared for:
AFCEE/MMR
Installation Restoration Program
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TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS vii
1.0 DECLARATION 1-1
1.1 SITE NAME AND LOCATION 1-1
1.2 STATEMENT OF BASIS AND PURPOSE 1-1
1.3 ASSESSMENT OF THE SITE 1-2
1.4 DESCRIPTION OF SELECTED REMEDY 1-2
1.5 STATUTORY DETERMINATIONS 1-3
1.6 DATA CERTIFICATION CHECKLIST 1-3
1.7 AUTHORIZING SIGNATURES 1-4
2.0 DECISION SUMMARY 2-4
2.1 SITE NAME, LOCATION, AND BRIEF DESCRIPTION 2-1
2.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES 2-2
2.3 COMMUNITY PARTICIPATION 2-10
2.4 SCOPE AND ROLE OF OPERABLE UNIT (OU) 2-13
2.5 SITE CHARACTERISTICS 2-13
2.5.1 Conceptual Site Model 2-14
2.5.2 Sampling Strategy 2-17
2.6 CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES 2-17
2.6.1 Land Use 2-18
2.6.2 Water Resource Use 2-18
2.7 SUMMARY OF SITE RISKS 2-19
2.7.1 Identification of Chemicals of Potential Concern (COPC) 2-19
2.7.2 Exposure Assessment 2-21
2.7.3 Toxicity Assessment 2-24
2.7.4 Risk Characterization 2-24
2.7.5 Uncertainty Analysis and Human Health Risk Assessment Conclusions 2-28
2.7.6 Ecological Risk Summary 2-29
2.8 REMEDIAL ACTION OBJECTIVES (RAO) 2-30
2.8.1 Basis and Rationale for Remedial Action Objectives (RAO) 2-30
2.8.2 Steps to Achieving Remedial Action Objectives (RAO) 2-31
2.9 DESCRIPTION OF ASHUMET VALLEY GROUNDWATER ALTERNATIVES 2-32
2.9.1 Groundwater Remedial Alternatives 2-33

TABLE OF CONTENTS

2.9.1.1 Alternative 1 – No Action 2-33

2.9.1.2 Alternative 2 – Long-Term Monitoring plus Land Use Controls (LUC) 2-34

2.9.1.3 Alternative 3 – Continue to Operate, Maintain, and Monitor the Existing Ashumet Valley System Plus Land Use Controls (LUC) 2-34

2.9.1.4 Alternative 4 – Continue to Operate, Maintain, and Monitor the Existing Ashumet Valley System Plus Land Use Controls with Additional Leading Edge Extraction, Treatment, and Discharge to Promote Additional Mass Capture 2-34

2.9.1.5 Alternative 5 – Continue to Operate, Maintain, and Monitor the Existing Ashumet Valley System Plus Land Use Controls with Additional Southern Plume Extraction, Treatment, and Discharge to Reduce Restoration Time 2-35

2.9.1.6 Alternative 6 – Operate, Maintain, and Monitor the Optimized Existing Ashumet Valley System plus Land Use Controls (LUC) 2-36

2.9.1.7 Alternative 7 – Operate, Maintain, and Monitor the Optimized Existing Ashumet Valley System plus Land Use Controls with Additional Downgradient Extraction, Treatment, and Infiltration to Promote Additional Mass Capture 2-36

2.9.2 Common Elements and Distinguishing Features of Alternatives 2-36

2.9.3 Expected Outcomes of the Alternatives 2-38

2.10 COMPARATIVE ANALYSIS OF ASHUMET VALLEY GROUNDWATER ALTERNATIVES 2-39

2.10.1 Criteria for Detailed Analysis of Alternatives 2-39

2.10.1.1 Threshold Criteria 2-39

2.10.1.2 Primary Balancing Criteria 2-40

2.10.1.3 Modifying Criteria 2-41

2.10.2 Comparison of Ashumet Valley Groundwater Plume Alternatives 2-41

2.10.2.1 Overall Protection of Human Health and the Environment 2-42

2.10.2.2 Compliance with ARARs 2-43

2.10.2.3 Long-Term Effectiveness and Permanence 2-43

2.10.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment 2-43

2.10.2.5 Short-Term Effectiveness 2-44

2.10.2.6 Implementability 2-46

2.10.2.7 Cost 2-47

2.10.2.8 State Acceptance 2-47

TABLE OF CONTENTS

2.10.2.9 Community Acceptance 2-48

2.11 SELECTED REMEDY FOR THE ASHUMET VALLEY GROUNDWATER OPERABLE UNIT (OU) 2-48

2.11.1 Summary of the Rationale for the Selected Remedy 2-49

2.11.2 Detailed Description of Selected Remedy 2-49

2.11.3 Cost Estimate for the Selected Remedy 2-56

2.11.4 Expected Outcomes of the Selected Remedy 2-57

2.12 STATUTORY DETERMINATIONS FOR THE ASHUMET VALLEY GROUNDWATER OPERABLE UNIT (OU) 2-58

2.12.1 Protection of Human Health and the Environment 2-58

2.12.2 Compliance with Applicable or Relevant and Appropriate Requirements (ARAR) 2-58

2.12.3 Cost-Effectiveness 2-59

2.12.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable 2-59

2.12.5 Preference for Treatment as a Principal Element 2-60

2.12.6 Five-Year Review Requirements 2-61

2.13 DOCUMENTATION OF CHANGES 2-61

3.0 RESPONSIVENESS SUMMARY 3-1

4.0 REFERENCES 4-1

Figures

Figure 2-1 Regional Surficial Geology Map and the Massachusetts Military Reservation

Figure 2-2 Ashumet Valley Area Land Use

Figure 2-3 Ashumet Valley Plume Source Area and Ashumet Valley Plume

Figure 2-4 Ashumet Valley Plume Conceptual Model

Figure 2-5 Human Health Conceptual Exposure Model Ashumet Valley

Figure 2-6 Ashumet Valley Groundwater Alternative 1—No Action

Figure 2-7 Ashumet Valley Groundwater Alternative 2—Long-Term Monitoring with Land Use Controls

Figure 2-8 Ashumet Valley Groundwater Alternative 3 Conceptual Design

Figure 2-9 Ashumet Valley Groundwater Alternative 4 Conceptual Design

Figure 2-10 Ashumet Valley Groundwater Alternative 5 Conceptual Design

TABLE OF CONTENTS

Figure 2-11	Ashumet Valley Groundwater Alternative 6 Conceptual Design
Figure 2-12	Ashumet Valley Groundwater Alternative 7 Conceptual Design
Figure 2-13	Ashumet Valley Groundwater Alternative 7 Modified Conceptual Design
Figure 2-14	Ashumet Valley Plume Land Use Control Area

Tables

Table 2-1	Occurrence, Distribution, and Selection of Chemicals of Potential Concern, Ashumet Valley Groundwater Within the Capture Zone
Table 2-2	Occurrence, Distribution, and Selection of Chemicals of Potential Concern, Ashumet Valley Groundwater Outside the Capture Zone North of Route 151
Table 2-3	Occurrence, Distribution, and Selection of Chemicals of Potential Concern, Ashumet Valley Groundwater Outside the Capture Zone South of Route 151
Table 2-4	Occurrence, Distribution, and Selection of Chemicals of Potential Concern, Backus River Surface Water
Table 2-5	Occurrence, Distribution and Selection of Chemicals of Potential Concern, Backus River Sediment
Table 2-6	Exposure Point Concentrations, Reasonable Maximum Exposure, Ashumet Valley Groundwater Within the Capture Zone
Table 2-7	Exposure Point Concentrations, Reasonable Maximum Exposure, Ashumet Valley Groundwater Outside the Capture Zone North of Route 151
Table 2-8	Exposure Point Concentrations, Reasonable Maximum Exposure, Ashumet Valley Groundwater Outside the Capture Zone South of Route 151
Table 2-9	Exposure Point Concentrations, Reasonable Maximum Exposure, Backus River Surface Water
Table 2-10	Values Used for Daily Intake Calculations, Reasonable Maximum Exposure, Ashumet Valley Groundwater
Table 2-11	Values Used for Daily Intake Calculations, Reasonable Maximum Exposure, Ashumet Valley, Backus River Surface Water
Table 2-12	Values Used for Daily Intake Calculations, Reasonable Maximum Exposure, Ashumet Valley Backus River, Fish Tissue
Table 2-13	Non-Cancer Chronic Toxicity Data - Oral/Dermal, Ashumet Valley
Table 2-14	Non-Cancer Chronic Toxicity Data - Inhalation, Ashumet Valley
Table 2-15	Cancer Toxicity Data - Oral/Dermal, Ashumet Valley

TABLE OF CONTENTS

Table 2-16	Cancer Toxicity Data – Inhalation, Ashumet Valley
Table 2-17	Risk Summary, Reasonable Maximum Exposure, Ashumet Valley Groundwater, Within the Capture Zone, Adult
Table 2-18	Risk Summary, Reasonable Maximum Exposure, Ashumet Valley Groundwater, Within the Capture Zone, Child
Table 2-19	Risk Summary, Reasonable Maximum Exposure, Ashumet Valley Groundwater, Outside the Capture Zone, North of Route 151, Adult
Table 2-20	Risk Summary, Reasonable Maximum Exposure, Ashumet Valley Groundwater, Outside the Capture Zone, North of Route 151, Child
Table 2-21	Risk Summary, Reasonable Maximum Exposure, Ashumet Valley Groundwater, Outside the Capture Zone, South of Route 151, Adult
Table 2-22	Risk Summary, Reasonable Maximum Exposure, Ashumet Valley Groundwater, Outside the Capture Zone, South of Route 151, Child
Table 2-23	Risk Summary, Reasonable Maximum Exposure, Ashumet Valley, Backus River Surface Water, Cranberry Worker
Table 2-24	Risk Summary, Reasonable Maximum Exposure, Ashumet Valley, Backus River Surface Water, Adult Wader
Table 2-25	Risk Summary, Reasonable Maximum Exposure, Ashumet Valley, Backus River Surface Water, Child Wader
Table 2-26	Risk Summary, Reasonable Maximum Exposure, Ashumet Valley, Backus River Surface Water, Adult Fish Consumer
Table 2-27	Identification of Contaminants of Concern for Ashumet Valley
Table 2-28	Evaluation of Ashumet Valley Groundwater Alternatives
Table 2-29	Model-Predicted Cleanup Years, Mass Removal Estimates, and Present Value Costs for Ashumet Valley Groundwater Alternatives
Table 2-30	Chemical-Specific ARARs for Ashumet Valley Groundwater Alternative 7 Modified
Table 2-31	Location-Specific ARARs for Ashumet Valley Groundwater Alternative 7 Modified
Table 2-32	Action-Specific ARARs for Ashumet Valley Groundwater Alternative 7 Modified
Table 2-33	Present Value Calculation for Ashumet Valley Groundwater Operable Unit Alternative 7 Modified
Table 2-34	Cost Estimate Basis for Ashumet Valley Groundwater Operable Unit Alternative 7 Modified

TABLE OF CONTENTS

Appendixes

Appendix A	MassDEP Concurrence Letter
Appendix B	Transcript of Public Hearing
Appendix C	Falmouth Board of Health Well Regulations
Appendix D	Groundwater Modeling of Alternatives 6 Modified and 7 Modified

ACRONYMS AND ABBREVIATIONS

AFCEE	Air Force Center for Engineering and the Environment
ANGI	Air National Guard Instruction
ARAR	applicable or relevant and appropriate requirement
BOH	Board of Health
CDI	chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
CWMA	Crane Wildlife Management Area
CS	Chemical Spill
cis-1,2-DCE	cis-1,2-dichloroethene
COC	contaminants of concern
COPC	chemicals of potential concern
DAD	dermal absorbed dose
DCM	decision criteria matrix
DOD	U.S. Department of Defense
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ESD	Explanation of Significant Differences
ETI	extraction, treatment, and infiltration
ETR	extraction, treatment, and reinjection
FFA	Federal Facility Agreement

ACRONYMS AND ABBREVIATIONS

FS	feasibility study
FTA-1	Fire Training Area-1
ft msl	feet mean sea level
GAC	granular activated carbon
gpm	gallons per minute
HI	hazard index
HQ	hazard quotient
IROD	Record of Decision for Interim Action
IRP	Installation Restoration Program
LTM	long-term monitoring
LUC	land use control
M	million
MassDEP	Massachusetts Department of Environmental Protection
MCL	maximum contaminant level
mgd	million gallons per day
mg/kg-day	milligrams per kilogram per day
MMR	Massachusetts Military Reservation
MMRCT	Massachusetts Military Reservation Cleanup Team
MPP	Mashpee Pitted Plain
MTU	mobile treatment unit
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NGB	National Guard Bureau
NPL	National Priorities List

ACRONYMS AND ABBREVIATIONS

O&M	Operations and Maintenance
OU	Operable Unit
PCE	tetrachloroethene
PCT	Plume Cleanup Team
PP	Proposed Plan
PRG	preliminary remediation goal
RfD	reference dose
RI	remedial investigation
RME	reasonable maximum exposure
ROD	Record of Decision
SF	slope factor
SPEIM	system performance and ecological impact monitoring
STP	Sewage Treatment Plant
SVOC	semivolatile organic compound
TCE	trichloroethene
TRET	Technical Review and Evaluation Team
UCL_{95}	95 percent upper confidence limit
USCG	U.S. Coast Guard
USGS	U.S. Geological Survey
VOC	volatile organic compound
µg/L	micrograms per liter

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1.0 DECLARATION

1.1 SITE NAME AND LOCATION

The Massachusetts Military Reservation (MMR) on Cape Cod, Massachusetts is located within the boundaries of the towns of Bourne, Mashpee, Sandwich, and Falmouth. This site is listed on the National Priorities List (NPL) as Otis Air National Guard/Camp Edwards in Falmouth, Massachusetts. This Record of Decision (ROD) addresses Ashumet Valley groundwater. The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) number for the MMR site is MA2570024487.

1.2 STATEMENT OF BASIS AND PURPOSE

This ROD presents the selected remedy for Ashumet Valley groundwater, which was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act, and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The source areas for Ashumet Valley groundwater contamination, including Fire Training Area-1 (FTA-1), and Chemical Spill (CS) areas 16 and 17, have been addressed in previous remedial actions, are not a part of the Ashumet Valley Groundwater Operable Unit (OU), and will not be addressed in this ROD (AFCEE 2000a, 2003).

The U.S. Department of Defense (DOD) (U.S. Air Force) is the lead agency for CERCLA remedial actions at the MMR. The U.S. Environmental Protection Agency (EPA), the U.S. Air Force, and the National Guard Bureau (NGB) are parties to the Federal Facility Agreement (FFA) (EPA et al. 2002) for this site. They, along with the Massachusetts Department of Environmental Protection (MassDEP), concur with the selected remedy.

1.3 ASSESSMENT OF THE SITE

The response action selected in this ROD is necessary to protect the public health, welfare, or the environment from actual or threatened releases of hazardous substances into the environment.

1.4 DESCRIPTION OF SELECTED REMEDY

The selected remedy for Ashumet Valley groundwater provides for continued active treatment of the Ashumet Valley plume using the existing extraction, treatment, and infiltration (ETI) system plus expansion of the system to improve capture of the leading edge of the plume. The existing system consists of a single extraction well (95EW0703) pumping at a rate of 350 gallons per minute (gpm). The contaminated water is pumped to the Ashumet Valley treatment plant and treated with granular activated carbon (GAC). The treated water is then discharged to two infiltration trenches. The source areas for the Ashumet Valley plume have been addressed in previous remedial actions (AFCEE 2000a, 2003). The system expansion involves installation of an additional extraction well in the Ashumet Valley plume (AVIP0001), from which water is processed at a mobile treatment unit (MTU) located near the extraction well and discharged to the Backus River by means of a bubbler. The objective of this remedy is to continue to operate, maintain, and optimize the existing ETI system with additional downgradient extraction to expedite aquifer restoration, capture additional mass, and implement land use controls (LUC) to reduce residential exposure to the Ashumet Valley plume. The ETI system consists of extracting and treating groundwater to federal and state standards for tetrachloroethene (PCE) and trichloroethene (TCE) as stipulated in the current Operations and Maintenance (O&M) Plan. This remedy leaves open the possibility of optimizing the treatment system including modifications to reduce the cleanup time frame. This remedy will also provide for chemical and hydraulic monitoring of the plume as long as active remediation continues. After active ETI no longer becomes effective at expediting plume cleanup, the Air Force Center for Engineering and the Environment (AFCEE), with regulatory agency concurrence, may cease operation of the ETI system and will continue to monitor the residual plume contamination until the

remedial action objectives (RAOs) have been met. The monitoring of the plume will be conducted as part of the system performance and ecological impact monitoring (SPEIM) program. This remedy provides the flexibility of modifying the monitoring network as necessary to adequately monitor the Ashumet Valley plume and optimize system performance. LUCs will reduce potential human exposure to contaminated groundwater. Five-year reviews and a residual risk assessment will be performed to determine if the remedy is still appropriate and protective.

1.5 STATUTORY DETERMINATIONS

The selected Ashumet Valley groundwater remedy is protective of human health and the environment, complies with federal and Commonwealth of Massachusetts requirements that are applicable or relevant and appropriate requirements (ARAR) for the remedial action, utilizes permanent solutions to the maximum extent possible, and is cost-effective. The remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduces the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment). Because hazardous substances are expected to remain in the aquifer for a number of years above levels that allow for unlimited use and unrestricted exposure, five-year reviews and a residual risk assessment will be conducted to ensure that the remedies continue to be protective of human health and the environment.

1.6 DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary (Section 2.0) section of this ROD. Additional information can be found in the Administrative Record for this site.

Data Item	Location in Document
Contaminants of Concern (COC) and their respective concentrations.	Sections 2.5.1 and 2.7.5
Baseline risk represented by the COCs.	Section 2.7
Cleanup levels established for the COCs and the basis for these levels.	Section 2.8

Data Item	Location in Document
How source materials constituting principal threats will be addressed.	Section 2.2
Current and reasonable anticipated future land use assumptions and current and potential future beneficial use of groundwater used in the baseline risk assessment and the ROD.	Section 2.6
Potential land and groundwater use that will be available at the site as a result of the selected remedy.	Section 2.8
Estimated annual and total present value costs, discount rate, and the number of years over which the remedy cost estimate is projected.	Section 2.11.3
Key factor(s) that led to selecting the remedy.	Sections 2.10.2 and 2.12

1.7 AUTHORIZING SIGNATURES

The foregoing represents the decision for remedial action for Ashumet Valley groundwater by AFCEE and the EPA, with the concurrence of the MassDEP.

Approve and recommend for immediate implementation.

AIR FORCE CENTER FOR ENGINEERING AND THE ENVIRONMENT

By: _____ Date: 1 May 09

Keith F. Yaktus, Colonel, USAF
Executive Director

U.S. ENVIRONMENTAL PROTECTION AGENCY

By: _____ Date: Jun 10 2009

for **James T. Owens III**
Director, Office of Site Remediation and Restoration

2.0 DECISION SUMMARY

The following sections describe the setting, potential risks, RAOs, and alternative evaluation for remediation of Ashumet Valley groundwater.

2.1 SITE NAME, LOCATION, AND BRIEF DESCRIPTION

The MMR is listed on the NPL as Otis Air National Guard/Camp Edwards in Falmouth, Massachusetts. The CERCLIS number for the MMR site is MA2570024487. In accordance with Executive Order 12580, the DOD is the lead agency for remedial actions at the MMR. The MMR was formally added to the NPL in 1989. The FFA for the MMR site was signed in 1991 by the DOD, the EPA, and the U.S. Coast Guard (USCG)/Department of Transportation[1] (EPA et al 2002). The Commonwealth of Massachusetts chose not to be a signatory to the FFA. In 1995, the FFA was amended to add the U.S. Air Force as the lead agent for the cleanup at MMR. The FFA, as amended, requires the U.S. Air Force to implement CERCLA requirements at the MMR (EPA et al. 2002).

The MMR occupies approximately 22,000 acres on Cape Cod (Figure 2-1) and consists of several operating command units: the Air National Guard, the Army National Guard, the Air Force, the USCG, and the Veterans Administration. Military training and maneuvers, military aircraft operations, and maintenance and support activities have resulted in past releases of hazardous materials at the MMR. Ashumet Valley is located on the south side of the MMR in the Town of Falmouth (Figure 2-1 and Figure 2-2). The Ashumet Valley groundwater plume is identified as OU ID 15, OU 01C – ASHU. VALLEY GW PLUME in the EPA database.

[1] In 2000, the FFA was amended to remove the USCG/U.S. Department of Transportation as a signatory to the FFA.

2.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES

Military use at the MMR began in 1911. The most intense periods of activity occurred from 1940 to 1946 and 1955 to 1970. Sources of contamination and chemical spills resulting from a variety of military operations include motor pools, landfills, fire training areas, and drainage structures such as dry wells and drainage swales.

The MMR history consists of a series of complex interactions between various federal agencies and the Commonwealth of Massachusetts. In 1940, the U.S. Army signed a 99-year lease with the Commonwealth of Massachusetts for the use of the MMR. The Army transferred this lease to the Air Force in 1953 for the Otis Air Force Base portion of the military reservation, and the Army maintained a sublease for the 14,000-acre area on the base known as Camp Edwards. In 1974, the Air Force licensed the Massachusetts Air National Guard to use Otis Air Force Base, and in 1975, the U.S. Army licensed the Massachusetts Army National Guard to use and occupy Camp Edwards. On 05 March 2002, a law was enacted to designate the northern 15,000 acres of the MMR as protected conservation land dedicated for the purposes of water supply and wildlife habitat, at the same time allowing military training compatible with the environmental protection of the land. In 2003, the Commonwealth of Massachusetts extended the lease with the National Guard until 2051.

Activities resulting in CERCLA actions are summarized below. In 1982, the DOD initiated the Installation Restoration Program (IRP) at the Otis Air National Guard Base area of the MMR. The IRP at the MMR is funded by the Defense Environmental Restoration Account. The NGB was responsible for implementing the IRP at the MMR. In 1986, the IRP was expanded to include all potential hazardous waste sites at the MMR. In 1989, the MMR was formally added to the NPL. An FFA among the NGB, the EPA, and the USCG was signed in 1991 and has since been amended (EPA et al. 2002). The FFA provides a framework for EPA oversight and enforcement of the MMR investigations and cleanup activities and identifies a schedule for cleanup activities. A Community Relations plan is included as an attachment to the FFA. In 1996, the regulatory agencies requested that the DOD provide a new management structure for the

MMR IRP. In response to that request, the U.S. Air Force assumed the lead role in the execution of the IRP and assigned AFCEE to manage the program. Under Amendment 2, additional enforceable milestones and the Plume Response Decision Criteria and Schedule were added to the FFA. Amendment 3 removed the USCG from its status as a party to the FFA because the USCG has not played an active role in implementing cleanup obligations under the FFA. Amendment 4 added Section 7003 of the Resource Conservation and Recovery Act (RCRA) to the FFA in order to address contamination caused solely by petroleum releases that fall within the scope of the CERCLA "petroleum exclusion" described in the last sentence of CERCLA Section 101(14). In June 2002, Amendment 5 was signed and removed the CS-13 site from the list of Study Areas and Areas of Contamination contained in Section 5.24 of the FFA. After investigation of the historical usage of the CS-13 site, it was removed based on a lack of evidence to indicate that any military component currently is or had been either an owner or operator of the site (i.e., real property comprising CS-13) as defined under CERCLA and the NCP.

The Ashumet Valley plume is the result of leaching of chlorinated volatile organic compounds (VOC) PCE and TCE from the former fire training area (FTA-1) and sewage-related groundwater contaminants (primarily phosphorus and nitrogen) from the CS-16/CS-17 sites also known as the Sewage Treatment Plant (STP) (Figure 2-3). A breakdown product of TCE, cis-1,2-dichloroethene (cis-1,2-DCE), was also present in the plume at elevated concentrations due to the reductive dechlorination of PCE and TCE as they interacted with the reducing conditions of the sewage plume. Recognition of the Ashumet Valley plume began in 1979 when the Massachusetts Department of Quality Engineering ordered the Town of Falmouth to shut down a municipal well due to levels of methylene-blue-active-substances (MBAS) that exceeded generally accepted standards (Witt 1979). The municipal water supply well was located approximately 300 feet east of Sandwich Road and approximately 1,500 feet south of Ashumet Road.

The FTA-1 was used from 1958 to 1985 for fire-training sessions by the MMR fire department (Figure 2-3). Six impoundments were used in this area for fire training. All but one of the impoundments was unlined. Flammable materials burned at the site

included JP-4, aviation gasoline, motor vehicle gasoline, diesel fuels, waste oils, solvents, paint thinners, transformer oils, and spent hydraulic fluid (E.C. Jordan 1986).

The STP occupied approximately 30 acres along the southern boundary of the MMR northwest of Ashumet Pond (Figure 2-3). In 1936, the primary wastewater treatment plant was constructed with a capacity of 0.9 million gallons per day (mgd). It was replaced in 1941 with a new 3 mgd secondary wastewater treatment plant. The plant employed the trickling filter method. The effluent was discharged to sand beds and the sludge from the sand beds was pumped to sludge drying beds. The dried sludge was then piled in a field behind the treatment plant. Source areas at the STP were designated as Chemical Spill-16 (CS-16; infiltration beds) and Chemical Spill-17 (CS-17; sludge disposal area) (E.C. Jordan 1986). Parts of the STP were in use until 1995 when the plant was closed and the infiltration beds were abandoned.

During a records search conducted for the MMR (ANG 1983), FTA-1 was identified as a potentially hazardous site. Prior to the developments of the remedial investigations (RI) a number of characterization studies were performed for the Ashumet Valley plume and source areas. Early characterization of Ashumet Pond and the impact of the sewage plume from the STP were conducted between 1969 and 1986 (McCann 1969, Meade and Vacarro 1970, Duerring and Rojko 1984, K-V Associates 1986). These studies indicated an increase in trophic state of Ashumet Pond due to the influx of sewage from the STP.

The sewage plume was first characterized by the U.S. Geological Survey (USGS) in a number of studies (LeBlanc 1984a, 1984b; Garabedian and LeBlanc 1991). These studies determined that the MMR STP had created a groundwater sewage plume that extended at least 11,000 feet from the base boundary and was characterized by elevated concentrations of dissolved solids, boron, chloride, sodium, phosphorus, ammonium, nitrate, detergents, and VOCs.

Pre-RI investigations in the Ashumet Valley source areas included a Phase I records search (E.C. Jordan 1986). A Phase II confirmation/qualification for FTA-1 showed soil samples with elevated concentrations of chlorinated organics, oil and grease, and lead;

and groundwater samples showed elevated levels of VOCs (Roy F. Weston Inc. 1985). Investigations of CS-16 and CS-17 conducted in 1988 determined surface soils from the sand filter beds contained measurable concentrations of pesticides, polychlorinated biphenyls (PCB), and semivolatile organic compounds (SVOC) (E.C. Jordan 1990d).

An interim RI was developed for the FTA-1 in 1989 (E.C. Jordan 1990a, 1990c; ABB 1993). Soils in FTA-1 were found to be contaminated with fuels and VOCs. Remedial actions performed at the FTA-1 source area consisted of soils excavation and onsite thermal treatment. The treatment of contaminated soils at FTA-1 began in June 1995 and was completed on 08 September 1997. A total of 42,531 tons of soils were excavated, thermally treated, and backfilled (AFCEE 2002). The *Final Closure Report FTA-1 Site* (AFCEE 2000a) outlines the soil excavation, thermal treatment, and backfilling activities.

An interim RI was developed for CS-16/CS-17 between 1989 and 1994 (E.C. Jordan 1990b, 1991a; ABB 1995). The RI concluded that the sand filter beds, sludge drying beds, and sludge piles contained SVOCs (primarily PAHs), pesticides, PCBs, and inorganics. Remedial actions at the CS-16/CS-17 source area consisted of excavation and offsite disposal of excavated soils. *The Record of Decision, Areas of Contamination CS-16/CS-17 Source Areas* (AFCEE 1999b) details the selected remedy for the CS-16/CS-17 source areas. Approximately 6,000 tons of soils were excavated for the CS-16/CS-17 source removal and disposed of offsite in the fall of 2001 (AFCEE 2002).

Numerous pre-RI groundwater investigations were conducted between 1985 and 1992 (E.J. Flynn 1985; E.C. Jordan 1987, 1989, 1990d, 1991b; ABB 1994). Groundwater downgradient of FTA-1 was found to be impacted by chlorinated solvents and fuels used during former fire training activities. Investigations determined that the STP was not a significant source of VOCs to the Ashumet Valley Plume (E.C. Jordan 1987). In 1988, as part of the Phase I groundwater investigation, the Ashumet Valley plume (then called the FTA-1 plume) was found to be comprised of primarily chlorinated solvents and to extend to within 1,000 feet north of Carriage Shop Road (E.C. Jordan 1991b). In 1993,

additional sampling indicated chlorinated solvents were detected 2,000 feet south of Carriage Shop Road and the results of the preliminary risk assessment indicated potential unacceptable carcinogenic and noncarcinogenic effects from drinking water (ABB 1994).

The Ashumet Valley groundwater RI found that PCE, TCE, DCE, fuel components (benzene), and inorganics (antimony, cadmium, and chromium) concentrations in groundwater exceeded regulatory guidelines (ABB 1995). The RI further concluded that the MMR STP was not a current source of VOCs to groundwater, but that FTA-1 remained a source of VOCs to groundwater. The RI also concluded that discharge of VOCs to Ashumet Pond was not significant.

An interim ROD for seven groundwater plumes emanating from the MMR was signed on 25 September 1995 (ANG 1995). For Ashumet Valley, the NGB funded two interim remedial measures to address the impact of the Ashumet Valley plume and to protect the public health of Ashumet Valley residents. The NGB reimbursed the Town of Falmouth for the cost of the Ashumet Valley water supply well and provided funds to extend the Falmouth municipal water system into the Ashumet Valley neighborhood north of Route 151. The interim remedial action was to intercept the contaminated groundwater plumes to prevent further downgradient movement of the contaminants.

In January 1996, a 60 percent plume containment design that met the design criteria of 100 percent capture of all plumes at the leading edge was submitted (OpTech 1994). The design consisted of using extraction wells and processing of the contaminated water through GAC systems (OpTech 1994). The Technical Review and Evaluation Team (TRET), established in 1996 as part of the new Record of Decision for Interim Action (IROD) management process, determined that the 60 percent design for containment of several of the IROD plumes would cause negative ecological impacts (TRET 1996). The remedy for Ashumet Valley was revised through a decision criteria matrix (DCM) process, which included public participation. The process used decision criteria that focused on protection of human health and the environment, regulatory requirements, effectiveness of treatment technologies, and community acceptance.

As part of the decision criteria selection process, 16 remedial alternatives to address the Ashumet Valley plume were considered. Six of these alternatives (including a no-action alternative) were carried forward. After consideration from the public, the RPMs selected Alternative I, with modifications. Alternative I used extraction, treatment, and reinjection (ETR) technology to achieve a significant degree of plume capture. An axial fence was proposed to be placed within the body of the plume to capture and treat VOCs. The fence would extend from Harney Golf Course north of Route 151, south through the Crane Wildlife Management Area (CWMA) to Hayway Road. To help protect Ashumet Pond, an ETR fence to capture phosphorus and VOCs would be located along the northwest shore of the pond. Phosphorus (and nitrates) in groundwater originated from the STP and a sewage plume was characterized by USGS from the base boundary to Ashumet Pond (LeBlanc 1984a, 1984b; Garabedian and LeBlanc 1991). Modifications to Alternative I included providing funds of $8.5 million (M) to the Town of Falmouth to address nitrate loading in surface waters near the toe of the plume, investigating the southeast portion of the plume between Hayway Road and Carriage Shop Road to determine if additional remediation would be required, and not installing an axial fence south of Carriage Shop Road. AFCEE would monitor the uncaptured portion of the plume (AFCEE 1997b).

The design of an axial wellfield array was developed in response to the selected alternative from the DCM process. The design removed the extraction wells from the sewage plume. The impact of the sewage plume to Ashumet Pond was addressed in other non-CERCLA remedial actions (AFCEE 2005b, 2001a). The final wellfield design for the VOC plume consisted of three extraction wells within the CWMA with the northernmost well located immediately south of Route 151, the second well located in the east-central portion of the CWMA (along a powerline), and the third located immediately north of Hayway Road (Figure 2-3). The extracted water is transported through underground pipe headers to a treatment facility within the CWMA along Sandwich Road. The treatment of extracted water utilized GAC with a combined system capacity of 1,200 gpm. Discharge of the treated water back to the aquifer was accomplished through two infiltration trenches located along Sandwich Road and Currier Road

(AFCEE 1999a). The goals of the system are restoration of the Falmouth wellfield and capture of all the contamination above the respective maximum contaminant level (MCL) north of Route 151 in a reasonable time frame. The FFA milestone for the startup of the Ashumet Valley treatment system was met on 22 November 1999.

There have been some changes to the operation of the system since it began operation. The original design extraction rate was 1,200 gpm using three extraction wells; the current optimized design extraction rate is 350 gpm using one extraction well (AFCEE 2008). From November 1999 to May 2007, the system operated, for the most part, at a capacity of 1,200 gpm. An optimization investigation (AFCEE 2007d) resulted in a recommendation that extraction well 95EW0701 be shut down because modeling indicated it was not capturing significant PCE or TCE mass. It also resulted in a recommendation that extraction well 95EW0702 be shut down because it captured minimal mass over the projected lifetime and did not significantly reduce cleanup timeframes in comparison to 95EW0703 operating alone (AFCEE 2007d). In May 2007, two of the three extraction wells were shut down (AFCEE 2007d). Since this time, only the southern-most extraction well (95EW0703) has been operating at a flow rate of 350 gpm. Prior to the May 2007 optimization, two modular treatment plants (A & B) were operating. After May 2007, only Plant A is required to handle the flow. Plant B is no longer used at Ashumet Valley. The extracted water is conveyed to Plant A where it is treated through a GAC system and is then returned to the aquifer via two infiltration trenches (at approximately 175 gpm each) aligned parallel to the long axis of the plume. Between November 1999 and December 2007, the Ashumet Valley treatment system has removed 181.9 pounds of PCE and 99.5 pounds of TCE from the Ashumet Valley plume (AFCEE 2008).

In addition to treatment, other actions have been taken to reduce potential risk of the Ashumet Valley plume through reducing exposure to contaminated groundwater. LUCs have been implemented to reduce exposure to groundwater impacted by the Ashumet Valley plume. For the area on-base, all base buildings have been connected to base supplied water from the J Well and the Upper Cape Cooperative. In the area of the

Ashumet Valley plume off-base, AFCEE has provided public water supply connections to all residences that were not already connected. Also the town of Falmouth has established regulations that prevent installation of private wells for human consumption or irrigation in areas of known plume contamination or in the direct path of an advancing plume without sampling and subsequent approval by the Falmouth Board of Health (BOH). The towns' regulations do not apply to use of existing drinking water wells and irrigation wells.

In support of reaching a final ROD for Ashumet Valley, a risk assessment was performed (AFCEE 2007a) using data collected from the ongoing SPEIM program to characterize the current plume and assess potential risks from exposure to the groundwater, surface, and sediment in the Ashumet Valley plume area. Because phosphates and nitrates are not considered CERCLA contaminants, the sewage plume is not addressed in this ROD. Other remedial actions are currently addressing the impact of the sewage plume on Ashumet Pond (AFCEE 2005a, 2001b). Based on the risk assessment, RAOs were established, which formed the basis of a feasibility study (FS). The FS (AFCEE 2007a) evaluated a range of remedial alternatives; the proposed remedies were presented in the Proposed Plan (PP) (AFCEE 2007c). The EPA submitted an explanation of concerns that was distributed with the PP outlining their opposition to AFCEE's preferred alternative (EPA 2007). Because an agreement could not be reached on a preferred alternative, AFCEE, EPA, and MassDEP agreed that additional information was required in order to come to an understanding on the best remedial action to take for the Ashumet Valley plume. A comprehensive sampling event was conducted in fall 2007 (November 2007 to January 2008) to fill in a number of data gaps in the understanding of the distribution of contamination in the southern portion of the Ashumet Valley plume. This consisted of a comprehensive sampling of Ashumet Valley monitoring wells in addition to the installation of a number of drive points in and around the Ashumet Valley plume. These data were incorporated into an updated Ashumet Valley plume shell for PCE and TCE for January 2008 (Appendix D). These plume shells were then placed in the Ashumet Valley groundwater model and an alternative was modified to address contamination downgradient of Carriage Shop Road west of the Backus River. After this

comprehensive sampling event, and a re-evaluation of FS alternatives, an agreement was made between AFCEE, the EPA, and the MassDEP on the selection of the final remedy. This ROD is the documentation of the selected remedy and considers information from all previous investigation and decision documentation.

2.3 COMMUNITY PARTICIPATION

The MMR IRP has a community involvement program that provides many opportunities for the public to become involved in the investigation and decision-making process. Public meetings and poster board sessions are held, display ads and notices are placed in newspapers to announce significant events, public comment periods and meetings, news releases are issued, tours of the sites and treatment facilities are conducted, and neighborhood notices are distributed to notify people of events impacting their neighborhoods.

In addition, several citizen teams have been formed over the years to advise the IRP and the regulatory agencies. Currently the Senior Management Board (SMB) and the Massachusetts Military Reservation Cleanup Team (MMRCT) are the two teams that continue to meet. The MMRCT was formerly known as the Plume Cleanup Team (PCT). They are made up of citizen volunteers and government representatives working together to resolve problems and advise on the cleanup process. All citizen team meetings are open to the public. Assumptions about reasonably anticipated future land use and potential beneficial uses of groundwater and surface water are regularly discussed.

The public has been kept up-to-date on the progress of the Ashumet Valley site through various public and citizen team meetings and public notices. The following updates on the IROD to ROD process for this ROD were presented to the PCT/MMRCT:

- 11 February 2004: Overview of the Final Work Plan for the Process Leading to Final Groundwater Decisions for Ashumet Valley and Landfill-1 (AFCEE 2004).
- 13 October 2004: Overview of the human health risk assessment and ecological risk assessment for Ashumet Valley.
- 09 February 2005: Initial groundwater alternatives remedial alternatives for the Ashumet Valley FS.

- 13 April 2005: An additional presentation on the four initial groundwater remedial alternatives for the Ashumet Valley FS.
- 11 January 2006: Update on the Draft Ashumet Valley Groundwater Feasibility Study.
- 08 March 2006: Update on the revised Ashumet Valley plume.
- 14 June 2006: Revised Ashumet Valley Feasibility Study Alternatives Analysis.
- 13 September 2006: Presentation of the Draft Ashumet Valley Groundwater Feasibility Study.
- 10 January 2007: Update on the *Proposed Plan for Ashumet Valley Groundwater* (AFCEE 2007c).
- 14 March 2007: Update on revised Ashumet Valley Feasibility Study Addendum Alternatives analysis.
- 13 June 2007: Presentation of the *Proposed Plan for Ashumet Valley Groundwater* (AFCEE 2007c).
- 12 September 2007: Update on the *Proposed Plan for Ashumet Valley Groundwater* (AFCEE 2007c).
- 14 November 2007: Update on the *Proposed Plan for Ashumet Valley Groundwater* (AFCEE 2007c).
- 13 February 2008: Presentation of additional data collected for Ashumet Valley groundwater.
- 09 April 2008: Presentation of Ashumet Valley plume shell update and preliminary alternatives for focused FS.
- 11 June 2008: Presentation on Ashumet Valley alternatives for focused FS.
- 09 July 2008: Presentation of preferred alternative for Ashumet Valley ROD.

On 13 June 2007, a presentation of the Ashumet Valley PP was made to the public in conjunction with the PCT with AFCEE presenting its preferred alternative and the EPA presenting its preference for another alternative. The meeting was held at the Unitarian Universalist Fellowship on Sandwich Road in Falmouth. From 14 June 2007 to 11 July 2007, AFCEE held a 30-day comment period to obtain public comments on the remedy presented in the PP for Ashumet Valley groundwater. Before the public comment period, the PP and EPA's explanation of concerns were delivered to the town libraries of Bourne, Sandwich, Falmouth, and Mashpee; and an electronic copy was posted on the IRP website. On 11 July 2007, AFCEE held a public hearing at the

Holiday Inn on Jones Road in Falmouth to accept formal comments on the PP. A transcript of the public hearing is provided in Appendix B. One verbal comment was presented at the meeting. On 22 July 2007, a letter was received by AFCEE from the Town of Falmouth requesting an extension of the public comment period after the 11 July 2007 deadline. A workshop was requested by the Town of Falmouth to AFCEE and the EPA to discuss the issues regarding the selection of alternatives for Ashumet Valley groundwater. The workshop was held on 25 July 2007 at the Town Hall in Falmouth with representatives from AFCEE, EPA, MassDEP, and the Town to discuss issues regarding potential remedial actions and the Town's future plans for wastewater treatment in the vicinity of the Ashumet Valley Plume. The comment period was extended to 13 August 2007 and this information was presented in the Cape Cod Times on the 13 July 2007 edition. On 20 August 2007, the Town of Falmouth submitted a letter to AFCEE clarifying its position on the preferred alternative. Due to the number of comments that were received in late August, comments dating to 29 August 2007 were accepted and are included in the Responsiveness Summary, which is Section 3.0 of this ROD.

AFCEE published display advertisements for the public information meeting, public comment period, and the public hearing on 13 June 2007 for the Ashumet Valley PP in the *Falmouth, Mashpee, Bourne,* and *Sandwich Enterprises;* and in the *Cape Cod Times.* AFCEE also circulated news releases for the public information meeting, public comment period, and public hearing on 13 June 2007. The additional public comment period notice was published on 13 July 2007. The PP was made available for public review at the main public libraries in Bourne, Falmouth, Mashpee, and Sandwich, Massachusetts; and on the MMR website. The PP has also been made part of the Administrative Record available for public review at the AFCEE IRP office at the MMR and on the MMR website, http://www.mmr.org.

2.4 SCOPE AND ROLE OF OPERABLE UNIT (OU)

The Ashumet Valley site is organized into one OU, focusing on groundwater. The source areas for the Ashumet Valley plume were addressed in previous remedial actions. This ROD addresses the groundwater OU (Figure 2-3).

The Ashumet Valley area is located along the south-southeastern boundary of the MMR where, through the IRP, AFCEE is responsible for the cleanup of contamination from past military practices. The NGB is actively investigating and remediating soil and groundwater contamination in the northern portion of the base (north of the Ashumet Valley site) as part of the Impact Area Groundwater Study Program.

2.5 SITE CHARACTERISTICS

As described in Section 2.2, environmental data have been collected from the Ashumet Valley area since 1983. The following overview of site characteristics will focus on the current site conditions.

The Ashumet Valley source area was located in the south-southeastern portion of the MMR, within the town of Falmouth (Figure 2-2). The source areas, FTA-1 and the STP, were located on Kittredge Road, which is bounded by to the south by the MMR boundary (Figure 2-3).

The Ashumet Valley plume is primarily located within the Mashpee Pitted Plain (MPP) (Figure 2-1). The MPP is a broad, flat, gently southward-sloping glacial outwash plain. The MPP consists of stratified outwash sand underlain by silty glaciolacustrine sediment. Some sections have remnants of gravel and basal till that overlie bedrock. The topography of the MPP gradually slopes from 140 feet mean sea level (ft msl) in the north to 70 ft msl in the south and is pocked with numerous kettle ponds. Beneath these sediments, a variable thickness of glacial till overlies the bedrock.

The single groundwater flow system that underlies western Cape Cod, including the MMR, is known as the Sagamore Lens. This sole-source aquifer is primarily unconfined

and recharged by infiltration of precipitation. Groundwater flow is generally radial from the recharge area toward the ocean, which forms the lateral boundary of the aquifer on three sides; the Bass River in Yarmouth forms the eastern boundary of the Sagamore Lens. Flow direction within the aquifer is generally horizontal with stronger vertical gradients near surface water bodies. Ponds are generally an expression of the water table and are hydraulically connected with the aquifer. Groundwater enters the upgradient portion of the pond, flows through the pond, and exits on the downgradient portion of the pond. Water table elevations fluctuate from 1 to 4 feet per year. The elevation of the water table is approximately 50 ft msl near the source area and 12 ft msl in the downgradient portion of the plume. The aquifer thickness varies from 240 to 290 feet in the Ashumet Valley area depending on the elevation of the bedrock surface, which forms the bottom of the aquifer.

2.5.1 Conceptual Site Model

The Ashumet Valley plume, based on the MCL extent of the contaminants PCE and TCE prior to system startup, was approximately 22,000 feet long, 2,600 feet wide (at its maximum point), and over 150 feet thick (AFCEE 2007a). Currently the plume is approximately 17,000 feet long, 2,000 feet wide, and 110 feet thick. The plume extends south of the southern shoreline of Ashumet Pond, to south (downgradient) of Carriage Shop Road, to a point just upgradient of Route 28 near Mill Pond (AFCEE 2008). The difference between the startup and current conceptual model of the plume is primarily due to attenuation of PCE and TCE upgradient of Ashumet Pond, migration of the Ashumet Valley plume in the direction of the Backus River, migration of PCE approximately 2,000 feet farther to the south, the widening of the plume east of the Backus River, the narrowing of the plume west of the Backus River, discharge of PCE and TCE to the Backus River, and decreasing concentrations within the plume core due to the operation of the Ashumet Valley ETI system. The primary COCs in the Ashumet Valley plume are PCE and TCE. Maximum concentrations of PCE and TCE at startup were 86 and 37 micrograms per liter (µg/L), respectively (AFCEE 2001). Current maximum concentrations of PCE and TCE are 54.9 and 16.1 µg/L, respectively (Appendix D, Attachment A).

The Ashumet Valley plume is located within the MPP, a late Wisconsinan physiographic formation comprised of variously sorted glacial outwash deposits. Although it is dominated by fine to coarse sand, silty and clayey layers are not uncommon in the deeper sections of the MPP. These deeper silty and clayey layers are believed to be discontinuous in nature and do not separate upper and lower sections of the aquifer. Underlying the MPP in most areas are fine-grained lacustrine sediments and basal till, although in some areas coarse grained MPP deposits directly overlie a granodiorite bedrock (Figure 2-4).

Groundwater flow in the vicinity of the Ashumet Valley plume is mainly to the south-southwest, except in the immediate vicinity of Ashumet Pond where groundwater flow is south-southeast toward the pond. Flow within the aquifer is predominantly horizontal, and with groundwater gradients in the vicinity of the Ashumet Valley plume ranging from 0.001 to 0.002 feet per foot (ft/ft) and horizontal flow velocities ranging from 1 to more than 4 feet per day (ft/day) in the MPP. Plume mapping, evaluation of MMR STP discharge, and groundwater modeling suggest that strong downward gradients were present at the STP when it was operating. These vertical gradients drove the VOCs and treated wastewater plume deep into the aquifer. Field data and groundwater modeling suggest upward gradients at the far southern extent of the plume near the Backus River.

The MMR STP (CS-16/CS-17) was a source of VOC and elevated inorganics, and sewage-related contaminants in the groundwater (Bussey and Walter 1996; Garabedian and LeBlanc 1991). Relatively mobile wastewater-related constituents (such as boron) associated with permitted disposal of secondarily treated wastewater on rapid infiltration beds have also been found throughout much of the plume. Consequently, elevated specific conductance has been mapped throughout the length of the plume and is an indicator of the impacts of sewage effluent. The concentrations of most sewage-related constituents, however, are much higher within the northern part of the plume, generally within 2,000 feet of the STP infiltration beds. Constituents such as phosphorus, iron, and manganese are particularly abundant in the area between the STP and Ashumet Pond (AFCEE 2000b). These contaminants have been moving with the sewage plume,

discharging to Ashumet Pond, and/or mixing with the VOCs from the Ashumet Valley plume. Biodegradation of the sewage contaminants have produced reducing conditions in the sewage plume where metals such as iron, manganese, and thallium have become more soluble and therefore, more common in the dissolved phase in groundwater.

The soils at FTA-1 contained petroleum hydrocarbons, lead, fuel-related VOCs, SVOCs, chlorinated solvents, pesticides, PCBs, and dioxin. The cessation of fire training activities, the remediation of impacted soils at the source area (FTA-1), and the rapid downgradient transport of previously introduced contaminants have greatly reduced the magnitude of VOC contamination present in the northern portion of the plume. Although the VOCs (PCE, TCE, and cis-1,2-DCE) are intermingled within the plume, there are indications that some of the TCE and subsequently cis-1,2-DCE was produced through reductive dechlorination of PCE and TCE within a strong reducing zone beneath and immediately downgradient of FTA-1 where the VOC plume intercepts the sewage plume.

The northern portion of the Ashumet Valley plume historically extended from FTA-1 to the southern boundary of Ashumet Pond. This portion of the historic plume consisted of PCE primarily and showed how the plume remained attached to the FTA-1 source area and also indicated some discharge into Ashumet Pond at Fisherman's Cove. Currently, the Ashumet Valley plume is detached from the source area and is not discharging into Ashumet Pond at concentrations greater than the MCL of 5 µg/L. There is only one well in the vicinity of former FTA-1 that has a PCE concentration that exceeds the MCL (6.7 µg/L, 18 September 2007).

The central plume zone is defined as that section of the plume extending from the southern boundary of Ashumet Pond southward to Hayway Road (Figure 2-3). Contamination in the central plume zone is located deeper in the aquifer than the southern plume zone. The central plume zone showed evidence of reductive dechlorination due to reducing conditions from the sewage plume that emanated from the STP. These reducing conditions developed areas in the central plume zone where elevated concentrations of TCE and cis-1,2-DCE indicated the breakdown of PCE and TCE. These reducing

conditions remain in the central plume zone with a majority of monitoring wells exhibiting dissolved oxygen (DO) concentrations less than 1 milligram per liter (mg/L). Maximum concentrations of PCE and TCE in the central plume zone are 26.4 µg/L and 15.8 µg/L respectively based on the most current monitoring (AFCEE 2008). Most of the contamination in this zone will be captured by the current Ashumet Valley ETI system.

The southern plume zone (Figure 2-3) is generally shallower and vertically thinner than the central plume zone. PCE is the primary VOC that exceeds its MCL in the southern plume zone. Maximum concentrations of PCE and TCE in the southern plume zone are 54.9 µg/L and 16.1 µg/L respectively (Appendix D, Attachment A). The southern plume zone is characterized by higher DO concentrations in comparison to the central plume zone and shows little of the reductive dechlorination that is evident in the central plume zone. The location of PCE and TCE in the shallower portion of the aquifer downgradient of Carriage Shop Road indicates a hydraulic gradient conducive to the upward migration of contaminants in the direction of the Backus River and Mill Pond.

2.5.2 Sampling Strategy

Groundwater samples have been collected in the Ashumet Valley area at prescribed frequencies (i.e., a maximum frequency of semiannual to a minimum frequency of triennial) as part of the SPEIM program, which was initiated before the operation of the Ashumet Valley ETI system in 1999. Reviews of the SPEIM monitoring program are made on an annual basis and sampling frequencies are adjusted accordingly. A total of 149 monitoring wells have been installed in support of monitoring the Ashumet Valley plume, and since 1996, a total of 2,485 samples have been collected. The sampling program was initiated as part of the interim remedy for Ashumet Valley groundwater and, thus, is ongoing.

2.6 CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

This section discusses the current and reasonably anticipated future land uses and current and potential beneficial groundwater uses at the Ashumet Valley source area and in the

vicinity of Ashumet Valley contaminated groundwater, and presents the basis for future land use and groundwater use assumptions.

2.6.1 Land Use

The on-base area of Ashumet Valley groundwater contamination includes the inactive STP and FTA-1 (i.e., the source areas), portions of a USGS research area, and undeveloped woodlands. Currently, PCE concentrations above the MCL are represented by a single well upgradient of Ashumet Pond and the Ashumet Valley plume is no longer mapped on-base. The off-base area south of the MMR boundary to Route 28 is characterized as primarily residential, with smaller areas characterized as recreational, conservational, and commercial (Figure 2-3). It is anticipated that the land use in the Ashumet Valley area will not change significantly over time.

2.6.2 Water Resource Use

The Ashumet Valley plume extends from an area downgradient of Ashumet Pond to Mill Pond and Route 28. Part of the Ashumet Valley plume was historically mapped between FTA-1 and Ashumet Pond and has manganese and thallium concentrations that exceed guidelines. PCE and TCE concentrations in this area are currently below their MCLs (with the exception of one well) and the Ashumet Valley plume is no longer mapped upgradient of Ashumet Pond. The aquifer in the Ashumet Valley area and throughout the upper Cape Cod, known as the Sagamore Lens, is generally a highly transmissive and productive aquifer, and designated by the MassDEP and EPA as a sole source aquifer (defined as the sole or principal source of drinking water for a given area). There are no active public water supply wells in the Ashumet Valley groundwater area.

Surface water bodies in the vicinity of the Ashumet Valley plume (e.g., Ashumet Pond, Backus River, and Mill Pond) are fed by groundwater and provide recreational use such as fishing, swimming, and boating. The Backus River supports a number of cranberry bogs.

AFCEE has developed a working relationship with the water commissioners of the four towns that surround MMR to ensure that future development of the groundwater resource is coordinated with groundwater monitoring and remediation at the MMR.

2.7 SUMMARY OF SITE RISKS

The risk assessment estimated the potential future risks posed by the Ashumet Valley groundwater contamination (AFCEE 2007b). It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed. The technical approach of the risk assessment is detailed in the *Final Work Plan for the Process Leading to Final Remedial Decisions Ashumet Valley and Landfill-1* (AFCEE 2004). The risk assessment evaluated the human health and ecological risks from exposure to contaminated groundwater in the Ashumet Valley area. Surface water and sediment from the Backus River was also included in the Ashumet Valley risk assessment. Soil exposure pathways at the source area were not considered due to the remediation of soils at CS-16, CS-17, and FTA-1; thus eradicating potential exposure to contamination.

This section of the ROD summarizes the results of the human health risk assessment for Ashumet Valley groundwater, surface water, and sediment and COC selection for Ashumet Valley groundwater (AFCEE 2007b). A complete description of the methods and results of the baseline human health risk assessment for Ashumet Valley is presented in Appendix A of the *Final Ashumet Valley Groundwater Feasibility Study* (AFCEE 2007a).

2.7.1 Identification of Chemicals of Potential Concern (COPC)

The selection of chemicals of potential concern (COPC) for inclusion in the quantitative human health risk calculations was typically based on three screening criteria:

- Frequency of detection;
- Compound concentration and toxicity, as compared to conservative risk and/or hazard-based concentrations; and
- Essential nutrient status.

The concentration-toxicity screen was conducted by comparing site data with a series of federal and Massachusetts risk-based criteria. The maximum detected concentration was used in the concentration-toxicity screen.

For groundwater, the following screening criteria were used:

- EPA Region IX preliminary remediation goals (PRG) for residential tap water (EPA 1999a),
- EPA MCLs, and
- Massachusetts drinking water standards and guidelines.

For surface water, the screening criteria were the EPA recommended water quality criteria for human health consumption of water and organisms (EPA 2002). The groundwater screening criteria were used as conservative surrogate values when EPA water quality criteria were not available. For sediment, the EPA Region IX PRGs for residential soil were used (EPA 1999a).

PRGs for noncarcinogens were modified (PRG was multiplied by 0.1) such that the PRGs were based on a non-cancer hazard quotient (HQ) of 0.1 (EPA 1995). PRGs for carcinogens were based on a cancer risk level of 1×10^{-6} and were not modified for the screening. When more than one criterion was available for a chemical (PRG, MCL, state standard, or guideline), the lowest of the available criteria was used in the concentration-toxicity screen.

Groundwater in the Ashumet Valley risk assessment was evaluated separately in subsets, based on the influence of the existing remedial system, and different environmental media: Ashumet Valley groundwater within the capture zone, Ashumet Valley groundwater outside the capture zone north of Route 151, and Ashumet Valley groundwater outside the capture zone south of Route 151 (Figure 2-3). Surface water and sediment in the Backus River were also evaluated. The tables presenting the screening process for identifying COPCs in each area are listed below:

- Ashumet Valley Groundwater Within the Capture Zone (Table 2-1),
- Ashumet Valley Groundwater Outside the Capture Zone North of Route 151 (Table 2-2),

- Ashumet Valley Groundwater Outside the Capture Zone South of Route 151 (Table 2-3),
- Backus River Surface Water (Table 2-4), and
- Backus River Sediment (Table 2-5).

Table 2-1, Table 2-2, Table 2-3, Table 2-4, and Table 2-5 present the occurrence and distribution of compounds detected in the Ashumet Valley areas listed above. For each detected chemical, these tables include the minimum and maximum detected concentration, the data qualifiers associated with these concentrations, the location of the maximum detected concentration, the frequency of detection, and the range of detection limits. The "J" qualifier indicates estimated concentrations.

2.7.2 Exposure Assessment

Several exposure pathways were eliminated from the assessment based on the likely absence of site-related contamination. Soil exposure pathways at the source area were not considered primarily because the source areas (soils) have been addressed in previous remedial actions. In addition, soil in non-source areas is not impacted by groundwater contamination. The only contamination at these sites is related to the migration of contaminants from the military base in groundwater.

There is currently no exposure to the Ashumet Valley plume on the MMR. No off-base residents are currently exposed to groundwater in close proximity to the Ashumet Valley plume. No off-base residents are believed to be exposed to groundwater in close proximity to the Ashumet Valley plume. However, potential future exposure to Ashumet Valley groundwater was evaluated since it was assumed that residential use of groundwater could occur anywhere on or off the base in the future. Exposures were evaluated separately for receptors potentially exposed to groundwater within the capture zone, groundwater outside the capture zone north of Route 151, and groundwater outside the capture zone south of Route 151. Exposure routes for this evaluation included groundwater ingestion, dermal contact, and inhalation of vapors released during

household use of groundwater. Migration of vapor phase VOCs from groundwater through the subsurface soil into a residential dwelling was also evaluated.

A portion of the Ashumet Valley groundwater plume (approximately 50 percent) is predicted by the model to discharge to the Backus River. Human receptors of concern evaluated for the Backus River were recreational waders (adult and child), adult cranberry bog workers, and adult fish consumers. Exposure of adult fish consumption was evaluated for ingestion of recreationally caught fish impacted by the bioaccumulation of contaminants from surface water. A quantitative risk evaluation of the fish consumption from the Backus River was only performed for an adult population of recreational fishermen since very limited data was available representing children's recreational fish consumption patterns of freshwater fish. Furthermore, the limited data available (West, et al. 1989) suggested that mean consumption patterns for children of freshwater recreational fish were comparable to reasonable maximum exposure (RME) consumption patterns assumed for adults in the Ashumet Valley risk evaluation, when expressed on a mg/kg/day basis.

The human health conceptual exposure model for the Ashumet Valley area is illustrated in Figure 2-5. After identifying which human receptors would be evaluated in the risk assessment, the exposure point concentrations (EPC) for each receptor were determined. A representative EPC was calculated for each COPC.

For groundwater, the EPCs for the RME condition were the maximum concentrations. For surface water, the RME condition was the 95 percent upper confidence limit (UCL_{95}) on the mean unless the UCL_{95} exceeded the maximum concentration. When this was the case, the RME EPC was the maximum concentration. For the metals that were selected based on both dissolved and total concentrations, the EPCs were selected as the higher of the total or dissolved concentration for the RME exposure scenario.

The EPCs for each area and media are presented in the tables listed below:

- Exposure Point Concentrations Reasonable Maximum Exposure, Ashumet Valley Groundwater Within the Capture Zone (Table 2-6);
- Exposure Point Concentrations, Reasonable Maximum Exposure, Ashumet Valley Groundwater Outside the Capture Zone North of Route 151 (Table 2-7);
- Exposure Point Concentrations, Reasonable Maximum Exposure, Ashumet Valley Groundwater Outside the Capture Zone South of Route 151 (Table 2-8); and
- Exposure Point Concentrations, Reasonable Maximum Exposure, Backus River Surface Water (Table 2-9).

To quantitatively assess the potential carcinogenic risks and health hazards, daily intakes of the COPCs were calculated. These exposure parameters are site-specific and chemical-specific, and vary depending on the time frame, exposure medium, exposure point, and receptor population and age. Exposure assumptions and other parameters used in the chronic daily intake (CDI) or dermal absorbed dose (DAD) algorithms are presented for each receptor and exposure medium in the tables listed below:

- Values Used for Daily Intake Calculations, Reasonable Maximum Exposure, Ashumet Valley Groundwater (Table 2-10);
- Values Used for Daily Intake Calculations, Reasonable Maximum Exposure, Ashumet Valley, Backus River Surface Water (Table 2-11); and
- Values Used for Daily Intake Calculations, Reasonable Maximum Exposure, Ashumet Valley, Backus River, Fish Tissue (Table 2-12).

All of the parameters used in the CDI and daily absorbed dose calculations are presented in these tables, except for some chemical-specific parameters (e.g., bioaccumulation factors for fish, dermal absorption factors, and other calculated parameters used in the daily absorbed dose calculations), which are presented in Appendix A of the *Final Ashumet Valley Groundwater Feasibility Study* (AFCEE 2007a).

2.7.3 Toxicity Assessment

The purpose of the toxicity assessment is to identify the types of adverse health effects that a COPC may potentially cause and to define the relationship between the dose of a compound and the likelihood and magnitude of an adverse effect (i.e., response). Adverse effects are characterized by EPA as carcinogenic or noncarcinogenic. Dose-response relationships are defined by the EPA for oral and inhalation exposures. For the Ashumet Valley risk assessment, oral dose-response values were also used to evaluate dermal exposure.

At the time each risk assessment was prepared, EPA's most current toxicity values were obtained from the following hierarchy of sources: (1) EPA's on-line Integrated Risk Information System (IRIS) (EPA 2004), (2) EPA's Health Effect Assessment Summary Tables (HEAST) (EPA 1997), (3) memoranda from the EPA's National Center for Environmental Assessment, and (4) dose-response values recommended by EPA. Cancer and non-cancer toxicity factors for each of the COPCs evaluated in the Ashumet Valley risk assessment are presented in the tables listed below:

- Non-Cancer Toxicity Data – Oral/Dermal, Ashumet Valley (Table 2-13);
- Non Cancer Toxicity Data – Inhalation, Ashumet Valley (Table 2-14);
- Cancer Toxicity Data – Oral/Dermal, Ashumet Valley (Table 2-15); and
- Cancer Toxicity Data – Inhalation, Ashumet Valley (Table 2-16).

2.7.4 Risk Characterization

Risk characterization integrates the results of the exposure and toxicity assessments to derive quantitative and qualitative estimates of the potential cancer risk and non-cancer hazards that may occur due to exposure to site-related contaminants.

For carcinogens, risks are generally expressed as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk (ELCR) is calculated from the following equation:

Risk = (CDI or DAD) x slope factor (SF)

Where:

Risk = a unitless probability of an individual's developing cancer

CDI = chronic daily intake [milligrams per kilogram per day (mg/kg-day)]

DAD = dermally absorbed dose (mg/kg-day)

SF = slope factor $(mg/kg\text{-}day)^{-1}$

Carcinogenic risks are probabilities that usually are expressed in scientific notation (e.g., 1E-06). An ELCR of 1E-06 indicates that an individual experiencing the RME theoretically has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an ELCR because it will be in addition to the risk of cancer an individual faces from other causes such as exposure to too much solar radiation or radon. The chance of an individual developing cancer from all other causes has been estimated to be as high as one in three. EPA's target risk range for site-related exposures is E-04 to E-06 (EPA 1991). Separate assumptions were used to calculate doses for adult and child residents, and then cancer risks for the adult and child were combined to represent total risks to residents for a 30-year exposure period.

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., lifetime) with a reference dose (RfD) derived for a similar exposure period. An RfD represents a level to which an individual may be exposed that is not expected to cause any deleterious effect. The ratio of exposure to toxicity, which is called an HQ, is calculated as follows:

Non-cancer HQ= (CDI or DAD)/(RfD)

Where:

CDI = chronic daily intake (mg/kg-day)

DAD = dermally absorbed dose (mg/kg-day)

RfD = reference dose (mg/kg-day)

The hazard index (HI) is calculated by adding the HQs for all COCs that affect the same target organ (e.g., prostate) within a medium or across all media to which a given individual may reasonably be exposed. An HI less than one indicates that, based on all of the different contaminants and exposure routes, toxic noncarcinogenic effects are unlikely (EPA 1991). An HI greater than one indicates that site-related exposures may present a hazard to human health.

The tables listed below are the risk assessment tables that summarize the cancer and non-cancer risks to each receptor under the RME exposure scenarios. Cancer and non-cancer risks that appear in these tables are limited to those for the COPCs that produced cancer or non-cancer risks at or near regulatory thresholds. Risks associated with COPCs that produced ELCRs less than 1E-06 or HQs less than 0.1 do not appear in these tables.

- Future Adult Resident, Ashumet Valley Groundwater Within the Capture Zone (Table 2-17);
- Future Child Resident, Ashumet Valley Groundwater Within the Capture Zone (Table 2-18);
- Future Adult Resident, Ashumet Valley Groundwater Outside the Capture Zone, North of Route 151 (Table 2-19);
- Future Child Resident, Ashumet Valley Groundwater Outside the Capture Zone, North of Route 151 (Table 2-20);
- Future Adult Resident, Ashumet Valley Groundwater Outside the Capture Zone, South of Route 151 (Table 2-21);
- Future Child Resident, Ashumet Valley Groundwater Outside the Capture Zone, South of Route 151 (Table 2-22);
- Future Adult Cranberry Worker, Ashumet Valley, Backus River Surface Water (Table 2-23);
- Future Adult Wader, Ashumet Valley, Backus River Surface Water (Table 2-24);
- Future Child Wader, Ashumet Valley, Backus River Surface Water (Table 2-25); and
- Future Adult Fish Consumer, Ashumet Valley, Backus River Surface Water (Table 2-26).

For groundwater at Ashumet Valley, potential unacceptable non-cancer hazards were found to be associated with TCE, arsenic, manganese, and thallium. Although the HI for arsenic exceeded unity, it wasn't retained as a COC because it was detected infrequently and only exceeded the MCL of 10 µg/L in one well outside the capture zone north of Route 151. Manganese and thallium were retained as COCs in the Ashumet Valley plume because concentrations of manganese exceeded the Health Advisory (HA) of 300 µg/L and thallium exceeded its MCL of 2 µg/L within the plume. Potential cancer risks associated with exposure to PCE and TCE in groundwater were found to exceed the EPA acceptable risk management range (1E-04 to 1E-06) and the MassDEP Cumulative Cancer Risk Limit of 1E-05. The potential RME carcinogenic risk levels for future residential exposure pathways are 2E-03 for Ashumet Valley groundwater within the capture zone, 1E-03 for Ashumet Valley groundwater outside the capture zone north of Route 151, and 1E-03 for Ashumet Valley groundwater outside the capture zone south of Route 151.

For Backus River surface water, potential cancer risks and non-cancer hazards associated with recreational exposures were found to be acceptable for each COPC. Exposure scenarios for the Backus River included bog workers, waders, and consumers of fish caught from the river. Surface water concentrations of groundwater COCs within the Backus River do not represent an unacceptable human health risk. The uncertainty evalutation in the risk assessment considered that PCE and TCE concentrations in the river are expected to increase in the future. Even considering the projected increased concentrations, human health risks associated with exposure to the river were found to be acceptable. Current maximum estimated concentrations of PCE and TCE discharging to the Backus River do not exceed risk values for human exposure to these contaminants. The potential cancer risks and non-cancer hazards associated with fish consumption were found to be unacceptable for bis(2-ethylhexyl)phthalate. However, this analyte is a common sampling artifact and laboratory contaminant; it is not related to Ashumet Valley.

2.7.5 Uncertainty Analysis and Human Health Risk Assessment Conclusions

There are uncertainties involved in the process of quantifying the risk for human receptors, and overall they make the risk assessment very conservative. Exposure assumptions, SFs, and oral-to-dermal adjustment factors are all very conservative. In the RME groundwater assumptions, the maximum concentrations of contaminants detected in groundwater were conservatively assumed to be present in all groundwater throughout the area for the entire 30 year period (neglecting contaminant degradation or plume movement). The assumption was also made that human exposure remains constant over the lifetime of an individual, when in fact, lifestyle changes due to age and actual time in residence will alter the projected exposure duration. Even the assumption that the groundwater in these areas would be used for household purposes is a conservative assumption, as no one is currently using it as such. This was done so that use of the aquifer, consistent with its beneficial use, could be evaluated from a public health risk perspective. In light of the conservatism that was built into many of the factors used in the risk assessment approach, the results should be considered to be significant overestimates of actual risk.

COPCs for which an RME were calculated result in an ELCR greater than one in a million or an HI greater than one are presented in Table 2-27. From this list, the COCs were identified based on a range of criteria. Several COPCs were eliminated from inclusion as COCs because they met one or more of the following criteria:

- The COPC is present at the site at concentrations similar to background concentrations.
- The COPC is present only at concentrations below state and federal drinking water standards.

In consideration of these criteria and based on discussions with the EPA and MassDEP, the following COCs were selected for the entire Ashumet Valley plume [the contaminant-specific evaluations are presented in the risk assessment (AFCEE 2007b)]:

- PCE,
- TCE,
- manganese, and
- thallium.

One of more significant COPCs associated with potential risks is arsenic. The Ashumet Valley risk assessment identified arsenic as a potential health risk based on a concentration of 17.5 µg/L. Although this concentration exceeds Total Adult and Total Child HI of 1.0 and exceeds the ELCR of 1E-06, this concentration was found to be comparable to background arsenic concentrations in groundwater (Jacobs 2002). Therefore arsenic was not determined to be a COC for Ashumet Valley.

2.7.6 Ecological Risk Summary

Analytical data for surface water and sediment samples collected from the Backus River were used to evaluate exposure to potential ecological receptors. Risk to populations of aquatic organisms was assessed using direct comparison of surface water and sediment concentrations to benchmarks. All of the contaminants that were contained in the screening step were identified as either laboratory contaminants, within background levels, or not correlated with contaminants in the Ashumet Valley plume. Six ecological receptors were evaluated as part of the food web screening assessment (black-crowned night heron, mallard duck, eastern box turtle, muskrat, osprey, and raccoon). This food web assessment also indicated that chemicals retained in the screen were either laboratory contaminants, within background levels, or have little correlation to Ashumet Valley plume contaminants. The ecological risk assessment concluded that it is very unlikely that there are ecological risks associated with receptor contact to surface water, sediment, or food (AFCEE 2007b).

2.8 REMEDIAL ACTION OBJECTIVES (RAO)

Results of the human health risk assessment for Ashumet Valley groundwater were considered in conjunction with expected current and future use of the aquifer to develop RAOs. Exposure to groundwater was the only viable exposure pathway for the Ashumet Valley plume. The following RAOs for the Ashumet Valley groundwater FS, agreed upon by AFCEE, the EPA, and the MassDEP, were developed to evaluate the alternatives with respect to protecting human health:

- Prevent residential exposure to Ashumet Valley groundwater with TCE concentrations greater than the MCL of 5 µg/L.
- Prevent residential exposure to Ashumet Valley groundwater with PCE concentrations greater than the MCL of 5 µg/L.
- Prevent residential exposure to groundwater located between Kittridge Road and the western shore of Ashumet Pond that has been impacted by the Ashumet Valley plume and that contains manganese concentrations greater than the lifetime HA of 300 µg/L.
- Prevent residential exposure to groundwater located between Kittridge Road and the western shore of Ashumet Pond that has been impacted by the Ashumet Valley plume and that contains thallium concentrations greater than the MCL of 2 µg/L.
- Restore usable groundwaters to their beneficial uses wherever practicable, within a time frame that is reasonable given the particular circumstances of the site.

The remedial alternatives were developed to satisfy these RAOs.

2.8.1 Basis and Rationale for Remedial Action Objectives (RAO)

For human health concerns, the only media/exposure pathway that presents a cancer risk and/or a non-cancer HI above the target values is the future potential residential exposure to groundwater. A summary of the human health total non-cancer HIs and cancer risks for the Ashumet Valley study area indicates that PCE, TCE, manganese, and thallium increase risk and hazards associated with exposure to groundwater.

2.8.2 Steps to Achieving Remedial Action Objectives (RAO)

MMR groundwater plumes, including the Ashumet Valley plume, are located within the Cape Cod sole-source aquifer. Therefore, AFCEE has agreed that for all active remedies selected, it will undertake a three-step process in achieving RAOs. This three-step process will be implemented in the following manner:

(1) **During the period that treatment systems are remediating the aquifer to federal and state drinking water standards or other risk-based cleanup levels, AFCEE will monitor the plume in accordance with an approved system performance monitoring plan.** The performance monitoring program will collect data for evaluating (a) whether the system is performing as designed, (b) whether the system is impacting ecologically sensitive areas, (c) the potential for short-term health effects due to exposures during active remediation, and (d) when the selected remedy will attain the remediation goals in the ROD.

(2) **In accordance with applicable EPA guidance, a residual risk assessment(s) will be performed to determine if unacceptable ecological and/or human health risks are present, system operation will continue, and/or additional measures pursued as required to achieve acceptable risks.** AFCEE shall conduct a residual risk assessment(s), if deemed necessary, of all contaminants remaining in the aquifer associated with Ashumet Valley to determine whether the groundwater contamination continues to pose unacceptable ecological and/or human health risks. This risk determination shall be made jointly by AFCEE and EPA, in consultation with the MassDEP, and may result in aquifer cleanup that is more protective than the NCP point-of-departure risk of 10^{-6} [40 Code of Federal Regulations (CFR) Part 300.430 (e)(2)], if justified, based on the following site-specific factors: cumulative effects of multiple contaminants, the potential for exposure from other pathways of exposure at the site, population, sensitivities, potential impacts on environmental receptors, and cross-media impacts (NCP Preamble, page 8717).

(3) **Once acceptable risk levels have been achieved, the technical and economic feasibility of additional remediation to approach or achieve background concentrations will be evaluated.** AFCEE shall proceed with a technical and economic feasibility analysis of approaching or achieving background concentrations in the aquifer. The feasibility of approaching or achieving background will be determined in accordance with the following criteria:

   (a) Technological – Not feasible if

      i. the existing technologies or modification cannot remediate to a level of no significant risk, or to levels that approach or achieve background; or

      ii. the reliability of the identified alternative has not been sufficiently proven and a substantial uncertainty exists as to whether it will effectively reduce risk; or

      iii. the remedy does not or cannot be modified to meet other regulatory requirements.

(b) Economic – The benefits of implementing a remedy and reducing the concentrations of contaminants in the environment to levels that approach or achieve background justifies related costs unless

i. the incremental cost for the remedy is substantial and disproportional to the increased reduction of risk, environmental restoration and monetary and non-monetary values; or

ii. the risk of harm to health/safety/public welfare/environment by the remedy cannot be adequately controlled.

AFCEE and EPA with input from MassDEP have also agreed that in the event that implementation of this process leads to a mutual decision to undertake additional cleanup and such decision results in a significant or fundamental change to the remedial approach, cleanup levels, and/or costs documented in this final ROD, AFCEE will execute an Explanation of Significant Differences (ESD) or ROD Amendment (with public comment), as appropriate. Whether any such additional cleanup actions result in a significant or fundamental change to this final ROD shall be determined by AFCEE in consultation with MassDEP and the EPA in accordance with the criteria set forth in EPA's *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and other Remedy Selection Decision Documents* (EPA 1999b). In this manner, such changes will be subject to regulatory review and stakeholder involvement through issuance of a new ESD or ROD amendment. In the event that a dispute arises regarding any of the determinations reached under the process outlined above, such dispute shall be resolved under the dispute resolution procedure of the MMR FFA.

2.9 DESCRIPTION OF ASHUMET VALLEY GROUNDWATER ALTERNATIVES

The alternatives evaluated in the FS were developed with input from the EPA, the MassDEP, and the PCT. Six alternatives were originally created to address the Ashumet Valley groundwater. Following an initial screening of alternatives (AFCEE 2005a), one of the six groundwater alternatives was eliminated from further consideration due to concerns with effectiveness, implementation, and/or cost. Therefore, five groundwater alternatives were retained and considered for detailed evaluation for the Ashumet Valley groundwater actions (AFCEE 2007a). The PCE and TCE plume shells were updated

in 2006 based on updated contaminant distributions in the Ashumet Valley plume. This work was performed to develop additional alternatives downgradient of Carriage Shop Road that were more efficient in capturing contamination and which exerted less hydraulic stress on ecosystems in the area. After this plume shell modification, Alternatives 6 and 7, were evaluated as part of an FS addendum and presented in the final FS (AFCEE 2007a).

Components common to most of the alternatives are LUCs. Several LUCs protect area residents from exposure to Ashumet Valley groundwater contaminants. The safety of all public water supplies within Massachusetts is currently regulated by the Commonwealth. Residents and workers on the MMR receive their water from the base water supply system that has wellhead treatment. All off-base residences within the Ashumet Valley plume are believed to be connected to municipal water supplies. The off-base LUCs include the town of Falmouth regulating installation of private wells to reduce potential residential exposure to contaminated groundwater. Implementation of AFCEE LUCs (see Section 2.11.2) will prevent any exposure to contaminated groundwater in the Ashumet Valley area through existing wells by confirming residences are connected to municipal supplies.

2.9.1 Groundwater Remedial Alternatives

The following sections present an overview of the seven Ashumet Valley groundwater remedial alternatives that were retained for detailed analysis.

2.9.1.1 Alternative 1 – No Action

The no-action alternative is required by the NCP [40 CFR 300.430(e)(6)] to provide a baseline condition if no remedial action is taken (Figure 2-6). This no-action alternative would mean that current active remediation would cease when the ROD is signed. Hydraulic and chemical monitoring of the plume would not continue. AFCEE would not check adherence to LUCs under Alternative 1.

2.9.1.2 Alternative 2 – Long-Term Monitoring plus Land Use Controls (LUC)

Alternative 2 is a limited-action alternative (Figure 2-7). Remediation via active treatment of the Ashumet Valley plume would cease. This alternative would provide for chemical monitoring of groundwater via existing wells. Continued monitoring and reporting would be implemented to assess the attenuation of the Ashumet Valley plume and determine when COC concentrations have reached cleanup levels. This alternative also includes LUCs that reduce the risk of future human exposure to the Ashumet Valley plume. A CERCLA review would be performed every five years throughout the lifetime of the alternative. AFCEE will conduct a residual risk assessment if deemed necessary and would likely include additional data collection and analysis.

2.9.1.3 Alternative 3 – Continue to Operate, Maintain, and Monitor the Existing Ashumet Valley System Plus Land Use Controls (LUC)

Alternative 3 provides for continued active treatment of the Ashumet Valley plume using the existing Ashumet Valley ETI system and maintaining the SPEIM program and LUCs. Groundwater would be extracted through three extraction wells and treated at the Ashumet Valley Treatment Facility for treatment and infiltration (Figure 2-8). The alternative includes SPEIM and long-term monitoring (LTM). A CERCLA review would be performed every five years throughout the lifetime of the alternative. A residual risk assessment would be performed, if necessary, and would likely include additional data collection and analysis.

