



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 1
5 Post Office Square, Suite 100
Boston, MA 02109-3912

September 24, 2018

Rose H. Forbes, P.E.
Remediation Program Manager
HQ AFCEC/JBCC
322 East Inner Road
Otis ANG Base, MA 02542 5028

Re: Final 5th Five-Year Review 2012-2017
Joint Base Cape Cod (JBCC) Superfund Site, Otis Air National Guard Base, MA

Dear Ms. Forbes:

Thank you for the opportunity to review the *Final 5th Five-Year Review 2012-2017, Joint Base Cape Cod (JBCC) Superfund Site, Otis Air National Guard Base, MA* ("the Report"), dated September 2018. EPA reviewed the report for compliance with the Comprehensive Five-Year Review Guidance (OSWER No. 9355.7-03B-P dated June 2001) and other relevant guidance. The Report establishes protectiveness statements for five source area sites and 16 groundwater plumes where hazardous substances, pollutants or contaminants remain at levels that do not allow for unlimited use and unrestricted exposure.

EPA concurs with the findings that all remedies as implemented or in the process of being implemented by AFCEC are protective of human health and the environment or protective in the short-term.

For sites which do not have a final remedy in place, EPA will be overseeing AFCEC's work to complete the CERCLA investigation and cleanup process. For sites with remedies found to be protective in the short-term, EPA concurs with the recommendations and follow-up actions identified in the Report. This includes several Operable Units (OUs) where supplemental investigations of emerging contaminants, including per- and polyfluoroalkyl substances (PFAS) and 1,4-dioxane are ongoing:

- OU15 - Ashumet Valley,
- OU9 - CS-20,
- OU14 - CS-10,
- OU6 - FS-1, and
- OU16 - LF-1.

Land use controls and/or current land use play a key role in EPA's determination that various OUs are currently protective. Land use controls are needed at many OUs to ensure protectiveness in the long-term. Additional sampling and risk assessment will also be necessary at some OUs.



SEMS Doc ID 100010387

This fifth five-year review was triggered by the first remedial action in October 1993. Consistent with Section 121(c) of CERCLA, the next statutory, required five-year review must be finalized by September 30, 2023.

Sincerely,

A handwritten signature in dark ink, appearing to read 'Bryan Olson', followed by a long horizontal line extending to the right.

Bryan Olson, Director
Office of Site Remediation & Restoration

cc. Ginny Lombardo, EPA
Anni Loughlin, EPA
Robert Lim, EPA
Monica McEaddy, EPA-HQ
Len Pinaud, MassDEP



DEPARTMENT OF THE AIR FORCE
AIR FORCE CIVIL ENGINEER CENTER
INSTALLATION RESTORATION PROGRAM
OTIS AIR NATIONAL GUARD BASE, MA 02542-1320

18 September 2018

AFCEC/JBCC
322 East Inner Road
Otis ANG Base, MA 02542-1320

Mr. Robert Lim
United States Environmental Protection Agency, Region One
5 Post Office Square – Suite 100
Mail Code 0SRR7-3
Boston, MA 02109-3912

Mr. Leonard Pinaud
Massachusetts Department of Environmental Protection, Southeast Region
20 Riverside Drive
Lakeville, MA 02347

Dear Mr. Lim and Mr. Pinaud:

Attached please find the Final 5th Five Year Review, 2012-2017, Joint Base Cape Cod (JBCC) Superfund Site, Otis Air National Guard Base, MA dated September 2018.

If you have any questions, please contact me at (508) 968-4670, extension 5613.

Sincerely,

A handwritten signature in black ink, appearing to read "Rose Forbes", is located below the "Sincerely," text.

ROSE FORBES, P.E.
Remediation Program Manager

c. Darriel Swatts, EPA
Elliot Jacobs, MassDEP
Kendall Walker, MassDEP
Ellie Donovan, MassDEP

Joint Base Cape Cod



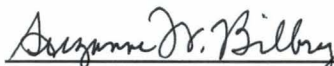
Final 5th Five Year Review, 2012 – 2017 Joint Base Cape Cod (JBCC) Superfund Site Otis Air National Guard Base, MA

September 2018

**Prepared by:
AFCEC/JBCC
Installation Restoration Program
322 East Inner Road
Otis ANGB, MA 02542**

Five-Year Review Report for the Joint Base Cape Cod

Approval signature:



SUZANNE W. BILBREY, P.E., GS-15, DAF
Director, Environmental Management Directorate



Date

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS	xii
EXECUTIVE SUMMARY	ES-1
1.0 INTRODUCTION	1-1
1.1 PURPOSE OF THE REVIEW	1-2
1.2 AUTHORITY FOR CONDUCTING THE FIVE YEAR REVIEW	1-2
1.3 WHO CONDUCTED THE FIVE YEAR REVIEW	1-3
1.4 REVIEW REFERENCE AND TRIGGERING ACTION	1-4
1.5 AREAS/SITES ADDRESSED WITH THIS FIVE YEAR REVIEW	1-4
1.6 ADMINISTRATIVE AND GLOBAL COMPONENTS OF FIVE YEAR REVIEW PROCESS	1-5
1.6.1 Document and Data Review	1-6
1.6.2 Technical Assessments	1-7
1.6.3 Community Involvement	1-8
1.6.4 Summary of Issues, Recommendations, and Follow-up Actions	1-8
1.7 NEXT FIVE YEAR REVIEW	1-9
1.8 REPORT ORGANIZATION	1-9
1.9 REFERENCES	1-10
2.0 JBCC OVERVIEW	2-1
2.1 SITE LOCATION AND DESCRIPTION	2-1
2.2 LAND USE AND SITE HISTORY	2-1
3.0 GLOBAL ISSUES FOR SOURCE AREA AND GROUNDWATER PLUME SITES	3-1
3.1 STATUS OF SOURCE AREA SITES FOR UU/UE CLOSURE	3-1
3.2 VAPOR INTRUSION	3-1
3.3 EMERGING CONTAMINANTS	3-2
3.3.1 1,4-Dioxane	3-2
3.3.2 Per- and Polyfluoroalkyl Substances	3-4
3.4 MILITARY MUNITIONS RESPONSE PROGRAM	3-5
3.5 LAND USE CONTROLS	3-7
3.5.1 Land Use Control Requirement for IRP Source Area Sites	3-7
3.5.2 Land Use Control Requirement for IRP Groundwater Sites	3-8
3.6 GLOBAL ESD FOR THE IRP GROUNDWATER SITES	3-8
3.7 SITE INSPECTIONS	3-11

TABLE OF CONTENTS

3.8 INTERVIEWS.....	3-12
3.9 OVERVIEW OF THE SPEIM/LTM PROGRAM.....	3-13
3.10 SUSTAINABILITY	3-14
3.11 REFERENCES	3-16
4.0 SOURCE AREAS REQUIRING FIVE-YEAR REVIEW	4-1
4.1 CS-10 (UTES/BOMARC DETAILS C AND F).....	4-2
4.1.1 Site Chronology.....	4-2
4.1.2 Background.....	4-3
4.1.3 Remedial Actions	4-7
4.1.4 Progress Since Last Five Year Review	4-12
4.1.5 Five Year Review Process.....	4-13
4.1.6 Technical Assessment	4-14
4.1.7 Issues, Recommendations, and Follow-Up Actions.....	4-16
4.1.8 Protectiveness Determination.....	4-16
4.1.9 References	4-16
4.2 LANDFILL-1 (LF-1) SOURCE AREA	4-20
4.2.1 Site Chronology.....	4-20
4.2.2 Background.....	4-21
4.2.3 Remedial Actions	4-24
4.2.4 Progress Since Last Five Year Review	4-27
4.2.5 Five Year Review Process.....	4-28
4.2.6 Technical Assessment	4-28
4.2.7 Issues, Recommendations, and Follow-Up Actions.....	4-30
4.2.8 Protectiveness Determination.....	4-30
4.2.9 References	4-30
4.3 FIRE TRAINING AREA-2/LANDFILL-2 (FTA-2/LF-2)	4-35
4.3.1 Site Chronology.....	4-35
4.3.2 Background.....	4-37
4.3.3 Remedial Actions	4-39
4.3.4 Progress Since Last Five Year Review	4-41
4.3.5 Five Year Review Process.....	4-42
4.3.6 Technical Assessment	4-43
4.3.7 Issues, Recommendations, and Follow-Up Actions.....	4-44

TABLE OF CONTENTS

4.3.8	Protectiveness Determination	4-44
4.3.9	References	4-45
4.4	LANDFILL-7 (LF-7).....	4-47
4.4.1	Site Chronology.....	4-47
4.4.2	Background.....	4-47
4.4.3	Remedial Actions	4-48
4.4.4	Progress Since Last Five Year Review	4-49
4.4.5	Five Year Review Process.....	4-50
4.4.6	Technical Assessment	4-51
4.4.7	Issues, Recommendations, and Follow-Up Actions.....	4-52
4.4.8	Protectiveness Determination.....	4-53
4.4.9	References	4-53
4.5	PETROLEUM FUELS STORAGE AREA (PFSA)	4-54
4.5.1	Site Chronology.....	4-54
4.5.2	Background.....	4-55
4.5.3	Remedial Actions	4-59
4.5.4	Progress Since Last Five Year Review	4-63
4.5.5	Five Year Review Process.....	4-65
4.5.6	Technical Assessment	4-66
4.5.7	Issues, Recommendations, and Follow-Up Actions.....	4-67
4.5.8	Protectiveness Determination.....	4-67
4.5.9	References	4-68
5.0	GROUNDWATER SITES REQUIRING FIVE YEAR REVIEW	5-1
5.1	ASHUMET VALLEY (AV) GROUNDWATER	5-1
5.1.1	Site Chronology.....	5-1
5.1.2	Background.....	5-4
5.1.3	Remedial Actions	5-12
5.1.4	Progress Since the Last Five Year Review.....	5-16
5.1.5	Five Year Review Process.....	5-18
5.1.6	Technical Assessment	5-19
5.1.7	Issues, Recommendations, and Follow-Up Actions.....	5-22
5.1.8	Protectiveness Determination.....	5-22
5.1.9	References	5-23

TABLE OF CONTENTS

5.2 CHEMICAL SPILL-4 (CS-4) GROUNDWATER	5-30
5.2.1 Site Chronology.....	5-30
5.2.2 Background.....	5-31
5.2.3 Remedial Actions	5-35
5.2.4 Progress Since the Last Five Year Review.....	5-37
5.2.5 Five Year Review Process.....	5-39
5.2.6 Technical Assessment	5-41
5.2.7 Issues, Recommendations, and Follow-Up Actions.....	5-42
5.2.8 Protectiveness Determination.....	5-42
5.2.9 References	5-43
5.3 CHEMICAL SPILL-10 (CS-10) GROUNDWATER	5-47
5.3.1 Site Chronology.....	5-47
5.3.2 Background.....	5-50
5.3.3 Remedial Actions	5-54
5.3.4 Progress Since the Last Five Year Review.....	5-58
5.3.5 Five Year Review Process.....	5-60
5.3.6 Technical Assessment	5-61
5.3.7 Issues, Recommendations, and Follow-Up Actions.....	5-64
5.3.8 Protectiveness Determination.....	5-64
5.3.9 References	5-65
5.4 CHEMICAL SPILL-19 (CS-19) GROUNDWATER	5-70
5.4.1 Site Chronology.....	5-70
5.4.2 Background.....	5-71
5.4.3 Remedial Actions	5-73
5.4.4 Progress Since the Last Five Year Review.....	5-74
5.4.5 Five Year Review Process.....	5-75
5.4.6 Technical Assessment	5-76
5.4.7 Issues, Recommendations, and Follow-Up Actions.....	5-77
5.4.8 Protectiveness Determination.....	5-77
5.4.9 References	5-77
5.5 CHEMICAL SPILL-20 (CS-20) GROUNDWATER	5-81
5.5.1 Site Chronology.....	5-81
5.5.2 Background.....	5-82