2.9.1.4 Alternative 4 – Continue to Operate, Maintain, and Monitor the Existing Ashumet Valley System Plus Land Use Controls with Additional Leading Edge Extraction, Treatment, and Discharge to Promote Additional Mass Capture

Alternative 4 consists of the extraction well configuration of Alternative 3 plus the addition of groundwater extraction, treatment, and discharge near the leading edge of the plume with LUCs. This alternative consists of the three original extraction wells and an additional four extraction wells, one near the toe of the Ashumet Valley plume and the other three upgradient in areas of higher concentration east of the Backus River

(Figure 2-9). These extraction wells would capture additional mass that would naturally attenuate and/or discharge to the Backus River under Alternative 3. The groundwater would be treated using GAC filtration in the Ashumet Valley treatment facility and in a new treatment facility to be located near the new extraction wells, and discharged to the Backus River after treatment. The alternative includes SPEIM and LTM. A CERCLA review would be performed every five years throughout the lifetime of the alternative. A residual risk assessment would be performed, if necessary, and would likely include additional data collection and analysis.

2.9.1.5 Alternative 5 – Continue to Operate, Maintain, and Monitor the Existing Ashumet Valley System Plus Land Use Controls with Additional Southern Plume Extraction, Treatment, and Discharge to Reduce Restoration Time

Alternative 5 consists of the extraction well configuration of Alternative 3 with the additional of groundwater extraction, treatment, and discharge in the portion of Ashumet Valley plume downgradient of Carriage Shop Road with LUCs. The conceptual design includes the existing three extraction wells from Alternative 3, three extraction wells downgradient of Carriage Shop Road in areas of higher concentration east of the Backus River, and three additional extraction wells across the width of the plume along Carriage Shop Road (Figure 2-10). These extraction wells would capture additional mass that would naturally attenuate and/or would be discharged to the Backus River under Alternative 3. In addition, this alternative would speed aquifer restoration by stopping plume migration at Carriage Shop Road in addition to capture of additional contaminant mass downgradient of Carriage Shop Road. The water extracted from the Ashumet Valley plume would be treated at the Ashumet Valley treatment facility and in a new treatment facility to be located south of Carriage Shop Road. The treated water would either infiltrate through the existing infiltration trenches or discharged to the Backus River. The alternative also includes five-year CERCLA reviews throughout the lifetime of the alternative, and a residual risk assessment, if deemed necessary.

2.9.1.6 Alternative 6 – Operate, Maintain, and Monitor the Optimized Existing Ashumet Valley System plus Land Use Controls (LUC)

Alternative 6 would provide for continued active treatment of the Ashumet Valley plume using the existing Ashumet Valley ETI system and maintaining LUCs. The treatment system would consist of one extraction well in proximity to the highest contaminant concentrations between Route 151 and Hayway Road (Figure 2-11). The contaminated water is piped to the Ashumet Valley treatment plant and treated with GAC. The treated water is returned to the aquifer by way of the existing infiltration trenches. The system is optimized based on the results of the *Final Ashumet Valley 2006 Optimization Technical Memorandum* (AFCEE 2007d). The alternative includes SPEIM and LTM, five-year CERCLA reviews throughout the lifetime of the alternative, and a residual risk assessment if deemed necessary.

2.9.1.7 Alternative 7 – Operate, Maintain, and Monitor the Optimized Existing Ashumet Valley System plus Land Use Controls with Additional Downgradient Extraction, Treatment, and Infiltration to Promote Additional Mass Capture.

Alternative 7 consists of Alternative 6 with the addition of groundwater extraction and treatment in the uncaptured portion of the plume south of Hayway Road. The conceptual design included the existing optimized extraction well from Alternative 6 with two additional extraction wells in areas of higher concentration east of the Backus River (Figure 2-12). These extraction wells would capture additional mass that would otherwise naturally attenuate and/or would be discharged to the Backus River under Alternative 6. The water would be treated using GAC filtration in the existing treatment facility and discharged through the existing infiltration trenches. The alternative includes SPEIM and LTM, five-year CERCLA reviews throughout the lifetime of the alternative, and a residual risk assessment if deemed necessary.

2.9.2 Common Elements and Distinguishing Features of Alternatives

Seven groundwater alternatives were evaluated as part of the FS: a no-action alternative (Alternative 1), a limited-action alternative (Alternative 2), and five active treatment

alternatives (Alternatives 3, 4, 5, 6, and 7). The five active treatment alternatives include varying degrees of increased plume remediation through the installation of additional extraction wells and increased pumping rates of existing extraction wells. All of the alternatives, except the no action alternative (Alternative 1), include LUCs, LTM, CERCLA reporting, and a residual risk assessment if deemed necessary.

Alternative 1 provides no action and would mean that the current treatment system would shut down, chemical and hydraulic monitoring would cease. Alternative 1 would not include LUCs that limit exposure to the Ashumet Valley plume and would not actively reduce the toxicity, mobility, or volume of the contaminants. The plume would naturally attenuate, but there would be no monitoring to document that it was occurring. Alternative 2 is similar to the no-action alternative in that the current treatment system would shut down. However, under Alternative 2, LTM of the plume would continue and LUCs would be implemented. Under Alternatives 1 and 2, the plume is not expected to naturally attenuate until approximately 2041.

Alternatives 3, 4, 5, 6, and 7 all provide for active treatment in addition to the existing treatment system. The additional active treatment alternatives include various combinations of the following:

- Use of Existing Treatment Facilities – continuation of three or one extraction well located between Route 151 and Hayway Road;
- Remediation of the southern plume at Carriage Shop Road – the addition of several wells along Carriage Shop Road to help promote aquifer restoration; and
- Remediation of the southern plume south of Carriage Shop Road – the likely addition of more than one extraction well downgradient of Carriage Shop Road and east of the Backus River, and the addition of new Ashumet Valley treatment facilities.

The five active treatment alternatives include various combinations of the options listed above. Table 2-28 presents a summary of the evaluation of the groundwater alternatives, and Table 2-29 presents the model-predicted mass removed, time to cleanup each area of the plume, and present value cost for each alternative. Refer to the *Final Ashumet Valley*

Groundwater Feasibility Study (AFCEE 2007a) for further analysis including a complete listing of ARARs for each alternative and how individual alternatives would comply with them. ARARs for the selected alternative (Alternative 7 modified) are listed in Table 2-30, Table 2-31, and Table 2-32.

2.9.3 Expected Outcomes of the Alternatives

Groundwater modeling indicates that under Alternatives 1 and 2 the plume moves south at concentrations higher than the cleanup standards as it migrates downgradient, naturally attenuates, and discharges to the Backus River. The plume eventually attenuates to concentrations below cleanup levels by approximately 2041. Modeling indicates plume cleanup time frames for the remaining five active treatment alternatives (Alternatives 3, 4, 5, 6, and 7), presented in Table 2-29, range from approximately 2024 to 2041; time frames varying depending on the number of extraction wells, extraction well flow rates, or the plume shell used in the modeling evaluation..

Based on current and reasonably anticipated future land use, human health risks are acceptable under all but one of the alternatives (Alternative 1 - No Action). The existing Falmouth BOH regulations reduce the risk of exposure of residents to contaminated groundwater. The Falmouth BOH well regulations do not apply to use of existing drinking water wells and irrigation wells. However, Alternatives 2, 3, 4, 5, 6, and 7 offer additional assurances that residents and workers will not be exposed to the Ashumet Valley plume through implementation and monitoring of LUCs. These LUCs were developed to assure that there is no exposure to Ashumet Valley groundwater contaminants. The Town of Falmouth prevents the drilling of new wells in areas of groundwater contamination. The AFCEE LUCs prevent exposure of residents though existing wells by documenting the numbers of wells that may intercept contaminated Ashumet Valley groundwater and offering hook-ups to public water supply, abandonment of suspect wells, and monitoring. The MassDEP prevents the installation of public water supply wells in areas of Ashumet Valley contamination. Programs such as Dig Safe provides notification to AFCEE should a proposed well or excavation be

located within the Ashumet Valley plume. A more detailed description of the LUCs for Ashumet Valley is presented in Section 2.11.2.

2.10 COMPARATIVE ANALYSIS OF ASHUMET VALLEY GROUNDWATER ALTERNATIVES

The following sections summarize the comparative analysis of the seven Ashumet Valley groundwater alternatives presented in the *Final Ashumet Valley Groundwater Feasibility Study* (AFCEE 2007a).

2.10.1 Criteria for Detailed Analysis of Alternatives

The NCP (40 CFR, Part 300) presents nine criteria for analyzing the acceptability of a given alternative. These nine criteria are categorized as threshold criteria, primary balancing criteria, and modifying criteria. The performance of the seven Ashumet Valley groundwater alternatives with respect to the threshold and primary balancing criteria are summarized in Table 2-28.

2.10.1.1 Threshold Criteria

There are two threshold criteria: overall protection of human health and the environment, and compliance with ARARs. Threshold criteria represent the minimum requirements that each alternative must meet to be eligible for selection.

Overall Protection of Human Health and the Environment - This criterion assesses the overall effectiveness of an alternative and focuses on whether that alternative achieves adequate protection and risk reduction, elimination, or control. The assessment of overall protection draws on assessments conducted under other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

Compliance with ARARs - Each alternative is assessed to determine whether it complies with ARARs under federal and state laws. Section 121(d) of CERCLA requires that remedial actions at CERCLA sites attain legally applicable or relevant and appropriate federal and state requirements, standards, criteria, and limitations, unless such ARARs are waived under CERCLA Section 121(d)(4). Appendix D of the *Final Ashumet Valley Groundwater Feasibility Study* (AFCEE 2007a) outlines ARARs for all the Ashumet Valley alternatives. ARARs for the selected alternatives are listed in Table 2-30, Table 2-31, and Table 2-32 (Alternative 7 modified).

2.10.1.2 Primary Balancing Criteria

The five primary balancing criteria are (1) long-term effectiveness and permanence; (2) reduction of toxicity, mobility, or volume through treatment; (3) short-term effectiveness; (4) implementability; and (5) cost. Primary balancing criteria form the basis for comparing alternatives in light of site-specific conditions.

Long-Term Effectiveness and Permanence - Each alternative is assessed for its long-term effectiveness and the permanence of the solution. This criterion assesses the magnitude of residual risks remaining at the conclusion of remedial activities and the adequacy and reliability of controls to be used to manage residual risk.

Reduction of Toxicity, Mobility, or Volume Through Treatment - Section 121 (Cleanup Standards) of CERCLA states a preference for remedial actions that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of contaminants as the primary element of the action. This criterion addresses the capacity of the alternative to reduce the principle risks through destruction of contaminants, reduction in the total mass of contaminants, irreversible reduction in contaminant mobility, or reduction in the total volume of contaminated media.

Short-Term Effectiveness - This criterion addresses the effects of the alternative during construction and operational phases until remedial objectives are met. Each alternative is evaluated with respect to its (potentially negative) effects on community health, worker

safety, and environmental quality during the course of remedial actions. This criterion also addresses the time required by each alternative until remedial objectives are achieved.

Implementability - The implementability criterion is used to assess the technical and administrative feasibility of implementing an alternative. Technical issues include the reliability of the technology under consideration, potential construction difficulties, and the availability of required services, materials, and equipment (preferably from multiple sources). Administrative issues include permitting and access for construction and monitoring.

Cost - Costs associated with carrying out an alternative are based on current (present day) information escalated at a rate of 5 percent until year zero; after year zero, costs are discounted at a rate of 3 percent [per Office of Management and Budget Circular A-94 (OMB 2006)]. Cost estimates included in this document are intended for comparative purposes only. The accuracy of the estimates are between -30 and +50 percent.

2.10.1.3 Modifying Criteria

There are two modifying criteria: state acceptance and community acceptance.

State Acceptance - The MassDEP has expressed its support for Alternative 7 for the Ashumet Valley groundwater plume.

Community Acceptance - The MMRCT supports Alternative 7 for the Ashumet Valley groundwater plume.

2.10.2 Comparison of Ashumet Valley Groundwater Plume Alternatives

Seven groundwater alternatives were evaluated in the FS, a no-action alternative (Alternative 1), a limited-action alternative (LTM) (Alternative 2), and five alternatives that consist of various active treatment scenarios (Alternatives 3, 4, 5, 6, and 7). All of

the alternatives (except for the no-action Alternative 1) are protective of human health and the environment and comply with ARARs. All active remediation alternatives use proven technologies, will permanently remove contaminants, and pose low risk to workers, the community, and the environment (alternatives with greater construction have greater risk and more impact to the community and the environment). The alternatives differ in the amount of plume volume reduction and mass removed, time frames to reach cleanup levels in different areas of the plume, degree of inconveniences and disturbance that will be generated by construction and long-term activities, and costs. Alternatives 1, 2, 3, 4, 5, 6, and 7 were evaluated against the nine NCP criteria. The following sections present the evaluation.

2.10.2.1 Overall Protection of Human Health and the Environment

AFCEE has already ensured protection of human health by providing municipal water supply hook-ups for all on-base and off-base residences impacted by the Ashumet Valley plume. Additional protection of human health is afforded by on-base LUCs and the Falmouth BOH Water Well Regulations which prevent the installation of private wells for water consumption or irrigation in areas of groundwater contamination. The Falmouth BOH Water Well Regulations do not apply to use of existing drinking water wells and irrigation wells. However, the LUCs developed assure that there is no exposure to Ashumet Valley groundwater contaminants. The LUCs prevent exposure of residents though existing wells by documenting the numbers of wells that may intercept contaminated Ashumet Valley groundwater and offering hook-ups to public water supply, abandonment of suspect wells, and monitoring. The MassDEP prevents the installation of public water supply wells in areas of Ashumet Valley contamination. Programs such as Dig Safe provides notification to AFCEE should a proposed well be placed within the Ashumet Valley plume. Therefore, for continuation of the current use of the aquifer, the risk to human health and the environment is the same for all alternatives, except for Alternative 1 (no action).

2.10.2.2 Compliance with ARARs

The point at which chemical-specific ARARs are met would not be known under Alternative 1 since monitoring would not be performed. All construction, treatment, and monitoring activities will be performed in accordance with location-specific and action-specific ARARs.

2.10.2.3 Long-Term Effectiveness and Permanence

The magnitude of residual risks and the adequacy and reliability of controls are similar for Alternatives 2, 3, 4, 5, 6, and 7: low residual risk because there are no untreated waste or treatment residuals. Reliability of controls is good for all alternatives because AFCEE has provided water supply connections to all on-base and off-base residences impacted by the Ashumet Valley plume.

All of the active treatment alternatives use proven and reliable technology as an integral part of the treatment train. Alternatives that include active treatment of the leading edge (Alternatives 4, 5, and 7) may result in fewer uncertainties over the long term regarding the fate and transport of the plume. For the ETI systems, spent carbon is removed from the site and regenerated, thus, permanently destroying contaminants. At the conclusion of the remedy, groundwater concentrations will be below RAOs and, thus, pose minimal risk.

2.10.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternatives 1 and 2 do not remove contaminants from the aquifer and therefore reduce plume volume by natural attenuation only. All active treatment alternatives (3, 4, 5, 6, and 7) satisfy the statutory preference that active treatment be a principal element in site remediation. Contaminants are permanently removed from the aquifer. Each active treatment alternative removes mass from the portion of the plume between Route 151 and Hayway Road. Alternatives 4, 5, and 7 remove mass from the portion of the plume south of Hayway Road. Alternative 3 removes approximately 134 pounds of PCE and TCE. The additional active treatment in the leading edge portion of the plume with

Alternatives 4 and 5 would result in an increase of approximately 239 pounds to 307 pounds captured over the model-predicted cleanup time, respectively in comparison to Alternative 3 based on the final FS (AFCEE 2007a). The optimized status quo system under Alternative 6 would remove approximately 106 pounds of PCE and TCE.

The additional active optimized treatment under Alternative 7 would result in an increase of approximately 102 pounds captured over the lifetime of the system in comparison to Alternative 6.

2.10.2.5 Short-Term Effectiveness

Alternatives 1, 2, 3, and 6 have the least impact on workers, the community, and the environment since they do not require any new construction activities. Alternatives 4, 5, and 7 involve additional active remediation in addition to the existing Ashumet Valley ETI system and would require site clearing, road grading, excavation, well installation, pipeline installation, and routine maintenance and monitoring of the treatment systems. Alternatives 4 and 5 would require the construction of an additional treatment system. Hazards associated with the construction of additional pipeline and/or treatment system would be posed but can be controlled by coordinating activities with the fire department and police department, school districts, using police details where necessary, and fencing the property.

All alternatives except no action (Alternative 1) carry additional short-term risks to the community from increased vehicle traffic associated with well monitoring and/or O&M. The risks to the community associated with increased traffic can be addressed through safe driving practices. There are no known risks to the community that cannot be controlled. Risks to workers include hazards associated with driving in the community, drilling, and construction (injury), and O&M of the treatment system (injury and exposure). Risks to workers can be addressed through training, safety procedures, and medical monitoring. There are no known risks to workers that cannot be controlled.

Environmental impacts would be associated with the construction phases for Alternatives 4, 5, and 7. These environmental impacts are due to the following: site preparation (clearing and grading) for the extraction and monitoring wells; excavation for the wells vaults; construction of additional pipeline; and additional vehicle traffic in the neighborhood of the site. Alternatives 4 and 5 would result in these additional environmental impacts plus impacts due to construction of a new treatment plant; surface water discharge points; increased sound levels associated with the operation of the system; and increased electrical demand. Environmental impacts for Alternatives 4, 5, and 7 will be addressed by working with the Natural Heritage and Endangered Species Program to identify threatened and endangered species at the site and appropriate mitigation procedures; conducting cultural surveys as necessary; minimizing the area to be cleared, excavated and graded; and reducing sound levels as much as possible. Environmental impacts that cannot be avoided include additional vehicle traffic; clearing, excavating, and grading; and increased electrical consumption during operation of the systems.

The predicted times to reach restoration goals, from FS model predictions, under Alternatives 1 and 2, where natural attenuation would be the primary remediation factor, would be 2041 for the area north of Route 151, 2018 for the area between Route 151 and Hayway Road, and 2035 for the area south of Hayway Road. Alternative 3 would improve cleanup time in the area between Route 151 and Hayway Road by two years where PCE reaches cleanup levels by 2016, and improve cleanup time north of Route 151 by two years over Alternatives 1 and 2. Alternative 3 shows no difference in cleanup times south of Hayway Road compared to Alternatives 1 and 2. Alternative 6 would improve cleanup time in the area between Route 151 and Hayway Road by two years, where PCE reaches cleanup levels by 2016, but does not improve cleanup time north of Route 151 compared to Alternatives 1 and 2. Alternative 6 shows no difference in cleanup times south of Hayway Road compared to Alternatives 1, 2, and 3. Alternatives 4 and 5, which would place the active treatment south of Hayway Road in addition to the system operating in Alternative 3, show improvement in the cleanup time frames over Alternative 3 in the area south of Hayway Road. Alternative 4 improves

cleanup time over Alternatives 1, 2, and 3 by 12 years in the area south of Hayway Road and Alternative 5 improves cleanup time over Alternatives 1, 2, 3, and 6 by 15 years south of Hayway Road. Alternative 7 improves cleanup times over Alternatives 1, 2, 3, and 6 by 11 years south of Hayway Road. Alternatives 4, 5, and 7 do not show improvement in cleanup time in other portions of the Ashumet Valley plume.

2.10.2.6 Implementability

Alternative 1 would require no action. Therefore, there are no technical or administrative implementability concerns for Alternative 1. Alternative 2 would have no technical implementability concerns because it would entail monitoring of the current groundwater network.

Alternatives 3 and 6 should have no technical implementability concerns since the operation of the existing system relies on proven technologies, including extraction wells, GAC filtration, and infiltration trenches, and because the Ashumet Valley treatment facility has been operating since 1999 without significant technical difficulties. Alternatives 3 and 6 should have no administrative implementability concerns, since coordination with other agencies at periodic regulatory agency meetings and active stakeholder communication have been ongoing. The affected neighborhoods would not change. Alternatives 3 and 6 do not exceed ecological criteria guidelines.

For Alternatives 4, 5, and 7, the GAC technology is considered reliable and is currently being used in the existing Ashumet Valley treatment system. Also, the implementation of no action, continued treatment, LTM, and additional active treatment are all technically feasible. The willingness of the town of Falmouth, the Commonwealth of Massachusetts, and private landowners to accommodate the remedial system on their property and the amount of site preparation required for Alternatives 4, 5, and 7 are unknown at this time. Access or terrain issues could potentially delay or even prevent active treatment in some areas. These access or terrain issues may negatively affect implementability for Alternatives 4, 5, and 7 proportionally to the amount of construction required for each alternative. Alternative 5 exceeds the ecological criteria guidelines for

drawdown in Falmouth Conservation Wetland and the Backus River based on groundwater modeling which is an implementability challenge. Alternative 7 does not exceed the ecological criteria guidelines for drawdown in Falmouth Conservation Wetland and the Backus River based on groundwater modeling.

Administrative implementation for all alternatives (except Alternative 1, no action) will include coordination with the town of Falmouth (implementation of LUCs and work within public rights of way) and other agencies for technical update meetings, RPM meetings, and active communication on all issues of concern. Well permits and long-term access agreements with private landowners are an administrative implementability concern for all alternatives, but particularly for those that require new construction.

2.10.2.7 Cost

Alternative 1 is the baseline scenario and, thus, no costs are associated with it. Alternative 2 is the lowest cost groundwater alternative ($4.7 M) because it does not have any costs associated with active treatment of the plume. The most significant costs are associated with construction of additional treatment components (e.g., extraction and reinjection wells, stand-alone ETI systems, etc.), and aggressive remediation can also result in high O&M costs. The costs of Alternatives 3 and 6 are similar—$4.7 M and $8.7 M respectively—and represent the lowest costs with active treatment. There are no additional construction costs associated with Alternatives 3 or 6. Alternatives 4 and 7 are comparable ($28 M and $18 M, respectively). The most expensive is Alternative 5 ($38 M), which is a result of the additional cost of construction of numerous treatment components and the high extraction rate estimated for alternative comparison, resulting in relatively high O&M costs.

2.10.2.8 State Acceptance

The MassDEP has expressed its support for Alternative 7 as noted in their concurrence letter in Appendix A.

2.10.2.9 Community Acceptance

The MMRCT supports Alternative 7.

2.11 SELECTED REMEDY FOR THE ASHUMET VALLEY GROUNDWATER OPERABLE UNIT (OU)

An agreement could not be reached between AFCEE, EPA, and MassDEP on a preferred alternative based on the information available in the final FS. AFCEE had produced a PP with Alternative 6 as the preferred alternative (AFCEE 2007c) in June 2007. EPA, in turn produced an explanation of concerns that was released jointly with the AFCEE PP that advocated a more aggressive remedy than outlined in Alternative 6 (EPA 2007). Comments from the public collected up to August 2007 were mixed (Section 3.0) and indicated a consensus for a preferred alternative was not easily derived. It was agreed that additional data were required to fill in a number of data gaps in the distribution of contaminants in the Ashumet Valley plume. A comprehensive groundwater monitoring effort was conducted and a number of drive points were installed to help characterize the distribution of PCE and TCE in the downgradinet portion of the Ashumet Valley plume. Plume shells representing January 2008 conditions for PCE and TCE were developed using these new data collected in the fall and winter 2007. Using these new plume shells, Alternative 7 was modified to address contamination downgradient of Carriage Shop Road and east of the Backus River. The major difference was the core of high concentrations of PCE had migrated farther south than the contamination predicted in the model in Alternative 7. Alternative 7 modified included one additional extraction well downgradient of Carriage Shop Road to intercept the core of the PCE plume. After a review of the modeling results, AFCEE, EPA, and MassDEP agreed to consider Alternative 7 modified as the remedy to be carried into the ROD. Based on the Administrative Record for Ashumet Valley and the evaluation of comments received by interested parties during the public comment period, AFCEE has selected Alternative 7 modified as the remedy for the Ashumet Valley groundwater OU.

2.11.1 Summary of the Rationale for the Selected Remedy

The selected remedy is Alternative 7 modified, which consists of continued operation of the current Ashumet Valley treatment system and the Ashumet Valley SPEIM program, the installation of one additional extraction well south of Carriage Shop Road and east of the Backus River to increase capture of the southern portion of the Ashumet Valley plume, and LUCs. The water from the additional extraction well will be pumped to a MTU in proximity to the extraction well for treatment and discharge to the Backus River. The selected remedy is protective of human health through implementation of LUCs, complies with ARARs, does not have any significant implementability concerns, and has minor impacts on worker safety, the community, and the environment. The preferred remedy was selected over the other alternatives because it is expected to achieve the RAOs in a reasonable time frame and is cost-effective.

2.11.2 Detailed Description of Selected Remedy

The selected remedy is Alternative 7 modified, which consists of the existing optimized Ashumet Valley ETI system (one extraction well and two associated infiltration trenches) with an additional extraction well placed in the southern portion of the plume (Figure 2-13) to improve capture of the plume in that area. The additional flow from the southern extraction well is treated at a MTU in close proximity to the extraction well and discharged through a bubbler to the Backus River.

The ETI system consists of ETI of groundwater following federal and state standards for PCE and TCE as stipulated in the current O&M plan. The alternative has the flexibility of modifying the treatment system to optimize the cleanup time frame and to insure it continues to meet performance objectives. Most likely, modifications would be executed with the existing extraction wells and infiltration trenches and galleries, and could involve the use of packers to reduce the effective vertical extent of the extraction screen, or adjusting flow rates. However, the alternative does not exclude the possibility of adding additional system components, if deemed necessary. Modifications would be made for the purpose of improving treatment system operation and expediting the plume

cleanup. The Ashumet Valley ETI system is not designed to remove manganese and thallium from groundwater. The higher concentrations of manganese and thallium are located upgradient of the active extraction well(s) capture zone(s), are currently outside the known dimensions of the Ashumet Valley plume, and should attenuate in place rather than migrate toward the extraction wells. Manganese and thallium will be addressed through LTM of wells in an area west of Ashumet Pond designated for monitoring of these contaminants (Figure 2-13). The LTM will confirm that concentrations of manganese and thallium are decreasing.

This alternative would provide for chemical and hydraulic monitoring of the plume, as long as active remediation continues, and chemical monitoring of the plume until the RAOs are met. Monitoring data would aid in ongoing optimization and could prompt additional action if COC concentrations did not decrease as expected. Monitoring results will be periodically reported in formal reports. CERCLA reviews would be performed every five years throughout the lifetime of the alternative. A residual risk assessment and/or an evaluation of the technical and economic feasibility of additional remediation to approach background concentrations would be performed, if deemed necessary. The selected remedy also includes implementation of LUCs.

The following text describes the LUCs that will be implemented for the Ashumet Valley groundwater selected remedy. The Ashumet Valley contaminated groundwater currently poses an unacceptable risk to human health if used for household purposes (i.e., ingestion, dermal contact, and inhalation of vapors released during household use of water).

The Ashumet Valley contaminated groundwater is located in the southern part of the MMR cantonment area, and all of the contaminated groundwater has migrated past the MMR boundary into the neighboring town of Falmouth. Therefore, administrative and/or legal controls that minimize the potential for human exposure to contamination by limiting land or resource use, known as "LUCs," must be established for the Ashumet Valley groundwater to avoid the risk of exposure to Ashumet Valley groundwater. These

LUCs are needed both on-base and off-base, within the town of Falmouth, until the Ashumet Valley contaminated groundwater no longer poses an unacceptable risk.

The performance objectives of the LUCs are to:

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

The LUCs will encompass the area including the Ashumet Valley contaminated groundwater and surrounding areas to reduce the risk from exposure to contaminated groundwater (Figure 2-14). The on-base area of concern is controlled and operated by the Air Force, who leases this land from the Commonwealth of Massachusetts. It is expected that this entity (U.S. Air Force) will control the area of concern and the surrounding area for the duration of this ROD. As a result, the Air Force will coordinate with the Commonwealth of Massachusetts as the Air Force fulfills its responsibility to establish, monitor, maintain, and report on the LUCs for this site.

Each LUC will be maintained until either (1) the concentrations of COCs in the groundwater are at such levels as to allow unrestricted use and exposure, or (2) the Air Force, with the prior approval of the EPA and MassDEP, modifies or terminates the LUC in question.

The Air Force is responsible for ensuring that the following two LUCs are established, monitored, maintained, and reported on as part of this final remedy to ensure protection of human health and the environment in accordance with CERCLA and the NCP for the duration of the final remedy selected in this ROD. The Town of Falmouth has enforcement authority on the first LUC. The Commonwealth of Massachusetts only has enforcement authority regarding the second LUC. In the event that the Town of Falmouth fails to promptly enforce the first LUC or the Commonwealth of Massachusetts fails to promptly enforce the second LUC, the Air Force will act in accordance with the

third to last paragraph in this section. For purposes of the preceding sentence, "promptly enforce" means if the violation or potential violation is imminent or on-going, enforce to prevent or terminate the violation within 10 days from the enforcing agency's (i.e., the Town or the Commonwealth) discovery of the violation or potential violation; otherwise, enforce as soon as possible.

(1) The Falmouth BOH requires a permit for the installation and use of all wells, including drinking water wells, irrigation wells, and monitoring wells. If a permit to install a drinking water well is approved, the Falmouth BOH will not approve the use of that well until its water has been tested and the BOH has determined that the water is potable. The Falmouth BOH Water Well Regulations do not apply to use of existing drinking water wells and irrigation wells. The regulations, which are reproduced in Appendix C, cover documented and anticipated areas of contamination from the Ashumet Valley plume. To assist the Town of Falmouth in the implementation of this LUC, the Air Force will meet with the BOH on an annual basis, or more frequently if needed, to provide and discuss plume maps that document the current and projected location of the Ashumet Valley plume within the town of Falmouth. While Figure 2-14 shows the current area of LUCs in the town, the Falmouth BOH may modify the areas where the BOH may require additional well testing, and this LUC will apply to such areas even if they differ from the area shown in Figure 2-14.

(2) In addition to the town of Falmouth BOH regulations, which generally applies to small water supply wells, existing LUCs also prevent the possible creation of a large potable water supply well. The MassDEP administers a permitting process for any new drinking water supply wells in Massachusetts that propose to service more than 25 customers or exceed a withdrawal rate of 100,000 gallons per day. This permitting process, which serves to regulate the use of the Ashumet Valley contaminated groundwater for any withdrawals of groundwater for drinking water purposes, constitutes an additional LUC for this final remedy. This LUC applies to both on-base and off-base portions of Ashumet Valley.

The Air Force has provided municipal water supply hook-ups for all residences in areas of current or anticipated groundwater contamination. In conjunction with the Falmouth BOH Water Well Regulations, the municipal water supply hook-ups significantly reduce the likelihood of exposure to contaminated groundwater from existing wells and from any future wells installed in areas of anticipated contamination. Additionally, the Air Force is responsible for ensuring that the following LUCs are established, monitored, maintained, reported on, and enforced as part of this final remedy to ensure protection of human

health and the environment in accordance with CERCLA and the NCP for the duration of this final remedy selected in this ROD.

(1) For the on-base area of concern, a prohibition on new drinking water wells serving 25 or fewer customers has been established and placed on file with the planning and facilities offices for the Massachusetts Air and Army National Guard and USCG (major tenants at the MMR). The prohibition will be applied to future land use planning per Air National Guard Instruction (ANGI) 32-1003, Facilities Board, Army National Guard Regulation 210-20, Real Property Development Planning for the Army National Guard, and Commandant Instruction Manual 11010.14, Shore Facility Project Development Manual.

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

(3) The Dig Safe program implemented in Massachusetts provides an added layer of protection to prevent the installation of water supply wells in the Ashumet Valley groundwater area and to protect monitoring wells and the treatment system's infrastructure. This program requires, by law, anyone conducting digging activities (e.g., well drilling) to request clearance through the Dig Safe network. The Air Force at the MMR is a member utility of Dig Safe. The Ashumet Valley groundwater plume is encompassed by a geographical area identified by the Air Force as a notification region within the Dig Safe program. Through the Dig Safe process, the Air Force will be electronically notified at least 72 hours prior to any digging within this area. The notification will include the name of the party contemplating, and the nature of, the digging activity. The Air Force will review each notification and if the digging activity is intended to provide a well, which has not been approved via the procedures above, the Air Force will immediately notify the project sponsor (of the well drilling), the EPA, the Falmouth BOH, and the MassDEP in order to curtail the digging activity. If the Dig Safe notification indicates proposed work near monitoring wells or the treatment system infrastructure, the Air Force will mark its components to prevent damage due to excavation. This LUC applies to both on-base and off-base portions of the Ashumet Valley plume. The extent of the Air Force's enforcement of this LUC does not address off-base parties failing to file a Dig Safe request nor Dig Safe improperly processing a notification, but if incidents do occur, the Air Force is responsible for ensuring remedy integrity and, if necessary, repairing damage cause by third parties to the remedial system infrastructure or monitoring wells.

The LUCs are intended to prevent exposure to groundwater impacted by the Ashumet Valley plume; however, to insure that the LUCs obtain the LUC performance objectives the Air Force will take the following action.

Within three years of the signing of the ROD, the Air Force shall:

a. Document all private wells (i.e., non-decommissioned wells, including wells not currently in use) that are above or within the projected path of the Ashumet Valley plume.
b. Demonstrate and document that the private well is not capable of drawing contaminated groundwater originating from the Ashumet Valley plume, or test the private well for contamination and demonstrate the private well to be safe for human use. The Air Force will continue such testing, on an appropriate frequency as determined in coordination with the EPA, until the plume no longer presents a threat to that well as determined in coordination with EPA.
c. If the Air Force identifies a well containing COCs, the Air Force shall assess the risk that current and potential future non-drinking uses of such a well pose to human health. The Air Force shall submit a draft version of any such risk assessment to EPA for review and approval.
d. If neither b nor c is able to confirm that the identified well is safe for human use, the Air Force will offer the owner decommissioning of the well. If accepted, the Air Force will document such action with the appropriate BOH. If the decommissioning is not accepted, the Air Force will take other steps to insure protectiveness to include, but not be limited to, requesting assistance from the appropriate BOH to issue health warnings to the property owner and any other person with access to the well (such as a lessee or licensee), offering bottled water (if well is used for drinking), or installing treatment systems on affected wells. In each instance, the Air Force shall submit a schedule subject to EPA concurrence, outlining and including time limitations for the completion of steps sufficient to prevent exposure to concentrations of contaminated groundwater from the Ashumet Valley plume having carcinogens in excess of ARARs (i.e., MCLs, non-zero MCLGs), and prevent exposure to groundwater from the Ashumet Valley plume that poses a cancer risk in excess of the EPA target risk range of 10^{-4} to 10^{-6} or which presents a non-carcinogenic HI greater than one.

Monitoring of the environmental use restrictions and controls will be conducted annually by the Air Force. The monitoring results will be included in a separate report or as a section of another environmental report, if appropriate, and provided to the EPA and MassDEP for informational purposes. The annual monitoring reports will be used in preparation of the five-year review to evaluate the effectiveness of the final remedy.

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

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

For the LUCs identified and selected for this ROD, the Air Force will provide notice to the EPA and MassDEP at least six months prior to relinquishing the lease to the Ashumet Valley groundwater area so the EPA and MassDEP can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective LUCs. If it is not possible for the Air Force to notify the EPA and MassDEP at least six months prior to any transfer or sale, then the Air Force will notify the EPA and MassDEP as soon as possible, but no later than 60 days prior to the transfer or sale of any property, subject to LUCs.

The Air Force shall not modify or terminate LUCs, implementation actions, or modify land use without approval by the EPA and MassDEP. The Air Force, in coordination with other agencies using or controlling the Ashumet Valley plume area, shall seek prior concurrence before taking any anticipated action that may disrupt the effectiveness of the LUCs or any action that may alter or negate the need for LUCs. The Air Force will provide EPA and MassDEP 30 days' notice of any changes to the internal procedures for maintaining LUCs which may affect Ashumet Valley.

2.11.3 Cost Estimate for the Selected Remedy

The cost estimate for Ashumet Valley groundwater OU Alternative 7 modified is provided in Table 2-33 and Table 2-34. The information for the cost estimate is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements may occur based on alterations in operation of the Ashumet Valley ETI system and the monitoring program. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to –30 percent of the actual project cost. The cost comes from the O&M of the Ashumet Valley ETI system, the SPEIM program, periodic CERCLA reporting, and the residual risk assessment. AFCEE has begun implementation of this alternative to accelerate the cleanup of the plume; and thus, some of the funds in the cost estimate have already been accrued.

O&M costs would be incurred for the operation of the Ashumet Valley treatment plant from the date the ROD is signed to 2019, when the treatment system is expected to cease operation. For the sake of comparablility with other FS alternative estimates, the signing of the ROD was assumed to occur in June 2008 and the remedy to by implemented by January 2010. AFCEE has begun implementation of this alternative to accelerate the cleanup of the plume, and therefore the remedial action will occur earlier than January 2010. O&M costs have been estimated using actual costs realized for the previous operation of the existing Ashumet Valley treatment system and projected costs for operation of an additional treatment facility. Previous costs have been adjusted for the expected future reductions in the total pumping rate and influent concentrations under the future operating conditions assumed for the purposes of this ROD.

Costs related to monitoring well maintenance, hydraulic measurement, sample collection, and groundwater analysis also would be incurred during this time. Groundwater monitoring could continue after the cleanup levels are met to ensure the aquifer had been restored. It is assumed (for cost-estimating purposes) that monitoring would continue for the entire plume for two years after the cleanup levels are met, making the total lifetime of this alternative 14 years. It is assumed that the number of monitoring points and frequency of testing would both continue to decrease with plume collapse, as has been the case under most SPEIM programs at the MMR to date. Monitoring costs include periodic reporting of results in technical update meetings and in formal reports.

Costs did not include those associated with potential LUCs because they were not determined until after the FS was completed. Additionally, no costs were included for negotiating and compensating for legal access to off-base property (for new monitoring wells). These omissions are anticipated to have a small impact on the overall net present value.

Costs associated with CERCLA reporting and a final risk assessment are also included in this alternative. The present value of this alternative is estimated to be $16 M.

Capital, annual, and periodic costs generated in the cost estimates and used in the present value calculations were assumed to start at the projected date of the ROD approval (June 2008). Cost estimates also included actuals from 2007 and were escalated to the start of the base year (June 2008); thus, escalation of one year at a rate of 5 percent has been used. A discount rate of 2.7 percent was used for all present value calculations per EPA guidance (EPA 2000) and Office of Management and Budget Circular A-94, revised January 2008 (OMB 2008).

2.11.4 Expected Outcomes of the Selected Remedy

Alternative 7 modified provides for protection of human health through implementation of LUCs. The groundwater model indicates that cleanup levels will be met by

approximately 2021 for the entire plume, at which time the groundwater will be useable as a source of drinking water.

2.12 STATUTORY DETERMINATIONS FOR THE ASHUMET VALLEY GROUNDWATER OPERABLE UNIT (OU)

Under CERCLA Section 121, selected remedies must be protective of human health and the environment, comply with ARARs (unless a waiver is justified), be cost-effective, and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element. The following sections discuss how the selected remedy meets these statutory requirements.

2.12.1 Protection of Human Health and the Environment

The selected remedy will protect human health and the environment through LUCs and monitoring of the groundwater plume to ensure contaminant concentrations are dissipating to below cleanup levels, as predicted by the groundwater model. Monitoring and LUCs reduce exposure to groundwater from the Ashumet Valley plume. Human health is adequately protected currently by municipal water provided to residences overlying or in the immediate vicinity of the Ashumet Valley plume. There are no short-term threats associated with the selected remedy that cannot be readily controlled.

2.12.2 Compliance with Applicable or Relevant and Appropriate Requirements (ARAR)

Operation of the Ashumet Valley ETI system with addition of extraction in the southern plume would remediate part of the plume, and the remainder of the plume contaminants would naturally attenuate to concentrations below the cleanup levels; therefore, Alternative 7 modified would meet the chemical-specific ARARs.

Location-specific ARARs address federal and state regulations that aim to protect wildlife habitats, historical resources, and vital waterways. These areas have already

been addressed during implementation of the existing ETI system and will be followed for the construction of the new southern treatment facility.

For this alternative, action-specific ARARs apply to the discharge (infiltration/discharge) of treated groundwater and the management of spent carbon and contaminated groundwater generated from sampling of wells or treatment plant maintenance. Because these same activities have been occurring for existing remedial actions at Ashumet Valley, appropriate procedures are already in place for the proper handling of these materials. It is expected that these practices would continue, and all action-specific ARARs would be met. Refer to Table 2-30, Table 2-31, and Table 2-32 for a listing of these ARARs.

2.12.3 Cost-Effectiveness

In AFCEE's judgment, the selected remedy for Ashumet Valley groundwater is cost-effective. The overall effectiveness of the selected remedy was determined to be proportional to its costs and, hence, to represent a reasonable value for the money to be spent.

The cost-effectiveness for the Ashumet Valley remedy was evaluated based on the data currently available for the Ashumet Valley plume and the following considerations: (1) cleanup levels will be met by approximately 2021, (2) the model predicted approximately 149 pounds of TCE and PCE will be removed from the aquifer, (3) contaminants are permanently destroyed, (4) risks to workers, the community, and the environment would be easily controlled, and (5) there is a high degree of confidence that the existing controls can adequately handle potential problems.

2.12.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

The selected remedy for the Ashumet Valley plume provides the best balance of trade-offs among the alternatives considered in the FS. Alternative 7 modified represents the maximum extent to which permanent solutions and treatment can be practicably utilized

at the site because Alternatives 1 (no action) and 2 (LTM) would not expedite aquifer restoration. Alternative 7 modified is preferable to Alternative 2 because it captures additional mass and thus decreases the amount of time it will take for the aquifer to become useable again as a drinking water supply. Under Alternative 7 modified, AFCEE will continue to operate, maintain, and monitor the performance of the Ashumet Valley ETI system with LUCs and operate a new treatment system in the southern portion of the Ashumet Valley plume. Groundwater modeling predicts that expansion of the Ashumet Valley ETI system from one to two extraction wells will enhance plume capture in the southern portion of the Ashumet Valley plume. Modeling predicts that after the Ashumet Valley system modification, the plume will reach cleanup levels by 2021; two years earlier than without treatment in the southern portion of the plume. Incremental improvements to the aquifer restoration time frame and risk reduction in area south of Hayway Road (Alternatives 4, 5, and 7) are not commensurate with the additional costs of active remediation. Based on the evaluation criteria and the statutory mandates, AFCEE finds Alternative 7 modified to be the most appropriate solution for the Ashumet Valley plume. The treatment, monitoring, and controls included in Alternative 7 modified will demonstrate compliance with ARARs and protectiveness of human health and the environment. The contaminants removed from the aquifer are destroyed through active treatment and contamination remaining in the aquifer is reduced to acceptable levels through natural attenuation. The selected remedy does not present any significant short-term risks. There are no special implementability issues that make the selected remedy unacceptable.

2.12.5 Preference for Treatment as a Principal Element

The selected remedy treats the contamination present in the Ashumet Valley plume. The contaminated groundwater is removed from the aquifer through extraction wells and piped to the treatment plants. Contaminants are removed from the groundwater through GAC filtration. The treated groundwater is returned to the aquifer via infiltration trenches or discharged to the Backus River.

2.12.6 Five-Year Review Requirements

Five-year statutory reviews will be performed for the Ashumet Valley plume, according to Section 121(c) of CERCLA and NCP Section 300.430(f)(4)(ii), which requires such reviews in those instances where the remedy results in any hazardous substances, pollutants, or contaminants remaining at the site in excess of levels that allow for unlimited use and unrestricted exposure. The purpose of the five-year reviews is to revisit the appropriateness of the remedy in providing adequate protection of human health and the environment. The five-year reviews for the Ashumet Valley groundwater OU will be part of the five-year reviews conducted for the CERCLA IRP sites on the MMR. The next five-year review covering the period 01 November 2007 through 31 October 2012 will be published in the spring of 2013.

2.13 DOCUMENTATION OF CHANGES

The PP for the Ashumet Valley groundwater was released for public comment in June 2007 (AFCEE 2007c). The PP identified Alternative 6 as AFCEE's preferred Ashumet Valley groundwater alternative. The EPA, at the same time presented an Ashumet Valley Groundwater Explanation of Concerns (EPA 2007) and presented their disagreement with AFCEE's preferred alternative. Although the MassDEP did not identify a preferred alternative, they stated their disagreement with AFCEE's preferred alternative in this same EPA document (EPA 2007).

AFCEE, the EPA, and the MassDEP reviewed all written and verbal comments submitted during the public comment period. A transcript of the public hearing is provided in Appendix B. Upon review of these comments, it was determined that a final agreement could not be made based on public opinion. One of the more important issues was the desire by the Town of Falmouth to site a portion of a proposed sewage treatment facility in the area of the Ashumet Valley plume downgradient of Hayway Road. The Town of Falmouth was concerned that active treatment would disrupt the operation of the system, and in turn, infiltration of treated sewage water would impact the Ashumet Valley plume. A workshop was requested by the Town of Falmouth to discuss the issues regarding the

selection of alternatives. The workshop, attended by representatives from the Town of Falmouth, AFCEE, EPA, and MassDEP, was held on 25 July 2007 and the comment period was extended to 29 August 2007. The Town of Falmouth submitted a letter to AFCEE clarifying its position on the preferred alternative.

Unable to reach an agreement, AFCEE, EPA, and MassDEP decided to re-evaluate the distribution of contaminants in the Ashumet Valley plume in an effort to devise a more realistic alternative for evaluation. This chemical monitoring effort was completed in Fall 2007 and new PCE and TCE plume shells were developed in early 2008. Using this additional information, a revision to Alternative 7, Alternative 7 modified, was developed to address concerns about contamination in the area of the Ashumet Valley plume downgradient of Hayway Road. The conceptual design was modified to address a core of PCE contamination that had migrated farther south than modeled in the scenario for Alternative 7. The design was modified from two extraction wells downgradient of Carriage Shop Road, to one extraction well downgradient of Carriage Shop Road placed further to the south to intercept the core of PCE contamination in the southern portion of the Ashumet Valley plume. The modeling of Alternative 7 modified is presented in Appendix D of this ROD. The major differences between Alternative 7 and Alternative 7 modified are as follows:

- Alternative 7 modified used a one-extraction well scenario downgradient of Carriage Shop Road pumping at 175 gpm in contrast to Alternative 7 which uses a two-extraction well scenario downgradient of Carriage Shop Road pumping at a rate of 750 gpm.
- Alternative 7 modified uses a pumping rate of 350 gpm at the existing extraction well on Hayway Road (95EW0703) in contrast to Alternative 7 which uses a pumping rate of 375 gpm.
- Alternative 7 modified pumps contaminated water from the downgradient extraction well to MTU located in proximity to the extraction and discharges the treated water to the Backus River. Alternative 7 would have pumped the contaminated water from a pipeline connecting the two downgradient wells back to the existing Ashumet Valley treatment plant.

- Alternative 7 modified is predicted to remove 149 pounds of contaminants from the Ashumet Valley plume compared to 280 pounds predicted for Alternative 7. The alternative is predicted to remove 27 pounds of contaminants from the portion of the plume downgradient of Hayway Road compared to 174 pounds removed under Alternative 7. The model predicts that PCE and TCE in the Ashumet Valley plume will decrease below 5 µg/L by the year 2021 under Alternative 7 modified compared to 2024 under Alternative 7 (Table 2-29).
- Alternative 7 modified is predicted to restore the aquifer by year 2021 compared to year 2024 for Alternative 7.

After consideration of all the updated modeling, AFCEE, EPA, and MassDEP agreed that an alternative like Alternative 7 modified would satisfy the RAOs for the Ashumet Valley plume. The selected alternative (Alternative 7 modified) is a modified version of an alternative previously described in the FS. However, EPA and AFCEE have determined that the changes could be reasonably anticipated by the public based on the alternatives and other information available in AFCEE's PP (AFCEE 2007c), EPA's Explanation of Concerns (EPA 2007), and other supporting analysis and information in the administrative record. In such cases, the NCP [40 CFR 300.430(f)(3)(ii)] and EPA guidance [*A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents*, Chapter 4 (EPA 1999b)] provide that the ROD must document the significant changes and reasons for such changes, but that it is not necessary to issue a revised PP.

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3.0 RESPONSIVENESS SUMMARY

The Responsiveness Summary is on the following pages.

MARCH 2009

RESPONSIVENESS SUMMARY

for Ashumet Valley Groundwater

INTRODUCTION

The purpose of this *Responsiveness Summary* is to provide written responses to the comments received during the public comment period for the Proposed Plan for Ashumet Valley Groundwater. The public comment period started 14 June 2007 and extended through 22 August 2007. The public comment period was longer than one month to comply with a request from the Town of Falmouth.

Comments	Responses
Comments from Charles Aftosmis (Citizen from Falmouth)—Dated 6/14/07	
I have received AFCEE subject proposal and I do not concur. The sooner that we can clean up any hazardous material from the underground plumes, the better off our community will be. I favor Alternative # 7.	Your comments and preferences are noted. We thank you for your participation. After carefully considering all of the comments received during the public comment period on the Proposed Plan, the AFCEE, USEPA, and MassDEP agreed that it was necessary to conduct further investigations into the nature and extent of the Ashumet Valley plume before any agreement on a preferred remedy could be reached. Further investigation of the uncaptured southern portion of the Ashumet Valley plume was deemed necessary for the several reasons. First, it was recognized that uncertainty existed in the groundwater model due to the large spacing (up to 2000 feet) between some of the

Comments	Responses
	monitoring wells in the southern plume zone.. Therefore, additional data points were considered to be necessary. A better understanding of the current distribution of the contaminant mass in the southern plume zone was essential to making appropriate determinations relative to potential remedial actions. Secondly, it was necessary to understand the current distribution of contaminant mass in order to determine the optimal placement of any additional remedial components (i.e., extraction wells, treatment systems, pipelines) for the Ashumet Valley plume. Finally, a better understanding of the distribution of contaminant mass in the southern plume zone would facilitate an evaluation of how the proposed infiltration from the future Falmouth wastewater treatment facility might affect the flow of the Ashumet Valley plume. A comprehensive sampling effort was conducted in November-December 2007. These included the installation of a number of drive point wells and the sampling of existing monitoring wells. Once the results were available, these data were then used to develop new PCE and TCE plume shells. The 2008 plume shells were then evaluated with the proposed Alternatives 6 and 7, and with additional modeled alternatives (in the southern portion of the plume downgradient of Carriage Shop Road) intent upon reducing plume mass and improving aquifer restoration time. AFCEE and the regulatory agencies determined that modification of the original Alternative 7 provided the best match to the original remedial action objectives and have selected it as the preferred alternative. Alternative 7 modified (7m) is a modification from the original Alternative 7 that was presented in the Addendum to the *Final Ashumet Valley Groundwater Feasibility Study*. The original Alternative 7 was designed

Comments	Responses
	with two additional in-plume extraction wells placed downgradient of Carriage Shop Road and was developed to support the FS Addendum that evaluated the Ashumet Valley plume based on the 2005 plume shell. This alternative was presented as the EPA's preferred alternative at the 13 June 2007 PCT meeting. This alternative consisted of one existing extraction well (95EW0703) pumping at a rate of 375 gpm and two additional in-plume wells placed downgradient of Carriage Shop Road pumping at a combined rate of 750 gpm. This scenario was designed to capture areas of high PCE concentrations (hot spots) downgradient of Carriage Shop Road as defined in the 2005 plume shell. Upon completion of the 2008 plume shell, it was apparent that these hot spots were located much farther south and the in-plume wells were not positioned appropriately to maximize mass capture. The scenarios presented at the 09 April 2008 team meeting were developed to address the mass as presented in the most up-to-date plume shell. After careful consideration of the various scenarios, the AFCEE, USEPA, and MassDEP have agreed to move with a new alternative, Alternative 7m. Alternative 7m consists of the existing extraction well (95EW0703) operating at 350 gpm. An additional extraction well will be placed in the toe of the Ashumet Valley plume just downgradient of two hot spots that were identified in the latest sampling event conducted in November-December 2007. This additional extraction well would operate at a flow rate of approximately 175 gpm, with the water being processed through a mobile treatment unit (MTU), similar to those used by the IAGWSP in the northern portion of the MMR. The treated water would then be discharged into the Backus River. Based on the latest groundwater

Comments	Responses
	modeling and assuming a startup time of January 2010, this scenario would improve cleanup time by two years to 2021 and remove an additional 27 pounds of contaminants by 2023 over the system currently in place. Because Alternative 7m involves construction of one new well, not two, it will cause less construction impact than the original Alternative 7. The AFCEE, the USEPA, and the MassDEP agree that this alternative meets the remedial action objectives of the Ashumet Valley FS and satisfies the criteria required for acceptance under CERCLA.
Comments from Jack Pearce (Citizen of Falmouth)—Dated 6/13/07 I have reviewed the Plan for Ashumet Valley Groundwater(s) and urge that Alternative 7 be selected. Alternative 7 will, as proposed, shorten the time within which waters will be "cleaned-up;" this is essential given the rapidity of development in eastern <u>and</u> western Cape Cod. Questions? Please contact me.	Your comments and preferences are noted. We thank you for your participation. The time to clean-up is evaluated as a part of the short-term effectiveness criterion for the Feasibility Study and has been evaluated as part of the selection of the preferred alternative. Please see response to comment from Mr. Charles Aftosmis.
Comments from Paul Mort (Citizen of Falmouth)—Dated 6/16/07 I have reviewed the Proposed Plan for Ashumet Valley Groundwater and I support the Air Force's selection of Alternative 6. There are bigger problems in Falmouth that are affecting the water quality in the coastal ponds that need attention. The plume is not high on my list given its current state and last of impact on residents' health.	Your comments and preferences are noted. We thank you for your participation. Please note that the alternatives were evaluated on their abilities to meet the remedial action objectives outlined in the feasibility study. Only PCE, TCE, manganese, and thallium were evaluated as part of the Ashumet Valley groundwater remedial alternatives, as these pose potential health risks to residents. Contaminants such as nitrogen and phosphorus were not considered in this evaluation because

Comments	Responses
	they are not hazardous substances as defined by CERCLA. The risk to human health is the same for both alternatives. Please see response to comment from Mr. Charles Aftosmis.
Comments from Frederick Flynn (Citizen of Falmouth)—Dated 6/16/07 The Air Force's proposal for cleanup of the Ashumet Valley Plume as described in the IRP documents at the Falmouth Library makes the most sense. Alternative 6 provides for the restoration of Falmouth's Ashumet Valley well field in a reasonable time. As the town looks to find areas for future supplies to keep up with demand, I believe that this action may fit in nicely with that future vision. Needless environmental disruption should be avoided. Whether it is to the nearby neighborhood's quality of life during construction and need for future maintenance activities or the potential for adverse ecological impacts in the Falmouth Conservation area. The difference of 11 years in estimated cleanup time is insignificant in comparison to the plume already having been in the aquifer for the 50 to 60 years. I read that the source of the contamination has been removed so there is nothing driving the need for additional action over and above what is currently being accomplished by the Air Force. It's time to put these base issues behind us so we can focus on the real problems facing the Town.	Your comments and preferences are noted. We thank you for your participation. As you have stated, the primary source areas of Fire Training Area-1 and the MMR Sewage Treatment Plant have been remediated, removing the source of contaminants from the Ashumet Valley plume. Please see response to comment from Mr. Charles Aftosmis.
Comments from Constance Calderwood (Citizen of Orleans)—Dated 6/16/07 We are opposed to the plume containing solvents perchloroethene. Clean water is imperative.	Your comments and preferences are noted. We thank you for your participation. Clean water is imperative

Comments	Responses
	and that objective has driven our interim action to restore the Falmouth wellfield north of Hayway Road. Please see response to comment from Mr. Charles Aftosmis.
Comments from Carol Rogers (Citizen of Bourne)—Dated 6/17/07 Interesting point and counterpoint in the two documents discussing the Ashumet Valley Groundwater contamination. I feel that the two agencies, as always, put too many words in print to justify a conclusion. So rather than talk about the lack of risk or the dilute nature of the plume, I'll just urge you to select Alternative 6 as proposed by the AFCEE for the final remedy.	Your comments and preferences are noted. We thank you for your participation. We apologize for the lengths of our decision documents and will strive to make them more streamlined without sacrificing the content. The similar risk to residents under each alternative and the nature of the plume are discussed to allow the readers to make informed conclusions. Please see response to comment from Mr. Charles Aftosmis.
Comments from Kerry Corr (Citizen of Falmouth)—Dated 6/17/07 I've reviewed the proposed plan for Ashumet Valley groundwater and I agree with the remedy proposed by AFCEE. Alternative 6 provides a good balance between the risk to residents and the future water supply needs of Falmouth. A populated area with private septic systems is no place for a municipal water supply. To spend over $9M to cleanup an area of the aquifer that will never be used a decade sooner as EPA suggests is not a good investment. Please continue to watch out for how our taxpayer dollars are being spent. Your recent optimization shows that you try to balance the costs of clean-up against the impacts to the community.	Your comments and preferences are noted. We thank you for your participation. In consideration of a preferred alternative, many criteria were considered including short-term effectiveness which includes impact to the community. Please see response to comment from Mr. Charles Aftosmis. A preliminary comparison between Alternative 6 and Alternative 7m show that additional groundwater extraction in the southern portion of the plume will represent an additional approximate estimate of $7M for Alternative 7m. In contrast, the Alternative 7 (evaluated in the FS Addendum) was estimated to cost an additional $10M in comparison to Alternative 6. Therefore, the AFCEE, the

Comments	Responses
	USEPA, and the MassDEP believe the modified Alternative 7m represents a cost-effective means of remediating the Ashumet Valley Plume.
Comments from Frank Geishecker (Citizen of Falmouth)—Dated 6/18/07 I think you should select alternative 6. I thought that the decisions had been made years ago. The Air Force has done a respectable job over the last decade reducing the risks to the community. Our water supply is safe and will be for the future. Our Town is giving consideration to construction of a waste water treatment plant in the area south of the golf course. As a taxpayer, I cannot understand why the EPA wants the AF to cleanup the groundwater only to let the Town dirty it again in the future. Thanks for the opportunity to voice my opinion.	Your comments and preferences are noted. We thank you for your participation. Please see response to comment from Mr. Charles Aftosmis. There are several issues regarding the proposed Falmouth wastewater treatment facility that may have an impact on the system proposed in modified Alternative 7. The preliminary plans from the Town of Falmouth identify three infiltration areas (A, B, and C) which will be modeled to receive treated water from the treatment plant. Areas A and B are located east of the Bournes Pond River and are estimated to receive between 5 and 8 million gallons per day (mgd). These areas are likely outside the mounding influence of the location of the Ashumet Valley Plume. Area C located between the Backus River and the Bournes Pond River is projected to receive approximately 0.3 gpd. The general plan is to initialize Areas A and B, and bring Area C on line (if necessary) sometime after the year 2020. Because the anticipated cleanup for Alternative 7 is 2021 and Area C is the only infiltration bed that may have an affect on the Ashumet Valley system, it is assumed at this time that the impact from the Falmouth wastewater treatment system will be insignificant.

Comments	Responses
Comments from Elizabeth Abeltin (Citizen of Falmouth)—Dated 6/18/07 After reading the article in the Cape Cod Times last week, I spent some time looking over the proposed plan information and have come to the conclusion that without a present day or future risk there is no need to spend any more money expanding the current system. I agree with the Air Force that Alternative 6 is sufficiently protective and based on the current clean-up system's past progress will in a reasonable time have the former Falmouth Ashumet Valley well field available for use once again.	Your comments and preferences are noted. We thank you for your participation. Please see response to comment from Mr. Charles Aftosmis. Please note that both Alternatives 6 and 7m restore the Falmouth wellfield by 2019.
Comment from Robert L. Whritenour, Jr. Town Manager, Town of Falmouth—Dated 6/22/07 On behalf of the Board of Selectmen of the Town of Falmouth, I wish to request an extension of the thirty-day comment period which commenced June 14, 2007 for the final Record of Decision on the Ashumet Valley Plume. The purpose of this extension is to offer officials from the Town of Falmouth an additional opportunity to review and make comments on the proposed options discussed by the EPA and AFCEE. If an extension of the comment period is acceptable, I wish to propose that you assist me in coordinating a workshop for Falmouth Town officials and the general public to be held on a selected afternoon during the week of July 16 or the week of July 23, at which time we may receive a presentation on the options and have the ability to raise any question or concerns that may be present. I am in hopes that we could use your consultant, The Consensus Building Institute, to assist in setting up and facilitating the workshop.	At the request of the Board of Selectmen, the comment was extended to August 2007 and written comments were accepted to those postmarked by 31 August 2007. A workshop sponsored by AFCEE and mediated through CBI was held in the Falmouth Town Hall on Wednesday, 25 July 2007. Representatives from AFCEE, the US EPA, MassDEP, the Falmouth Board of Selectmen, and the general public were in attendance.

Comments	Responses
This would provide for an orderly and methodical approach to involving local officials and residents in this process in a meaningful way. Thank you for consideration in this matter. Please keep me informed of your decision, and feel free to contact me at any time to review this request. If the proposed workshop is acceptable, I can be the point of contact for coordinating with the Board of Selectmen and other local officials.	
Comments from Robert Ottaviano (Citizen of Falmouth)—Dated 6/27/07 I have been following the information provided by AFCEE the last few years concerning the Backus River watershed. The majority of the reporting has been coming from the Ashumet Valley Nitrates Advisory Group. The results point to a problem with elevated nitrate levels within the watershed which ultimately affect our coastal waters. The competing plans presented by AFCEE and the EPA provide a comparison of approaches to dealing with groundwater contamination within the watershed. As I see it, the risk to anyone with a private well comes more from the nitrates than from any other compound because of the shallowness of the wells. I do not believe that it is necessary to spend over $9m to cleanup the aquifer 11 years sooner when neither of the proposed remedies addresses the real issue potentially affecting people's health. Therefore I support the Air Force's recommendation of Alternative 6 as the final remedy to restore the Falmouth well field area in case we ever need it in the future.	Your comments and preferences are noted. We thank you for your participation. Please note that the impacts of the sewage plume are much more elevated in the area of the aquifer between the former MMR Sewage Treatment Plant and Ashumet Pond. While it is evident that portions of this plume have migrated downgradient of Ashumet Pond, the sewage plume's effects are diminished with distance downgradient. Therefore, the primary risks evaluated for the Ashumet Valley plume south of Hayway Road was focused on the contaminants PCE and TCE. Please see response to comment from Mr. Charles Aftosmis. A preliminary comparison between Alternative 6 and Alternative 7 shows that additional groundwater extraction in the southern portion of the plume will result an estimate of an additional $7M for Alternative 7. In contrast, the Alternative 7 evaluated in the FS Addendum was estimated to cost an additional $10M in comparison to Alternative 6. Therefore, the AFCEE, the USEPA, and the MassDEP believe the modified Alternative 7 represents a cost-effective means of remediating the Ashumet Valley Plume.

Comments	Responses
	Please note that the alternatives were evaluated on their abilities to meet the remedial action objectives outlined in the feasibility study. Only PCE, TCE, manganese, and thallium were evaluated as part of the Ashumet Valley groundwater remedial alternatives, as these pose potential health risks to residents. Contaminants such as nitrogen and phosphorus were not considered in this evaluation because they are not hazardous substances as defined by CERCLA. The risk to human health is the same for both alternatives.
Comments from Keith Richardson (Citizen of Falmouth)—Dated 6/29/07 I read with interest the Air Force's Proposed Plan for the Ashumet Valley Plume. Having lived in the area for a long time, I've come to understand the problem and have seen the progress that has been made to clean-up Otis. The EPA's Explanation of Concerns was overly focused on trying to convince me that there is so much uncertainty the only answer is to spend an additional $9,000,000 in order to reduce that uncertainty. The EPA has been involved since the base was designated a Superfund site so I have difficulty fathoming why they are still not sure what is going on. The scientific community prefers an iterative approach to problem solving. I can see that the Air Force has followed that process as evidenced by the recent shutdown of two of the original three extraction wells. So given that there will be continued monitoring of groundwater (and of progress), I agree with the Air Force's preferred remedy. Alternative 6 provides an appropriate level of protection to the residents of Falmouth and should be selected.	Your comments and preferences are noted. We thank you for your participation. We agree that an iterative approach is appropriate. That is why all of these alternatives evaluated included not only a remedial action, but a continuation of groundwater monitoring to assure that the plume is behaving as predicted. Each alternative (with the exception of Alternative 1---No Action) monitors the development of the plume and, if appropriate, the progress of the remediation. Should the conditions of the plume change beyond model predictions, then actions can be implemented to address the changes that might lead to contaminant exposure. This strategy has been used for other MMR remedial actions with a great deal of success. We agree that this is the best means to address future uncertainty. Please see response to comment from Mr. Charles Aftosmis. A preliminary comparison between Alternative 6 and Alternative 7 shows that additional groundwater extraction in the southern portion of the plume will result an estimate of an additional $7M for Alternative 7. In contrast, the Alternative 7 evaluated in the FS

Comments	Responses
	Addendum was estimated to cost an additional $10M in comparison to Alternative 6. Therefore, the AFCEE, the USEPA, and the MassDEP believe the modified Alternative 7 represents a cost-effective means of remediating the Ashumet Valley Plume. Please note that the alternatives were evaluated on their abilities to meet the remedial action objectives outlined in the feasibility study. Only PCE, TCE, manganese, and thallium were evaluated as part of the Ashumet Valley groundwater remedial alternatives, as these pose potential health risks to residents. Contaminants such as nitrogen and phosphorus were not considered in this evaluation because they are not hazardous substances as defined by CERCLA. The risk to human health is the same for both alternatives.
Comments from Oliver and Marsha Zafiriou (Citizens of Falmouth)—Dated 7/6/07 We live near Flax Pond, an area marginally affected by the aforementioned plume. After reading and considering the MMR and the EPA and DEP responses, we believe that considering risks, benefits, and costs, Alternative #6 (with minor modifications) is the best choice as opposed to #7. 1. No effort has been made, or proposed, to identify the supposed users of groundwater exceeding MCL's for drinking, irrigation, showering, etc. (MCL applies only to drinking, other references are fearmongering). 2. Any such users could far more cheaply be identified by additional rounds of fliers, door-to-door questioning, if necessary repeated every few years, at far lower cost, and by then providing them with town water hook-ups.	Your comments and preferences are noted. We thank you for your participation. Please see response to comment from Mr. Charles Aftosmis. Under either alternative, AFCEE will identify those residents that may have wells located within the footprint of the Ashumet Valley plume and assess their potential risk from exposure to plume contaminants. Residents in and around the Ashumet Valley area will be contacted through fliers, mail, phone calls, and door-to-door interviews. All of these data will be archived in a GIS derived database to assure that all avenues of contact have been exhausted. In this manner, all residents with private wells in the vicinity

Comments	Responses
3. Alternative 7 does not eliminate the hypothetical dangers, it just lowers the odds somewhat. It seems extremely unlikely that anyone will actually drink the water remediated by #7, so unlikely that there is any restoration of real (as opposed to theoretical) benefits. "Restored" water will largely end up in the Backus river, and then in the atmosphere/estuary, likely at sub-MCL levels due to additional dilution by surface flow. This is not great, but it is tolerable. 4. For the eight million dollars in cost (#7 vs. #6) assuming 25% goes to profits and waste, option #7 will spend almost 6 million dollars, largely on electricity, fuel, and energy-intensive materials (pipes, pumps...), that will release a lot of carbon dioxide into the air. EPA/DEP have not considered the balance of this negative impact vs. the supposed (and uncertifiable) benefits. For these reasons, it seems that this disagreement is mainly a bureaucratic turf war with the citizens paying to satisfy regulations rather than to reap real benefits. We favor an action such as #6 plus some modest but thorough effort to continue to identify possible consumers of over-the-MCL water (If anyone knowingly uses such water, fine).	of the Ashumet Valley plume will be identified. Alternative 7m does capture more mass than Alternative 6, but as you point out, does not prohibit the discharge of PCE and TCE to the Backus River. AFCEE has made every effort to supply residents over the Ashumet Valley plume with drinking water via town hook-ups to eliminate exposure to the Ashumet Valley plume. If there is a resident with an active well, there is a possibility they could benefit from remediation south of Carriage Shop Road, but it is believed this scenario is less than likely. The fate of contaminants entering the Backus River is by volatilization and recent studies on the surface water and cranberry crops have shown little or no impact from these solvents. An update of the plume shells used in the Feasibility Study has shown that there is less mass and smaller plumes than what were previously analyzed. The selection of Alternative 7m will help improve the water quality of groundwater entering the Backus River and the associated cranberry bogs. The impacts of a remedial action on the community are evaluated as part of the short-term effectiveness criterion. We agree that Alternative 7 has greater community impact than Alternative 6. A preliminary comparison between Alternative 6 and Alternative 7 shows that additional groundwater extraction in the southern portion of the plume will result an estimate of an additional $7M for Alternative 7. In contrast, the Alternative 7 evaluated in the FS Addendum was estimated to cost an additional $10M in comparison to Alternative 6. Therefore, the AFCEE, the USEPA, and the MassDEP believe the modified Alternative 7 represents a cost-effective means of remediating the Ashumet Valley Plume.

Comments	Responses
	AFCEE has committed to identify any possible users of water that may be impacted by the Ashumet Valley plume and to assess their chances of exposure to these contaminants. The selection of Alternative 7m will help reduce contaminant mass in the areas of highest concentration in the Ashumet Valley plume and therefore, help to reduce the uncertainty taking no action in the southern portion of the plume.
Comment from William Winters (Citizen of Falmouth)—Dated 7/6/07	
It was good to be at the Plume Cleanup Team (PCT) meet a few weeks ago. I gained a lot of information both from the displayed posters and the presentations. Thanks for the opportunity to once more provide my comments on the future of the Ashumet Valley Plume (AVP) cleanup. As you may remember I provided comments 10 years ago when there were 4 out of 5 initial plans on the table to completely treat the leading edge of the AVP. The only plan initially deemed unacceptable to everyone was a plan to let a part of the leading edge remain untreated. Not only was the most initially unacceptable plan finally implemented, it was significantly modified to allow much more of the leading edge to remain untreated with the potential for eventual upwelling into the Backus River. This decision was made without further input from the public. This incredible decision was made partly at the request of a closed door meeting to which the public was not invited. However, I believe selectmen were at that meeting. With money saved by not treating the leading edge of the plume, AFCEE (at the town's request) provided funds for studying pollution not connected with the AVP. At the time, I thought this was an incredible breech of the public trust on the part of AFCEE, EPA, Falmouth town officials,	Your comments and preferences are noted. We thank you for your participation. The comments you made 10 years ago were duly noted. As you probably remember, a public meeting was held 19 August 1997 at the Universalist Unitarian Church where seven alternatives were presented for consideration. Public comments on the alternatives were solicited at that time and were accepted until 02 September 1997. Numerous comments were received regarding the "new" alternative proposed by the Falmouth Board of Selectmen which was based on the Woods Hole Workshop held on 23 August 1997 (closed door meeting referenced in your comment). Within those comments, the following organizations all requested an extension to the public comment period in order for the public to evaluate the "new" alternative: Falmouth Board of Selectmen, Ashumet Valley Property Owners Association, Senior Management Board Selectmen, Association to Preserve Cape Cod, Barnstable County Science Advisory Panel, and the Cape Cod Commission. The record indicates numerous discussions were held among AFCEE, EPA, and MassDEP regarding the need to extend the public comment

Comments	Responses
and other concerned parties. I still feel this way. With pollution upwelling occasionally into the Backus River and a much greater (in area) plume to contend with now, we have to face the final remediation decisions based on those faulty decisions from 10 years ago. I am not completely blind to the reasons for making the decisions, back then. I believe that modeling did not indicate the plume would upwell into the Backus River. If the model had proved correct, then there would be less immediate concern about the present situation. As I learned at the PCT meeting, there is no present health concern. This certainly is good news, but it is only half the issue. Perception is the other concern. However, as we learned, models are not always correct. This is one of the contentions of the EPA now. That we should clean up more of the leading edge because we don't really know how the plume will behave in the long term. My recommendation would be to implement the EPA-supported plan ALTERNATIVE 7. PLEASE, do not implement another plan not currently on the table without further public comment. Also, please do not significantly modify any of the existing alternatives, and pretend that it is just a minor adjustment, without public comment. This is what happened 10 years ago and we are now paying the price for it. There is a much larger plume to contend with now, when it would essentially be gone if one of the originally "acceptable" plans was implemented.	period. EPA and MassDEP believed "the present discussion of alternatives constitute a modification of what has already been reviewed by the public and that those modifications take into account the public comments received, and therefore, no new comment period is indicated" (RPM minutes, 11 September 1997). AFCEE, on the other hand, "cited concerns about public perception of the process and believes that a new public comment period is warranted" (RPM minutes, 11 September 1997). The decision to forego an additional public comment period was made in an environment of extreme scrutiny and pressure for all agencies to get cleanup systems in place. We concur that it was a mistake to not extend the public comment period to address the modified alternative selected during the Woods Hole Workshop. The $8.5M used by the Air Force to fund the Falmouth nitrate offset program was paid in increments from 1998 to 2005 and was programmed separately from the 1999 funds used for Ashumet Valley construction. Any new scenarios or modifications not provided in the administrative record will be provided to the public, usually through presentations to the PCT. It is unclear if one of the original 1997 plans for treatment south of Carriage Shop Road could have ever been implemented based on the strong opposition to construction in that area. This opposition, gathered during the 1997 public comment period, was one of the primary drivers for establishing a more balanced alternative for the interim remedy. In regard to comments on the groundwater model, the original modeling that was conducted for the DCM did show some discharge of contaminants to the Backus River as well as Ashumet Pond,

Comments	Responses
	however, the mass discharged was not predicted to be as large as the current model shows. This is due, in part, to eight years of additional monitoring in the area of the Backus River which filled a number of data gaps. It is true that the risk assessment conducted prior to the feasibility study shows no risk under the scenarios that were employed. There is uncertainty, however, should the conditions of the plume change beyond model predictions, then actions can be implemented to address the changes that might lead to contaminant exposure. This strategy has been used for other MMR remedial actions with a great deal of success. We believe that this is the best means to address future uncertainty. The latest revised alternative, Alternative 7m, was presented to the PCT on 09 July 2008. A workshop was held for the Town of Falmouth 25 July 2007 regarding potential remedial actions and the Town's future plans for wastewater treatment in the vicinity of the Ashumet Valley plume. This has held prior to the extended comment period on the Proposed Plan that ended on 29 August 2007. Updates were provided to the PCT after the initial presentation of the proposed plan on 13 June 2007. These included updates on 12 September and 14 November 2007. Additional data collected to refine the groundwater alternatives was presented to the PCT on 13 February 2008. The revised Ashumet Valley plume shell (used to develop the latest alternative) was presented to the PCT/MMRCT on 09 April 2008. The revised alternatives were presented to the PCT/MMRCT on 11 June 2008, and the preferred alternative (Alternative 7m) was presented to the PCT/MMRCT on 09 July 2008. Please see response to comment from Mr. Charles Aftosmis.

Comments	Responses
Comments from David Heimann (Sierra Club—Massachusetts Chapter)—Dated 7/9/07	
The Massachusetts Chapter of the Sierra Club is submitting the following comments on the proposed plan for remediating the Ashumet Valley Plume (AVP) on behalf of our 27,000 members. Dennis LeBlanc (U.S. Geological Survey) highlighted the history of this groundwater pollution plume in his MIT Freeman Lecture: "Cape Cod's Billion Dollar Cleanup: The Hydrologic Story" from its discovery in 1978 to the recent AFCEE (Air Force Center for Engineering and the Environment) proposal almost 30 years later. The combination of source removal of chlorinated solvent contaminated soils (PCE and TCE) downgradient plume migration and mass removal by the 3 ETR wells (extraction, treatment and reinjection in trenches) under the interim record of decision (IROD), the main plume is currently 18,000 feet long, 3100 feet wide and 100 feet thick. Much of the remaining plume contaminant mass is south of the IROD remaining ETR well near Hayway Road, with the existing treatment plant now having underutilized activated carbon treatment capacity (since two ETR wells were shut down in May 2007). The Sierra Club favors a mitigation approach which prevents further migration of the toe of the AVP and reduction of the contaminant mass south of Hayway Road in order to speedup aquifer restoration.	Your comments and preferences are noted. We thank you for your participation. An aquifer restoration scenario was evaluated as part of the final Feasibility Study. Alternative 5 consisted of continuing the three-well axial system that is currently in-place as part of the Ashumet Valley ETI system. An additional six wells would be added south of Carriage Shop Road to address the PCE and TCE contamination south of Hayway Road. Three wells of these six wells would be placed across the plume on Carriage Shop Road and the remaining three wells placed in an axial arrangement downgradient of Carriage Shop Road east of the Backus River. While restoring the aquifer much more quickly, the alternative was considered unacceptable because of the excessive drawdown of Falmouth Conservation Wetland.
The Sierra Club favors a variant of Alternative 4 which would remove 85% of the contaminants that exist in the southern portion of the AVP. Our proposed alternative (Alt. 4a) would: install some ETR wells along the Backus River/closer to the toe of the plume; replace the in plume ETR wells south of Hayway Road with recirculating wells to	The most aggressive alternative analyzed in the Feasibility Study (Alternative 5), was not able to accomplish the goals that are presented in your comment. Alternative 5, pumping at 3750 gpm with a total of nine extraction wells was only able to accomplish a 67 percent reduction in total PCE and TCE mass removed. One of the problems with the Sierra Club

Comments	Responses
remove contaminant mass in some of the hot spots; close down the Hayway Rd. ETR in 2016; and use the existing treatment plant for the Hayway Rd. ETR and those along the Backus River/plume toe. Alternative 4a would support the Sierra Club philosophy that dilution is not the answer to toxic pollution (natural attenuation with land use controls is not an option). Alternative 4a is also consistent with the National Contingency Plan (NCP) preferences for: active treatment to reduce volume/mobility of contaminants; short and long term effectiveness; and implementability and cost. This alternative would also be supportive of the Massachusetts Contingency Plan's (MCP) emphasis on the modifying criteria: community and state acceptance. The Cape Cod and the Islands Group has 1100 members, many of who live over top of the Sagamore lens which has been contaminated by the plumes emanating from the MMR (Massachusetts Military Reservation). Finally, Alternative 4a is more consistent with Tad McCalls's (Former Deputy Undersecretary of Air Force in Clinton Administration) promise to make the Cape Cod Community whole from the contamination of our sole source aquifer from past military training activities. From the Sierra Club perspective AFCEE's preferred alternative 6 (status quo active treatment system plus monitored natural attenuation with land use controls in the 2/3 of the AVP south of Hayway Rd.) is a non-starter, because it satisfies none of the above (Sierra Club policy on toxic pollution, NCP and MCP preferences). Alternative 6 would also delay the time during which the southern AVP region could be considered as a potential public water supply region under the criteria (PCE and TCE have to be reduced to 50% of mcl levels before eligibility to apply as a PWS) developed by the Massachusetts Department of	Scenario is that the closer one places wells near the river, the harder that well has to work to overcome the hydraulic gradient between the aquifer and the river. Flow rates necessary to come close to the objectives of the Sierra Club Scenario would exceed the capacity of the current Ashumet Valley ETI system. Recirculation wells have been proved to be inefficient in the heterogeneous stratigraphy in the Ashumet Valley study area and cannot reach the necessary flow rates (at least 250 gpm) to reasonably remove contaminants and counter the hydraulic gradients. Therefore, a scenario that would remove 85 percent of the contamination south of Hayway Road, remain within the Ashumet Valley ETI capacity, and implement recirculation wells, without exceeding any of the guidelines set for a remedial system is not feasible. Alternative 7m, described below, is an active treatment scenario and therefore satisfies NCP preference for active treatment. Please see response to comment from Mr. Charles Aftosmis. Alternative 7m satisfies the threshold criteria; one which any selected alternative must meet, of Overall Protection of Human Health and Compliance with ARARs. There is currently no known exposure to the Ashumet Valley plume because of the Air Force's program of providing public water to all residences within and near the footprint of the Ashumet Valley plume if they so wish. The risk assessment for Ashumet Valley was based on exposure by cranberry workers and recreational waders in the Backus River. There was no risk identified for conducting these activities. The threat of the Ashumet Valley plume is as a water supply. If the exposure is prevented, then the alternative meets the two threshold

Comments	Responses
Environmental Protection (Ma. DEP). Dennis LeBlanc's (USGS) Freeman lecture ended with the observation that the future challenge will be plume management in the context of water supply. His notion that pollution deeper in the saturated layer will rise towards the surface as a result of water extraction is especially relevant in this context. Both our Alternative 4a and the U.S. Environmental Protection Agency's (EPA) preferred Alt. 7 seem more consistent with future aquifer restoration from AFCEE's preference. The IROD solution was chosen to address the Town of Falmouth's desire to restore the water quality in the former town Ashumet Valley well field and restore this to an active system. EPA's preferred Alternative 7 is a compromise between Alt. 6 and current Alternative 4. It removes roughly 63% of the contaminant mass in the southern AVP and is preferable to AFCEE's Alt. 6 which removes less than 25% of the remaining contaminant mass. Alternative 4 would remove 85% of the contaminant mass in the southern AVP, while helping prevent the toe of the plume migrating beyond the Falmouth Country Club property where the town is considering constructing a new tertiary sewage treatment plant to remove nitrate pollution (diminishing water quality in coastal embayments adjacent to Nantucket Sound). Since Alt. 4a has not gone through design evaluation, it is hard to evaluate its total cost and cleanup completion date, but presumably it would in the neighborhood of Alt. 4 (without building an additional treatment plant near Carriage Shop Rd.). Our second choice option would be Alt. 7. Thanks for the opportunity to comment on this proposal.	criteria. The remaining criteria are balancing and acceptance.