TABLE OF CONTENTS

5.5.3 Remedial Actions	5-84
5.5.4 Progress Since the Last Five Year Review.....	5-87
5.5.5 Five Year Review Process.....	5-88
5.5.6 Technical Assessment	5-90
5.5.7 Issues, Recommendations, and Follow-Up Actions.....	5-91
5.5.8 Protectiveness Determination.....	5-91
5.5.9 References	5-92
5.6 CHEMICAL SPILL-21 (CS-21) GROUNDWATER	5-96
5.6.1 Site Chronology.....	5-96
5.6.2 Background.....	5-97
5.6.3 Remedial Actions	5-99
5.6.4 Progress Since the Last Five Year Review.....	5-102
5.6.5 Five Year Review Process.....	5-103
5.6.6 Technical Assessment	5-104
5.6.7 Issues, Recommendations, and Follow-Up Actions.....	5-106
5.6.8 Protectiveness Determination.....	5-106
5.6.9 References	5-106
5.7 CHEMICAL SPILL-23 (CS-23) GROUNDWATER	5-110
5.7.1 Site Chronology.....	5-110
5.7.2 Background.....	5-111
5.7.3 Remedial Actions	5-113
5.7.4 Progress Since the Last Five Year Review.....	5-116
5.7.5 Five Year Review Process.....	5-118
5.7.6 Technical Assessment	5-120
5.7.7 Issues, Recommendations, and Follow-Up Actions.....	5-121
5.7.8 Protectiveness Determination.....	5-121
5.7.9 References	5-121
5.8 FUEL SPILL-1 (FS-1) GROUNDWATER	5-126
5.8.1 Site Chronology.....	5-126
5.8.2 Background.....	5-128
5.8.3 Remedial Actions	5-131
5.8.4 Progress Since the Last Five Year Review.....	5-135
5.8.5 Five Year Review Process.....	5-136

TABLE OF CONTENTS

5.8.6 Technical Assessment	5-137
5.8.7 Issues, Recommendations, and Follow-Up Actions.....	5-140
5.8.8 Protectiveness Determination.....	5-140
5.8.9 References	5-140
5.9 FUEL SPILL-12 (FS-12) GROUNDWATER	5-144
5.9.1 Site Chronology.....	5-144
5.9.2 Background.....	5-145
5.9.3 Remedial Actions	5-147
5.9.4 Progress Since the Last Five Year Review.....	5-150
5.9.5 Five Year Review Process.....	5-152
5.9.6 Technical Assessment	5-153
5.9.7 Issues, Recommendations, and Follow-Up Actions.....	5-154
5.9.8 Protectiveness Determination.....	5-155
5.9.9 References	5-156
5.10 FUEL SPILL-13 (FS-13) GROUNDWATER	5-159
5.10.1 Site Chronology.....	5-159
5.10.2 Background.....	5-160
5.10.3 Remedial Actions	5-161
5.10.4 Progress Since the Last Five Year Review.....	5-163
5.10.5 Five Year Review Process.....	5-164
5.10.6 Technical Assessment	5-165
5.10.7 Issues, Recommendations, and Follow-Up Actions.....	5-167
5.10.8 Protectiveness Determination.....	5-167
5.10.9 References	5-167
5.11 FUEL SPILL-28 (FS-28) GROUNDWATER	5-170
5.11.1 Site Chronology.....	5-170
5.11.2 Background.....	5-171
5.11.3 Remedial Actions	5-174
5.11.4 Progress Since the Last Five Year Review.....	5-178
5.11.5 Five Year Review Process.....	5-179
5.11.6 Technical Assessment	5-180
5.11.7 Issues, Recommendations, and Follow-Up Actions.....	5-182
5.11.8 Protectiveness Determination.....	5-182

TABLE OF CONTENTS

5.11.9 References	5-182
5.12 FUEL SPILL-29 (FS-29) GROUNDWATER	5-186
5.12.1 Site Chronology.....	5-186
5.12.2 Background.....	5-187
5.12.3 Remedial Actions	5-190
5.12.4 Progress Since the Last Five Year Review.....	5-193
5.12.5 Five Year Review Process.....	5-193
5.12.6 Technical Assessment	5-195
5.12.7 Issues, Recommendations, and Follow-Up Actions.....	5-196
5.12.8 Protectiveness Determination.....	5-197
5.12.9 References	5-197
5.13 LANDFILL-1 (LF-1) GROUNDWATER	5-200
5.13.1 Site Chronology.....	5-200
5.13.2 Background.....	5-202
5.13.3 Remedial Actions	5-206
5.13.4 Progress Since the Last Five Year Review.....	5-210
5.13.5 Five Year Review Process.....	5-212
5.13.6 Technical Assessment	5-214
5.13.7 Issues, Recommendations, and Follow-Up Actions.....	5-216
5.13.8 Protectiveness Determination.....	5-216
5.13.9 References	5-216
5.14 STORM DRAIN-5 (SD-5) GROUNDWATER.....	5-222
5.14.1 Site Chronology.....	5-222
5.14.2 Background.....	5-223
5.14.3 Remedial Actions	5-227
5.14.4 Progress Since the Last Five Year Review.....	5-228
5.14.5 Five Year Review Process.....	5-229
5.14.6 Technical Assessment	5-230
5.14.7 Issues, Recommendations, and Follow-Up Actions.....	5-231
5.14.8 Protectiveness Determination.....	5-231
5.14.9 References	5-231
5.15 FIRE TRAINING AREA-2/LANDFILL-2 (FTA-2/LF-2)	5-234
5.15.1 Site Chronology.....	5-234

TABLE OF CONTENTS

5.15.2 Background.....	5-236
5.15.3 Remedial Actions	5-240
5.15.4 Progress Since Last Five Year Review	5-244
5.15.5 Five Year Review Process.....	5-245
5.15.6 Technical Assessment	5-246
5.15.7 Issues, Recommendations, and Follow-Up Actions.....	5-247
5.15.8 Protectiveness Determination.....	5-248
5.15.9 References	5-249
5.16 PETROLEUM FUELS STORAGE AREA (PFSA)	5-252
5.16.1 Site Chronology.....	5-252
5.16.2 Background.....	5-255
5.16.3 Remedial Actions	5-259
5.16.4 Progress Since Last Five Year Review	5-261
5.16.5 Five Year Review Process.....	5-263
5.16.6 Technical Assessment	5-264
5.16.7 Issues, Recommendations, and Follow-Up Actions.....	5-265
5.16.8 Protectiveness Determination.....	5-265
5.16.9 References	5-265

Figures

Figure 1-1	Joint Base Cape Cod, Cape Cod, Massachusetts
Figure 1-2	All JBCC - IRP Site Locations
Figure 1-3	JBCC IRP Groundwater Plumes and Remedial Technology Designation
Figure 1-4	Overview of the Superfund Investigation and Cleanup Process
Figure 4-1	CS-10 Source Area
Figure 4-2	LF-1 Source Area
Figure 4-3	FTA-2/LF-2 Source Area
Figure 4-4	LF-7 Source Area
Figure 4-5	PFSA (FS-10/FS-11) Source Area
Figure 5-1A	Ashumet Valley Groundwater Plume and Treatment Systems
Figure 5-1B	Ashumet Valley Groundwater Plume 2012 and 2017 Comparison
Figure 5-2A	CS-4 Groundwater Plume and Treatment System
Figure 5-2B	CS-4 Groundwater Plume 2012 and 2017 Comparison

TABLE OF CONTENTS

Figure 5-3A	CS-10 Groundwater Plume and Treatment Systems
Figure 5-3B	CS-10 Groundwater Plume 2012 and 2017 Comparison
Figure 5-4	CS-19 Groundwater Plume 2012 and 2017 Comparison
Figure 5-5A	CS-20 Groundwater Plume and Treatment System
Figure 5-5B	CS-20 Groundwater Plume 2012 and 2017 Comparison
Figure 5-6A	CS-21 Groundwater Plume and Treatment System
Figure 5-6B	CS-21 Groundwater Plume 2012 and 2017 Comparison
Figure 5-7A	CS-23 Groundwater Plume and Treatment System
Figure 5-7B	CS-23 Groundwater Plume 2012 and 2017 Comparison
Figure 5-8A	FS-1 Groundwater Plume and Treatment System
Figure 5-8B	FS-1 Groundwater Plume 2012 and 2017 Comparison
Figure 5-9A	FS-12 Groundwater Plume and Treatment System
Figure 5-9B	FS-12 Groundwater Plume 2012 and 2017 Comparison
Figure 5-10	FS-13 Groundwater Plume (2004 Delineation)
Figure 5-11A	FS-28 Groundwater Plume and Treatment System
Figure 5-11B	FS-28 Groundwater Plume 2012 and 2017 Comparison
Figure 5-12A	FS-29 Groundwater Plume and Treatment System
Figure 5-12B	FS-29 Groundwater Plume 2012 and 2017 Comparison
Figure 5-13A	LF-1 Groundwater Plume and Treatment Systems
Figure 5-13B	LF-1 Groundwater Plume 2012 and 2017 Comparison
Figure 5-14	SD-5 Groundwater Plume (2005 Delineation)
Figure 5-15	FTA-2/LF-2 Groundwater Plume 2012 and 2017 Comparison
Figure 5-16	PFSA Groundwater 2012 and 2017 Comparison

Tables

Table 1-1a	IRP Source Area Sites No Longer Requiring a Five Year Review
Table 1-1b	Summary of All IRP Source Area Sites No Longer Requiring a Five Year Review
Table 1-1c	Summary of Future IRP Sites Requiring a Five Year Review
Table 1-2	Decision Summary of Source Area Sites Addressed in this Five Year Review
Table 1-3	Decision Summary of Groundwater Sites Addressed in this Five Year Review
Table 1-4	Issue Description and Recommendations/Follow-up Actions
Table 1-5	Summary of Protectiveness Determinations

TABLE OF CONTENTS

Table 1-6	EPA CERCLIS Operable Unit Number and Document Section
Table 3-1	Summary of Site Inspections

TABLE OF CONTENTS

Appendices

Appendix A	Newspaper Announcement
Appendix B	Source Area Site Inspection Reports
Appendix C	Technical Evaluations in Support of Land Use Control Program (including the MDPH Recreational Use of Water Bodies On or Near JBCC Fact Sheet)
Appendix D	Regulatory Comment Resolution Documentation and Concurrence Letters
Appendix E	Risk Based Calculation Information

ACRONYMS AND ABBREVIATIONS

ABB-ES	ABB Environmental Services, Inc.
AFCEC	Air Force Civil Engineer Center
AFCEE	Air Force Center for Engineering and the Environment
AFFF	aqueous film forming foam
AFOMS/SGPR	Air Force Office of Medical Support
ANG	Air National Guard
AOC	area of concern
ARAR	applicable or relevant and appropriate requirement
ARNG	Army National Guard
ASI	Advanced Sciences Inc.
AST	aboveground storage tank
ATSDR	Agency for Toxic Substances and Disease Registry
AV	Ashumet Valley
AVGAS	aviation gasoline
bgs	below ground surface
BOH	Board of Health
BOMARC	Boeing Michigan Aerospace Research Center
BSVR	biosparge/vapor recovery
BTEX	benzene, toluene, ethylbenzene, xylene
CCl ₄	carbon tetrachloride
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (Superfund)

CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
cfm	cubic feet per minute
CFR	Code of Federal Regulations
CIA	Central Impact Area
CMR	Code of Massachusetts Regulations
COC	contaminant of concern
COPC	contaminant of potential concern
CS	Chemical Spill
CSE	Comprehensive Site Evaluation
CSM	conceptual site model
CWMA	Crane Wildlife Management Area
CWSW	Coonamessett Water Supply Well
CY	Coal Yard
DDT	dichlorodiphenyltrichloroethane
DEQE	Department of Environmental Quality Engineering
DoD	Department of Defense
DPDO	Defense Property Disposal Office
DSRP	Drainage Structure Removal Program
EDB	ethylene dibromide
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Environmental Protection Agency
EPH	extractable petroleum hydrocarbon
ERA	Ecological Risk Assessment

ESD	Explanation of Significant Difference
ETD	extraction, treatment, and discharge
ETI	extraction, treatment, and infiltration
ETR	extraction, treatment, and reinjection
FFA	Federal Facilities Agreement
FIW	Fighter-Interceptor Wing
FS	Fuel Spill
FTA	Fire Training Area
ft	feet/foot
ft ²	square feet/foot
GAC	granular activated carbon
gpm	gallons per minute
GP	Gun Position
GW-1	Groundwater-1
HA	Health Advisory
HATF	Hunter Avenue Treatment Facility
HEC	hazard equivalent concentration
HI	hazard index
HRR	historical records reviews
HRS	Hazard Ranking System
IAGWSP	Impact Area Ground Water Study Program
IP	In-Plume
IRIS	Integrated Risk Information System

IROD	Interim Record of Decision
IRP	Installation Restoration Program
JBCC	Joint Base Cape Cod
JBCCCT	JBCC Cleanup Team
JP-4	Jet Propulsion-4
lbs	pounds
LF	Landfill
LTM	long term monitoring
LUC	Land Use Control
MassDEP	Massachusetts Department of Environmental Protection
MassDPH	Massachusetts Department of Public Health
MC	Munitions Constituents
MCL	Maximum Contaminant Level
MCP	Massachusetts Contingency Plan
MDFW	Massachusetts Division of Fisheries and Wildlife
MEC	munitions and explosives of concern
mg/kg	milligrams per kilogram
MMCL	Massachusetts Maximum Contaminant Level
MMR	Massachusetts Military Reservation
MMRP	Military Munitions Response Program
Mn	manganese
MNA	monitored natural attenuation
MXN	hexahydro-1-nitroso-3,5-dinitro-1,3,5-triazine