Comments	Responses
Comments from Phil Goddard (Citizen of Bourne)—Dated 7/11/07	
My name is Phil Goddard, I'm a resident of Bourne and a member of the Plume Cleanup Team.	Your comments and preferences are noted. We thank you for your participation.
My comment tonight is that – is similar to what I expressed at the last PCT meeting. First, I just wanted to thank the Air Force for extending the comment period for another period of time. I just heard the press release; I think that's a good thing you're doing because of the complicated series of options here. I think the Town of Falmouth needs some time to contemplate those.	Please see response to comment from Mr. Charles Aftosmis.
My comment is that when I reviewed this it seems that there was a choice between one system that the Air Force is proposing and then another system that the regulators were recommending; there was a difference of about $10 million, and the question that I was struggling with is: it worth going after pollution and the plume south of Hayway Road for $10 million? Those are the types of things I was weighing.	A preliminary comparison between Alternative 6 and Alternative 7 show that additional groundwater extraction in the southern portion of the plume will represent an additional approximate estimate of $7M for Alternative 7. In contrast, the Alternative 7 evaluated in the FS Addendum was estimated to cost an additional $10M in comparison to Alternative 6. Therefore, the AFCEE, the USEPA, and the MassDEP believe the modified Alternative 7 represents a cost-effective means of remediating the Ashumet Valley Plume.
My comment is that it may not be either/or; there may be a third or fourth way to look at this. And I had suggested at that time and I've suggested at other meetings with plumes that there are these alternative technologies you may want to look at that could target the hot spots and one being recirculating wells or the other was a reactive wall that's been kicked around at the site for a while. If there's anything applicable there, I'd like that addressed or explained why those are not feasible versus the Alternative 7, which is $10 million more, new pipelines and disruptions in the neighborhood. The other recommendation that I would like explored is a system that is being used on the impact area and groundwater study program, which is the mobile treatment systems. Ben Gregson, I think,	A reactive barrier would likely handle the contaminants of concern in the southern portion of the Ashumet Valley plume, but there are several reasons this technology was not considered. For one, the fence would be rather deep; an estimated minimum of 120 feet from the ground surface based on the extent from maximum plume depth to the discharge point at the Backus River. The reactive barrier wall would also be long, an estimated 6,500 feet to prevent discharge of the Ashumet Valley plume to the Backus River. The reactive barrier would be placed in a residential area making it less implementable due to potential difficulty obtaining access to areas where the barrier would be effective and excessive site disturbance. Based on very rough cost estimates, the cost would

Comments	Responses
and Hap Gonser should be consulted on that and brought down to provide information about what they're doing with mobile units, that are these units, apparently that are pump and treat, but are modular to be scaled up to meet the demand and then removed very quickly with little disruption. Perhaps there's something like that that could be brought to bear in the southern portion for a period of time, throw that into the model and see if there's certain areas in the south that it could be applied to to try to go after the hottest areas of contamination and perhaps have a way of addressing some of the concerns of the regulators, but without having to spend an extra $10 million. I think one of my hopes has been that both programs learn from one another and can share technology and techniques for being successful that the Air Force can help the Army side with the Community Outreach they've explored and, down the other way, that the Army can share maybe innovative technologies they're applying in the north with the southern portion. So, I hope that's considered by the Air Force and I hope that it's not necessarily an all or nothing situation with what the demands of the – or the recommendations of the regulators are versus the projections or the proposed plan of the Air Force, and I would like to see that considered and responded to. Thank you very much.	be approximately $51M in addition to the present action if carried to completion. Estimates of the most expensive action in the southern portion of the plume (a six extraction well system) would be approximately $29M in additional cost. The reactive barrier wall would also not satisfy the remedial action objective of aquifer restoration. Because the reactive barrier is a passive system, the estimated length of time for aquifer restoration would likely be no different than a no action alternative. Recirculating wells were not considered because of their limitations as far as pumping rates. Recirculating wells have been used effectively on the MMR and provide a viable alternative given the proper circumstances. Recirculating wells are effective in source areas for removing contaminants from low conductivity deposits and in areas that are sensitive to excessive drawdown. The nature of the recirculating well means that it will reprocess previously treated water which can be effective in areas of higher VOC concentrations where more than one treatment is desirable to reach the action level. However, VOC concentrations in the lower Ashumet Valley plume would likely only require one treatment and the recirculation of the treated water would be inefficient. Also, testing of recirculating wells in Ashumet Valley determined that the heterogeneity of the sediment matrix was not ideal for their operation. It is necessary to consider a technology with the flexibility to handle higher flow rates, and perhaps modify those flow rates over time. Extraction wells accomplish this with fewer installed wells. AFCEE believes that extraction with carbon treatment provides the most efficient and flexible means of designing an alternative. The revised alternative, Alternative 7m, will implement a mobile treatment unit

Comments	Responses
	(MTU) in the area downgradient of Carriage Shop Road. This system is very similar to the systems currently in place to remediate plumes in the IAGSWP. We thank you for this helpful advice.
Comments from Sue Walker (Citizen of Lake Arrowhead, California)—Dated 8/3/07 I do not support AFCEE's preferred alternative of continuing to operate one of the three original groundwater extraction wells north of Hayway Road in Falmouth. Rather I agree with the US EPA that construction is needed for additional wells in the southern portion of the plume. The people of Cape Cod deserve the best cleanup possible for the single source aquifer.	Your comments and preferences are noted. We thank you for your participation. Please see response to comment from Mr. Charles Aftosmis.
Comments from Thomas Cambareri (Water Resources Program Manager, Cape Cod Commission)—Dated 8/8/07 I have reviewed the Proposed Remedial Plan for the Ashumet Valley Plume, the AFCEE June 2007 Fact Sheet and the EPA June 2007 Explanation of Concerns. I have followed the progress of this project in meeting notes of the Plume Cleanup Team and attended the Falmouth Workshop on July 25. I offer the following comments based upon my professional involvement in MMR cleanup issues since 1990. I have also discussed these comments with Dr. Brian Howes who was Chair of the Barnstable County Science Panel on MMR issues that provided comments on the 1997 Ashumet Valley Interim Record of Decision (attached for your review). At the present time I marginally support Alternative 6. Part of this opinion derives from my recognition of the remedial efforts already conducted and underway including, mid-plume restoration of potential water supply area in the	Your comments and preferences are noted. We thank you for your participation. Please see response to comment from Mr. Charles Aftosmis.

Comments	Responses
Ashumet Valley, remediation of Ashumet pond through phosphorus inactivation and installation of a passive iron treatment wall, and an $8 million dollar offset towards nitrogen. In addition, groundwater conditions in the Ashumet Valley have been improved by removal of the wastewater effluent discharge, and a number Dept of Defense of cost allowances have been secured by the Town for hooking up private residences to public water and to assist Falmouth in its efforts to secure long-term water supplies both within and outside the town. Alternative 6 does not include the capture of contaminants in the southern part of the plume and allows them to flow with the groundwater to ultimately discharge into the surface waters associated with the Backus River and Green Pond. A portion of the contaminants would still flow into these systems under Alternative 7, but for a shorter period of time. I take note that the discharge of Ashumet Plume contaminants into these systems has been occurring for a period of years already and the ecological risk posed by these contaminates is low. It would have been instructive for the community if an attempt was made to calculate the cumulative total mass of contaminants that has already discharged into these waters overtime. I also am confident in the Town's aggressive planning for adequate future water supplies that does not target this area for potential public water supply. The alternative analysis is flawed because it does not account for the Town of Falmouth's plan to import water into this region of the watershed by using the area of the Golf Course properties for wastewater disposal. This fact was pointed out to Team members early in the process but was not incorporated into the feasibility study. Over the last decade, the town of Falmouth has been in the	It is not known at the present time how long these contaminants have been discharging to the surface water bodies along the Ashumet Valley plume flow-path. Two wells constructed in the southern portion of the plume, 95MW0104 and 95MW0106, were constructed in June 1997. 95MW0104 had TCE concentrations above the MCL in June 1997 and PCE concentrations above the MCL in April 2003. Concentrations of PCE and TCE in 95MW0106 were first detected in May 2004 and October 2003 (respectively), but below the MCL for all sampling events. Based on the location of the source and the travel times, it seems reasonable that discharge of PCE and TCE to the Backus River was occurring prior to 1997. However, to develop a calculation of mass discharge to date would require that a number of simplifying assumptions be made to estimate the mass of contaminants and the extent of these contaminants from the early stages to the present. While this can be done, the estimate would have a great deal of uncertainty and the value would be conjecture at best. The Feasibility Study did not include an estimation of the impact of a nitrogen treatment facility in the vicinity of the proposed location. At the time the Feasibility Study was prepared, there was no information provided to AFCEE as to discharge locations of treated water or an

Comments	Responses
process of assessing the health of its embayments through its volunteer groups and its participation with the Massachusetts Estuary Project. This work has documented the poor water quality and ecological health of its coastal ponds. Nitrogen from residential septic systems in the watersheds migrates in groundwater to discharge into the coastal waters where it is the primary nutrient causing eutrophication. Eutrophication in Mill Pond and Green Pond, the freshwater and estuarine recipients of Backus River waters, is causing ecological impairment to these systems. Wastewater collection and treatment is the only viable method to remove this nitrogen from the watershed. Sites for wastewater facilities and effluent disposal are necessary components of this infrastructure. The town participated in the County sponsored USGS project to identify and provide preliminary groundwater modeling to evaluate suitable sites for discharge of treated effluent. Identifying and selecting viable effluent recharge sites is a large problem for any town, but particularly for Cape towns that have many conflicting land uses and few suitable large parcels available. However, three sites (referred to as P1, P2 and P3) among others were evaluated and deemed suitable for effluent disposal in this area. As I understand it, the town already secured access to the site using funds from the Ashumet Plume Offset from the Interim Decision. The magnitude of the wastewater problem facing Falmouth, and especially this area of the Town, eclipses the benefits associated with reducing the plume clean-up time for this particular plume. Therefore the Town's potential use of these sites should not be pre-empted by an aggressive plume cleanup strategy that places plume recovery wells in or near these sites. Additional analysis that prioritizes the wastewater use of the	estimation of the amount of discharge expected. This was something that could have been incorporated in the model, but was not available at the time of the preparation of the document (initial modeling runs were developed in Fall 2004). However, it would be reasonable to assume that additional recharge in concert with the competing gradients between the aquifer and the Backus River would complicate the extraction of contaminant mass and would effect any action south of Carriage Shop Road in a similar manner. Therefore, the performance of the alternatives under a revised scenario would be similarly affected. Because the Feasibility Study is a relative comparison of alternatives with a rather broad range of cost tolerance, the addition of the influx of treated water should not affect the alternatives beyond this tolerance. There are several issues regarding the proposed Falmouth wastewater treatment facility that may have an impact on the system proposed in modified Alternative 7. The preliminary plans from the Town of Falmouth identify three infiltration areas (A, B, and C) which will be modeled to receive treated water from the treatment plant. Areas A and B are located east of the Bournes Pond River and are estimated to receive between 5 and 8 million gallons per day (mgd). These areas are likely outside the mounding influence of the location of the Ashumet Valley Plume. Area C located between the Backus River and the Bournes Pond River is projected to receive approximately 0.3 gpd. The general plan is to initialize Areas A and B, and bring Area C on line (if necessary) sometime after the year 2020. Because the anticipated cleanup for Alternative 7 is 2021 and Area C is the only infiltration bed that may have an affect on the Ashumet Valley system, it is assumed at this time that the impact from the

Comments	Responses
sites over the short-term gains for plume remedial action could result in an interim alternative.	Falmouth wastewater treatment system will be insignificant.
There are a number of suggestions for refinements to the alternatives for follow-up discussions to support any decisions on this matter. 1) The undocumented risk to private well users can be better documented by a GIS evaluation of water use data from the Water Department billing records. 2) the use of these sites for treated effluent recharge will have three effects; a) it will immediately dilute the Ashumet Plume beneath the sites b) will displace the portion flowing to the site laterally, and c) the ecological health of the estuatries will be restored to their water quality standard, from their present designation as significantly impaired-severly degraded, by the planned collection and treatment of wastewater. 3) AFCEE should work with the Town to use their groundwater modeling expertise to assist in evaluating the interaction of the Plume with treated effluent discharge. 4) According to the Massachusetts Estuary Project Technical Report, the Ashumet Plume accounts for approximately 5% of the Total Load that is discharging into the Green Pond estuary. The total effort for wastewater management in Falmouth has been ballparked at $500 million. Five percent of the total cost is $2.5 million. 5) The MEP Technical Report and work by the Ashumet Plume Offset Committee has indicated that enhanced natural attenuation of nitrogen within the upper surface waters is a potential money saving part of a nitrogen removal strategy in these watersheds. The MEP also indicated that Mill Pond be further examined as a potential site. Such solutions typically include increasing the residence time of surface waters in wetland systems. It is conceivable that such a system could also provide a benefit for the solvent contamination of	AFCEE will, as part of any final remedy, identify those residents who may have wells located within the footprint of the Ashumet Valley plume to assess their potential exposure to plume contaminants. In addition, AFCEE intends to cooperate with the Town of Falmouth as much as possible in its wastewater effluent disposal evaluation.

Comments	Responses
the Ashumet Plume. 6) Additional funds could be provided to assist the Town in the implementation of its private well bylaws until such a time that monitoring indicates that the solvents, much like the detergents from the former Otis treatment plant have passed through the area.	
Comments from Jean Crocker (Citizen of Barnstable)—Dated 8/21/07 I DO NOT think the EPA position on the currently final Ashumet Valley Plumes cleanup Plans should be supported..... Because the land is currently responding to Air Force Cleanup and restoration Activities already in place, AND Because of the realistic status of financing, more funding being unnecessary AND As the Air Force is cutting back on Superfunds, THEREFORE funds should be spent for highest priority environmental Cleanup and Environmental Impacts that are appropriate for the highest priority of needs to the environmental restoration and other more needed, higher priority needs. I believe that the Air Force position is best; AND To act as EPA wishes is to act with an OVERDO BECAUSE; It does not make common sense to go so far; AND The EPA position and most current thought was not included in the original and more recent plan for environmental restoration planning; AND The current water and land status problem is not going to infringe upon Falmouth's water supply safety; AND THEREFORE:	Your comments and preferences are noted. We thank you for your participation.

Comments	Responses
The extra funds which EPA would want to just do what the nice thing is to do is an act of extreme extravagance at this time; I believe the state regulators would agree with my conclusion as follows: Work on the lands can be considered completed for drinking water safety, as the Safe Water Act requires, as well as the original law that governed this Ashumet area cleanup. As it stands now, it seems to me that standards for the Safe Water Act and second law (as referred to above) have been met. Please include my (this Email) report in the package of reaction by the public, as I present my position to the Team of the PCT. I do thank all the cleanup people, team members from such diverse scientific backgrounds: the joint Army and Air National Guard personnel, contractors, and regulators for their hard work. I believe that all have been actively doing good and studious research, development of the plan, and its broad-spectrumed implementation. Their work, all included, has accomplished an especially important level in community understanding and relationships. They have implemented the environmental management of land and water being safe again. NOW, the health of cranberry crops, other surrounding lands, drinking water, and the future is safe for people in the Ashumet Valley area. It is especially important that all the players on the teams should communicate positively regards the present and future status of the Ashumet Valley with community leaders and the public.	Please see response to comment from Mr. Charles Aftosmis.

Comments	Responses
Local people now have reason to lose their fears; False scare-tactic information has been eliminated; and THEREFORE the public feels safe once more. The land and water are much as they were much earlier times; BEFORE the Air Force fuel, disposal treatment plant, and Fire Fighting activities damaged the health of the land and groundwater. I just don't agree with the EPA conclusions and recommendations. At this time, I do recommend acceptance of the details and concepts within the Air Force Plan.	
Comments from Brian Handy (Handy Cranberry Trust and Citizen of Bourne)—Dated 8/22/07 I am writing you to express my concern and dismay in the recent plan by AFCEE to not pursue additional treatment for the Ashumet Valley Plume. The recent vote by the Falmouth Board of Selectmen **do not** reflect my feelings on this matter nor do they I suspect reflect the feelings of my neighbors surrounding my property on Old Barnstable Road in East Falmouth. I would suggest that had we been properly notified of the hearing that I believe was held **out of Town** for some unknown reason that you would have received more negative responses toward your proposed plan. I live with fear each year that the contamination from this plume that currently exists in my cranberry bog will render my crop unsaleable. I would suggest that no one at AFCEE would enjoy living under like circumstances. I applaud EPA for questioning the proposed **inaction** by AFCEE and I hope that they press for more appropriate action by AFCEE.	Your comments and preferences are noted. We thank you for your participation. We urge you to read all the official comments received during this public comment period and discuss them with your neighbors. AFCEE mailed the proposed plan to members of the site mailing list. The proposed plan contained information on the dates of the comment period, the public meeting, and public hearing, all of which were held in Falmouth. AFCEE issued a news release to local media on 04 June 2007, and placed paid advertisements in the 08 June 2007 issues of *Enterprise* and *Cape Cod Times* newspapers announcing the comment period, meeting and hearing prior to the start of the comment period. On 09 July 2007 AFCEE issued a news release announcing the 11 July 2007 public hearing and the extension of the comment period, and placed paid advertisements in the 13 July 2007 issues of *Enterprise* and *Cape Cod Times* newspapers for the hearing and the extension. The community was well informed of the public comment period and the public hearing, as evidenced by

Comments	Responses
	the many community members attending the public meeting and providing official comments. It is conceivable that the plume has been discharging into the Backus River since 1997, but studies on the surface water and cranberry crops have shown little or no impact from these solvents. Please see response to comment from Mr. Charles Aftosmis.
Comments from Office of Selectmen and Administrator, Town of Falmouth—Dated 8/20/07	
The Town of Falmouth appreciates the effort of both AFCEE and EPA to extend the public comment period and to conduct a special workshop for Falmouth officials on the Alternative Remediation Options for the Ashumet Valley Plume. The additional time and process allowed for a thorough and deliberative review upon which our recommendations are based.	Your comments and preferences are noted. We thank you for your participation.
The Board of Selectman, on behalf on the Town of Falmouth, offers the following comments about the Ashumet Valley Groundwater Proposed Plan to include the EPA's Explanation of Concern. In addition to the workshop session, we solicited, received, and evaluated comments from our Senior Management Representative for the base cleanup, our Nutrient management Working Group, the Falmouth Board of Health, the Falmouth Department of Public Works, Cape Cod Commission and comments and questions at the AFCEE sponsored Workshop on July 25, 2007 and Board of Selectmen's meeting of August 13, 2008. We have incorporated by reference all written and oral comments received.	Please see response to comment from Mr. Charles Aftosmis.
The Board of Selectmen, following the extended public input period has concluded that Alternative 6 is in the best interests of the Town of Falmouth and our	Both Alternative 6 and Alternative 7m include Long Term Monitoring (LTM) and Land Use Controls (LUCs) as components of the alternative. LTM

Comments	Responses
citizens. AFCEE has completed a risk assessment which concludes that the health and ecological risks are the same for both Alternatives. The EPA has not disputed that finding and has not shown that Alternative 7 offers any greater risk reduction for public health or the environment. The Town requests that the final ROD continue to assure a robust monitoring and evaluation program to include public outreach and education. We also request that the ROD require that AFCEE: revalidate that the Town of Falmouth has no property relying on private wells for drinking water, that all residents and property owners are notified that private wells should not be used for drinking water or any other use and aggressively implement Land Use Controls.	would provide confirmation for the contamination location and levels for as long as the contamination exists, plus two years beyond the date the cleanup standards are met. LUCs would provide for working with the Falmouth Board of Health to make sure residents are not drinking water from the contaminated aquifer. Also under the LUCs, AFCEE would identify those residents who currently have wells located within the footprint of the Ashumet Valley plume and assess their potential risk from exposure to plume contaminants.
The Board finds that the construction required for Alternative 7 will result in environmental impacts that outweigh the incremental benefit of treatment. The Town has already invested millions local tax dollars and $4 million federal AFCEE funds into the site proposed for the treatment facility. Falmouth Country Club and the adjacent property was a strategic acquisition intended to serve as potential discharge location for wastewater. We are extremely concerned about the impact of the extraction and movement of groundwater in the area of the treatment system. Changes in regional hydrology could impair our ability to maximize the discharge capacity, and our ability sight and permit waste water disposal alternatives associated with anticipated federal and state mandated Total Maximum Daily Load requirements. We have also share concerns about use of federal tax money to remediate an area already proposed for the discharge of treated wastewater.	There are several issues regarding the proposed Falmouth wastewater treatment facility that may have an impact on the system proposed in modified Alternative 7. The preliminary plans from the Town of Falmouth identify three infiltration areas (A, B, and C) which will be modeled to receive treated water from the treatment plant. Areas A and B are located east of the Bournes Pond River and are estimated to receive between 5 and 8 million gallons per day (mgd). These areas are likely outside the mounding influence of the location of the Ashumet Valley Plume. Area C located between the Backus River and the Bournes Pond River is projected to receive approximately 0.3 gpd. The general plan is to initialize Areas A and B, and bring Area C on line (if necessary) sometime after the year 2020. Because the anticipated cleanup for Alternative 7 is 2021 and Area C is the only infiltration bed that may have an affect on the Ashumet Valley system, it is assumed at this time that the impact from the Falmouth wastewater treatment system will be insignificant.
The Town must be held harmless in any alternative selection that has adverse	The DoD by letter dated 18 September 2003 to Governor Romney

Comments	Responses
impacts to hydrologic evaluations needed to permit wastewater disposal capacity. The MADEP has not given the Town any assurances regarding hydrological evaluations. We understand that the level of treatment from our waste water facility can only be made in accordance with a permit process. We request that the final ROD pledge the full resources of EPA and AFCEE to assure that waste water disposal capacity is not adversely impact by the final cleanup plan. While the Town does not have any plan to use the area mitigated by Alternative 7 for future public or private water supplies, in the event the area is unitized for potable water supply, the EPA and AFCEE must commit to water treatment for the protection of public health. We appreciate the opportunity to comment and look forward to hearing of the future decisions that will impact our community resources.	regarding the lease extension for the MMR stated; "When access to validated water requirements is impaired due to contamination from MMR that exceeds applicable and duly promulgated federal or state regulatory standards and for which the Air Force or Army is responsible, the Air Force or Army will reimburse the affected water district for the reasonable incremental costs to develop those water supplies that are directly attributable to that contamination, i.e., costs over and above those that the water district would have incurred in the absence of the contamination."
Comment from Maura Hanning (Citizen of Falmouth)—Dated 8/28/07 Thank you for considering comments from the public regarding the Proposed Plan for the Ashumet Valley Plume remediation. I moved to Falmouth, MA 3 years ago and was previously employed by the New Mexico Environment Department as a manager of their Superfund oversight program and, later, as a manager of their ground water quality protection program. I feel very strongly that the EPA should select a remedy in keeping with the NCP that requires active remediation to remove as much of the contaminants as practicable (Alternatives 4, 5, and 7). Due to my background in protecting ground water quality, I have strong feelings that this critical resource be remediated and protected regardless of whether people are actually using that water today. We will need the water in the future and the	Your comments and preferences are noted. We thank you for your participation. Please see response to comment from Mr. Charles Aftosmis. Alternative 7m also satisfies the threshold criteria, of Overall Protection of Human Health and Compliance with ARARs. There is currently no known exposure to the Ashumet Valley plume because of the Air Force's program of offering to provide public water to all residences within and near the footprint of the Ashumet Valley plume. The risk assessment for Ashumet Valley was based on exposure of cranberry workers and recreational waders in the Backus River. There was no risk identified for conducting these activities.

Comments	Responses
citizens of the Commonwealth of Massachusetts have a right to clean, safe ground water. Knowing what I know about how MCL's are derived, I do not believe there is a "safe level" for ingesting known carcinogens or inhalation of those carcinogens in our shower water. In my 5 years of work with the NM Superfund program, every federal facility we worked with proposed natural attenuation as a solution and spent lots of money on modeling to support their position. TCE and PCE do not naturally attenuate in the absence of air and sunlight, so I feel it is an inappropriate choice of words to describe that aspect of Alternative 6 – the correct way to word it would be dilution. Please do not support the AFCEE preferred Alternative 6. I think it is unfortunate that the Falmouth Board of Selectmen voted to support the AFCEE preferred Alternative 6. I understand that they feel they had to make a choice between future wastewater discharge and protecting human health and the environment from the Ashumet Valley Plume. The Town is facing limited options in addressing the nitrate contamination from septic systems and it is unfortunate that the decision had to go before the Selectmen before more could be understood about how wastewater discharge might co-exist with additional plume extraction wells. Above all, I wish the federal and state agencies would work with the Town to find solutions to both very important problems in a way that does not result in having to compromise on protection of human health and the environment. Again, thank you for considering my comments.	We believe you have misinterpreted our term "natural attenuation," and hope to clarify the term here. TCE and PCE do naturally attenuate in groundwater, since "natural attenuation" includes dilution (as you point out) as advection and diffusion. In the absence of air and sunlight, TCE and PCE will degrade (via anaerobic reductive chlorination) to 1,1-dichloroethene, vinyl chloride, and ultimately to carbon dioxide, water, and chlorine. This reductive dechlorination has occurred in the northern portion of the Ashumet Valley plume where it co-mingles with the STP sewage plume. Once the PCE and TCE reaches a surface water body, such as Ashumet Pond or the Backus River, the compound readily volatilizes and therefore exhibits little residence time in the water body. These processes are in place and affecting the distribution of PCE and TCE in the Ashumet Valley Plume. Thus these compounds are naturally attenuating in addition to the current active extraction.

Comments	Responses
Comment from Elizabeth W. Cant (Citizen of Falmouth)—Dated 8/19/07 I wish to go on the record as in support of the EPA plan for the continued clean up of the Ashumet Valley ground water plume. If the EPA plan can give us cleaner water the AFCEE plan is not acceptable. The Superfund is for this sort of remediation and we have every right to it.	Your comments and preferences are noted. We thank you for your participation. As a point of clarification, the term "Superfund" is sometimes used to refer to the CERCLA statute and program as a whole, and sometimes to a specific trust fund established under that statute. In this case, the Air Force is remediating the Ashumet Valley plume pursuant to CERCLA, but with Air Force (not trust fund) money. Please see response to comment from Mr. Charles Aftosmis.
Comments from Lillia Frantin and Herb Edwards (Citizens of Falmouth)—Dated 8/29/07 My husband and I are concerned citizens and taxpayers of Falmouth, Massachusetts. We are writing in regards to the recent vote taken by the Falmouth Board of Selectmen in regards to the long standing problem facing our community: The Ashumet Valley Plume and its health consequences. In contrast to the vote of three Selectmen, Board member Selectmen Catherine O'Brien Bumpus was the only voice representing a strong consensus of public opinion that supports the EPA recommendation for a more thorough and effective program that will give us back a clean and healthy water supply contaminated by the Air Force base and its long practices. Many of us were shocked by the Selectmen's vote and deeply disturbed. It is up to our elected representatives and government agencies to protect our water supply and environment. Since our Selectmen have shown they support a less acceptable clean-up program, for whatever reasons, we are writing directly and requesting the EPA do whatever it can to correctly resolve this issue as quickly as possible and support 'doing the right thing.'	Your comments and preferences are noted. We thank you for your participation. Please see response to comment from Mr. Charles Aftosmis. The remediation alternatives presented in the feasibility study and proposed plan were developed and evaluated prior to and independent of the Town's plans for sewage treatment in the area. As a point of clarification, the term "Superfund" is sometimes used to refer to the CERCLA statute and program as a whole, and sometimes to a specific trust fund established under that statute. In this case, the Air Force is remediating the Ashumet Valley plume pursuant to CERCLA, but with Air Force (not trust fund) money.

Comments	Responses
In the Enterprise news article report on the Selectmen's discussion and vote on this issue, we read that the main reasons Selectmen would permit a lesser clean-up effort, one not surprisingly supported by AFCEE, is it will be faster and cheaper. And also because there is the 'possibility' that the EPA's proposal would interfere with town plans for a waste treatment facility at the Town's Golf Course. Both reasons need clarification. The superfunds are there to be used and should not be the subject of negotiations. And, as regards the other issue of our town sewage plan, we feel the EPA should come back to Town regards the other issue of our town sewage plan, we feel the EPA should come back to Town to clarify for residents and concerned citizens and taxpayers exactly what this 'possibility' really means and offer an alternative to the impression left by Selectmen that we either take a lesser clean-up, or give up town plans for the sewer treatment/golf course proposal. It is obvious the town needs the BEST clean-up AND a good sewage treatment plan. Neither should be jeopardized. We citizens need clarification by the EPA and your serious attention before things go any further and we are left with a new sewage facility but an unacceptable environment to live in. We hope the EPA takes this as a serious problem and realizes that the Selectmen have, in the mind of many of the residents and with the exception of Selectmen Bumpus, not made the best choice in providing our residents with the safest environment. We feel the EPA is the duly authorized government agency to protect our health and environment, and that your recommendation should be the one most logically followed. If the recommendations of the EPA aren't followed, we feel we need to be fully informed, by facts, as to "why." As to	AFCEE has worked with the EPA, MassDEP, and the Town of Falmouth to decide on an acceptable and reasonable final remedy.

Comments	Responses
costs, Superfund funds were set up for exactly this purpose and if $9 Million Dollars need to be spent, then so be it. We are talking about the future health and well-being of our children and grandchildren- which is priceless. Superfund efforts should not be interfered with by another "agency" nor any quick vote by Selectmen, especially when the vote was NOT UNANIMOUS and came as a surprise to residents. We need your help in knowing all the facts before any lesser plan is adopted. Please, do your utmost as a protector of our natural resources and the public's health to give us the clean-up we deserve, not the cheapest that can get hurried thru without redress. As citizens, we deserve no less.	
Comment from Anthony Colacchio (Citizen of Falmouth)—Dated 8/29/07 I thank you for the opportunity to comment on the Air Force's Proposed Plan for clean-up of the Ashumet Valley Groundwater. I only wish I had been paying more attention when the Air Force was looking for comments on the FS-29 plume in the Ballymeade area. I've experienced first hand the actual construction impacts of system installation. What I found after asking for answers was that there were no risks associated with letting the plume clean itself naturally. Residents were not exposed to the contaminated water because we get our drinking water from the Town. Thee inconveniences I experienced were really unnecessary abnd therefore, I support the Air Force's proposed remedy, Alternative 6. I don't feel another part of town should have to put up with what we went through at Ballymeade when there is no risk.	Your comments and preferences are noted. We thank you for your participation. Please see response to comment from Mr. Charles Aftosmis.

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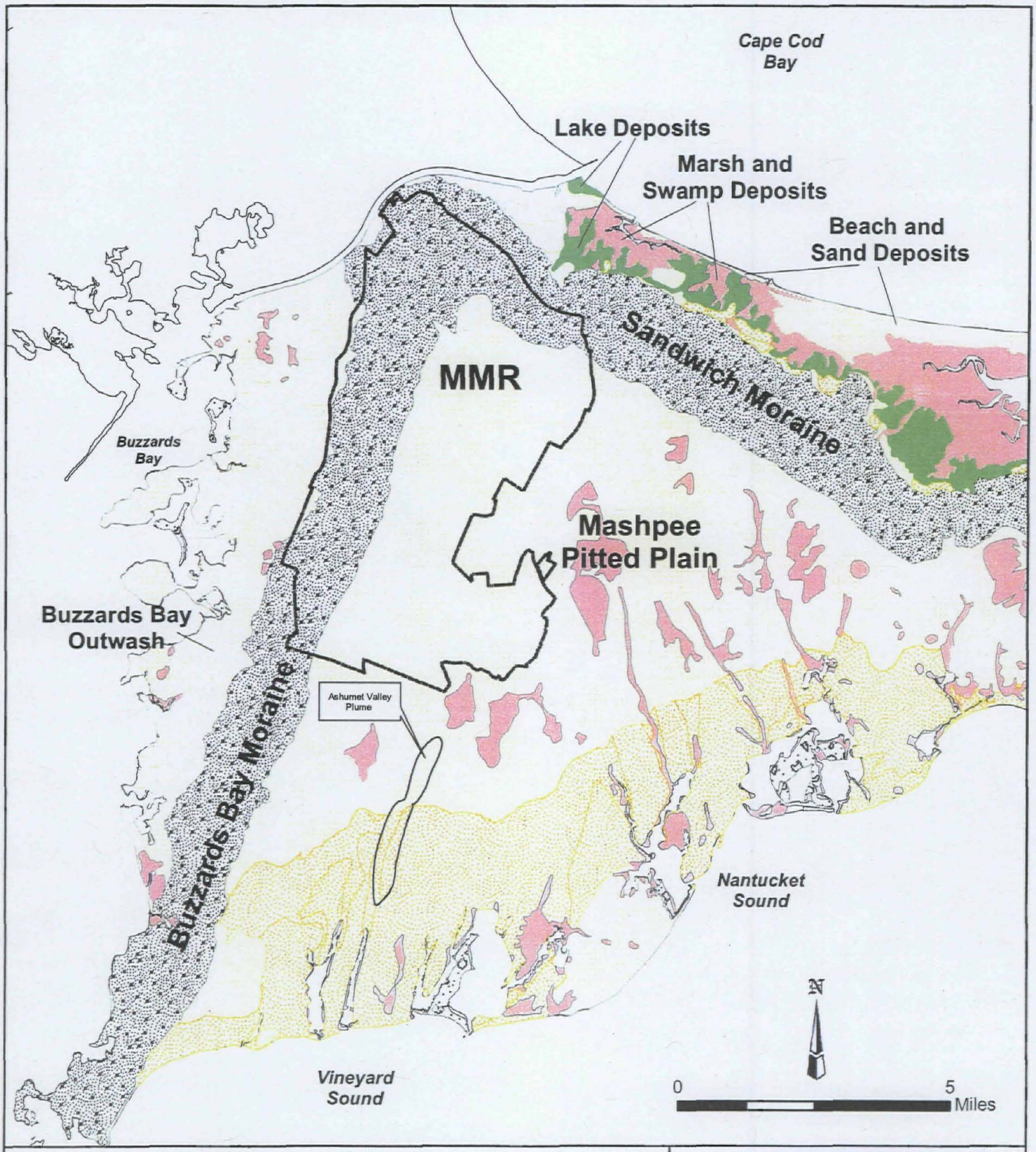
FIGURES



LEGEND

MMR Boundary

Surficial Geology Units

- end moraines
- fine-grained deposits
- floodplain alluvium
- large sand deposits
- sand and gravel deposits
- sandy till over sand
- till or bedrock

JACOBS™

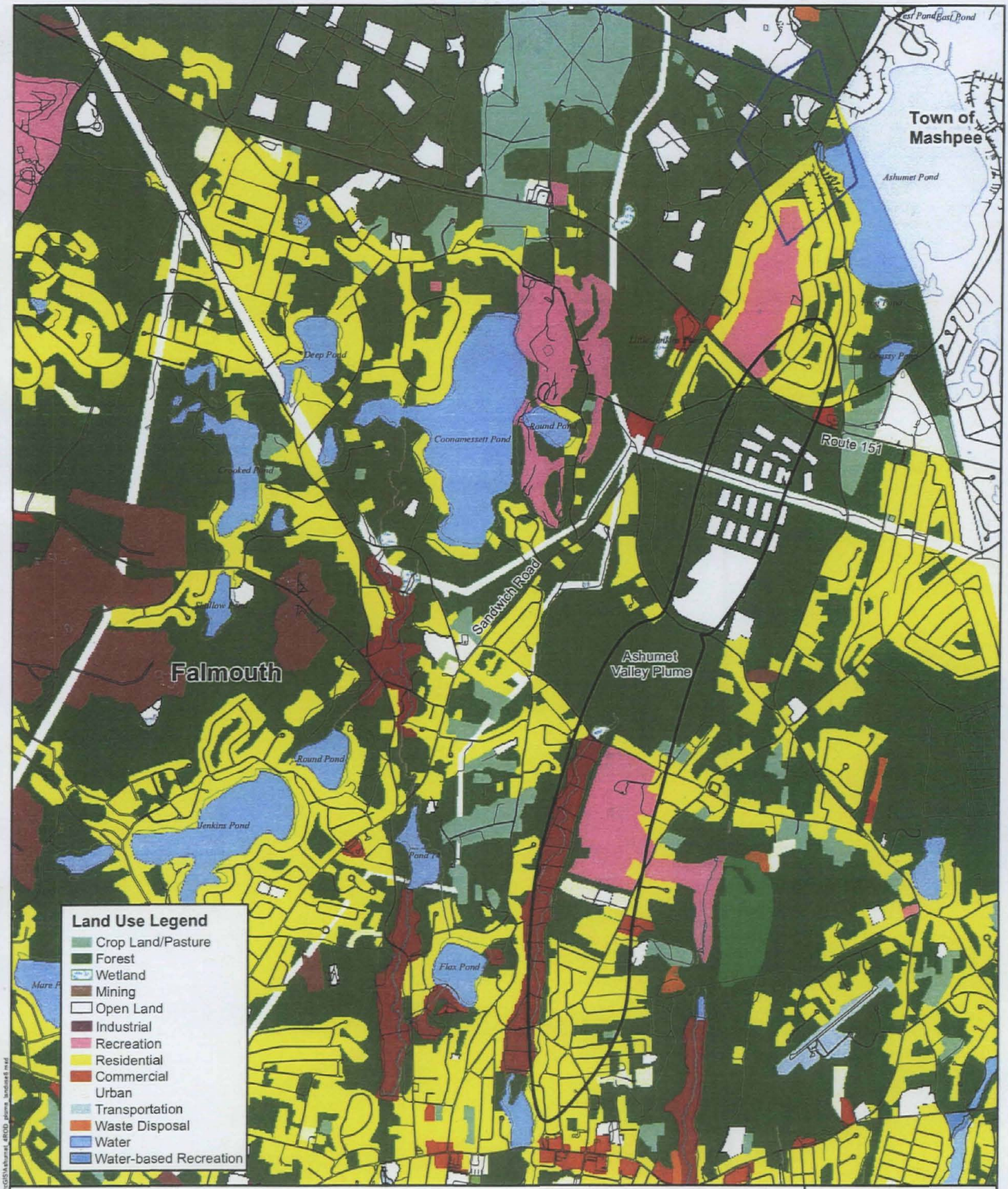
Regional Surficial Geology Map and the Massachusetts Military Reservation

Massachusetts Military Reservation
Cape Cod, Massachusetts

NAME: jpiccuito DATE: 9/17/2008

Figure 2-1

Y:\GIS\projects\35BC02\VA\20080917\ArcGIS\ASH_4ROD_Geology2.mxd



Legend

Ashumet Valley Plume

Area of Interest for Manganese and Thallium in Groundwater

N

0 2,500 Feet

Scale 1:30,000

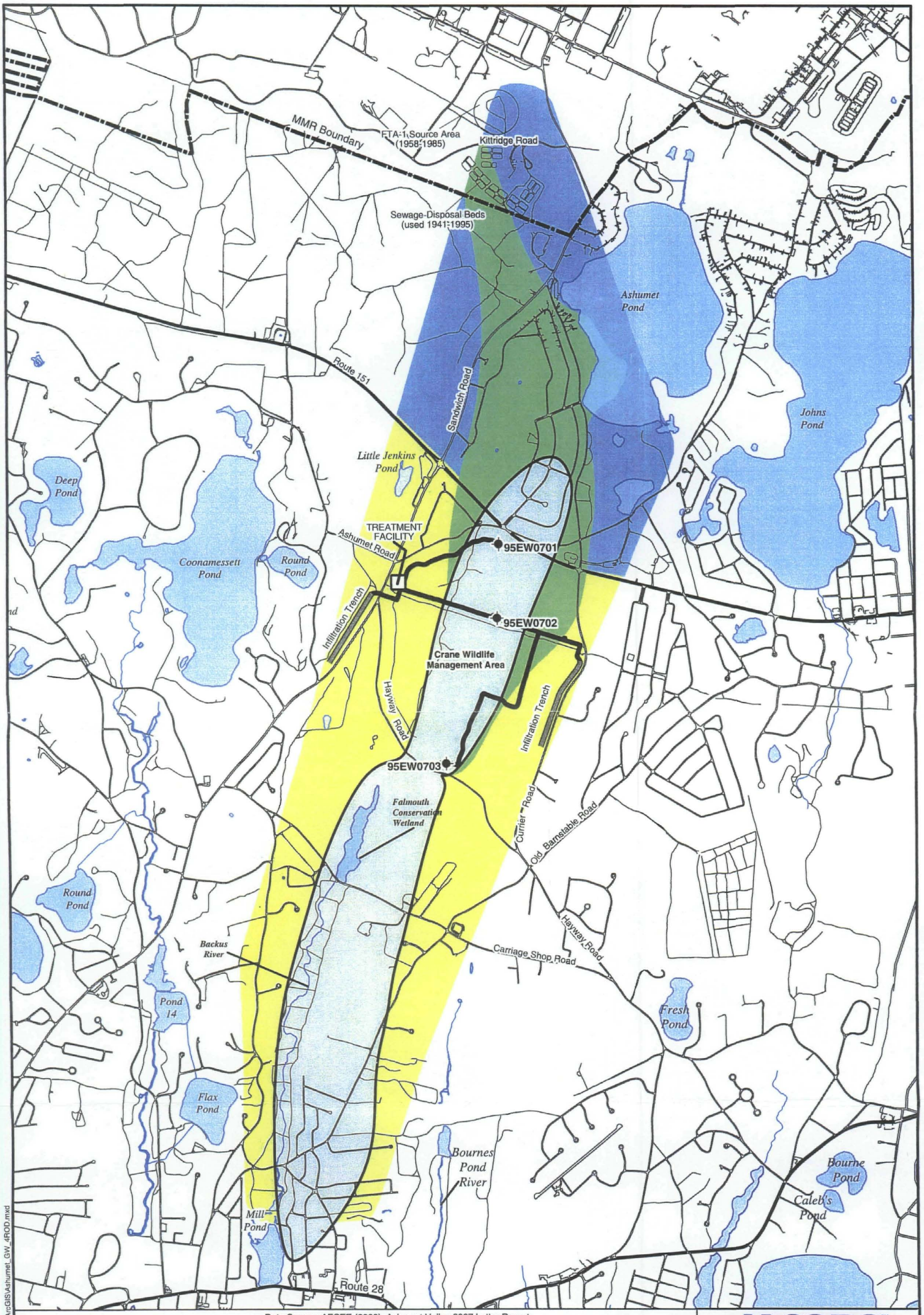
JACOBS

Ashumet Valley Area Land Use

Massachusetts Military Reservation
Cape Cod, Massachusetts

NAME: jacobs DATE: 11/03/2006

Figure 2-2



Data Source: AFCEE (2008), Ashumet Valley 2007 Letter Report

Legend

- Extraction Well
- ETI System Pipeline
- Infiltration Trench
- MMR Boundary
- Within Capture Zone — Model-Predicted Capture Zone - 2002 Zoom Model [AFCEE 2007b].
- Outside Capture Zone North of Rt. 151
- Outside of Capture Zone South of Rt. 151
- 2007 Plume Contour - AFCEE (TCE, PCE MCL = 5.0 µg/L)

N

0 900 1,800 Feet

Scale 1:21,600

JACOBS™

Ashumet Valley Plume Source Area and Ashumet Valley Plume

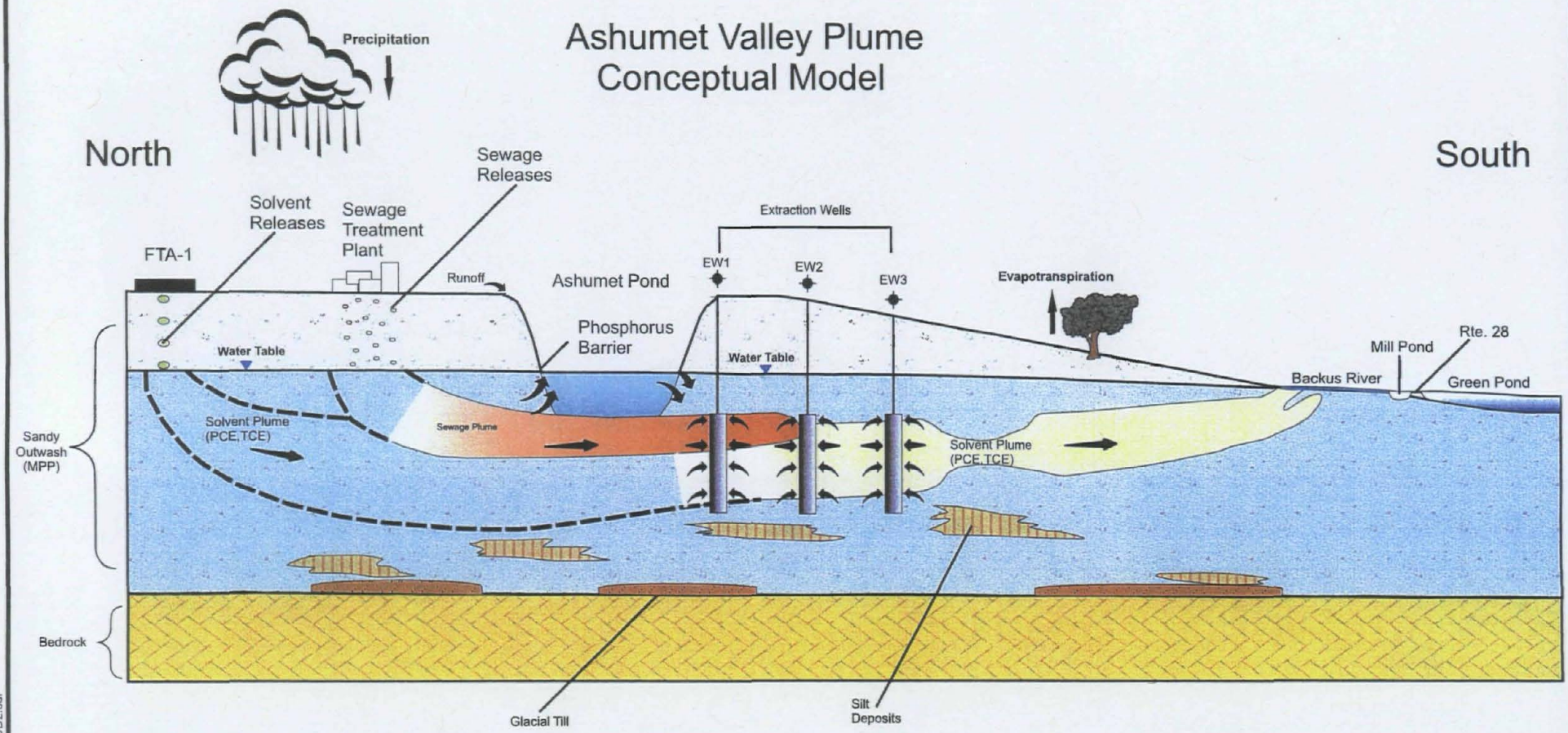
Massachusetts Military Reservation
Cape Cod, Massachusetts

NAME: jpiccullo DATE: 3/25/2009

Figure 2-3

Y:\GIS\projects\35BC02\VA\20090325\ArcGIS\Ashumet_GW_4ROD.mxd

Ashumet Valley Plume Conceptual Model



Legend

- Extraction Well
- Plume Depiction
- Historic Plume Depiction

PCE = Tetrachloroethene
TCE = Trichloroethene
FTA-1 = Fire Training Area
STP = Sewage Treatment Plant

MPP = Mashpee Pitted Plain

Vertical Exaggeration (not to scale)

JACOBS™

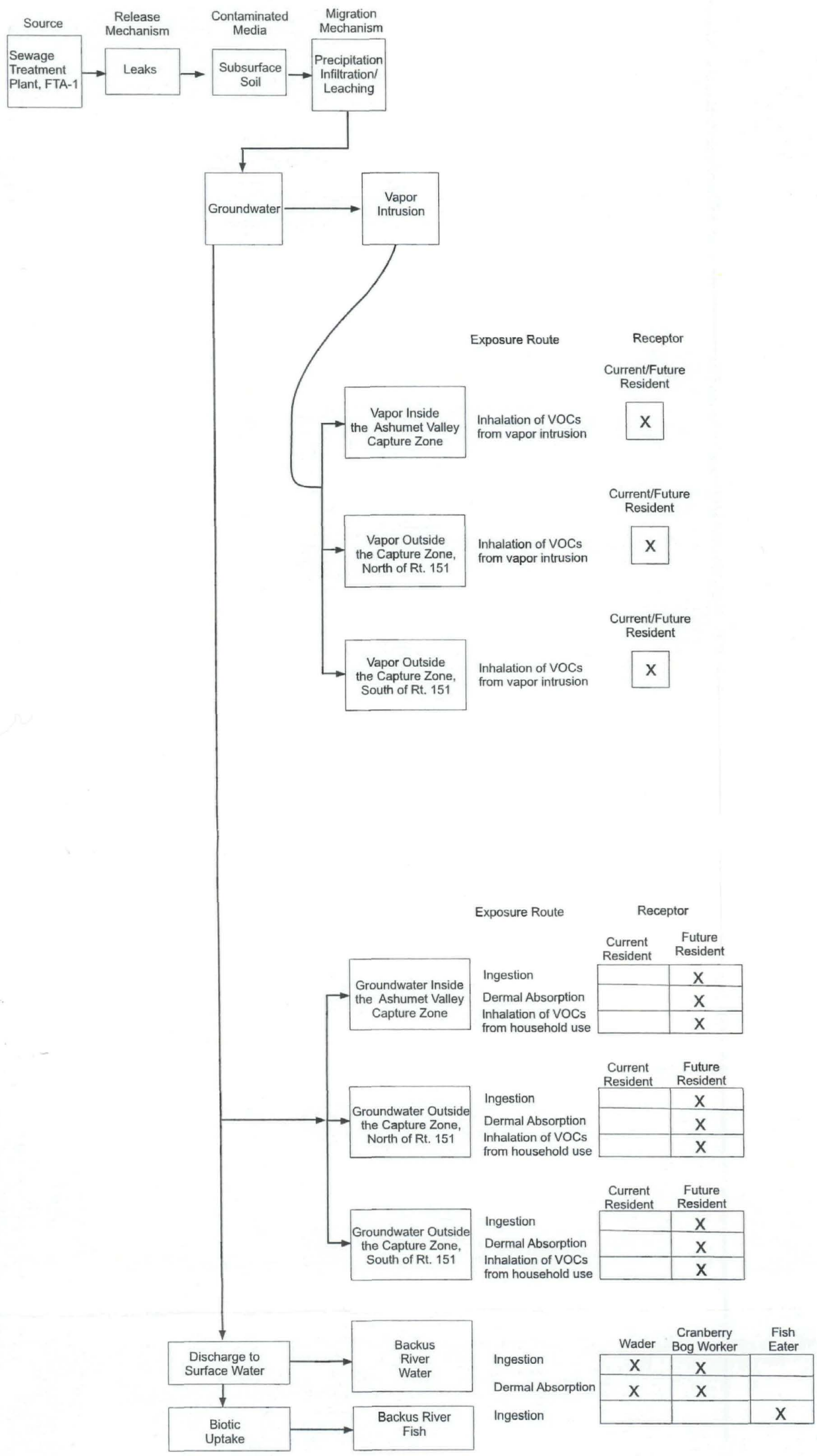
Ashumet Valley Plume Conceptual Model

Massachusetts Military Reservation
Cape Cod, Massachusetts

9/17/08 JP

Figure 2-4

Y:\projects\35BC02\VA\20080917\Corel\concep_ash_4ROD2.cdr



Legend

VOC volatile organic compound

FTA-1 Fire Training Area- 1

JACOBS™

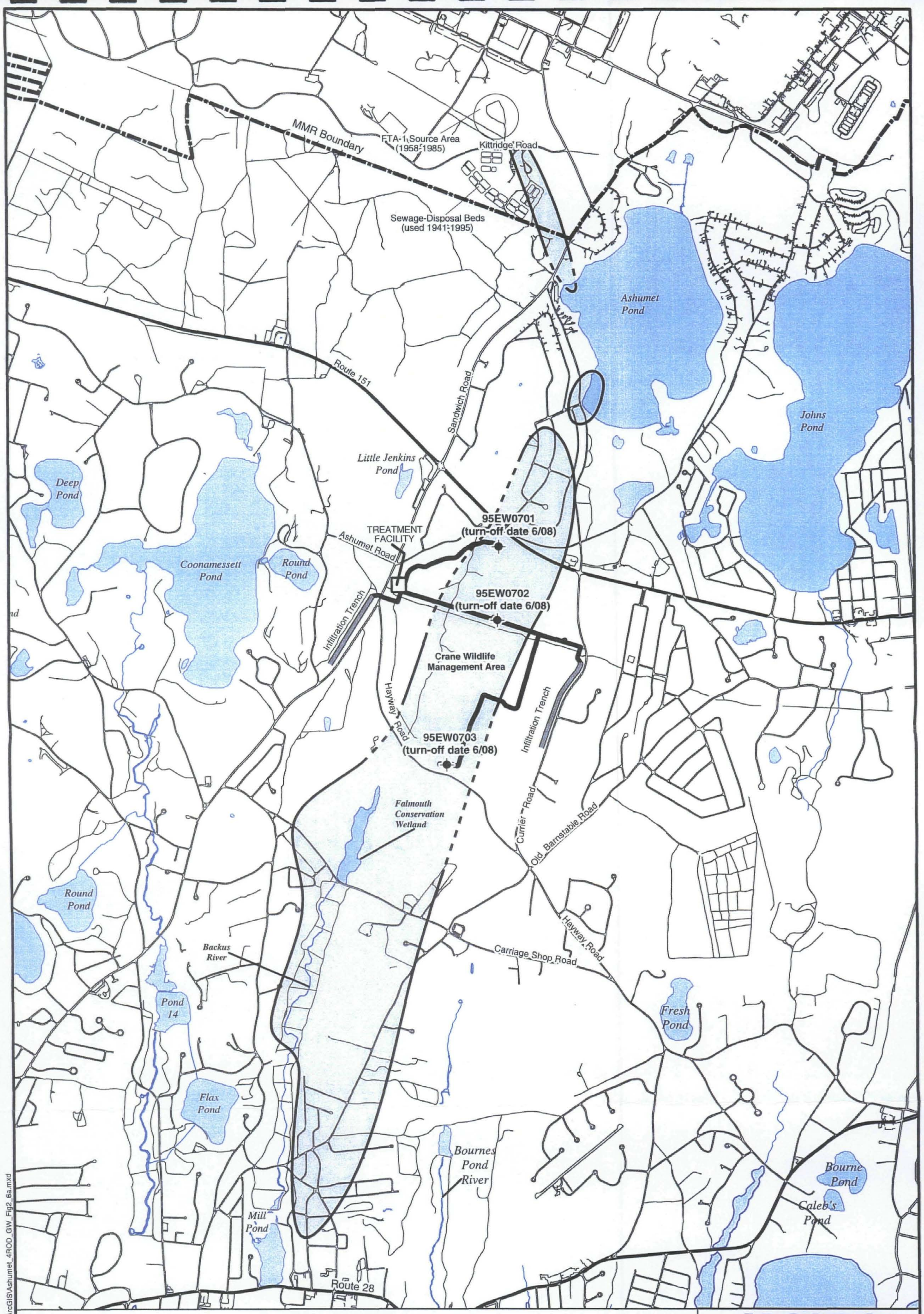
Human Health
Conceptual Exposure Model
Ashumet Valley

Massachusetts Military Reservation
Cape Cod, Massachusetts

9/17/08 JP File...ASH_4ROD_CEM_3a.cdr

Figure 2-5

Y:\projects\35BC02\VA\20080917\Corel\ASH_4ROD_CEM_3a.cdr



Data Source: AFCEE (2006b), Ashumet Valley 2005 Letter Report

Legend

- Extraction Well
- ETI System Pipeline
- Infiltration Trench
- MMR Boundary
- 2006 Plume Contour - AFCEE (Dashed Where Inferred) (TCE, PCE MCL = 5.0 µg/L)

N

0 900 1,800 Feet

Scale 1:21,600

JACOBS™

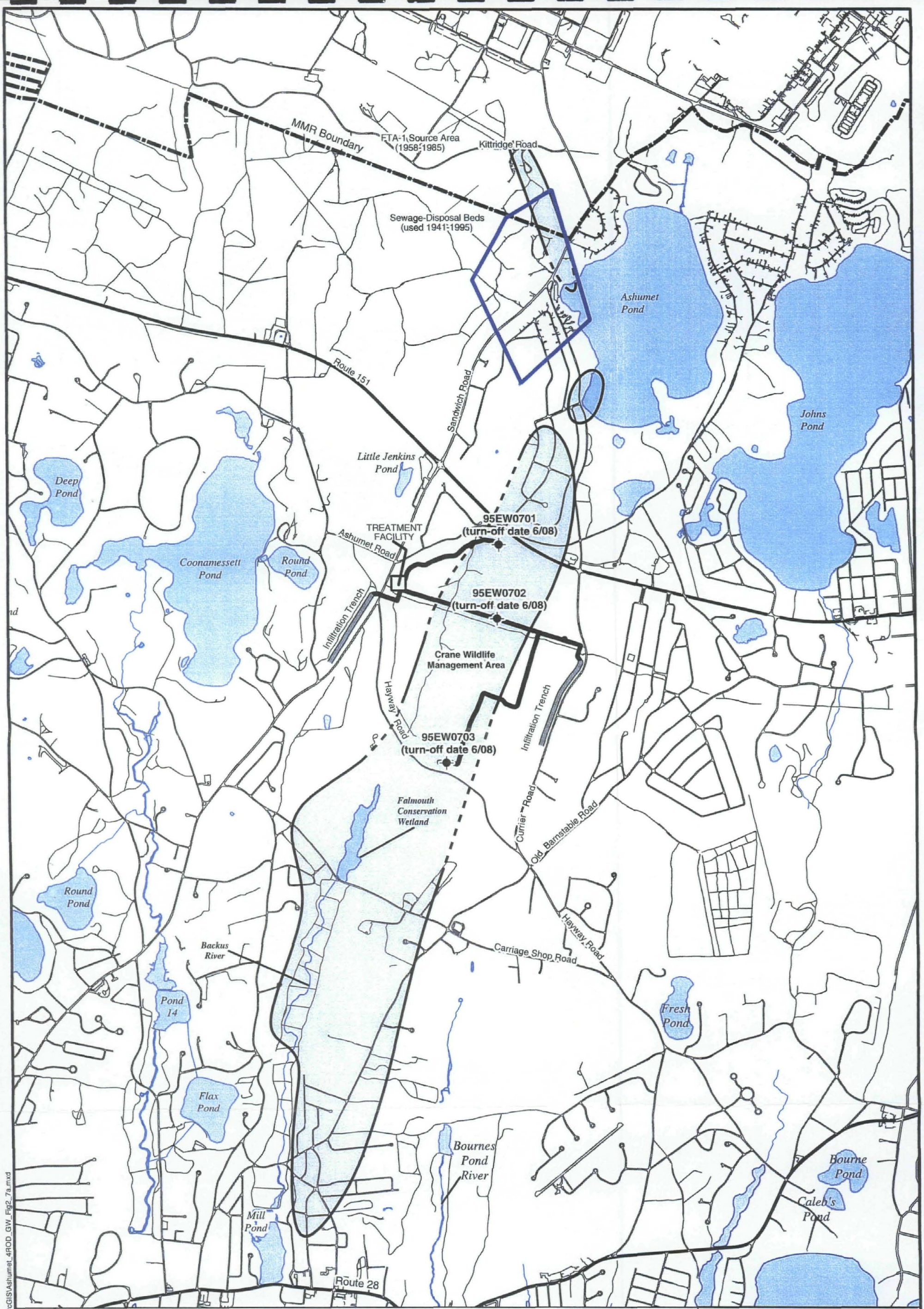
Ashumet Valley Groundwater
Alternative 1 - No Action

Massachusetts Military Reservation
Cape Cod, Massachusetts

NAME: jpiccuito DATE: 9/17/2008

Figure 2-6

Y:\GIS\projects\35BC02\VA\20080917\ArcGIS\Ashumet_4ROD_GW_Fig2_6a.mxd



Data Source: AFCEE (2006b), Ashumet Valley 2005 Letter Report

Legend

- Extraction Well
- ETI System Pipeline
- Infiltration Trench
- MMR Boundary
- 2006 Plume Contour - AFCEE (Dashed Where Inferred) (TCE, PCE MCL = 5.0 µg/L)
- Area of Interest for Manganese and Thallium in Groundwater. Based on Final Risk Assessment for Ashumet Valley (Appendix A of Final Ashumet Valley Groundwater Feasibility Study, AFCEE 2007a).

N

0 900 1,800 Feet

Scale 1:21,600

JACOBS™

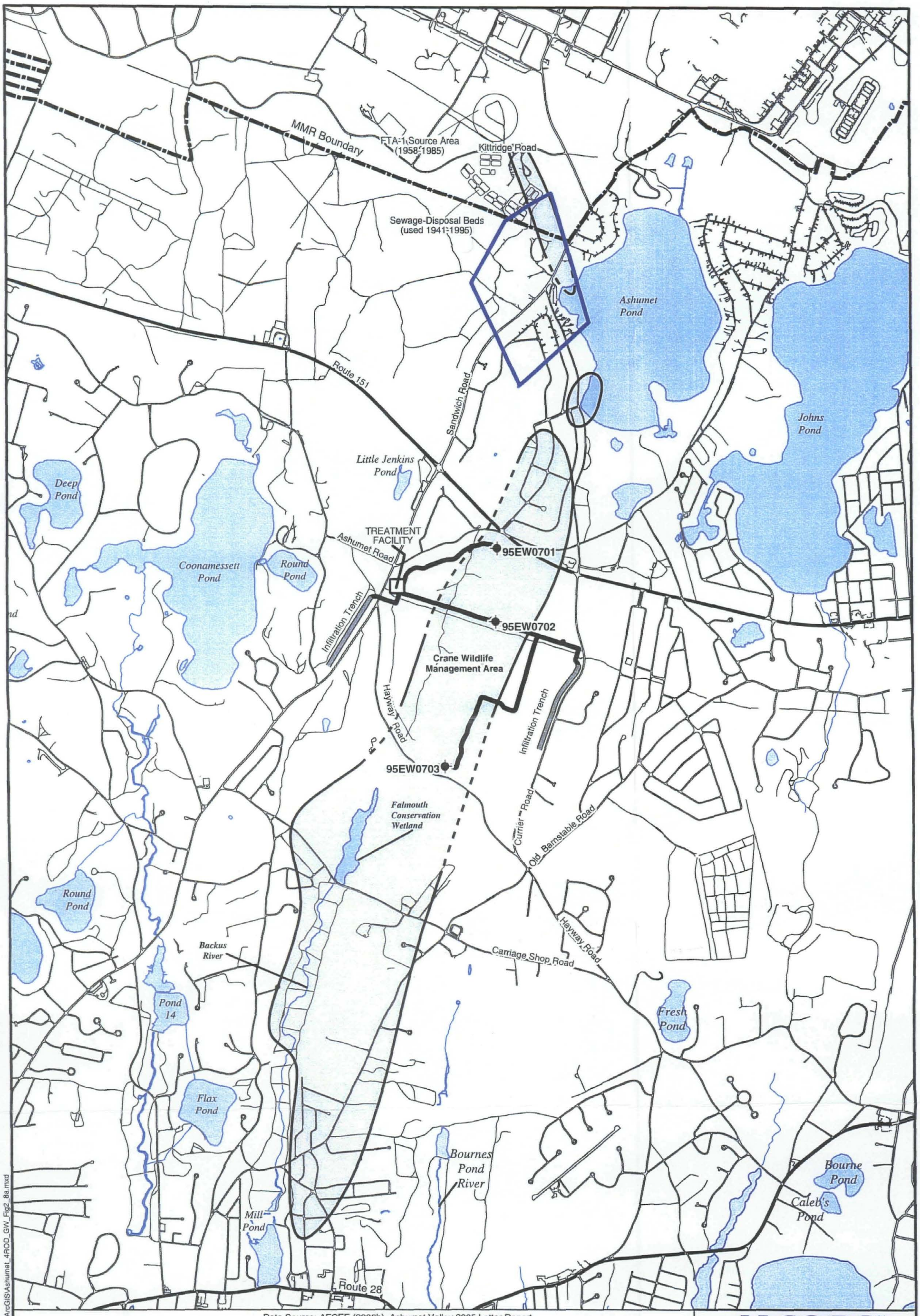
Ashumet Valley Groundwater Alternative 2 - Long-Term Monitoring with Land Use Controls

Massachusetts Military Reservation
Cape Cod, Massachusetts

NAME: jpiccullo DATE: 9/17/2008

Figure 2-7

Y:\GIS\projects\35BC02\VA\20080917\ArcGIS\Ashumet_4ROD_GW_Fig2_7a.mxd



Data Source: AFCEE (2006b), Ashumet Valley 2005 Letter Report

Legend

- Extraction Well
- ETI System Pipeline
- Infiltration Trench
- MMR Boundary
- 2006 Plume Contour - AFCEE (Dashed Where Inferred) (TCE, PCE MCL = 5.0 µg/L)
- Area of Interest for Manganese and Thallium in Groundwater. Based on Final Risk Assessment for Ashumet Valley (Appendix A of Final Ashumet Valley Groundwater Feasibility Study, AFCEE 2007a).

N

0 900 1,800 Feet

Scale 1:21,600

JACOBS™

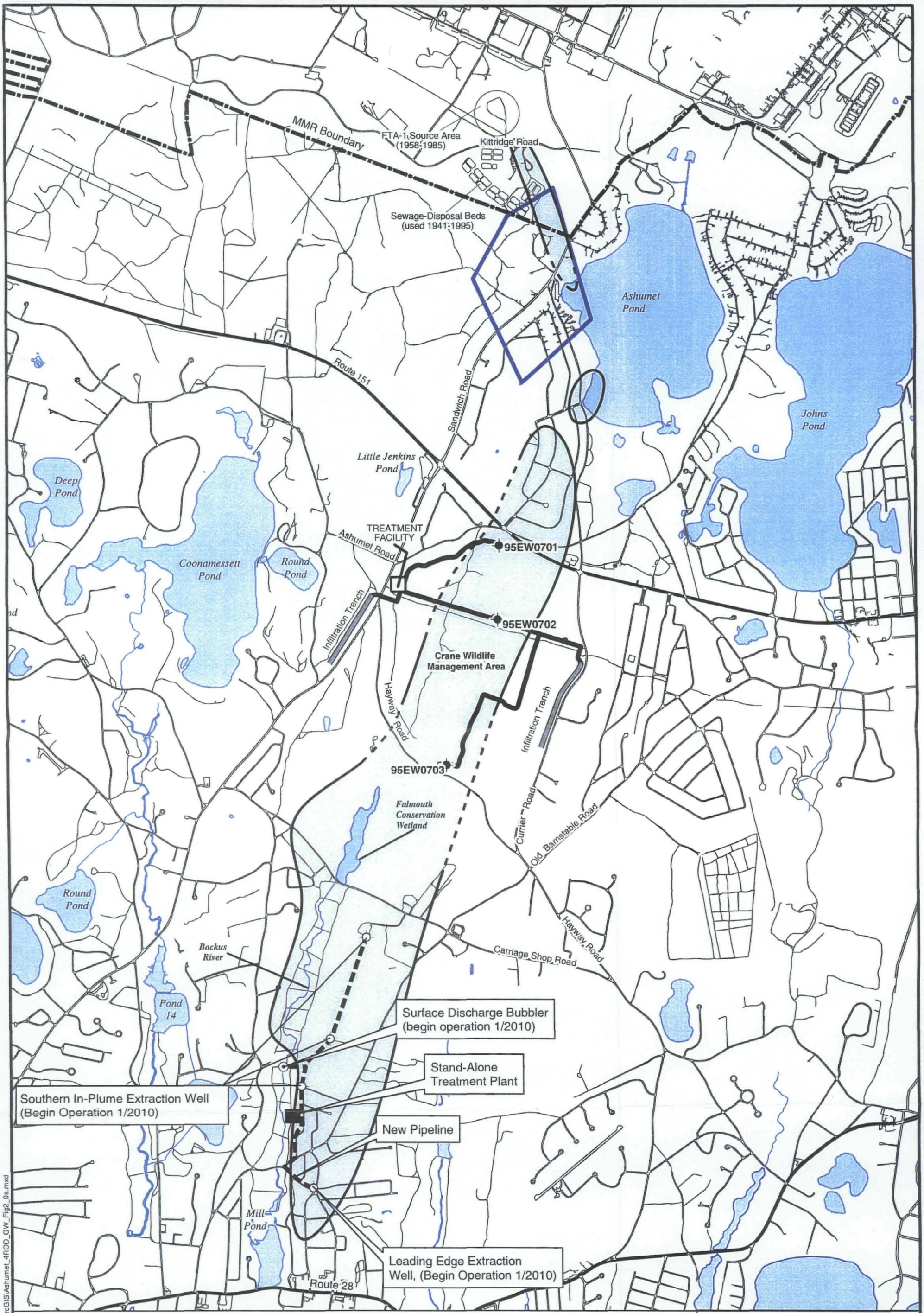
Ashumet Valley Groundwater Alternative 3 Conceptual Design

Massachusetts Military Reservation
Cape Cod, Massachusetts

NAME: jpiccullo DATE: 9/17/2008

Figure 2-8

Y:\GIS\projects\35BC02\VA\20080917\ArcGIS\Ashumet_4ROD_GW_Fig2_8a.mxd



Legend

Data Source: AFCEE (2006b), Ashumet Valley 2005 Letter Report

- Extraction Well
- Proposed Extraction Well
- Surface Discharge - Bubbler
- MMR Boundary
- 2006 Plume Contour - AFCEE (Dashed Where Inferred) (TCE, PCE MCL = 5.0 µg/L)
- Area of Interest for Manganese and Thallium in Groundwater. Based on Final Risk Assessment for Ashumet Valley (Appendix A of Final Ashumet Valley Groundwater Feasibility Study, AFCEE 2007a).
- ETI System Pipeline
- New Pipeline
- Infiltration Trench

N

0 900 1,800 Feet

Scale 1:21,600

JACOBS™

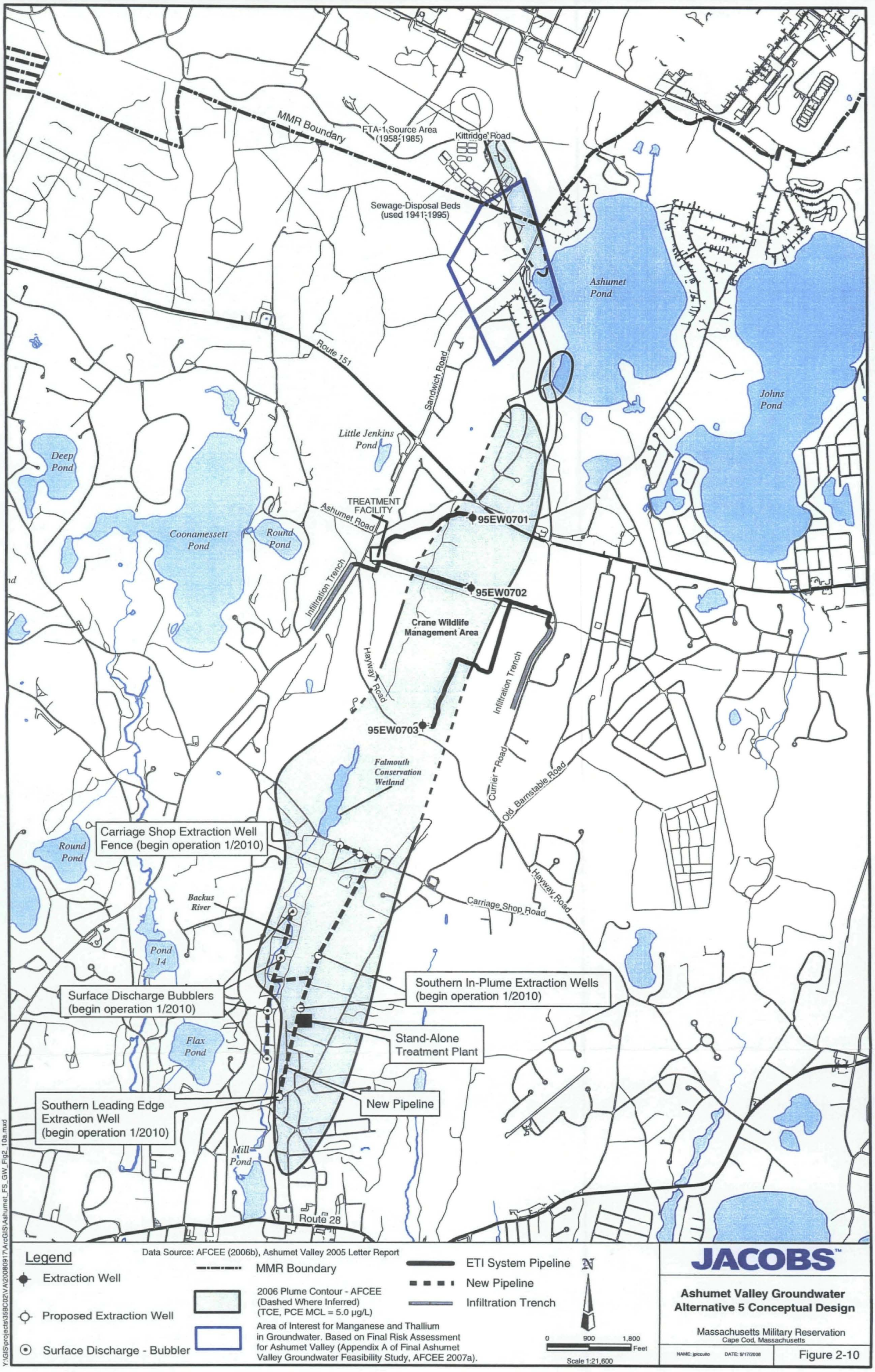
Ashumet Valley Groundwater Alternative 4 Conceptual Design

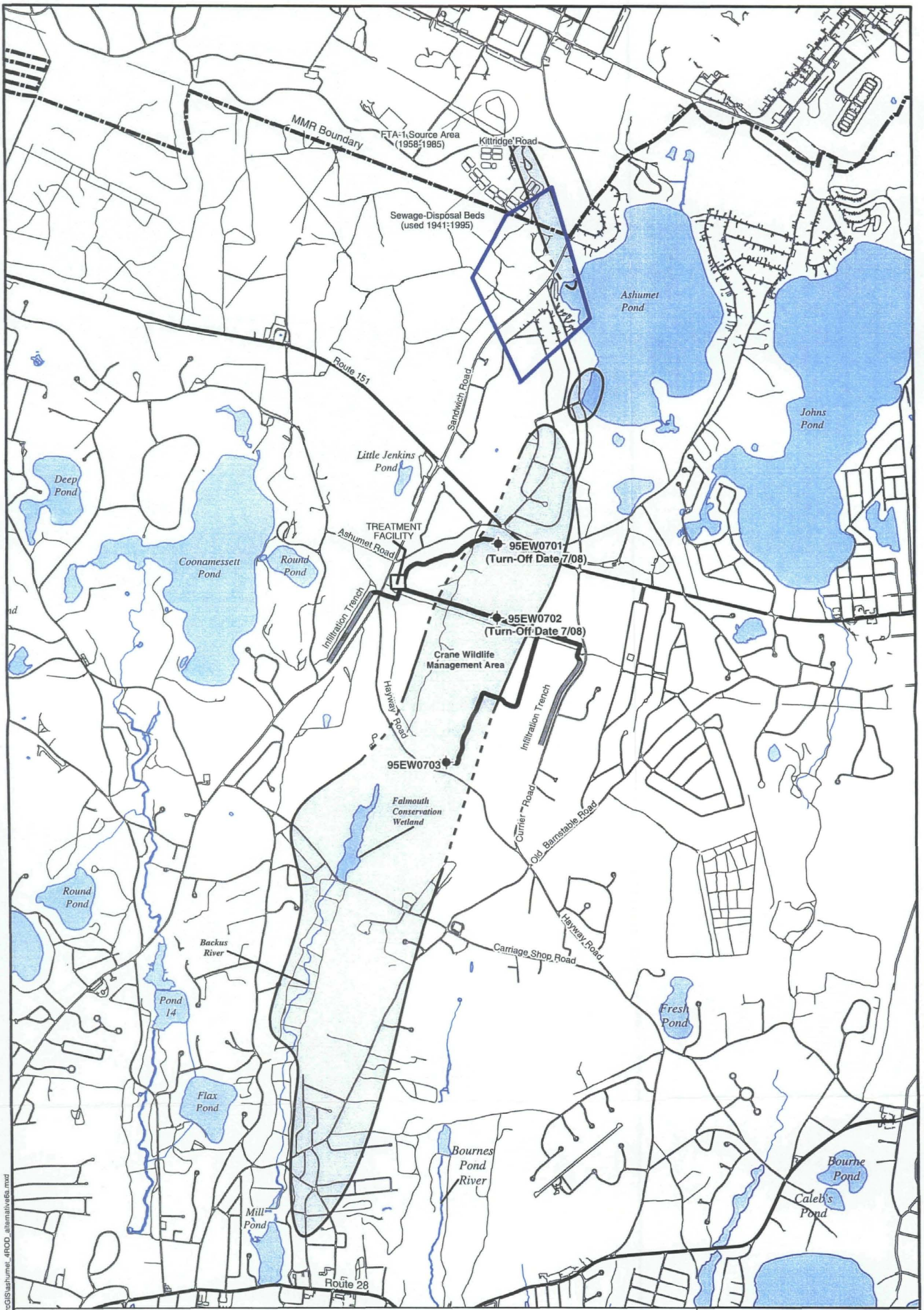
Massachusetts Military Reservation
Cape Cod, Massachusetts

NAME: jpiccuito DATE: 9/17/2008

Figure 2-9

Y:\GIS\projects\35BC02\VA\20080917\ArcGIS\Ashumet_4ROD_GW_Fig2_9a.mxd


MMR Boundary
FTA-1 Source Area
(1958-1985)
Kittridge Road
Sewage-Disposal Beds
(used 1941-1995)
Ashumet
Pond
Johns
Pond
Route 151
Sandwich Road
Little Jenkins
Pond
Deep
Pond
TREATMENT
FACILITY
Ashumet Road
95EW0701
Coonamessett
Pond
Round
Pond
Infiltration Trench
95EW0702
Crane Wildlife
Management Area
Hayway Road
Infiltration Trench
95EW0703
Falmouth
Conservation
Wetland
Currier Road
Old Barnstable Road
Carriage Shop Extraction Well
Fence (begin operation 1/2010)
Round
Pond
Hayway Road
Backus
River
Carriage Shop Road
Pond
14
Southern In-Plume Extraction Wells
(begin operation 1/2010)
Surface Discharge Bubblers
(begin operation 1/2010)
Flax
Pond
Stand-Alone
Treatment Plant
Southern Leading Edge
Extraction Well
(begin operation 1/2010)
New Pipeline
Mill
Pond
Route 28
Legend
Extraction Well
Proposed Extraction Well
Surface Discharge - Bubbler
Data Source: AFCEE (2006b), Ashumet Valley 2005 Letter Report
MMR Boundary
2006 Plume Contour - AFCEE
(Dashed Where Inferred)
(TCE, PCE MCL = 5.0 µg/L)
Area of Interest for Manganese and Thallium
in Groundwater. Based on Final Risk Assessment
for Ashumet Valley (Appendix A of Final Ashumet
Valley Groundwater Feasibility Study, AFCEE 2007a).
ETI System Pipeline
New Pipeline
Infiltration Trench
N
0
900
1,800
Feet
Scale 1:21,600
JACOBS™
Ashumet Valley Groundwater
Alternative 5 Conceptual Design
Massachusetts Military Reservation
Cape Cod, Massachusetts
NAME: jpiccuito
DATE: 9/17/2008
Figure 2-10
Y:\GIS\projects\35BC02\VA\20080917\ArcGIS\Ashumet_FS_GW_Fig2_10a.mxd



Data Source: AFCEE (2006b), Ashumet Valley 2005 Letter Report

Legend

- Extraction Well
- ETI System Pipeline
- Infiltration Trench
- MMR Boundary
- 2006 Plume Contour - AFCEE (Dashed Where Inferred) (TCE, PCE MCL = 5.0 µg/L)
- Area of Interest for Manganese and Thallium in Groundwater. Based on Final Risk Assessment for Ashumet Valley (Appendix A of Final Ashumet Valley Groundwater Feasibility Study, AFCEE 2007a).