MRA	Munitions Response Area
MRS	munitions response sites
MRSPP	Munitions Response Site Prioritization Protocol
msl	mean sea level
MTU	mobile treatment unit
NCL	North-Central lobe
NCP	National Contingency Plan
NDIL	Non-Destructive Inspection Laboratory
NFA	No Further Action
NGB	National Guard Bureau
NL	Northern lobe
NPL	National Priorities List
NWOU	Northwest Operable Unit
O&M	operations and maintenance
OWS	oil/water separator
PA	Preliminary Assessment
PAH	polycyclic aromatic hydrocarbon
PAWS	Phased Array Warning System
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
pCi	picoCuries
PCM	post-closure monitoring
PEST	Parameter Estimation

PFAS	Per- and Polyfluoroalkyl Substances
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane Sulfonic Acid
PFSA	Petroleum Fuels Storage Area
PHA	Provisional Health Advisory
PRA	preliminary risk assessment
PVI	petroleum vapor intrusion
PWS	Public Water Supply
PWSW	Public Water Supply Well
RAL	remedial action level
RAO	Remedial Action Objective
RAR	Remedial Action Report
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RDX	Royal Demolition Explosive or hexahydro-1,3,5-trinitro-1,3,5-triazine
RI	remedial investigation
ROD	Record of Decision
RSL	Regional Screening Level
SD	Storm Drain
SI	site inspection
SITM	Site Inspection Technical Memorandum
SL	Southern lobe
SLR	Summary Letter Report

SPEIM	System Performance and Ecological Impact Monitoring
SRTF	Sandwich Road Treatment Facility
SSI	Supplemental Site Inspection
STCL	soil target cleanup level
STP	sewage treatment plant
SVE	soil vapor extraction
SVOC	semivolatile organic compound
SWOU	Southwest Operable Unit
SWP	shallow wellpoint
TBC	To Be Considered
TCE	trichloroethene
TMB	trimethylbenzene
TPH	total petroleum hydrocarbon
TRET	Technical Review and Evaluation Team
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USAF	U.S. Air Force
USAFSAM/OEC	U.S. Air Force School of Aerospace Medicine
UCRTS	Upper Cape Regional Transfer Station
USCG	U.S. Coast Guard
USGS	U.S. Geological Survey
UST	underground storage tank
UTES	Unit Training Equipment Site
UU/UE	unlimited use and unrestricted exposure

UXO	unexploded ordnance
VC	vinyl chloride
VI	vapor intrusion
VOC	volatile organic compound
VPH	volatile petroleum hydrocarbon
WWII	World War II
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
1,1,1-TCA	1,1,1-trichloroethane
1,1,2,2-TeCA	1,1,2,2-tetrachloroethane
1,1-DCE	1,1-dichloroethene
1,4-DCB	1,4-dichlorobenzene

EXECUTIVE SUMMARY

The U.S. Air Force conducted a Five Year Review of the remedies implemented at the Installation Restoration Program sites at Joint Base Cape Cod, located on western Cape Cod in Barnstable County, Massachusetts. The sites were reviewed because hazardous substances, pollutants, or contaminants remaining at one or more of the sites are above levels that allow for unlimited use and unrestricted exposure. The purpose of the Five Year Review is to determine whether the remedial actions implemented at each site remain protective of human health and the environment. There are two types of five year reviews, statutory and policy, which are explained further in Section 1.2. In total, seven source area sites (Section 4.0) and 18 groundwater plumes/sites (Section 5.0) were assessed in this Five Year Review.

The remedies at six of the seven source area sites [Petroleum Fuel Storage Area (FS-10 and FS-11), Landfill-1, Landfill-2, Fire Training Area-2 and Landfill-7] are considered protective of human health and the environment due to the implemented remedial actions. The remedy for the remaining source area site (Chemical Spill-10) evaluated in this Five Year Review is protective of human health and the environment in the short-term based on current land use.

The remedies at all 18 groundwater sites evaluated in this Five Year Review are considered protective of human health and the environment due to the implemented remedial actions including the full implementation of the land use controls which were completed during this five year review period. The primary actions recommended for the groundwater plumes/sites are related to assessment of contaminants of concern. Decision Documents were not completed for the emerging contaminants during this Five Year Review. However, background information and a brief summary of the investigation work completed at JBCC to date has been included on emerging contaminants as they pertain to the sites required in this Five Year Review for reference. An abbreviated summary of the issues, recommendations, and follow up actions for the source area and groundwater plume sites evaluated in this Five Year Review are included in the Five Year Review Summary Form at the end of this Executive Summary. More detailed summaries of the recommendations and/or follow up actions are included in Table 1-4 and detailed descriptions are included in each of the source area and plume specific narratives in Sections 4.0 and 5.0. A summary of the protectiveness determinations for the source area sites and groundwater plumes is included in Table 1-5.

The triggering action for the statutory Five Year Review process for Joint Base Cape Cod began with the initiation of the remedial action on-site construction date of the Chemical Spill-4 treatment system on October 15, 1992. As a result of this triggering action, the first Five Year Review, covering the period 1992-1997, was published in March 1999. Subsequently, the second, third, and fourth Five Year Reviews, covering the periods 1997-2002, 2002-2007, and 2007-2012 were published in May 2003, September 2008, and September 2013, respectively. This is the fifth Five Year Review for the Joint Base Cape Cod Site and covers the period from 01 October 2012 through 30 September 2017.

Prior to the selection of a remedy, remedial investigations were conducted. Based on the results of these investigations, remedial action objectives were presented for each Installation Restoration Program site. These objectives were then used to select the remedial actions for the site that are detailed in site-specific decision documents. During the Five Year Review, the selected action is reviewed for its continued ability to achieve its goal of protection of human health and the environment, implementation, and system operation and maintenance (if applicable).

Data and information collected since the last Five Year Review were reviewed against the remedial action objectives for each site, trends in contaminant concentrations, changes in contaminant distribution, remedial system performance at sites with active treatment, land use, and status and performance of institutional controls.

Also, the data and information reviewed for the Five Year Review are collected under the System Performance and Ecological Impact Monitoring program and are continually assessed by a team of on-site professional staff. The results of these assessments are presented to the regulatory agencies during Technical Update meetings and then through technical memoranda, Summary Letter Reports or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues. There are no new data being introduced in this Five Year Review, the data reviewed have already been presented to the regulators and is being used here to ensure the protectiveness of the remedy selected.

FIVE YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Joint Base Cape Cod		
EPA ID: MA2570024487		
Region: 1	State: MA	City/County: Barnstable County
SITE STATUS		
NPL Status: Final		
Multiple OUs? Yes	Has the site achieved construction completion? Yes, for current COCs (not including emerging contaminants).	
REVIEW STATUS		
Lead agency: Other Federal Agency If "Other Federal Agency" was selected above, enter Agency name: U.S. Air Force		
Author name: Various – Refer to Section 1.3		
Author affiliation: Northwind – Portage and AFCEC/JBCC		
Review period: 01 October 2012 – 30 September 2017		
Date of site inspection: 14 June 2017		
Type of review: Statutory		
Review number: 5		
Triggering action date: 30 September 2013 (submittal date of Fourth Five Year Review)		
Due date (<i>five years after triggering action date</i>): 30 September 2018		
Issues/Recommendations		
OU(s) without Issues/Recommendations Identified in the Five-Year Review:		
Source Area Sites: PFSA (FS-10 and FS-11), FTA-2/LF-2, LF-1, LF-7; Groundwater Sites: CS-19, CS-21, CS-23, FS-12, FS-13, FS-29, SD-5, PFSA, FTA-2/LF-2		
Issues and Recommendations Identified in the Five-Year Review:		
See Table 1-4 for a detailed summary by site.		

FIVE YEAR REVIEW SUMMARY FORM

Protectiveness Determination(s)

See Table 1-5 for Protectiveness Determinations by site.

Site wide Protectiveness Determination (if applicable)

For sites that have achieved construction completion, enter a site wide protectiveness determination and statement.

<i>Protectiveness Determination:</i> Protective/Short-term	<i>Addendum Due Date (if applicable):</i> Not applicable
---	---

Protectiveness Determination:

Site wide, the remedies are either protective or short-term protective – see Table 1-5 for a summary by site.

Key:

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980

COC = Contaminant of Concern

CS = Chemical Spill

FS = Fuel Spill

FTA = Fire Training Area

LF = Landfill

LUC = Land Use Control

PFSA = Petroleum Fuel Storage Area

SD = Storm Drain

UU/UE = unlimited use/unrestricted exposure

VI = vapor intrusion

1.0 INTRODUCTION

The U.S. Air Force (USAF) conducted a Five Year Review of the remedies implemented at Installation Restoration Program (IRP) sites at the Joint Base Cape Cod (JBCC) Superfund Site, located on western Cape Cod in Barnstable County, Massachusetts, approximately 60 miles south of Boston and immediately south of the Cape Cod Canal (Figure 1-1). The sites were reviewed because hazardous substances, pollutants, or contaminants remaining at one or more of the sites are above levels that allow for unlimited use and unrestricted exposure (UU/UE). The general locations of the IRP sites are shown in Figure 1-2.

Since 1990, the USAF IRP has managed the characterization and remediation of the contamination at the JBCC with the exception of the areas managed by the Impact Area Groundwater Study Program at Camp Edwards. The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) number for the JBCC site is MA2570024487. The JBCC (then known as Massachusetts Military Reservation), was formally added to the National Priorities List (NPL) in 1989. A Federal Facilities Agreement (FFA), which provided the legal framework for investigating and remediating numerous operable units at the JBCC, was signed in 1991 (EPA et al. 1991). In 1996, the FFA was amended to add the USAF as the lead agency for the cleanup at JBCC (EPA et al. 2002). The FFA, as amended, requires the USAF to implement Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements at JBCC. In addition to the USAF, the U.S. Environmental Protection Agency (EPA) and National Guard Bureau (NGB) are parties to the FFA for the JBCC. The Air Force Civil Engineer Center (AFCEC)¹ is managing the soil and groundwater contamination sites under the IRP and Military Munitions Response Program (MMRP) in accordance with CERCLA as required by the Defense Environmental Restoration Program. The Massachusetts Department of Environmental Protection (MassDEP) is not a signatory of the FFA, but is an active participant in the cleanup process and provides

¹In October 2012, the Air Force Center for Engineering and the Environment (AFCEE) adopted a new organizational name, the Air Force Civil Engineer Center (AFCEC). Therefore, the AFCEE and AFCEC acronyms refer to the same entity, but are used in this document in relation to the date of the specific topic/document.

guidance and direction to the process. The USAF and EPA have jointly selected the remedies for these sites. The MassDEP has concurred with the selected remedies (AFCEE 2011, AFCEC 2013).

1.1 PURPOSE OF THE REVIEW

The purpose of the Five Year Review is to evaluate the implementation and performance of a site cleanup remedy in order to determine if the remedy is or will be protective of human health and the environment. There are two types of five year reviews, statutory and policy, which are explained further in Section 1.2. The EPA guidance for Five Year Reviews (EPA 2001) requires each site be evaluated and three questions answered regarding the protectiveness of the cleanup actions that have occurred or are occurring at the Site. These three questions are:

- A. Is the remedy functioning as intended by the decision documents?
- B. Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy still valid?
- C. Has any other information come to light that could call in to question the protectiveness of the remedy?

For the purposes of this Five Year Review, the word “Site” (capital “S”) refers to the collection of all the individual source areas and groundwater sites at the JBCC that are being cleaned up pursuant to the FFA for the JBCC Superfund Site, signed July 17, 1991 and its amendments under the IRP (EPA et al 1991, 2002).

Each individual site was evaluated following the EPA Five Year Review guidance (EPA 2001). The methods, findings, and conclusions of the reviews are documented within this Five Year Review report. In addition, this Five Year Review report identified certain issues found during the review and identified specific recommendations to address them.

1.2 AUTHORITY FOR CONDUCTING THE FIVE YEAR REVIEW

The USAF is the designated lead agency for this Five Year Review. This Five Year Review report was prepared pursuant to CERCLA of 1980 (Superfund) §121 and the National

Contingency Plan (NCP). CERCLA §121 states:

If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the Site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such Site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.