N

0 900 1,800 Feet

Scale 1:21,600

JACOBS™

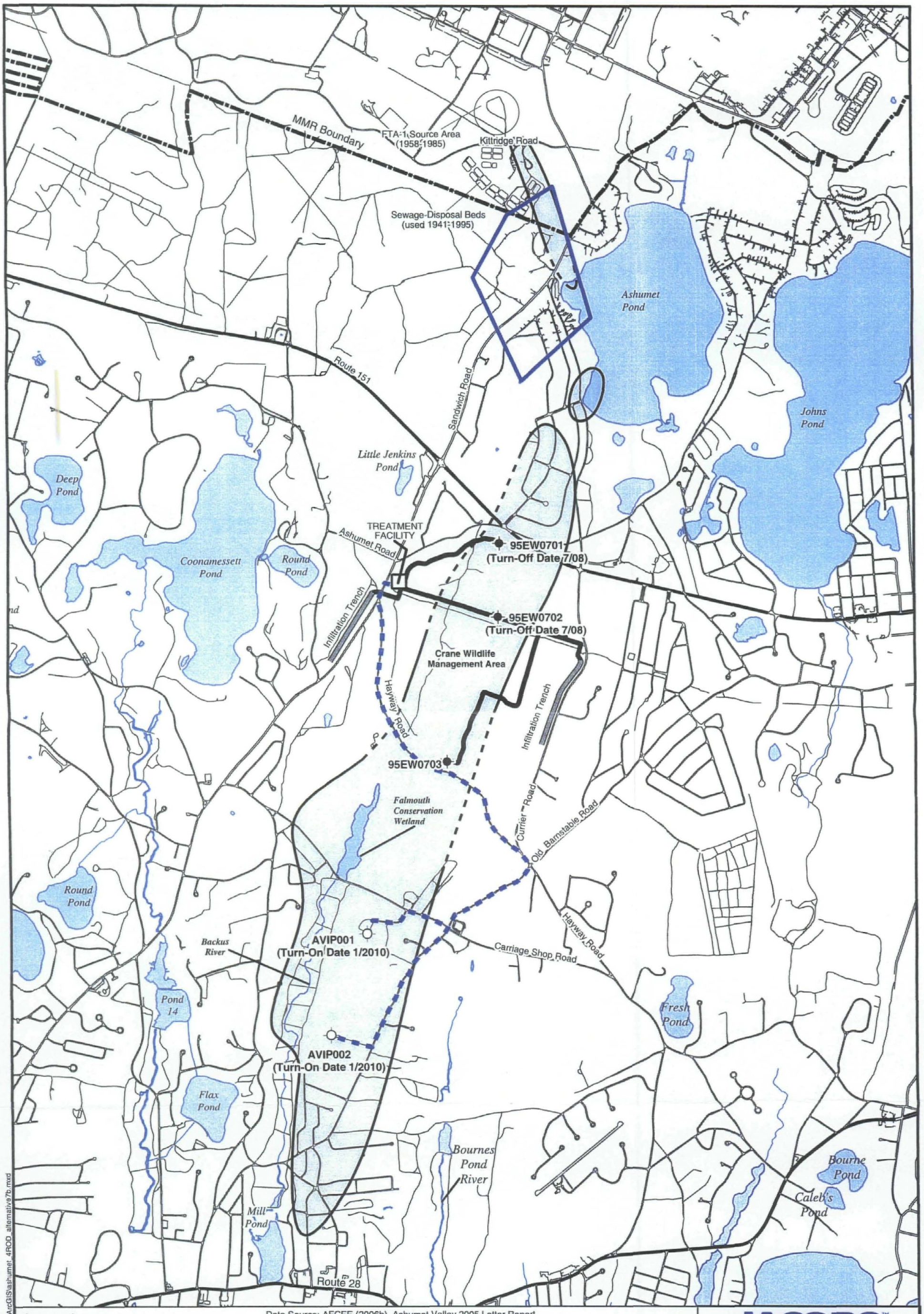
Ashumet Valley Groundwater Alternative 6 Conceptual Design

Massachusetts Military Reservation
Cape Cod, Massachusetts

NAME: jpiccullo DATE: 9/17/2008

Figure 2-11

Y:\GIS\projects\35BC02\VA\20080917\ArcGIS\ashumet_4ROD_alternative6a.mxd



Legend

- Extraction Well
- Proposed Extraction Well
- ETI System Pipeline
- Proposed ETI System Pipeline
- Infiltration Trench
- MMR Boundary
- 2006 Plume Contour - AFCEE (Dashed Where Inferred) (TCE, PCE MCL = 5.0 µg/L)
- Area of Interest for Manganese and Thallium in Groundwater. Based on Final Risk Assessment for Ashumet Valley (Appendix A of Final Ashumet Valley Groundwater Feasibility Study, AFCEE 2007a).

Data Source: AFCEE (2006b), Ashumet Valley 2005 Letter Report

N

0 900 1,800 Feet

Scale 1:21,600

JACOBS™

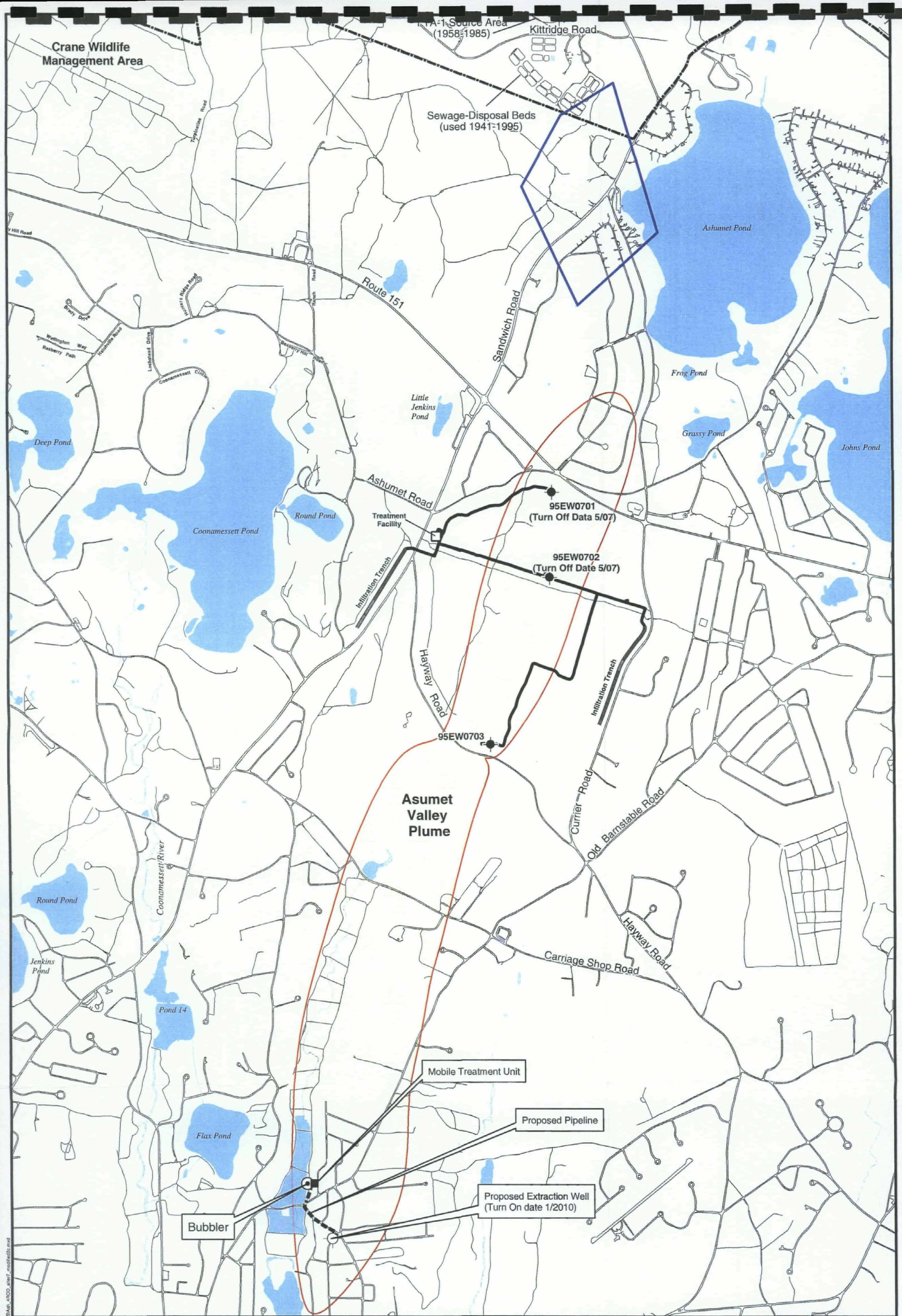
Ashumet Valley Groundwater Alternative 7 Conceptual Design

Massachusetts Military Reservation
Cape Cod, Massachusetts

NAME: jpiccuito DATE: 9/24/2007

Figure 2-12

Y:\GIS\projects\35BC02\VA\20080924\ArcGIS\ashumet_4ROD_alternative7b.mxd



Legend

- Extraction Well
- Proposed Extraction Well
- Surface Discharge - Bubbler
- 2007 Ashumet Valley Plume Boundary (TCE, PCE MCL = 5.0 µg/L)
- Area of Interest for Manganese and Thallium in Groundwater. Based on Final Risk Assessment for Ashumet Valley (Appendix A of Final Ashumet Valley Groundwater Feasibility Study, AFCEE 2007a).
- ETI System Pipeline
- New Pipeline
- Infiltration Trench

Data Source: AFCEE (2008), Ashumet Valley 2007 Letter Report

N

0 750 1,500 Feet

1: 18,000

JACOBS™

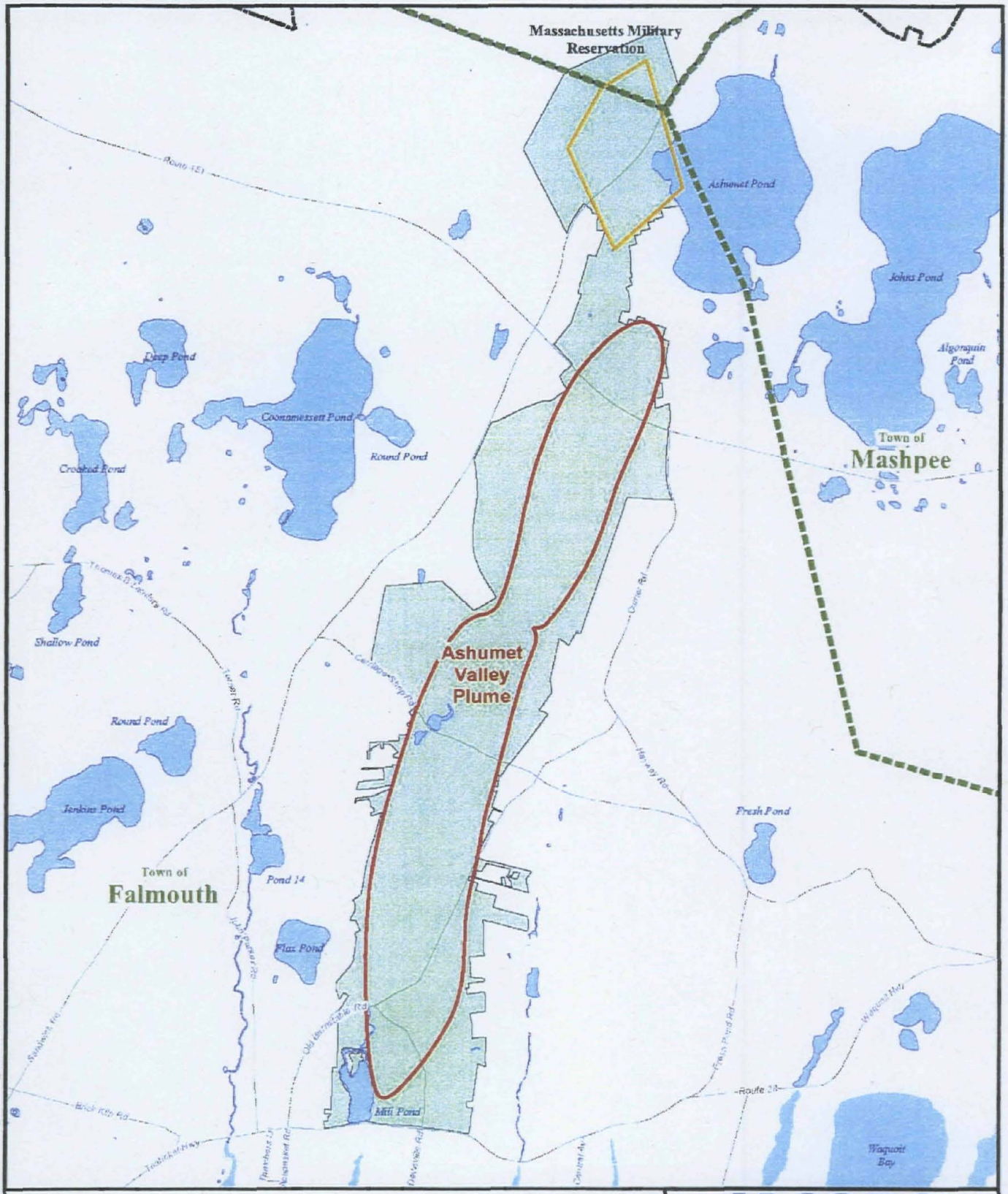
Ashumet Valley Groundwater Alternative 7 Modified Conceptual Design

Massachusetts Military Reservation
Cape Cod, Massachusetts

NAME: jpiccuito DATE: 6/16/2008

Figure 2-13

Y:\GIS\projects\35BC02\VB\20090516\ArcGIS\Alt_4ROD_alter7_modified2c.mxd



Legend

- Plume Boundary
- Town Boundary
- Ashumet Valley Plume Land Use Control Area
- Area of Inorganic Compounds

Data Source: AFCEE, MMR-AFCEE Data Warehouse

N

0 1,500 3,000 Feet

JACOBS™

Ashumet Valley Plume
Land Use Control Area

Massachusetts Military Reservation
Cape Cod, Massachusetts

NAME: jpicuito DATE: 1/26/2009

Figure 2-14

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TABLES

Table 2-1
Occurence, Distribution, and Selection of Chemicals of Potential Concern
Ashumet Valley Groundwater Within the Capture Zone

Scenario Timeframe: current/future
Medium: groundwater
Exposure Medium: groundwater

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifer) (1)	Maximum Concentration (Qualifier) (1)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (N/C) (4)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (5)
Ashumet Valley Within the Capture Zone	79-34-5	1,1,1-Trichloroethane	0.37(J)	0.5(J)	µg/L	30MW0584B	3/61	0.196 - 0.528	0.5(J)		320 N	2	MGW-1	N	BSL, IFD
	75-34-2	1,1-Dichloroethane	0.24(J)	2	µg/L	95MW1174A	16/61	0.133 - 0.156	2		81 N	70	ORSG	N	BSL
	75-34-4	1,1-Dichloroethene	0.25(J)	0.4(J)	µg/L	95MW0212A	2/61	0.226 - 0.258	0.4(J)		34 N	7	MCL	N	BSL, IFD
	71-43-2	Benzene	0.17(J)	0.24(J)	µg/L	30MW0585A	2/61	0.131 - 0.216	0.24(J)		0.34 C	5	MCL	N	BSL, IFD
	67-66-3	Chloroform	0.2(J)	1.86	µg/L	95MW1173B	16/61	0.105 - 0.336	1.86		6.2 C/N	80	MCL	N	BSL
	156-59-2	cis-1,2-Dichloroethene	0.23(J)	82.6	µg/L	95MW0211A	29/61	0.144 - 0.347	82.6		6.1 N	70	MCL	Y	ASL
	156-60-5	trans-1,2-Dichloroethene	0.24(J)	0.47(J)	µg/L	95MW0211A	4/61	0.197 - 0.304	0.47(J)		12 N	100	MCL	N	BSL
	1634-04-4	tert-butyl-Methyl-Ether	0.41(J)	1.1	µg/L	30MW0584C	2/61	0.196 - 0.42	1.1		13 C	70	ORSG	N	BSL, IFD
	127-18-4	Tetrachloroethene (PCE)	0.18(J)	21.2	µg/L	95MW1172A	32/61	0.137 - 1	21.2		0.66 C	5	MCL	Y	ASL
	79-01-6	Trichloroethene (TCE)	0.24(J)	44	µg/L	30MW0584B	36/61	0.138 - 0.241	44		0.028 C	5	MCL	Y	ASL
	117-81-7	bis (2-ethylhexyl) phthalate	2(J)	2(J)	µg/L	30MW0583A	2/6	0.8 - 1	2(J)		4.8 C	6	MCL	N	BSL
	7429-90-5	Aluminum (dissolved)	14(J)	235(J)	µg/L	95MW0211B	3/34	7.4 - 105	235(J)		3600 N	50 to 200	SMCL	N	BSL
	7429-90-5	Aluminum (total)	24(J)	146	µg/L	USFW422065	5/14	18 - 88	146		3600 N	50 to 200	SMCL	N	BSL
	7440-36-0	Antimony (dissolved)	2.05(J)	2.05(J)	µg/L	USFW460080	1/34	1.8 - 3.2	2.05(J)		1.5 N	6	MCL	N	IFD
	7440-38-2	Arsenic (dissolved)	2.29	3.11	µg/L	95MW0212A	3/34	1.3 - 2.7	3.11		0.045 C	10	MCL	Y	ASL
	7440-38-2	Arsenic (total)	3.5(J)	3.5(J)	µg/L	03MW2623A	1/14	1.7 - 3.5	3.5(J)		0.045 C	10	MCL	Y	ASL
	7440-39-3	Barium (dissolved)	3.66(J)	114	µg/L	USFW422065	33/34	0.2 - 0.3	114		260 N	2000	MCL	N	BSL
	7440-39-3	Barium (total)	4.5(J)	110	µg/L	USFW422065	1/14	0.2 - 0.3	110		260 N	2000	MCL	N	BSL
	7440-42-8	Boron (dissolved)	41.4(J)	400	µg/L	USFW422085	33/40	1 - 83.8	400		730 N	600	HA	N	BSL
	7440-42-8	Boron (total)	39.9(J)	392	µg/L	USFW422085	16/23	1 - 75.8	392		730 N	600	HA	N	BSL
	7440-43-9	Cadmium (dissolved)	0.3(J)	1.7	µg/L	USFW262109	6/34	0.18 - 0.34	1.7		1.8 N	5	MCL	N	BSL
	7440-70-2	Calcium (dissolved)	586	15100	µg/L	USFW422065	34/34	4.6 - 18.7	15100		NA	NA	NA	N	NUT, NSL
	7440-70-2	Calcium (total)	1480	15700	µg/L	USFW422065	14/14	5.7 - 17.7	15700		NA	NA	NA	N	NUT, NSL
	7440-47-3	Chromium (dissolved)	0.81(J)	4.9(J)	µg/L	30MW0588	5/34	0.55 - 0.8	4.9(J)		11 N	100	MCL	N	BSL
	7440-47-3	Chromium (total)	0.86(J)	0.86(J)	µg/L	USFW422045	2/14	0.55 - 1.4	0.86(J)		11 N	100	MCL	N	BSL
	7440-48-4	Cobalt (dissolved)	0.69(J)	13	µg/L	95MW0212A	24/34	0.4 - 2.2	13		73 N	NA	NA	N	BSL
	7440-48-4	Cobalt (total)	0.94(J)	12.5	µg/L	USFW422105	9/14	0.6 - 2.5	12.5		73 N	NA	NA	N	BSL
	7440-50-8	Copper (total)	14.2	18.3	µg/L	30MW0589	2/14	0.76 - 10.9	18.3		150 N	1000	SMCL	N	BSL
	7439-89-6	Iron (dissolved)	13.2(J)	6100	µg/L	95MW0212B	13/38	12.5 - 239	6100		1100 N	300	SMCL	N	NUT
	7439-89-6	Iron (total)	28.9(J)	5700	µg/L	03MW2623A	5/19	13.7 - 165	5700		1100 N	300	SMCL	N	NUT

Table 2-1
Occurence, Distribution, and Selection of Chemicals of Potential Concern
Ashumet Valley Groundwater Within the Capture Zone

Scenario Timeframe: current/future
Medium: groundwater
Exposure Medium: groundwater

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifer) (1)	Maximum Concentration (Qualifier) (1)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (N/C) (4)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (5)
	7439-92-1	Lead (dissolved)	1.3(J)	3.16	µg/L	USFW357079	5/34	1.1 - 2.85	3.16		NA	15	AL	N	BAL
	7439-92-1	Lead (total)	1.5(J)	1.5(J)	µg/L	USFW422085	1/14	1.1 - 1.4	1.5(J)		NA	15	AL	N	BAL
	7439-95-4	Magnesium (dissolved)	503	6640	µg/L	USFW422065	34/34	4.8 - 25.2	6640		NA	NA	NA	N	NUT, NSL
	7439-95-4	Magnesium (total)	1180	6900	µg/L	USFW422065	14/14	15.1 - 25.2	6900		NA	NA	NA	N	NUT, NSL
	7439-96-5	Manganese (dissolved)	4.79(J)	5710	µg/L	USFW422105	38/38	0.21 - 0.42	5710		88 N	50	SMCL	Y	ASL
	7439-96-5	Manganese (total)	12.8	5630	µg/L	USFW422105	17/19	0.21 - 2.66	5630		88 N	50	SMCL	Y	ASL
	7440-02-0	Nickel (dissolved)	0.67(J)	9.09(J)	µg/L	USFW254072	22/34	0.6 - 4.2	9.09(J)		73 N	100	ORSG	N	BSL
	7440-02-0	Nickel (total)	1.3(J)	5.8(J)	µg/L	USFW422085	6/14	1 - 4.9	5.8(J)		73 N	100	ORSG	N	BSL
	7440-09-7	Potassium (dissolved)	580(J)	8920	µg/L	USFW422065	32/34	20.4 - 2870	8920		NA	NA	NA	N	NUT, NSL
	7440-09-7	Potassium (total)	921(J)	8870	µg/L	USFW422065	2/14	26.5 - 2710	8870		NA	NA	NA	N	NUT, NSL
	7440-22-4	Silver (dissolved)	1.72(J)	1.85(J)	µg/L	USFW373061	2/34	0.7 - 0.89	1.85(J)		18 N	100	SMCL	N	BSL
	7440-23-5	Sodium (dissolved)	3410	50500	µg/L	USFW422065	34/34	22.9 - 276	50500		NA	20000	ORSG	N	CC, NSL
	7440-23-5	Sodium (total)	8960	53300	µg/L	USFW422065	14/14	22.9 - 115	53300		NA	20000	ORSG	N	CC, NSL
	7440-28-0	Thallium (dissolved)	2.8(J)	2.8(J)	µg/L	USFW422085	1/34	1.1 - 7.6	2.8(J)		0.24 N	2	MCL	N	IFD
	7440-28-0	Thallium (total)	4.6(J)	4.6(J)	µg/L	USFW422085	1/14	2.7 - 9	4.6(J)		0.24 N	2	MCL	Y	ASL
	7440-66-6	Zinc (dissolved)	2.52(J)	826	µg/L	USFW357079	9/34	0.4 - 21.6	826		1100 N	5000	SMCL	N	BSL
	7440-66-6	Zinc (total)	30.9	30.9	µg/L	USFW422045	1/14	1.4 - 16.1	30.9		1100 N	5000	SMCL	N	BSL

Data Source: AFCEE, 6 April 2004, AFCEE-MMR Data Warehouse.

Footnotes:
(1) Maximum/minimum detected concentration
(2) Maximum detected concentration
(3) N/A - Refer to Table 3-3 of text for information on background.
(4) N = one-tenth of the EPA Region IX PRG based on non-carcinogenic effects
C = EPA Region IX PRG based on carcinogenic effects (at a risk of 1E-06)
(5) Rationale Codes:
Common Cation (CC)
Above Screening Level (ASL)
Below Action Level (BAL)
Below Screening Level (BSL)
Infrequent Detection (IFD)
Essential Nutrient (NUT)
No Screening Level (NSL)

Definitions:
AL = Action Level
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
C = Carcinogenic
CAS = Chemical Abstract Service
COPC = Chemical of Potential Concern
EPA = U.S. Environmental Protection Agency
J = estimated value
HA = Health Advisory
MCL = Federal Maximum Contaminant Level
MGW-1 = Massachusetts Groundwater 1 standard
N = Non-Carcinogenic
NA = Not Available
ORSG = Office of Research and Standards Guidelines
PRG = preliminary remediation goal
SMCL = Secondary Maximum Contaminant Level
µg/L = micrograms per liter

Table 2-2
Occurence, Distribution, and Selection of Chemicals of Potential Concern
Ashumet Valley Groundwater Outside the Capture Zone North of Route 151

Scenario Timeframe: current/future
Medium: groundwater
Exposure Medium: groundwater

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier) (1)	Maximum Concentration (Qualifier) (1)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (N/C) (4)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (5)
Ashumet Valley Outside the Capture Zone North of Route 151	75-34-2	1,1-Dichloroethane	0.38(J)	0.94(J)	µg/L	30MW0582D	3/48	0.104-0.156	0.94(J)		81 N	70	ORSG	N	BSL
	95-50-1	1,2-Dichlorobenzene	0.22(J)	1.2	µg/L	USFW347046	4/48	0.08-0.305	1.2		37 N	600	MCL	N	BSL
	541-73-1	1,3-Dichlorobenzene	0.23(J)	0.87(J)	µg/L	30MW0426B	3/48	0.135-0.229	0.87(J)		0.55 N			Y	ASL
	106-46-7	1,4-Dichlorobenzene	0.88(J)	5.4	µg/L	USFW347046	5/48	0.147-0.38	5.4		0.5 C	5	MMCL	Y	ASL
	71-43-2	Benzene	0.47(J)	1.5	µg/L	USFW347046	3/48	0.131-0.223	1.5		0.34 C	5	MCL	Y	ASL
	67-66-3	Chloroform	0.28(J)	8.57	µg/L	30MW0431	22/48	0.091-0.336	8.57		6.2 C/N	80	MCL	Y	ASL
	108-90-7	Chlorobenzene	0.68(J)	1.6	µg/L	USFW347046	3/48	0.115-0.198	1.6		11 N	100	MCL	N	BSL
	74-87-3	Chloromethane	0.27(J)	1.13	µg/L	USSD316082	2/48	0.167-0.486	1.13		1.5 C	30	HA	N	BSL, IFD
	156-59-2	cis-1,2-Dichloroethene	0.25(J)	46	µg/L	30MW0582C	4/48	0.102-0.347	46		6.1 N	70	MCL	Y	ASL
	95-47-6	O-xylene	1.93	1.93	µg/L	30MW0426B	1/48	0.131-0.188	1.93		21 N	10000	MCL	N	BSL, IFD
	156-60-5	trans-1,2-Dichloroethene	0.34(J)	0.34(J)	µg/L	30MW0582C	1/48	0.153-0.304	0.34(J)		12 N	100	MCL	N	BSL, IFD
	127-18-4	Tetrachloroethene (PCE)	0.22(J)	40.8	µg/L	30MW0430	29/48	0.104-0.421	40.8		0.66 C	5	MCL	Y	ASL
	108-88-3	Toluene	0.8(J)	0.8(J)	µg/L	03MW0102B	1/48	0.123-0.271	0.8(J)		72 N	1000	MCL	N	BSL, IFD
	79-01-6	Trichloroethene (TCE)	0.27(J)	9.37	µg/L	03MW0102B	11/48	0.138-0.241	9.37		0.028 C	5	MCL	Y	ASL
	91-57-6	2-Methylnaphthalene*	17	17	µg/L	30MW0417C	1/5	0.57-1	17		0.62 N	140	ORSG	Y	ASL
	106-44-5	4-Methylphenol (p-Cresol)	1.1(J)	1.1(J)	µg/L	30MW0417C	1/5	0.5-1	1.1(J)		18 N			N	BSL
	91-20-3	Naphthalene	50	50	µg/L	30MW0417C	1/5	0.5-1	50		0.62 N	140	ORSG	Y	ASL
	7429-90-5	Aluminum (dissolved)	22.2(J)	181	µg/L	USSD316051	9/41	22.1-49.8	181		3600 N	50 to 200	SMCL	N	BSL
	7429-90-5	Aluminum (total)	23.5(J)	325	µg/L	USFW424020	17/48	22.1-95.5	325		3600 N	50 to 200	SMCL	N	BSL
	7440-36-0	Antimony (total)	6.5	6.5	µg/L	USSD316066	1/48	3.2-3.2	6.5		1.5 N	6	MCL	Y	ASL, IFD
	7440-38-2	Arsenic (dissolved)	3.3(J)	15.6	µg/L	USFW347067	3/41	1.3-2.3	15.6		0.045 C	10	MCL	Y	ASL
	7440-38-2	Arsenic (total)	4.7(J)	17.5	µg/L	USFW347067	2/48	2.3-8.9	17.5		0.045 C	10	MCL	Y	ASL, IFD
	7440-39-3	Barium (dissolved)	1.2(J)	20.1	µg/L	95MW0214A	31/41	0.2-8.1	20.1		260 N	2000	MCL	N	BSL
	7440-39-3	Barium (total)	1.2(J)	22.4	µg/L	USFW347046	38/48	0.2-8.2	22.4		260 N	2000	MCL	N	BSL
	7440-41-7	Beryllium (dissolved)	0.14(J)	1.1	µg/L	95MW0107A	2/41	0.09-0.9	1.1		7.3 N	4	MCL	N	BSL, IFD
	7440-42-8	Boron (dissolved)	29.9(J)	386	µg/L	30MW0582C	45/83	1-130	386		730 N	600	HA	N	BSL
	7440-42-8	Boron (total)	35.3(J)	345	µg/L	30MW0581C	35/47	1-89.6	345		730 N	600	HA	N	BSL
	7440-43-9	Cadmium (dissolved)	0.35(J)	1.5	µg/L	USFW230068	4/41	0.3-0.34	1.5		1.8 N	5	MCL	N	BSL, IFD
	7440-43-9	Cadmium (total)	0.36(J)	6.4	µg/L	95MW0109C	5/48	0.34-0.34	6.4		1.8 N	5	MCL	Y	ASL
	7440-70-2	Calcium (dissolved)	1110	14000	µg/L	USSD316066	41/41	17.3-18.7	14000		NA	NA	NA	N	NUT
	7440-70-2	Calcium (total)	1170	14700	µg/L	USSD316066	48/48	17.3-17.3	14700		NA	NA	NA	N	NUT
	7440-47-3	Chromium (dissolved)	0.67(J)	1.9(J)	µg/L	95MW0107A	3/41	0.65-0.87	1.9(J)		11 N	100	MCL	N	BSL
	7440-47-3	Chromium (total)	0.99(J)	8.6	µg/L	USSD383023	9/48	0.65-2.1	8.6		11 N	100	MCL	N	BSL
	7440-48-4	Cobalt (dissolved)	0.67(J)	22.6	µg/L	USFW230078	25/41	0.4-8.6	22.6		73 N	NA	NA	N	BSL
	7440-48-4	Cobalt (total)	0.79(J)	21.4	µg/L	USFW230078	32/48	0.77-8.9	21.4		73 N	NA	NA	N	BSL
	7440-50-8	Copper (dissolved)	0.89(J)	67.2	µg/L	USFW300138	10/41	0.6-2.6	67.2		150 N	1000	SMCL	N	BSL

Table 2-2
Occurence, Distribution, and Selection of Chemicals of Potential Concern
Ashumet Valley Groundwater Outside the Capture Zone North of Route 151

Scenario Timeframe: current/future
Medium: groundwater
Exposure Medium: groundwater

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier) (1)	Maximum Concentration (Qualifier) (1)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (N/C) (4)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (5)
	7440-50-8	Copper (total)	1.6(J)	306	µg/L	USFW230127	7/48	0.88-1.8	306		150 N	1000	SMCL	Y	ASL
	7439-89-6	Iron (dissolved)	17.6(J)	10400	µg/L	USFW347067	18/84	12.5-80.9	10400		1100 N	300	SMCL	N	NUT
	7439-89-6	Iron (total)	15.5(J)	10700	µg/L	USFW347067	26/48	13.8-65	10700		1100 N	300	SMCL	N	NUT
	7439-92-1	Lead (dissolved)	1.4(J)	1.4(J)	µg/L	95MW0107B	1/41	1.1-1.4	1.4(J)		NA	15	AL	N	BAL, IFD
	7439-92-1	Lead (total)	2.2	4.1	µg/L	95MW0109A	2/41	1.4-1.4	4.1		NA	15	AL	N	BSL, IFD
	7439-95-4	Magnesium (dissolved)	558	4150	µg/L	USFW383061	41/41	4.8-25.2	4150		NA	NA	NA	N	NUT
	7439-95-4	Magnesium (total)	619	5630	µg/L	95MW0109C	48/48	25.2-25.2	5630		NA	NA	NA	N	NUT
	7439-96-5	Manganese (dissolved)	0.92(J)	3990	µg/L	30MW0581C	76/84	0.3-5.5	3990		88 N	50	SMCL	Y	ASL
	7439-96-5	Manganese (total)	2.5(J)	3930	µg/L	USFW300030	47/48	0.33-2.6	3930		88 N	50	SMCL	Y	ASL
	7439-97-6	Mercury (dissolved)	0.18(J)	0.18(J)	µg/L	95MW0107A	1/41	0.012-0.18	0.18(J)		1.1 N	2	MCL	N	BSL, IFD
	7439-97-6	Mercury (total)	0.056(J)	0.056(J)	µg/L	USFW383040	1/48	0.012-0.23	0.056(J)		1.1 N	2	MCL	N	BSL, IFD
	7440-02-0	Nickel (dissolved)	0.66(J)	12.2(J)	µg/L	USFW230088	26/41	0.6-2.4	12.2(J)		73 N	100	ORSG	N	BSL
	7440-02-0	Nickel (total)	1.2(J)	13.1(J)	µg/L	USFW230088	27/48	1.2-3.1	13.1(J)		73 N	100	ORSG	N	BSL
	7440-09-7	Potassium (dissolved)	863(J)	6670	µg/L	USFW383061	34/41	20.4-726	6670		NA	NA	NA	N	NUT
	7440-09-7	Potassium (total)	738(J)	8280	µg/L	USFW347046	41/48	726-726	8280		NA	NA	NA	N	NUT
	7440-23-5	Sodium (dissolved)	4100	47000	µg/L	30MW0581C	41/41	22.9-276	47000		NA	20000	ORSG	N	CC, NSL
	7440-23-5	Sodium (total)	3920	44400	µg/L	30MW0581C	48/48	22.9-22.9	44400		NA	20000	ORSG	N	CC, NSL
	7440-28-0	Thallium (dissolved)	4.2(J)	5.5(J)	µg/L	95MW0107B	3/41	1.4-7.6	5.5(J)		0.24 N	2	MCL	Y	ASL
	7440-28-0	Thallium (total)	3(J)	7.9(J)	µg/L	USFW300010	7/48	2.8-5.9	7.9(J)		0.24 N	2	MCL	Y	ASL
	7440-62-2	Vanadium (dissolved)	0.76(J)	6(J)	µg/L	USSD316066	8/41	0.6-0.67	6(J)		26 N			N	BSL
	7440-62-2	Vanadium (total)	0.7(J)	6.2(J)	µg/L	USSD316066	11/48	0.67-1.6	6.2(J)		26 N			N	BSL
	7440-66-6	Zinc (dissolved)	11.2(J)	317	µg/L	USFW230078	9/41	1-35.7	317		1100 N	5000	SMCL	N	BSL
	7440-66-6	Zinc (total)	5.6	280	µg/L	USFW230078	18/48	1-31	280		1100 N	5000	SMCL	N	BSL

Data Source: AFCEE, 8 April 2004, AFCEE-MMR Data Warehouse.

Footnotes:
* = Used naphthalene as a surrogate for 2-methylnaphthalene.
(1) Maximum/minimum detected concentration
(2) Maximum detected concentration
(3) N/A - Refer to Table 3-3 of text for information on background.
(4) N = one-tenth of the EPA Region IX PRG based on non-carcinogenic effects
C = EPA Region IX PRG based on carcinogenic effects (at a risk of 1E-06)
(5) Rationale Codes:
Common Cation (CC)
Above Screening Level (ASL)
Below Action Level (BAL)
Below Screening Level (BSL)
Infrequent Detection (IFD)
Essential Nutrient (NUT)
No Screening Level (NSL)

Definitions:
AL = Action Level
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considere
C = Carcinogenic
CAS = Chemical Abstract Service
COPC = Chemical of Potential Concern
EPA = U.S. Environmental Protection Agency
J = Estimated Value
HA = health advisory
MCL = Federal Maximum Contaminant Level
MMCL = Massachusetts Maximum Contaminant Level
MGW-1 = Massachusetts Groundwater 1 standard
N = Non-Carcinogenic
NA = Not Available
ORSG = Office of Research and Standards Guidelines
PRG = preliminary remediation goal
SMCL = Secondary Maximum Contaminant Level
µg/L = micrograms per liter

Table 2-3
Occurence, Distribution, and Selection of Chemicals of Potential Concern
Ashumet Valley Groundwater Outside the Capture Zone South of Route 151

Scenario Timeframe: current/future
Medium: groundwater
Exposure Medium: groundwater

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier) (1)	Maximum Concentration (Qualifier) (1)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (N/C) (4)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (5)
Ashumet Valley Plume Outside the Capture Zone South of Route 151	75-34-2	1,1-Dichloroethane	0.15(J)	0.45(J)	µg/L	USFW443117	6/110	0.104-0.156	0.45(J)		81 N	70	ORSG	N	BSL
	75-34-4	1,1 Dichloroethene	0.32(J)	0.32(J)	µg/L	USFW430075	1/110	0.116-0.258	0.32(J)		34 N	7	MCL	N	BSL, IFD
	95-50-1	1,2-Dichlorobenzene	0.25(J)	0.25(J)	µg/L	95MW0604F	1/110	0.08-0.305	0.25(J)		37 N	600	MCL	N	BSL, IFD
	106-46-7	1,4-Dichlorobenzene	0.28(J)	0.45(J)	µg/L	95MW0604F	2/110	0.147-0.38	0.45(J)		0.5 C	5	MMCL	N	BSL, IFD
	79-34-5	1,1,1-Trichloroethane	0.25(J)	0.44(J)	µg/L	USFW430075	4/110	0.081-0.528	0.44(J)		320 N	2	MGW-1	N	BSL, IFD
	67-66-3	Chloroform	0.21(J)	2.05	µg/L	95MW1232B	51/110	0.091-0.336	2.05		6.2 C/N	80	MCL	N	BSL
	156-59-2	cis-1,2-Dichloroethene	0.14(J)	10.8	µg/L	USFW443117	32/110	0.102-0.347	10.8		6.1 N	70	MCL	Y	ASL
	1634-04-4	tert-butyl-Methyl-Ether	0.73(J)	1.01	µg/L	USFW375055	2/110	0.108-0.42	1.01		13 C	70	ORSG	N	BSL, IFD
	127-18-4	Tetrachloroethene (PCE)	0.18(J)	52.4	µg/L	USFW443117	66/110	0.104-1.3	52.4		0.66 C	5	MCL	Y	ASL
	108-88-3	Toluene	0.57(J)	1.1	µg/L	95MW0604E	2/110	0.123-0.271	1.1		72 N	100	MCL	N	BSL, IFD
	79-01-6	Trichloroethene (TCE)	0.23(J)	16	µg/L	95MW0604F	57/110	0.138-0.241	16		0.028 C	5	MCL	Y	ASL
	117-81-7	bis-(2-ethylhexyl) phthalate	0.9(J)	55.4	µg/L	95MW0601C	4/49	0.8-33.3	55.4		4.8 C	6	MCL	Y	ASL
	7429-90-5	Aluminum (total)	35.8(J)	1660	µg/L	95MW0603C	5/78	13.7-296	1660		3600 N	50 to 200	SMCL	N	BSL
	7440-36-0	Antimony (dissolved)	2.04(J)	2.04(J)	µg/L	95MW0607C	1/73	1.8-3.48	2.04(J)		1.5 N	6	MCL	N	IFD
	7440-36-0	Antimony (total)	2.8(J)	4.9(J)	µg/L	USFW375071	2/78	1.9-5.5	4.9(J)		1.5 N	6	MCL	N	IFD
	7440-38-2	Arsenic (dissolved)	2.17	2.17	µg/L	95MW0213A	1/73	1.3-2.73	2.17		0.045 C	10	MCL	N	IFD
	7440-38-2	Arsenic (total)	1.65(J)	3.12(J)	µg/L	95MW0609H	2/78	1.3-6.2	3.12(J)		0.045 C	10	MCL	N	IFD
	7440-39-3	Barium (dissolved)	1.15(J)	76.4	µg/L	95MW0213A	72/73	0.3-2.75	76.4		260 N	2000	MCL	N	BSL
	7440-39-3	Barium (total)	1.31(J)	79.1(J)	µg/L	ECMWBKR01S	78/78	0.2-0.5	79.1(J)		260 N	2000	MCL	N	BSL
	7440-42-8	Boron (dissolved)	57	256	µg/L	USFW350084	11/20	1.3-138	256		730 N	600	HA	N	BSL
	7440-42-8	Boron (total)	34.3(J)	79.1(J)	µg/L	ECMWBKR01D	12/16	1.6-41.1	79.1(J)		730 N	600	HA	N	BSL
	7440-43-9	Cadmium (dissolved)	0.33(J)	2.7	µg/L	USFW436036	10/73	0.3-0.55	2.7		1.8 N	5	MCL	Y	ASL
	7440-43-9	Cadmium (total)	0.45(J)	0.83(J)	µg/L	95MW0609H	8/78	0.28-0.7	0.83(J)		1.8 N	5	MCL	N	BSL
	7440-70-2	Calcium (dissolved)	520	43400	µg/L	95MW0213A	72/73	4.6-4720	43400		NA	NA	NA	N	NUT, NSL
	7440-70-2	Calcium (total)	772(J)	14900	µg/L	USFW436076	77/78	13.3-4840	14900		NA	NA	NA	N	NUT, NSL
	7440-47-3	Chromium (dissolved)	0.52(J)	2.07(J)	µg/L	95MW0604C	15/73	0.5-0.8	2.07(J)		11 N	100	MCL	N	BSL
	7440-47-3	Chromium (total)	0.5(J)	7.32(J)	µg/L	95MW0605D	42/78	0.5-6.7	7.32(J)		11 N	100	MCL	N	BSL
	7440-48-4	Cobalt (dissolved)	0.55(J)	5.06	µg/L	95MW0208A	24/73	0.4-3.42	5.06		73 N	NA	NA	N	BSL
	7440-48-4	Cobalt (total)	0.74(J)	6.4(J)	µg/L	ECMWBKR01S	16/78	0.5-3.6	6.4(J)		73 N	NA	NA	N	BSL
	7440-50-8	Copper (dissolved)	0.54(J)	0.59(J)	µg/L	95MW0606C	2/73	0.5-4.75	0.59(J)		150 N	1000	SMCL	N	BSL, IFD
	7440-50-8	Copper (total)	0.95(J)	2.21(J)	µg/L	USFW375055	5/78	0.5-6.06	2.21(J)		150 N	1000	SMCL	N	BSL
	7439-89-6	Iron (dissolved)	14.6(J)	15700	µg/L	95MW0213A	11/73	12.5-499	15700		1100 N	300	SMCL	N	NUT

Table 2-3
Occurence, Distribution, and Selection of Chemicals of Potential Concern
Ashumet Valley Groundwater Outside the Capture Zone South of Route 151

Scenario Timeframe: current/future
Medium: groundwater
Exposure Medium: groundwater

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier) (1)	Maximum Concentration (Qualifier) (1)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (N/C) (4)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (5)
	7439-89-6	Iron (total)	17.4(J)	3170	µg/L	95MW0606F	25/78	12.7-118	3170		1100 N	300	SMCL	N	NUT
	7439-92-1	Lead (dissolved)	2.04(J)	18	µg/L	95MW0605A	14/73	1.1-2.27	18		NA	15	AL	Y	AAL
	7439-92-1	Lead (total)	1.52(J)	16.5	µg/L	95MW0603C	13/77	1.1-9.3	16.5		NA	15	AL	Y	AAL
	7439-95-4	Magnesium (dissolved)	201(J)	19800	µg/L	95MW0213A	73/73	4.8-28.6	19800		NA	NA	NA	N	NUT, NSL
	7439-95-4	Magnesium (total)	939	3740(J)	µg/L	95MW0606D	78/78	6.5-72.8	3740(J)		NA	NA	NA	N	NUT, NSL
	7439-96-5	Manganese (dissolved)	0.67(J)	2400	µg/L	95MW0208B	43/73	0.3-6.3	2400		88 N	50	SMCL	Y	ASL
	7439-96-5	Manganese (total)	0.69(J)	137	µg/L	95MW0609H	43/78	0.33-9.1	137		88 N	50	SMCL	Y	ASL
	7439-97-6	Mercury (total)	0.12(J)	0.22	µg/L	USFW436076	2/81	0.034-0.1	0.22		1.1 N	2	MCL	N	BSL, IFD
	7440-02-0	Nickel (dissolved)	0.74(J)	5.69(J)	µg/L	95MW0606F	29/73	0.6-4.5	5.69(J)		73 N	100	ORSG	N	BSL
	7440-02-0	Nickel (total)	0.81(J)	5.76(J)	µg/L	95MW0605D	23/78	0.7-4.9	5.76(J)		73 N	100	ORSG	N	BSL
	7440-09-7	Potassium (dissolved)	607(J)	5170	µg/L	95MW0213A	71/73	14.9-974	5170		NA	NA	NA	N	NUT, NSL
	7440-09-7	Potassium (total)	593	2840(J)	µg/L	ECMWBKR01S	74/78	14.9-1370	2840(J)		NA	NA	NA	N	NUT, NSL
	7782-49-2	Selenium (dissolved)	2.2(J)	2.8(J)	µg/L	95MW0604F	7/73	1.6-2.2	2.8(J)		18 N	50	MCL	N	BSL
	7782-49-2	Selenium (total)	2.21(J)	2.69(J)	µg/L	95MW0608C	4/78	1.4-4.6	2.69(J)		18 N	50	MCL	N	BSL
	7440-22-4	Silver (dissolved)	1.03(J)	1.8(J)	µg/L	USFW358089	2/73	0.5-0.7	1.8(J)		18 N	100	SMCL	N	BSL, IFD
	7440-23-5	Sodium (dissolved)	4980	118000	µg/L	95MW0213A	73/73	188-276	118000		NA	20000	ORSG	N	CC, NSL
	7440-23-5	Sodium (total)	5920	17400	µg/L	95MW0601E	78/78	96.6-464	17400		NA	20000	ORSG	N	CC, NSL
	7440-62-2	Vanadium (total)	0.97(J)	3.4(J)	µg/L	ECMWBKR01S	3/78	0.7-3.96	3.4(J)		26 N			N	BSL, IFD
	7440-66-6	Zinc (dissolved)	0.52(J)	112	µg/L	USFW350084	31/73	0.4-7.44	112		1100 N	5000	SMCL	N	BSL
	7440-66-6	Zinc (total)	0.66(J)	25.7	µg/L	ECMWBKR01D	26/78	0.4-12.5	25.7		1100 N	5000	SMCL	N	BSL

Data Source: AFCEE, 8 April 2004, AFCEE-MMR Data Warehouse.
Notes:

(1) Maximum/minimum detected concentraion
(2) Maximum detected concentration
(3) N/A - Refer to Table 3-3 of text for information on background.
(4) N = one-tenth of the EPA Region IX PRG based on non-carcinogenic effects
C = EPA Region IX PRG based on carcinogenic effects (at a risk of 1E-06)
(5) Rationale Codes:
Above Action Level (AAL)
Above Screening Level (ASL)
Below Screening Level (BSL)
Common Cation (CC)
Infrequent Detection (IFD)
Essential Nutrient (NUT)
No Screening Level (NSL)

Definitions:
AL = Action Level
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
C = Carcinogenic
CAS = Chemical Abstract Service
COPC = Chemical of Potential Concern
EPA = U.S. Environmental Protection Agency
J = Estimated Value
HA = health advisory
MCL = Federal Maximum Contaminant Level
MGW-1 = Massachusetts Groundwater 1 standard
MMCL = Massachusetts Maximum Contaminant Level
N = Non-Carcinogenic
NA = Not Available
ORSG = Office of Research and Standards Guidelines
PRG = preliminary remediation goal
SMCL = Secondary Maximum Contaminant Level
µg/L = micrograms per liter

Table 2-4
Occurence, Distribution, and Selection of Chemicals of Potential Concern
Backus River Surface Water

Scenario Timeframe: current/future
Medium: surface water
Exposure Medium: surface water

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier) (1)	Maximum Concentration (Qualifier) (1)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (N/C) (4)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (5)
Backus River	67-64-1	Acetone	11(J)	11(J)	µg/L	ECBKR01	1/1	2.8-2.8	11(J)		61 N	3000	ORSG	N	BSL
	67-66-3	Chloroform	0.3(J)	0.47(J)	µg/L	95SW2001	4/31	0.08-0.29	0.47(J)		6.2 C/N	5.7	WQC	N	BSL
	75-09-2	Methylene Chloride	0.52(J)	0.52(J)	µg/L	ECBKR03	1/31	0.08-0.28	0.52(J)		4.3 C	4.6	WQC	N	BSL, IFD
	127-18-4	Tetrachloroethene (PCE)	0.43(J)	2.04	µg/L	95SW2001	5/31	0.11-0.421	2.04		0.66 C	0.69	WQC	Y	ASL
	108-88-3	Toluene	0.17(J)	0.17(J)	µg/L	95SW2004	1/31	0.09-0.29	0.17(J)		72 N	1000	MCL	N	BSL, IFD
	79-01-6	Trichloroethene (TCE)	0.29(J)	1.06	µg/L	95SW2001	3/31	0.09-0.35	1.06		0.028 C	2.5	WQC	Y	ASL
	117-81-7	bis (2-ethylhexyl) phthalate	1(J)	316	µg/L	ECBKR04	6/16	0.08-26	316		4.8 C	1.2	WQC	Y	ASL
	7429-90-5	Aluminum (total)	178(J)	923	µg/L	ECBKR01	9/16	17.5-221	923		3600 N	50 to 200	SMCL	N	BSL
	7440-38-2	Arsenic (total)	1.67(J)	2.31	µg/L	ECBKR04	2/16	1.3-6.2	2.31		0.045 C	0.018	WQC	Y	ASL
	7440-39-3	Barium (dissolved)	12(J)	21.1	µg/L	ECBKR05	5/5	0.3-0.3	21.1		260 N	1000	WQC	N	BSL
	7440-39-3	Barium (total)	9(J)	57.3(J)	µg/L	ECBKR05	16/16	20-200	57.3(J)		260 N	1000	WQC	N	BSL
	7440-42-8	Boron (total)	65.5	67.7	µg/L	ECBKR04	3/10	1.1-59.5	67.7		730 N	600	HA	N	BSL
	7440-70-2	Calcium (dissolved)	1050	2460	µg/L	ECBKR05	5/5	28.7-28.7	2460		NA	NA	NA	N	NUT
	7440-70-2	Calcium (total)	799	4930(J)	µg/L	ECBKR05	16/16	14.7-71.9	4930(J)		NA	NA	NA	N	NUT
	7440-47-3	Chromium (total)	0.7(J)	1.91(J)	µg/L	ECBKR01	5/16	0.7-1.41	1.91(J)		11 N	100	MCL	N	BSL
	7440-48-4	Cobalt (total)	0.86(J)	1.56(J)	µg/L	ECBKR04	2/16	0.7-1.8	1.56(J)		73 N	NA	NA	N	BSL
	7440-50-8	Copper (dissolved)	0.55(J)	2.3(J)	µg/L	ECBKR05	2/5	0.5-0.5	2.3(J)		150 N	1000	SMCL	N	BSL
	7440-50-8	Copper (total)	1.21(J)	23(J)	µg/L	ECBKR01	8/16	0.5-4.7	23(J)		150 N	1000	SMCL	N	BSL
	7439-89-6	Iron (dissolved)	471	948	µg/L	ECBKR02	5/5	16.1-16.1	948		1100 N	300	WQC	N	NUT
	7439-89-6	Iron (total)	737	7840	µg/L	ECBKR01	16/16	16.1-29	7840		1100 N	300	WQC	N	NUT
	7439-92-1	Lead (dissolved)	8.04	8.04	µg/L	ECBKR03	1/5	1-1.3	8.04		NA	15	AL	N	BAL
	7439-92-1	Lead (total)	1.1(J)	9.62	µg/L	ECBKR01	8/16	0.97-4.98	9.62		NA	15	AL	N	BAL
	7439-95-4	Magnesium (dissolved)	1130	1640	µg/L	ECBKR05	5/5	28.6-28.6	1640		NA	NA	NA	N	NUT
	7439-95-4	Magnesium (total)	923	1990(J)	µg/L	ECBKR05	16/16	13.7-72.8	1990(J)		NA	NA	NA	N	NUT
	7439-96-5	Manganese (dissolved)	38.4	157	µg/L	ECBKR05	5/5	0.6-0.6	157		88 N	50	WQC	Y	ASL
	7439-96-5	Manganese (total)	37.6	307	µg/L	ECBKR04	16/16	0.4-1.4	307		88 N	50	WQC	Y	ASL
	7440-02-0	Nickel (dissolved)	2.61(J)	2.61(J)	µg/L	ECBKR05	1/5	0.8-0.8	2.61(J)		73 N	610	WQC	N	BSL

Table 2-4
Occurence, Distribution, and Selection of Chemicals of Potential Concern
Backus River Surface Water

Scenario Timeframe: current/future
Medium: surface water
Exposure Medium: surface water

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier) (1)	Maximum Concentration (Qualifier) (1)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (N/C) (4)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (5)
	7440-09-7	Potassium (dissolved)	8.02	1650	µg/L	ECBKR05	5/5	20.6-20.6	1650		NA	NA	NA	N	NUT
	7440-09-7	Potassium (total)	773	3650(J)	µg/L	ECBKR01	14/16	20.6-2940	3650(J)		NA	NA	NA	N	NUT
	7440-23-5	Sodium (dissolved)	7600	8640	µg/L	ECBKR04	5/5	205-205	8640		NA	NA	NA	N	CC
	7440-23-5	Sodium (total)	7290	9650	µg/L	ECBKR03	16/16	96.6-419	9650		NA	20000	ORSG	N	NUT
	7440-62-2	Vanadium (total)	6.1(J)	7.13(J)	µg/L	ECBKR01	2/16	0.7-2.4	7.13(J)		26 N	NA	NA	N	BSL
	7440-66-6	Zinc (dissolved)	3.42(J)	3.73(J)	µg/L	ECBKR03	3/5	0.4-2.96	3.73(J)		1100 N	5000	SMCL	N	BSL
	7440-66-6	Zinc (total)	3.71(J)	64.7	µg/L	ECBKR03	5/16	0.3-14.6	64.7		1100 N	5000	SMCL	N	BSL

Data Source: AFCEE, 5 April 2004, AFCEE-MMR Data Warehouse.

Footnotes:

(1) Maximum/minimum detected concentraion
(2) Maximum detected concentration
(3) N/A - Refer to Table 3-3 of text for information on background.
(4) N = one-tenth of the EPA Region IX PRG based on non-carcinogenic effects
C = EPA Region IX PRG based on carcinogenic effects (at a risk of 1E-06)
WQC = EPA Water Qualtiy Criteria for protection of human health due to ingestion of water and organisms (EPA 2002b)
(5) Rationale Codes:
Above Screening Level (ASL)
Below Action Level (BAL)
Below Screening Level (BSL)
Common Cation (CC)
Infrequent Detection (IFD)
Essential Nutrient (NUT)
No Screening Level (NSL)

Definitions:
AL = Action Level
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
C = Carcinogenic
COPC = Chemical of Potential Concern
EPA = U.S. Environmental Protection Agency
J = Estimated Value
HA = health advisory
MCL = Federal Maximum Contaminant Level
MGW-1 = Massachusetts Groundwater 1 standard
N = Non-Carcinogenic
NA = Not Available
ORSG = Office of Research and Standards Guidelines
PRG = preliminary remediation goal
SMCL = Secondary Maximum Contaminant Level
WQC = Water Quality Criteria
µg/L = micrograms per liter

Table 2-5
Occurence, Distribution, and Selectioin of Chemicals of Potential Concern
Backus River Sediment

Scenario Timeframe: current/future
Medium: sediment
Exposure Medium: sediment

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier) (1)	Maximum Concentration (Qualifier) (1)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (N/C) (4)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (5)
Backus River	120-82-1	1,2,4-Trichlorobenzene	3.34(J)	3.34(J)	µg/kg	ECBKR02	1/2	0.79 - 5.26	3.34(J)		65000 N	NA	NA	N	BSL
	96-12-8	1,2-Dibromo-3-Chloropropane	4.8	4.8	µg/kg	ECBKR02	1/5	0.787 - 5.9	4.8		450 C	NA	NA	N	BSL
	67-64-1	Acetone	14.3(J)	14.3(J)	µg/kg	ECBKR04	1/5	8.7 - 10.6	14.3(J)		160000 N	NA	NA	N	BSL
	56-55-3	Benzo(a)anthrancene	63(J)	63(J)	µg/kg	ECBKR01	1/10	9.31 - 165	63(J)		620 C	NA	NA	N	BSL
	50-32-8	Benzo(a)pyrene	62.3(J)	62.3(J)	µg/kg	ECBKR01	1/10	7.12 - 138	62.3(J)		62 C	NA	NA	Y	ASL
	205-99-2	Benzo(b)fluoranthene	100(J)	100(J)	µg/kg	ECBKR01	1/10	11-169	100(J)		620 C	NA	NA	N	BSL
	218-01-9	Chrysene	75.6(J)	75.6(J)	µg/kg	ECBKR01	1/10	9.92 - 160	75.6(J)		62000 C	NA	NA	N	BSL
	206-44-0	Fluoranthene	100(J)	100(J)	µg/kg	ECBKR01	1/10	15.9 - 156	100(J)		230000 N	NA	NA	N	BSL
	129-00-0	Pyrene	51.6(J)	113(J)	µg/kg	ECBKR01	2/10	14.2 - 184	113(J)		230000 N	NA	NA	N	BSL
	7429-90-5	Aluminum	167	1840	mg/kg	ECBKR01	10/10	3.14-7.56	1840		7600 N	NA	NA	N	BSL
	7440-36-0	Antimony	0.516(J)	0.516(J)	mg/kg	ECBKR01	1/10	0.377-0.5	0.516(J)		3.1 N	NA	NA	N	BSL
	7440-38-2	Arsenic	0.909(J)	2.55(J)	mg/kg	ECBKR01	3/10	0.53-0.831	2.55(J)		0.39 C	NA	NA	Y	ASL
	7440-39-3	Barium	2.62(J)	6.31(J)	mg/kg	ECBKR05	10/10	0.035-0.07	6.31(J)		540 N	NA	NA	N	BSL
	7440-41-7	Beryllium	0.07(J)	0.1(J)	mg/kg	ECBKR01	4/10	0.053-0.07	0.1(J)		15 N	NA	NA	N	BSL
	7440-43-9	Cadmium	0.13(J)	0.13(J)	mg/kg	ECBKR01	1/10	0.071-0.1	0.13(J)		3.7 N	NA	NA	N	BSL
	7440-70-2	Calcium	74.3(J)	2490(J)	mg/kg	ECBKR01	6/10	2.81-105	2490(J)		NA	NA	NA	N	NUT
	7440-47-3	Chromium	0.377(J)	2.35(J)	mg/kg	ECBKR01	10/10	0.15-0.197	2.35(J)		22 N	NA	NA	N	BSL
	7440-48-4	Cobalt	0.316(J)	0.316(J)	mg/kg	ECBKR04	1/10	0.15-2.19	0.316(J)		140 N	NA	NA	N	BSL
	7440-50-8	Copper	0.27(J)	3.5	mg/kg	ECBKR04	10/10	0.1-0.24	3.5		310 N	NA	NA	N	BSL
	7439-89-6	Iron	233	9590	mg/kg	ECBKR01	10/10	3.44-4.35	9590		2300 N	NA	NA	N	NUT
	7439-92-1	Lead	2.09	5.22	mg/kg	ECBKR01	8/10	0.32-3.66	5.22		400 N*	NA	NA	N	BSL
	7439-95-4	Magnesium	69.1(J)	1560(J)	mg/kg	ECBKR01	9/10	2.46-27	1560(J)		NA	NA	NA	N	NUT
	7439-96-5	Manganese	4.04	16.8(J)	mg/kg	ECBKR01	10/10	0.071-0.15	16.8(J)		180 N	NA	NA	N	BSL
	7440-02-0	Nickel	0.21(J)	0.474(J)	mg/kg	ECBKR02	4/10	0.17-0.24	0.474(J)		160 N	NA	NA	N	BSL
	7440-09-7	Potassium	173(J)	173(J)	mg/kg	ECBKR01	1/10	5.44-118	173(J)		NA	NA	NA	N	NUT
	7440-23-5	Sodium	85.8(J)	239(J)	mg/kg	ECBKR05	4/10	43.8-91.6	239(J)		NA	NA	NA	N	NUT
	7440-62-2	Vanadium	2.41(J)	9.5(J)	mg/kg	ECBKR01	9/10	0.126-0.543	9.5(J)		55 N	NA	NA	N	BSL
	7440-66-6	Zinc	1.49(J)	6.08	mg/kg	ECBKR01	8/10	0.08-2.8	6.08		2300 N	NA	NA	N	BSL

Data Source: AFCEE, 7 April 2004, AFCEE-MMR Data Warehouse.

Footnotes: Refer to Table 1.1 (Selection of Exposure Pathways Ashumet Valley) for explanation of treatment of sediment COPCs. In Appendix A of Final Ashumet Valley Groundwater Feasibility Study (AFCEE 2007a)
(1) Maximum/minimum detected concentraion
(2) Maximum detected concentration
(3) N/A - Refer to Table 3-3 (Appendix A, AFCEE 2007a) for information on background.
(4) N = one-tenth of the EPA Region IX PRG based on non-carcinogenic effects
C = EPA Region IX PRG based on carcinogenic effects (at a risk of 1E-06)
(5) Rationale Codes:
Above Screening Level (ASL)
Below Screening Level (BSL)
Essential Nutrient (NUT)

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
C = Carcinogenic
CAS = Chemical Abstracts Service
COPC = Chemical of Potential Concern
EPA = U.S. Environmental Protection Agency
J = Estimated Value
mg/kg = milligrams per kilogram
N = Non-Carcinogenic
NA = Not Available
PRG = preliminary remediation goal
µg/kg = micrograms per kilogram

Table 2-6
Exposure Point Concentrations
Reasonable Maximum Exposure
Ashumet Valley Groundwater Within the Capture Zone

Scenario Timeframe: Current/future
Medium: groundwater
Exposure Medium: groundwater

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Ashumet Valley Within the Capture Zone	cis-1,2-Dichloroethene	µg/L	NA	NA	82.6	82.6	µg/L	Maximum	EPA Region I Guidance
	Tetrachloroethene (PCE)	µg/L	NA	NA	21.2	21.2	µg/L	Maximum	EPA Region I Guidance
	Trichloroethene (TCE)	µg/L	NA	NA	44	44	µg/L	Maximum	EPA Region I Guidance
	Arsenic (dissolved)	µg/L	NA	NA	3.11	3.11	µg/L	Maximum	EPA Region I Guidance
	Arsenic (total)	µg/L	NA	NA	3.5 (J)	3.5	µg/L	Maximum	EPA Region I Guidance
	Manganese (dissolved)	µg/L	NA	NA	5710	5710	µg/L	Maximum	EPA Region I Guidance
	Manganese (total)	µg/L	NA	NA	5630	5630	µg/L	Maximum	EPA Region I Guidance
	Thallium (total)	µg/L	NA	NA	4.6 (J)	4.6	µg/L	Maximum	EPA Region I Guidance

Notes:
J = estimated value
NA = not applicable
UCL = upper confidence limit
µg/L = microgams per liter

Table 2-7
Exposure Point Concentrations
Reasonable Maximum Exposure
Ashumet Valley Groundwater Outside the Capture Zone North of Route 151

Scenario Timeframe: Current/future
Medium: groundwater
Exposure Medium: groundwater

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Ashumet Valley Outside the Capture Zone North of Route 151	Benzene	µg/L	NA	NA	1.5	1.5	µg/L	Maximum	EPA Region I Guidance
	1,3-Dichlorobenzene	µg/L	NA	NA	0.87(J)	0.87	µg/L	Maximum	EPA Region I Guidance
	1,4-Dichlorobenzene	µg/L	NA	NA	5.4	5.4	µg/L	Maximum	EPA Region I Guidance
	Chloroform	µg/L	NA	NA	8.57	8.57	µg/L	Maximum	EPA Region I Guidance
	cis-1,2-Dichloroethene	µg/L	NA	NA	46	46	µg/L	Maximum	EPA Region I Guidance
	Tetrachloroethene (PCE)	µg/L	NA	NA	40.8	40.8	µg/L	Maximum	EPA Region I Guidance
	Trichloroethene (TCE)	µg/L	NA	NA	9.37	9.37	µg/L	Maximum	EPA Region I Guidance
	2-Methylnaphthalene	µg/L	NA	NA	17	17	µg/L	Maximum	EPA Region I Guidance
	Naphthalene	µg/L	NA	NA	50	50	µg/L	Maximum	EPA Region I Guidance
	Antimony (total)	µg/L	NA	NA	6.5	6.5	µg/L	Maximum	EPA Region I Guidance
	Arsenic (dissolved)	µg/L	NA	NA	15.6	15.6	µg/L	Maximum	EPA Region I Guidance
	Arsenic (total)	µg/L	NA	NA	17.5	17.5	µg/L	Maximum	EPA Region I Guidance
	Cadmium (total)	µg/L	NA	NA	6.4	6.4	µg/L	Maximum	EPA Region I Guidance
	Copper (total)	µg/L	NA	NA	306	306	µg/L	Maximum	EPA Region I Guidance
	Manganese (dissolved)	µg/L	NA	NA	3990	3990	µg/L	Maximum	EPA Region I Guidance
	Manganese (total)	µg/L	NA	NA	3930	3930	µg/L	Maximum	EPA Region I Guidance
	Thallium (dissolved)	µg/L	NA	NA	5.5(J)	5.5	µg/L	Maximum	EPA Region I Guidance
	Thallium (total)	µg/L	NA	NA	7.9(J)	7.9	µg/L	Maximum	EPA Region I Guidance

Notes:
J = estimated value
NA = not applicable
UCL = upper confidence limit
µg/L = microgams per liter

Table 2-8
Exposure Point Concentrations
Reasonable Maximum Exposure
Ashumet Valley Groundwater Outside the Capture Zone South of Route 151

Scenario Timeframe: Current/future
Medium: groundwater
Exposure Medium: groundwater

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL	Maximum Concentration	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Ashumet Valley Outside the Capture Zone South of Route 151	cis-1,2-Dichloroethene	µg/L	NA	NA	10.8	10.8	µg/L	Maximum	EPA Region I Guidance
	Tetrachloroethene (PCE)	µg/L	NA	NA	52.4	52.4	µg/L	Maximum	EPA Region I Guidance
	Trichloroethene (TCE)	µg/L	NA	NA	16	16	µg/L	Maximum	EPA Region I Guidance
	bis-(2-ethylhexyl) phthalate	µg/L	NA	NA	55.4	55.4	µg/L	Maximum	EPA Region I Guidance
	Cadmium (dissolved)	µg/L	NA	NA	2.7	2.7	µg/L	Maximum	EPA Region I Guidance
	Lead (dissolved)	µg/L	NA	NA	18	18	µg/L	Maximum	EPA Region I Guidance
	Lead (total)	µg/L	NA	NA	16.5	16.5	µg/L	Maximum	EPA Region I Guidance
	Manganese (dissolved)	µg/L	NA	NA	2400	2400	µg/L	Maximum	EPA Region I Guidance
	Manganese (total)	µg/L	NA	NA	137	137	µg/L	Maximum	EPA Region I Guidance

Notes:
NA = not applicable
UCL = upper confidence limit
µg/L = micrograms per liter

Table 2-9
Exposure Point Concentrations
Reasonable Maximum Exposure
Backus River Surface Water

Scenario Timeframe: Current/future
Medium: surface water
Exposure Medium: surface water

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL	Maximum Concentration	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Backus River	Tetrachloroethene (PCE)	µg/L	0.268	NA	2.04	2.04	µg/L	Maximum	SW-Test (1)
	Trichloroethene (TCE)	µg/L	0.173	NA	1.06	1.06	µg/L	Maximum	SW-Test (1)
	bis-(2-ethylhexyl) phthalate	µg/L	25.6	NA	316	316	µg/L	Maximum	SW-Test (1)
	Arsenic (total)	µg/L	1.82	NA	2.31	2.31	µg/L	Maximum	SW-Test (1)
	Manganese (dissolved)	µg/L	101	144	157	144	µg/L	95% UCL	SW-Test (2)
	Manganese (total)	µg/L	120	157	307	157	µg/L	95%UCL	SW-Test (3)

Notes:
NA = not applicable
UCL = upper confidence limit
µg/L = microgams per liter
SW-Test (1) = Shaprio-Wilk test indicates that the data are neither normally nor log-normally distributed.
SW-Test (2) = Shapiro-Wilk test indicates that the data are normally distributed.
SW-Test (3) = Shaprio-Wilk test indicates that the data are log-normally distributed.

Table 2-10
Values Used For Daily Intake Calculations
Reasonable Maximum Exposure
Ashumet Valley Groundwater

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/Model Name
Ingestion	Resident	Adult	Aquifer - Tap Water	CW	Chemical Concentration in Water	Chem.-specific Maximum	µg/L	-	Chronic Daily Intake (CDI) (mg/kg/day) = CW x IRW x EF x ED x CF1 x 1/BW x 1/AT
				IRW	Ingestion Rate of Water	2	L/day	EPA 1995a	
				EF	Exposure Frequency	350	days/yr	Site-specific	
				ED	Exposure Duration	24	yrs	EPA 1989	
				CF1	Conversion Factor	0.001	mg/µg	-	
				BW	Body Weight	70	kg	EPA 1989	
				AT-NC	Averaging Time (noncancer)	8760	days	EPA 1989	AT-NC = ED*365
				AT- C	Averaging Time (cancer)	25,550	days	EPA 1989	AT-C = 70*365
Dermal				CW	Chemical Concentration in Water	Chem.-specific Maximum	µg/L	-	Dermal Absorbed Dose (DAD) (mg/kg/day) = DA_{event} x SA x EV x EF x ED x 1/BW x 1/AT
				DAevent	Dose absorbed per unit area per event	Chem.-specific	mg/cm^2-event	EPA 2001b	Where DA_{event} (mg/cm^2-event) is calculated in accordance
				SA	Skin surface area available for contact	18000	cm^2	EPA 2001b	with EPA Superfund Dermal Risk Guidance (EPA, 2001)
				ET	Exposure Time	0.58	hr/day	EPA 2001b	
				EV	Event	1	event/day	EPA 2001b	
				EF	Exposure Frequency	350	days/yr	Site-specific	
				ED	Exposure Duration	24	yrs	EPA 1989	
				BW	Body Weight	70	kg	EPA 1989	
				AT-NC	Averaging Time (noncancer)	8760	days	EPA 1989	AT-NC = ED*365
				AT- C	Averaging Time (cancer)	25,550	days	EPA 1989	AT-C = 70*365
Inhalation				CA	Chemical Concentration in Air	Chem.-specific	µg/m^3	EPA 2003a	Lifetime Average Air Concentration (LAAC) =
				CW	Chemical Concentration in Water	Chem.-specific Maximum	µg/L	-	CA x ET x EF x ED x CF1 x 1/AT Based on EPA 1994
				VF	Volatilization Factor*	0.5	L/m^3	EPA 1991b	For vapors associated with household use of groundwater, CA
				ET	Exposure Time	24	hr/day	-	is estimated by CW x VF
				EF	Exposure Frequency	350	days/yr	Site-specific	For vapors associated with the groundwater vapor intrusion
				ED	Exposure Duration	30	yrs	EPA 1989	pathway, CA is estimated by the Johnson and Ettinger Model
				CF1	Conversion Factor	0.001	mg/µg	-	(1991) in accordance with EPA (2002)
				AT-NC	Averaging Time (noncancer)	262,800	hours	EPA 1989	AT-NC = ED*365
				AT- C	Averaging Time (cancer)	613,200	hours	EPA 1989	AT-C = 70*365

Table 2-10
Values Used For Daily Intake Calculations
Reasonable Maximum Exposure
Ashumet Valley Groundwater

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/Model Name
Ingestion	Resident	Child	Aquifer - Tap Water	CW	Chemical Concentration in Water	Chem.-specific Maximum	µg/L	-	Chronic Daily Intake (CDI) (mg/kg/day) = CW x IRW x EF x ED x CF1 x 1/BW x 1/AT
				IRW	Ingestion Rate of Water	1	L/day	EPA 1995a	
				EF	Exposure Frequency	350	days/yr	Site-specific	
				ED	Exposure Duration	6	yrs	EPA 1989	
				CF1	Conversion Factor	0.001	mg/µg	-	
				BW	Body Weight	15	kg	EPA 1989	
				AT-NC	Averaging Time (noncancer)	2190	days	EPA 1989	AT-NC = ED*365
				AT- C	Averaging Time (cancer)	25,550	days	EPA 1989	AT-C = 70*365
Dermal				CW	Chemical Concentration in Water	Chem.-specific Maximum	µg/L	-	Dermal Absorbed Dose (DAD) (mg/kg/day) = DA_{event} x SA x EV x EF x ED x 1/BW x 1/AT
				DAevent	Dose absorbed per unit area per event	Chem.-specific	mg/cm^2-event	EPA 2001b	Where DA_{event} (mg/cm^2-event) is calculated in accordance
				SA	Skin surface area available for contact	6600	cm^2	EPA 2001b	with EPA Superfund Dermal Risk Guidance (EPA, 2001)
				ET	Exposure Time	1	hr/day	EPA 2001b	
				EV	Event	1	event/day	EPA 2001b	
				EF	Exposure Frequency	350	days/yr	Site-specific	
				ED	Exposure Duration	6	yrs	EPA 1989	
				BW	Body Weight	15	kg	EPA 1989	
				AT-NC	Averaging Time (noncancer)	2190	days	EPA 1989	AT-NC = ED*365
				AT- C	Averaging Time (cancer)	25,550	days	EPA 1989	AT-C = 70*365

Notes:
cm^2 = square centimeter
hr = hours
kg = kilograms
L = liters
mg = milligrams
m^3 = cubic meter
yrs = years
µg = micrograms

Table 2-11
Values Used For Daily Intake Calculations
Reasonable Maximum EXxposure
Ashumet Valley, Backus River Surface Water

Scenario Timeframe:	Current/Future
Medium:	Surface Water
Exposure Medium:	Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/Model Name
Ingestion	Cranberry Worker	Adult	Backus River	Csw	Chemical Concentration in Surface Water	max or 95% UCL of mean	µg/L	Site-specific	Chronic Daily Intake (CDI) (mg/kg/day) = Csw x IRsw x EF x ED x CF1 x 1/BW x 1/AT
				IRsw	Ingestion Rate of Surface Water	0.05	L/day	EPA 1998	
				EF	Exposure Frequency	34	days/yr	AFCEE 2004b	
				ED	Exposure Duration	25	yrs	EPA 1991b	
				CF1	Conversion Factor	0.001	mg/µg	-	
				BW	Body Weight	70	kg	EPA 1989	
				AT-NC	Averaging Time (noncancer)	9,125	days	EPA 1989	AT-NC = ED*365
				AT- C	Averaging Time (cancer)	25,550	days	EPA 1989	AT-C = 70*365
Dermal				Csw	Chemical Concentration in Surface Water	max or 95% UCL of mean	µg/L	Site-specific	Dermal Absorbed Dose (DAD) (mg/kg/day) = DA_{event} x SAw x EV x EF x ED x 1/BW x 1/AT
				DA_{event}	Dose absorbed per unit area per event	Chem.-specific	mg/cm^2-event	EPA 2001b	Where DA_{event} (mg/cm^2-event) is calculated in accordance
				SAw	Skin surface area available for contact	6,600	cm^2	EPA 1997a	with Draft EPA Superfund Dermal Risk Guidance (EPA, 2001a)
				ET	Exposure Time	8	hr/day	Site-specific	
				EV	Event	1	event/day	EPA 2001b	
				EF	Exposure Frequency	34	days/yr	AFCEE 2004b	
				ED	Exposure Duration	25	yrs	EPA 1991b	
				BW	Body Weight	70	kg	EPA 1989	
				AT-NC	Averaging Time (noncancer)	9,125	days	EPA 1989	AT-NC = ED*365
				AT- C	Averaging Time (cancer)	25,550	days	EPA 1989	AT-C = 70*365
Ingestion	Wader	Adult	Backhus River	Csw	Chemical Concentration in Surface Water	max or 95% UCL of mean	µg/L	Site-specific	Chronic Daily Intake (CDI) (mg/kg/day) = Csw x IRsw x EF x ED x CF1 x 1/BW x 1/AT
				IRsw	Ingestion Rate of Surface Water	0.05	L/day	EPA 1998	
				EF	Exposure Frequency	104	days/yr	EPA 1998	
				ED	Exposure Duration	24	yrs	EPA 1989	
				CF1	Conversion Factor	0.001	mg/µg	-	
				BW	Body Weight	70	kg	EPA 1989	
				AT-NC	Averaging Time (noncancer)	8,760	days	EPA 1989	AT-NC = ED*365
				AT- C	Averaging Time (cancer)	25,550	days	EPA 1989	AT-C = 70*365
Dermal				Csw	Chemical Concentration in Surface Water	max or 95% UCL of mean	µg/L	Site-specific	Dermal Absorbed Dose (DAD) (mg/kg/day) = DA_{event} x SAw x EV x EF x ED x 1/BW x 1/AT
				DA_{event}	Dose absorbed per unit area per event	Chem.-specific	mg/cm^2-event	EPA 2001b	Where DA_{event} (mg/cm^2-event) is calculated in accordance
				SAw	Skin surface area available for contact	6,900	cm^2	EPA 1997a	with Draft EPA Superfund Dermal Risk Guidance (EPA 2001b)
				ET	Exposure Time	1	hr/day	ANG 1994	
				EV	Event	1	event/day	EPA 2001b	
				EF	Exposure Frequency	104	days/yr	EPA 1998	
				ED	Exposure Duration	24	yrs	EPA 1989	
				BW	Body Weight	70	kg	EPA 1989	

Table 2-11
Values Used For Daily Intake Calculations
Reasonable Maximum EXxposure
Ashumet Valley, Backus River Surface Water

Scenario Timeframe:	Current/Future
Medium:	Surface Water
Exposure Medium:	Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/Model Name
				AT-NC	Averaging Time (noncancer)	8,760	days	EPA 1989	AT-NC = ED*365
				AT- C	Averaging Time (cancer)	25,550	days	EPA 1989	AT-C = 70*365
Ingestion	Wader	Child	Backhus River	Csw	Chemical Concentration in Surface Water	max or 95% UCL of mean	µg/L	Site-specific	Chronic Daily Intake (CDI) (mg/kg/day) = Csw x IRsw x EF x ED x CF1 x 1/BW x 1/AT
				IRsw	Ingestion Rate of Surface Water	0.05	L/day	EPA 1998	
				EF	Exposure Frequency	104	days/yr	EPA 1998	
				ED	Exposure Duration	6	yrs	EPA 1989	Age-specific value
				CF1	Conversion Factor	0.001	mg/µg	-	
				BW	Body Weight	15	kg	EPA 1989	
				AT-NC	Averaging Time (noncancer)	2,190	days	EPA 1989	AT-NC = ED*365
				AT- C	Averaging Time (cancer)	25,550	days	EPA 1989	AT-C = 70*365
Dermal				Csw	Chemical Concentration in Surface Water	max or 95% UCL of mean	µg/L	Site-specific	Dermal Absorbed Dose (DAD) (mg/kg/day) = DA_{event} x SAw x EV x EF x ED x 1/BW x 1/AT
				DA_{event}	Dose absorbed per unit area per event	Chem.-specific	mg/cm^2-event	EPA 2001b	Where DA_{event} (mg/cm^2-event) is calculated in accordance
				SAw	Skin surface area available for contact	2,800	cm^2	EPA 2001b	with Draft EPA Superfund Dermal Risk Guidance (EPA, 2001a)
				ET	Exposure Time	1	hr/day	ANG 1994	
				EV	Event	1	event/day	EPA 2001b	
				EF	Exposure Frequency	104	days/yr	EPA 1998	
				ED	Exposure Duration	6	yrs	EPA 1989	
				BW	Body Weight	15	kg	EPA 1989	
				AT-NC	Averaging Time (noncancer)	2,190	days	EPA 1989	AT-NC = ED*365
				AT- C	Averaging Time (cancer)	25,550	days	EPA 1989	AT-C = 70*365

Notes:
cm^2 = square centimeter
hr = hours
kg = kilograms
L = liters
mg = milligrams
yrs = years
µg= micrograms

Table 2-12
Values Used For Daily Intake Calculations
Reasonable Maximum Exposure
Ashumet Valley Backus River, Fish Tissue

Scenario Timeframe:	Current/Future
Medium:	Surface Water
Exposure Medium:	Fish Tissue

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/Model Name
Ingestion	Recreational Fisherman	Adult	Backus River	Csw	Chemical Concentration in Surface Water	Chem.-specific Maximum	mg/L	-	Chronic Daily Intake (CDI) (mg/kg/day) = Csw x BAF x IRf x FI x EF x ED x CF1 x 1/BW x 1/AT
				BAF	Bioaccumulation Factor	Chem.-specific	L/kg		
				IRf	Ingestion Rate, Fish	26	g/day	AFCEE 2004b	
				FI	Fraction Ingested	1	dimensionless	Assumption	
				EF	Exposure Frequency	350	days/yr	EPA 1991a	
				ED	Exposure Duration	30	yrs	EPA 1989	
				CF1	Conversion Factor	0.001	kg/g	-	
				BW	Body Weight	70	kg	EPA 1989	
				AT-NC	Averaging Time (noncancer)	10,950	days	EPA 1989	AT-NC = ED*365
				AT- C	Averaging Time (cancer)	25,550	days	EPA 1989	AT-C = 70*365

Notes:
g = grams
kg = kilograms
L = liters
mg = milligrams
yrs = years

Table 2-13
Non-Cancer Toxicity Data - Oral/Dermal, Ashumet Valley

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal RfD (1)	Units	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (MM/DD/YY)
bis(2-ethylhexyl)phthalate (BEHP)	Chronic	2.0E-02	mg/kg/day	none	2.0E-02	mg/kg/day	Liver	1000	IRIS	05/01/91
1,3-Dichlorobenzene	Chronic	9.0E-04	mg/kg/day	none	9.0E-04	mg/kg/day	NA	NA	NCEA	10/01/02
1,4-Dichlorobenzene	Chronic	3.0E-02	mg/kg/day	none	3.0E-02	mg/kg/day	NA	NA	NCEA	10/01/02
Benzene	Chronic	4.0E-03	mg/kg/day	none	4.0E-03	mg/kg/day	Lymph	300	IRIS	04/17/03
Chloroform	Chronic	1.0E-02	mg/kg/day	none	1.0E-02	mg/kg/day	Liver	1000	IRIS	10/19/01
cis-1,2-Dichloroethene	Chronic	1.0E-02	mg/kg/day	none	1.0E-02	mg/kg/day	NA	NA	HEAST	7/97
Tetrachloroethene (PCE)	Chronic	1.0E-02	mg/kg/day	none	1.0E-02	mg/kg/day	Liver	1000	IRIS	03/01/98
Trichloroethene (TCE)	Chronic	3.0E-04	mg/kg/day	none	3.0E-04	mg/kg/day	Liver	NA	NCEA	10/01/02
2-Methylnaphthalene	Chronic	4.0E-03	mg/kg/day	none	4.0E-03	mg/kg/day	Lungs	1000	IRIS	12/22/03
Naphthalene	Chronic	2.0E-02	mg/kg/day	none	2.0E-02	mg/kg/day	Body Weight	3000	IRIS	09/17/98
Antimony	Chronic	4.0E-04	mg/kg/day	1.5E-01	6.0E-05	mg/kg/day	Blood	1000	IRIS	02/01/91
Arsenic	Chronic	3.0E-04	mg/kg/day	none	3.0E-04	mg/kg/day	Skin	3	IRIS	02/01/93
Cadmium	Chronic	5.0E-04	mg/kg/day	2.5E-02	1.3E-05	mg/kg/day	Kidney	10	IRIS	002/01/94
Copper	Chronic	4.0E-02	mg/kg/day	none	4.0E-02	mg/kg/day	NA	NA	HEAST	07/01/97
Lead	Chronic	NA	mg/kg/day	none	ND	mg/kg/day	NA	NA	IRIS	02/01/91
Manganese	Chronic	2.4E-02	mg/kg/day	4.0E-02	9.6E-04	mg/kg/day	CNS	1	EPA Region 1	11/96
Thallium	Chronic	6.6E-05	mg/kg/day	none	6.6E-05	mg/kg/day	Liver	3000	HEAST	07/01/97

Notes:
(1) EPA 2001b (September). Risk Assessment Guidance for Superfund (RAGS): Volume I: Human Health Evaluation Manual. (Part E, Supplemental Guidance for Dermal Risk Assessment). Interim Guidance.
EPA 1996a. Region I, Risk Updates, Number 4. November 1996.
EPA 1999b. Region I, Risk Updates, Number 5. September 1999.
EPA 2002b. U.S. EPA Region 9 PRGs Table 2002 Update, October 1, 2002
References are located in Appendix A of *Final Ashumet Valley Groundwater Feasibility Study* (AFCEE 2007a)
CNS = central nervous system
HEAST=Health Effects Assessment Summary Tables
IRIS =Integrated Risk Information System. Online database. Accessed 05/10/2004 EPA, 2004.
mg/kg/day = milligrams per kilogram per day
NA = not available
NCEA = National Center for Environmental Assessment
ND = not determined
PRG = preliminary remediation goal
RfD = reference dose

Table 2-14
Non-Cancer Toxicity Data - Inhalation, Ashumet Valley

Chemical of Potential Concern	Chronic/ Subchronic	Value Inhalation RfC	Units	Adjusted (1) Inhalation RfD	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfD: Target Organ	Dates (MM/YY)
bis(2-ethylhexyl)phthalate (BEHP)	Chronic	NA	mg/m^3	NA	mg/kg/day	NA	NA	IRIS	10/29/03
1,3-Dichlorobenzene	Chronic	NA	mg/m^3	NA	mg/kg/day	NA	NA	IRIS	05/10/04
1,4-Dichlorobenzene	Chronic	8.0E-01	mg/m^3	2.3E-01	mg/kg/day	Liver	100	IRIS	11/01/96
Benzene	Chronic	3.0E-02	mg/m^3	8.6E-03	mg/kg/day	Lymph	300	IRIS	04/17/03
Chloroform	Chronic	3.0E-03	mg/m^3	8.6E-04	mg/kg/day	NA	NA	NCEA	10/29/03
cis-1,2-Dichloroethene	Chronic	NA	mg/m^3	NA	mg/kg/day	NA	NA	IRIS	02/13/04
Tetrachloroethene (PCE)	Chronic	6.0E-01	mg/m^3	1.7E-01	mg/kg/day	NA	NA	NCEA	10/29/03
Trichloroethene (TCE)	Chronic	4.0E-02	mg/m^3	1.0E-02	mg/kg/day	CNS, Liver, ES	NA	EPA, 2001	10/01/02
2-Methylnaphthalene	Chronic	NA	mg/m^3	NA	mg/kg/day	NA	NA	IRIS	12/22/03
Naphthalene	Chronic	3.0E-03	mg/m^3	8.6E-04	mg/kg/day	Lungs	3000	IRIS	09/17/98

Notes:
EPA 2002b. U.S. EPA Region 9 PRGs Table 2002 Update, October 1, 2002
References are located in Appendix A of *Final Ashumet Valley Groundwater Feasibility Study* (AFCEE 2007a)
(1) Adjustment factor applied to inhalation RfC to calculate inhalation RfD = 20 m^3/day x 1/70 kg.
CNS = central nervous system
IRIS =Integrated Risk Information System. Online database. Accessed 05/10/04 EPA, 2004.
mg/kg/day = milligrams per kilogram per day
mg/m^3= milligrams per cubic meter
NA = not available
NCEA = National Center for Environmental Assessment
PRG = preliminary remediation goal
RfC = reference concentration
RfD = reference dose

Table 2-15
Cancer Toxicity Data - Oral/Dermal, Ashumet Valley

Chemical of Potential Concern	Oral Cancer Slope Factor	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal Cancer Slope Factor (1)	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date
bis(2-ethylhexyl)phthalate (BEHP)	1.4E-02	none	1.4E-02	$(mg/kg/day)^{-1}$	B2	IRIS	02/01/93
1,3-Dichlorobenzene	NA	none	NA	$(mg/kg/day)^{-1}$	D	IRIS	09/01/90
1,4-Dichlorobenzene	2.4E-02	none	2.4E-02	$(mg/kg/day)^{-1}$	ND	HEAST	7/97
Benzene	5.5E-02	none	5.5E-02	$(mg/kg/day)^{-1}$	A	IRIS	01/09/00
Chloroform	NA	ND	NA	$(mg/kg/day)^{-1}$	B2	IRIS	10/19/01
cis-1,2-Dichloroethene	NA	ND	NA	$(mg/kg/day)^{-1}$	D	IRIS	02/01/95
Tetrachloroethene (PCE)	5.4E-01	none	5.4E-01	$(mg/kg/day)^{-1}$	NA	EPA 2003a	06/12/03
Trichloroethene (TCE)	4.0E-01	none	4.0E-01	$(mg/kg/day)^{-1}$	NA	EPA 2003a	10/01/02
2-Methylnaphthalene	NA	none	NA	$(mg/kg/day)^{-1}$	D	IRIS	12/22/03
Naphthalene	NA	none	NA	$(mg/kg/day)^{-1}$	C	IRIS	09/17/98
Antimony	NA	none	NA	$(mg/kg/day)^{-1}$	NA	IRIS	05/10/04
Arsenic	1.5E+00	none	1.5E+00	$(mg/kg/day)^{-1}$	A	IRIS	04/10/98
Cadmium	NA	none	NA	$(mg/kg/day)^{-1}$	B1	IRIS	06/01/92
Copper	NA	none	NA	$(mg/kg/day)^{-1}$	D	IRIS	08/01/91
Lead	NA	none	NA	$(mg/kg/day)^{-1}$	B2	IRIS	11/01/93
Manganese	NA	ND	NA	$(mg/kg/day)^{-1}$	D	IRIS	12/01/96
Thallium	NA	none	NA	$(mg/kg/day)^{-1}$	D	IRIS	10/29/02

Notes:

(1) EPA 2001b (September). Risk Assessment Guidance for Superfund (RAGS): Volume I: Human Health Evaluation Manual. (Part E, Supplemental Guidance for Dermal Risk Assessment). Interim Guidance

EPA 2003a. U.S. EPA Region 1 Comments on the *Draft Work Plan for the Process Leading to Final Remedial Decisions for Ashumet Valley and Landfill-1* . October 16, 2003.

References are located in Appendix A of *Final Ashumet Valley Groundwater Feasibility Study* (AFCEE 2007a)

HEAST - Toxicity values were obtained from Health Effects Assessment Summary Tables (HEAST) Annual FY-1997. EPA 1997c.

IRIS =Integrated Risk Information System. Online database. Accessed 05/10/04. EPA 2004.

mg/kg/day = milligrams per kilogram per day

NA = not available

ND = not determined

EPA Weight of Evidence Classification:

- A - Human carcinogen
- B1 - Probable human carcinogen - indicates that limited human data are available
- B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
- C - Possible human carcinogen
- D - Not classifiable as a human carcinogen

Table 2-16
Cancer Toxicity - Inhalation, Ashumet Valley

Chemical of Potential Concern	Unit Risk	Units	Adjustment (1)	Inhalation Cancer Slope Factor (1)	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date
bis(2-ethylhexyl)phthalate (BEHP)	NA	$(mg/m^3)^{-1}$	3.5E+00	NA	$(mg/kg/day)^{-1}$	B2	IRIS	02/13/04
1,3-Dichlorobenzene	NA	$(mg/m^3)^{-1}$	3.5E+00	NA	$(mg/kg/day)^{-1}$	D	IRIS	09/01/90
1,4-Dichlorobenzene	NA	$(mg/m^3)^{-1}$	3.5E+00	NA	(mg/kg/day)-1	NA	IRIS	02/13/04
Benzene	7.8E-03	$(mg/m^3)^{-1}$	3.5E+00	2.7E-02	$(mg/kg/day)^{-1}$	A	IRIS	01/09/00
Chloroform	2.3E-02	$(mg/m^3)^{-1}$	3.5E+00	8.1E-02	$(mg/kg/day)^{-1}$	B2	IRIS	10/19/01
cis-1,2-Dichloroethene	NA	$(mg/m^3)^{-1}$	3.5E+00	NA	$(mg/kg/day)^{-1}$	D	IRIS	02/01/95
Tetrachloroethene (PCE)	5.9E-03	$(mg/m^3)^{-1}$	3.5E+00	2.1E-02	$(mg/kg/day)^{-1}$	NA	EPA 2003a	06/12/03
Trichloroethene (TCE)	1.1E-01	$(mg/m^3)^{-1}$	3.5E+00	3.9E-01	$(mg/kg/day)^{-1}$	NA	EPA 2003a	06/12/03
2-Methylnaphthalene	NA	$(mg/m^3)^{-1}$	3.5E+00	NA	$(mg/kg/day)^{-1}$	D	IRIS	12/22/03
Naphthalene	NA	$(mg/m^3)^{-1}$	3.5E+00	NA	$(mg/kg/day)^{-1}$	C	IRIS	09/17/98

Notes:

(1) Adjustment factor applied to Unit Risk to calculate Inhalation Slope Factor = 70 kg x 1/20 m^3/day

EPA 2002b. U.S. EPA Region 9 PRGs Table 2002 Update, October 1, 2002.

EPA 2003a. U.S. EPA Region 1 Comments on the *Draft Work Plan for the Process Leading to Final Remedial Decisions for Ashumet Valley and Landfill-1* . October 16, 2003.

References are located in Appendix A of *Final Ashumet Valley Groundwater Feasibility Study* (AFCEE 2007a)

IRIS =Integrated Risk Information System. Online database. Accessed 05/10/04. EPA 2004.

mg/kg/day = milligrams per kilogram per day

NA = not available

PRG = preliminary remediation goal

$\mu g/m^3$ = micrograms per cubic meter

EPA Weight of Evidence Classification:

A - Human carcinogen

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

B1 - Probable human carcinogen - indicates that limited human data are available

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

Table 2-17
Risk Summary
Reasonable Maximum Exposure
Ashumet Valley Groundwater, Within the Capture Zone, Adult

Scenario Timeframe:	Future
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Within the Capture Zone - Tap Water	cis-1,2-Dichloroethene					NA	2.3E-01	NA	2.1E-02	2.5E-01
			Tetrachloroethene (PCE)	1.1E-04	NA	6.8E-05	1.8E-04					
			Trichloroethene (TCE)	1.7E-04	NA	2.9E-05	1.9E-04	Liver	4.0E+00	NA	7.0E-01	4.7E+00
			Arsenic	4.9E-05	NA	2.6E-07	5.0E-05	Skin	3.2E-01	NA	1.7E-03	3.2E-01
			Manganese					CNS	6.5E+00	NA	8.6E-01	7.4E+00
			Thallium					Liver	1.9E+00	NA	1.0E-02	1.9E+00
			Chemical Total	3.2E-04	NA	9.8E-05	4.2E-04		1.3E+01	NA	1.6E+00	1.5E+01
		Exposure Point Total					4.2E-04					1.5E+01
	Groundwater	Within the Capture Zone - Vapor	cis-1,2-Dichloroethene					NA	NA	NA	NA	NA
			Tetrachloroethene (PCE)	NA	2.6E-05	NA	2.6E-05					
			Trichloroethene (TCE)	NA	9.9E-04	NA	9.9E-04	CNS, Liver, ES	NA	5.3E-01	NA	5.3E-01
			Chemical Total	NA	1.0E-03	NA	1.0E-03		NA	5.3E-01	NA	5.3E-01
		Exposure Point Total					1.0E-03					5.3E-01
	Exposure Medium Total						1.4E-03					1.5E+01
Medium Total							1.4E-03					1.5E+01
Receptor Total							1.4E-03				Receptor HI Total	1.5E+01

Total HI Across All Media	Skin	3.2E-01
Total HI Across All Media	Liver	6.6E+00
Total HI Across All Media	CNS	7.4E+00
Total HI Across All Media	CNS, Liver, ES	5.3E-01

Notes:
CNS = central nervous system
ES = endocrine system
HI = hazard index
NA = not available

Table 2-18
Risk Summary
Reasonable Maximum Exposure
Ashumet Valley Groundwater, Within the Capture Zone, Child

Scenario Timeframe:	Future
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Within the Capture Zone - Tap Water	cis-1,2-Dichloroethene					NA	5.3E-01	NA	4.8E-02	5.8E-01
			Tetrachloroethene (PCE)	6.3E-05	NA	3.8E-05	1.0E-04	Liver	1.4E-01	NA	8.3E-02	2.2E-01
			Trichloroethene (TCE)	9.7E-05	NA	1.6E-05	1.1E-04	Liver	9.4E+00	NA	1.6E+00	1.1E+01
			Arsenic	2.9E-05	NA	1.9E-07	2.9E-05	Skin	7.5E-01	NA	4.9E-03	7.5E-01
			Manganese					CNS	1.5E+01	NA	2.5E+00	1.8E+01
			Thallium					Liver	4.5E+00	NA	2.9E-02	4.5E+00
			Chemical Total	1.9E-04	NA	5.5E-05	2.4E-04		3.0E+01	NA	4.3E+00	3.5E+01
		Exposure Point Total					2.4E-04					3.5E+01
	Exposure Medium Total											
Medium Total							2.4E-04					3.5E+01
Receptor Total							2.4E-04				Receptor HI Total	3.5E+01

Total HI Across All Media	Skin	7.5E-01
Total HI Across All Media	Liver	1.6E+01
Total HI Across All Media	CNS	1.8E+01

Notes:
CNS = central nervous system
HI = hazard index
NA = not available

Table 2-19
Risk Summary
Reasonable Maximum Exposure
Ashumet Valley Groundwater, Outside the Capture Zone, North of Route 151, Adult

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Outside the Capture Zone North of Route 151-Tap Water	Benzene	7.8E-07	NA	1.2E-07	9.0E-07					
			1,3-Dichlorobenzene									
			1,4-Dichlorobenzene	1.2E-06	NA	8.6E-07	2.1E-06					
			Chloroform	NA	NA	NA	NA	Liver	2.3E-02	NA	2.2E-03	2.6E-02
			cis-1,2-Dichloroethene					NA	1.3E-01	NA	1.2E-02	1.4E-01
			Tetrachloroethene (PCE)	2.1E-04	NA	1.3E-04	3.4E-04	Liver	1.1E-01	NA	7.1E-02	1.8E-01
			Trichloroethene (TCE)	3.5E-05	NA	6.2E-06	4.1E-05	Liver	8.6E-01	NA	1.5E-01	1.0E+00
			2-Methylnaphthalene					Lungs	1.2E-01	NA	1.9E-01	3.0E-01
			Naphthalene					Body Weight	6.8E-02	NA	4.8E-02	1.2E-01
			Antimony					Blood	4.5E-01	NA	1.6E-02	4.6E-01
			Arsenic	2.5E-04	NA	1.3E-06	2.5E-04	Skin	1.6E+00	NA	8.4E-03	1.6E+00
			Cadmium					Kidney	3.5E-01	NA	7.4E-02	4.2E-01
			Copper					NA	2.1E-01	NA	1.1E-03	2.1E-01
			Manganese					CNS	4.6E+00	NA	6.0E-01	5.2E+00
			Thallium					Liver	3.3E+00	NA	1.7E-02	3.3E+00
			Chemical Total	4.9E-04	NA	1.4E-04	6.3E-04		1.2E+01	NA	1.2E+00	1.3E+01
		Exposure Point Total					6.3E-04					1.3E+01
	Groundwater	Outside the Capture Zone North of Route 151-Vapor	Benzene	NA	2.4E-06	NA	2.4E-06					
			1,3-Dichlorobenzene	NA	NA	NA	NA					
			1,4-Dichlorobenzene	NA	NA	NA	NA					
			Chloroform	NA	4.1E-05	NA	4.1E-05	NA	NA	1.4E+00	NA	1.4E+00
			cis-1,2-Dichloroethene					NA	NA	NA	NA	NA
			Tetrachloroethene (PCE)	NA	4.9E-05	NA	4.9E-05	NA	NA	3.3E-02	NA	3.3E-02
			Trichloroethene (TCE)	NA	2.1E-04	NA	2.1E-04	CNS, Liver, ES	NA	1.1E-01	NA	1.1E-01
			2-Methylnaphthalene					NA	NA	NA	NA	NA
			Naphthalene					Lungs	NA	8.0E+00	NA	8.0E+00
			Chemical Total	NA	3.0E-04	NA	3.0E-04		NA	9.5E+00	NA	9.5E+00
		Exposure Point Total					3.0E-04					9.5E+00
	Exposure Medium Total						9.4E-04					2.2E+01
Medium Total							9.4E-04					2.2E+01
Receptor Total							9.4E-04				Receptor HI Total	2.2E+01

Total HI Across All Media	Skin	1.6E+00
Total HI Across All Media	Liver	4.5E+00
Total HI Across All Media	CNS	5.2E+00
Total HI Across All Media	Lungs	8.3E+00
Total HI Across All Media	Body Weight	1.2E-01
Total HI Across All Media	Blood	4.6E-01
Total HI Across All Media	Kidney	4.2E-01
Total HI Across All Media	CNS, Liver, ES	1.1E-01

Notes:
CNS = central nervous system
ES = endocrine system
HI = hazard index
NA = not available

Table 2-20
Risk Summary
Reasonable Maximum Exposure
Ashumet Valley Groundwater, Outside the Capture Zone, North of Route 151, Child

Scenario Timeframe	Future
Receptor Population	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Outside the Capture Zone North of Route 151 Tap Water	Benzene									
			1,3-Dichlorobenzene					NA	6.2E-02	NA	5.8E-02	1.2E-01
			1,4-Dichlorobenzene	7.1E-07	NA	4.8E-07	1.2E-06					
			cis-1,2-Dichloroethene					NA	2.9E-01	NA	2.7E-02	3.2E-01
			Tetrachloroethene (PCE)	1.2E-04	NA	7.4E-05	1.9E-04	Liver	2.6E-01	NA	1.6E-01	4.2E-01
			Trichloroethene (TCE)	2.1E-05	NA	3.5E-06	2.4E-05	Liver	2.0E+00	NA	3.4E-01	2.3E+00
			2-Methylnaphthalene					Lungs	2.7E-01	NA	4.2E-01	6.9E-01
			Naphthalene					Body Weight	1.6E-01	NA	1.1E-01	2.7E-01
			Antimony					Blood	1.0E+00	NA	4.6E-02	1.1E+00
			Arsenic	1.4E-04	NA	9.5E-07	1.5E-04	Skin	3.7E+00	NA	2.5E-02	3.8E+00
			Cadmium					Kidney	8.2E-01	NA	2.2E-01	1.0E+00
			Copper					NA	4.9E-01	NA	3.2E-03	4.9E-01
			Manganese					CNS	1.1E+01	NA	1.8E+00	1.2E+01
			Thallium					Liver	7.7E+00	NA	5.1E-02	7.7E+00
			Chemical Total	2.9E-04	NA	7.9E-05	3.6E-04		2.7E+01	NA	3.2E+00	3.1E+01
		Exposure Point Total					3.6E-04					3.1E+01
Medium Total							3.6E-04					3.1E+01
Receptor Total							3.6E-04				Receptor HI Total	3.1E+01

Total HI Across All Media	Skin	3.8E+00
Total HI Across All Media	Liver	1.0E+01
Total HI Across All Media	CNS	1.2E+01
Total HI Across All Media	Lungs	6.9E-01
Total HI Across All Media	Body Weight	2.7E-01
Total HI Across All Media	Blood	1.1E+00
Total HI Across All Media	Kidney	1.0E+00

Notes:
CNS = central nervous system
HI = hazard index
NA = not available

Table 2-21
Risk Summary
Reasonable Maximum Exposure
Ashumet Valley Groundwater, Outside the Capture Zone, South of Route 151, Adult

Scenario Timeframe:	Future
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Outside the Capture Zone South of Route 151 - Tap Water	Tetrachloroethene (PCE)	2.7E-04	NA	1.7E-04	4.4E-04	Liver	1.4E-01	NA	9.1E-02	2.3E-01
			Trichloroethene (TCE)	6.0E-05	NA	1.1E-05	7.1E-05	Liver	1.5E+00	NA	2.6E-01	1.7E+00
			bis(2-ethylhexyl)phthalate (BEHP)	7.3E-06	NA	1.2E-05	1.9E-05	#N/A	7.6E-02	NA	1.3E-01	2.0E-01
			Cadmium					Kidney	1.5E-01	NA	3.1E-02	1.8E-01
			Manganese					CNS	2.7E+00	NA	3.6E-01	3.1E+00
			Chemical Total	3.3E-04	NA	1.9E-04	5.3E-04		4.6E+00	NA	8.6E-01	5.4E+00
		Exposure Point Total					5.3E-04					5.4E+00
	Groundwater	Outside the Capture Zone South of Route 151 - Tap Water	Tetrachloroethene (PCE)	NA	6.4E-05	NA	6.4E-05	NA	NA	4.2E-02	NA	4.2E-02
			Trichloroethene (TCE)	NA	3.6E-04	NA	3.6E-04	CNS, Liver, ES	NA	3.2E-02	NA	3.2E-02
			bis(2-ethylhexyl)phthalate (BEHP)	NA	NA	NA	NA	#N/A	NA	NA	NA	NA
			Chemical Total	NA	4.3E-04	NA	4.3E-04		NA	7.5E-02	NA	7.5E-02
		Exposure Point Total					4.3E-04					7.5E-02
	Exposure Medium Total						9.5E-04					5.5E+00
Medium Total							9.5E-04					5.5E+00
Receptor Total							9.5E-04				Receptor HI Total	5.5E+00

Total HI Across All Media	Liver	2.0E+00
Total HI Across All Media	CNS	3.1E+00
Total HI Across All Media	Kidney	1.8E-01
Total HI Across All Media	CNS, Liver, ES	3.2E-02

Notes:
CNS = central nervous system
ES = endocrine system
HI = hazard index
NA = not available

Table 2-22
Risk Summary
Reasonable Maximum Exposure
Ashumet Valley Groundwater, Outside the Capture Zone, South of Route 151, Child

Scenario Timeframe	Future
Receptor Population	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Outside the Capture Zone South of Route 151 - Tap Water	Tetrachloroethene (PCE)	1.6E-04	NA	9.5E-05	2.5E-04	Liver	3.3E-01	NA	2.0E-01	5.4E-01
			Trichloroethene (TCE)	3.5E-05	NA	5.9E-06	4.1E-05	Liver	3.4E+00	NA	5.7E-01	4.0E+00
			bis(2-ethylhexyl)phthalate (BEHP)	4.3E-06	NA	6.8E-06	1.1E-05	#N/A	1.8E-01	NA	2.8E-01	4.6E-01
			Cadmium					Kidney	3.5E-01	NA	9.1E-02	4.4E-01
			Manganese					CNS	6.4E+00	NA	1.1E+00	7.4E+00
			Chemical Total	1.9E-04	NA	1.1E-04	3.0E-04		1.1E+01	NA	2.2E+00	1.3E+01
		Exposure Point Total					3.0E-04					1.3E+01
	Exposure Medium Total						3.0E-04					1.3E+01
Medium Total							3.0E-04					1.3E+01
Receptor Total							3.0E-04				Receptor HI Total	1.3E+01

Total HI Across All Media	Liver	4.5E+00
Total HI Across All Media	CNS	7.4E+00
Total HI Across All Media	Kidney	4.4E-01

Notes:
CNS = central nervous system
HI = hazard index
NA = not available

Table 2-23
Risk Summary
Reasonable Maximum Exposure
Ashumet Valley, Backus River Surface Water, Cranberry Worker

Scenario Timeframe:	Future
Receptor Population:	Cranberry Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water	Surface Water	Backus River Surface Water	Tetrachloroethene (PCE)	2.6E-08	NA	1.1E-06	1.1E-06	(intentionally blank)				
			bis(2-ethylhexyl)phthalate (BEHP)	1.1E-07	NA	9.5E-06	9.6E-06					
			Chemical Total	1.3E-07	NA	1.1E-05	1.1E-05		NA	NA	NA	0.0E+00
		Exposure Point Total					1.1E-05					0.0E+00
	Exposure Medium Total						1.1E-05					0.0E+00
Medium Total							1.1E-05					0.0E+00
Receptor Total							1.1E-05				Receptor HI Total	0.0E+00

Total HI Across All Media	Liver	0.0E+00
Total HI Across All Media	Skin	0.0E+00
Total HI Across All Media	CNS	0.0E+00

Notes:
CNS = central nervous system
HI = hazard index
NA = not available

Table 2-24
Risk Summary
Reasonable Maximum Exposure
Ashumet Valley, Backus River Surface Water, Adult Wader

Scenario Timeframe:	Future
Receptor Population:	Wader
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water	Surface Water	Backus River Surface Water	Tetrachloroethene (PCE)	7.7E-08	NA	9.8E-07	1.1E-06					
			bis(2-ethylhexyl)phthalate (BEHP)	3.1E-07	NA	1.0E-05	1.1E-05	#N/A	3.2E-03	NA	1.1E-01	1.1E-01
			Chemical Total	3.9E-07	NA	1.1E-05	1.2E-05		3.2E-03	NA	1.1E-01	1.1E-01
		Exposure Point Total					1.2E-05					1.1E-01
	Exposure Medium Total						1.2E-05					1.1E-01
Medium Total							1.2E-05					1.1E-01
Receptor Total							1.2E-05	Receptor HI Total				1.1E-01

Total HI Across All Media	Liver	0.0E+00
Total HI Across All Media	Skin	0.0E+00
Total HI Across All Media	CNS	0.0E+00

Notes:
CNS = central nervous system
HI = hazard index
NA = not available

Table 2-25
Risk Summary
Reasonable Maximum Exposure
Ashumet Valley, Backus River Surface Water, Child Wader

Scenario Timeframe:	Future
Receptor Population:	Wader
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water	Surface Water	Backus River Surface Water	bis(2-ethylhexyl)phthalate (BEHP)	3.6E-07	NA	4.9E-06	5.3E-06	(intentionally blank)				
			Chemical Total	3.6E-07	NA	4.9E-06	5.3E-06		NA	NA	NA	0.0E+00
		Exposure Point Total					5.3E-06					0.0E+00
	Exposure Medium Total						5.3E-06					0.0E+00
Medium Total							5.3E-06					0.0E+00
Receptor Total							5.3E-06				Receptor HI Total	0.0E+00

Total HI Across All Media	Liver	0.0E+00
Total HI Across All Media	Skin	0.0E+00
Total HI Across All Media	CNS	0.0E+00

Notes:
CNS = central nervous system
HI = hazard index
NA = not available

Table 2-26
Risk Summary
Reasonable Maximum Exposure
Ashumet Valley, Backus River Surface Water, Adult Fish Consumer

Scenario Timeframe:	Future
Receptor Population:	Fish Eater
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water	Fish	Backus River Surface Water	Tetrachloroethene (PCE)	8.4E-06	NA	NA	8.4E-06					
			Trichloroethene (TCE)	2.7E-06	NA	NA	2.7E-06					
			bis(2-ethylhexyl)phthalate (BEHP)	2.4E-04	NA	NA	2.4E-04	#N/A	2.0E+00	NA	NA	2.0E+00
			Arsenic	1.1E-05	NA	NA	1.1E-05					
			Chemical Total	2.6E-04	NA	NA	2.6E-04		2.0E+00	NA	NA	2.0E+00
		Exposure Point Total					2.6E-04					2.0E+00
	Exposure Medium Total						2.6E-04					2.0E+00
Medium Total							2.6E-04					2.0E+00
Receptor Total							2.6E-04				Receptor HI Total	2.0E+00

Total HI Across All Media	Liver	0.0E+00
Total HI Across All Media	Skin	0.0E+00
Total HI Across All Media	CNS	0.0E+00

Notes:
CNS = central nervous system
HI = hazard index
NA = not available

Table 2-27
Identification of Contaminants of Concern for Ashumet Valley

Area	COPC	RME EPC (µg/L)	Total Adult HI	Total Child HI	ELCR	COC (Yes/No)	Comments
Groundwater Within the Capture Zone							
	Arsenic	3.5 (J)	3.E-01	8.E-01	8.E-05	No	equivalent to background
	cis-1,2 Dichloroethene (cis-1,2 DCE)	82.6	3.E-01	6.E-01	NA	No	low risk
	Manganese	5710	7.E+00	2.E+01	NA	**Yes**	
	Tetrachloroethene (PCE)	21.2	1.E-01	2.E-01	3.E-04	**Yes**	
	Thallium	4.6 (J)	2.E+00	5.E+00	NA	**Yes**	
	Trichloroethene (TCE)	44	5.E+00	1.E+01	1.E-03	**Yes**	
Groundwater Outside the Capture Zone North of Route 151							
	1,3-Dichlorobenzene	0.87(J)	5.E-02	1.E-01		No	low risk
	1,4-Dichlorobenzene	5.4	1.E-02	2.E-02	3.E-06	No	low risk
	2-Methylnaphthalene	17	3.E-01	7.E-01		No	low risk
	Antimony	6.5	5.E-01	1.E+00		No	low risk
	Arsenic	17.5	2.E+00	4.E+00	4.E-04	No	equivalent to background
	Benzene	1.5	4.E-02	3.E-02	4.E-05	No	low risk
	Cadmium	6.4	4.E-01	1.E+00		No	low risk
	Chloroform	8.57	1.E+00	6.E-02	4.1.E-05	No	equivalent to background
	cis-1,2 Dichloroethene (cis-1,2 DCE)	46	1.E-01	3.E-01		No	low risk
	Copper	306	2.E-01	5.E-01		No	low risk
	Manganese	3990	5.E+00	1.E+01		**Yes**	
	Naphthalene	50	8.E+00	3.E-01		No	see note 1
	Tetrachloroethene (PCE)	40.8	2.E-01	4.E-01	6.E-04	**Yes**	
	Thallium	7.9 (J)	3.E+00	8.E+00		**Yes**	exceeds MCL
	Trichloroethene (TCE)	9.37	1.E+00	2.E+00	3.E-04	**Yes**	
Groundwater Outside the Capture Zone South of Route 151							
	bis(2-ethylhexyl)phthalate	55.4	2.E-01	5.E-01	3.0.E-05	No	not site-related
	Cadmium	2.7	2.E-01	4.E-01		No	low risk
	cis-1,2 Dichloroethene (cis-1,2 DCE)	10.8	3.E-02	8.E-02		No	low risk
	Lead	18				No	low risk
	Manganese	2400	3.E+00	7.E+00		No	equivalent to background
	Tetrachloroethene (PCE)	52.4	3.E-01	5.E-01	8.E-04	**Yes**	
	Trichloroethene (TCE)	16	2.E+00	4.E+00	5.E-04	**Yes**	
Backus River Surface Water--Waders							
	Arsenic	2.31	2.E-03	1.E-02	6.E-07	No	low risk/background
	Manganese	157	6.E-03	2.E-02		No	low risk/background
	bis(2-ethylhexyl)phthalate	316	1.E-01	2.E-02	2.E-05	No	not site-related
	Tetrachloroethene	2.04	6.E-04	1.E-03	2.E-06	No	low risk
	Trichloroethene	1.06	3.E-03	1.E-02	2.E-07	No	low risk

Table 2-27
Identification of Contaminants of Concern for Ashumet Valley

Area	COPC	RME EPC (µg/L)	Total Adult HI	Total Child HI	ELCR	COC (Yes/No)	Comments
Backus River Surface Water--Cranberry Bog Worker							
	Arsenic	2.31	1.E-03	NA	2.E-07	No	low risk/background
	Manganese	157	1.E-02	NA		No	low risk/background
	bis(2-ethylhexyl)phthalate	316	1.E-01	NA	1.E-05	No	not site-related
	Tetrachloroethene	2.04	6.E-04	NA	1.E-06	No	low risk
	Trichloroethene	1.06	4.E-03	NA	2.E-07	No	low risk
Backus River Surface Water--Fish Eater							
	Arsenic	2.31	6.E-02	NA	1.E-05	No	low risk/background
	Manganese	157	8.E-03	NA		No	low risk/background
	bis(2-ethylhexyl)phthalate	316	2.E+00	NA	2.E-04	No	not site-related
	Tetrachloroethene	2.04	4.E-03	NA	8.E-06	No	low risk
	Trichloroethene	1.06	5.E-02	NA	3.E-06	No	low risk

Notes:

(1) Naphthalene is not believed to be site-related. Naphthalene, 2-methylnaphthalene, and 4-methylphenol were detected in one monitoring well (30MW0417C) in the outside-north area, in a sample collected 6/8/1999. No SVOCs were detected in a subsequent sample from this well collected 12/28/2001.

COC = contaminant of concern

COPC = contaminant of potential concern

ELCR = excess lifetime cancer risk

EPC = exposure point concentration

HI = hazard index

J = estimated value

MCL = maximum contaminant level

NA = not applicable

RME = reasonable maximum exposure

SVOC = semivolatile organic compound

µg/L = micrograms per liter

Table 2-28
Evaluation of Ashumet Valley Groundwater Alternatives

Alternative - Remedy Option	Overall Protection	ARARs	Long-Term Effectiveness	Short-Term Effectiveness	Reduction of Toxicity, etc.	Implement-ability	Cost[1]
1 No Action	Not Protective	No ARARs	Good	Good	Poor	Good	$0 M
2 Long-Term Monitoring plus Land Use Controls	Protective	Yes	Good	Good	Poor	Good	$4.7 M
3 Continue to Operate, Maintain, and Monitor the Existing Ashumet Valley System Plus Land Use Controls	Protective	Yes	Good	Good	Good	Good	$11 M
4 Continue to Operate, Maintain, and Monitor the Existing Ashumet Valley System Plus Land Use Controls with Additional Leading Edge Extraction, Treament, and Discharge to Promote Additional Mass Capture	Protective	Yes	Good	Moderate	Good	Moderate	$28 M
5 Continue to Operate, Maintain, and Monitor the Existing Ashumet Valley System Plus Land Use Controls with Additional Southern Plume Extraction, Treatment, and Discharge to Reduce Restoration Time	Protective	Yes	Good	Poor	Good	Poor	$38 M
6 Operate, Maintain, and Monitor the Optimized Existing Ashumet Valley System Plus Land Use Controls	Protective	Yes	Good	Good	Good	Good	$8.7 M
7 Operate, Maintain, and Monitor the Optimized Existing Ashumet Valley System Plus Land Use Controls with Additional Downgradient Extraction, Treatment, and Infiltration to Promote Additional Mass Capture	Protective	Yes	Good	Moderate	Good	Moderate	$18 M
7m Operate, Maintain, and Monitor the Optimized Existing Ashumet Valley System Plus Land Use Controls with Additional Downgradient Extraction, Treatment, and Discharge to Promote Additional Mass Capture	**Protective**	**Yes**	**Good**	**Moderate**	**Good**	**Moderate**	**$16 M**

Notes:
[1] Present Value costs do not include those for interim remedial action taken prior to the signing of the final Record of Decision.
Bold text indicates the selected remedy.
ARAR = applicable or relevant and appropriate requirement
M = million

Table 2-29
Model-Predicted Cleanup Years, Mass Removal Estimates, and Present Value Costs for Ashumet Valley Groundwater Alternatives

Alternative	Area North of Hayway Road		Area South of Hayway Road		All Areas		Present Value Cost
	Cleanup Year	Mass Removed (lb)	Cleanup Year	Mass Removed (lb)	Cleanup Year	Mass Removed (lb)	
Alternative 1	2041	49	2035	0	2041	49	$0 M
Alternative 2	2041	49	2035	0	2041	49	$4.7 M
Alternative 3	2039	134	2035	0	2039	134	$11 M
Alternative 4	2038	134	2023	239	2038	373	$28 M
Alternative 5	2039	134	2020	307	2039	441	$37 M
Alternative 6[1]	2041	106	2035	0	2035	106	$8.7 M
Alternative 7[1]	2041	106	2024	174	2024	280	$18 M
Alternative 7m[2]	2019	122	2021	27	2021	149	$16 M

Notes:
Mass removed is an estimated of total mass of TCE (trichloroethene) and PCE (tetrachloroethene) from 2006 to the date indicated. Alternatives 6m and 7m were initiated in 2008.
[1]Evaluted in *Final Ashumet Valley Groundwater Feasbility Study* Addendum using the 2006 Ashumet Valley plume shells
[2]Evaluated in Appendix D using the 2008 Ashumet Valley plume shells.
lb = pounds
M = million
m = modified

Table 2-30
Chemical-Specific ARARs
for Ashumet Valley Groundwater Alternative 7 Modified

Media	Requirements	Requirement Synopsis	Action to be Taken to Attain Requirements	Status
Groundwater	FEDERAL – SDWA MCLs (40 CFR 141.61-141.63)	MCLs have been promulgated for organic and inorganic contaminants. These levels regulate the concentration of contaminants in public drinking water supplies, but are also considered relevant and appropriate for CERCLA groundwater response actions where the groundwater aquifer is used or classified for use as drinking water.	These standards will be used to develop cleanup standards to be met through cleanup of the Ashumet Valley plume, unless a more stringent state standard has been promulgated, in which case the more stringent state standard must be met. SPEIM results will be used to evaluate when these cleanup standards are met.	Relevant and Appropriate
Groundwater	FEDERAL – SDWA Non-Zero MCLGs (40 CFR 141.50-141.51)	Non-zero MCLGs are nonenforceable health goals for public water systems. MCLGs are set at levels that would result in no known or expected adverse health effects with an adequate margin of safety. Non-zero MCLGs are also considered relevant and appropriate for CERCLA groundwater response actions where the groundwater aquifer is used or classified for use as drinking water.	These standards will be used, where available, to develop cleanup standards for any newly identified contaminants that do not have promulgated state or federal MCLs.	Relevant and Appropriate
Groundwater	STATE – MA Drinking Water Standards (310 CMR 22.05-22.09)	These standards establish MCLs for public drinking water systems, but are also considered relevant and appropriate for CERCLA groundwater response actions. When state MCLs are more stringent than federal levels, state levels must be used.	These standards will be used to develop cleanup standards to be met through cleanup of the Ashumet Valley plume. The state MCL for TCE and PCE is 5 µg/L, and the state MCL for thallium is 2 µg/L. These are the same as the federal MCLs. SPEIM results will be used to evaluate when these cleanup standards are met.	Relevant and Appropriate
Groundwater	STATE – MA Groundwater Quality Standards (314 CMR 6.06)	These standards limit the concentration of certain materials allowed in classified Massachusetts waters. The groundwater beneath MMR has been classified as a Class I water (fresh groundwater found in the saturated zone of unconsolidated deposits) and is designated as a source of potable water. The standards for Class I groundwater are the same as the state's	These standards will be used as cleanup standards to be met through cleanup of the Ashumet Valley plume. SPEIM results will be used to evaluate when these cleanup standards are met.	Applicable

Table 2-30
Chemical-Specific ARARs
for Ashumet Valley Groundwater Alternative 7 Modified

Media	Requirements	Requirement Synopsis	Action to be Taken to Attain Requirements	Status
		MCLs.		
Groundwater	FEDERAL – EPA Risk Reference Doses (RfDs)	RfDs are considered the levels unlikely to cause significant adverse health effects associated with a threshold mechanism of action in human exposure for a lifetime.	The RfD for manganese has been set at 0.14 mg/kg/day of dietary manganese. This RfD will be considered when calculating a cleanup level for manganese. SPEIM results will be used to evaluate when these cleanup standards are met. The residual risk assessment, if deemed necessary, will use the most up-to-date RfDs for all contaminants.	TBC
Groundwater	FEDERAL – EPA Health Advisories (HAs) and Drinking Water Equivalent Levels (DWELs)	Lifetime HAs establish the concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effect over a lifetime of exposure with a margin of safety. DWELs establish the same concentrations but are based on an assumption that all of the exposure to a contaminant is from drinking water.	The lifetime HA for manganese is set at 0.3 mg/L and the DWEL at 1.6 mg/L. These levels will be considered when calculating a cleanup level for manganese. SPEIM results will be used to evaluate when these cleanup standards are met. The residual risk assessment, if deemed necessary, will use the most up-to-date DWELs for all contaminants.	TBC

ARAR applicable or relevant and appropriate requirement
CERCLA Comprehensive Environmental Response, Compensation, and Liability Act
CFR *Code of Federal Regulations*
CMR *Code of Massachusetts Regulations*
DWEL drinking water equivalent level
EPA U.S. Environmental Protection Agency
HA health advisory
MA Massachusetts
MCL maximum contaminant level
MCLG maximum contaminant level goal
mg/kg/day milligrams per kilogram per day
mg/L milligrams per liter
MMR Massachusetts Military Reservation
PCE tetrachloroethene
RfD reference dose
SDWA Safe Drinking Water Act
SPEIM system performance and ecological impact monitoring
TBC to be considered
TCE trichloroethene
µg/L micrograms per liter

Table 2-31
Location-Specific ARARs
for Ashumet Valley Groundwater Alternative 7 Modified

Media	Requirements	Requirement Synopsis	Action to be Taken to Attain Requirements	Status
Endangered and threatened species and their habitats	STATE – MA Endangered Species Act (321 CMR 10.00 et seq.)	Actions that jeopardize state-listed endangered or threatened species or species of special concern or their habitats must be avoided, or appropriate mitigation measures must be taken.	The response action will be designed and implemented to minimize effects to endangered or threatened species on the MMR. Several state-listed species have been identified on the MMR. The Camp Edwards Natural Resource Office (http://www.eandrc.org/rarespecies.htm) continues to search for, identify, and map locations of rare species on the MMR and provides this information to the Massachusetts Division of Fisheries and Wildlife.	Applicable
Historic, archeological, and Native American artifacts and resources	FEDERAL – NHPA (16 USCA 470 et seq.; 36 CFR 800); AHPA (16 USCA 469a-c); ARPA (16 USC 470aa-ll; 43 CFR 7); NAGPRA (25 USCA 3001-3013; 43 CFR 10)	These statutes and regulations provide for the protection of historical, archaeological, and Native American burial sites, artifacts, and objects that might be lost as a result of a federal construction project. If a discovery is made, all activity in the area must stop and reasonable effort must be made to secure and protect the objects discovered.	After consultation with the Wampanoag Indian Tribes and the SHPO, the parties may determine that a cultural resources survey is needed to discover and identify objects and artifacts, particularly Native American artifacts of the Wampanoag Indian Tribes. If LTM or extraction wells need to be sited in areas that may have such resources, all such resources discovered during a survey or inadvertently discovered during on-site remedial activities will be secured and protected as required by law and in accordance with the consulting parties' memorandum of agreement.	Applicable
Historic, archeological, and Native American artifacts and resources	STATE – MA Historic Preservation Act (MGL Ch. 9 Sections 26-27C; MGL Ch. 7, Section 38A; MGL Ch. 38 Sections 6B-6C; and 950 CMR 70-71)	The MHC is the state historic preservation office and is authorized by Massachusetts law to identify, evaluate, and protect the Commonwealth's important historic and archaeological resources. The MHC administers state and federal preservation programs, including planning, review, and compliance.	After consultation with the Wampanoag Indian Tribes and the SHPO, the parties may determine that a cultural resources survey is needed to discover and identify objects and artifacts, particularly Native American artifacts of the Wampanoag Indian Tribes. If LTM or extraction wells need to be sited in areas that may have such resources, all such resources discovered during a survey or inadvertently discovered during on-site remedial activities will be secured and protected as required by law and in accordance with the consulting parties' memorandum of agreement.	Applicable

Table 2-31
Location-Specific ARARs
for Ashumet Valley Groundwater Alternative 7 Modified

Media	Requirements	Requirement Synopsis	Action to be Taken to Attain Requirements	Status
Wetlands	FEDERAL – Protection of Wetlands (EO 11990, 40 CFR 6, Appendix A)	Under this order, federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and preserve beneficial values of wetlands. Appendix A requires that no remedial alternatives adversely affect a wetland if another practicable alternative is available. If no alternative is available, effects from implementing the alternative must be mitigated.	If the operation and maintenance of the remedial system and/or LTM well system and construction of any new wells is needed and would adversely affect nearby wetlands, such potential impacts will be minimized to comply with these requirements.	Applicable
Wetlands	FEDERAL – CWA Section 404 (40 CFR 230; 33 CFR Parts 320-323)	No activity that adversely affects a wetland shall be permitted if a practicable alternative with fewer effects is available. If no practicable alternative exists, impacts must be mitigated.	If the operation and maintenance of the remedial system and/or LTM well system and construction of any new wells is needed and would adversely affect nearby wetlands, such potential impacts will be mitigated to comply with CWA 404 requirements.	Applicable
Wetlands	STATE – MassDEP Wetlands Protection Act (MGL Ch. 131, Section 40) and regulations (310 CMR 10.00)	This regulation outlines performance standards that must be met to work within 100 feet of a coastal or inland wetland and within 200 feet of a river. It governs all work involving the filling, dredging, or alteration of wetlands, banks, land under water bodies, waterways, land subject to flooding and riverfront areas.	The operation and maintenance of the remedial system and/or LTM well system and construction of any new wells, if needed, will be designed and implemented to meet the performance standards in 310 CMR 10.21 through 10.60 to minimize adverse effects to any nearby wetlands.	Applicable
Wetlands	FEDERAL – Fish and Wildlife Coordination Act (40 CFR 6.302; 16 USC 661 et seq.)	This act and regulations require federal agencies to take into consideration the effect that water-related projects would have on fish and wildlife, and to consult with the U.S. Fish and Wildlife Service and the state to develop measures to prevent, mitigate, or compensate for project-related losses to fish and wildlife.	The response action will be designed and implemented to minimize and/or compensate for adverse effects to fish and wildlife in any water bodies including wetland areas. Relevant federal and state agencies will be contacted, if indicated, to help analyze the effects of the response action on fish and wildlife in water bodies including wetlands in and around the site.	Applicable

Table 2-31
Location-Specific ARARs
for Ashumet Valley Groundwater Alternative 7 Modified

Media	Requirements	Requirement Synopsis	Action to be Taken to Attain Requirements	Status
Floodplains	FEDERAL – Protection of Floodplains (EO 11988, 40 CFR 6, Appendix A)	Requires federal agencies to minimize potential harm to or within floodplains and avoid the long- and short-term adverse impacts with modifications to floodplains. Appendix A requires that no remedial alternatives adversely affect a floodplain if another practicable alternative is available. If no alternative is available, effects from implementing the alternative must be mitigated.	These requirements are ARARs only if new wells are needed and are sited in floodplains. If the placement of any such well is needed, these requirements will be complied with if the location is within or will affect a floodplain.	Applicable
Floodplains	STATE – MassDEP Wetland Protection Act (MGL Ch. 131, Section 40, and 310 CMR 10.00)	Governs work proposed within land subject to flooding (100-year floodplain) and coastal storm flow. Compensatory flood storage is required for any loss of floodplain area.	These requirements are ARARs only if new wells are needed and are sited in floodplains. If the placement of any such well is needed, these requirements will be complied with if the location is within or will affect a floodplain.	Applicable

AHPA	Archaeological and Historic Preservation Act
ARAR	applicable or relevant and appropriate requirement
ARPA	Archaeological Resources Protection Act
CFR	*Code of Federal Regulations*
Ch.	chapter
CMR	*Code of Massachusetts Regulations*
CWA	Clean Water Act
EO	Executive Order
LTM	long-term monitoring
MA	Massachusetts
MassDEP	Massachusetts Department of Environmental Protection
MGL	Massachusetts General Law
MHC	Massachusetts Historic Commission
MMR	Massachusetts Military Reservation
NAGPRA	Native American Graves Protection and Repatriation Act
NHPA	National Historic Preservation Act
SHPO	State Historic Preservation Officer
USC	*United States Code*
USCA	*United States Code, Annotated*

Table 2-32
Action-Specific ARARs
for Ashumet Valley Groundwater Alternative 7 Modified

Media	Requirements	Requirement Synopsis	Action to be Taken to Attain Requirements	Status
Groundwater	FEDERAL – Underground Injection Control Program (40 CFR 144.1, 144.3, 144.4, 144.11 – 144.14, 144.82, 146.10 – 146.72, 147.1100, 148.1 – 148.18)	These 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 under 40 CFR 142 in the aquifer. The state program has been authorized by EPA and takes effect through the state requirements listed below.	Monitoring well sample water and groundwater will be treated to levels at or below the most stringent federal and state primary drinking water standards prior to release to the leachfield to ensure that releases will not cause any violation of drinking water standards in the receiving aquifer. SPEIM results will be used to evaluate when groundwater contaminant levels are at or below these standards.	Applicable
Groundwater	STATE – MA Underground Water Source Protection (310 CMR 27.00 et seq.)	These regulations prohibit the 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 regulations under 310 CMR 22.00 or adversely affect the health of persons.	Monitoring well sample water and groundwater will be treated to levels at or below the most stringent federal and state primary drinking water standards prior to release to the leachfield to ensure that releases will not cause any violation of drinking water standards in the receiving aquifer. SPEIM results will be used to evaluate when groundwater contaminant levels are at or below these standards.	Applicable
Groundwater	STATE – MassDEP Drinking Water Program, Private Well Guidelines (2008), available at http://www.mass.gov/dep/water/laws/prwellgd.doc	These are guidelines concerning private well location, design, construction, development, water quality testing, operation, maintenance, and decommissioning.	These guidelines will be used in locating, designing, constructing, developing, testing, operating, maintaining, and decommissioning monitoring wells, extraction wells, and reinjection wells, and testing and decommissioning private water supply wells.	TBC
Discharge to surface water	FEDERAL – National Pollutant Discharge Elimination System (40 CFR 122)	Establishes requirements for point source discharges to water of the U.S. Requires that all such discharges not result in a violation of the applicable surface water quality standards in the receiving stream.	Levels of contaminants in untreated groundwater currently discharging to surface water bodies are below applicable surface water quality standards. Discharge of treated groundwater to the Backus River by a surface water bubbler under Alternative 7 modified will be at levels that will not cause a violation of applicable surface water quality standards in the receiving water body.	Applicable

Table 2-32
Action-Specific ARARs
for Ashumet Valley Groundwater Alternative 7 Modified

Media	Requirements	Requirement Synopsis	Action to be Taken to Attain Requirements	Status
Discharge to surface water	STATE – Surface Water Discharge Permit Program (314 CMR 3.10, 3.11, and 3.19)	Establishes requirements for point source discharges to surface waters of the Commonwealth through the MPDES program. Requires that all such discharges not result in a violation of the applicable MA surface water quality standards (314 CMR 4.00 et seq.) in the receiving stream or the MA groundwater quality standards (314 CMR 6.00 et seq.) in the receiving water body.	Levels of contaminants in untreated groundwater currently discharging to surface water bodies are below applicable surface water quality standards. Discharge of treated groundwater to the Backus River by a surface water bubbler under Alternative 7 modified will be at levels that will not cause a violation of applicable surface or groundwater quality standards in the receiving water body.	Applicable
Surface water	STATE – Surface Water Quality Standards (314 CMR 4.00)	These standards limit the concentration of certain materials allowed in classified Massachusetts surface waters. The surface water surrounding the MMR has been classified as Class SA and SB coastal waters and Class B inland water.	Levels of contaminants in untreated groundwater currently discharging to surface water bodies are below applicable surface water quality standards. Discharge to the Backus River by a surface water bubbler under Alternative 7 modified will be at levels that will not cause a violation of applicable surface water quality standards in the receiving water body.	Applicable
Air	STATE – MA Air Pollution Control Regulations (310 CMR 7.06, 7.08 – 7.10, 7.14, and 7.18 – 7.24)	Establishes the standards and requirements for air pollution control in the Commonwealth. Potentially relevant sections include those pertaining to: visible emissions (7.06); dust, odor, construction and demolition (7.09); and noise (7.10). The regulations also contain air pollutant emission standards for, among other things, hazardous waste incinerators, organic materials, and VOCs.	Dust, noise, and visible emissions will be managed to meet the state requirements during response activities. Site remedial work and water treatment operations will be managed and performed in accordance with these regulations. Air emissions from the treatment systems will not be at a level high enough to trigger the standards for hazardous waste incinerators, organic materials, or VOCs.	Applicable

Table 2-32
Action-Specific ARARs
for Ashumet Valley Groundwater Alternative 7 Modified

Media	Requirements	Requirement Synopsis	Action to be Taken to Attain Requirements	Status
Stormwater runoff	FEDERAL – CWA NPDES Stormwater Discharge Requirements (40 CFR 122.26)	Establishes requirements for stormwater discharges associated with construction activities that result in a land disturbance of equal to or greater than one acre of land. The requirements include good construction management techniques; phasing of construction projects; minimal clearing; and sediment, erosion, structural, and vegetative controls to be implemented to mitigate stormwater run-on and runoff.	If stormwater runoff associated with remedial action construction, operation, and maintenance activities discharges to a surface water body, including wetlands, and the area of disturbance is greater than one acre of land, it will be controlled in accordance with these requirements.	Applicable
Stormwater runoff	STATE – Stormwater Discharge Requirements (314 CMR 3.04 and 314 CMR 3.19)	Requires that stormwater discharges associated with construction activities be managed in accordance with the general permit conditions of 314 CMR 3.19 so as not to cause a violation of Massachusetts surface water quality standards in the receiving surface water body (including wetlands).	If stormwater runoff associated with remedial action construction, operation, and maintenance activities discharges to a surface water body, including wetlands, and the area of disturbance is greater than one acre of land, it will be controlled in accordance with these requirements	Applicable
Stormwater runoff	STATE – Stormwater Management Program Policy (18 November 1996)	Provides policies and guidance on complying with the state's stormwater discharge requirements.	If stormwater runoff associated with remedial action construction, operation, and maintenance activities discharges to a surface water body, including wetlands, it will be controlled in accordance with these requirements	TBC
Soil	STATE – MA Erosion and Sediment Control Guidelines for Urban and Suburban Areas (May 2003)	Provides guidance and best management practices regarding erosion and sediment control.	Construction of any new SPEIM wells (if needed) and operations and maintenance of SPEIM activities will be performed in accordance with this guidance as appropriate.	TBC

Table 2-32
Action-Specific ARARs
for Ashumet Valley Groundwater Alternative 7 Modified

Media	Requirements	Requirement Synopsis	Action to be Taken to Attain Requirements	Status
Hazardous waste	FEDERAL – Subtitle C Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (40 CFR 264 et seq.)	These requirements establish minimum national standards that define the acceptable management of hazardous waste.	Because Massachusetts has been authorized to run the RCRA base program, hazardous materials will be managed according to the state requirements listed below.	Applicable
Hazardous waste	STATE – MA HWMR Requirements for Generators of Hazardous Waste (310 CMR 30.300 – 30.305)	A generator of solid waste must determine whether that waste is hazardous using various methods, including the TCLP method, or application of knowledge of hazardous characteristics of the waste. If waste is determined to be hazardous, it must be managed in accordance with the applicable Massachusetts generator requirements, which require management in accordance with 310 CMR 30.000 et seq.	Hazardous materials generated during the remedial action will be managed in accordance with these regulations and disposed of off-site in a RCRA-permitted treatment, storage, and disposal facility.	Applicable
Hazardous waste	STATE – RCRA Identification and Listing of Hazardous Waste (310 CMR 30.120-125)	These requirements identify the concentrations of contaminants at or above which the waste would be considered characteristically hazardous waste.	RCRA status of groundwater samples, soils, and other materials generated during response actions will be determined based on generator knowledge or prescribed test methods. Materials will be analyzed as necessary. If results exceed the standards in 310 CMR 30.120-125, the material will be managed in accordance with hazardous waste regulations.	Applicable

Notes:

ARAR	applicable or relevant and appropriate requirement
CFR	*Code of Federal Regulations*
CMR	*Code of Massachusetts Regulations*
CWA	Clean Water Act
EPA	U.S. Environmental Protection Agency
HWMR	hazardous waste management regulations
MA	Massachusetts
NPDES	National Pollutant Discharge Elimination System
RCRA	Resource Conservation and Recovery Act
SPEIM	system performance and ecological impact monitoring
TBC	to be considered
TCLP	Toxicity Characteristic Leaching Procedure
VOC	volatile organic compound

Table 2-33
Present Value Calculation for Ashumet Valley Groundwater Operable Unit Alternative 7 Modified

Year	Treatment System Design, Construction, and Start-up Costs	Baseline Monitoring Costs	Annual Existing System O&M	Annual New System O&M	Annual Existing System & Tl, Mn Chemical Monitoring	Annual New EW Chemical Monitoring	Annual Existing System Hydraulic Monitoring	Annual New EW Hydraulic Monitoring	Periodic Costs	Total Cost (0% Discount)	Discount Factor (for 2.7%)	Total Present Value Cost at 2.7%	Calendar Year
0	934,145	91,118	543,988	0	602,466	0	195,227	0	0	2,366,944	1.0000	2,366,944	2008
1	0	0	543,988	344,298	602,466	11,714	195,227	3,905	0	1,701,596	0.9737	1,656,861	2009
2	0	0	543,988	344,298	512,096	11,714	195,227	3,905	0	1,611,226	0.9481	1,527,621	2010
3	0	0	543,988	344,298	512,096	9,957	195,227	3,905	0	1,609,469	0.9232	1,485,838	2011
4	0	0	543,988	344,298	435,281	9,957	195,227	3,905	0	1,532,655	0.8989	1,377,725	2012
5	0	0	543,988	344,298	435,281	8,463	195,227	3,905	3,060	1,534,222	0.8753	1,342,876	2013
6	0	0	543,988	344,298	369,989	8,463	195,227	3,905	0	1,465,869	0.8523	1,249,317	2014
7	0	0	543,988	344,298	369,989	7,194	195,227	3,905	0	1,464,600	0.8299	1,215,419	2015
8	0	0	543,988	344,298	92,497	7,194	195,227	3,905	0	1,187,108	0.8080	959,239	2016
9	0	0	543,988	344,298	92,497	6,115	195,227	3,905	0	1,186,029	0.7868	933,171	2017
10	0	0	543,988	344,298	87,872	6,115	195,227	3,905	3,060	1,184,464	0.7661	907,439	2018
11	0	0	543,988	344,298	87,872	5,197	195,227	3,905	0	1,180,487	0.7460	880,615	2019
12	0	0	0	344,298	83,479	5,197	0	0	0	432,974	0.7264	314,497	2020
13	0	0	0	0	83,479	0	0	0	0	83,479	0.7073	59,042	2021
14	0	0	0	0	79,305	0	0	0	0	79,305	0.6887	54,615	2022
15	0	0	0	0	79,305	0	0	0	79,571	158,876	0.6706	106,537	2023
TOTAL	934,145	91,118	6,527,856	4,131,571	4,525,971	97,278	2,342,723	42,950	85,692	18,779,304		16,437,757	

Table 2-34
Cost Estimate Basis for Ashumet Valley Groundwater Operable Unit Alternative 7 Modified

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL	SUBTOTAL	COMMENTS	ASSUMPTIONS
WELL FIELD AND TREATMENT UNIT CONSTRUCTION COSTS							
CAPITAL COSTS						Actual Costs provided by AFCEE	
Extraction Well Installation	1	LS	$ 334,011	$ 334,011			
New Treatment Facility	1	LS	$ 284,317	$ 284,317			
Pipeline Installation	1	LS	$ 159,863	$ 159,863			
Extraction Well and Treatment Facility Controls, Electrical, and Instrumentation	1	LS	$ 109,346	$ 109,346			
Site Restoration	1	LS	$ 26,164	$ 26,164			
Final Survey and Easement Plan	1	LS	$ 10,350	$ 10,350			
Demobilization	1	LS	$ 10,093	$ 10,093			
TOTAL				$ 934,145			
TREATMENT SYSTEM O&M							
ANNUAL COSTS							
New System	1	YR	$ 320,000	$ 320,000		Based on actual costs from similar system in 2007	
New System TOTAL					$ 320,000		
New System ESCALATED					$ 344,298	Costs escalated from 2007.	
Existing AV Treatment System	1	YR	$ 505,598	$ 505,598		Actuals for 2007 adjusted for one year optimized operation (350 gpm) include overhead and support	Operating only 95EW0703
Existing TOTAL					$ 505,598		
Existing ESCALATED					$ 543,988	Costs escalated from 2007 AFCEE estimate.	
BASELINE GROUNDWATER MONITORING							
CAPITAL COSTS							
Baseline Performance and Environmental Sampling						Two quarters samples collected prior to system start-up.	Hydraulic measurements only.
New EW	2	QTR	$ 907	$ 1,814			for monitoring points related to each new EW and associated wellfield only.
Baseline Report	1	LS	$ 75,000	$ 75,000		Based on historical experience with similar reports for the MMR project.	
TOTAL					$ 76,814		
TOTAL ESCALATED					$ 91,118	Costs escalated from 2005.	

Table 2-34
Cost Estimate Basis for Ashumet Valley Groundwater Operable Unit Alternative 7 Modified

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL	SUBTOTAL	COMMENTS	ASSUMPTIONS
ANNUAL GROUNDWATER MONITORING							
ANNUAL COSTS							
Hydraulic Monitoring and Reporting							
Existing AV Wellfield (95EW0703)	1	LS	$ 181,450	$ 181,450		Based on actual costs for the 2007 AV SPEIM program. Includes equipment, personnel, equipment maintenance, data interpretation, and reporting. Actual costs also include overhead and support.	
Escalated-Existing					$ 195,227	Actual costs escalated from 2007.	
New EW	1	WELL	$ 3,629	$ 3,629		Annual hydraulic monitoring costs of new extraction wells and SPEIM wells	
Escalated-New EW					$ 3,905	Costs escalated from 2007.	
Chemical Monitoring and Reporting							
Existing Wellfield (95EW0703)	1	LS	$ 544,349	$ 544,349		Based on actual costs for the 2007 AV SPEIM program. Includes equipment, personnel, laboratory analyses, IDM, equipment maintenance, data interpretation, and reporting. Actual costs also include overhead and support.	
Escalated-Existing					$ 585,681	Actual costs escalated from 2007.	
Tl and Mn sampling	1	LS	$ 9,400	$ 9,400		Includes management	2 samplers for 7 days at 9 hours/day
Tl and Mn analysis	20	WELL	$ 60	$ 1,200			assume 20 well screens sampled
Access Logistics	1	LS	$ 1,800	$ 1,800		Telephone calls, notices and other arrangements to sample on private property.	assume 10 residences, 2 hours per residence
Expendable Field Equipment	1	LS	$ 150	$ 150			
Data Management	1	LS	$ 1,600	$ 1,600			
Tl and Mn SUBTOTAL					$ 14,150		
Escalated - Tl and Mn					$ 16,785	Escalated from 2005.	
Total Existing				$ 558,499			
Total Existing Escalated					$ 602,466		
New EWs	1	LS	$ 10,887	$ 10,887			
Escalated-New EWs					$ 11,714	Costs escalated from 2007.	
TOTAL				$ 1,127,884			
TOTAL ESCALATED					$ 614,179		
CERCLA 5-YEAR REPORTING							
PERIODIC COSTS							
Report Preparation and Submittal	1	EA	$ 2,000	$ 2,000			Report is part of a larger review of all sources and systems at MMR.
OVERHEAD & SUPPORT				$ 580			
TOTAL					$ 2,580		
TOTAL ESCALATED					$ 3,060	Escalated from 2005.	
RESIDUAL RISK ASSESSMENT							
DIRECT COSTS							
Report Preparation and Submittal	1	EA	$ 50,000	$ 50,000			
OVERHEAD & SUPPORT				$ 14,500			
TOTAL					$ 64,500		
TOTAL ESCALATED					$ 76,511	Escalated from 2005.	

APPENDIX A

MassDEP Concurrence Letter

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENERGY & ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENVIRONMENTAL PROTECTION
SOUTHEAST REGIONAL OFFICE
20 RIVERSIDE DRIVE, LAKEVILLE, MA 02347 508-946-2700

DEVAL L. PATRICK
Governor

TIMOTHY P. MURRAY
Lieutenant Governor

IAN A. BOWLES
Secretary

LAURIE BURT
Commissioner

June 5, 2009

Mr. James T. Owens III, Director
Office of Site Remediation and Restoration
U.S. Environmental Protection Agency,
New England Office
One Congress Street, Suite 1100
Boston, MA 02114-2023

RE: BOURNE—BWSC-4-0037
Massachusetts Military Reservation (MMR),
Final Record of Decision for Ashumet Valley Groundwater, Concurrence

Dear Mr. Owens;

The Massachusetts Department of Environmental Protection (MassDEP) has reviewed the document entitled *Final Record of Decision for Ashumet Valley Groundwater* (the ROD), dated March 2009. The ROD was prepared by the Air Force Center for Engineering and the Environment (AFCEE) at the Massachusetts Military Reservation (MMR) in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The ROD presents the selected remedy for the Ashumet Valley groundwater plume chosen in accordance with CERCLA. The U.S. Air Force is the lead agency for CERCLA remedial actions at the MMR.

The source areas for the Ashumet Valley groundwater plume are the former fire training area (FTA-1) and the former sewage treatment plant (STP) at the MMR. The FTA-1 was used, from 1958 to 1985, for fire training exercises by the former Otis Air Force Base fire department. Flammable materials burned at the FTA-1 included JP-4, aviation gasoline, motor vehicle gasoline, diesel fuels, waste oils, solvents, paint thinner, transformer oils, and spent hydraulic fluid. The STP was an approximately 30-acre area along the southern boundary of the MMR that operated from 1936 until 1995. The STP sand filter beds, sludge drying beds and dried sludge contained semi-volatile organic compounds (SVOCs), pesticides, PCBs and inorganics. Dissolved contaminants leached from the FTA-1 and STP areas into the underlying groundwater resulting in the formation of the Ashumet Valley groundwater plume. The Ashumet Valley groundwater plume is over three miles long and extends from the southern edge of Ashumet Pond near the southeast corner of the MMR southward to Route 28 in Falmouth. The primary contaminants of concern (COCs) in the Ashumet Valley plume are tetrachloroethene (PCE) and

trichloroethene (TCE). Manganese and thallium are also COCs present in a limited area of the Ashumet Valley plume near the MMR boundary.

In September 1995, a *Final Record of Decision for Interim Action, Containment of Seven Groundwater Plumes at Massachusetts Military Reservation, Cape Cod, Massachusetts* (referred to as the Interim Record of Decision or IROD) was signed by the Department of Defense and the EPA, with concurrence from MassDEP. After consideration of input from the public, a remedial alternative was selected that involved installing an axial extraction, treatment and infiltration (ETI) system to achieve a significant degree of plume capture and restoration of the aquifer in the vicinity of the Falmouth public water supply wellfield. AFCEE commenced the interim remedy for the Ashumet Valley groundwater plume in November 1999 with the startup of three axial extraction wells extending from Route 151 to the north to Hayway Road to the south. The extracted groundwater was treated with granular activated carbon (GAC) at a treatment facility located along Sandwich Road. The treated groundwater was discharged back into the aquifer through two infiltration trenches.

The selected final remedy for the Ashumet Valley groundwater plume consists of *continued monitoring and active treatment* of the Ashumet Valley groundwater plume with the existing extraction, treatment, and infiltration (ETI) system, plus *expansion of the system* to improve capture of the leading edge of the Ashumet Valley groundwater plume. The ETI system expansion involves the installation of an additional extraction well and a mobile treatment unit (MTU) in the uncaptured southern portion of the plume. Effluent from the MTU will be discharged to the Backus River. The final remedy also includes *land use controls* (LUCs) to reduce human exposure to contaminated groundwater. LUCs have already been implemented by AFCEE to prevent access to or use of the groundwater from the Ashumet Valley plume until the groundwater no longer poses an unacceptable risk to human health. Monitoring of the LUCs will be conducted annually by AFCEE. Additionally, AFCEE will submit an annual monitoring report to the regulatory agencies that will evaluate the status of the LUCs and how any identified deficiencies and/or inconsistent uses have been addressed.

The final remedy will ensure a sufficient level of control for the groundwater plume such that none of the contamination associated with the plume will present a significant risk of harm to health, safety, public welfare or the environment during any foreseeable period of time. Moreover, the remedy has been designed to reduce the level of contaminants to background levels, consistent with the Massachusetts Contingency Plan (MCP). The majority of public comments support the selected remedy.

MassDEP concurs with the final ROD. MassDEP's concurrence with the ROD is based upon representations made to MassDEP by the AFCEE and assumes that all information provided is substantially complete and accurate. Without limitation, if MassDEP determines that any material omissions or misstatements exist, if new information becomes available, if LUCs are not properly implemented, monitored and/or maintained, or if conditions within the Ashumet Valley groundwater plume change, resulting in potential or actual human exposure or threats to the environment, MassDEP reserves its authority under M.G.L. c. 21E, and the MCP, 310 CMR 40.0000 et seq., and any other applicable law or regulation, to require further response actions.

Please incorporate this letter into the Administrative Record for the Ashumet Valley groundwater plume. If you have any questions regarding this matter, please contact Leonard J. Pinaud, Chief of Federal Facilities Remediation Section, at (508) 946-2871 or Millie Garcia-Serrano, Deputy Regional Director of the Bureau of Waste Site Cleanup at (508) 946-2727.

Sincerely,

Laurie Burt
Commissioner
Massachusetts Department of Environmental Protection

LB/lp
MassDEP Ashumet Valley ROD Concurrence Letter.doc

Cc: DEP - SERO
Attn: David Johnston, Acting Regional Director
Millie Garcia-Serrano, Deputy Regional Director
Leonard J. Pinaud, Chief Federal Facilities Remediation Section
Rebecca Tobin, Regional Counsel

Distributions: SERO
SMB
MMR Plume Cleanup Team
Boards of Selectmen
Boards of Health
Mark Begley, Environmental Management Commission

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APPENDIX B

Transcript of Public Hearing

(14)

MASSACHUSETTS MILITARY RESERVATION

AIR FORCE CENTER FOR ENGINEERING AND THE ENVIRONMENT

IN RE:
PROPOSED PLAN FOR GROUNDWATER AT ASHUMET VALLEY

Holiday Inn
291 Jones Road
Falmouth, Massachusetts
Public Hearing

HEARING OFFICER: Douglas Karson, AFCEE

Wednesday, July 11, 2007
6:30 p.m.