EPA interpreted this requirement further. In the NCP, 40 Code of Regulations (CFR) §300.430(f)(4)(ii) states:

If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the Site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.

In addition to these statutory categories of Five Year Review, section 1.2.1 of EPA's guidance also provides for policy-based Five Year Reviews:

Five-year reviews generally should be conducted as a matter of policy for following types of actions:

- *A . . . remedial action that, upon completion, will not leave hazardous substances, pollutants, or contaminants on site above levels that allow for unlimited use and unrestricted exposure, but requires five years or more to complete . . . ;*
- *A removal-only site on the NPL where a removal action leaves hazardous substances, pollutants, or contaminants on site above levels that allow for unlimited use and unrestricted exposure and where no remedial action has or will take place.*

1.3 WHO CONDUCTED THE FIVE YEAR REVIEW

Northwind - Portage was retained by the USAF to conduct the Five Year Review under AFCEC contract FA890317F0405, Task Order 0028. This review was conducted from 01 October 2012 through 30 September 2017 for the JBCC IRP Superfund Site located on Cape Cod, Massachusetts.

The Five Year Review team included Ms. Kimberly Gill (Northwind –Portage project scientist), Ms. Rose Forbes (AFCEC JBCC Remedial Program Manager), and Mr. Doug Karson (AFCEC Community Involvement Lead). Input also was provided by base contractors, the EPA, and the MassDEP.

1.4 REVIEW REFERENCE AND TRIGGERING ACTION

This is the fifth Five Year Review for the JBCC IRP Superfund Site, covering the period from 01 October 2012 through 30 September 2017. The triggering action for the statutory review process for JBCC began with the initiation of the remedial action on-site construction date of the Chemical Spill-4 (CS-4) treatment system on October 15, 1992. As a result of this triggering action, the first Five Year Review, covering the period 1992-1997 (AFCEE 1999), was published in March 1999. Subsequently, the second, third and fourth Five Year Reviews, covering the periods 1997-2002 (AFCEE 2003), 2002-2007 (AFCEE 2008) and 2007-2012 (AFCEC 2013) were published in May 2003, September 2008 and September 2013, respectively.

1.5 AREAS/SITES ADDRESSED WITH THIS FIVE YEAR REVIEW

JBCC IRP sites have been divided into three general categories. The three categories of sites are as follows:

- IRP Sites Not Requiring a Five Year Review during 2012 and 2017: Table 1-1a is a comprehensive list of the JBCC IRP sites that have been closed and includes the rationale for why each of these sites no longer needs to be included in the Five Year Review process; further details are provided in Section 3.1. Table 1-1b contains a listing of all sites that have been closed without restriction as documented in this and prior Five-Year Reviews. Table 1-1c contains a list of emerging contaminant and MMRP sites, which have not yet progressed to the ROD and therefore were not addressed during this Five Year Review. The sites not requiring a Five Year Review (74 in total) are identified on Figure 1-2 by the green shaded areas.

- **IRP Source Area Sites Requiring a Five Year Review:** These sites require a Five Year Review because they are under investigation, remedial action has not been completed; or the site has restricted use. Section 4.0 presents JBCC IRP source area sites that require a Five Year Review. The source area sites are identified on Figure 1-2 by the orange shaded areas. Table 1-2 lists the Source Area IRP sites that are addressed in this Five Year Review. Summaries of the decision status for each of these sites are also presented in Table 1-2.
- **IRP Groundwater Sites Requiring a Five Year Review:** These sites require a Five Year Review because they are under Remedial Action - Operation status. The 18 JBCC IRP groundwater sites that require a Five Year Review are presented in Section 5.0 and shown on Figure 1-2 and Figure 1-3. Table 1-3 lists the Groundwater IRP sites that are addressed in this Five Year Review. Summaries of the decision status for each of these sites are also presented in Table 1-3.

1.6 ADMINISTRATIVE AND GLOBAL COMPONENTS OF FIVE YEAR REVIEW PROCESS

According to the EPA guidance, the Five Year Review must, for each Site:

- *describe the Site's chronology and background,*
- *summarize the remedial actions that have taken place at the Site,*
- *describe the progress in the CERCLA cleanup process that has taken place at the Site since the last review (if applicable),*
- *outline the actual five-year review process conducted on the Site,*
- *do a technical assessment of the Site,*
- *describe any issues arising from the review process,*
- *make recommendations and follow-up actions needed at the Site, and*
- *provide a statement of protectiveness for the Site.*

Under EPA policy, if cleanup at a site is deferred to a corrective action order under another statute (such as the Resource Conservation and Recovery Act [RCRA] or the Safe Drinking Water Act), it is not necessary to conduct a Five Year Review. Therefore, the contaminated sites at JBCC that are being cleaned up by the JBCC Impact Area Ground Water Study Program (IAGWSP), pursuant to the EPA Region 1 Administrative Order, under the authority of the Safe Drinking Water Act, are not included in this report. It should be noted, however, that a separate Five Year Review was conducted by the IAGWSP for their sites.

This Five Year Review report covers multiple remedies and operable units in the JBCC cleanup program. Regardless of whether operable units or areas of concern are active or inactive, each JBCC IRP site was evaluated according to the EPA guidance for Five Year Reviews. The status and progress of each site in the CERCLA cleanup process was considered in each evaluation. Figure 1-4 is a flow diagram that shows how this process works. The primary focus of this document is the technical assessment and any subsequent issues and required follow-up actions that relate to the continued protectiveness of the cleanup actions associated with each site subject to this Five Year Review. The following subsections are major components of the Five Year Review.

1.6.1 Document and Data Review

This Five Year Review consisted of a review of relevant documents including operations and maintenance (O&M) records and manuals, health and safety plans, sampling and analysis plans, monitoring data and monitoring reports, applicable cleanup standards, and decision documents.

A summary of information about each site has been provided for background purposes in Sections 4.0 (source areas) and 5.0 (groundwater). Each site's history is outlined, explaining what occurred at the site and how it became contaminated, if this information is known. In addition, the specific actions that were taken at each site, from investigation through cleanup, are also summarized.

References are provided to all documents supporting the history, investigations, and cleanup decisions for each site. Individual reports are located in the official Administrative Record of the JBCC IRP Superfund Site. This record is physically maintained at the JBCC IRP Offices, located in Building 322 on Otis Air National Guard (ANG) Base, Massachusetts. In addition, the public libraries in the four towns surrounding JBCC can help locate and obtain copies of specific documents using their on-line reference systems. Finally, an electronic copy of the index of the JBCC IRP Administrative Record documents is maintained at the Bourne Public Library.

1.6.2 Technical Assessments

Technical assessments were made of every site requiring a Five Year Review to determine the current level of protectiveness of the cleanup actions that have occurred or are occurring at each site. The three questions listed in Section 1.1 guided these technical reviews.

For sites where a remedy is still functioning, Question A requires an assessment of whether the remedy is still functioning as intended by the decision documents. This assessment was done by examining the histories of the groundwater treatment system summary letter reports, the source area project notes (as applicable), and the status of any institutional control procedures required by the decision documents.

Question B requires that the assumptions and criteria used when the decisions were made to do the remedial actions and to eventually close the sites be reexamined using today's standards. Question C requires the Remedial Program Manager to examine any other information that may have come to light regarding the protectiveness of the selected remedy and the decision to close the site. These two questions apply to all sites that do not meet UU/UE conditions.

In doing these technical assessments, all the cleanup levels that were factored in the decisions for these sites were checked against current cleanup levels to make sure that a more conservative remedial action objective cleanup standard would not now be required. If a Maximum Contaminant Level (MCL) that was used in an on-going or completed cleanup action has now become more restrictive, then the affected decision would potentially have to be reevaluated using today's standards and adjustments to the cleanup process for that site would have to be made.

The technical assessments used information gathered during the routine surveillance of JBCC source areas and groundwater sites over the reporting period, as well as inputs from the community via the JBCC Cleanup Team (JBCCCT), to determine if conditions along the exposure pathways and at the receptors, for example, had changed at any of the sites. Examples of typical situations that would drive a reassessment of the remedy's

effectiveness and protectiveness would be a detection of a contaminant of concern (COC) above standards outside established Land Use Controls (LUC) area or a change in land and/or resource use in the vicinity of a source area or groundwater plume. Again, the visibility of the JBCC IRP activities assures these kinds of changes are routinely identified and their consequences considered.

The public plays a vital role in the oversight of the JBCC IRP. Information from the community regarding these sites, or potential new sites, was evaluated and considered in the technical assessments.

1.6.3 Community Involvement

Public notices for this Five Year Review were published in the local newspapers listed below on the dates specified:

Bourne Enterprise (22 June 2018), and
Falmouth/Mashpee/Sandwich Enterprises (22 June 2018).

These notices announced the start of the Five Year Review process and specified that updates on the Five Year Review would be given at future meetings with the JBCCCT which are open to the public. The notice also indicated the expected schedule for completion of the Five Year Review and stated that the final report would be available in the main libraries of the four towns that surround the JBCC. Finally, contact information for the AFCEC Community Involvement Lead was provided. A copy of this announcement is provided in Appendix A.

On 07 February 2018, Ms. Rose Forbes presented an overview and schedule for the Five Year Review process to the JBCCCT. In addition, AFCEC plans to prepare a fact sheet summarizing the findings of this Five Year Review for submittal in September 2018.

1.6.4 Summary of Issues, Recommendations, and Follow-up Actions

During the process of the Five Year Review, some specific issues were identified at certain sites. Although none of these issues put the overall short-term protectiveness of any of the remedies in jeopardy, these issues are important to long-term protectiveness and provide thorough documentation of site decisions and conditions. As a result, recommendations and follow-up actions were made as part of this review and are summarized in Table 1-4. A summary of the protectiveness determinations for each of the sites subject to this Five Year Review is included in Table 1-5. Although none of the issues identified in Table 1-4 adversely affect the status of the short-term protectiveness of any of the sites, the resulting recommendations will be tracked through the regular activities of the JBCC IRP stakeholder groups, which include community advisors and regulators.

1.7 NEXT FIVE YEAR REVIEW

The next Five Year Review for the JBCC IRP Superfund Site is required by September 2023, five years from the date of the final previous Five Year Review document and will cover the period 01 October 2017 through 30 September 2022.

1.8 REPORT ORGANIZATION

Section 1.0 provides an introduction to this Five Year Review and Section 2.0 provides an overview of the JBCC that is subject to this Five Year Review. Section 3.0 presents a summary of the JBCC IRP sites that have met UU/UE requirements since the last Five Year Review and presents an overview of global issues or activities that are common to all of the IRP source area and/or groundwater sites addressed in this Five Year Review. Sections 4.0 and 5.0 provide the Five Year Review assessment findings including answering the three protectiveness questions and providing the protectiveness determination for the IRP source areas, and groundwater plumes, respectively. A matrix that cross references the EPA CERCLIS Operable Unit Numbers to the IRP site names and document section is provided in Table 1-6. Appendix A includes a copy of newspaper announcement of the commencement of JBCC IRP Five Year Review Process; Appendix B includes site inspection (SI) reports; Appendix C includes technical evaluations for select

private wells assessed under the Land Use Control (LUC) program as part of this Five Year Review; and Appendix D includes documentation on regulator comment resolution and concurrence letters. Appendix E includes information supporting updated risk based concentration calculations.

1.9 REFERENCES

- Air Force Civil Engineer Center (AFCEC). 2013 (October). *Final 4th Five-Year Review, 2007-2012 Massachusetts Military Reservation (MMR) Superfund Site, Otis Air National Guard Base, MA.* 473147-SPEIM-MUTLIPLERPT-001. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis ANG Base, MA.
- Air Force Center for Engineering and the Environment (AFCEE). 2011 (September). *Final Explanation of Significant Differences for the Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation.* 389849-SPEIM-Multiple-RPT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2008 (September). *Final 3rd Five-Year Review, 2002-2007 Massachusetts Military Reservation (JBCC) Superfund Site, Otis Air National Guard Base, MA.* Prepared by Engineering Strategies Corporation, Portage and CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2003 (May). *Final 2nd Five-Year Review, 1998-2002 Massachusetts Military Reservation (JBCC) Superfund Site, Otis Air National Guard Base, MA.* Prepared by AFCEE/JBCC and Portage Environmental, Inc. for AFCEE/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 1999 (March). *Five-Year Review Report Massachusetts Military Reservation Installation Restoration Program.* Prepared by Waste Policy Institute Air Force Center for Environmental Excellence, Installation Restoration Program, Otis ANG Base, MA.
- EPA. 2001 (June). Comprehensive Five-Year Review Guidance, EPA 540R-01-007.
- EPA Region I and the United States Department of Defense, National Guard Bureau. 2002 (June). *Federal Facility Agreement (FFA) Under CERCLA § 120 and RCRA § 7003 for the Massachusetts Military Reservation as amended.*
- EPA Region I and the United States Department of Defense, National Guard Bureau. 1991 (and subsequently amended). *Federal Facility Agreement Under CERCLA § 120 and RCRA § 7003* In the matter of: The U.S. Department of Defense, National Guard Bureau, Massachusetts Military Reservation, Cape Cod, MA.