Carol P. Tinkham
Professional Court Reporter
321 Head of the Bay Road
Buzzards Bay, MA 02532
(508) 759-9162
caroltinkham@gmail.com

A T T E N D E E S:

Phil Goddard - Bourne Citizen

Michael Minior - Air National Guard

Lynn Jennings - USEPA

Paul Marchessault - USEPA

Anita Rigassio-Smith - Jacobs Engineering

Mike Morris - Jacobs Engineering

Nigel Tindall - CH2MHill

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P R O C E E D I N G S

HEARING OFFICER KARSON: Good evening. The official record is now open for this public hearing on the proposed plan for Ashumet Valley Groundwater. My name is Douglas Karson, Community Involvement Lead for the Air Force Center for Engineering and the Environment. I will be the hearing officer tonight. The purpose of this hearing is to accept oral and written comments on the Air Force's proposed plan for Ashumet Valley groundwater.

There are copies of the proposed plan located in the back -- over on this side, by the main door -- and attached to that is an Explanation of Concern supplement from the US EPA, which disagrees with the Air Force's Preferred Alternative Number 6.

All comments that are received tonight will be transcribed verbatim. Those comments, along with any comments submitted in writing tonight and during the comment period will become part of the official record on this project. AFCEE and the regulatory agencies will consider all comments prior to making a final decision.

1 Each and every comment will be responded to in
2 a Responsiveness Summary that will be issued at a
3 later date as part of the Record of Decision. The
4 Record of Decision will contain the Air Force's
5 final decision for the Ashumet Valley Groundwater
6 Plume.
7 This hearing is exclusively for listening to
8 and recording your oral comments. I will not
9 respond to your comments during the hearing unless
10 you need clarification on something. I may ask
11 you for clarification if I am not sure what your
12 comment is.
13 You can also provide written comments to me at
14 any time tonight.
15 Everyone wanting to make an oral comment must
16 state their name and town of residence.
17 The floor is now open for public comment. Mr.
18 Goddard.
19 MR. GODDARD: My name is Phil Goddard,
20 I'm a resident of Bourne and a member of the Plume
21 Cleanup Team.
22 My comment tonight is that - is similar to
23 what I expressed at the last PCT meeting. First,
24 I just wanted to thank the Air Force for extending

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1 the comment period for another period of time. I
2 just heard the press release; I think that's a good
3 thing you're doing because of the complicated
4 series of options here. I think the Town of
5 Falmouth needs some time to contemplate those.
6 My comment is that when I reviewed this it
7 seems that there was a choice between one system
8 that the Air Force is proposing and then another
9 system that the regulators were recommending; there
10 was a difference of about $10 million, and the
11 question that I was struggling with is: it worth
12 going after pollution and the plume south of Hayway
13 Road for $10 million? Those are the types of
14 things I was weighing.
15 My comment is that it may not be either/or;
16 there may be a third or fourth way to look at this.
17 And I had suggested at that time and I've suggested
18 at other meetings with plumes that there are these
19 alternative technologies you may want to look at
20 that could target the hot spots, and one being
21 recirculating wells or the other was a reactive
22 wall that's been kicked around at the site for a
23 while. If there's anything applicable there, I'd
24 like that addressed or explained why those are not

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1 feasible versus the Alternative 7, which is $10
2 million more, new pipelines and disruptions in the
3 neighborhood.
4 The other recommendation that I would like
5 explored is a system that is being used on the
6 impact area groundwater study program, which is the
7 mobile treatment systems. Ben Gregson, I think,
8 and Hap Gonser should be consulted on that and
9 brought down to provide information about what
10 they're doing with mobile units, that are these
11 units, apparently that are pump and treat, but are
12 modular to be scaled up to meet the demand and then
13 removed very quickly with little disruption.
14 Perhaps there's something like that that could be
15 brought to bear in the southern portion for a
16 period of time, throw that into the model and see
17 if there's certain areas in the south that it could
18 be applied to to try to go after the hottest areas
19 of contamination and perhaps have a way of
20 addressing some of the concerns of the regulators,
21 but without having to spend an extra $10 million.
22 I think one of my hopes has been that both
23 programs learn from one another and can share
24 technology and techniques for being successful that

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the Air Force can help the Army side with the Community Outreach they've explored and, down the other way, that the Army can share maybe innovative technologies they're applying in the north with the southern portion.

So, I hope that's considered by the Air Force and I hope that it's not necessarily an all or nothing situation with what the demands of the - or the recommendations of the regulators are versus the projections or the proposed plan of the Air Force, and I would like to see that considered and responded to. Thank you very much.

HEARING OFFICER KARSON: Thank you, Mr. Goddard.

Anyone else wish to offer comment this evening on the proposed plan?

[No response.]

HEARING OFFICER KARSON: I'll ask again, are there any further comments to be offered at this time on the proposed plan?

[No response.]

HEARING OFFICER KARSON: Last chance.

[No response.]

HEARING OFFICER KARSON: If there are no

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further comments to be made, then please note that you can still provide written comments through August 22nd, 2007. There is a news release on the table that explains how to do that.

I shall now close the public hearing for the proposed plan for Ashumet Valley Groundwater. Thank you for coming.

[Whereupon, this matter ended.]

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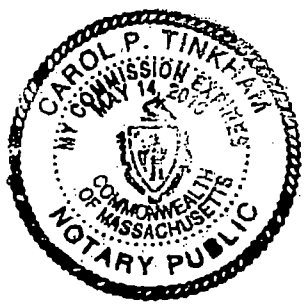
C E R T I F I C A T E

COMMONWEALTH OF MASSACHUSETTS
COUNTY OF BARNSTABLE

I, Carol P. Tinkham, a Professional Court Reporter and Notary Public in and for the Commonwealth of Massachusetts, do hereby certify that the foregoing transcript represents a complete, true and accurate transcription of my audiographic recordings taken in the matter of Massachusetts Military Reservation AFCEE Public Hearing on Ashumet Valley Groundwater Plan, heard at the Holiday Inn on Wednesday, July 11, 2007.

Carol P. Tinkham

Carol P. Tinkham
Notary Public
My Commission Expires
May 14, 2010



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APPENDIX C

Falmouth Board of Health Well Regulations

Falmouth Board of Health

Water Well Regulations

Purpose

The Falmouth Board of Health recognizes that certain areas of the groundwater aquifer beneath Falmouth have been contaminated by activities associated with the Massachusetts Military Reservation and others, and that not all areas of groundwater contamination have been identified. There are risks associated with exposure to these contaminants through direct ingestion, dermal contact, inhalation, irrigation of food crops, or watering of animals that are later to be consumed.

In order to protect the public from exposure to potentially contaminated groundwater, the Falmouth Board of Health adopts the following regulations for the permitting, installation and use of water wells, under the authority of Massachusetts General Laws Chapter 111, Section 30.

The testing requirements herein reflect prudent means of minimizing, but not eliminating the risk from exposure to groundwater contamination. Persons withdrawing water for drinking or irrigation are encouraged to stay informed about newly identified contaminants that may be contained in the groundwater they use, and to exercise prudence in all aspects of water withdrawal.

Section 1. Definitions:

A. Drinking Water Well - Any private source of groundwater for human use, including but not limited to, a source approved for such by the Falmouth Board of Health or Massachusetts Department of Environmental Protection (DEP) in accordance with MGL 11 sec 122A or 310 CMR 22.00.

B. Irrigation Well - Any water supply well not approved as a drinking water supply used for the watering of plants and livestock or for commercial or industrial use.

C. Monitoring Well - A well installed for the expressed purpose of monitoring water quality or water level in an area. Excluded from these requirements are wells less than twenty feet deep used for purposes of determining groundwater elevations associated

with the installation of a septic system and which are removed at the time of septic system installation or when they are no longer needed.

D. Volatile Organic Compounds - The class of organic compounds detected and quantified using United States Environmental Protection Agency (EPA) Methods 502.2, 502.4, 624.0, and 625 and 504 (modified for the analysis of Ethylene Dibromide (EBD) to a detection limits of 0.02 ug/l or 2.0 parts per billion).

Section 2. Permits Required:

A permit from the Board of Health shall be required for the installation and use of all wells, including Drinking Water Wells, Irrigation Wells, and Monitoring Wells within the Town of Falmouth. A permit granted under these regulations will that is not exercised within one year may be renewed annually for up to two additional years.

A) Drinking Water Well - A permit application for a Drinking Water Well shall include: a plan of the lot on which the Drinking Water Well is to be located showing the location of any septic systems within 150 ft of the proposed well, the location of the house or any permanent structures (existing or proposed), and a description of the proposed well that includes the location, construction material, anticipated depth of the well, and the maximum anticipated withdrawal rate in gallons per minute. The application shall also include proof that all abutters within 100 feet of the property line have been notified by receipted mail using a form of letter approved by the Board of Health. In the case of new construction, well location and description may be shown on the same plan submitted under the requirements for the Board of Health approval of the septic system. Replacement of a Drinking Water Well within 5 feet of the original location shall not require a permit under these regulations.

B) Irrigation Well - A permit application for an Irrigation Well shall include a plan of the lot on which the Irrigation Well is to be located that shows the location of any septic systems or water supply wells within 150 ft of the proposed Irrigation Well, the location of the house or any permanent structure(s) (existing or proposed), and a description of the proposed well that includes the location, construction material, anticipated depth of the well, an the maximum anticipated withdrawal rate in gallons per minute and all proposed faucets and discharge points. This permit does not relieve the applicant from being

required to secure any and all additional permits that may be required by the State under the Water Management Act or any other pertinent regulation.

C) Monitoring Well - A permit for a Monitoring Well shall include an exact location at which the Monitoring Well is to be located in degrees latitude and longitude, a description of the Monitoring Well that includes the construction material and depth, a statement of purpose for which the Monitoring Well is being installed and its proposed length of service. The name, address, and telephone number of a contact person shall be included in the application. Permits for monitoring wells shall be granted for a period requested or any period deemed appropriate by the Board of Health.

Section 3. Requirements for use.

A. Drinking Water Wells - All Drinking Water Wells shall be located: 1) to maintain a minimum lateral distance from the well to the nearest septic system of 100 ft., 2) to provide minimum risk of exposure to contamination from any known or suspected source, and 3) so that they do not infringe upon the ability of adjacent property owners to locate septic systems. No Drinking Water Well shall be physically connected with a public water supply line. A Drinking Water Well must tested for coliform, nitrate-nitrogen, and volatile organic compounds and found to be within potable water limits as defined in 310 CMR 22.000 Drinking Water Regulations and must not exceed the Commonwealth of Massachusetts' Maximum Contaminant Levels. The Board of Health, by this regulation reserves the right to require more extensive testing in areas of known or suspected contamination. A Drinking Water Well shall not be used until an as-built plan and the results of all required testing have been submitted and approved by the Board of Health.

B) Irrigation Wells - Irrigation Wells shall be located: 1) to maintain a minimum lateral distance from the well to the nearest septic system of 50 ft, 2) a minimum of 50 ft. from a lot line, and 3) to provide minimum risk of exposure to contamination from any known or suspected source. No irrigation well shall be physically cross-connected with the plumbing of either a drinking water well or a public water supply line. All irrigation well spigots shall be placarded with a notice that reads "Irrigation Well - Not for Drinking Water Purposes". Spigots for Irrigation Wells shall not be attached to a residence. An Irrigation Well shall not be used until: 1) an as-built plan and the results of all required testing have been submitted and approved by the Board of Health, and 2) A notice of the

existence and location of an irrigation well shall be recorded with the Barnstable County Registry of Deeds. In areas of known or suspected contamination, such as exist in certain areas near the Massachusetts Military Reservation, initial tests of Irrigation Wells for volatile organic compounds shall be required prior to use. Irrigation Wells must not exceed the Maximum Contaminant Levels set forth in 310 CMR 22.00 for volatile organic compounds referred to in section 1D.

C) Monitoring Wells - All Monitoring Wells shall have a locking cap or other device or structure to prevent unlawful use or entry. Caps shall be secure at all times when the well is not in use.

Section 4. Conversion of Irrigation Wells:

Water from an Irrigation Well shall not be used as a drinking water well until it is demonstrated that: 1) the water meets all the requirements of potability (Section 3A) ; 2) the well meets all the requirements of a Drinking Water Well relative to setbacks from septic systems and other potential sources of contamination; 3) the use of a well for such purposes shall not infringe upon the rights of all adjacent property owners to construct or replace their septic systems, and; 4) the well is permitted as a Drinking Water Well.

Section 5. Abandonment of Wells

A) Drinking Water Wells - A Drinking Water Well may be abandoned by: 1) Downgrading it to the classification of an Irrigation Well, or 2) Permanently taking it out of service by disconnecting it from the residential drinking water system and sealing it with concrete followed by notice and inspection by the Falmouth Board of Health. Downgrading a Drinking Water Well to an Irrigation Well requires that the well meet all the requirements denoted in Section 3 B.(Irrigation Wells).

B) Irrigation Well - An Irrigation Well may be abandoned by filling the entire pipe volume with concrete, followed by a notice and inspection by the Falmouth Board of Health and recording said abandonment with the Registry of Deeds.

C) Monitoring Well - A Monitoring Well may be abandoned by filling the entire pipe volume with concrete, followed by a notice and inspection by the Falmouth Board of Health, or removal of the entire length of pipe from the ground.

Section 6. Enforcement

This regulation will be enforced by the Board of Health under the authority granted it under MGL Chapter 111, Section 30.

These regulations are adopted on September 13, 1999 and become effective on the date of publication:

Dr. Albert Price, Chairman

Robert Chausse

Robert Chausse

George Heufelder

Arthur Vidal III

John Waterbury

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APPENDIX D

Groundwater Modeling of Alternatives 6 Modified and 7 Modified

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS ..... D-iii
1.0 INTRODUCTION D-1
2.0 MODELING EVALUATION OF MODIFIED ALTERNATIVES D-1
2.1 ALTERNATIVE 6 MODIFIED D-2
2.2 ALTERNATIVE 7 MODIFIED D-3
3.0 CONCLUSIONS D-1
4.0 REFERENCES D-1

Figures

Figure D2-1 Ashumet Valley Groundwater Alternative 6 Modified Conceptual Design
Figure D2-2 Ashumet Valley Groundwater Alternative 7 Modified Conceptual Design
Figure D2-3 Modeled Drawdown and Mounding for Alternative 6 Modified
Figure D2-4 Alternative 6 Modified, Model Predicted PCE Concentrations
Figure D2-5 Alternative 6 Modified, Model Predicted TCE Concentrations
Figure D2-6 PCE Mass Capture and Discharge
Figure D2-7 TCE Mass Capture and Discharge
Figure D2-8 Modeled Drawdown and Mounding for Alternative 7 Modified
Figure D2-9 Alternative 7 Modified, Model Predicted PCE Concentrations
Figure D2-10 Alternative 7 Modified, Model Predicted TCE Concentrations

Tables

Table D2-1 Summary of Modeled Ashumet Valley Feasibility Study Flow Rates
Table D2-2 PCE Mass Removed and Mass Discharged to Backus River for Ashumet Valley Groundwater
Table D2-3 TCE Mass Removed and Mass Discharged to Backus River for Ashumet Valley Groundwater

Attachments

Attachment A Ashumet Valley 2008 Plume Shell

TABLE OF CONTENTS

Animations

Animation D2-1 Alternative 6 modified, PCE Plume

Animation D2-2 Alternative 6 modified, TCE Plume

Animation D2-3 Alternative 7 modified, PCE Plume

Animation D2-4 Alternative 7 modified, TCE Plume

ACRONYMS AND ABBREVIATIONS

AFCEE	Air Force Center for Engineering and the Environment
EPA	U.S. Environmental Protection Agency
FS	feasibility study
gpm	gallons per minute
kg	kilograms
MassDEP	Massachusetts Department of Environmental Protection
MCL	maximum contaminant level
OU	operable unit
PCE	tetrachloroethene
PP	proposed plan
ROD	Record of Decision
TCE	trichloroethene

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1.0 INTRODUCTION

This appendix to the *Draft Ashumet Valley Groundwater Record of Decision* (ROD) was prepared to document modeling activities that were performed after the Ashumet Valley proposed plan (PP) comment period in support of the Ashumet Valley ROD. An agreement between the Air Force Center for Engineering and the Environment (AFCEE), the U.S. Environmental Protection Agency (EPA), and the Massachusetts Department of Environmental Protection (MassDEP) was reached on 17 June 2008 on modeling of a modified alternative that would be evaluated as a potential remedial action for the Ashumet Valley groundwater operable unit (OU).

An agreement could not be reached between AFCEE, EPA, and MassDEP on a preferred alternative based on the information available in the final feasibility study (FS) after the PP comment period. It was agreed that additional data were required to fill in a number of data gaps in the distribution of contaminants in the Ashumet Valley plume. A comprehensive groundwater monitoring effort was conducted and a number of drive points were installed to help characterize the distribution of tetrachloroethene (PCE) and trichloroethene (TCE) in the downgradient portion of the Ashumet Valley plume (AFCEE 2008). Plume shells representing January 2008 conditions for PCE and TCE were developed using these new data collected in the fall and winter 2007 (Attachment A). The conceptual design of Alternative 7 was modified to address contamination downgradient of Carriage Shop Road and east of the Backus River. After further evaluation of the distribution of PCE and TCE in the Ashumet Valley plume, the conceptual design of Alternative 7 was modified. Alternative 7 modified was simulated in the groundwater flow model with the 2008 plume shells. Alternative 6, with updated flow parameters (AFCEE 2008), was also simulated with the 2008 plume shells.

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2.0 MODELING EVALUATION OF MODIFIED ALTERNATIVES

This section presents the results of the groundwater contaminant fate and transport modeling conducted to support the evaluation of Alternatives 6 modified and 7 modified. Conceptualizations of each alternative in this addendum were simulated in the same groundwater contaminant fate and transport model (AFCEE 2003) used in the FS and using the 2008 plume shell (Attachment A). The groundwater data used to develop the plume shells include groundwater samples collected between January 2003 and January 2008. The mass of dissolved PCE and TCE contamination that exceeded their maximum contaminant levels (MCL) [5 micrograms per liter (µg/L) for each] in the 2008 plume shells is approximately 186.2 pounds [84.5 kilograms (kg)] and 56.6 pounds (25.7 kg) respectively. Total mass of PCE and TCE (dissolved and sorbed) simulated in the Ashumet Valley model is 376 pounds (171 kg) and 142 pounds (64.3 kg) respectively. The fate and transport of PCE and TCE under stressed conditions (active remediation) were simulated for Alternatives 6 modified and 7 modified. Animations of these alternatives are provided as Animation D2-1, Animation D2-2, Animation D2-3, and Animation D2-4.

For ease of discussion, the plume has been conceptually divided into three separate areas to explain the plume fate and the remedial actions in the different sections. North of Route 151, the plume includes PCE and TCE that are now downgradient of Ashumet Pond. The area between Route 151 and Hayway Road is the Falmouth Wellfield that the Interim Record of Decision (IROD) addresses. The current Ashumet Valley extraction, treatment, and infiltration (ETI) has three extraction wells, one active and two inactive, in this area to help restore the Falmouth Wellfield. The area south of Hayway Road is located where additional remedial action (Alternative 7 modified) addresses contamination that would otherwise migrate downgradient of the current system, naturally attenuate, or eventually discharge to the Backus River.

The extraction well and infiltration trench locations, screen lengths, and flow rates used in each alternative are summarized in Table D2-1. The conceptual designs for each alternative are shown in Figure D2-1 and Figure D2-2. The mass removal and discharge

estimates from the modeling results for these alternatives are included in Table D2-2 (PCE) and Table D2-3 (TCE).

2.1 ALTERNATIVE 6 MODIFIED

Alternative 6 modified represents the operation of the current remediation system operating at current conditions from January 2008. Alternative 6 modified consists of one extraction well pumping at 350 gallons per minute (gpm) from model initiation (January 2008) to the end of the simulation (2058). Alternative 6 modified differs from Alternative 6 (AFCEE 2007a) in the pumping rate used in the simulation. Alternative 6 uses a pumping rate of 375 gpm in extraction well 95EW0703. Treated water from Alternative 6 modified is reintroduced to the aquifer by means of two parallel infiltration trenches that are located east and west of the Ashumet Valley plume. An examination of the change in hydraulic gradients from ambient conditions is presented in Figure D2-3. This figure shows drawdown in the location of the extraction well and mounding around each infiltration trench. A review of the animations (Animation D2-1, Animation D2-2, Figure D2-4 and Figure D2-5) indicates PCE concentrations would decrease below the MCL in the area between Route 151 and Hayway Road by 2019 (TCE decreases below the MCL by 2016). North of Route 151, PCE concentrations above the MCL would continue to migrate downgradient of Ashumet Pond until 2013 when those concentrations are predicted to fall below the MCL. South of Hayway Road, where no active remediation would occur, PCE, and TCE would migrate in a southwesterly direction. The plume is predicted to naturally attenuate or upwell in this area toward the Backus River where the remainder of the plume would discharge to Backus River [approximately 46 pounds (21 kg) of TCE and 146 pounds (66 kg) of PCE] until concentrations of PCE and TCE fall below their MCLs by 2023. Estimates of mass removed for Alternative 6 modified are based on the extraction well 95EW0703 simulated in the model until the end of the simulation. Modeling predicts that, after January 2008, the Alternative 6 modified system will remove 64 pounds (29 kg) of PCE and 30 pounds (14 kg) of TCE by 2023 when all PCE and TCE concentrations in the entire Ashumet Valley plume fall below the MCL (Table D2-2, Table D2-3, Figure D2-6, and Figure D2-7). These estimates are additional to the 182 pounds (83 kg) of PCE and 100 pounds (45 kg) of TCE previously

removed by the Ashumet Valley system prior to December 2007 (AFCEE 2008). Modeling predicts that 193 pounds (87 kg) of PCE and 58 pounds (26 kg) of TCE will discharge to the Backus River between 2008 and 2053 (Table D2-2 and Table D2-3).

2.2 ALTERNATIVE 7 MODIFIED

Alternative 7 modified consists of the pumping scenario described for Alternative 6 modified plus one extraction well located south of Hayway Road to remove some of the mass that would otherwise naturally attenuate or discharge to the river (Figure D2-2). The modeled scenario for Alternative 7 modified included one additional well located east of the Backus River placed in an area of higher concentration in the southern portion of the Ashumet Valley plume. This contrasts with Alternative 7 which used a two extraction well scenario downgradient of Carriage Shop Road in a more northerly location to intercept the core of contamination mapped in the Ashumet Valley 2006 plume shells. The Alternative 7 modified scenario simulates pumping of 175 gpm in addition to the 350 gpm at 95EW0703 resulting in a total extraction of 525 gpm. Water from the southern portion of the plume would be pumped to a new mobile treatment unit (MTU) and the treated water would be discharged to the Backus River. In contrast, Alternative 7 used a total pumping rate of 1,125 gpm and pumped all water back to the Ashumet Valley treatment plant. Figure D2-8 shows the effects of drawdown and mounding of the complete system on the water table from Alternative 7 modified. Drawdown is clearly indicated in the locations of the extraction wells, and mounding is found in association with the infiltration trenches. The figure also shows that this alternative does not exceed 0.2 foot of drawdown or mounding for the Backus River. Animations show that additional mass is captured by this system that would otherwise naturally attenuate and discharge to the Backus River (Animation D2-3, Animation D2-4; Figure D2-9, and Figure D2-10). The plume area north of Route 151 is predicted to behave similarly to Alternative 6 modified and will fall below MCLs downgradient of Ashumet Pond by 2013. Modeling predicts that cleanup between Route 151 and Hayway Road will occur in 2019, with concentrations of PCE and TCE reaching their MCLs in 2019 and 2016, respectively. Plume migration is in a southwesterly direction, and the plume upwells in the direction of and into the Backus River. The restoration time frame

south of Hayway Road is predicted to be 2021, with PCE and TCE reaching their MCLs in 2021 and 2011, respectively. Estimates of mass removed for Alternative 7 modified are based on the extraction wells (95EW0703 and AVIP0001) simulated in the model until the end of the simulation. Modeling predicts that Alternative 7 modified will capture approximately 91 pounds (41 kg) of PCE and 37 pounds (17 kg) of TCE by 2021 when all PCE and TCE concentrations in the entire Ashumet Valley plume fall below the MCL (Table D2-2, Table D2-3, Figure D2-6, and Figure D2-7). These figures are additional to the 182 pounds (83 kg) of PCE and 100 pounds (45 kg) of TCE previously removed by the Ashumet Valley system prior to December 2007 (AFCEE 2008). Modeling predicts that 171 pounds (77 kg) of PCE and 52 pounds (23 kg) of TCE will discharge to the Backus River between 2008 and 2053 (Table D2-2 and Table D2-3).

3.0 CONCLUSIONS

A revision to Alternative 7, Alternative 7 modified, was developed to address concerns about contamination in the area of the Ashumet Valley plume downgradient of Hayway Road. The conceptual design was modified to address a core of PCE contamination that had migrated farther south than modeled in the scenario for Alternative 7 (AFCEE 2007a). The design was modified from two extraction wells downgradient of Carriage Shop Road, to one extraction well downgradient of Carriage Shop Road placed further to the south to intercept the core of PCE contamination in the southern portion of the Ashumet Valley plume.

After consideration of all the updated modeling, AFCEE, EPA, and MassDEP agreed that Alternative 7 modified would satisfy the collective concerns about an appropriate remedy. AFCEE will therefore present Alternative 7 modified as the selected remedy for the Ashumet Valley groundwater OU.

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4.0 REFERENCES

AFCEE. 2008 (March). *Ashumet Valley 2007 Summary Letter Report.* Prepared by CH2M Hill for AFCEE/MMR, Installation Restoration Program, Otis ANG Base, MA.

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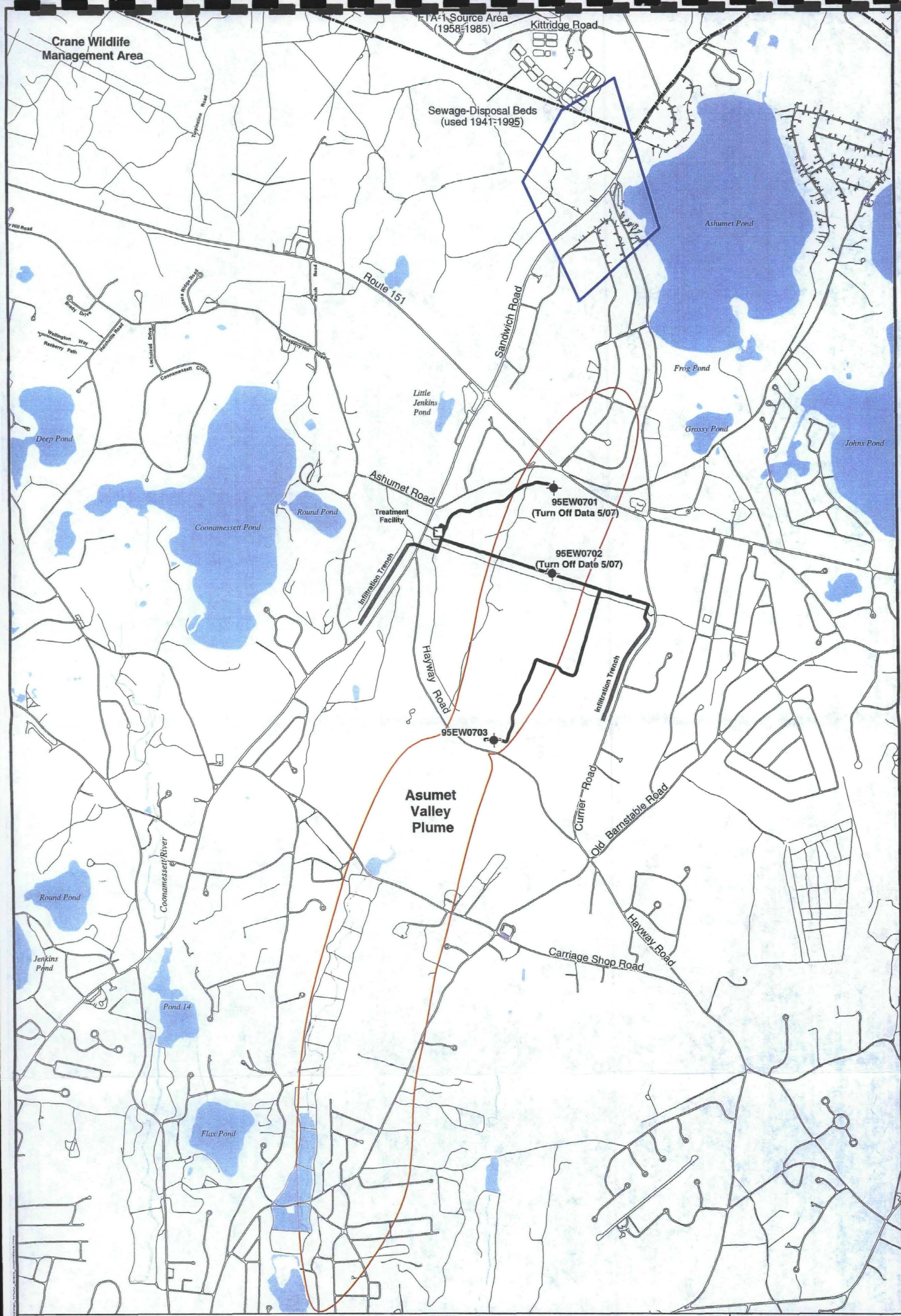
APPENDIX D

Figures



Legend

- Extraction Well
- ETI System Pipeline
- Infiltration Trench
- 2007 Ashumet Valley Plume Boundary (TCE, PCE MCL = 5.0 µg/L)
- Area of Interest for Manganese and Thallium in Groundwater. Based on Final Risk Assessment for Ashumet Valley (Appendix A of Final Ashumet Valley Groundwater Feasibility Study, AFCEE 2007a).

Data Source: AFCEE (2008), Ashumet Valley 2007 Letter Report

N

0 750 1,500 Feet

1: 18,000

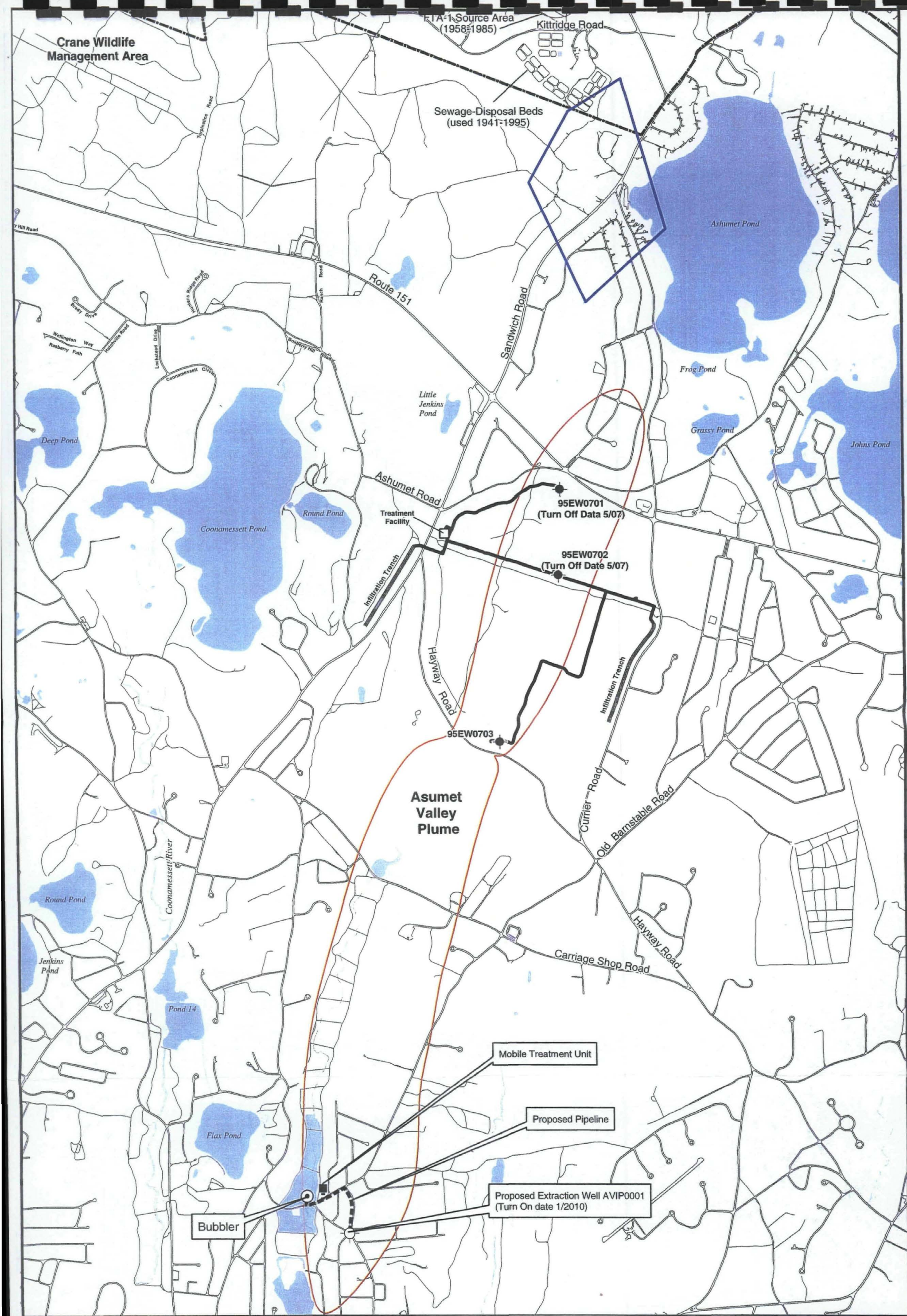
JACOBS™

Ashumet Valley Groundwater Alternative 6 Modified Conceptual Design

Massachusetts Military Reservation
Cape Cod, Massachusetts

NAME: jpiccuito DATE: 9/17/2008

Figure D2-1



Legend

- Extraction Well
- Proposed Extraction Well
- Surface Discharge - Bubbler
- 2007 Ashumet Valley Plume Boundary (TCE, PCE MCL = 5.0 µg/L)
- Area of Interest for Manganese and Thallium in Groundwater. Based on Final Risk Assessment for Ashumet Valley (Appendix A of Final Ashumet Valley Groundwater Feasibility Study, AFCEE 2007a).

Data Source: AFCEE (2008), Ashumet Valley 2007 Letter Report

- ETI System Pipeline
- New Pipeline
- Infiltration Trench

N

0 750 1,500 Feet

1: 18,000

JACOBS™

Ashumet Valley Groundwater Alternative 7 Modified Conceptual Design

Massachusetts Military Reservation
Cape Cod, Massachusetts

NAME: jpicuito DATE: 9/17/2008

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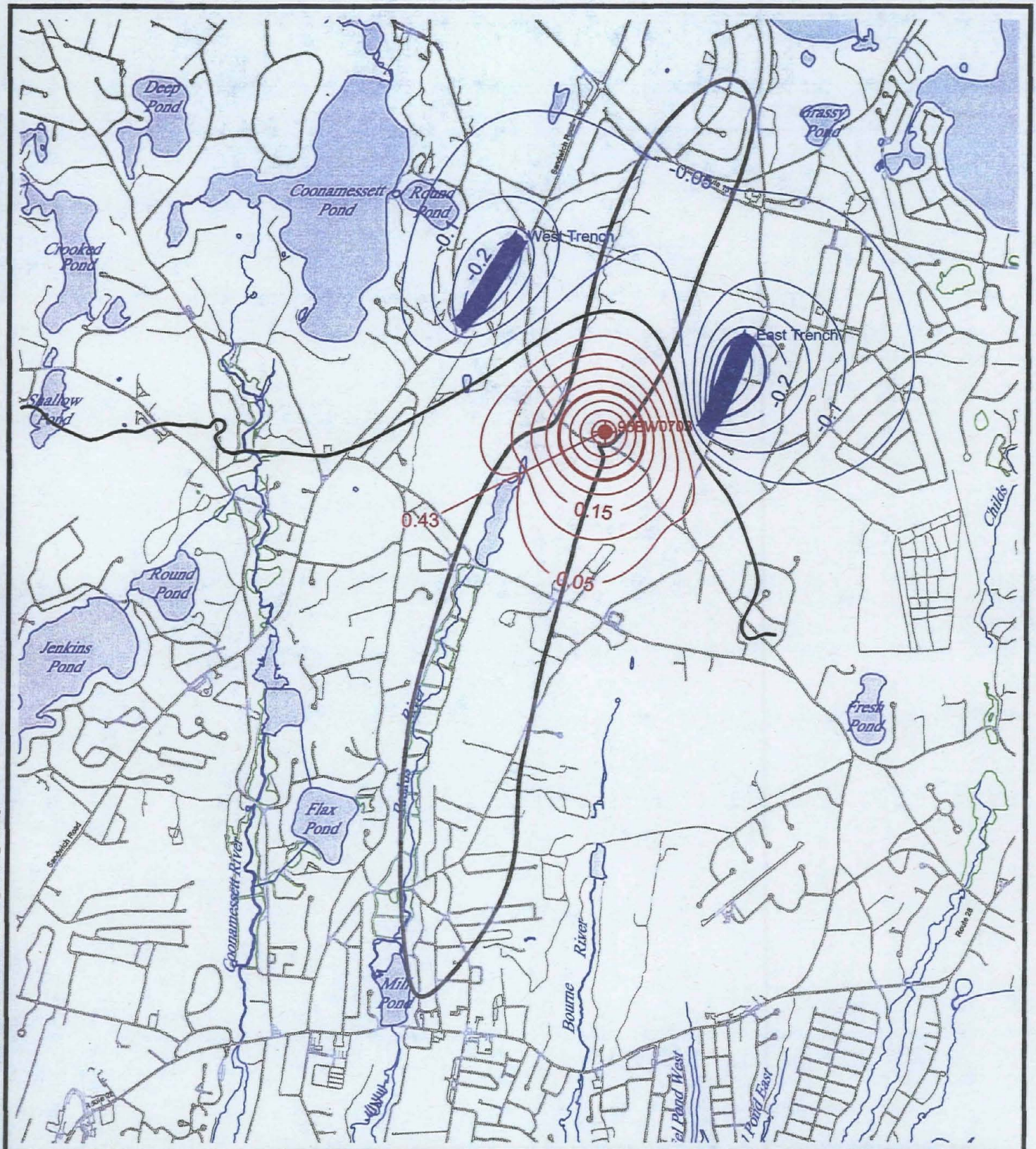

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Data Source: AFCEE (2008), Ashumet Valley 2007 Letter Report

0.25 Drawdown Contour (feet)

-0.25 Mounding Contour (feet)

2007 Ashumet Valley TCE/PCE Plume (5 µg/L)

0 2400

Scale in Feet

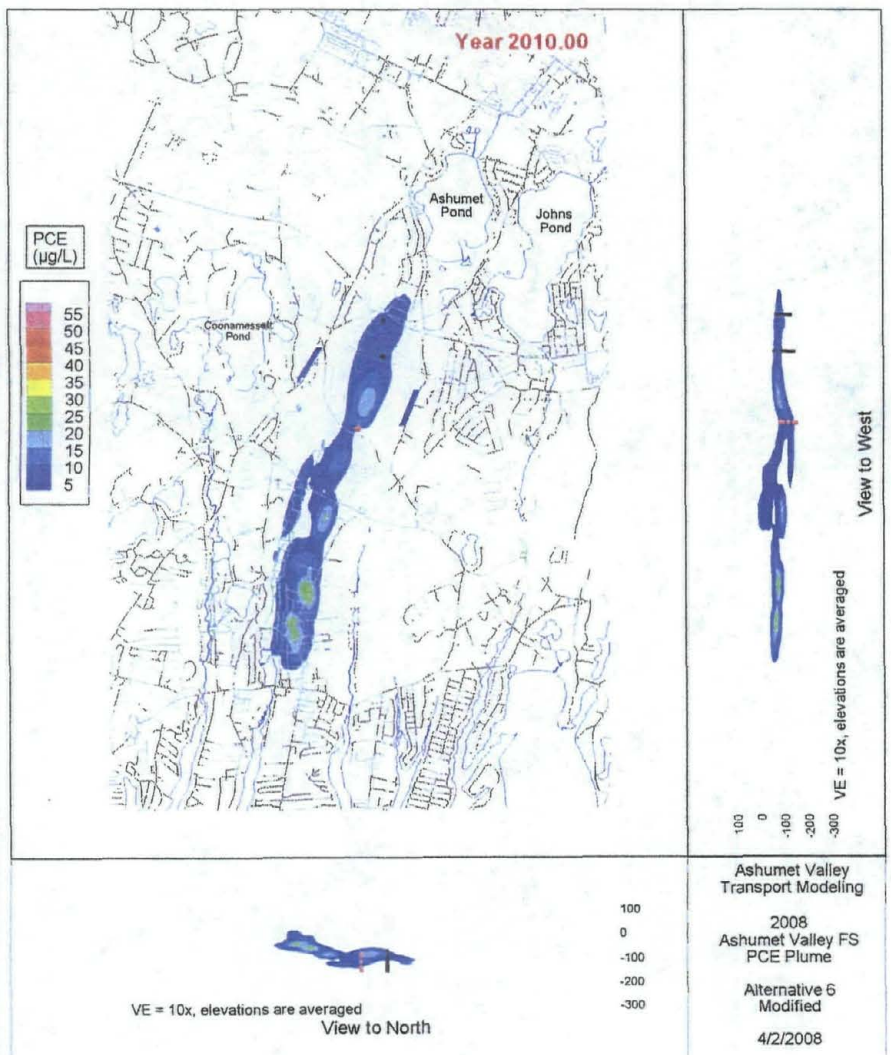
JACOBS

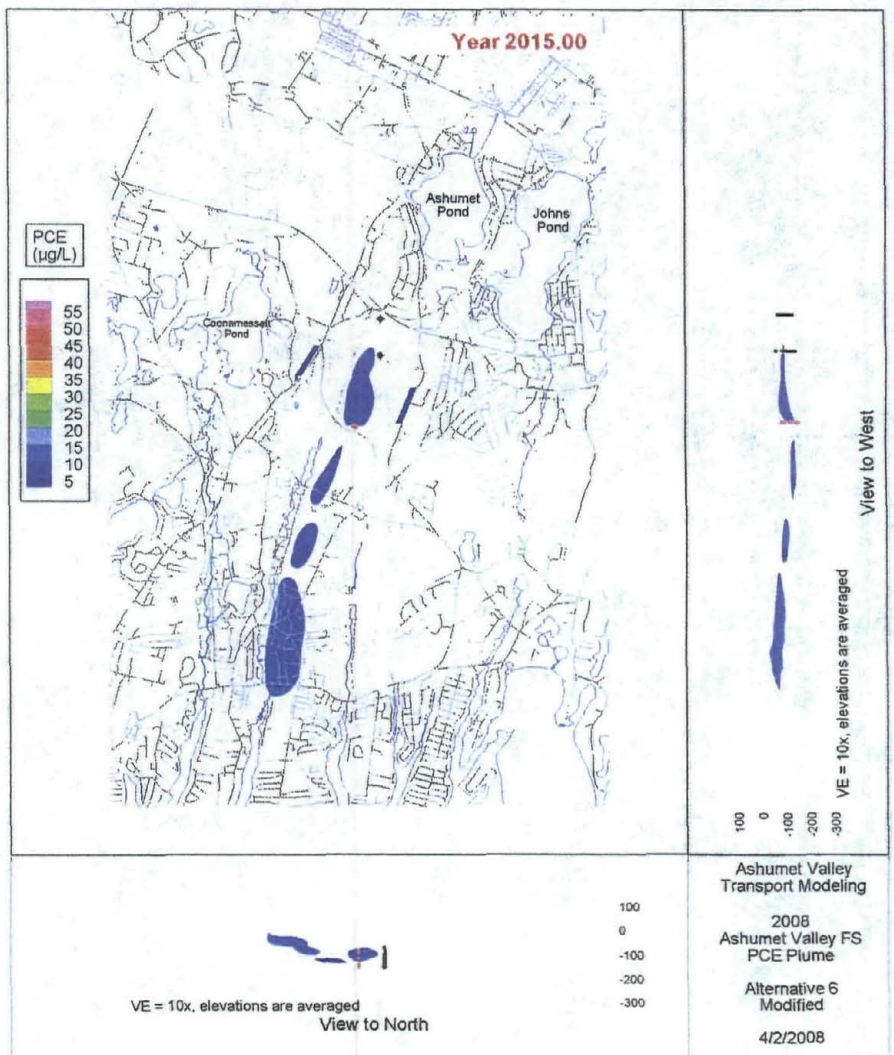
Modeled Drawdown and Mounding for Alternative 6 Modified

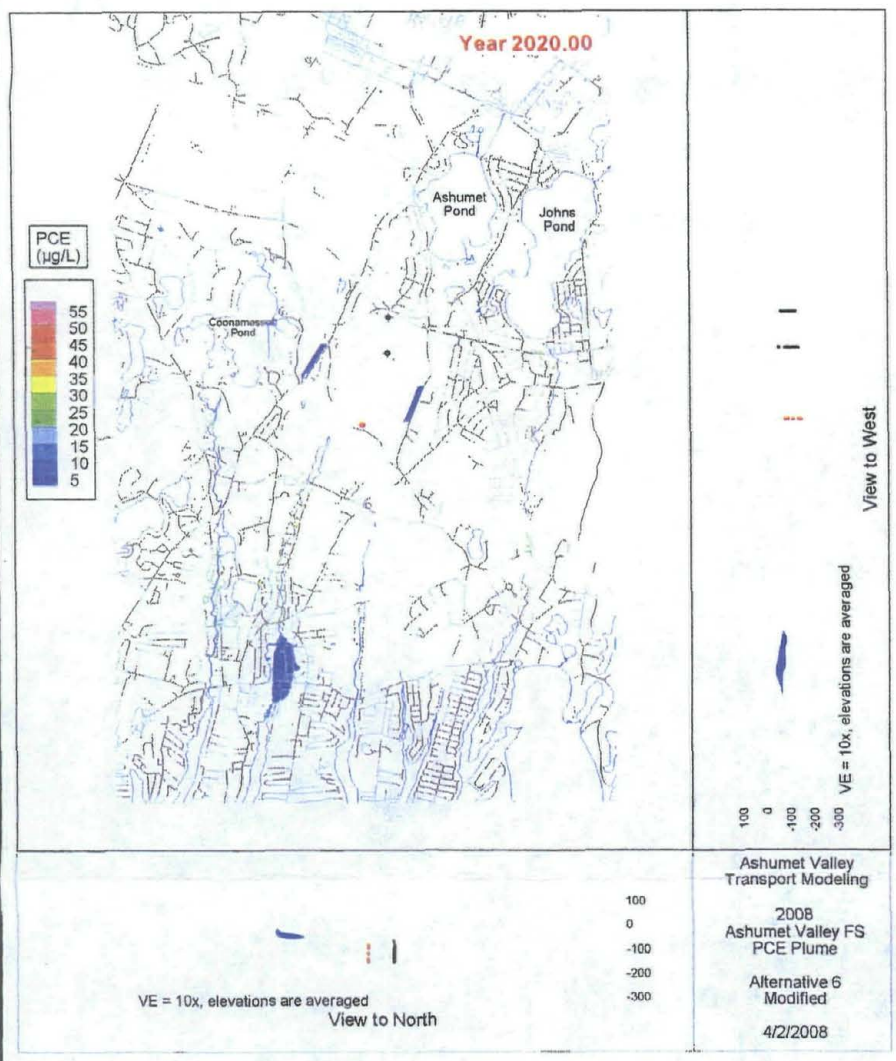
Massachusetts Military Reservation
Cape Cod, Massachusetts

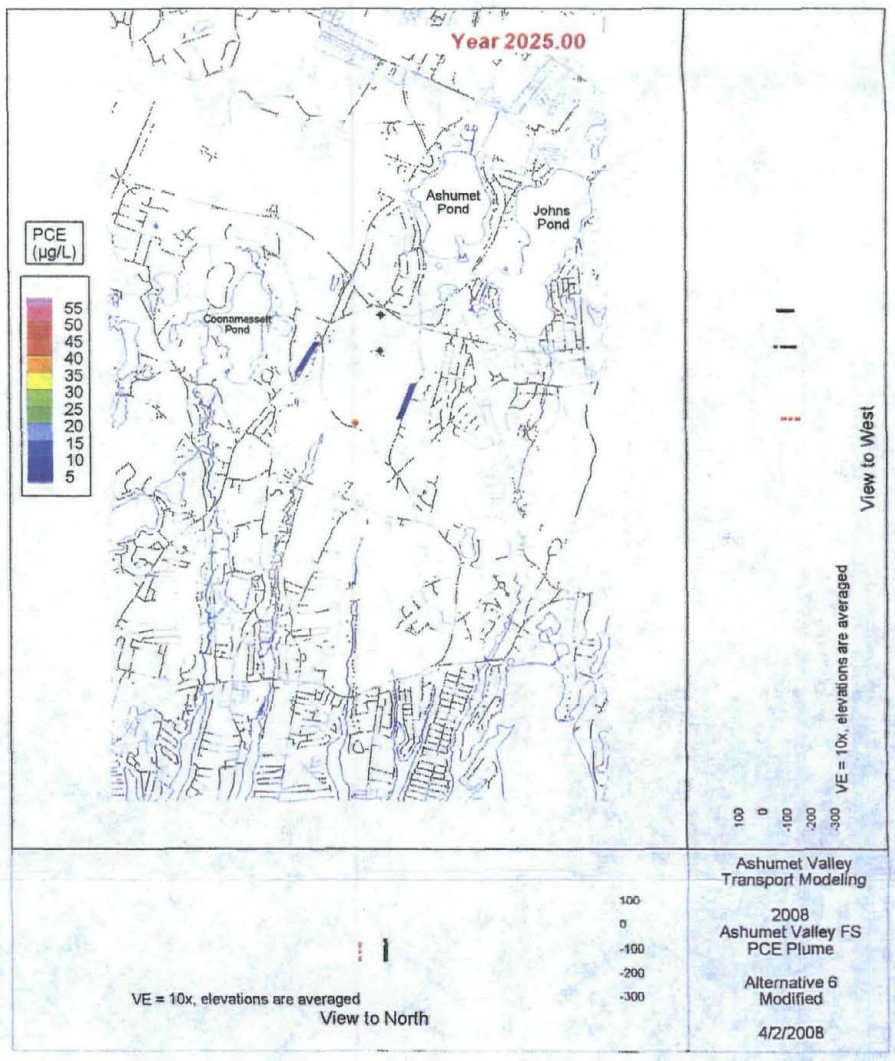
11/05/08 JP ashumet_drawdown_alt6b.dwg

Figure D2-3









Legend

- Pumping Well
- Infiltration Trench

Note:

PCE MCL = 5 µg/L (micrograms per liter)
Decay Half-life = 60 years

Model Parameters

Retardation = 1.56
Horizontal Dispersivity = 10.0 ft.
Transverse Dispersivity = 0.3 ft.
Vertical Dispersivity = 0.03 ft.

Viewport depicts the highest concentration in the plume.

N

0 7500
Scale in Feet

JACOBS™

Alternative 6 Modified, Model Predicted PCE Concentrations

Massachusetts Military Reservation
Cape Cod, Massachusetts

02-17-09
FigD2-4_PCEa.cdr

Figure D2-4

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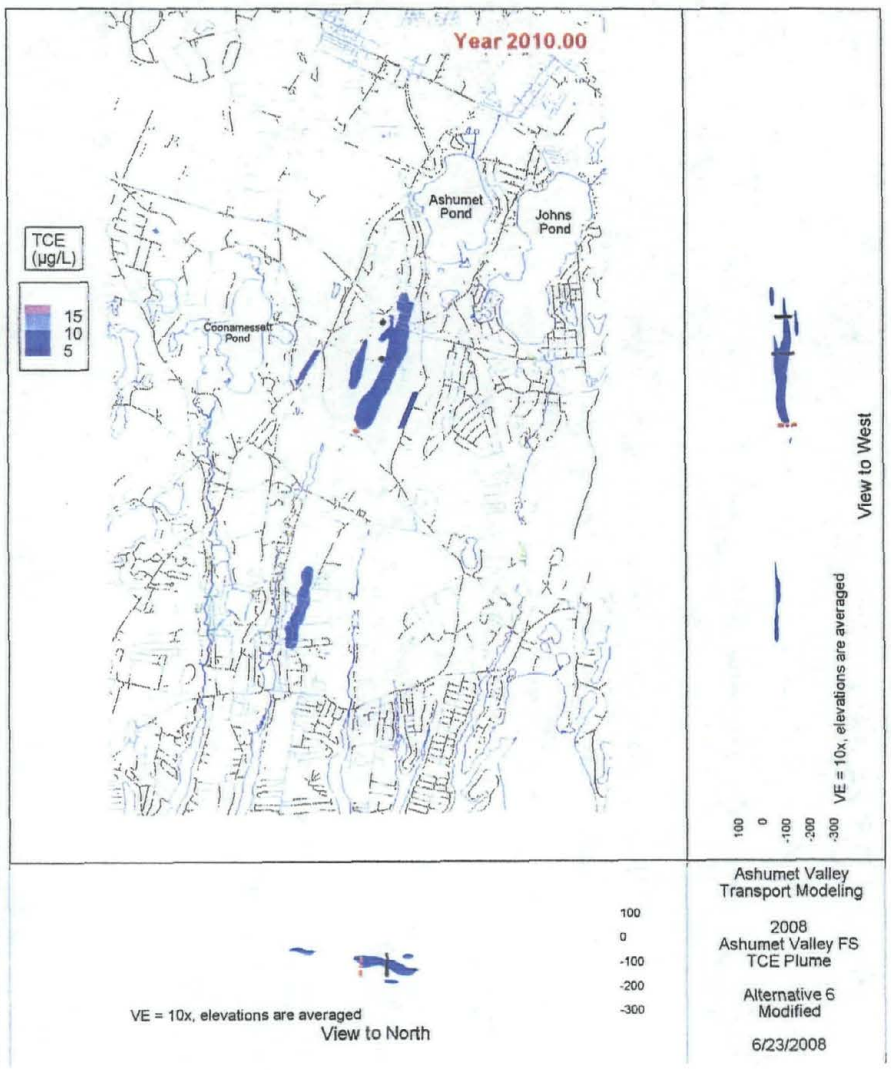

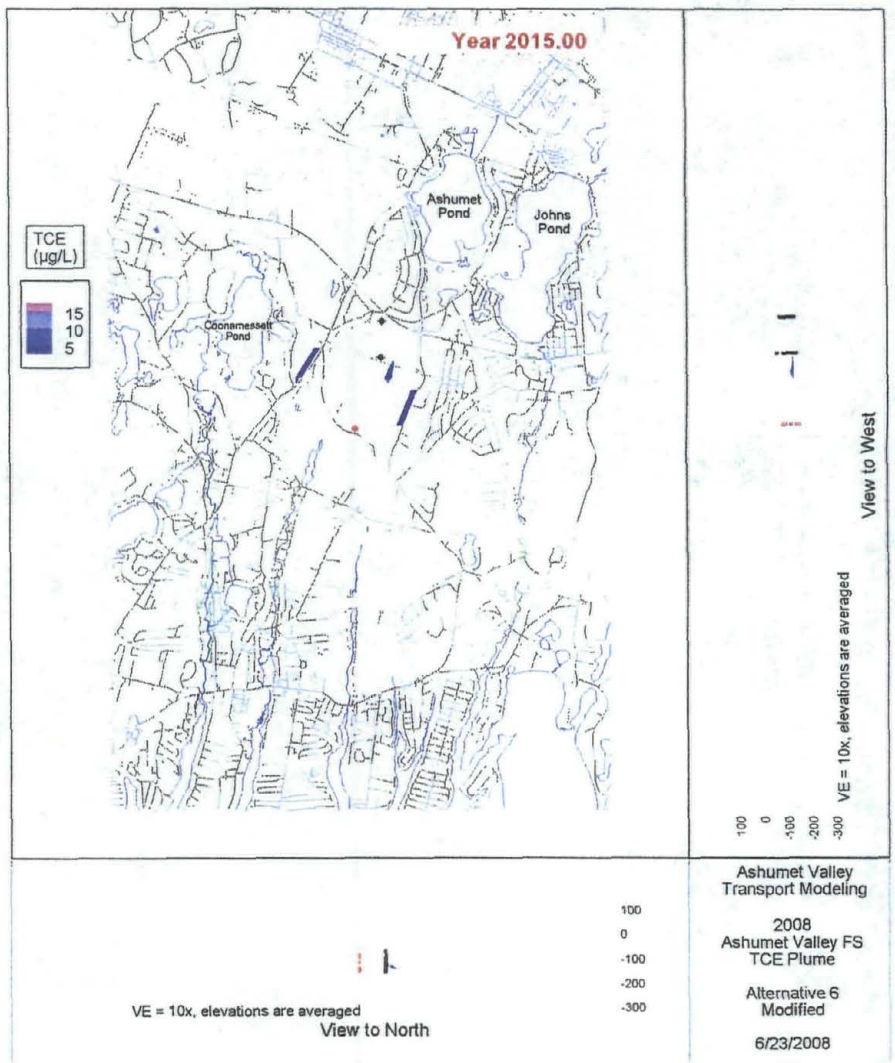

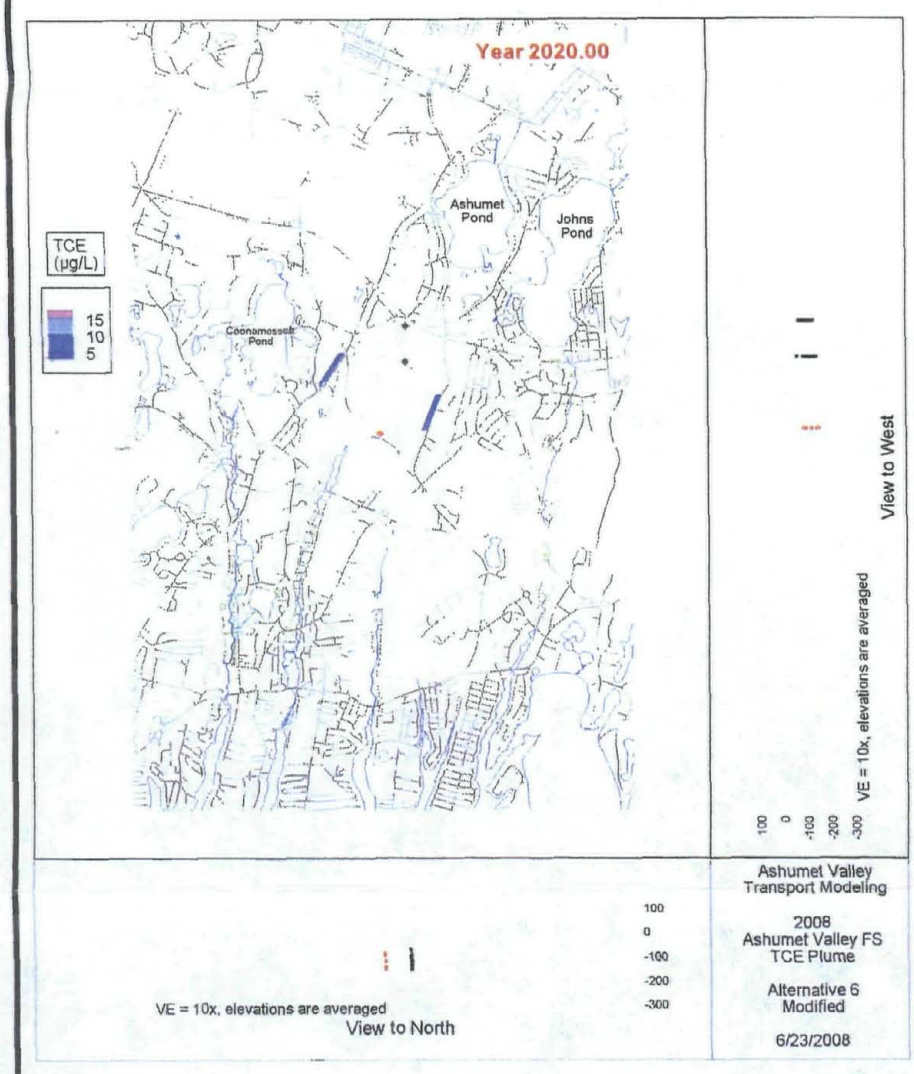

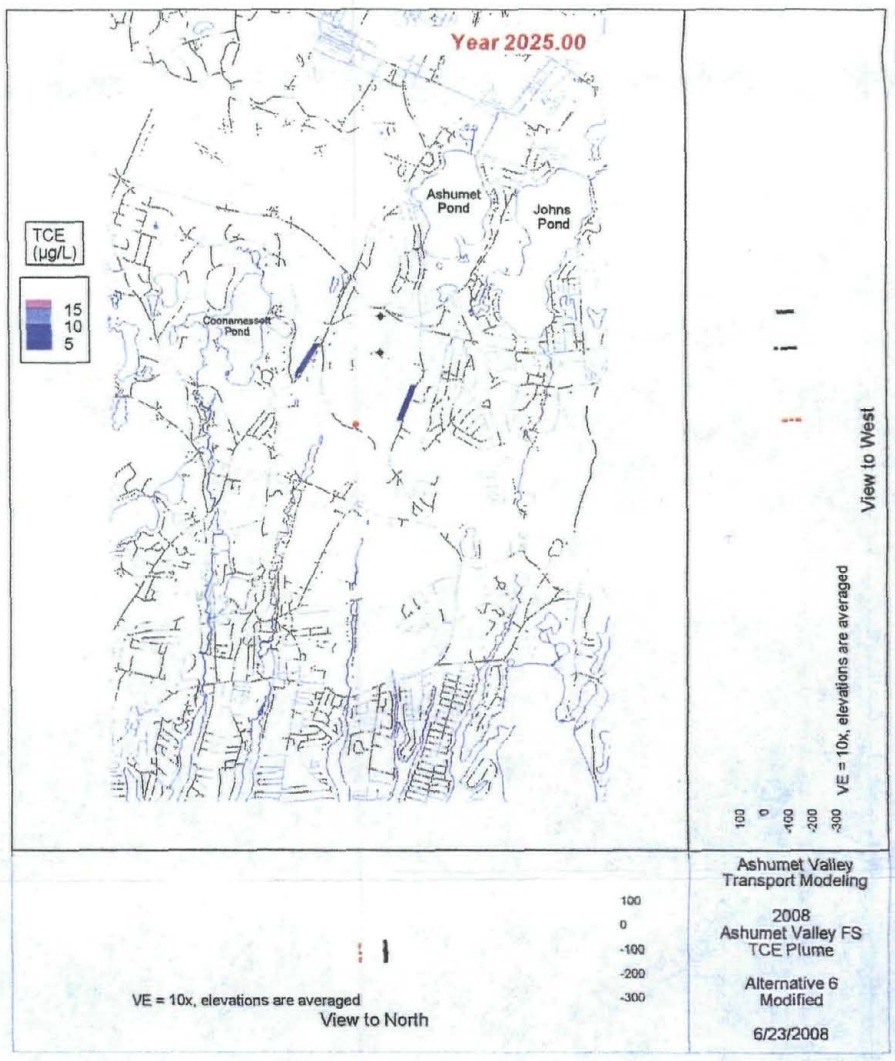

Legend

- Pumping Well
- Infiltration Trench

Note:

TCE MCL = 5 µg/L (micrograms per liter)
Decay Half-life = 60 years

Model Parameters

Retardation = 1.2
Horizontal Dispersivity = 10.0 ft.
Transverse Dispersivity = 0.3 ft.
Vertical Dispersivity = 0.03 ft.

Viewport depicts the highest concentration in the plume.

N

0 7500
Scale in Feet

JACOBS™

Alternative 6 Modified, Model Predicted TCE Concentrations

Massachusetts Military Reservation
Cape Cod, Massachusetts

02-17-09
FigD2-5_TCEa.cdr

Figure D2-5

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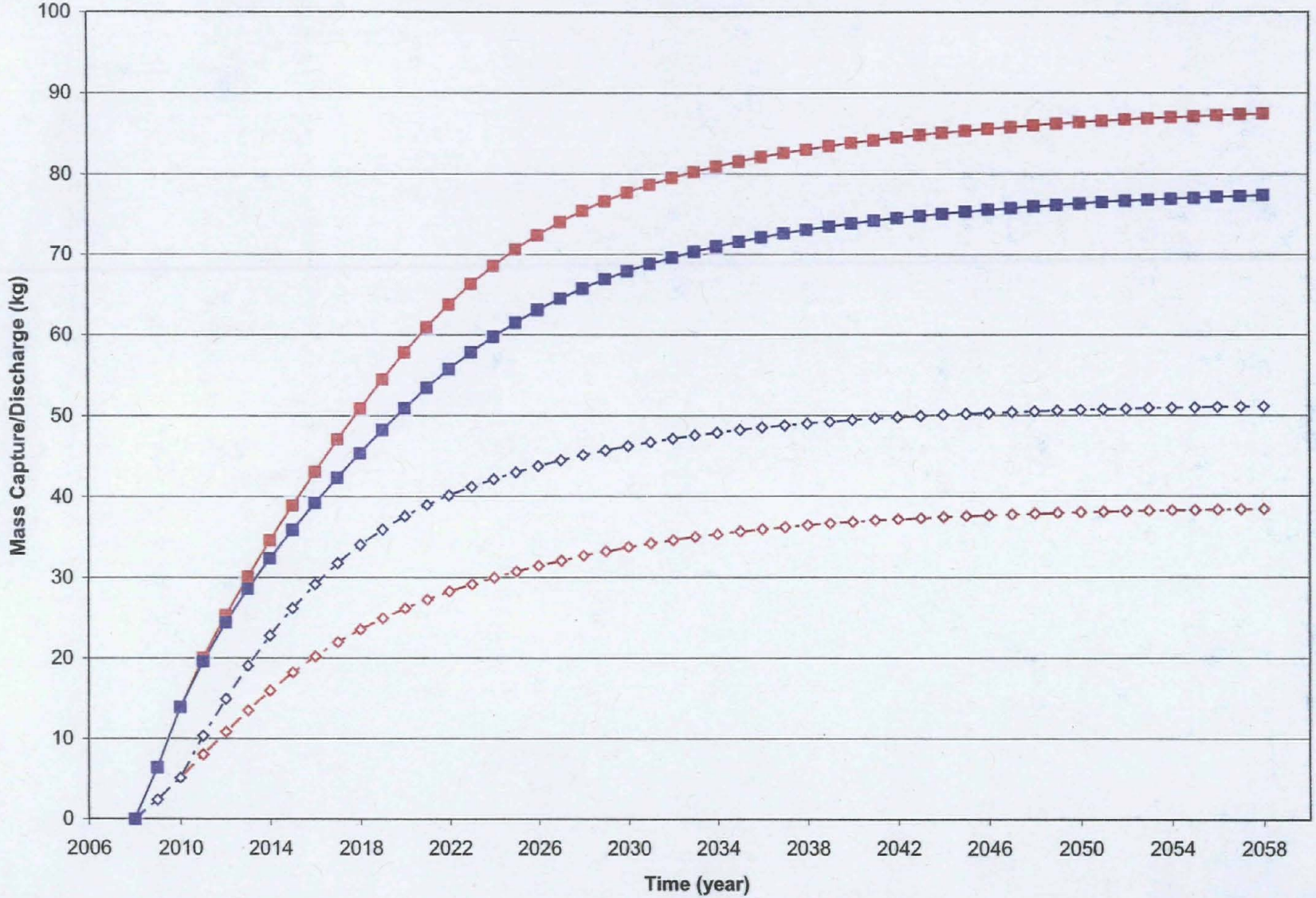

Legend

Alt 6 m Mass Captured — Alt 6 m Discharge to River — Alt 7 m Mass Captured — Alt 7 m Discharge to River

JACOBS™

PCE Mass Capture and Discharge

Massachusetts Military Reservation
Cape Cod, Massachusetts

9/24/08 JP
ashumet_pce_mass3.cdr

Figure D2-6

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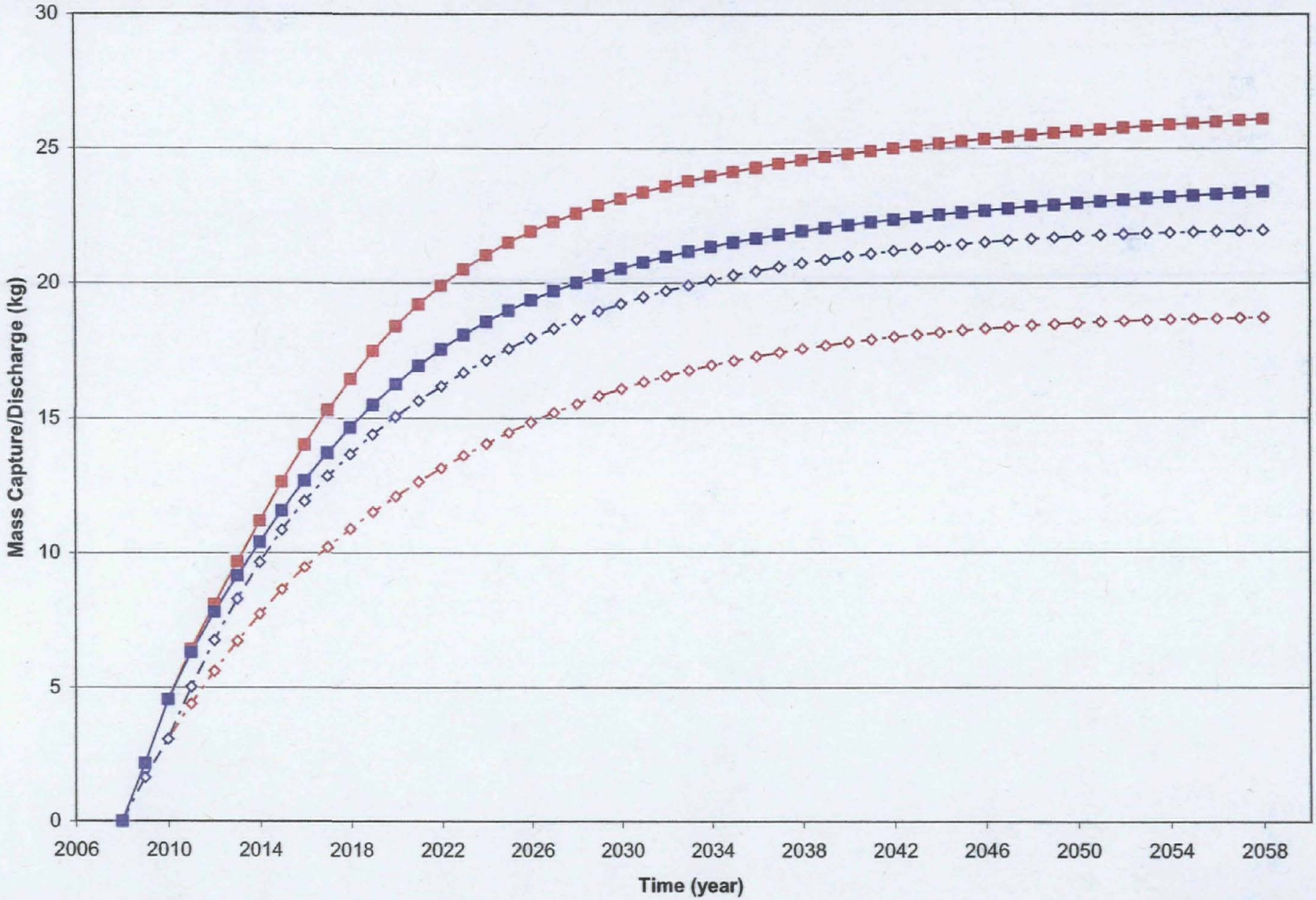

Legend

Alt 6 m Mass Captured — Alt 6 m Discharge to River — Alt 7 m Mass Captured — Alt 7 m Discharge to River

JACOBS™

TCE Mass Capture and Discharge

Massachusetts Military Reservation
Cape Cod, Massachusetts

9/24/08 JP
ashumet_pce_mass3.cdr

Figure D2-7

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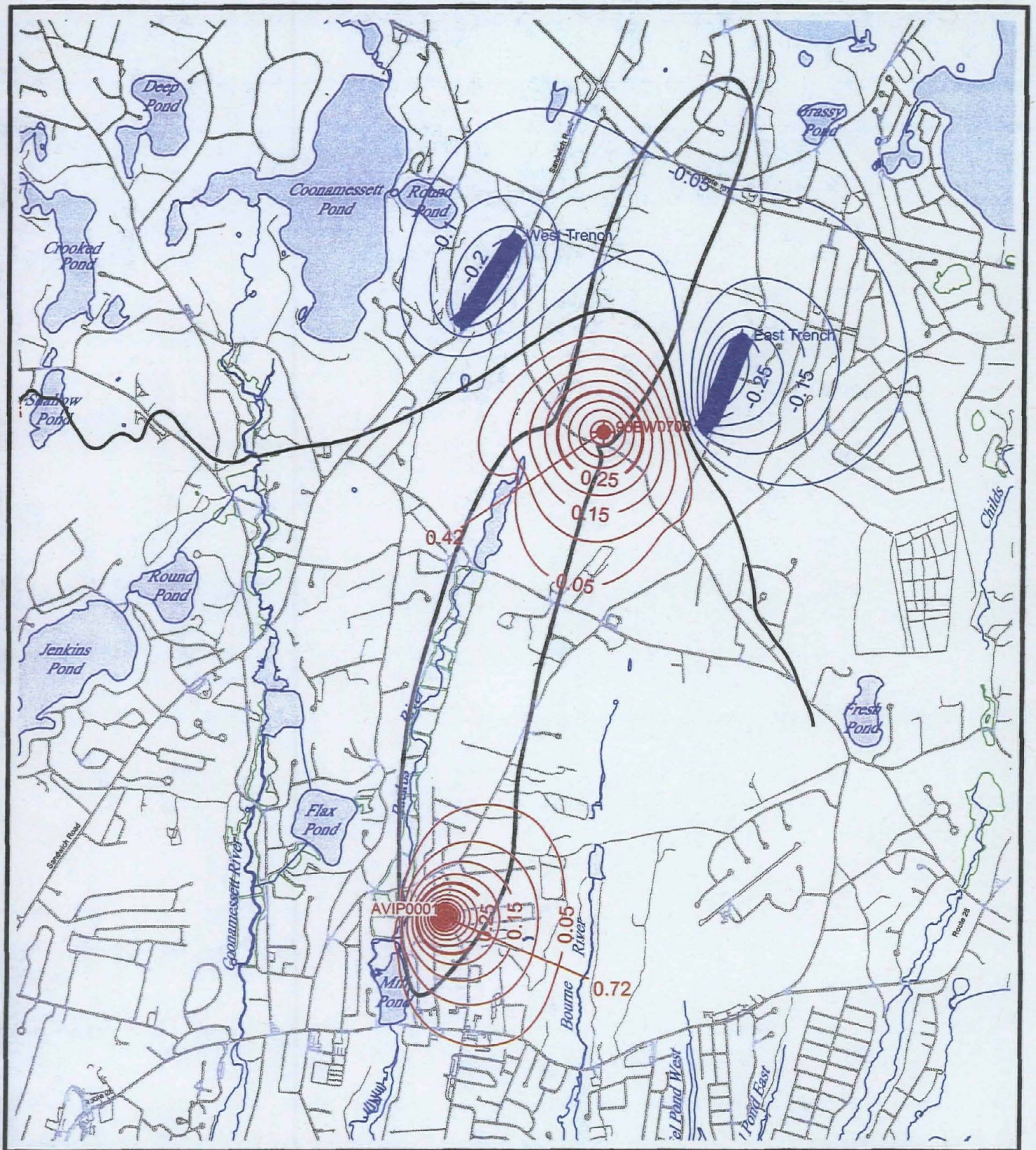


Legend

- 0.25 — Drawdown Contour (feet)
- -0.25 — Mounding Contour (feet)
- Ashumet Valley TCE/PCE Plume (5 µg/L)

Data Source: AFCEE (2008), Ashumet Valley 2007 Letter Report

0 2400
Scale in Feet

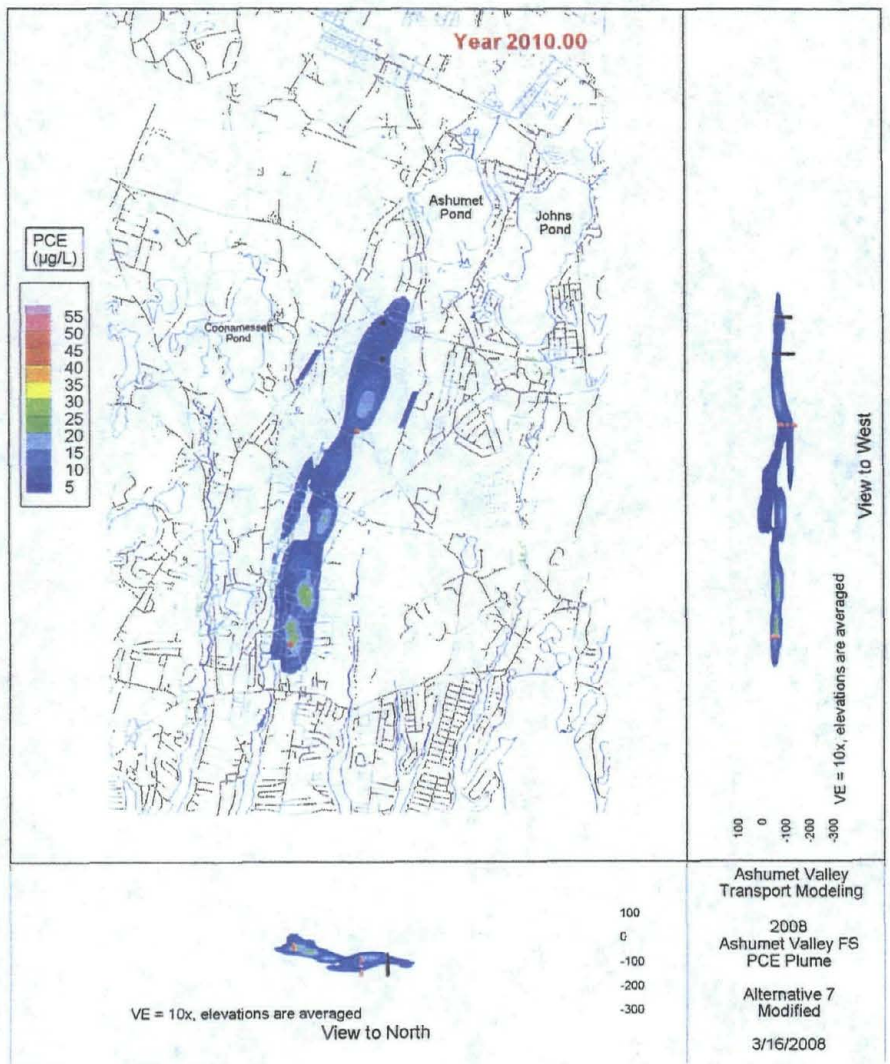
JACOBS

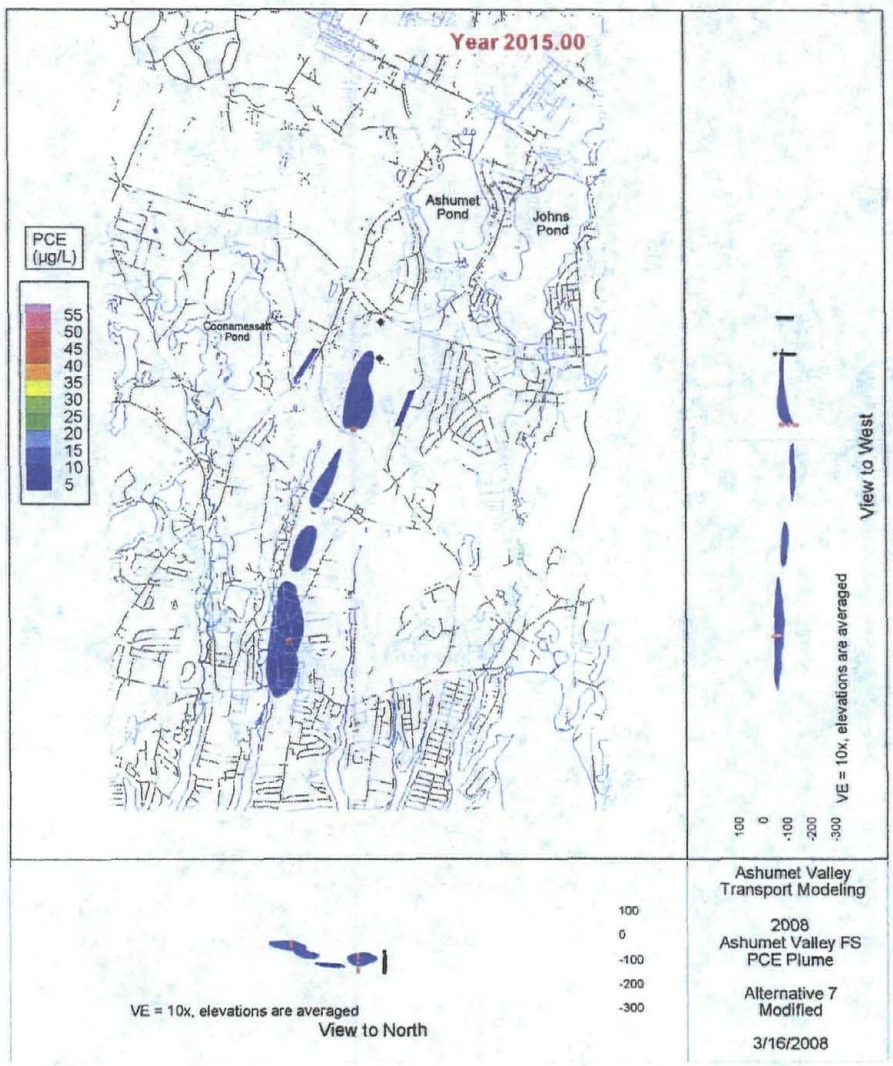
Modeled Drawdown and Mounding for Alternative 7 Modified

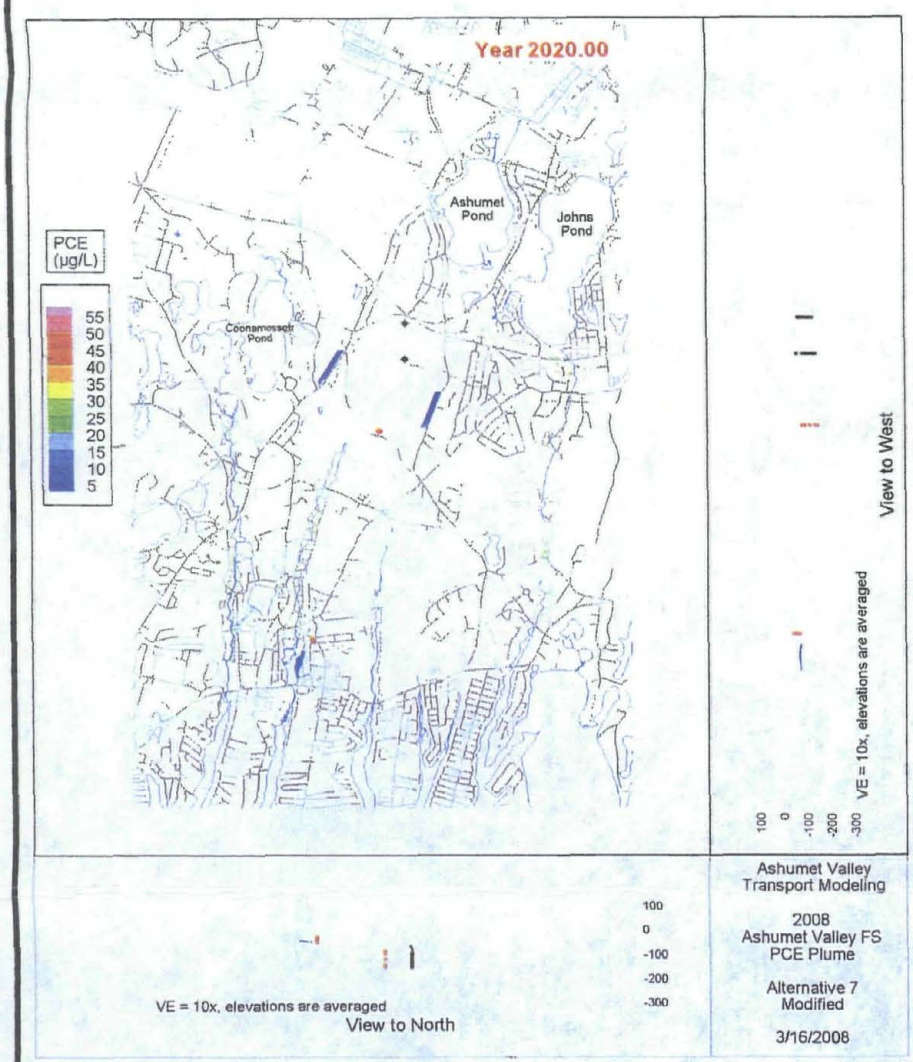
Massachusetts Military Reservation
Cape Cod, Massachusetts

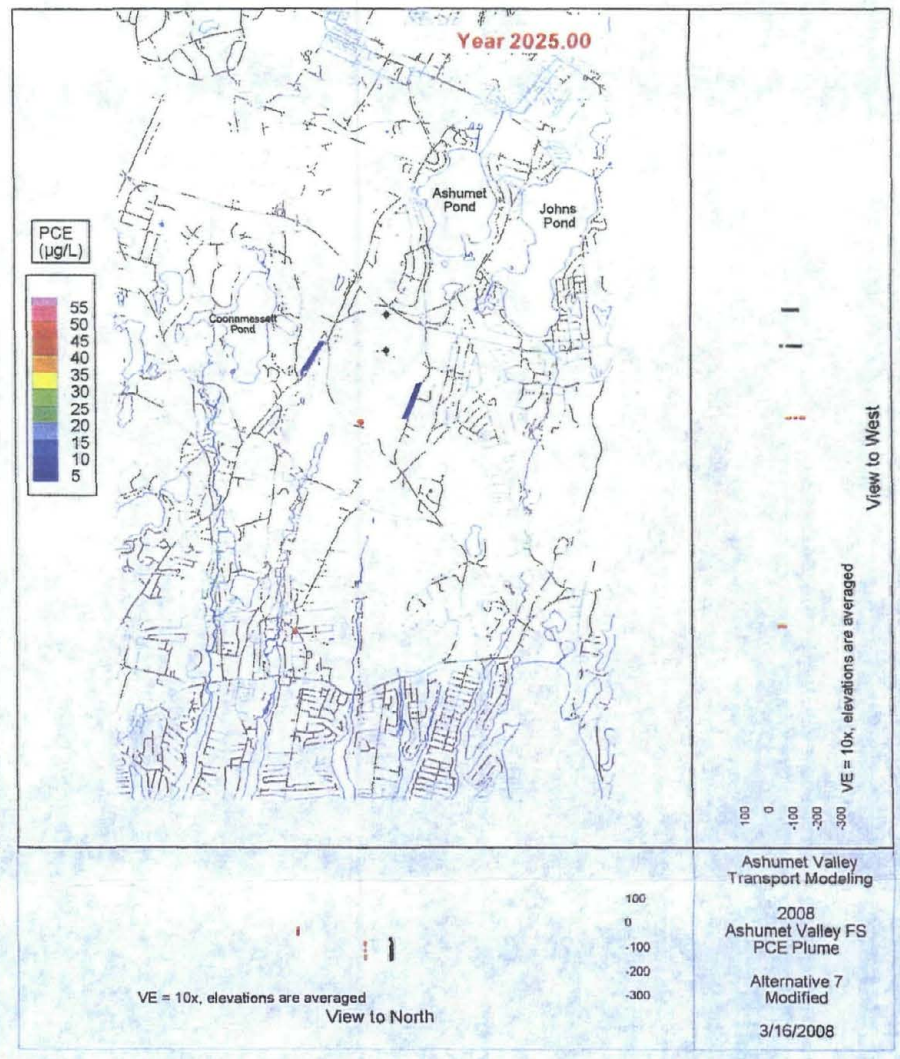
11/03/08 JP ashumet_drawdown_alt7c.dwg

Figure D2-8









Legend

- Pumping Well
- Infiltration Trench

Note:

PCE MCL = 5 µg/L (micrograms per liter)
Decay Half-life = 60 years

Model Parameters

Retardation = 1.56
Horizontal Dispersivity = 10.0 ft.
Transverse Dispersivity = 0.3 ft.
Vertical Dispersivity = 0.03 ft.