2.0 JBCC OVERVIEW

2.1 SITE LOCATION AND DESCRIPTION

The JBCC IRP Superfund Site is located on western Cape Cod in Barnstable County, Massachusetts, approximately 60 miles south of Boston and immediately southeast of the Cape Cod Canal. The JBCC occupies approximately 22,000 acres within the towns of Bourne, Falmouth, Mashpee, and Sandwich. The JBCC is organized into four principal functional areas:

Range Maneuver and Impact Area. This area consists of approximately 15,000 acres occupying the northern 70 percent of JBCC and is used for training and maneuvers as part of the Army National Guard's (ARNG) Camp Edwards.

Cantonment Area. This area consists of approximately 7,000 acres in the southern portion of JBCC and is the location for all or part of the administrative, operational, maintenance, housing, and support facilities and the flightline for Otis ANG Base, U.S. Coast Guard (USCG) Air Station Cape Cod, and Camp Edwards.

Massachusetts National Cemetery. This area consists of approximately 750 acres along the western edge of JBCC and contains the Veterans Affairs cemetery and support facilities.

Cape Cod Air Force Station. This area occupies 100 acres of the northern portion of the Range Maneuver and Impact Area and consists of the USAF fixed base phased array warning system known as PAVE Phased Array Warning System (PAWS).

Upper Cape Water Supply Reserve. The Upper Cape Water Supply Reserve is co-located with the Camp Edwards Range Maneuver and Impact Area and is public conservation land dedicated to water supply and wildlife habitat protection; the development and construction of public water supply systems, and the use and training of the military forces of the commonwealth, provided that such military use and training is compatible with the natural resource purposes of water supply and wildlife habitat protection.

2.2 LAND USE AND SITE HISTORY

Military use of portions of JBCC began as early as 1911. From 1911 to 1935, the Massachusetts National Guard periodically camped to conduct maneuvers and weapons training in portions of the Shawme Crowell State Forest. In 1935, the Commonwealth of Massachusetts purchased the area now occupied by JBCC for permanent training facilities.

Most of the activity at JBCC has occurred since 1935, including operations by the U.S. Army, the U.S. Navy, USCG, USAF, Massachusetts ARNG, Massachusetts ANG, and the Veterans Affairs.

In general, two different types of operations have dominated military activity at JBCC: (1) mechanized army training, maneuvers, and maintenance support (Camp Edwards) and (2) military aircraft operations, maintenance, and support [Otis Army Air Field/Air Force Base/Coast Guard Air Station]. The level of activity has varied over the JBCC operational history. The most intensive U.S. Army activity occurred during World War II (WWII) (1940-1944) and during demobilization following the war. During the last two years of WWII, the U.S. Navy used the JBCC runways, flightline, and housing areas for advanced naval aviation carrier-based flight training.

The most intensive air craft operations occurred from 1955 to 1970, when large numbers of surveillance and air defense aircraft operated from JBCC. Then, the USAF operated 45 EC-121 (Super Constellation) Airborne Early Warning and Control aircraft and a Fighter-Interceptor Wing (FIW) from JBCC.

A major military hospital was in operation at JBCC from WWII to 1970. Immediately following WWII, the hospital was a major orthopedic rehabilitation center. In the early 1970s, the hospital was decommissioned and demolished.

The intensive periods of activity occurred under separate organizational control and were staged in two separate portions of the Cantonment Area. The WWII period of activity (1940-1944) occurred under U.S. Army control when JBCC had been federalized and was known as Camp Edwards. Large-scale motor pool activities and troop billeting occurred in the center of the Cantonment Area. These operations were carried out in units surrounding a central parade ground, as bounded on four sides by West, South, East, and North Inner Roads. During WWII, air operations at Otis Army Airfield were reportedly of a relatively low level of intensity. The most intensive aircraft operations occurred along the expanded flightline areas located in the southeastern portion of the Cantonment Area, under USAF control (1941-1945). From 1960 to 1973, a Boeing Michigan Aeronautical

Research Center (BOMARC) air defense missile installation was located at the JBCC (see Section 4.1 for more details). During the 1970s, the Strategic Air Command also used the runways at JBCC to park refueling aircraft.

In 1970, the airborne surveillance activity was phased out. The air defense mission was carried on by the USAF until 1973, when this mission, as well as management of the base, was transferred to the 102nd FIW of the Massachusetts ANG. In March 1992, the 102nd was redesignated the 102nd Fighter Wing; and in April 2008, under Base Realignment and Closure initiatives, was redesignated the 102nd Intelligence Wing. The mission of the 102nd was also revised to provide world-wide precision intelligence, and command and control along with trained and experienced Airmen for expeditionary combat support and homeland security.

Other major operations have been ongoing at JBCC. The ARNG and U.S. Army Reserve training has been carried out at variable levels since the early 1950s. The USCG began operations at Air Station Cape Cod at JBCC in 1970. Since 1978, the USAF has operated the PAVE PAWS missile and space vehicle tracking system from Cape Cod Air Force Station, located at the northern end of JBCC, and in 1978, the Veterans Affairs acquired 750 acres in the western portion of JBCC to develop the Massachusetts National Cemetery, which began operations in 1980. There are five major organizations now using JBCC. They are the Massachusetts ARNG, operating Camp Edwards; the ANG/Massachusetts ANG, operating Otis ANGB; the USAF, operating Cape Cod Air Force Station; the USCG, operating Air Station Cape Cod; and the Veterans Affairs, operating the Massachusetts National Cemetery.

Activities at JBCC that had the potential for contaminating the environment included the storage, handling, and disposal of solvents and petroleum fuels as well as the leakage of these materials into storm water drainage systems and the sanitary sewer system. Landfill operations, firefighter training, coal and ash storage, sewage treatment, and numerous chemical and fuel spills have also resulted in environmental contamination of both soil and groundwater.

The Upper Cape Water Supply Reserve was established by Chapter 47 of the Acts of 2002 as public conservation land dedicated to three primary purposes: water supply and wildlife habitat protection; the development and construction of public water supply systems, and, the use and training of the military forces of the commonwealth; provided that, such military use and training is compatible with the natural resource purposes of water supply and wildlife habitat protection. It is co-located with Camp Edwards' 15,000-acre northern training area. Cape Cod Air Force Station and US Coast Guard Communications Station Boston are both located within the boundary of the Upper Cape Water Supply Reserve.

3.0 GLOBAL ISSUES FOR SOURCE AREA AND GROUNDWATER PLUME SITES

3.1 STATUS OF SOURCE AREA SITES FOR UU/UE CLOSURE

The fourth Five Year Review included a listing of 37 source area sites that were no longer subject to Five Year Reviews (AFCEC 2013a). Four separate technical memoranda (AFCEC 2016a, c, d, 2014c) were prepared to examine the existing data and present newer data where applicable to determine whether these source area sites met UU/UE. The UU/UE criterion were met, and those sites are no longer subject to future Five Year Reviews (Table 1-1b). Source area sites that did not qualify for UU/UE are included in this Five Year Review (Table 1-2 and Section 4.0).

3.2 VAPOR INTRUSION

The VI exposure pathway has been considered in the past in some of the risk assessments prepared for the IRP sites during the RI/Feasibility Study phase of the CERCLA process. However, the third JBCC IRP Five Year Review (AFCEE 2008a) contained a recommendation to complete a more comprehensive and consistent VI evaluation for the various IRP groundwater plumes due to the more recent increased regulatory focus on the VI exposure pathway and the advances in the science of VI.

In response to this recommendation, the potential for VI was assessed (or re-assessed if a prior assessment was completed during the RI) for each of the 18 IRP groundwater sites (evaluated in Section 5.0) and at the Petroleum Fuel Storage Area (PFSA) and Fire Training Area (FTA-2)/Landfill-2 (LF-2) source area sites where residual petroleum-related soil and groundwater contamination remains (see Sections 4.4. and 4.6). The VI assessment process initially involves determining whether there is a potentially complete VI exposure pathway associated with each groundwater or soil site where volatile contaminants remain. If a potentially complete VI exposure pathway is identified, a preliminary screening step is completed. The results of this screening step were used to determine if further investigation is necessary to evaluate whether VI risk above target levels is likely or unlikely. The results of the VI evaluation are detailed in the *Final 2011 JBCC Vapor Intrusion Evaluation*

Technical Memorandum (AFCEE 2012) and are also summarized in each of the applicable Five Year Review subsections that cover the sites included in the VI assessment. The VI assessment completed for the IRP sites referred to above meets the requirements presented in the EPA Five Year Review supplemental guidance *Assessing Protectiveness at Sites for Vapor Intrusion* (EPA 2012a). In addition, the remaining source area sites that are subject to this Five Year Review (CS-10 Details C and F, PFSA, FTA-2/LF-2, LF-1, and LF-7) were assessed following the VI pathway evaluation process presented in the 2012 VI technical memorandum. The results of this VI pathway screening including recommendations for further evaluation at two source area sites (CS-10 and PFSA) following updated VI screening guidance that is focused on petroleum release sites are included in each of the corresponding source area discussions in section 4.0. The results for this evaluation can also be found in the *Final CS-10 Source Area Details C and F Vapor Intrusion Evaluation Project Note* (AFCEC 2014d) and the *Final 2014 PFSA Source Area Vapor Intrusion Evaluation* (AFCEC 2015d).

3.3 EMERGING CONTAMINANTS

The initial recommendation for investigation of the emerging contaminants 1,4-dioxane and per- and polyfluoroalkyl substances (PFAS) was presented in the Final 4th Five-Year Review, 2007-2012, Massachusetts Military Reservation (MMR) Superfund Site Otis Air National Guard Base, MA (AFCEC 2013a). The following sections provide background information on these emerging contaminants and a brief summary of the investigation work completed at JBCC to date.

3.3.1 1,4-Dioxane

The primary industrial use of 1,4-dioxane was to stabilize solvents, particularly 1,1,1-trichloroethane (TCA), which is less chemically stable than other common solvents such as tetrachloroethylene (PCE) and trichloroethylene (TCE). Therefore, 1,4-dioxane is commonly associated with 1,1,1-TCA, or its breakdown product 1,1-dichloroethene (1,1-DCE). 1,4-Dioxane has also been used in printing and textiles (e.g., polyester); household cleaners and detergents; cosmetics; paints, varnishes, and paint remover; industrial

processing of fats and oils; pharmaceuticals; and the chemical industry. 1,4-Dioxane is soluble and mobile in groundwater and biologically persistent in the environment and is not readily adsorbed or treated by GAC. There is no MCL or Massachusetts MCL (MMCL) for 1,4-dioxane in drinking water, but there is a EPA lifetime drinking water health advisory of 0.2 milligrams per liter (mg/L) for drinking water exposure (U.S. EPA 2016), a MassDEP MCP Method 1 Groundwater-1 (GW-1) standard of 0.3 micrograms per liter (µg/L) (MassDEP 2014). A presence/absence (CERCLA SI equivalent) field investigation for 1,4-dioxane was completed between October 2013 and June 2014 at seven IRP chlorinated solvent plumes (Ashumet Valley, CS-4, CS-10, CS-20, CS-21, CS-23, and LF-1). Sampling for 1,4-dioxane was completed at the treatment plant influent and effluent ports, operating extraction wells, selected monitoring wells, selected private wells, and selected public water supply (PWS) wells. The results of this investigation confirmed that 1,4-dioxane was present at four plumes (Ashumet Valley, CS-10, CS-20 and LF-1) and additional investigation was recommended (AFCEC 2014b,c).