Viewport depicts the highest concentration in the plume.

N

0 7500
Scale in Feet

JACOBS™

Alternative 7 Modified, Model Predicted PCE Concentrations

Massachusetts Military Reservation
Cape Cod, Massachusetts

02-17-09
FigD2-9_PCEa.cdr

Figure D2-9

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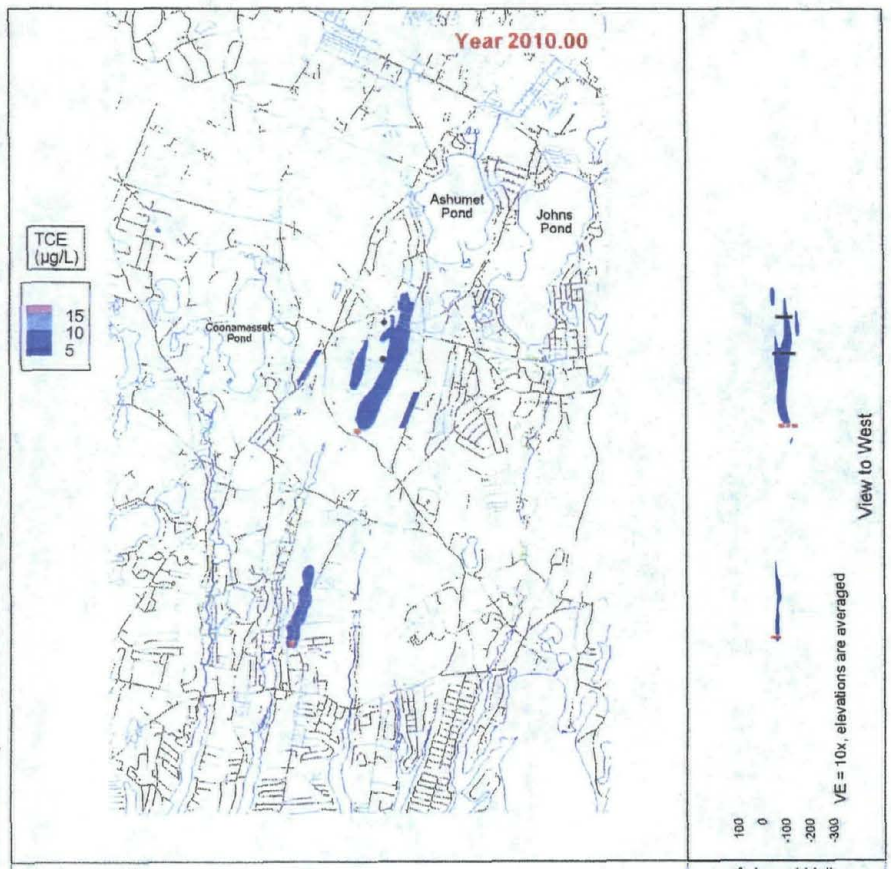
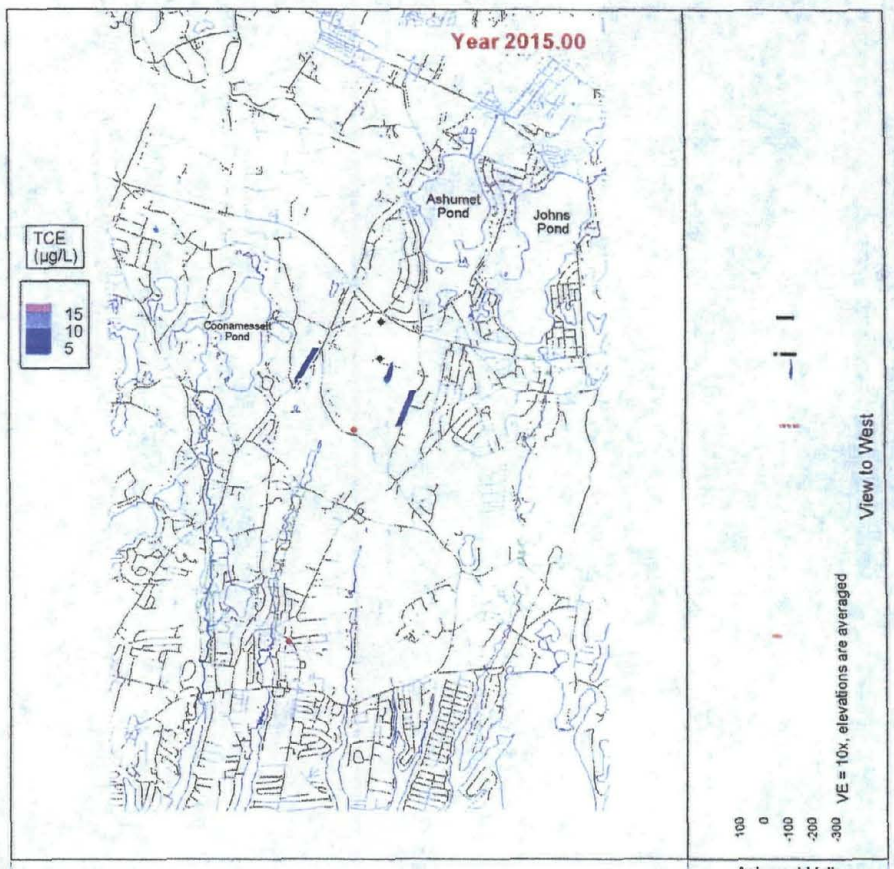
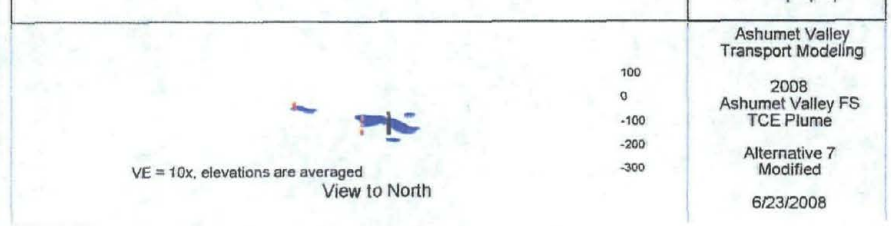




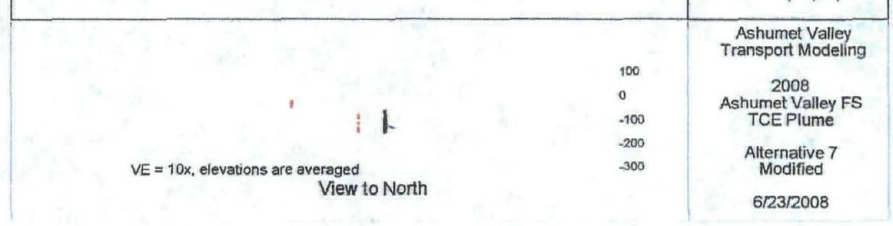


Ashumet Valley Transport Modeling

2008
Ashumet Valley FS
TCE Plume

Alternative 7 Modified

6/23/2008

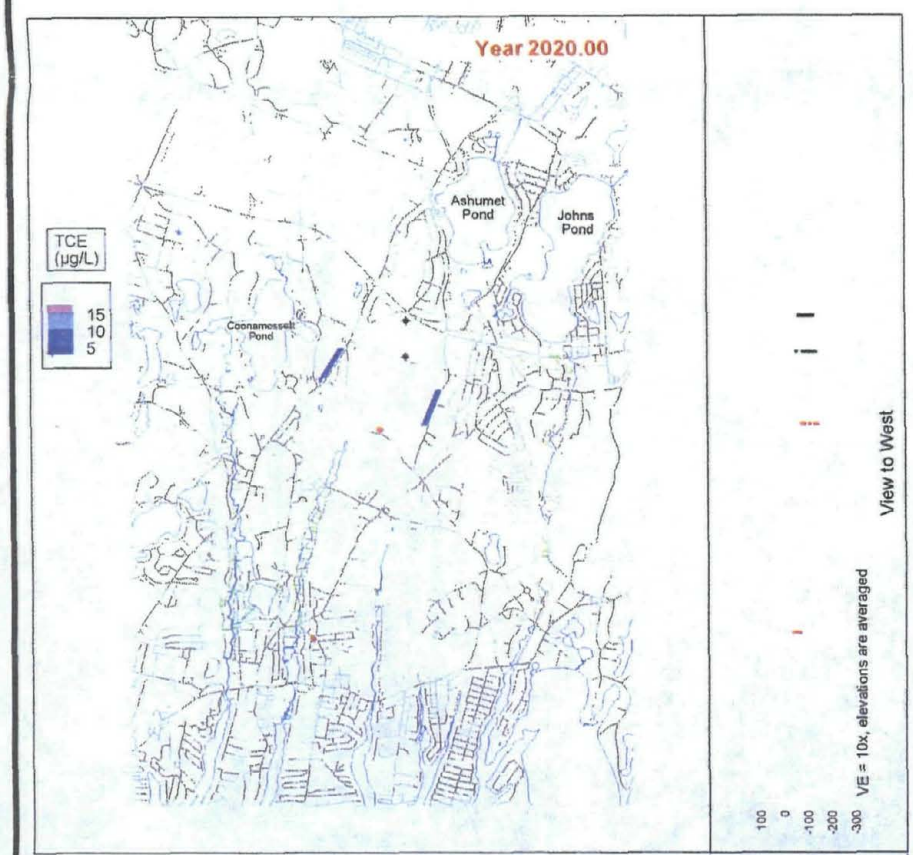


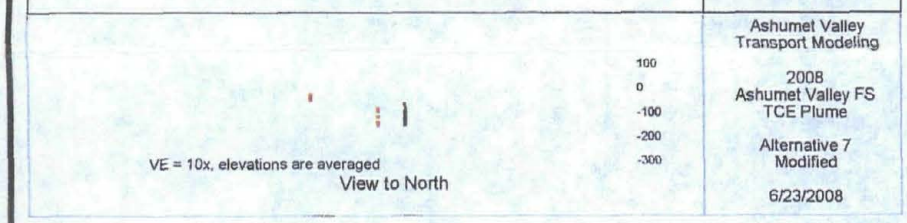
Ashumet Valley Transport Modeling

2008
Ashumet Valley FS
TCE Plume

Alternative 7 Modified

6/23/2008



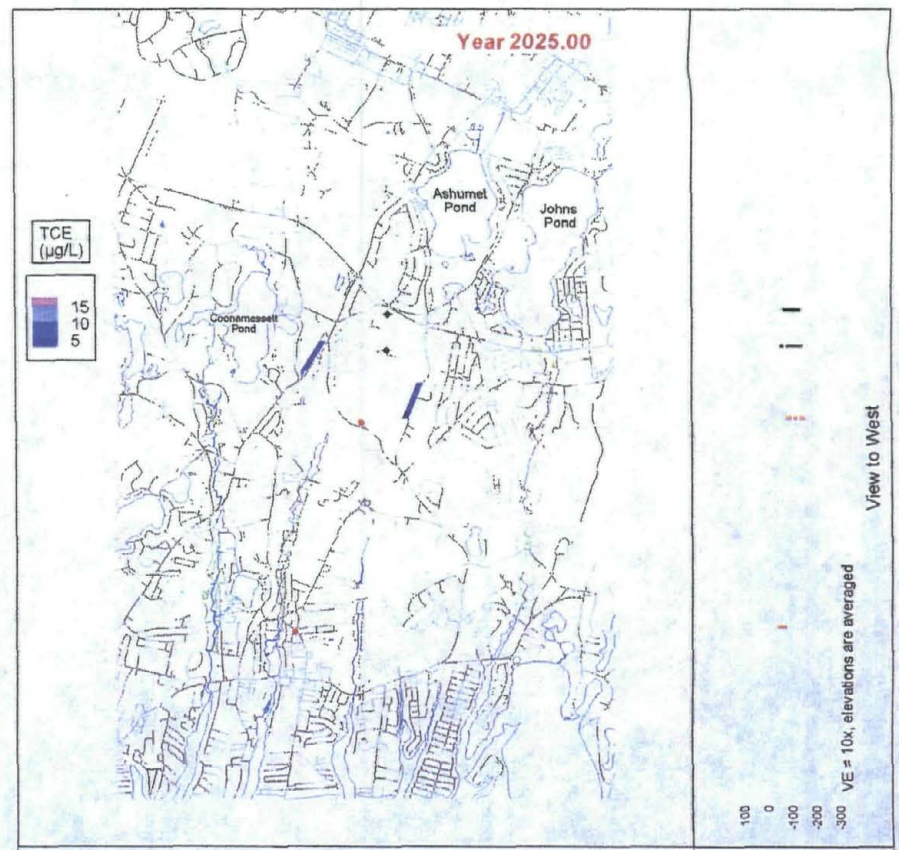


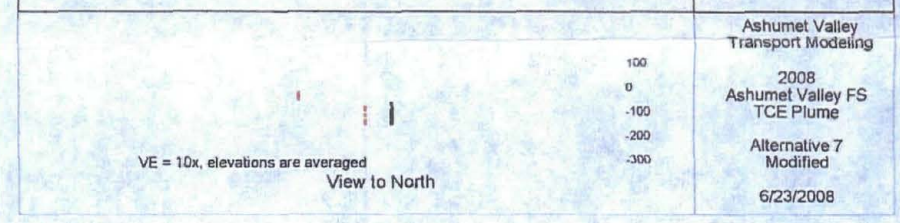
Ashumet Valley Transport Modeling

2008
Ashumet Valley FS
TCE Plume

Alternative 7 Modified

6/23/2008





Ashumet Valley Transport Modeling

2008
Ashumet Valley FS
TCE Plume

Alternative 7 Modified

6/23/2008

Legend

- Pumping Well
- Infiltration Trench

Note:

TCE MCL = 5 µg/L (micrograms per liter)
Decay Half-life = 60 years

Model Parameters

Retardation = 1.2
Horizontal Dispersivity = 10.0 ft.
Transverse Dispersivity = 0.3 ft.
Vertical Dispersivity = 0.03 ft.

Viewport depicts the highest concentration in the plume.

N

0 7500
Scale in Feet

JACOBS™

Alternative 7 Modified, Model Predicted TCE Concentrations

Massachusetts Military Reservation
Cape Cod, Massachusetts

02-17-09
FigD2-10_TCEa.cdr

Figure D2-10

Y:\GIS\projects\35BC02\VA\20090217\Corel\FigD2-10_TCEa.cdr

APPENDIX D

Tables

Table D2-1
Summary of Modeled Ashumet Valley Feasibility Study Flow Rates

Location	Component Type	Easting Coordinate (ft)	Northing Coordinate (ft)	Top of Screen Elevation (ft msl)	Bottom of Screen Elevation (ft msl)	Flow (gpm)	Comments
Alternative 6 modified							
95EW0701	Extraction Well	860865	227437	-64.28	-139.28	0	System optimized in May 2007, Simulation starts January 2008.
95EW0702	Extraction Well	860828	225928	-52.83	-150.63	0	
95EW0703	Extraction Well	859763	222957	-73.4	-157.1	350	
Trench along Sandwich Road	Infiltration Trench	862218 to 861576	224590 to 223072	36	30	175	
Trench along Currier Road	Infiltration Trench	858195 to 857245	226346 to 224952	36	32	175	
Alternative 7 modified							
95EW0701	Extraction Well	860865	227437	-64.28	-139.28	0	System optimized in May 2007, Simulation starts January 2008.
95EW0702	Extraction Well	860828	225928	-52.83	-150.63	0	
95EW0703	Extraction Well	859763	222957	-73.4	-157.1	350	
Trench along Sandwich Road	Infiltration Trench	862218 to 861576	224590 to 223072	36	30	175	
Trench along Currier Road	Infiltration Trench	858195 to 857245	226346 to 224952	36	32	175	
AVIP001	Extraction Well	856985	214325	-35	-75	175	System added in January 2010.
	Bubbler					175	

Notes:
ft = feet
ft msl = feet mean sea level
gpm = gallons per minute

Table D2-2
PCE Mass Removed and Mass Discharged to Backus River for Ashumet Valley Groundwater

Scenario	Total Flow Rate (gpm)	PCE Mass Removed (lb)	PCE Mass Discharged to Backus River After 2006 (lb)	PCE Mass Discharged to Backus River After 2010 (lb)	PCE Adsorbed Mass Remaining After Restoration (lb)	PCE Dissolved Mass Remaining After Restoration (lb)[2]	Restoration Year South of Hayway Road	Restoration Year Between Rte 151 and Hayway Road	Restoration Year North of Rte 151
Alternative 6m[1]	350	64	193	162	44	78	2023	2019	2013
Alternative 7m[1]	525	91	171	140	49	87	2021	2019	2013

Note: Mass removed and mass discharged based on 2008 to restoration year and includes mass extracted from the existing AV system.
Restoration year is 2023 (Alternative 6 modified) and 2021 (Alternative 7 modified). Restoration times are based on the time PCE and TCE in the Ashumet Valley plume falls below its MCL of 5 µg/L. Mass remaining after restoration is below MCLs.

[1]Assumes new system components start in 2010 (1.5 years after signing of ROD).

[2]Represents mass that naturally attenuates to concentrations less than the MCL of 5 µg/L.

AV = Ashumet Valley
gpm = gallons per minute
lb = pounds
m = modified
PCE = tetrachloroethene
ROD = Record of Decision
TCE = trichloroethene

Table D2-3
TCE Mass Removed and Mass Discharged to Backus River for Ashumet Valley Groundwater

Scenario	Total Flow Rate (gpm)	TCE Mass Removed (lb)	TCE Mass Discharged to Backus River After 2006 (lb)	TCE Mass Discharged to Backus River After 2010 (lb)	TCE Adsorbed Mass Remaining After Restoration (lb)	TCE Dissolved Mass Remaining After Restoration (lb)	Restoration Year South of Hayway Road	Restoration Year Between Rte 151 and Hayway Road	Restoration Year North of Rte 151
Alternative 6m[1]	350	30	58	44	9	42	2011	2016	2012
Alternative 7m[1]	525	37	52	38	9	47	2011	2016	2012

Note: Mass removed and mass discharged based on 2008 to restoration year and includes mass extracted from the existing AV system.

Restoration year is 2023 (Alternative 6 modified) and 2021 (Alternative 7 modified). Restoration times are based on the time PCE and TCE in the Ashumet Valley plume falls below its MCL of 5 µg/L. Mass remaining after restoration is below MCLs.

[1]Assumes new system components start in 2010 (1.5 years after signing of ROD).

AV = Ashumet Valley
gpm = gallons per minute
lb = pounds
m = modified
MCL = maximum contaminant level
PCE = tetrachloroethene
ROD = Record of Decision
TCE = trichloroethene

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APPENDIX D

ATTACHMENT A

Ashumet Valley 2008 Plume Shell

CH2MHILL	PROJECT NOTE	TASK ORDER 0003
		PROJECT NO. 371335
AFCEE SPEIM/LTM/O&M Otis ANG Base, Massachusetts 4P08 Contract FA8903-08-D-8769	DOCUMENT CONTROL NUMBER: 371335-SPEIM-AVP-PRJNOT-001 CDRL A001i	PAGE 1 OF 8

Confirmation Of: ☐ Meeting ☐ Change Notice ☒ General Project Note	Date Issued: 25 June 2008 Recorded By: Paul Clement
Subject: ASHUMET VALLEY 2008 DATA GAP INVESTIGATION AND PLUME SHELL UPDATE	Issued By: Nigel Tindall CH2M HILL TECHNICAL SERVICES GROUP MANAGER

ITEM	REMARKS
1.0	**INTRODUCTION**

The purpose of this project note is to present: (i) groundwater vertical profiling results from 10 direct push borings and one sonic boring that were installed during a data gap investigation at the southern portion of the Ashumet Valley plume between December 2007 and February 2008; and (ii) a 2008 update to the tetrachloroethene (PCE) and trichloroethene (TCE) plume shells for the Ashumet Valley plume.

The borings were advanced within the southern portion of the plume to address plume characterization data gaps identified during the process to reach a final Record of Decision (ROD) for the Ashumet Valley groundwater plume. It was determined that addressing these data gaps was necessary to better understand the distribution of contamination within the plume to assist in evaluating the remedial alternatives being considered. The area that required additional characterization data is located within the footprint of the plume and to the south of Carriage Shop Road (Figure 1). Specifically, the need for supplemental characterization data was identified below the following areas: (i) the parcel occupied by the Falmouth Country Club Golf Course (south of Carriage Shop Road and west of Old Barnstable Road, between existing monitoring wells USFW502 and USFW501) and (ii) the residential neighborhoods to the south of the Falmouth Country Club property between existing monitoring wells 95MW0103, 95MW0104, and 95PZ0005A.

The data collected during this data gap investigation were used to supplement data collected during a comprehensive groundwater monitoring event that was conducted in fall 2007 under the System Performance and Ecological Impact Monitoring (SPEIM) Program. During this SPEIM sampling event, 117 monitoring wells were sampled throughout the plume. The results of the fall 2007 SPEIM sampling event are presented in the Ashumet Valley 2007 Summary Letter Report (AFCEE 2008). This combined dataset from the SPEIM sampling event and the data gap investigation were used to update the PCE and TCE Ashumet Valley plume shells (Tables 1 and 2, respectively). The plume shells are three-dimensional representations of the distribution of contamination in the aquifer and provide a convenient mechanism for visualizing the plume in

ITEM	REMARKS
	three dimensions, as well as initializing the groundwater model for running contaminant transport simulations. It was agreed between the Air Force Center for Engineering and the Environment (AFCEE) and the regulatory agencies that these updated 2008 plume shells would be used for the modeling evaluations associated with the process to reach a final ROD. The following sections provide more details and the results of each of these activities.
2.0	**DATA GAP INVESTIGATION** Ten direct push borings (95DP0215 through 95DP0224) and one sonic boring (95MW1234) were installed during this investigation. No monitoring wells were installed at the direct push drilling locations, however, a three-screen monitoring well cluster was installed at the sonic drilling location. These monitoring wells are designated 95MW1234A, B, and C (Figure 1). Groundwater vertical profile samples were collected at each drilling location at 10-foot intervals from the water table to refusal and were analyzed for volatile organic compounds (VOCs) using U.S. Environmental Protection Agency Method 8260B at the Groundwater Analytical, Inc. on-site laboratory. In addition, lithologic logging from the water table to bedrock was completed at 95MW1234. The groundwater vertical profile screening results for PCE and TCE for each boring are presented in Attachment A; the soil boring log and monitoring well construction diagrams for 95MW1234A, B, and C are included in Attachment B.
2.1	**Results – Northern Portion of Study Area** The groundwater data collected at the borings installed in the northern portion of the study area (i.e., 95DP0215 through 95DP0220, and 95MW1234) indicate the plume is present in the aquifer between approximately -45 feet mean sea level (ft msl) and -65 ft msl (Attachment A). This characterization is supported by the data collected at the existing SPEIM monitoring wells located in this immediate area (USFW501 well cluster, USFW502 well cluster, 95MW0604F, and 95MW0605F). The SPEIM data also indicate that the plume is slightly deeper in the aquifer (up to -80 ft msl) below the northeast corner of this portion of the golf course based on the results of sampling at the USFW443 well cluster (Figure 1; Tables 1 and 2). PCE concentrations detected in the vertical profile samples collected from this northern study area ranged up to a maximum of 24.1 micrograms per liter (µg/L) (95DP0220 at elevation -51.5 ft msl); the maximum TCE concentration of 9.1 µg/L was observed at the same boring location and sampling interval (Attachment A). In general, the portion of the plume below the Falmouth Country Club property occupies a relatively thin vertical section within the aquifer (i.e., less than 20 feet thick) and is overlain by approximately 60 feet of groundwater that shows no presence of the plume contaminants. Groundwater vertical profiling data was collected to bedrock at sonic boring 95MW1234. Neither PCE nor TCE was detected in samples collected deeper in the aquifer between -66.5 ft msl and -216 ft msl at this location (Attachment A).

ITEM	REMARKS
	A review of the lithologic information collected at 95MW1234 indicates the aquifer materials from the water table (approximately 20 ft msl) to approximately -54 ft msl are predominantly comprised of fine to medium sand with trace amounts of silt, very fine sand, coarse sand, and some fine gravel. This sandier unit is underlain by a 13-foot thick unit classified as a clayey silt with trace coarse sand and fine to coarse gravel (observed from -54 to -67 ft msl). At this location, the plume was present in the sand unit located immediately above this clayey silt unit. Below this clayey silt unit, the aquifer is characterized by interbedded silt and sand units that, in general, become increasingly fine grained with depth. A 3-foot thick gravelly sand unit was observed immediately above bedrock which was encountered at -221 ft msl (approximately 276 feet below ground surface). No plume contaminants were observed in these deeper sand, silt, and gravel units located below the 13-foot thick clayey silt unit. Direct push drilling refusal was encountered at the six northern boring locations between approximately -60 and -80 ft msl. It is likely that the clayey silt unit observed at 95MW1234 was the cause of the direct push refusals and that the unit is laterally continuous below this portion of the Falmouth Country Club property.
2.2	**Results – Southern Portion of Study Area** Four direct push borings were installed in the southern portion of the study area (Figure 1). Borings 95DP0221 and 95DP0222 were installed along Country Club Lane; 95DP0223 at the intersection of Old Barnstable Road and Mill Farm Way; and 95DP0224 at the intersection of Old Barnstable Road and Old Waquoit Road. The data collected at these locations indicate the plume is present in the aquifer between approximately -40 ft msl and -80 ft msl (Attachment A). The observed elevation of the plume is consistent with the historical data collected at the nearby monitoring wells (95MW0103, 95MW0104, and 95PZ0005A) during the fall 2007 SPEIM sampling event (Tables 1 and 2). PCE was detected in the vertical profile samples collected from this southern study area at concentrations up to a maximum of approximately 55 µg/L at 95DP0221 (elevation -64.5 ft msl) and 95DP0224 (elevation -62.5 ft msl). These more elevated zones of PCE contamination do not appear to be continuous but instead represent discrete zones of higher (greater than 50 µg/L) PCE concentrations. These two zones of higher concentrations appear to be limited in areal extent since similar concentrations were not observed at nearby borings 95DP0222 (maximum PCE concentration of 15.3 µg/L at elevation -68.5 ft msl), 95DP0223 (maximum PCE concentration of 12.9 µg/L at elevation -50.5 ft msl), or in the nearby SPEIM network wells. The extent of the plume also appears to be limited vertically in the aquifer (similar to that observed to the north described above) and ranges from approximately 10 to 30 feet thick and is overlain by up to 60 feet of groundwater containing no detectable levels of PCE or TCE. TCE concentrations in the vertical profile samples were detected up to 16.1 µg/L and were generally coincident with the intervals where PCE contamination was detected (Attachment A).

ITEM	REMARKS
	In the southern portion of the study area the plume was observed between approximately -50 and -80 ft msl. It should be noted that at three of the four drilling locations installed in the southern portion of the study area, boring refusal was not encountered immediately below the plume. Rather, the direct push tooling could be advanced and samples collected up to 60 feet below the plume suggesting the clayey silt unit observed below the northern portion of the study area may not be laterally continuous or even present to the south. However, a review of the lithologic log for 95MW0104 (Attachment B) indicates the presence of interbedded silts, clayey silts, and sands are present in the aquifer below approximately -50 ft msl, to the south of these four direct push borings.
2.3	**Data Gap Investigation Conclusions** The vertical profile groundwater screening data collected from the 11 borings installed as part of this effort has successfully met the data gap investigation objective of improving the understanding of the distribution of contamination in the Ashumet Valley plume to the south of Carriage Shop Road. The improved data density, both laterally and vertically in the aquifer, has reduced the uncertainty in the characterization of the nature and extent of the Ashumet Valley plume. These supplemental characterization data have been used along with data collected during the routine fall 2007 SPEIM sampling event and in consideration of historic data collected under the SPEIM program to update the Ashumet Valley PCE and TCE plume shells as described in the following section.
3.0	**PLUME SHELL UPDATE** The updated PCE and TCE plume shells, referred to as the 2008 plume shells, are shown on Figures 2 and 3, respectively. The sub-panels on Figures 2 and 3 show a plan view of the PCE and TCE plume shells, a cross-sectional view looking directly north, and a cross-sectional view looking directly west. Each view depicts the distribution of the maximum contaminant concentrations projected through the plume in the direction normal to the plane of the view.
3.1	**Contaminant Data Set** The data used to develop the PCE and TCE plume shells are listed in Tables 1 and 2, respectively, and comprise primarily of the fall 2007 SPEIM sampling results supplemented by the vertical profile data collected during the data gap investigation described above in Section 2.0. The dataset include sample dates ranging from 19 April 2004 to 25 February 2008. The maximum PCE and TCE concentrations in this data set are 54.9 µg/L, and 16.1 µg/L, respectively (at location 95DP0221 on 17 January 2008). Representative elevations for the chemical data were assumed to be the midpoint of the screen or sampled interval from which the sample was collected. A zero result was substituted for all contaminant nondetects.

ITEM	REMARKS
3.2	**Interpolation of Contaminant Concentrations** The contaminant concentrations from the sampling data set were interpolated to the plume shell grid using kriging. Kriging is a linear, unbiased, least-squares spatial interpolation method that uses a weighted-average estimator to approximate the value of a regionalized variable at a spatial location. The interpolated contaminant concentrations were contoured and visualized using wire-net isosurfaces. The kriging process was adjusted until the resulting plume shells fit the known data as closely as possible and was hydrologically plausible. The isosurface representing the 5.0 µg/L concentration, which corresponds to the Maximum Contaminant Levels (MCLs) for PCE and TCE, was considered to be the plume boundary for each plume shell.
3.3	**Plume Shall Scaling** Since the estimated contaminant concentration at a particular location is derived from the weighted average of nearby concentration data, the maximum interpolated contaminant concentrations are generally lower than the actual maximum data point concentrations. To offset this tendency, the interpolated values were scaled by the ratio of the highest observed value to the highest interpolated value. This forces a match between the highest observed and interpolated values, but likely results in an overestimation of the total mass in the scaled plume shell for a given dataset.
3.4	**Plume Shell Masking** Each plume shell was masked to eliminate artifacts of the kriging process that would otherwise produce hydraulically unreasonable extensions of a plume into areas with no data coverage. The mask is the plan view of the maximum lateral extent of interpolated contaminant concentrations present at the MCL of 5.0 µg/L.
3.5	**Plume Shell Contaminant Mass and Volume** The volume of contaminated groundwater at concentrations above the MCL and the dissolved phase contaminant mass in each plume shell were estimated assuming an aquifer porosity of 30 percent and a 5.0 µg/L plume boundary and are listed in the following table. Also listed for comparison purposes is the estimated volume of contaminated groundwater and contaminant mass for the previous version of the PCE and TCE plume shells that were presented in the *Ashumet Valley 2006 Plume Shell Update Project Note* (AFCEE 2006).

ITEM	REMARKS

	2006 Plume Shells		2008 Plume Shells	
Contaminant	PCE	TCE	PCE	TCE
Dissolved Phase Plume Mass (pounds)	244.1	102.6	186.2	56.6
Plume Volume above MCL ($x10^8$ ft^3)	2.95	1.94	2.91	1.25

The estimated volume of contaminated groundwater and the plume shell mass statistics show that the volume and mass of both PCE and TCE in the plume shells has decreased between the 2006 and 2008 updates. These volume and mass differences can be primarily attributed to: (1) the continued operation of the Ashumet Valley extraction, treatment, and infiltration (ETI) system which has successfully removed contaminant mass in the central portion of the plume (i.e., north of Hayway Road) between 2006 and 2008; and (2) the incorporation of new characterization data collected south of Carriage Shop Road (as described above in Section 2.0).

Notable differences between the 2006 and 2008 PCE and TCE plume shell data sets are summarized below:

1) Improved characterization data was available for the 2008 update in the southern portion of the plume due to the completion of the data gap investigation described above in Section 2.0. The vertical profile data collected at the 11 new boring locations improved the data density both laterally and vertically, thus improving the ability to define the upper and lower boundaries of the plume as well as the internal distribution of contamination within the plume. Prior to the installation of these borings, the characterization of this area for the 2006 plume shell update relied upon data collected at wells spaced approximately 1,000 to 2,000 feet apart. The installation of the 11 borings has increased the data density such that data points are now spaced approximately 500 to 1,000 feet apart. This improvement in data density has reduced the overall uncertainty in the characterization of the PCE and TCE plumes to the south of Carriage Shop Road.

2) Decreases in PCE concentrations were observed in the central plume zone north of extraction well 95EW0703. Some examples of the PCE concentration decreases were at monitoring well USFW356134 from 38.4 µg/L in October 2004 to 18.2 µg/L in August 2007; USFW356108 from 13.8 µg/L in October 2004 to below the reporting limit (BRL) in August 2007; 95MW1172A from 17.5 µg/L in October 2004 to 1.4 µg/L in August 2007; and USFW350110 from 8.7 µg/L in October 2004 to 2.9 µg/L in August 2007.

ITEM	REMARKS
	3) The PCE concentration at 95MW1233A, located to the south of 95EW0703 between Hayway Road and Carriage Shop Road, declined from 52.8 µg/L in October 2004 to 8.2 µg/L in August 2007. This rapid decline in the PCE concentration at this well indicates that the PCE mass in the 2006 version of the plume shell near this monitoring well was significantly overestimated. TCE concentrations also declined at this location from 11.7 µg/L to 2.1 µg/L between October 2004 and August 2007. 4) The PCE concentration at 95MW0103, located to the south of the Falmouth Country Club property, declined from 28.8 µg/L in November 2004 to 3.7 µg/L in September 2007. As stated above for 95MW1233A, the rapid decline in the PCE concentration at this well indicates that the PCE mass in the 2006 version of the plume shell near this well was likely overestimated. This conclusion is further supported by the results of the data gap investigation conducted in this area. 5) PCE and TCE concentration decreases were observed at shallow elevations (-30 ft msl and above) under the Backus River in the vicinity of monitor well cluster USFW375. At monitoring well USFW375055, PCE concentrations declined from 44.5 µg/L in October 2004 to nondetect in August 2007. TCE concentrations in this well also declined from 15.8 µg/L in October 2004 to nondetect in August 2007. However, it should be noted that the deeper screens in this monitoring well cluster showed slight concentration increases. PCE concentrations in monitoring well USFW375081 (midscreen elevation -50 ft msl) increased from 3.1 µg/L in October 2004 to 10.2 µg/L in August 2007. Similar modest increase in TCE concentrations were also observed in this well although TCE concentrations are close to the MCL of 5 µg/L. 6) A contiguous PCE plume can no longer be delineated in the northern plume zone between the MMR boundary and Ashumet Pond (as was possible for the 2006 PCE plume shell update). 7) There are no longer any sampling data above the MCL to support the continued existence of an isolated zone of TCE contamination formerly seen at monitoring well 30MW0584B in the northern plume zone. TCE concentrations in monitoring well 30MW0584B decreased from 33.6 µg/L in October 2004 to 2.1 µg/L in October 2007.
3.6	**Plume Shell Uncertainty** The spatial distribution of sampling locations, particularly vertically (i.e., with depth), often determines the level of uncertainty in the characterization of a plume. Many of the sample locations in this Ashumet Valley plume shell data set are over 1,500 feet apart along the direction of groundwater flow and 600 to 800 feet apart perpendicular to the direction of flow. In addition, data from multiple depth intervals at a given location are often somewhat limited. In the vertical direction, there is often 50 to 70 feet of separation between samples or there is only one sample interval available to define the concentrations in the plume, with no sample data to

ITEM	REMARKS
	delineate the upper or lower boundary of the plume shell. However, for this plume shell update, the addition of vertical profiling data south of Carriage Shop Road and southward toward the leading edge of the plume has improved both the vertical and horizontal definition of the plume characterization. Uncertainty exists in the availability and interpretation of data below the Backus River and associated cranberry bogs due to the complex nature of the groundwater-surface water interactions. The agricultural practices at these active cranberry bogs, such as flooding the bogs for harvesting and frost protection in the fall and winter, as well as the operation of a network of shallow irrigation wells during the growing season (May to September) are believed to have substantial influences on the groundwater flow field in this area. It is very likely that these influences on the flow field impact not only the migration of the plume where it is present below the river, but also the plume discharge patterns in the areas where the plume is rising in the aquifer and discharging to the river and the associated network of bog ditches. However, for the purpose of evaluating remedial alternatives associated with the remedial decision making process, this level of uncertainty is considered acceptable and no additional characterization data is needed in the area of the Backus River.
4.0	**REFERENCES** AFCEE (Air Force Center for Engineering and the Environment). 2008 (March). *Ashumet Valley 2007 Summary Letter Report.* 337105-SPEIM-AVP-SLR-002. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA. _____. 2006 (April). *Ashumet Valley 2006 Plume Shell Update Project Note.* 337105-SPEIM-AVP-PRJNOT-002. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

Attachments:
Figure 1. Ashumet Valley Data Gap Investigation Drilling Locations
Figure 2. Ashumet Valley 2008 PCE Plume Shell
Figure 3. Ashumet Valley 2008 TCE Plume Shell
Table 1. Ashumet Valley 2008 PCE Plume Shell Data Set
Table 2. Ashumet Valley 2008 TCE Plume Shell Data Set
Attachment A. Groundwater Screening Results
Attachment B. Soil Boring Logs and Monitoring Well Diagram

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Legend

- Monitoring Well
- Direct Push
- Piezometer
- Plume Boundary (Dashed Where Inferred)
- Falmouth Country Club Property (Town of Falmouth)

Data Source: AFCEE, June 2008, MMR-AFCEE Data Warehouse

N

0 270 540 Feet

FIGURE 1

ASHUMET VALLEY DATA GAP INVESTIGATION DRILLING LOCATIONS

AFCEE - Massachusetts Military Reservation

Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note

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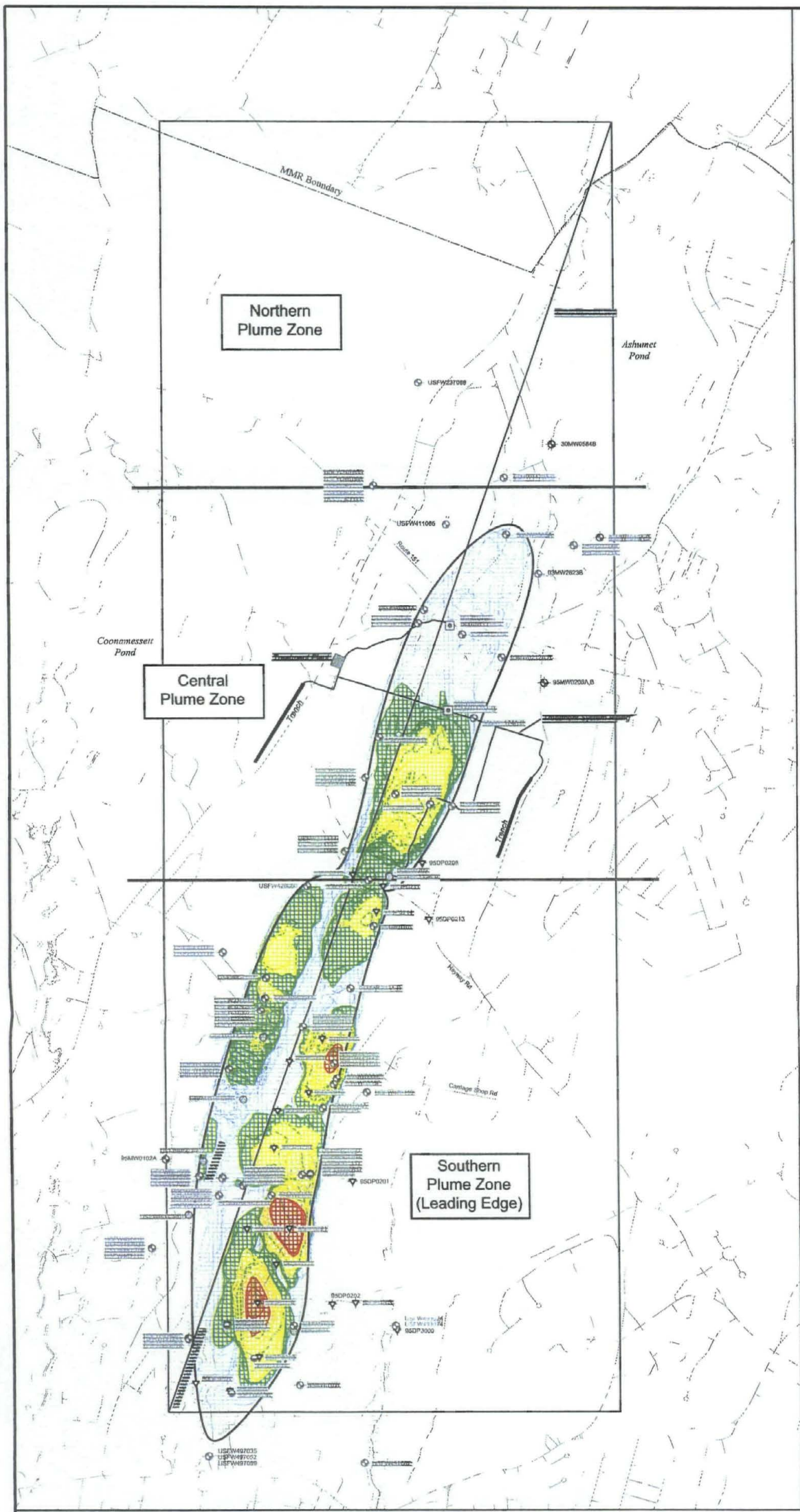

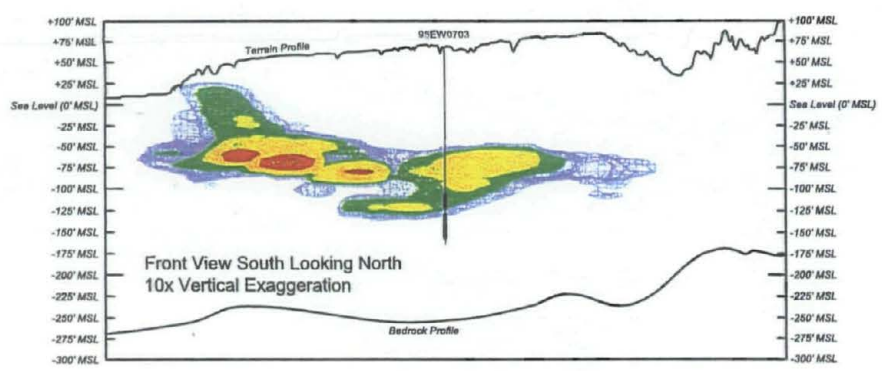

2008 PCE Plume Shell:

- 5 µg/L
- 10 µg/L
- 15 µg/L
- 30 µg/L

Note: Maximum PCE concentration in 2008 PCE plume shell dataset is 54.9 µg/L at 95DP0221.

Data Source: AFCEE, March 2008, MMR-AFCEE Data Warehouse

Legend

- Monitoring Well
- Extraction Well (On)
- Extraction Well (Off)
- Direct Push Location
- Irrigation Well
- Plume Boundary (Dashed Where Inferred)
- Extraction Well and Well Screen

0 1900 Feet

FIGURE 2

ASHUMET VALLEY 2008 PCE PLUME SHELL

AFCEE - Massachusetts Military Reservation

Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note

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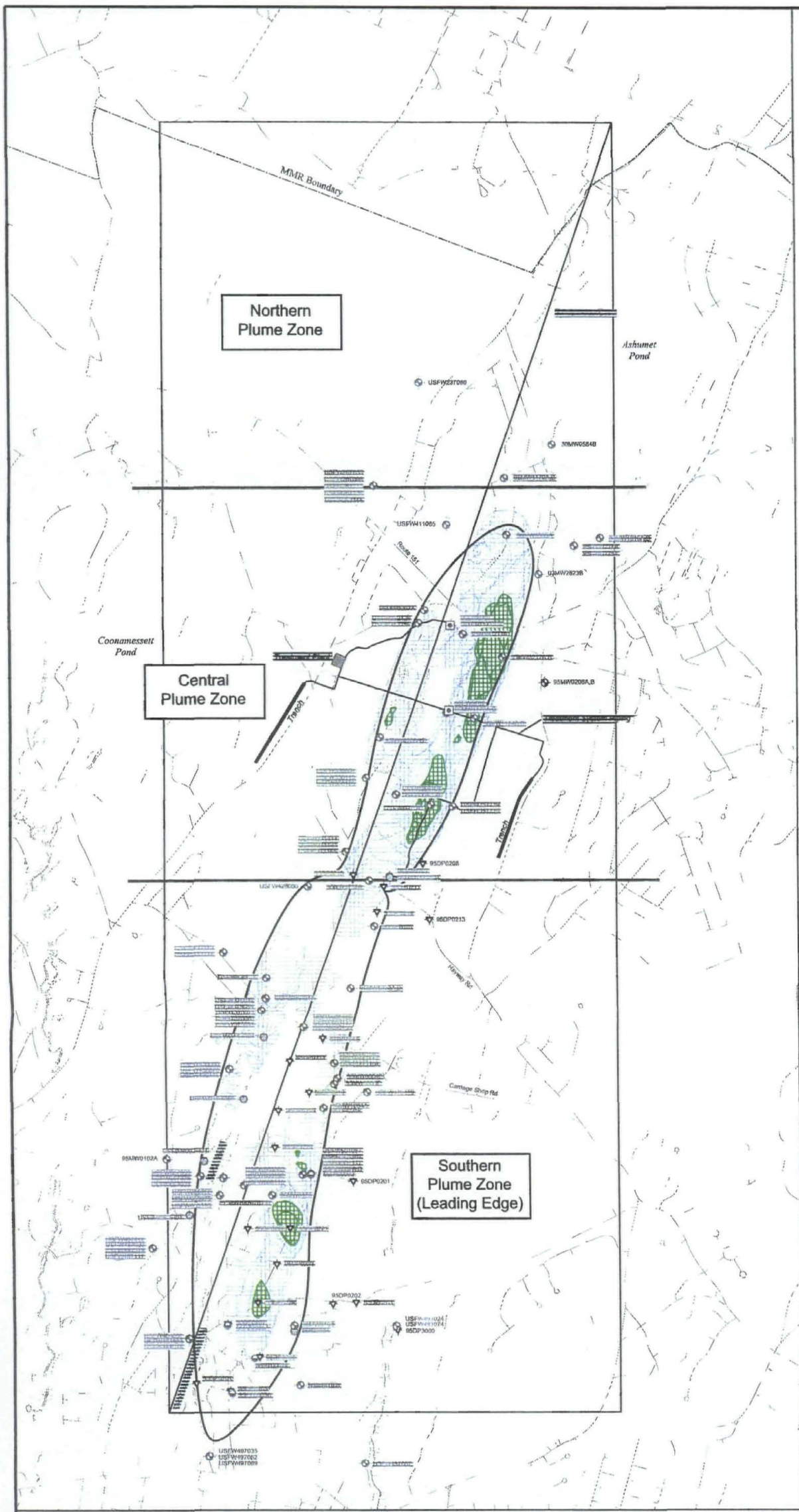

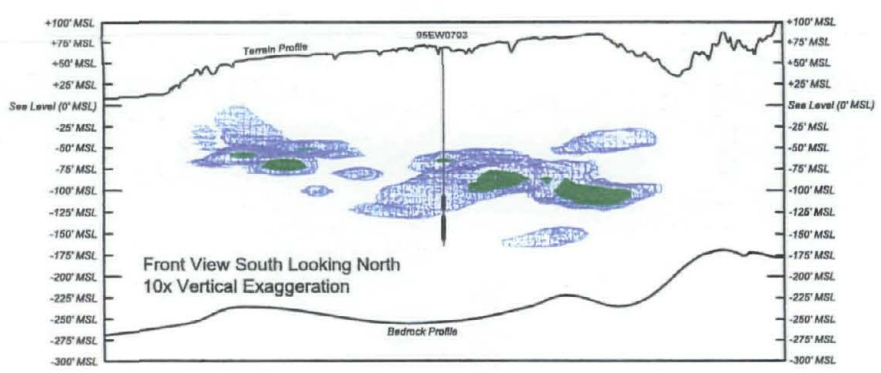

2008 TCE Plume Shell:

5 µg/L

10 µg/L

Note: Maximum TCE concentration in 2008 TCE plume shell dataset is 16.1 µg/L at 95DP0221.

Data Source: AFCEE, March 2008, MMR-AFCEE Data Warehouse

Legend

- Monitoring Well
- Extraction Well (On)
- Extraction Well (Off)
- Direct Push Location
- Irrigation Well
- Plume Boundary (Dashed Where Inferred)
- Extraction Well and Well Screen

0 1900 Feet

FIGURE 3

ASHUMET VALLEY 2008 TCE PLUME SHELL

AFCEE - Massachusetts Military Reservation

Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note

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Table 1
Ashumet Valley 2008 PCE Plume Shell Data Set
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note

Location	Easting (ft)	Northing (ft)	Sample Elevation (ft msl)	Sample PCE Concentration[1] (µg/L)	Sample Date
03MW2623B	862457	228339	-61.72	0	9/24/2007
30MW0584B	862708	230627	-99.42	0	10/11/2007
30MW0585A	861887	229028	-40.03	1.1	9/21/2007
95DP0201	859057	217483	-26.00	0	4/19/2004
95DP0201	859057	217483	-36.00	0	4/19/2004
95DP0201	859057	217483	-46.00	0	4/19/2004
95DP0202	858672	215292	-29.62	0	4/23/2004
95DP0202	858672	215292	-39.62	0	4/23/2004
95DP0202	858672	215292	-61.22	0	10/1/2007
95DP0203	859084	215317	-52.34	0	5/4/2004
95DP0203	859084	215317	-66.74	0	5/4/2004
95DP0204	856240	213877	-24.14	0.54	5/3/2004
95DP0204	856240	213877	-34.14	1.5	5/3/2004
95DP0204	856240	213877	-44.14	0.55	5/3/2004
95DP0205	856846	213740	5.50	0	12/7/2005
95DP0205	856846	213740	-4.50	0	12/7/2005
95DP0205	856846	213740	-14.50	0	12/7/2005
95DP0205	856846	213740	-24.50	0	12/7/2005
95DP0205	856846	213740	-34.50	0	12/8/2005
95DP0205	856846	213740	-44.50	0	12/8/2005
95DP0205	856846	213740	-54.50	5.8	12/8/2005
95DP0205	856846	213740	-64.50	3.4	12/8/2005
95DP0206	857367	214350	5.50	0	12/19/2005
95DP0206	857367	214350	-4.50	0	12/19/2005
95DP0206	857367	214350	-14.50	0	12/19/2005
95DP0206	857367	214350	-24.50	0	12/19/2005
95DP0206	857367	214350	-34.50	0	12/19/2005
95DP0206	857367	214350	-44.50	24.9	12/19/2005
95DP0207	856804	214937	4.50	0	12/19/2005
95DP0207	856804	214937	-5.50	0	12/19/2005
95DP0207	856804	214937	-15.50	0	12/19/2005
95DP0207	856804	214937	-25.50	0	12/19/2005
95DP0207	856804	214937	-35.50	0	12/19/2005
95DP0207	856804	214937	-45.50	0	12/19/2005
95DP0207	856804	214937	-55.50	0.5	12/19/2005
95DP0207	856804	214937	-65.50	5.7	12/19/2005
95DP0207	856804	214937	-75.50	9.1	12/20/2005
95DP0207	856804	214937	-80.50	7.7	12/20/2005
95DP0208	860349	223204	15.50	0	3/22/2006
95DP0208	860349	223204	5.50	0	3/22/2006
95DP0208	860349	223204	-4.50	0	3/22/2006
95DP0208	860349	223204	-14.50	0	3/22/2006
95DP0208	860349	223204	-24.50	0	3/22/2006
95DP0208	860349	223204	-34.50	0	3/22/2006
95DP0208	860349	223204	-44.50	0	3/22/2006
95DP0208	860349	223204	-54.50	0	3/22/2006
95DP0208	860349	223204	-64.50	1.1	3/22/2006
95DP0208	860349	223204	-74.50	3.1	3/23/2006

Table 1
Ashumet Valley 2008 PCE Plume Shell Data Set
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note

Location	Easting (ft)	Northing (ft)	Sample Elevation (ft msl)	Sample PCE Concentration[1] (µg/L)	Sample Date
95DP0208	860349	223204	-82.50	2.6	3/23/2006
95DP0210	859107	223004	26.50	0	2/20/2006
95DP0210	859107	223004	16.50	0	2/20/2006
95DP0210	859107	223004	6.50	0	2/20/2006
95DP0210	859107	223004	-3.50	0	2/20/2006
95DP0210	859107	223004	-13.50	0	2/20/2006
95DP0210	859107	223004	-23.50	0	2/20/2006
95DP0210	859107	223004	-33.50	0	2/20/2006
95DP0210	859107	223004	-43.50	1.2	2/20/2006
95DP0210	859107	223004	-53.50	4.9	2/21/2006
95DP0210	859107	223004	-63.50	6.9	2/21/2006
95DP0210	859107	223004	-73.50	6.8	2/21/2006
95DP0210	859107	223004	-80.50	11.2	2/21/2006
95DP0211	859649	222798	27.50	0	2/15/2006
95DP0211	859649	222798	17.50	0	2/15/2006
95DP0211	859649	222798	7.50	0	2/15/2006
95DP0211	859649	222798	-2.50	0	2/15/2006
95DP0211	859649	222798	-12.50	0	2/15/2006
95DP0211	859649	222798	-22.50	0	2/15/2006
95DP0211	859649	222798	-32.50	0	2/15/2006
95DP0211	859649	222798	-42.50	0	2/15/2006
95DP0211	859649	222798	-52.50	0	2/16/2006
95DP0211	859649	222798	-62.50	0	2/16/2006
95DP0211	859649	222798	-72.50	0	2/16/2006
95DP0211	859649	222798	-82.50	0	2/16/2006
95DP0213	860464	222205	26.50	0	2/27/2006
95DP0213	860464	222205	16.50	0	2/27/2006
95DP0213	860464	222205	6.50	0	2/27/2006
95DP0213	860464	222205	-3.50	0	2/27/2006
95DP0213	860464	222205	-13.50	0	2/27/2006
95DP0213	860464	222205	-23.50	0	2/27/2006
95DP0213	860464	222205	-33.50	0	2/28/2006
95DP0213	860464	222205	-43.50	0	2/28/2006
95DP0213	860464	222205	-51.50	0	2/28/2006
95DP0214	859526	222344	21.50	0	2/8/2006
95DP0214	859526	222344	11.50	0	2/8/2006
95DP0214	859526	222344	1.50	0	2/8/2006
95DP0214	859526	222344	-8.50	0	2/8/2006
95DP0214	859526	222344	-18.50	0	2/8/2006
95DP0214	859526	222344	-28.50	0	2/8/2006
95DP0214	859526	222344	-38.50	0	2/8/2006
95DP0214	859526	222344	-48.50	0	2/8/2006
95DP0214	859526	222344	-58.50	0	2/8/2006
95DP0214	859526	222344	-68.50	0	2/8/2006
95DP0214	859526	222344	-78.50	0.38	2/9/2006
95DP0214	859526	222344	-88.50	0	2/9/2006
95DP0214	859526	222344	-98.50	0	2/9/2006
95DP0214	859526	222344	-108.50	0.87	2/9/2006

Table 1
Ashumet Valley 2008 PCE Plume Shell Data Set
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note

Location	Easting (ft)	Northing (ft)	Sample Elevation (ft msl)	Sample PCE Concentration[1] (µg/L)	Sample Date
95DP0214	859526	222344	-118.50	20.6	2/9/2006
95DP0214	859526	222344	-124.50	15.4	2/10/2006
95DP0215	858544	220051	22.50	0	12/3/2007
95DP0215	858544	220051	12.50	0	12/3/2007
95DP0215	858544	220051	2.50	0	12/4/2007
95DP0215	858544	220051	-7.50	0	12/4/2007
95DP0215	858544	220051	-17.50	0	12/4/2007
95DP0215	858544	220051	-27.50	0	12/4/2007
95DP0215	858544	220051	-37.50	0	12/4/2007
95DP0215	858544	220051	-47.50	0.49	12/5/2007
95DP0215	858544	220051	-57.50	12.3	12/5/2007
95DP0215	858544	220051	-67.50	0.66	12/5/2007
95DP0216	858296	219075	14.50	0	1/3/2008
95DP0216	858296	219075	4.50	0	1/3/2008
95DP0216	858296	219075	-5.50	0	1/3/2008
95DP0216	858296	219075	-15.50	0	1/3/2008
95DP0216	858296	219075	-25.50	0	1/3/2008
95DP0216	858296	219075	-35.50	0.29	1/3/2008
95DP0216	858296	219075	-45.50	10.3	1/4/2008
95DP0216	858296	219075	-55.50	0	1/4/2008
95DP0217	857958	219635	15.50	0	12/6/2007
95DP0217	857958	219635	5.50	0	12/6/2007
95DP0217	857958	219635	-4.50	0	12/7/2007
95DP0217	857958	219635	-14.50	0	12/7/2007
95DP0217	857958	219635	-24.50	0	12/7/2007
95DP0217	857958	219635	-34.50	0	12/7/2007
95DP0217	857958	219635	-44.50	1.4	12/7/2007
95DP0217	857958	219635	-54.50	5.2	12/7/2007
95DP0217	857958	219635	-64.50	0	12/10/2007
95DP0218	858545	218788	13.50	0	12/13/2007
95DP0218	858545	218788	3.50	0	12/13/2007
95DP0218	858545	218788	-6.50	0	12/13/2007
95DP0218	858545	218788	-16.50	0	12/17/2007
95DP0218	858545	218788	-26.50	0	12/17/2007
95DP0218	858545	218788	-36.50	1.5	12/17/2007
95DP0218	858545	218788	-46.50	12.2	12/18/2007
95DP0218	858545	218788	-56.50	0	12/18/2007
95DP0218	858545	218788	-61.50	0.5	12/19/2007
95DP0219	857743	218749	13.50	0	1/7/2008
95DP0219	857743	218749	3.50	0	1/7/2008
95DP0219	857743	218749	-6.50	0	1/8/2008
95DP0219	857743	218749	-16.50	0	1/8/2008
95DP0219	857743	218749	-26.50	0	1/8/2008
95DP0219	857743	218749	-36.50	0	1/8/2008
95DP0219	857743	218749	-46.50	9.3	1/8/2008
95DP0219	857743	218749	-56.50	1.7	1/8/2008
95DP0219	857743	218749	-66.50	0	1/8/2008
95DP0220	857673	218086	8.50	0	1/10/2008

Table 1
Ashumet Valley 2008 PCE Plume Shell Data Set
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note

Location	Easting (ft)	Northing (ft)	Sample Elevation (ft msl)	Sample PCE Concentration[1] (µg/L)	Sample Date
95DP0220	857673	218086	-1.50	0	1/10/2008
95DP0220	857673	218086	-11.50	0	1/10/2008
95DP0220	857673	218086	-21.50	0	1/10/2008
95DP0220	857673	218086	-31.50	0	1/10/2008
95DP0220	857673	218086	-41.50	1.5	1/10/2008
95DP0220	857673	218086	-51.50	24.1	1/10/2008
95DP0220	857673	218086	-61.50	12.6	1/11/2008
95DP0221	857924	216647	5.50	0	1/15/2008
95DP0221	857924	216647	-4.50	0	1/15/2008
95DP0221	857924	216647	-14.50	0	1/17/2008
95DP0221	857924	216647	-24.50	0	1/17/2008
95DP0221	857924	216647	-34.50	0	1/17/2008
95DP0221	857924	216647	-44.50	0.64	1/17/2008
95DP0221	857924	216647	-54.50	8	1/17/2008
95DP0221	857924	216647	-64.50	54.9	1/17/2008
95DP0221	857924	216647	-74.50	48.4	1/17/2008
95DP0221	857924	216647	-84.50	0.36	1/17/2008
95DP0221	857924	216647	-94.50	0	1/18/2008
95DP0221	857924	216647	-104.50	0	1/18/2008
95DP0221	857924	216647	-114.50	0	1/18/2008
95DP0221	857924	216647	-124.50	0	1/18/2008
95DP0222	857170	216635	1.50	0	1/22/2008
95DP0222	857170	216635	-8.50	0	1/22/2008
95DP0222	857170	216635	-18.50	0	1/22/2008
95DP0222	857170	216635	-28.50	0	1/22/2008
95DP0222	857170	216635	-38.50	0	1/22/2008
95DP0222	857170	216635	-48.50	0	1/22/2008
95DP0222	857170	216635	-58.50	3	1/22/2008
95DP0222	857170	216635	-68.50	15.3	1/23/2008
95DP0222	857170	216635	-78.50	10.5	1/23/2008
95DP0222	857170	216635	-88.50	3.6	1/23/2008
95DP0222	857170	216635	-98.50	0	1/23/2008
95DP0222	857170	216635	-108.50	0	1/23/2008
95DP0222	857170	216635	-118.50	0	1/23/2008
95DP0223	857681	216006	-0.50	0	02/12/08
95DP0223	857681	216006	-10.50	0	02/12/08
95DP0223	857681	216006	-20.50	0	02/14/08
95DP0223	857681	216006	-30.50	0	02/14/08
95DP0223	857681	216006	-40.50	0	02/14/08
95DP0223	857681	216006	-50.50	12.9	02/14/08
95DP0223	857681	216006	-60.50	1.1	02/14/08
95DP0223	857681	216006	-70.50	0	02/14/08
95DP0223	857681	216006	-80.50	0	02/14/08
95DP0224	857342	215315	-2.50	0	02/20/08
95DP0224	857342	215315	-12.50	0	02/20/08
95DP0224	857342	215315	-22.50	0	02/20/08
95DP0224	857342	215315	-32.50	0	02/20/08
95DP0224	857342	215315	-42.50	21	02/20/08

Table 1
Ashumet Valley 2008 PCE Plume Shell Data Set
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note

Location	Easting (ft)	Northing (ft)	Sample Elevation (ft msl)	Sample PCE Concentration[1] (µg/L)	Sample Date
95DP0224	857342	215315	-52.50	20.3	02/21/08
95DP0224	857342	215315	-62.50	54.6	02/21/08
95DP0224	857342	215315	-72.50	2.3	02/21/08
95DP0224	857342	215315	-82.50	3.3	02/25/08
95DP3000	859828	214822	7.11	0	10/10/2007
95IG0004	857982	214801	-25.10	0	5/24/2007
95MW0102A	855744	217877	-49.14	2.7	9/11/2007
95MW0103	857613	217228	-55.25	3.7	9/11/2007
95MW0104	857982	214901	-59.06	12.5	9/13/2007
95MW0106	858088	213836	-61.49	2	9/13/2007
95MW0201	859476	222083	-73.16	0	9/11/2007
95MW0206A	862548	226419	-138.19	0	3/21/2005
95MW0206B	862548	226420	-88.19	0	9/11/2007
95MW0207A	860404	227711	-133.90	1.6	8/27/2007
95MW0208A	859587	225452	-66.94	10.5	8/30/2007
95MW0208B	859588	225451	-31.94	0.32	8/30/2007
95MW0211A	861084	227278	-153.73	4.3	8/27/2007
95MW0212A	861790	226875	-109.12	5.8	8/23/2007
95MW0212B	861790	226875	-45.12	0	8/23/2007
95MW0214A	863100	228842	-203.72	0	3/29/2005
95MW0215A	863097	228834	-128.76	0.36	3/29/2005
95MW0604F	858798	219320	-56.18	3.7	10/10/2007
95MW0605F	858742	219219	-57.21	16	10/12/2007
95MW1170A	861849	230030	-120.76	0	8/23/2007
95MW1170B	861849	230030	-63.76	1.4	8/23/2007
95MW1171A	860883	227432	-102.53	2.7	8/27/2007
95MW1171B	860883	227433	-38.53	2	8/27/2007
95MW1172A	860785	225888	-101.37	1.4	8/23/2007
95MW1172B	860830	225937	-37.87	0	8/23/2007
95MW1173A	859755	222972	-119.98	9	8/29/2007
95MW1173B	859755	222972	-40.88	0	8/29/2007
95MW1174A	861283	225790	-75.71	4.5	8/23/2007
95MW1174B	861283	225789	-48.21	0	8/23/2007
95MW1232A	859388	222899	-128.65	11.7	8/29/2007
95MW1233A	859049	220969	-119.99	8.2	8/29/2007
95MW1233B	859049	220970	-80.02	3.9	8/29/2007
95MW1234A	858543	218786	-66.50	0	02/08/08
95MW1234A	858543	218786	-86.50	0	02/12/08
95MW1234A	858543	218786	-96.50	0	02/12/08
95MW1234A	858543	218786	-106.50	0	02/12/08
95MW1234A	858543	218786	-116.50	0	02/13/08
95MW1234A	858543	218786	-126.50	0	02/13/08
95MW1234A	858543	218786	-136.50	0	02/14/08
95MW1234A	858543	218786	-146.50	0	02/14/08
95MW1234A	858543	218786	-176.50	0	02/15/08
95MW1234A	858543	218786	-186.50	0	02/15/08
95MW1234A	858543	218786	-196.50	0	02/15/08
95MW1234A	858543	218786	-206.50	0	02/19/08

Table 1
Ashumet Valley 2008 PCE Plume Shell Data Set
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note

Location	Easting (ft)	Northing (ft)	Sample Elevation (ft msl)	Sample PCE Concentration[1] (µg/L)	Sample Date
95MW1234A	858543	218786	-216.50	0	02/19/08
95PW0002	858308	217608	-96.52	7.3	1/10/2008
95PZ0002A	858299	217591	-104.72	7.8	1/10/2008
95PZ0002B	858308	217592	-75.00	0	1/10/2008
95PZ0003A	856875	213689	-49.92	9.2	9/7/2007
95PZ0004A	857275	214317	-44.10	13.2	10/1/2007
95PZ0005A	856793	214905	-67.20	17.2	10/1/2007
ECMWBKR01D	856679	217227	-54.64	7.1	8/16/2007
ECMWBKR01M	856679	217227	-14.63	0	8/16/2007
ECPZBKR01A	857529	220793	18.30	0	10/27/2005
USFW237088	860323	231731	3.96	0	6/20/2005
USFW262126	860295	227479	-78.44	6.7	8/30/2007
USFW262159	860295	227479	-110.90	2.6	8/30/2007
USFW267055	859510	229901	1.90	0	6/28/2005
USFW267088	859508	229899	-32.08	0.18	6/16/2005
USFW267111	859508	229899	-55.18	0	6/16/2005
USFW267136	859508	229899	-79.87	0	6/16/2005
USFW267155	859508	229899	-99.65	0	6/16/2005
USFW271114	858973	223415	-77.12	0.58	8/7/2007
USFW271141	858974	223416	-104.16	3.6	8/7/2007
USFW271165	858973	223415	-128.53	0	8/7/2007
USFW350064	859338	224735	-25.94	0.66	9/20/2005
USFW350110	859338	224735	-71.46	2.9	8/7/2007
USFW350125	859338	224735	-86.00	0.94	8/7/2007
USFW356108	859873	224437	-42.26	0.33	8/8/2007
USFW356134	859873	224437	-67.78	18.2	8/8/2007
USFW357119	860503	224257	-47.47	0	8/8/2007
USFW357139	860493	224261	-67.65	26.4	8/8/2007
USFW375041	857447	220566	-10.65	0	8/9/2007
USFW375055	857441	220570	-24.60	0	8/9/2007
USFW375071	857442	220568	-40.83	11.9	9/20/2005
USFW375081	857446	220567	-50.35	10.2	8/9/2007
USFW375099	857443	220567	-68.20	0	6/1/2005
USFW411065	860807	229206	-12.05	0.55	9/19/2005
USFW428080	858296	222800	-46.75	9.4	9/7/2007
USFW430075	857555	221157	-44.69	20.1	9/7/2007
USFW433118	856795	221625	-57.19	3.1	8/9/2007
USFW433140	856791	221615	-79.42	0	8/9/2007
USFW436060	856876	219491	-34.18	0	8/10/2007
USFW436076	856880	219495	-50.20	10	8/10/2007
USFW436115	856884	219493	-89.96	0	8/10/2007
USFW443104	858747	219597	-44.02	0	9/28/2007
USFW443117	858749	219596	-57.08	8.3	9/28/2007
USFW443140	858747	219594	-80.02	34.6	9/28/2007
USFW460140	860885	224227	-68.26	0.18	8/30/2007
USFW470119	859328	219071	-60.72	0	8/10/2007
USFW484007	856118	214682	6.01	0	10/10/2007
USFW484023	856116	214669	-10.12	5.3	10/10/2007

Table 1
Ashumet Valley 2008 PCE Plume Shell Data Set
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note

Location	Easting (ft)	Northing (ft)	Sample Elevation (ft msl)	Sample PCE Concentration[1] (µg/L)	Sample Date
USFW484078	856117	214672	-65.12	5.6	10/10/2007
USFW487012	855480	216291	8.96	0	8/16/2007
USFW487023	855480	216291	-2.56	0	8/16/2007
USFW487078	855480	216291	-57.36	0	8/16/2007
USFW487112	855480	216291	-91.77	0	8/16/2007
USFW492007	859233	212427	1.33	0	8/14/2007
USFW493024	859806	214898	-6.81	0	8/14/2007
USFW493074	859804	214894	-56.69	0	8/14/2007
USFW497035	856463	212550	0.14	0	10/15/2007
USFW497052	856461	212547	-16.71	0	10/15/2007
USFW497089	856464	212554	-53.09	1.6	10/15/2007
USFW501087	858160	217595	-34.62	0	10/9/2007
USFW501102	858160	217595	-49.47	30.6	10/9/2007
USFW501117	858160	217595	-65.60	0.76	10/9/2007
USFW502102	858201	220252	-40.97	0.39	10/10/2007
USFW502117	858196	220255	-56.22	7.9	10/10/2007
USFW502139	858193	220257	-78.19	0	10/10/2007
USFW655055	856748	217547	-35.22	0.75	10/11/2007
USFW655075	856747	217543	-55.20	5.6	10/11/2007
USFW655110	856743	217536	-90.12	5.7	10/11/2007
USFW657063	856340	217568	-43.20	0	10/22/2007
USFW657078	856340	217571	-58.12	12.7	10/22/2007
USFW657093	856340	217574	-73.08	0	10/22/2007
USFW660085	857110	217406	-37.62	0	10/12/2007
USFW660102	857112	217405	-54.57	11.8	10/12/2007
USFW660118	857116	217404	-70.31	0	10/12/2007
USFWB01-P05	855726	213871	-26*	0	9/14/07
USFWB06-IR04	856140	216881	-26*	0	9/14/07
USFWB09-IR03	856409	217837	-26*	0	9/14/07
USFWB12-IR02	857131	218947	-26*	8.8	9/14/07
USFWB14-IR01	857497	220069	-26*	16.8	9/14/07

Data Source: AFCEE, March 2008, MMR - AFCEE Data Warehouse

[1] Zero (0) concentration substituted for nondetect reported by the analytical laboratory for purpose of plume shell preparation.