For more information, the following technical deliverables were prepared to present the results of 1,4-dioxane investigations to date at JBCC:

- *1,4-Dioxane Monitoring Well Sample Results Data Presentation Project Note.* (AFCEC 2014b)
- *1,4-Dioxane Extraction Well, LUC, and PWS Sample Results and Monitoring Well Sampling Plan Data Presentation Project Note* (AFCEC 2014c)
- *Final Supplemental Remedial Investigation/Feasibility Study Work Plan for 1,4-Dioxane at Chemical Spill-10, Chemical Spill-20, and Landfill-1* (AFCEC 2016b)
- *Final Supplemental Remedial Investigation/Feasibility Study Work Plan for 1,4-Dioxane and Perfluorinated Compounds at Ashumet Valley* (AFCEC 2016e)
- *Final Supplemental Remedial Investigation Report for 1,4-Dioxane at Chemical Spill-10* (AFCEC 2017c)
- *Final Supplemental Remedial Investigation for 1,4-Dioxane and Perfluorinated Compounds at Landfill-1, Joint Base Cape Cod, MA.* (AFCEC 2018d)

3.3.2 Per- and Polyfluoroalkyl Substances

PFAS are found in aqueous film-forming foam (AFFF), a firefighting foam used in fire training exercises, suppressing aircraft and other vehicle fires, and in aircraft hangar fire suppression systems since 1970. PFAS are also used extensively in household and industrial products, clothing, and food wrappers. PFAS are soluble and mobile in groundwater and are chemically and biologically persistent in the environment and some PFAS can be treated by GAC with varying effectiveness. There are no MCLs or MMCLs for PFAS. In May 2016, the EPA Provisional Health Advisory (PHA) values for Perfluorooctane Sulfonic Acid (PFOS) (0.2 µg/L) and Perfluorooctanoic Acid (PFOA) (0.4 µg/L) were reduced to the final HAs of 0.07 µg/L for each compound (EPA 2016). In addition, the EPA published oral non-cancer reference doses (RfDs) of 0.00002 mg/kg/day for both PFOS and PFOA (EPA 2016). In situations where both PFOS and PFOA are present in drinking water, the EPA recommends that the concentrations be added together and the sum compared to the HA of 0.07 µg/L. MassDEP established its guideline in 2018 to include the following three additional PFAS chemicals: perfluorononanoic acid (PFNA), perfluorohexanesulfonic acid (PFHxS), and perfluoroheptanoic acid (PFHpA). The ORS Guideline (ORSG) is 70 part per trillion (ppt), and applies to the total summed level of all five compounds. A presence/absence (CERCLA SI equivalent) field investigation was completed between October 2013 and September 2014 at Ashumet Valley in response to the recommendation in the last Five Year Review (AFCEC 2013a). The results of this PFAS investigation confirmed a release of PFASs above the available EPA health advisories HA to the environment at Ashumet Valley and additional investigation was recommended (AFCEC 2014a, f). A Supplemental RI/FS is ongoing at Ashumet Valley, LF-1 and CS-10 to determine the nature and extent of PFAS contamination at JBCC.

For more information the following technical deliverables were prepared to present the results of PFAS investigations at JBCC:

- *Perfluorinated Compounds Sampling Approach at Ashumet Valley Data Presentation Project Note* (AFCEC 2014a)
- *Perfluorinated Compounds Sample Results at Ashumet Valley Data*

Presentation Project Note (AFCEC 2014f)

- *Final Preliminary Assessment Report For Perfluorinated Compounds at JBCC (AFCEC 2015c)*
- *Final Supplemental Remedial Investigation/Feasibility Study Work Plan for 1,4-Dioxane and Perfluorinated Compounds at Ashumet Valley (AFCEC 2016e)*
- *Final Focused Site Inspection Work Plan for Perfluorinated Compounds at the Flight Line Area (AFCEC 2016f)*
- *Final Focused Site Inspection Report for Perfluorinated Compounds at the Flight Line Area (AFCEC 2016h)*
- *Final Supplemental Remedial Investigation Report for 1,4-Dioxane and Perfluorinated Compounds at Landfill-1 (AFCEC 2018d)*

3.4 MILITARY MUNITIONS RESPONSE PROGRAM

In support of the MMRP, a Comprehensive Site Evaluation (CSE) was conducted at JBCC. The USAF developed the CSE concept from existing data acquisition methods and data analysis, tracking, and reporting tools to serve as the initial site assessment (CERCLA Preliminary Assessment [PA]/ SI) for sites covered under the MMRP. The CSE is an approach to munitions response and environmental restoration that assesses the unique challenges faced at Munitions Response Areas (MRAs), including explosives safety issues posed by Munitions and Explosives of Concern (MEC) and associated releases of Munitions Constituents (MC) (e.g., hazardous substances, pollutants, contaminants, and petroleum, oil, and lubricants) to the environment. An MRA is defined as any area on a defense site that is known or suspected to contain MEC (includes unexploded ordnance [UXO], discarded military munitions, or MC in high enough concentrations to pose an explosive hazard) or MC (e.g., former ranges or munitions burial areas).

The CSE process provides the historical, anecdotal, visual, analytical, and geophysical data that serve as the basis for USAF decision-making regarding follow-on munitions response actions (USAF 2006). The CSE is conducted in two distinct phases. The CSE Phase I, which generally consists of historical records reviews (HRR), visual surveys, and interviews. The CSE Phase II generally will consist of visual surveys, environmental

sampling, and geophysical surveys. The CSE Phase I and Phase II investigations differ from the traditional CERCLA PA and SI, however, with respect to data requirements. PA and SI activities primarily are focused on obtaining data to input into the Department of Defense (DoD) Munitions Response Site Prioritization Protocol (MRSPP) and site-sequencing for cleanup. The CSE process utilizes an expanded array of analytical, tracking, and reporting tools to support decision-making, and therefore, has greater data requirements. Tools utilized as part of the CSE for each MRA include:

- Conceptual Site Model (CSM) for project communication, hazard assessment, and data gap analysis
- MRSPP to prioritize MRAs for further munitions response actions, based on relative risk
- Hazard Ranking System (HRS) data elements to ensure full characterization of the MRA

The objective of the CSE Phase I and II investigations was to determine whether any of the 10 individual MRAs within JBCC warrant additional munitions response activities, require definition as munitions response sites (MRSs), or documentation for a No Further Action (NFA) decision. The JBCC MRAs are presented below:

- MB701: Former Otis Bomb Storage Magazines
- MB702: Ordnance Area 1 (WWII Era)
- ML701: Otis Target Butt
- MMR-001-R-01: Mock Village
- MMR-003-R-01: Old Grenade Courts
- MMR-004-R-01: Old K Range
- MMR-009-R-01: Otis Gun Club
- MMR-010-R-01: Former Ammunition Supply Point - West
- MMR-011-R-01: Former Ammunition Supply Point – East
- TS701: Skeet Range

The goal of the USAF MMRP is to make MRAs safe for reuse and to protect human health

and the environment in the process. The MMRP addresses issues related to MEC and MC associated with the then MRAs at JBCC, as related to hazardous substances, pollutants, and potential contaminants of concern on other than operational ranges. The following reports presents the results of the CSE Phase I and II investigations completed to date for JBCC.

- *Final Comprehensive Site Evaluation Phase I, Military Munitions Response Program, Joint Base Cape Cod, Massachusetts.* (USACE 2014)
- *Final Comprehensive Site Evaluation Phase II Former Ammunition Supply Point – West* (USACE 2015)
- *Final Comprehensive Site Evaluation Phase II* (AFCEC 2015a)
- *Explosives Site Plan, Comprehensive Site Evaluation Phase II, Old Grenade Courts (MMR-003-R-01), Mock Village (MMR-001-R-01), Old K Range, (MMR-004-R-01) Ordnance Area 1 (MB702), and Former Otis Bomb Storage Magazines (MB701), Joint Base Cape Cod* (AFCEC 2015b)
- *Final Work Plan for the Remedial Investigation at the Old K Range Munitions Response Area* (AFCEC 2017b)
- *Final Comprehensive Site Evaluation Phase II Report* (AFCEC 2018b)
- *Uniform Federal Policy-Quality Assurance Project Plan, Remedial Investigation, Otis Gun Club Munitions Response Area, Joint Base Cape Cod, Massachusetts* (AFCEC 2018c)
- *Final Comprehensive Site Evaluation Phase II Work Plan FASP– East* (AFCEC 2018a)

3.5 LAND USE CONTROLS

3.5.1 Land Use Control Requirement for IRP Source Area Sites

The majority of the IRP source area sites are located within the installation fence line and many have met UU/UE conditions as documented in prior Five Year Reviews (AFCEC 2013a, AFCEE 2008a, 2003, 1999) and as summarized in Tables 1-1a and 1-1b. Within the installation fence line, sites have typically been designated as “outside the flightline”

(such as the LF-1 source area) and “inside the flightline” (such as the FTA-2/LF-2 source area) (Figure 1-2). In general, surface soil for “outside the flightline” sites were evaluated based on a future residential exposure scenario. Subsurface soil was either evaluated based on worker exposure scenario or not evaluated based on disposal practices at the site. It should be noted that for some sites, regardless of the depth of contamination in subsurface soil, a worker exposure scenario was used for the risk assessment. “Inside the flightline” sites were evaluated based on a worker exposure scenario for both surface and subsurface soil. Based on current land use, restricted access to the base, and land use and management that is strictly controlled by federal entities, the remedies for the source area sites subject to this Five Year Review are protective in the short-term. However, for any source area or exposure pathway (e.g., subsurface soil) within that source area where hazardous substances, pollutants, or contaminants remain or may remain above levels that allow for UU/UE exposure and institutional controls are not in place, additional cleanup and/or enforceable LUCs may be necessary to ensure long-term protectiveness. Specific recommendations related to the need for LUCs are included in each of the source area narratives presented in Section 4.0.

3.5.2 Land Use Control Requirement for IRP Groundwater Sites

Each of the groundwater sites assessed in Section 5.0, except CS-19, FTA-2 and FS-13, are located partially or entirely outside the boundaries of the JBCC (Figures 1-2 and 1-3). These off-base groundwater plume areas are located in four different towns: Bourne, Sandwich, Mashpee, and Falmouth; some groundwater plumes (e.g., CS-10) are located in more than one town.

The AFCEC, EPA, and MassDEP have coordinated with the four towns in past years to develop town-specific groundwater use regulations issued through the towns’ respective Boards of Health (BOH). Additionally, AFCEC has provided municipal water service and/or household connections to homes in the areas of the groundwater plumes that were previously serviced by private wells. During the development of the RODs for CS-23 and LF-1 in the summer of 2007 (AFCEE 2007a and 2007b), AFCEC and the regulatory agencies agreed that the BOH regulations and ancillary enforcement procedures were not

adequate to ensure the prevention of potential exposure to contaminated groundwater from the JBCC plumes. Examples of potential exposure include: residents using former private drinking water wells for irrigation, filling of swimming pools, or car washing; parcels with more than one home using a combination of private wells and municipal water supply; or residents that declined earlier offers from AFCEC for connection to a municipal water supply.

As a result of these discussions, the groundwater site RODs and Explanation of Significant Differences (ESDs) (Table 1-3) contain specific procedures that require the Air Force to verify the private well status of all parcels within the plume footprints. The well verification requirements (modified to read generically for all off-base JBCC plumes) follow:

Within three years of the signing of the ROD or ESD, 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 plume(s).
- b. Demonstrate and document that the private well is not capable of drawing contaminated groundwater originating from the plume(s), 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 and MassDEP, until the plume(s) no longer presents a threat to that well as determined in coordination with EPA and MassDEP.
- 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 the well may pose to human health. The Air Force shall submit a draft version of any such risk assessment to EPA and MassDEP for review and concurrence.
- 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 and MassDEP concurrence, outlining and including time limitations for the completion of steps sufficient to prevent exposure to concentrations of contaminated groundwater from the plume(s) having carcinogens in excess of applicable or relevant and appropriate requirements (ARARs) (i.e., MCLs, non-zero MCL goals), and prevent exposure to groundwater from the plume(s) 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 hazard index greater than one.

The Air Force has developed a guideline for implementing this requirement titled *Verification, Decommissioning, and Documentation Guidelines for Private Wells in Areas of Potential Concern* (AFCEE 2008b). Additionally, the Air Force developed and is using a LUC database to record the status of the well verification process and subsequent results for the over 2,312 parcels located in plume areas. As reported in Section 5.0 of this Five Year Review, the initial well verification and well determination process required by the RODs and/or ESDs was completed by AFCEC during the previous Five Year Review Period (2007-2012). Outreach associated with the PFSA and FTA-2 ROD Amendments which addressed the groundwater media at these sites was completed in 2016 (AFCEC 2014d, 2015d).

Based on technical evaluations, well determinations were made that concluded that none of the identified private wells represent a current unacceptable exposure risk to the IRP groundwater plumes. Further details are provided in each of the groundwater site evaluations presented in Section 5.0.

This Five Year Review has determined that the remedies in place for groundwater sites are protective in the short-term since there is no evidence that there is current, unacceptable

exposure to contaminated groundwater including through the use of the private wells identified during the LUC well verification process. However, in order to ensure long-term protectiveness while remedial actions associated with the groundwater plumes are ongoing, AFCEC will continue to assess data collected under the IRP's System Performance and Ecological Impact Monitoring/Long-Term Monitoring (SPEIM/LTM) program to determine whether these actively used private wells identified through the well verification and well determination process represent an unacceptable exposure risk. In the event that new private well information is obtained or plume monitoring data indicate a change to the CSM for each plume, AFCEC will perform the necessary well determinations at the time the information becomes available with the objective of determining whether protectiveness is being maintained. These protectiveness determinations for active private wells located near the IRP groundwater plumes will be included in the associated plume data presentation project notes and/or appended to the annual LUC letter reports that are prepared by AFCEC.

The status of non-operational private wells continued to be tracked during this five year review period. AFCEC distributed a mailing, on an annual basis, to property owners within each LUC area that have inactive or decommissioned wells for which no technical evaluation could be completed due to lack of known well depths and/or inability to sample. The intent of the annual mailing is to remind these property owners that they should contact AFCEC for a technical evaluation, which may include sampling, in the event their well is put back into service. Any changes to the private well LUC monitoring program or technical evaluations completed in support of a private well that may have been restarted were reported in the Annual LUC letter Reports (AFCEC 2013c, 2014g, 2015e, 2016g), are summarized for each groundwater site in Section 5.0, and the technical evaluations are included in Appendix C.

3.6 SITE INSPECTIONS

SIs have been completed for each of the source area sites addressed in Section 4.0 that require a Five Year Review. A summary of the findings is included in each source area evaluation and completed SI forms are provided in Appendix B. In addition, Table 3-1

provides a summary of the site inspection findings, planned corrective actions including responsible party, and whether any issues affect protectiveness. It is noted that no issues were identified at any of the source area sites that required corrective action or affect protectiveness. Routine annual inspections required as part of the LUC programs at LF-1 and LF-7 will continue.

Similar to prior Five Year Reviews, SIs for the 18 groundwater sites evaluated in this Five Year Review were not conducted because these sites, and the associated remedial systems for the plumes with active treatment, are routinely inspected (daily during the work week) as part of the ongoing O&M activities by AFCEC's full time O&M contractor. Any operational or other issues, such as operational downtime, are reported to the regulatory agencies via notification e-mails. Restart notifications are also provided via e-mail. The IRP remedial systems are operated and maintained under an approved O&M Plan (AFCEC 2017a). The O&M Plan is updated on an annual basis and includes operational requirements, a summary of the operational history of the systems, and details of any system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and continue to be, addressed in a timely and effective manner such that O&M associated with the remedy is considered effective at achieving the remedy goals. O&M data and activities are summarized in O&M monthly reports and system performance and reliability is reported at Technical Update meetings and in annual Summary Letter Reports (SLRs) which are submitted to the regulatory agencies.

3.7 INTERVIEWS

Similar to the last Five Year Review (AFCEC 2013a) and with concurrence from EPA, interviews were not conducted as part of this Five Year Review. It was agreed that the ongoing, iterative interaction between AFCEC, the regulatory agencies, and the broader stakeholder group, for example through the JBCCCT meeting process, provided sufficient opportunity for any and all stakeholders to communicate issues or concerns.

3.8 OVERVIEW OF THE SPEIM/LTM PROGRAM

AFCEC's SPEIM/LTM program was developed to monitor changes to the groundwater plumes and to ensure the effective operation of the AFCEC groundwater remediation systems at the JBCC. These objectives are met through the routine monitoring of selected media (i.e., groundwater, surface water) within and outside the groundwater plume boundaries, at the treatment plants, and through groundwater flow and transport modeling. The data collected under the SPEIM/LTM program are continually assessed by a team of professional staff and the results of these assessments are presented to the regulatory agencies initially during periodic Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues. Updates on the status of the remedial action at each plume are provided to a broader stakeholder group at JBCCCT meetings.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being addressed through active treatment under the SPEIM program. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program. The SLRs also include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual reporting period as attachments or by reference. For the groundwater sites where active treatment was not part of the remedy, remedial progress is assessed and the results are provided through the submittal of LTM project notes or letter reports. The SLRs and LTM deliverables are provided to the broad stakeholder group for each plume or site including Federal (EPA) and State (MassDEP, Massachusetts Department of Public Health [MassDPH]) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties as applicable. The SLRs and LTM deliverables are publically available in the IRP Administrative Record and copies are maintained at the local town libraries.

3.9 SUSTAINABILITY

In a world that is resource limited and increasingly aware of activities that could impact global climate, there is growing emphasis on designing and maintaining more sustainable, low-impact engineering solutions. This emphasis on sustainability extends to the remediation of soil and groundwater. AFCEC is committed to a more complete evaluation of sustainability metrics when considering and comparing the total impacts, benefits, and life-cycle costs of the environmental remediation decisions and actions made in support of the IRP at JBCC.

Various private and public organizations have developed policies and guidance documents on the application of sustainable practices in remediation. These practices are driven by social, environmental, and economic pressures which constitute the “triple bottom line” of sustainability. Presidential Executive Orders 13423 (Bush 2007), 13514 (Obama 2009) imposed specific goals to federal agencies regarding the incorporation of sustainable practices. The EPA clarified and enhanced those goals through a technology primer on green remediation (EPA 2008) and *Principles for Greener Cleanups* (EPA 2009). EPA Region 1 reiterated the principles described in EPA 2009 through a policy statement in 2010 which was updated in February 2012 (EPA 2012b).

As outlined in the EPA’s Technology Innovation Program’s CLU-IN website, the EPA is committed to developing and promoting innovative cleanup strategies that restore contaminated sites to productive use, reduce costs, and promote environmental stewardship, while ensuring that cleanups are protective of human health and the environment. In accordance with EPA’s strategic plan for compliance and environmental stewardship, the Agency strives for cleanup programs that use natural resources and energy efficiently, reduce negative impacts on the environment, minimize pollution at its source, and reduce waste to the greatest extent possible. EPA supports the adoption of green remediation as the practice of considering all environmental effects of cleanup actions and incorporating strategies to maximize the net environmental benefit.

Green remediation results in effective cleanups minimizing the environmental and energy

"footprints" of site remediation and reuse. Sustainable practices emphasize the need to more closely evaluate core elements of a cleanup project:

- energy requirements of the treatment system,
- air emissions,
- water requirements and associated impacts on water resources,
- impacts on land and ecosystems,
- material consumption and waste generation, and
- long-term stewardship actions.

Starting in 2003, AFCEC has been promoting a strategy that fully encompasses environmental effects of cleanup actions when evaluating groundwater system operations and optimizations in order to more holistically address protectiveness. Since 2003 and prior to the development of the current green and sustainable guidance documents and approaches, AFCEC has been proactive in incorporating sustainability considerations into the SPEIM/LTM/O&M program at JBCC. Examples of sustainability initiatives implemented by AFCEC at JBCC include:

- Construction of three 1.5-megawatt wind turbines resulting in the AFCEC IRP power use being offset by 100 percent renewable energy.
- Conducting energy audits and implementing energy conservation measures such as efficient lighting, occupancy sensors, and programmable thermostats; and enrollment in a demand response program.
- Performing remedial system optimization evaluations with the objective of accelerating aquifer restoration timeframe while reducing operational flow rates and total treated volume. Initiatives include adjusting flow rates and installing packers at individual extraction wells and developing beneficial reinjection/infiltration strategies.
- Applying remedial process optimization to treatment processes including the assessment of alternative granular activated carbon (GAC) products with the goal of reducing the overall program costs and/or providing for a more sustainable treatment approach.
- Installing variable frequency drives which can eliminate booster pumps and downsize pump motors.
- Using AFCEC-owned and self-performed direct push drilling technology to reduce costs and waste generation and minimize impacts on the environment and community.

- Increasing use of biofuels and environmentally sensitive hydraulic oil in fleet vehicles.
- Improving the trophic health of a pond by using an innovative zero-valent iron geochemical barrier that passively removes phosphorus discharging into the pond.
- Reusing treated water for irrigation.
- Using passive/no-purge sampling techniques, where applicable, rather than techniques that require pumps, resulting in energy savings and less waste generation.

3.10 REFERENCES

- AFCEC. 2018a (April) *Final Comprehensive Site Evaluation Phase II Work Plan FASP–East*. Prepared by USACE for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA
- _____. 2018b (February). *Final Comprehensive Site Evaluation Phase II Report*. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA
- _____. 2018c (January) *Uniform Federal Policy-Quality Assurance Project Plan, Remedial Investigation, Otis Gun Club Munitions Response Area, Joint Base Cape Cod, Massachusetts*. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA
- _____. 2018d (January). *Final Supplemental Remedial Investigation for 1,4-Dioxane and Perfluorinated Compounds at Landfill-1, Joint Base Cape Cod, MA*. 658003-EC-LF1- RPT-002. Prepared by CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2017a (November). *2017 Operations and Maintenance Plan for Groundwater Extraction and Treatment Systems and Wind Turbine*. 652000-O&M-MULTIPLE-OMPLN-003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2017b (September). *Final Work Plan for the Remedial Investigation at the Old K Range Munitions Response Area*. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA
- _____. 2017c (March). *Final Supplemental Remedial Investigation Report for 1,4-Dioxane at Chemical Spill-10, Joint Base Cape Cod, MA*. 658003-EC-CS10-RPT-002. Prepared by CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016a (May). *Decision Document Addendum for Study Areas CS-1, CS-2 (USCG), CS-6/FS-22, CS-6 (USCG), CS-14, CS-15, CY-1/CY-3, FS-2 (USCG)*,
-

FS-3, FS-25, and SD-1. Prepared by Portage for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA

- _____. 2016b (March). *Final Supplemental Remedial Investigation/Feasibility Study Work Plan for 1,4-Dioxane at Chemical Spill-10, Chemical Spill-20, and Landfill-1, Joint Base Cape Cod, MA.* 658003-EC-Multiple-QAPP-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2016c (February). *Final Technical Memorandum for Areas of Contamination SD-2/FS-6/FS-8, SD-3/FTA-3/CY-4, and SD-5/FS-5.* Prepared by AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA
- _____. 2016d (February). *Final Technical Memorandum Area of Contamination CS-16/CS-17.* Prepared by AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA
- _____. 2016e (February). *Final Supplemental Remedial Investigation/ Feasibility Study Work Plan for 1,4-Dioxane and Perfluorinated Compounds at Ashumet Valley, Joint Base Cape Cod, MA.* 658003-EC-FL- QAPP-002. Prepared by CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016f (January). *Final Focused Site Inspection Work Plan for Perfluorinated Compounds at the Flight Line Area.* 658003-ECAV- QAPP-003. Prepared by CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016g (May). *Land Use Control letter Report for 2015.* Prepared AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016h (April). *Final Focused Site Inspection Report for Perfluorinated Compounds at the Flight Line Area, Joint Base Cape Cod, MA.* 658003-EC-FL-RPT-002. Prepared by CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015a. (October). *Final Comprehensive Site Evaluation Phase II Work Plan (Work Plan), Joint Base Cape Cod, Massachusetts.* Prepared by EA Engineering, Science, and Technology, Inc. PBC. October.
- _____. 2015b. *Explosives Site Plan, Comprehensive Site Evaluation Phase II, Old Grenade Courts (MMR-003-R-01), Mock Village (MMR-001-R-01), Old K Range, (MMR-004-R-01) Ordnance Area 1 (MB702), and Former Otis Bomb Storage Magazines (MB701), Joint Base Cape Cod.* Prepared by EA Engineering, Science, and Technology, Inc., PBC. June.
- _____. 2015c (June). *Final Preliminary Assessment Report for Perfluorinated Compounds at Joint Base Cape Cod, Massachusetts.* Prepared by HGL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base,

MA.