Key:
ft = feet
msl = mean sea level
PCE = tetrachloroethene
µg/L = micrograms per liter
* = estimated elevation

Table 2
Ashumet Valley 2008 TCE Plume Shell Data Set
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note

Location	Easting (ft)	Northing (ft)	Sample Elevation (ft msl)	Sample TCE Concentration[1] (µg/L)	Sample Date
03MW2623B	862457	228339	-61.72	0.18	9/24/2007
30MW0584B	862708	230627	-99.42	2.1	10/11/2007
30MW0585A	861887	229028	-40.03	10.2	9/21/2007
95DP0201	859057	217483	-26.00	0	4/19/2004
95DP0201	859057	217483	-36.00	0	4/19/2004
95DP0201	859057	217483	-46.00	0	4/19/2004
95DP0202	858672	215292	-29.62	0	4/23/2004
95DP0202	858672	215292	-39.62	0.18	4/23/2004
95DP0202	858672	215292	-61.22	0	10/1/2007
95DP0203	859084	215317	-52.34	0	5/4/2004
95DP0203	859084	215317	-66.74	0	5/4/2004
95DP0204	856240	213877	-24.14	0.52	5/3/2004
95DP0204	856240	213877	-34.14	1.5	5/3/2004
95DP0204	856240	213877	-44.14	0.5	5/3/2004
95DP0205	856846	213740	5.50	0	12/7/2005
95DP0205	856846	213740	-4.50	0	12/7/2005
95DP0205	856846	213740	-14.50	0	12/7/2005
95DP0205	856846	213740	-24.50	0	12/7/2005
95DP0205	856846	213740	-34.50	0	12/8/2005
95DP0205	856846	213740	-44.50	0	12/8/2005
95DP0205	856846	213740	-54.50	1.1	12/8/2005
95DP0205	856846	213740	-64.50	1.1	12/8/2005
95DP0206	857367	214350	5.50	0	12/19/2005
95DP0206	857367	214350	-4.50	0	12/19/2005
95DP0206	857367	214350	-14.50	0	12/19/2005
95DP0206	857367	214350	-24.50	0	12/19/2005
95DP0206	857367	214350	-34.50	0	12/19/2005
95DP0206	857367	214350	-44.50	4.4	12/19/2005
95DP0207	856804	214937	4.50	0	12/19/2005
95DP0207	856804	214937	-5.50	0	12/19/2005
95DP0207	856804	214937	-15.50	0	12/19/2005
95DP0207	856804	214937	-25.50	0	12/19/2005
95DP0207	856804	214937	-35.50	0	12/19/2005
95DP0207	856804	214937	-45.50	0	12/19/2005
95DP0207	856804	214937	-55.50	0	12/19/2005
95DP0207	856804	214937	-65.50	1.4	12/19/2005
95DP0207	856804	214937	-75.50	3	12/20/2005
95DP0207	856804	214937	-80.50	3.5	12/20/2005
95DP0208	860349	223204	15.50	0	3/22/2006
95DP0208	860349	223204	5.50	0	3/22/2006
95DP0208	860349	223204	-4.50	0	3/22/2006
95DP0208	860349	223204	-14.50	0	3/22/2006
95DP0208	860349	223204	-24.50	0	3/22/2006
95DP0208	860349	223204	-34.50	0	3/22/2006
95DP0208	860349	223204	-44.50	0	3/22/2006
95DP0208	860349	223204	-54.50	0	3/22/2006
95DP0208	860349	223204	-64.50	1.1	3/22/2006
95DP0208	860349	223204	-74.50	5.6	3/23/2006
95DP0208	860349	223204	-82.50	3.2	3/23/2006

Table 2
Ashumet Valley 2008 TCE Plume Shell Data Set
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note

Location	Easting (ft)	Northing (ft)	Sample Elevation (ft msl)	Sample TCE Concentration[1] (µg/L)	Sample Date
95DP0210	859107	223004	26.50	0	2/20/2006
95DP0210	859107	223004	16.50	0	2/20/2006
95DP0210	859107	223004	6.50	0	2/20/2006
95DP0210	859107	223004	-3.50	0	2/20/2006
95DP0210	859107	223004	-13.50	0	2/20/2006
95DP0210	859107	223004	-23.50	0	2/20/2006
95DP0210	859107	223004	-33.50	0	2/20/2006
95DP0210	859107	223004	-43.50	0	2/20/2006
95DP0210	859107	223004	-53.50	0	2/21/2006
95DP0210	859107	223004	-63.50	0	2/21/2006
95DP0210	859107	223004	-73.50	0.21	2/21/2006
95DP0210	859107	223004	-80.50	0.88	2/21/2006
95DP0211	859649	222798	27.50	0	2/15/2006
95DP0211	859649	222798	17.50	0	2/15/2006
95DP0211	859649	222798	7.50	0	2/15/2006
95DP0211	859649	222798	-2.50	0	2/15/2006
95DP0211	859649	222798	-12.50	0	2/15/2006
95DP0211	859649	222798	-22.50	0	2/15/2006
95DP0211	859649	222798	-32.50	0	2/15/2006
95DP0211	859649	222798	-42.50	0	2/15/2006
95DP0211	859649	222798	-52.50	0	2/16/2006
95DP0211	859649	222798	-62.50	0	2/16/2006
95DP0211	859649	222798	-72.50	0	2/16/2006
95DP0211	859649	222798	-82.50	0	2/16/2006
95DP0213	860464	222205	26.50	0	2/27/2006
95DP0213	860464	222205	16.50	0	2/27/2006
95DP0213	860464	222205	6.50	0	2/27/2006
95DP0213	860464	222205	-3.50	0	2/27/2006
95DP0213	860464	222205	-13.50	0	2/27/2006
95DP0213	860464	222205	-23.50	0	2/27/2006
95DP0213	860464	222205	-33.50	0	2/28/2006
95DP0213	860464	222205	-43.50	0.25	2/28/2006
95DP0213	860464	222205	-51.50	0.24	2/28/2006
95DP0214	859526	222344	21.50	0	2/8/2006
95DP0214	859526	222344	11.50	0	2/8/2006
95DP0214	859526	222344	1.50	0	2/8/2006
95DP0214	859526	222344	-8.50	0	2/8/2006
95DP0214	859526	222344	-18.50	0	2/8/2006
95DP0214	859526	222344	-28.50	0	2/8/2006
95DP0214	859526	222344	-38.50	0	2/8/2006
95DP0214	859526	222344	-48.50	0	2/8/2006
95DP0214	859526	222344	-58.50	0	2/8/2006
95DP0214	859526	222344	-68.50	0	2/8/2006
95DP0214	859526	222344	-78.50	0.21	2/9/2006
95DP0214	859526	222344	-88.50	0	2/9/2006
95DP0214	859526	222344	-98.50	0	2/9/2006
95DP0214	859526	222344	-108.50	0.21	2/9/2006
95DP0214	859526	222344	-118.50	4.9	2/9/2006
95DP0214	859526	222344	-124.50	3.9	2/10/2006

Table 2
Ashumet Valley 2008 TCE Plume Shell Data Set
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note

Location	Easting (ft)	Northing (ft)	Sample Elevation (ft msl)	Sample TCE Concentration[1] (µg/L)	Sample Date
95DP0215	858544	220051	22.50	0	12/3/2007
95DP0215	858544	220051	12.50	0	12/3/2007
95DP0215	858544	220051	2.50	0	12/4/2007
95DP0215	858544	220051	-7.50	0	12/4/2007
95DP0215	858544	220051	-17.50	0	12/4/2007
95DP0215	858544	220051	-27.50	0	12/4/2007
95DP0215	858544	220051	-37.50	0	12/4/2007
95DP0215	858544	220051	-47.50	0	12/5/2007
95DP0215	858544	220051	-57.50	4.9	12/5/2007
95DP0215	858544	220051	-67.50	0.88	12/5/2007
95DP0216	858296	219075	14.50	0	1/3/2008
95DP0216	858296	219075	4.50	0	1/3/2008
95DP0216	858296	219075	-5.50	0	1/3/2008
95DP0216	858296	219075	-15.50	0	1/3/2008
95DP0216	858296	219075	-25.50	0	1/3/2008
95DP0216	858296	219075	-35.50	0	1/3/2008
95DP0216	858296	219075	-45.50	5.1	1/4/2008
95DP0216	858296	219075	-55.50	0	1/4/2008
95DP0217	857958	219635	15.50	0	12/6/2007
95DP0217	857958	219635	5.50	0	12/6/2007
95DP0217	857958	219635	-4.50	0	12/7/2007
95DP0217	857958	219635	-14.50	0	12/7/2007
95DP0217	857958	219635	-24.50	0.17	12/7/2007
95DP0217	857958	219635	-34.50	0	12/7/2007
95DP0217	857958	219635	-44.50	0	12/7/2007
95DP0217	857958	219635	-54.50	3	12/7/2007
95DP0217	857958	219635	-64.50	0	12/10/2007
95DP0218	858545	218788	13.50	0	12/13/2007
95DP0218	858545	218788	3.50	0	12/13/2007
95DP0218	858545	218788	-6.50	0	12/13/2007
95DP0218	858545	218788	-16.50	0	12/17/2007
95DP0218	858545	218788	-26.50	0	12/17/2007
95DP0218	858545	218788	-36.50	0.45	12/17/2007
95DP0218	858545	218788	-46.50	6.4	12/18/2007
95DP0218	858545	218788	-56.50	0	12/18/2007
95DP0218	858545	218788	-61.50	0.42	12/19/2007
95DP0219	857743	218749	13.50	0	1/7/2008
95DP0219	857743	218749	3.50	0	1/7/2008
95DP0219	857743	218749	-6.50	0	1/8/2008
95DP0219	857743	218749	-16.50	0	1/8/2008
95DP0219	857743	218749	-26.50	0	1/8/2008
95DP0219	857743	218749	-36.50	0	1/8/2008
95DP0219	857743	218749	-46.50	3.2	1/8/2008
95DP0219	857743	218749	-56.50	0.79	1/8/2008
95DP0219	857743	218749	-66.50	0	1/8/2008
95DP0220	857673	218086	8.50	0	1/10/2008
95DP0220	857673	218086	-1.50	0	1/10/2008
95DP0220	857673	218086	-11.50	0	1/10/2008
95DP0220	857673	218086	-21.50	0	1/10/2008

Table 2
Ashumet Valley 2008 TCE Plume Shell Data Set
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note

Location	Easting (ft)	Northing (ft)	Sample Elevation (ft msl)	Sample TCE Concentration[1] (µg/L)	Sample Date
95DP0220	857673	218086	-31.50	0	1/10/2008
95DP0220	857673	218086	-41.50	0.31	1/10/2008
95DP0220	857673	218086	-51.50	9.1	1/10/2008
95DP0220	857673	218086	-61.50	5.5	1/11/2008
95DP0221	857924	216647	5.50	0	1/15/2008
95DP0221	857924	216647	-4.50	0	1/15/2008
95DP0221	857924	216647	-14.50	0	1/17/2008
95DP0221	857924	216647	-24.50	0	1/17/2008
95DP0221	857924	216647	-34.50	0	1/17/2008
95DP0221	857924	216647	-44.50	0	1/17/2008
95DP0221	857924	216647	-54.50	1.5	1/17/2008
95DP0221	857924	216647	-64.50	10.7	1/17/2008
95DP0221	857924	216647	-74.50	16.1	1/17/2008
95DP0221	857924	216647	-84.50	0.25	1/17/2008
95DP0221	857924	216647	-94.50	0	1/18/2008
95DP0221	857924	216647	-104.50	0	1/18/2008
95DP0221	857924	216647	-114.50	0	1/18/2008
95DP0221	857924	216647	-124.50	0	1/18/2008
95DP0222	857170	216635	1.50	0	1/22/2008
95DP0222	857170	216635	-8.50	0	1/22/2008
95DP0222	857170	216635	-18.50	0	1/22/2008
95DP0222	857170	216635	-28.50	0	1/22/2008
95DP0222	857170	216635	-38.50	0	1/22/2008
95DP0222	857170	216635	-48.50	0	1/22/2008
95DP0222	857170	216635	-58.50	0.77	1/22/2008
95DP0222	857170	216635	-68.50	5.3	1/23/2008
95DP0222	857170	216635	-78.50	3.8	1/23/2008
95DP0222	857170	216635	-88.50	2.5	1/23/2008
95DP0222	857170	216635	-98.50	0	1/23/2008
95DP0222	857170	216635	-108.50	0	1/23/2008
95DP0222	857170	216635	-118.50	0	1/23/2008
95DP0223	857681	216006	-0.50	0	02/12/08
95DP0223	857681	216006	-10.50	0	02/12/08
95DP0223	857681	216006	-20.50	0	02/14/08
95DP0223	857681	216006	-30.50	0	02/14/08
95DP0223	857681	216006	-40.50	0	02/14/08
95DP0223	857681	216006	-50.50	6.3	02/14/08
95DP0223	857681	216006	-60.50	9.6	02/14/08
95DP0223	857681	216006	-70.50	0	02/14/08
95DP0223	857681	216006	-80.50	0	02/14/08
95DP0224	857342	215315	-2.50	0	02/20/08
95DP0224	857342	215315	-12.50	0	02/20/08
95DP0224	857342	215315	-22.50	0	02/20/08
95DP0224	857342	215315	-32.50	0	02/20/08
95DP0224	857342	215315	-42.50	3.4	02/20/08
95DP0224	857342	215315	-52.50	6.5	02/21/08
95DP0224	857342	215315	-62.50	12.6	02/21/08
95DP0224	857342	215315	-72.50	0	02/21/08
95DP0224	857342	215315	-82.50	4.4	02/25/08

Table 2
Ashumet Valley 2008 TCE Plume Shell Data Set
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note

Location	Easting (ft)	Northing (ft)	Sample Elevation (ft msl)	Sample TCE Concentration[1] (µg/L)	Sample Date
95DP3000	859828	214822	7.11	0	10/10/2007
95IG0004	857982	214801	-25.10	0	5/24/2007
95MW0102A	855744	217877	-49.14	2.3	9/11/2007
95MW0103	857613	217228	-55.25	1.2	9/11/2007
95MW0104	857982	214901	-59.06	2.4	9/13/2007
95MW0106	858088	213836	-61.49	1.7	9/13/2007
95MW0201	859476	222083	-73.16	0	9/11/2007
95MW0206A	862548	226419	-138.19	0.43	3/21/2005
95MW0206B	862548	226420	-88.19	0	9/11/2007
95MW0207A	860404	227711	-133.90	0.58	8/27/2007
95MW0208A	859587	225452	-66.94	10.4	8/30/2007
95MW0208B	859588	225451	-31.94	0	8/30/2007
95MW0211A	861084	227278	-153.73	7.7	8/27/2007
95MW0212A	861790	226875	-109.12	15.8	8/23/2007
95MW0212B	861790	226875	-45.12	0	8/23/2007
95MW0214A	863100	228842	-203.72	0	3/29/2005
95MW0215A	863097	228834	-128.76	0.26	3/29/2005
95MW0604F	858798	219320	-56.18	3.4	10/10/2007
95MW0605F	858742	219219	-57.21	8.8	10/12/2007
95MW1170A	861849	230030	-120.76	0	8/23/2007
95MW1170B	861849	230030	-63.76	2	8/23/2007
95MW1171A	860883	227432	-102.53	0	8/27/2007
95MW1171B	860883	227433	-38.53	0.35	8/27/2007
95MW1172A	860785	225888	-101.37	0.41	8/23/2007
95MW1172B	860830	225937	-37.87	0	8/23/2007
95MW1173A	859755	222972	-119.98	7.9	8/29/2007
95MW1173B	859755	222972	-40.88	0	8/29/2007
95MW1174A	861283	225790	-75.71	7.4	8/23/2007
95MW1174B	861283	225789	-48.21	0	8/23/2007
95MW1232A	859388	222899	-128.65	10.2	8/29/2007
95MW1233A	859049	220969	-119.99	2.1	8/29/2007
95MW1233B	859049	220970	-80.02	2.2	8/29/2007
95MW1234A	858543	218786	-66.50	0	02/08/08
95MW1234A	858543	218786	-86.50	0	02/12/08
95MW1234A	858543	218786	-96.50	0	02/12/08
95MW1234A	858543	218786	-106.50	0	02/12/08
95MW1234A	858543	218786	-116.50	0	02/13/08
95MW1234A	858543	218786	-126.50	0	02/13/08
95MW1234A	858543	218786	-136.50	0	02/14/08
95MW1234A	858543	218786	-146.50	0	02/14/08
95MW1234A	858543	218786	-176.50	0	02/15/08
95MW1234A	858543	218786	-186.50	0	02/15/08
95MW1234A	858543	218786	-196.50	0	02/15/08
95MW1234A	858543	218786	-206.50	0	02/19/08
95MW1234A	858543	218786	-216.50	0	02/19/08
95PW0002	858308	217608	-96.52	6.1	1/10/2008
95PZ0002A	858299	217591	-104.72	6.1	1/10/2008
95PZ0002B	858308	217592	-75.00	0	1/10/2008
95PZ0003A	856875	213689	-49.92	1.7	9/7/2007

Table 2
Ashumet Valley 2008 TCE Plume Shell Data Set
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note

Location	Easting (ft)	Northing (ft)	Sample Elevation (ft msl)	Sample TCE Concentration[1] (µg/L)	Sample Date
95PZ0004A	857275	214317	-44.10	2.4	10/1/2007
95PZ0005A	856793	214905	-67.20	6.1	10/1/2007
95SW3000	856128	214684	10.00	0	9/13/2007
95SW3001	856382	216436	14.00	0	9/13/2007
95SW3002	856360	217332	16.00	0	9/13/2007
95SW3003	856889	218347	18.00	0	9/13/2007
95SW3004	856959	219007	20.00	0	9/13/2007
95SW3005	857046	219458	22.00	1.4	9/13/2007
95SW3006	857169	219883	24.00	1.2	9/13/2007
95SW3007	857420	220468	24.00	0	9/13/2007
95SWAP03	862626	230246	10.00	0	7/17/2007
ECMWBKR01D	856679	217227	-54.64	2.6	8/16/2007
ECMWBKR01M	856679	217227	-14.63	0	8/16/2007
ECPZBKR01A	857529	220793	18.30	0	10/27/2005
USFW237088	860323	231731	3.96	0	6/20/2005
USFW262126	860295	227479	-78.44	2.1	8/30/2007
USFW262159	860295	227479	-110.90	1.3	8/30/2007
USFW267055	859510	229901	1.90	0	6/28/2005
USFW267088	859508	229899	-32.08	0	6/16/2005
USFW267111	859508	229899	-55.18	0	6/16/2005
USFW267136	859508	229899	-79.87	1.4	6/16/2005
USFW267155	859508	229899	-99.65	0	6/16/2005
USFW271114	858973	223415	-77.12	0	8/7/2007
USFW271141	858974	223416	-104.16	3.5	8/7/2007
USFW271165	858973	223415	-128.53	0	8/7/2007
USFW350064	859338	224735	-25.94	0	9/20/2005
USFW350110	859338	224735	-71.46	1.7	8/7/2007
USFW350125	859338	224735	-86.00	1.9	8/7/2007
USFW356108	859873	224437	-42.26	0	8/8/2007
USFW356134	859873	224437	-67.78	3.8	8/8/2007
USFW357119	860503	224257	-47.47	0	8/8/2007
USFW357139	860493	224261	-67.65	8.7	8/8/2007
USFW375041	857447	220566	-10.65	0	8/9/2007
USFW375055	857441	220570	-24.60	0	8/9/2007
USFW375071	857442	220568	-40.83	6.1	9/20/2005
USFW375081	857446	220567	-50.35	5	8/9/2007
USFW375099	857443	220567	-68.20	0	6/1/2005
USFW411065	860807	229206	-12.05	0	9/19/2005
USFW428080	858296	222800	-46.75	3.1	9/7/2007
USFW430075	857555	221157	-44.69	7.9	9/7/2007
USFW433118	856795	221625	-57.19	2.4	8/9/2007
USFW433140	856791	221615	-79.42	0	8/9/2007
USFW436060	856876	219491	-34.18	0	8/10/2007
USFW436076	856880	219495	-50.20	5.2	8/10/2007
USFW436115	856884	219493	-89.96	0	8/10/2007
USFW443104	858747	219597	-44.02	0	9/28/2007
USFW443117	858749	219596	-57.08	1.7	9/28/2007
USFW443140	858747	219594	-80.02	8.2	9/28/2007
USFW460140	860885	224227	-68.26	0.23	8/30/2007

Table 2
Ashumet Valley 2008 TCE Plume Shell Data Set
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note

Location	Easting (ft)	Northing (ft)	Sample Elevation (ft msl)	Sample TCE Concentration[1] (µg/L)	Sample Date
USFW470119	859328	219071	-60.72	0	8/10/2007
USFW484007	856118	214682	6.01	0	10/10/2007
USFW484023	856116	214669	-10.12	1.9	10/10/2007
USFW484078	856117	214672	-65.12	2.4	10/10/2007
USFW487012	855480	216291	8.96	0	8/16/2007
USFW487023	855480	216291	-2.56	0	8/16/2007
USFW487078	855480	216291	-57.36	0	8/16/2007
USFW487112	855480	216291	-91.77	0	8/16/2007
USFW492007	859233	212427	1.33	0	8/14/2007
USFW493024	859806	214898	-6.81	0	8/14/2007
USFW493074	859804	214894	-56.69	0	8/14/2007
USFW497035	856463	212550	0.14	0	10/15/2007
USFW497052	856461	212547	-16.71	0	10/15/2007
USFW497089	856464	212554	-53.09	0.32	10/15/2007
USFW501087	858160	217595	-34.62	0	10/9/2007
USFW501102	858160	217595	-49.47	11.4	10/9/2007
USFW501117	858160	217595	-65.60	1.4	10/9/2007
USFW502102	858201	220252	-40.97	0	10/10/2007
USFW502117	858196	220255	-56.22	5.2	10/10/2007
USFW502139	858193	220257	-78.19	0	10/10/2007
USFW655055	856748	217547	-35.22	0	10/11/2007
USFW655075	856747	217543	-55.20	2.1	10/11/2007
USFW655110	856743	217536	-90.12	2.4	10/11/2007
USFW657063	856340	217568	-43.20	0	10/22/2007
USFW657078	856340	217571	-58.12	4	10/22/2007
USFW657093	856340	217574	-73.08	0	10/22/2007
USFW660085	857110	217406	-37.62	0	10/12/2007
USFW660102	857112	217405	-54.57	4.4	10/12/2007
USFW660118	857116	217404	-70.31	0	10/12/2007
USFWB01-P05	855726	213871	-26*	0	9/14/07
USFWB06-IR04	856140	216881	-26*	0	9/14/07
USFWB09-IR03	856409	217837	-26*	0	9/14/07
USFWB12-IR02	857131	218947	-26*	4.8	9/14/07
USFWB14-IR01	857497	220069	-26*	8.6	9/14/07

Data Source: AFCEE, March 2008, MMR - AFCEE Data Warehouse

[1] Zero (0) concentration substituted for nondetect reported by the analytical laboratory for purpose of plume shell preparation.

Key:
ft = feet
msl = mean sea level
TCE = trichloroethene
µg/L = micrograms per liter
* = estimated elevation

ATTACHMENT A

Groundwater Screening Results

Attachment A
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note
Groundwater Screening Results
Direct Push Location 95DP0215
(Falmouth Country Club Golf Course)

Date Sampled	Sample Interval	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	PCE (µg/L) MCL = 5 µg/L	TCE (µg/L) MCL = 5 µg/L
12/3/07	A	35	40	37.5	22.5	ND	ND
12/3/07	B	45	50	47.5	12.5	ND	ND
12/4/07	C	55	60	57.5	2.5	ND	ND
12/4/07	D	65	70	67.5	-7.5	ND	ND
12/4/07	E	75	80	77.5	-17.5	ND	ND
12/4/07	F	85	90	87.5	-27.5	ND	ND
12/4/07	G	95	100	97.5	-37.5	ND	ND
12/5/07	H	105	110	107.5	-47.5	BRL	ND
12/5/07	I	115	120	117.5	-57.5	**12.3**	4.9
12/5/07	J	125	130	127.5	-67.5	BRL	BRL

Data Source: AFCEE-MMR Data Warehouse, February 2008

Key:

BOS = bottom of sample interval
BRL = below reporting limit (1.0 µg/L)
ft bgs = feet below ground surface
ft msl = feet mean sea level
MCL = Maximum Contaminant Level
ND = not detected
NS = not sampled due to non-productive zone
PCE = tetrachloroethene
TCE = trichloroethene
TOS = top of sample interval
µg/L = micrograms per liter

Approximate elevation of ground surface is 60 ft msl.
Water level at 36.6 ft bgs (approximate).
Boring refusal was obtained at 133.9 ft bgs (-73.9 ft msl).

Attachment A
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note
Groundwater Screening Results
Direct Push Location 95DP0216
(Falmouth Country Club Golf Course)

Date Sampled	Sample Interval	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	PCE (µg/L) MCL = 5 µg/L	TCE (µg/L) MCL = 5 µg/L
1/3/08	A	40	45	42.5	14.5	ND	ND
1/3/08	B	50	55	52.5	4.5	ND	ND
1/3/08	C	60	65	62.5	-5.5	ND	ND
1/3/08	D	70	75	72.5	-15.5	ND	ND
1/3/08	E	80	85	82.5	-25.5	ND	ND
1/3/08	F	90	95	92.5	-35.5	BRL	ND
1/4/08	G	100	105	102.5	-45.5	**10.3**	**5.1**
1/4/08	H	110	115	112.5	-55.5	ND	ND
1/4/08	I	120	125	122.5	-65.5	NS	NS

Data Source: AFCEE-MMR Data Warehouse, February 2008

Key:

BOS = bottom of sample interval
BRL = below reporting limit (1.0 µg/L)
ft bgs = feet below ground surface
ft msl = feet mean sea level
MCL = Maximum Contaminant Level
ND = not detected
NS = not sampled due to non-productive zone
PCE = tetrachloroethene
TCE = trichloroethene
TOS = top of sample interval
µg/L = micrograms per liter

Approximate elevation of ground surface is 57 ft msl.
Water level at 38 ft bgs (approximate).
Boring refusal was obtained at 125 ft bgs (-58 ft msl).

Attachment A
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note
Groundwater Screening Results
Direct Push Location 95DP0217
(Falmouth Country Club Golf Course)

Date Sampled	Sample Interval	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	PCE (µg/L) MCL = 5 µg/L	TCE (µg/L) MCL = 5 µg/L
12/6/07	A	40	45	42.5	15.5	ND	ND
12/6/07	B	50	55	52.5	5.5	ND	ND
12/7/07	C	60	65	62.5	-4.5	ND	ND
12/7/07	D	70	75	72.5	-14.5	ND	ND
12/7/07	E	80	85	82.5	-24.5	ND	BRL
12/7/07	F	90	95	92.5	-34.5	ND	ND
12/7/07	G	100	105	102.5	-44.5	1.4	ND
12/7/07	H	110	115	112.5	-54.5	**5.2**	3.0
12/10/07	I	120	125	122.5	-64.5	ND	ND
12/10/07	J	130	135	132.5	-74.5	NS	NS

Data Source: AFCEE-MMR Data Warehouse, February 2008

Key:
BOS = bottom of sample interval
BRL = below reporting limit (1.0 µg/L)
ft bgs = feet below ground surface
ft msl = feet mean sea level
MCL = Maximum Contaminant Level
ND = not detected
NS = not sampled due to non-productive zone
PCE = tetrachloroethene
TCE = trichloroethene
TOS = top of sample interval
µg/L = micrograms per liter

Approximate elevation of ground surface is 58 ft msl.
Water level at 36.7 ft bgs (approximate).
Boring refusal was obtained at 136 ft bgs (-78 ft msl).

Attachment A
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note
Groundwater Screening Results
Direct Push Location 95DP0218
(Co-located with sonic boring 95MW1234A)
(Falmouth Country Club Golf Course)

Date Sampled	Sample Interval	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	PCE (µg/L) MCL = 5 µg/L	TCE (µg/L) MCL = 5 µg/L
12/13/07	A	40	45	42.5	13.5	ND	ND
12/13/07	B	50	55	52.5	3.5	ND	ND
12/13/07	C	60	65	62.5	-6.5	ND	ND
12/17/07	D	70	75	72.5	-16.5	ND	ND
12/17/07	E	80	85	82.5	-26.5	ND	ND
12/17/07	F	90	95	92.5	-36.5	1.5	BRL
12/18/07	G	100	105	102.5	-46.5	12.2	6.4
12/18/07	H	110	115	112.5	-56.5	ND	ND
12/19/07	I	115	120	117.5	-61.5	BRL	BRL

Data Source: AFCEE-MMR Data Warehouse, February 2008

Key:

BOS = bottom of sample interval
BRL = below reporting limit (1.0 µg/L)
ft bgs = feet below ground surface
ft msl = feet mean sea level
MCL = Maximum Contaminant Level
ND = not detected
NS = not sampled due to non-productive zone
PCE = tetrachloroethene
TCE = trichloroethene
TOS = top of sample interval
µg/L = micrograms per liter

Approximate elevation of ground surface is 56 ft msl.
Water level at 36.4 ft bgs (approximate).
Boring refusal was obtained at 120 ft bgs (-64 ft msl).
Monitoring Well Installation (95MW1234).
"A" Screen: approximately 265-270 ft bgs (see groundwater profiling for 95MW1234A for 120 to 275 ft bgs).
"B" Screen: approximately 140-145 ft bgs (see groundwater profiling for 95MW1234A for 120 to 275 ft bgs).
"C" Screen: approximately 100-105 ft bgs.

Attachment A
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note
Groundwater Screening Results
Sonic Drilling Location 95MW1234A
(Co-located with direct push boring 95DP0218)
(Falmouth Country Club Golf Course)

Date Sampled	Sample Interval	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	PCE (µg/L) MCL = 5 µg/L	TCE (µg/L) MCL = 5 µg/L
02/08/08	A	120	125	122.5	-66.5	ND	ND
NS	B	130	135	132.5	-76.5	NS	NS
02/12/08	C	140	145	142.5	-86.5	ND	ND
02/12/08	D	150	155	152.5	-96.5	ND	ND
02/12/08	E	160	165	162.5	-106.5	ND	ND
02/13/08	F	170	175	172.5	-116.5	ND	ND
02/13/08	G	180	185	182.5	-126.5	ND	ND
02/14/08	H	190	195	192.5	-136.5	ND	ND
02/14/08	I	200	205	202.5	-146.5	ND	ND
NS	J	210	215	212.5	-156.5	NS	NS
NS	K	220	225	222.5	-166.5	NS	NS
02/15/08	L	230	235	232.5	-176.5	ND	ND
02/15/08	M	240	245	242.5	-186.5	ND	ND
02/15/08	N	250	255	252.5	-196.5	ND	ND
02/19/08	O	260	265	262.5	-206.5	ND	ND
02/19/08	P	270	275	272.5	-216.5	ND	ND

Data Source: AFCEE-MMR Data Warehouse, March 2008

Key:

BOS = bottom of sample interval
BRL = below reporting limit (1.0 µg/L)
ft bgs = feet below ground surface
ft msl = feet mean sea level
MCL = Maximum Contaminant Level
ND = not detected
NS = not sampled due to non-productive zone
PCE = tetrachloroethene
TCE = trichloroethene
TOS = top of sample interval
µg/L = micrograms per liter

Approximate elevation of ground surface is 56 ft msl.

Water level at 36 ft bgs (approximate).

Boring refusal at bedrock was obtained at approximately 276 ft bgs (-220 ft msl).

Monitoring Well Installation (95MW1234).

"A" Screen: approximately 265-270 ft bgs.

"B" Screen: approximately 140-145 ft bgs.

"C" Screen: approximately 100-105 ft bgs (see groundwater profiling for 95DP0218 for 40 to 120 ft bgs).

Attachment A
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note
Groundwater Screening Results
Direct Push Location 95DP0219
(Falmouth Country Club Golf Course)

Date Sampled	Sample Interval	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	PCE (µg/L) MCL = 5 µg/L	TCE (µg/L) MCL = 5 µg/L
01/07/08	A	40	45	42.5	13.5	ND	ND
01/07/08	B	50	55	52.5	3.5	ND	ND
01/08/08	C	60	65	62.5	-6.5	ND	ND
01/08/08	D	70	75	72.5	-16.5	ND	ND
01/08/08	E	80	85	82.5	-26.5	ND	ND
01/08/08	F	90	95	92.5	-36.5	ND	ND
01/08/08	G	100	105	102.5	-46.5	**9.3**	3.2
01/08/08	H	110	115	112.5	-56.5	1.7	BRL
01/08/08	I	120	125	122.5	-66.5	ND	ND
01/09/08	J	130	135	132.5	-76.5	NS	NS
01/09/08	K	140	145	142.5	-86.5	NS	NS

Data Source: AFCEE-MMR Data Warehouse, February 2008

Key:

BOS = bottom of sample interval
BRL = below reporting limit (1.0 µg/L)
ft bgs = feet below ground surface
ft msl = feet mean sea level
MCL = Maximum Contaminant Level
ND = not detected
NS = not sampled due to non-productive zone
PCE = tetrachloroethene
TCE = trichloroethene
TOS = top of sample interval
µg/L = micrograms per liter

Approximate elevation of ground surface is 56 ft msl.
Water level at 41.0 ft bgs (approximate).
Boring refusal was obtained at 145 ft bgs (-89 ft msl).

Attachment A
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note
Groundwater Screening Results
Direct Push Location 95DP0220
(Falmouth Country Club Golf Course)

Date Sampled	Sample Interval	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	PCE (µg/L) MCL = 5 µg/L	TCE (µg/L) MCL = 5 µg/L
01/10/08	A	40	45	42.5	8.5	ND	ND
01/10/08	B	50	55	52.5	-1.5	ND	ND
01/10/08	C	60	65	62.5	-11.5	ND	ND
01/10/08	D	70	75	72.5	-21.5	ND	ND
01/10/08	E	80	85	82.5	-31.5	ND	ND
01/10/08	F	90	95	92.5	-41.5	1.5	BRL
01/10/08	G	100	105	102.5	-51.5	**24.1**	**9.1**
01/10/08	H	110	115	112.5	-61.5	**12.6**	**5.5**
01/10/08	I	120	125	122.5	-71.5	NS	NS

Data Source: AFCEE-MMR Data Warehouse, February 2008

Key:

BOS = bottom of sample interval
BRL = below reporting limit (1.0 µg/L)
ft bgs = feet below ground surface
ft msl = feet mean sea level
MCL = Maximum Contaminant Level
ND = not detected
NS = not sampled due to non-productive zone
PCE = tetrachloroethene
TCE = trichloroethene
TOS = top of sample interval
µg/L = micrograms per liter

Approximate elevation of ground surface is 51 ft msl.
Water level at 35.0 ft bgs (approximate).
Boring refusal was obtained at 125 ft bgs (-74 ft msl).

Attachment A
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note
Groundwater Screening Results
Direct Push Location 95DP0221
(Country Club Lane)

Date Sampled	Sample Interval	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	PCE (µg/L) MCL = 5 µg/L	TCE (µg/L) MCL = 5 µg/L
01/15/08	A	40	45	42.5	5.5	ND	ND
01/15/08	B	50	55	52.5	-4.5	ND	ND
01/17/08	C	60	65	62.5	-14.5	ND	ND
01/17/08	D	70	75	72.5	-24.5	ND	ND
01/17/08	E	80	85	82.5	-34.5	ND	ND
01/17/08	F	90	95	92.5	-44.5	BRL	ND
01/17/08	G	100	105	102.5	-54.5	**8.0**	1.5
01/17/08	H	110	115	112.5	-64.5	**54.9**	**10.7**
01/17/08	I	120	125	122.5	-74.5	**48.4**	**16.1**
01/17/08	J	130	135	132.5	-84.5	BRL	BRL
01/18/08	K	140	145	142.5	-94.5	ND	ND
01/18/08	L	150	155	152.5	-104.5	ND	ND
01/18/08	M	160	165	162.5	-114.5	ND	ND
01/18/08	N	169.2	174.2	171.7	-123.7	ND	ND

Data Source: AFCEE-MMR Data Warehouse, February 2008

Key:

BOS = bottom of sample interval
BRL = below reporting limit (1.0 µg/L)
ft bgs = feet below ground surface
ft msl = feet mean sea level
MCL = Maximum Contaminant Level
ND = not detected
PCE = tetrachloroethene
TCE = trichloroethene
TOS = top of sample interval
µg/L = micrograms per liter

Approximate elevation of ground surface is 48 ft msl.
Samples were analyzed at Groundwater Analytical on-site laboratory.
Water level at 32 ft bgs (approximate).
Boring refusal was obtained at 174.2 ft bgs (-126.2 ft msl).

Attachment A
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note
Groundwater Screening Results
Direct Push Location 95DP0222
(Country Club Lane)

Date Sampled	Sample Interval	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	PCE (µg/L) MCL = 5 µg/L	TCE (µg/L) MCL = 5 µg/L
01/22/08	A	40	45	42.5	1.5	ND	ND
01/22/08	B	50	55	52.5	-8.5	ND	ND
01/22/08	C	60	65	62.5	-18.5	ND	ND
01/22/08	D	70	75	72.5	-28.5	ND	ND
01/22/08	E	80	85	82.5	-38.5	ND	ND
01/22/08	F	90	95	92.5	-48.5	ND	ND
01/22/08	G	100	105	102.5	-58.5	3.0	BRL
01/23/08	H	110	115	112.5	-68.5	**15.3**	**5.3**
01/23/08	I	120	125	122.5	-78.5	**10.5**	3.8
01/23/08	J	130	135	132.5	-88.5	3.6	2.5
01/23/08	K	140	145	142.5	-98.5	ND	ND
01/23/08	L	150	155	152.5	-108.5	ND	ND
01/23/08	M	160	165	162.5	-118.5	ND	ND
01/24/08	N	170	175	172.5	-128.5	ND	ND
01/24/08	O	178.9	183.9	181.4	-137.4	NS	NS

Data Source: AFCEE-MMR Data Warehouse, February 2008

Key:

BOS = bottom of sample interval
BRL = below reporting limit (1.0 µg/L)
ft bgs = feet below ground surface
ft msl = feet mean sea level
MCL = Maximum Contaminant Level
ND = not detected
NS = not sampled due to non-productive zone
PCE = tetrachloroethene
TCE = trichloroethene
TOS = top of sample interval
µg/L = micrograms per liter

Approximate elevation of ground surface is 44 ft msl.
Samples were analyzed at Groundwater Analytical on-site laboratory.
Water level at 31 ft bgs (approximate).
Boring refusal was obtained at 183.9 ft bgs (-139.9 ft msl).

Attachment A
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note
Groundwater Screening Results
Direct Push Location 95DP0223
(Old Barnstable Rd/Mill Farm Way)

Date Sampled	Sample Interval	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	PCE (µg/L) MCL = 5 µg/L	TCE (µg/L) MCL = 5 µg/L
02/12/08	A	45	50	47.5	-0.5	ND	ND
02/12/08	B	55	60	57.5	-10.5	ND	ND
02/14/08	C	65	70	67.5	-20.5	ND	ND
02/14/08	D	75	80	77.5	-30.5	ND	ND
02/14/08	E	85	90	87.5	-40.5	BRL	ND
02/14/08	F	95	100	97.5	-50.5	**12.9**	**6.3**
02/14/08	G	105	110	107.5	-60.5	1.1	**9.6**
02/14/08	H	115	120	117.5	-70.5	ND	BRL
02/14/08	I	125	130	127.5	-80.5	ND	ND
NS	J	135	140	137.5	-90.5	NS	NS

Data Source: AFCEE-MMR Data Warehouse, March, 2008

Key:

BOS = bottom of sample interval
BRL = below reporting limit (1.0 µg/L)
ft bgs = feet below ground surface
ft msl = feet mean sea level
MCL = Maximum Contaminant Level
ND = not detected
NS = not sampled due to non-productive zone
PCE = tetrachloroethene
TCE = trichloroethene
TOS = top of sample interval
µg/L = micrograms per liter

Approximate elevation of ground surface is 47 ft msl.
Samples were analyzed at Groundwater Analytical on-site laboratory.
Water level at 34 ft bgs (approximate).
Boring refusal was obtained at 147 ft bgs (-100 ft msl).

Attachment A
Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note
Groundwater Screening Results
Direct Push Location 95DP0224
(Old Barnstable Rd/Old Waquoit Rd)

Date Sampled	Sample Interval	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	PCE (µg/L) MCL = 5 µg/L	TCE (µg/L) MCL = 5 µg/L
02/20/08	A	45	50	47.5	-2.5	ND	ND
02/20/08	B	55	60	57.5	-12.5	ND	ND
02/20/08	C	65	70	67.5	-22.5	ND	ND
02/20/08	D	75	80	77.5	-32.5	ND	ND
02/20/08	E	85	90	87.5	-42.5	**21.0**	3.4
02/21/08	F	95	100	97.5	-52.5	**20.3**	**6.5**
02/21/08	G	105	110	107.5	-62.5	**54.6**	**12.6**
02/21/08	H	115	120	117.5	-72.5	2.3	BRL
02/25/08	I	125	130	127.5	-82.5	3.3	4.4

All data preliminary and unvalidated.

Key:

BOS = bottom of sample interval
BRL = below reporting limit (1.0 µg/L)
ft bgs = feet below ground surface
ft msl = feet mean sea level
MCL = Maximum Contaminant Level
ND = not detected
NS = not sampled due to non-productive zone
PCE = tetrachloroethene
TCE = trichloroethene
TOS = top of sample interval
µg/L = micrograms per liter

Approximate elevation of ground surface is 45 ft msl.
Samples were analyzed at Groundwater Analytical on-site laboratory.
Water level at 34 ft bgs (approximate).
Boring refusal was obtained at 131.8 ft bgs (-86.8 ft msl).

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ATTACHMENT B

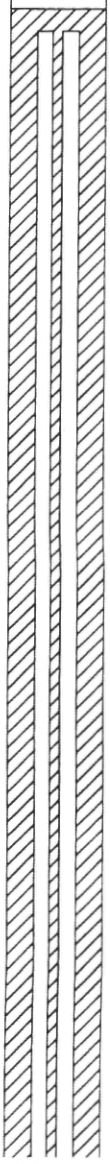
Soil Boring Logs and Monitoring Well Diagram

CH2MHILL

LOCATION: 95MW1234AB

Ashumet Valley

Project Name: Ashumet Valley		Location: Falmouth Country Club Property-Old Barnstable Rd.	
Project Number: 337105	Northing A: 218862.31 B: 218862.09	Easting A: 858554.72 B: 858554.52	GS Elev: 55.26
Drilling Contractor: Boart Longyear Co.	MP Elevation ft (MSL) A: 54.83 B: 54.83	Measuring Point: TOC	
Drilling Equipment: #1509 GP24-300RS	Date Started: 2/8/2008	Date Finished: 2/20/2008	
Drilling Method: Sonication	Total Depth Drilled ft (BGS): 280	First Water ft (BGS): 32.0	
Sampling Method: Core Barrel/Sub Pump	Borehole Diameter (in.): 7.625	Well Diameter (in.): 2.5, 1	
Const. Materials: SCH 80 PVC	Well Depth ft (BGS) A: 270.57 B: 145.04	Static Water ft (BTOC): 32.58	
Logged By: A. Young	Reviewed By: CH2M Hill	Completion: Flush mount	Date Measured: 2/13/2008

Depth (ft-bgs)	Purge Rate (gpm)	Sample Interval /Recovery	Driller's Comments and Sample ID	PID/FID	USCS Class	Lithologic Description and Associated Lithographic Symbol	Well Construction Diagram	Elevation (ft msl)
0			Monitoring wells 95MW1234A and B are installed in the same borehole with 95MW1234C. Soil logging started at 35 feet bgs.					55
5								50
10								45
15								40
20								35

LOCATION: **95MW1234AB**

Project Name: Ashumet Valley

Location: Falmouth Country Club Property-Old Barnstable Rd.

Depth (ft-bgs)	Purge Rate (gpm)	Sample Interval /Recovery	Driller's Comments and Sample ID	PID/FID	USCS Class	Lithologic Description and Associated Lithographic Symbol	Well Construction Diagram	Elevation (ft msl)
25								30
30								25
			Driller thinks he encountered the water table at approximately 35 ft.					
35			35-45 ft.: Driller reports that core run drilled smoothly.	0.0/0.0	SP	SAND, 2.5Y 5/6 light olive brown, medium grained, some fine sand, trace to little coarse sand, trace subangular fine gravel, trace silt, wet.		20
					SP	SAND, 2.5Y 5/6 light olive brown, fine and medium grained, trace fine gravel, trace coarse sand, trace silt, wet.		
				0.0/0.0	SP	SAND, 2.5Y 5/6 light olive brown, medium grained, little fine sand, trace to little coarse sand, trace fine gravel, trace silt, wet.		
40					SP			15
					NSNR	SAND, 2.5Y 5/6 light olive brown, fine and medium grained, trace coarse sand, trace subangular fine gravel, trace silt, wet.		
						No recovery.		
45			45-65 ft.: Driller reports that core run drilled smoothly.	0.0/0.0	SP	SAND, 2.5Y 5/6 light olive brown, fine and medium grained, trace coarse sand, trace angular fine gravel, trace silt, wet.		10
50								5

Project Name: Ashumet Valley | Location: Falmouth Country Club Property-Old Barnstable Rd.

Depth (ft-bgs)	Purge Rate (gpm)	Sample Interval /Recovery	Driller's Comments and Sample ID	PID/FID	USCS Class	Lithologic Description and Associated Lithographic Symbol	Well Construction Diagram	Elevation (ft msl)
55								0
				0.0/0.0	SP	SAND, 2.5Y 5/6 light olive brown, fine and medium grained, trace to little coarse sand, trace fine gravel, trace silt, wet.		
				0.0/0.0	SP	SAND, 2.5Y 5/6 light olive brown, very fine grained, trace coarse sand, trace subrounded fine and coarse gravel, trace silt, wet.		
60								-5
					NSNR	No recovery.		
65			65-85 ft.: Driller reports that core run drilled smoothly.	0.0/0.0	SP	SAND, 2.5Y 5/6 light olive brown, fine and medium grained, trace coarse sand, trace subrounded fine and coarse gravel, trace silt, wet.		-10
70								-15
				0.0/0.0	SP	SAND, 2.5Y 5/6 light olive brown, very fine grained, trace medium sand, trace subrounded fine gravel, trace silt, wet.		
					SP	SAND, 2.5Y 5/6 light olive brown, fine and medium grained, trace coarse sand, trace subrounded fine and coarse gravel, trace silt, wet.		
75								-20

Project Name: Ashumet Valley | Location: Falmouth Country Club Property-Old Barnstable Rd.

Depth (ft-bgs)	Purge Rate (gpm)	Sample Interval /Recovery	Driller's Comments and Sample ID	PID/FID	USCS Class	Lithologic Description and Associated Lithographic Symbol	Well Construction Diagram	Elevation (ft msl)
80								-25
					NSNR	No recovery.		
85			85-105 ft.: Driller reports that core run drilled smoothly.	0.0/0.0	SP	SAND, 2.5Y 5/4 light olive brown, fine and medium grained, trace coarse sand, trace subangular fine gravel, trace silt, wet.		-30
			Black on surface of core.		SP	SAND, 2.5Y 4/6 light olive brown, medium grained, trace to little fine and coarse sand, rounded cobble, trace fine gravel, trace silt, wet. Soil transitions from 2.5Y 4/6 to 10YR 4/6 dark yellowish brown.		
90								-35
				0.0/0.0	SP	SAND, 2.5Y 5/6 light olive brown, fine and medium grained, trace coarse sand, trace silt, wet.		
95					SP	SAND, 2.5Y 5/6 light olive brown, very fine grained, trace medium sand, trace silt, wet.		-40
				0.0/0.0	SP	SAND, 2.5Y 5/6 light olive brown, fine and medium grained, trace coarse sand, trace silt, trace fine gravel, wet. At 98 ft, color transition from 2.5Y 5/6 to 10YR 4/6 dark yellowish brown.		
100					NSNR	No recovery.		-45
105			105-125 ft.: Driller reports that core run drilled tightly.	0.0/0.0	SP	SAND, 2.5Y 5/6 light olive brown, fine grained, trace medium and coarse sand, trace silt, wet.		-50

LOCATION: **95MW1234AB**

Project Name: Ashumet Valley | Location: Falmouth Country Club Property-Old Barnstable Rd.

Depth (ft-bgs)	Purge Rate (gpm)	Sample Interval /Recovery	Driller's Comments and Sample ID	PID/FID	USCS Class	Lithologic Description and Associated Lithographic Symbol	Well Construction Diagram	Elevation (ft msl)
110					ML	CLAYEY SILT, W2.5Y 4/1 dark gray, trace coarse sand, trace subangular fine and coarse gravel, moist-dry, dense, one subrounded cobble at end of interval.		-55
115								-60
120	10.3							-65
				0.0/0.0	SP	SAND, 2.5Y 4/3 olive brown, fine grained, some medium sand, trace coarse sand, trace silt, wet.		
125			125-145 ft.: Driller reports that first ten feet of core run drilled smoothly. Second ten feet drilled tight and slowly. Driller had difficulty extracting core barrel from boring.	0.0/0.0	SP	SAND, 2.5Y 5/4 light olive brown, medium grained, trace to little fine sand, trace coarse sand, trace silt, trace angular fine gravel, wet.		-70
				0.0/2.0	ML	SILT, 2.5Y 3.1 very dark gray, trace to little clay, trace fine to coarse sand, trace subrounded fine and coarse gravel, dense, dry.		
130								-75
135								-80

LOCATION: **95MW1234AB**

Project Name: Ashumet Valley

Location: Falmouth Country Club Property-Old Barnstable Rd.

Depth (ft-bgs)	Purge Rate (gpm)	Sample Interval /Recovery	Driller's Comments and Sample ID	PID/FID	USCS Class	Lithologic Description and Associated Lithographic Symbol	Well Construction Diagram	Elevation (ft msl)
140	12			0.0/0.0	SP	SAND, 2.5Y 4/2 olive gray, medium grained, trace coarse and fine sand, trace to little subrounded fine gravel, trace silt, wet.		-85
				0.0/0.2	SPSM	SAND, 2.5Y 4/2 olive gray, very fine grained, trace to little silt, trace round fine gravel, wet.		
					SP	SAND, 2.5Y 4/2 olive gray, very fine grained, trace silt, wet to moist.		
145			145-165 ft.: Driller reports that core run drilled tight.	0.0/0.3	SP	SAND, 2.5Y 5/1gray, medium grained, trace to little fine sand, trace coarse sand, trace silt, moist to wet.		-90
150	9.6							-95
				0.0/0.4	SPSM	SAND, 2.5Y 5/1gray, very fine grained, trace coarse sand, trace to little silt, most to wet.		
155								-100
160	10							-105
165								

Project Name: Ashumet Valley | Location: Falmouth Country Club Property-Old Barnstable Rd.

Depth (ft-bgs)	Purge Rate (gpm)	Sample Interval /Recovery	Driller's Comments and Sample ID	PID/FID	USCS Class	Lithologic Description and Associated Lithographic Symbol	Well Construction Diagram	Elevation (ft msl)
			165-185 ft.: Driller reports that core run drilled smoothly.	0.0/1.8	SP	SAND, 2.5Y 5/1 gray, very fine grained, little medium sand, trace coarse sand, trace silt, wet.		-110
					SP	SAND, 2.5Y 5/2 grayish brown, fine and medium grained, trace coarse sand, trace silt, trace fine gravel, wet.		
170	8.1							-115
				0.0/3.9	SP	SAND, 2.5Y 5/1 gray, very fine grained, little medium sand, trace coarse sand, trace silt, wet. At last 0.3 feet of interval, color changes to 10YR 4/4, dark yellowish brown.		
175								-120
180	10			0.0/1.4	SP	SAND, 10Y 4/4 dark yellowish brown, medium grained, trace to little fine sand, trace coarse sand, trace silt, wet.		-125
					SP	SAND, 2.5Y 5/1 gray, very fine grained, trace medium and coarse sand, trace to little subrounded fine and coarse gravel, trace silt, wet.		
185			185-205 ft.: Driller reports that first ten feet drilled smoothly and second ten feet drilled very slowly.	0.0/2.5	SP	SAND, 2.5Y 5/2 grayish brown, fine and medium grained, trace coarse sand, trace subangular fine and coarse gravel, trace silt, wet.		-130
				0.0/0.9	SM	SAND, 2.5Y 4/1 dark gray, fine grained, some silt, trace clay, little medium sand, trace fine gravel, moist to dry, very dense.		
190	11.5							-135

Project Name: Ashumet Valley | Location: Falmouth Country Club Property-Old Barnstable Rd.

Depth (ft-bgs)	Purge Rate (gpm)	Sample Interval /Recovery	Driller's Comments and Sample ID	PID/FID	USCS Class	Lithologic Description and Associated Lithographic Symbol	Well Construction Diagram	Elevation (ft msl)
195				0.0/0.0	SP	SAND, 2.5Y 5/2 grayish brown, medium grained, trace to little coarse sand, trace fine sand, trace subangular fine and coarse gravel, trace subrounded cobble, trace silt, wet.		-140
200	9.3			0.0/0.0	SP	SAND, 2.5Y 5/2 grayish brown, very fine grained, trace medium sand, trace silt, wet.		-145
205			205-225 ft.: Driller reports core run drilled slowly.	0.0/0.0	SM	SILT and SAND, 2.5Y 3/1 very dark gray, very fine grained sand, trace medium and coarse sand, trace fine gravel, moist to dry.		-150
210				0.0/0.0	SPSM	SAND, 2.5Y 3/1 very dark gray, very fine grained, trace medium and coarse sand, trace to little silt, trace subrounded to round fine and coarse gravel, wet.		-155
215					SM	SILT and SAND, 2.5Y 3/1 very dark gray, very fine grained sand, trace medium and coarse sand, trace fine gravel, trace subrounded cobble, moist to dry.		-160
220								-165
				0.0/0.0	SP	SAND, 2.5Y 4/2 dark gray, medium grained, trace to little coarse sand, trace fine sand, trace		

Project Name: Ashumet Valley | Location: Falmouth Country Club Property-Old Barnstable Rd.

Depth (ft-bgs)	Purge Rate (gpm)	Sample Interval /Recovery	Driller's Comments and Sample ID	PID/FID	USCS Class	Lithologic Description and Associated Lithographic Symbol	Well Construction Diagram	Elevation (ft msl)
					SM	silt, wet. SILT and SAND, 2.5Y 3/1 very dark gray, very fine grained sand, trace medium and coarse sand, trace fine gravel, moist to dry.		
225			225-245 ft.: Driller reports second ten feet drilled slowly and very tight. Driller reports that last five feet of core fell out of barrel.	0.0/1.5	SP	SAND, 2.5Y 5/2 grayish brown, very fine grained, trace silt, wet.		-170
					SP	SAND, 2.5Y 5/2 grayish brown, medium grained, little fine sand, trace to little coarse sand, trace subangular fine and coarse gravel, trace silt, wet.		
230	11.4							-175
235				0.0/1.4	SP	SAND, 2.5Y 5/2 grayish brown, medium grained, some fine sands, trace coarse sand, trace subangular fine and coarse gravel, trace silt, wet.		-180
				0.0/1.4	SP	SAND, 2.5Y 5/2 grayish brown, very fine grained, trace silt, wet.		
240	10.7				NSNR	No recovery.		-185
245			245-262 ft.: Driller reports that core run drilled very tight. Core barrel stopped moving at 262 ft.	0.0/2.3	SM	SILTY SAND, 2.5Y 4/1 dark gray, very fine grained, trace medium and coarse sand, wet to saturated.		-190
250	7.1							-195

LOCATION: **95MW1234AB**

Project Name: Ashumet Valley

Location: Falmouth Country Club Property-Old Barnstable Rd.

Depth (ft-bgs)	Purge Rate (gpm)	Sample Interval /Recovery	Driller's Comments and Sample ID	PID/FID	USCS Class	Lithologic Description and Associated Lithographic Symbol	Well Construction Diagram	Elevation (ft msl)
255								-200
				0.0/0.0	SP	SAND, 2.5Y 4/2 olive gray, fine and medium grained, trace silt, wet.		
260	6.5			0.0/0.0	SPSM	SAND, 2.5Y 4/2 olive brown, fine grained, trace to little silt, wet.		-205
			262-276 ft.: Driller reports that core run drilled slowly.		SP	SAND, 2.5Y 4/2 olive brown, medium grained, some fine sand, trace coarse sand, trace silt, wet.		
265								-210
270	9.6				SP	SAND, 2.5Y 4/2 olive brown, very fine grained, trace silt, wet.		-215
					GPGM	GRAVELLY SAND, 2.5Y 4/4 olive brown, angular to subangular fine and coarse gravel, fine grained sand, trace coarse sand, trace to little silt, wet.		
275								-220
			Driller reports he encountered bedrock at 276 feet.		NACM	BEDROCK, granite, pinkish white.		
					NSNR	No recovery.		

LOCATION: **95MW1234AB**

Project Name: Ashumet Valley								Location: Falmouth Country Club Property-Old Barnstable Rd.	
Depth (ft-bgs)	Purge Rate (gpm)	Sample Interval /Recovery		Driller's Comments and Sample ID	PID/FID	USCS Class		Lithologic Description and Associated Lithographic Symbol	Well Construction Diagram	Elevation (ft msl)
280				Bottom of boring at 280 feet bgs.						-225
								Notes: 1. Well Depth 95MW1234B: 145.04 ft. bgs 95MW1234A: 270.57 ft. bgs 2. SCH 80 PVC Screens 3. Screen length 95MW1234B: 4.93 feet 95MW1234A: 4.82 feet 4. Screen Interval 95MW1234B: 140.07 - 145 ft. bgs 95MW1234A: 265.18 - 270 ft. bgs 5. Slot Size: 0.01 in. Printed on 3/26/2008		
285										-230

WELL CONSTRUCTION DIAGRAM

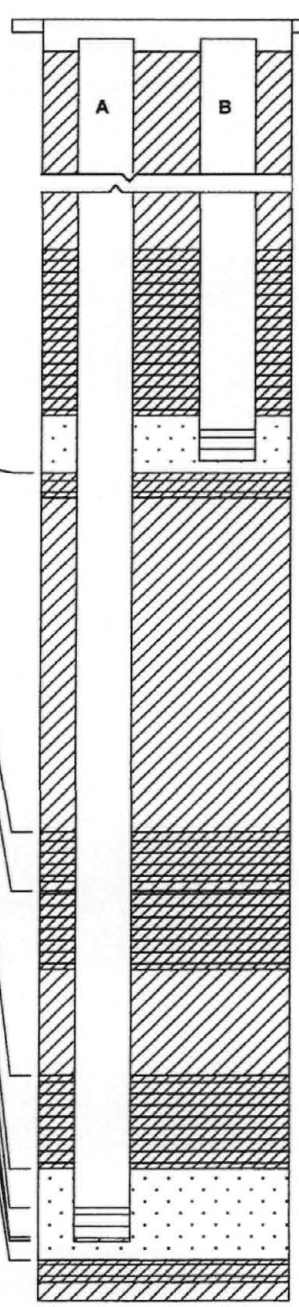
CH2MHILL

LOCATION: **95MW1234AB** Ashumet Valley

Project Name: Ashumet Valley		Location: Falmouth Country Club Property-Old Barnstable Rd.	
Project Number: 337105	Northing A: 218862.31 B: 218862.09	Easting A: 858554.72 B: 858554.52	GS Elev: 55.26
Drilling Contractor: Boart Longyear Co.	MP Elevation (ft msl) A: 54.83 B: 54.83	Measuring Point: TOC	
Drilling Equipment: #1509 GP24-300RS	Date Started: 2/8/2008		Date Finished: 2/20/2008
Drilling Method: Sonication	Sampling Method: Core Barrel/Sub Pump		Total Depth Drilled (ft bgs): 280
Const. Materials: SCH 80 PVC	Borehole Diameter (in.): 7.625		Well Diameter (in.): 2.5, 1
Screen Slot Size (in) A: 0.01 B: 0.01	Well Depth (ft bgs) A: 270.57 B: 145.04		First Water (ft bgs): 32.0 Static Water (ft btoc): 32.58 Date Measured: 2/13/2008
Logged By: A. Young	Reviewed By: CH2M Hill	Completion: Flush mount	

LOCID: 95MW1234A LOCID: 95MW1234B

Monitoring wells 95MW1234A and 95MW1234B are installed in the same borehole as 95MW1234C



Ground Surface

TOC Height: 0.43

Top of Backfill Sand: 0

Top of Bentonite Seal: 111

Top of #00N Well Gravel Filter Pack: 137.8

Top of Screen: 140.07

Bottom of Screen: 145

Bottom of Well: 145.04

Top of Bentonite Seal: 147

Top of Bentonite Seal: 205

Top of Bentonite Seal: 214.5

Top of Bentonite Seal: 244

Top of #00N Well Gravel Filter Pack: 259

Top of Screen: 265.18

Bottom of Screen: 270

Bottom of Well: 270.57

Top of Bentonite Seal: 273.5

Bottom of Boring: 280

All depths shown in ft bgs

Drawing Not to Scale

Legend: In-Situ Soil Filter Pack Bentonite Seal Backfill Sand

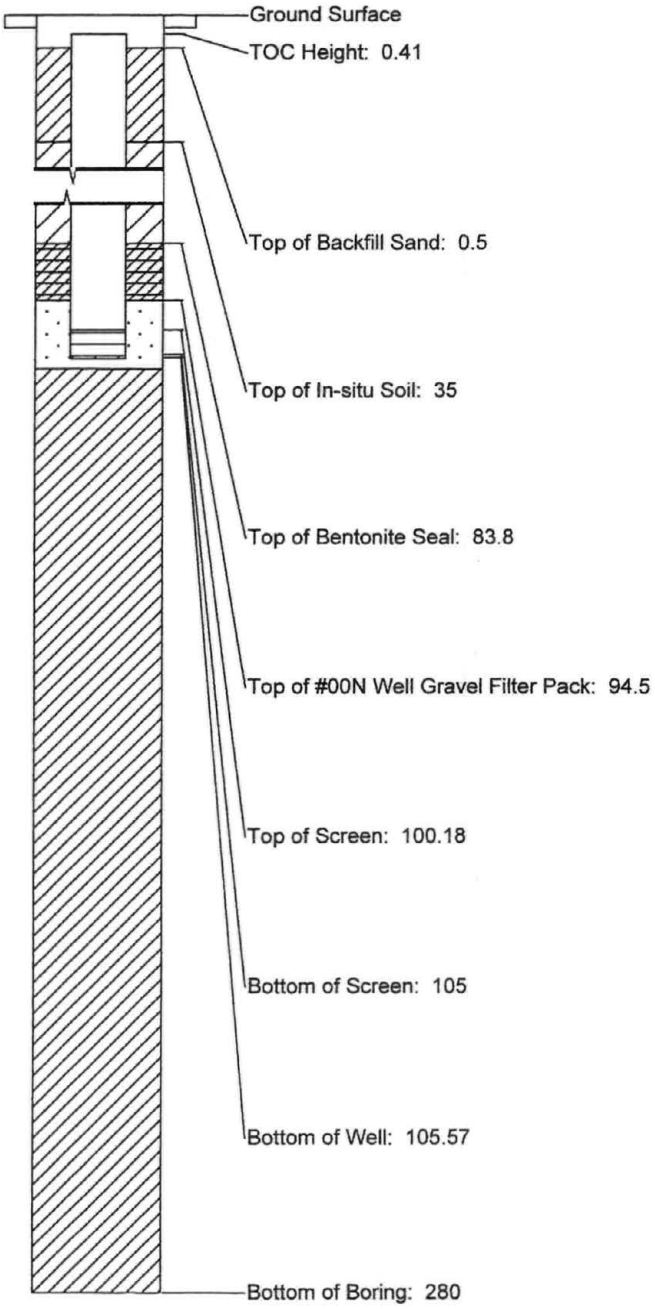
WELL CONSTRUCTION DIAGRAM

CH2MHILL

LOCATION: **95MW1234C** Ashumet Valley

Project Name: Ashumet Valley		Location: Falmouth Country Club Property-Old Barnstable Rd.	
Project Number: 337105	Northing: 218862.43	Easting: 858554.56	Ground Surface Elevation: 55.26
Drilling Contractor: Boart Longyear Co.	MP Elevation (ft msl): 54.85		Measuring Point: TOC
Drilling Equipment: #1509 GP24-300RS	Date Started: 2/8/2008		Date Finished: 2/20/2008
Drilling Method: Sonication	Sampling Method: Core Barrel/Sub Pump		Total Depth Drilled (ft bgs): 280
Const. Materials: SCH 80 PVC	Borehole Diameter (in.): 7.625		Well Diameter (in.): 2.5
Screen Slot Size (in): 0.01	Well Depth (ft bgs): 105.57		First Water (ft bgs): 32.0 Static Water ft (ft btoc): 32.58 Date Measured: 2/13/2008
Logged By: A. Young	Reviewed By: CH2M Hill	Completion: Flush mount	

Monitoring well 95MW1234C is installed in the same borehole as 95MW1234A and 95MW1234B



All depths shown in ft bgs

Drawing Not to Scale

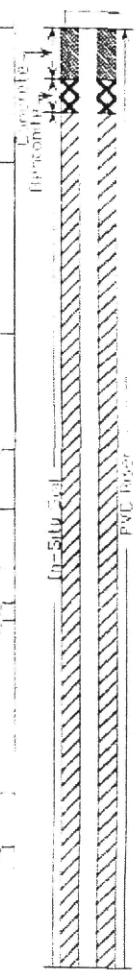
Legend: In-Situ Soil, Filter Pack, Bentonite Seal, Backfill Sand

Jacobs Engineering Group Inc.
MMR PLUME RESPONSE PROGRAM

95MW0104 Ashumet ETR

Project Name: Ashumet Valley ETR		Location: Pineland Farms	
Project Number: 35/78407	Well ID: 95MW0104	Northing: 214800.71	Easting: 857954.14
Drilling Contractor: Boart Longyear		Elevation: 44.39 feet above mean sea level	
Drilling Equipment: Guspech GI 24		Date Started: 06/16/97	Date Finished: 06/25/97
Drilling Method: Rotosonic		Total Depth Drilled: 321.0 feet	First Water: 34.0 feet (BGS)
Sampling Method: Rotosonic core barrel		Borehole Diameter: 7.87, 5.57	Well Diameter: 2.5 inch
Const. Materials: SCH 80 PVC		Well Total Depth: 106.5 feet	Static Water: 32.82 feet (BGS)
Logged by: T. Woodson	Reviewed by: S. Fox	Completion: Flushmount	Date Measured: 06/23/97

Depth (ft-bgs)	Sample Interval	Recovery	Sample ID	PID/FID	Gamma Log CPS (20 – 45 – 70) / Conductivity mS/m (2 – 6 – 10)	USCS CLASS	Lithologic Description and Associated Lithographic Symbol	Well Construction Diagram
0						SP	SAND: 10YR5/4 yellow brown, fine to coarse grained, trace silt, little fine to coarse subangular gravel, loose, dry	
5				1.4				
10							SAND: 2.5Y7/4 pale yellow, fine to coarse grained, trace silt, trace fine to coarse subangular gravel, loose, dry (mostly medium sand)	
15				3.5				
20							Same as above	
25						SP	No recovery. Same as above	
30							SAND: 2.5Y5/3 light olive brown, fine to coarse grained, trace silt, little fine to coarse subangular gravel, loose, dry.	
35				1.0		SP	SAND: 2.5Y7/4 pale yellow, fine to coarse grained, trace silt, trace fine to coarse subrounded to subangular gravel, loose, wet (mostly medium sand)	
40							No recovery. Same as above	
45				1.4			SAND: 2.5Y7/3 pale yellow, fine to coarse grained, trace silt, trace fine subangular gravel, loose, wet (mostly medium sand)	
50							No recovery.	
55				1.2		SP		



Jacobs Engineering Group Inc.
MMR PLUME RESPONSE PROGRAM

95MW0104 Ashumet ETR

Project Name: Ashumet Valley ETR | Location: Pineland Farms
Project Number: 35K78407 | Well ID: 95MW0104 | Northing: 214900.71 | Easting: 857984.34

Depth (ft-bgs)	Sample Interval	Recovery	Sample ID	PID/FID	Gamma Log CPS (20–70) / Conductivity mS/m (2–10)	USCS CLASS	Lithologic Description and Associated Lithographic Symbol
55						SP	SAND: 2.5Y7/4 pale yellow, fine to coarse grained, trace silt, trace fine subangular gravel, loose, wet (mostly medium sand)
60							Same as above
65							
70							
75				1.0			SAND: 10YR5/6 yellow brown, fine to coarse grained, trace silt, loose, wet (mostly medium sand)
80						CL / SP	SANDY CLAY: 2.5Y3/1 very dark gray, firm, moist. SAND: 2.5Y5/3 light olive brown, fine to coarse grained, trace silt, trace fine subangular gravel, loose, wet (mostly medium sand)
85				1.0			No recovery.
90							
95				1.4		ML	SANDY SILT: 2.5Y6/6 olive yellow, fine to medium grained, little 2.5Y5/1 gray clay interbedded, some iron oxide staining, very stiff, moist.
100						SM / SP	SAND: 5Y5/4 olive, fine grained, some silt, coarse angular gravel, firm, wet. SAND: 2.5Y7/3 pale yellow, fine to coarse grained, trace silt, firm, wet.
105				1.0			SAND: 5Y6/3 pale olive, fine to medium grained, trace to little silt, trace fine to coarse subangular gravel, firm, wet.
110							SAND: 2.5Y5/6 light olive brown, medium to coarse grained, trace silt, firm, wet (mostly medium sand)
115				0.4		CL	SILTY CLAY: 2.5Y4/3 olive brown to 5Y4/1 dark gray, little fine to medium sand, hard, moist.

Well Construction Diagram: In-Situ Seal; PVC Riser; Bentonite; #00 Mono Filter Sand; Screen Interval 101.5–106.5; Bentonite

Jacobs Engineering Group Inc.
MMR PLUME RESPONSE PROGRAM

95MW0104 Ashumet ETR

Project Name: Ashumet Valley ETR | Location: Pineland Farms
Project Number: 35K78407 | Well ID: 95MW0104 | Northing: 214900.71 | Easting: 857954.14

Depth (ft-bgs)	Sample Interval	Recovery	Sample ID	PID/FID	Gamma Log CPS (20–45–70) / Conductivity mS/m (2–6–10)	USCS CLASS	Lithologic Description and Associated Lithographic Symbol	Well Construction Diagram
115						CL	Same as above.	Bentonite
						SM	SAND: 5Y7/4 pale yellow, fine to medium grained, little silt, dense, wet (mostly fine sand)	
120			OT-T031301 OT-T031302			SP	SAND: 5Y7/2 light gray, fine to coarse grained, trace silt, dense, wet (mostly medium sand)	In-Situ Soil
125				0.6			SAND: 5Y7/2 light gray, fine to coarse grained, trace silt, dense, wet (mostly medium sand). No recovery.	
130								
135				0.0		CL	SANDY CLAY: 5Y5/3 pale olive, fine grained, very stiff to hard, moist (becoming more clayey at 135', 6" gray clay lense).	
						SMML	SILT AND SAND: 5Y5/1 gray, fine grained, dense, slightly cohesive, wet	Bentonite
140								
145						ML	SANDY SILT: 5Y5/3 olive, fine grained, trace to little clay, dense, moist (iron oxide staining).	
150							SILT: 5Y5/1 gray, firm, wet.	
155				1.0		SM	SAND: 5Y5/2 olive gray, fine grained, little to some silt, dense, wet	
						SP	SAND: 5Y6/3 pale olive, fine grained, trace to little silt, dense, wet	
160						SM	SAND: 5Y5/3 olive, fine grained, little silt, dense, wet.	
165				1.0		SP	SAND: 5Y7/2 light gray, fine to medium grained, trace to little silt, dense, wet (mostly fine sand). No recovery.	In-Situ Soil
170						SPSM	No recovery. SAND: 5Y6/2 light olive gray, fine to medium grained, little silt, dense, wet (mostly fine sand, trace iron oxide banding).	
175				1.2			SAND: 5Y5/1 gray, fine grained, little medium sand, little silt, dense, wet. No recovery	

Jacobs Engineering Group Inc.
MMR PLUME RESPONSE PROGRAM

95MW0104 Ashumet ETR

Project Name: Ashumet Valley ETR | Location: Pineland Farms
Project Number: 35478407 | Well ID: 95MW0104 | Northing: 2148[illegible].71 | Easting: 857984.14

Depth (ft-bgs)	Sample Interval	Recovery	Sample ID	PID/FID	Gamma Log CPS (20–45–70) / Conductivity mS/m (2–6–10)	USCS CLASS	Lithologic Description and Associated Lithographic Symbol	Well Construction Diagram
175								175
180						ML	CLAYEY SILT: 5Y6/1 gray, trace fine sand, stiff, moist.	Bentonite 180
						SP	SAND: 5Y6/1 gray, fine to medium grained, trace silt, dense, wet.	
185			OT-T03I400 OT-T03I402	1.2			Same as above.	185
190						SW	SAND: 5Y6/1 gray, fine grained, some silt, dense, wet.	In-Situ Soil 190
						SP	SAND: 5Y6/2 light olive gray, fine to medium grained, trace silt, firm, wet.	
195				1.0				195
200						ML	SANDY SILT: 5Y4/1 dark gray, little clay very stiff, moist to wet.	200
							Same as above.	
205				1.1		SP	SAND: 5Y6/1 gray, fine grained, little medium sand, trace to little silt, firm, wet.	205
						ML	SANDY SILT: 5Y3/1 very dark gray, fine to medium sand, stiff, wet.	Bentonite
210						SP	SAND: 5Y5/3 olive, fine to medium grained, trace silt, firm, wet. (mostly medium sand).	210
215				1.0				In-Situ Soil 215
							SAND: 5Y6/1 gray, fine to medium grained, trace silt, firm, wet. (mostly medium sand).	
220			OT-T03I403 OT-T03I404			ML	SANDY SILT: 5Y6/1 dark gray, fine grained, dense, moist.	220
							No recovery	Bentonite
225				1.0		SP	SAND: 5Y5/1 gray, fine to coarse grained, little to some fine to coarse gravel, trace silt, loose, wet.	225
230							SAND: 5Y6/1 gray, fine to medium grained, trace silt.	In-Situ Soil 230
235				1.0		ML	SANDY SILT: 5Y6/1 gray, medium sand, very stiff, moist.	235

Jacobs Engineering Group Inc.
MMR PLUME RESPONSE PROGRAM

95MW0104 Ashumet ETR

Project Name: Ashumet Valley ETR | Location: Pine and Farms
Project Number: 35478407 | Well ID: 95MW0104 | Northing: 214900.71 | Easting: 857984.14

Depth (ft-bgs)	Sample Interval	Recovery	Sample ID	PID/FID	Gamma Log CPS (20–45–70) / Conductivity mS/m (2–6–10)	USCS CLASS	Lithologic Description and Associated Lithographic Symbol	Well Construction Diagram
235						ML	Same as above.	235
						SP	SAND: 5Y6/1 gray, fine to medium grained, trace silt, firm, wet.	
240							SAND: 2.5Y5/6 light olive brown, fine to coarse grained, trace coarse subangular gravel, firm, wet.	240
							No recovery.	
245				1.0		CL	3" clay layer.	245
						SP	SAND: 2.5Y6/4 light yellow brown, fine to coarse grained, some subrounded gravel, firm, wet.	
250				0.0				250
							SAND: 5Y6/4 pale olive, fine to medium grained, trace silt, firm, wet.	
255						SP	SANDY GRAVEL: 2.5Y6/4 light yellow brown, fine to coarse sand, fine to coarse subangular gravel, trace silt, trace cobbles, firm, wet.	255
						CL		
						SP		
						LL	CLAY: gray.	
						SP/SP	SAND: 5Y6/4 pale olive, fine to medium grained, trace silt, firm, wet.	
260				0.0			SAND: 2.5Y6/4 light yellow brown, fine to medium grained, trace silt, firm, wet.	260
							SANDY CLAY: brown.	
							SAND AND GRAVEL: 2.5Y6/4 light yellow brown, fine to coarse grained, subrounded gravel, trace cobble, firm, wet.	
265						SP	No recovery.	265
							SAND: 5Y5/3 olive, fine to medium grained, trace silt, firm, wet.	
270							Same as above.	270
							COBBLE.	
			QT-T03160 QT-T031602				SAND: 5Y5/1 gray, fine to medium grained, trace to little silt, firm to dense, wet.	
275				0.0			(mostly fine sand)	275
							SAND: 5Y5/1 gray, fine to coarse grained, trace silt, trace black coarse gravel at 275', firm, wet.	
						SN	(mostly medium sand)	
280				0.0		SP	SAND: 5Y5/2 olive gray, fine grained, little to some silt, trace medium sand, firm to dense, wet.	280
							SAND: 5Y4/1 dark gray, fine to coarse grained, trace silt, trace fine to coarse subrounded gravel.	
285				2.0		SP	No recovery.	285
							SAND: 5Y6/2 light olive gray, fine to medium grained, trace silt, firm to dense, wet.	
290								290
295				1.2				295

In-Situ Well

Jacobs Engineering Group Inc.

MMR PLUME RESPONSE PROGRAM

95MW0104 Ashumet ETR

Project Name: Ashumet Valley ETR | Location: Pineland Farms

Project Number: 35K78407 | Well ID: 95MW0104 | Northing: 214200.71 | Easting: 857984.14

Depth (ft-bgs)	Sample Interval	Recovery	Sample ID	PID/FID	Gamma Log CPS (20 – 45 – 70) / Conductivity mS/m (2 – 6 – 10)	USCS CLASS	Lithologic Description and Associated Lithographic Symbol	Well Construction Diagram
295						SP		
300							SAND: 5Y5/2 olive gray, fine to coarse grained, trace silt, little fine to coarse subangular gravel, firm, wet.	
							SAND: 5Y6/2 light olive gray, fine to medium grained, trace silt, firm, wet.	
305				1.0		SP	No recovery.	
							SAND: 5Y5/1 gray, fine to medium grained, trace silt, trace fine subangular gravel, firm, wet.	
310				0				
315				1.0				
						GP	GRAVEL: 5Y5/2 olive gray, fine grained, subangular, some medium to coarse sand, trace fine sand and silt, loose, wet.	
						BR	GRANITE: dark green to red, some clay, biotite, quartz nodules.	
320							Bottom of boring.	
325							Notes: 1. Total depth 321.0 feet bgs 2. 2.5 inch SCH 80 PVC riser 3. 2.5 inch SCH 80 PVC screen 0.010 slot size, 5 foot interval. 4. First water encountered ▽ 5. Static water level ▼	
330								
335								
340								
345								
350								
355								

Well Construction Diagram: In-Situ Coil

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