- _____. 2015d (January). *Final 2014 PFSA Source Area Vapor Intrusion Evaluation* 425445-O&M-MULTIPLE-OMPLN-001. Prepared by CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2015e (May). *Land Use Control letter Report for 2014*. Prepared AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2014a (November). *PFC Sample Results at Ashumet Valley Data Presentation Project Note*. 473147-SPEIM-AVP-PRJNOT-004. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2014b (August). *1,4-Dioxane Monitoring Well Sample Results Data Presentation Project Note*. 473147-SPEIM-MULTIPLE-PRJNOT-007. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2014c (August). *1,4-Dioxane Extraction Well, LUC, and PWS Sample Results and Monitoring Well Sampling Plan Data Presentation Project Note*. 473147-SPEIM-MULTIPLE-PRJNOT-004. Prepared by CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2014d (July). *Final CS-10 Source Area Details C and F Vapor Intrusion Evaluation Project Note*. 473147-SPEIM-CS10-PRJNOT-002. Prepared by CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2014e (July). *Final Action Memorandum Technical Memorandum for Areas of Concern (AOCs) CS-4 (USCG)/FS-1 (USCG), CS-5, CS-11, FS-7, FS-18, DDOU, FS-4, FTA-1, and FS-1*. Prepared by Portage for AFCEC/MMR, Installation Restoration Program, Otis ANG Base, MA.
 - _____. 2014f (June). *PFC Sampling Approach at Ashumet Valley Data Presentation Project Note*. 473147-SPEIM-AV-PRJNOT-003. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis ANG Base, MA.
 - _____. 2014g (May). *Land Use Control letter Report for 2013*. Prepared AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2013a (October). *Final 4th Five-Year Review, 2007-2012 Massachusetts Military Reservation (MMR) Superfund Site, Otis Air National Guard Base, MA*. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis ANG Base, MA.
 - _____. 2013b (June). *Confirmation of Private Well Operational Status: Installation Restoration Program Land Use Control Areas*. 437075-LUC-MULTIPLE-PRJNOT-002. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
-

- _____. 2013c (May). *Land Use Control letter Report for 2012*. Prepared AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- AFCEE. 2012 (August). *Final 2011 MMR Vapor Intrusion Evaluation Technical Memorandum*. 420005-SPEIM-MULTIPLE-TECHMEM-002. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2008a (September). *Final 3rd Five-Year Review, 2002-2007 Massachusetts Military Reservation (JBCC) Superfund Site, Otis Air National Guard Base, MA*. Prepared by Engineering Strategies Corporation, Portage and CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2008b (May). *Verification, Decommissioning, and Documentation Guidelines for Private Wells in Areas of Potential Concern*. Prepared by Air Force Center for Engineering and the Environment Massachusetts Military Reservation Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2007a (October). *Final Record of Decision for Chemical Spill-23 Groundwater*. A4P-J23-35BC02VA-M26-0008. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2007b (October). *Final Record of Decision for Landfill-1 Source Area and Groundwater*. A4P-J23-35BC02VA-M26-0007. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2003 (May). *Final 2nd Five-Year Review, 1998-2002 Massachusetts Military Reservation (MMR) Superfund Site, Otis Air National Guard Base, MA*. Prepared by AFCEE/MMR and Portage Environmental, Inc. for AFCEE/MMR, Installation Restoration Program, Otis ANG Base, MA.
- _____. 1999 (March). *Five-Year Review Report Massachusetts Military Reservation Installation Restoration Program*. Prepared by Air Force Center for Environmental Excellence, Installation Restoration Program, Otis ANG Base, MA.
- Bush. 2007 (January). Executive Order 13423 – *Strengthening Federal Environmental, Energy, and Transportation Management*. Federal Register Vol. 72, No. 17.
- MassDEP. 2014 (June). Massachusetts Contingency Plan from MassDEP web page: <http://www.mass.gov/eea/agencies/massdep/cleanup/regulations/site-cleanup-regulations-andstandards.html>.
- EPA. 2016 (November). Technical Fact Sheet - Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS). Office of Water. U.S. Environmental Protection Agency.
-

- _____. 2012a (November). Assessing Protectiveness at Sites for Vapor Intrusion (Supplement to the Comprehensive Five-Year Review Guidance) OSWER Directive 9200.2-84.
- _____. 2012b (February). Clean and Green Policy for Contaminated Sites. EPA Region 1. Office of Site Remediation and Restoration. Available online: <http://www.epa.gov/region1/brownfields/pdfs/CleanGreenPolicy.pdf>.
- _____. 2009 (August). Principles for Greener Cleanups. OSWER. Available online: http://www.epa.gov/oswer/greenercleanups/pdfs/oswer_greencleanup_principles.pdf.
- _____. 2008 (April). Technology Primer. Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites. OSWER. EPA 542-R-08-002 Available online: <http://www.clu-in.org/greenremediation/docs/Green-Remediation-Primer.pdf>.
- Obama. 2009 (October). Executive Order 13514 – *Federal Leadership in Environmental, Energy, and Economic Performance*. Federal Register Vol. 74, No. 194. U.S. Army Corps of Engineers (USACE) 2015 (July). *Final Comprehensive Site Evaluation Phase II Former Ammunition Supply Point – West*. Prepared by EW Wells Group, LLC.
- United States Air Force (USAF). 2006 (October). *Air Force Guide for Conducting the Comprehensive Site Evaluation Phase II at Air Force Munitions Response Areas, Version 4*.
- United States Army Corps of Engineers (USACE). 2015 (November). *Final Comprehensive Site Evaluation Phase I, Military Munitions Response Program, Joint Base Cape Cod, Massachusetts*.
- _____. 2014 (February). *Final Comprehensive Site Evaluation Phase I, Military Munitions Response Program, Joint Base Cape Cod, Massachusetts*.

4.0 SOURCE AREAS REQUIRING FIVE-YEAR REVIEW

This section presents the source area sites for which a Five Year Review is required. Seven sites (Table 1-2) require a Five Year Review because of one of the following conditions:

- additional investigative work and/or data evaluation has been completed during this Five Year Review period that indicates further evaluation and/or remedial actions are required [CS-10/FTA-2/PFSA (FS-10 and FS-11)];
- landfills that have restricted use (LF-1, LF-2, LF-7).

4.1 CS-10 (UTES/BOMARC DETAILS C AND F)

The CS-10 source area occupies approximately 52 acres at the eastern boundary of the JBCC (Figures 1-2 and 4-1). Originally, the CS-10 source area consisted of a number of buildings constructed as part of the BOMARC site by the USAF. Shelters utilized by the missile launcher systems along with a subsurface utility corridor connecting the shelters (utilidor system) were removed from the site in 2005. The site is currently used by the Massachusetts ARNG as the Unit Training Equipment Site (UTES) facility for maintenance and storage of vehicles. In addition, the CS-10/FS-24 source area was the primary source for the CS-10 groundwater plume discussed in Section 5.3.

4.1.1 Site Chronology

Pre-1956: CS-10 consisted of a wooded area.

1958: Construction of the BOMARC missile site begins.

1960-1973: The USAF maintains approximately 56 BOMARC ground-to-air missile launcher systems in a state of operational readiness. The BOMARC facility was abandoned in 1973.

1978: The ARNG incorporated the abandoned missile facility into Camp Edwards UTES and began limited use of the abandoned buildings for equipment maintenance and storage. UTES personnel are responsible for maintaining 300 to 350 armored track and wheeled vehicles used for Camp Edwards ARNG training activities.

1985-1988: Records search and SI activities were completed (E.C. Jordan Co. 1986, 1989, and 1990).

1989-1990: RI activities were conducted at CS-10 (ABB-ES 1992, AFCEE 1997).

1998-1999: A focused feasibility study (AFCEE 1998) and a ROD (AFCEE 1999) were completed.

2002-2005: The CS-10 Detail C soil vapor extraction (SVE) system operated from February 2002 through June 2005. The SVE system consisted of three extraction wells, eight monitoring/observation wells, and a vapor treatment system. The three extraction wells were shut down in March 2003, January 2004, and June 2005, respectively. The system was decommissioned in June 2005.

2003: An ESD was prepared addressing changes at CS-10 source area Details A, B, and E (AFCEE 2003a).

2005: Shelters utilized by the BOMARC missile launcher systems along with a subsurface utility corridor connecting the shelters (utilidor system) were removed.

2011: An ESD was prepared addressing various changes to the remedy for the CS-10 source area details (AFCEE 2011). This ESD supports the UU/UE determinations for CS-10 Detail A, Detail B, Detail D, Detail E, Detail G, Detail H, and Detail I. CS-10 Detail C and Detail F did not meet UU/UE conditions.

2014: A VI screening evaluation was conducted for CS-10 Detail C and Detail F (AFCEC 2014).

4.1.2 Background

4.1.2.1 History of Contamination

The former BOMARC facility, now demolished, and UTES facility are considered the primary sources of historic contamination to soils in the source area and the CS-10 groundwater plume from 1960 to the early 1990s. Other sources of contamination are presumed to have contributed to the CS-10 groundwater plume as it traveled beneath the JBCC (see Section 5.3).

Maintenance operations at CS-10 involved the use of cleaning solvents (methylene chloride, 1,1,1-TCA, TCE, PCE, and Freon). BOMARC fuels included Jet Propulsion-4 (JP-4), Aerozine-50, red fuming nitric acid, and hydrazine. Fuels used for power and heat generation included No. 2 fuel oil and diesel fuel. Several buildings had floor drains

connected to dry wells, building sumps, oil interceptors, and other drainage structures; some of these drainage structures were connected to the site storm drain system, which discharges to either the Eastern Storm Sewer Drainage Impoundment or the Southern Storm Sewer Outfall Drainage Ditch. The BOMARC facility was abandoned by the USAF in 1973. Activities at the UTES facility included the handling and use of motor oil, hydraulic fluid, battery electrolyte, PCE, PD-680 Safety Clean, paints, and paint removers (AFCEE 2008).

In 1985, during an investigation of the possible impact of UTES/BOMARC activities on local groundwater quality, several chlorinated organics were detected in the groundwater (E.C. Jordan Co. 1986). An SI conducted from 1986 to 1988 identified numerous contamination sources in the BOMARC area and detected contaminants in the soil (fuel- and oil-related polycyclic aromatic hydrocarbons [PAHs], pesticides, polychlorinated biphenyls [PCBs], and inorganics) and groundwater (halogenated solvents cis-1,2-dichloroethene, TCE, and PCE) (E.C. Jordan Co. 1989 and 1990). Based on the results of the SI, an RI was performed. An interim RI (ABB-ES 1992) and final RI (AFCEE 1997) conducted in 1989 and 1990 characterized potential sources of groundwater contamination, confirmed conceptual models, and delineated the extent of contaminant source areas (i.e., leaching pits, oil/water interceptors, residual soil). The CS-10/FS-24 source area was divided into nine details as described in Section 4.1.2.4.

4.1.2.2 Physical Characteristics, Land and Resource Use

The CS-10 source area is located near the eastern boundary of the JBCC to the west of Snake and Weeks ponds (Figure 1-2). Groundwater beneath the source area is at approximately 85 feet (ft) below grade and flows in a general southerly direction. The land in the area is currently used for the UTES operations. The area is abutted to the north, south, and west by woodland areas that are used by ARNG for training. Private residences are located to the east of CS-10.

4.1.2.3 Initial Response

A summary of the initial responses is as follows:

Underground Storage Tank Removal: A leaking 25,000-gallon underground storage tank (UST) located at the northwest corner of Building 4606 at the BOMARC/UTES site was removed. Fewer than 500 gallons of No. 2 fuel oil were reportedly released from the tank. This fuel spill site was designated FS-24 (Detail G). Soil affected by the fuel spill was excavated to the maximum extent possible and removed from the site, and the excavation was backfilled with clean sand (AFCEE 2008).

Drainage Structure Removal Program: Sixteen drainage structures, associated piping, and surrounding soil were removed and two drainage structures were cleaned and filled in place with concrete at CS-10 as part of the Drainage Structure Removal Program (DSRP). In addition to the drainage structures, a total of 31,550 gallons of liquids were removed from the structures and 702 cubic yards of contaminated soil were removed (AFCEE 2008).

CS-10 Source Area Remedial Action: Approximately 250 cubic yards of contaminated soil were removed from the CS-10 Details A, B, E, and H and transported off site. An SVE system (Figure 4-1) was constructed and operated in the CS-10 source area (Detail C) from 2002 to 2005 and during that time the system removed approximately 5 pounds (lbs) of volatile organic compounds (VOCs) from the soil (AFCEE 2008).

4.1.2.4 Basis for Taking Action

The Final RI (AFCEE 1997) characterized potential sources of groundwater contamination, confirmed conceptual models, and delineated the extent of contaminant source areas (i.e., leaching pits, oil/water interceptors, residual soil). The CS-10/FS-24 source area was divided into nine discrete details as described below. Figure 4-1 presents the locations of the CS-10/FS-24 details.

- Detail A consisted of surface soil contamination associated with an abandoned electrical switching station. Surface soil samples collected in the vicinity of the abandoned electrical switching station along the utilidor system were found to contain elevated concentrations of total petroleum hydrocarbons (TPH) and inorganics (arsenic, cadmium, chromium, copper, lead, vanadium, and zinc).
- Detail B consisted of surface soil contamination associated with operations at a former BOMARC maintenance shop. PAHs and TPH were detected in surface soils.

- Detail C consisted of subsurface soil contamination associated with a former 300 gallon JP-4 UST. PCE and TPH were detected in subsurface soils. Leaching of contaminants to groundwater was a concern for this detail.
- Detail D consisted of surface soil contamination associated with waste oil disposal activities. The disposal site is located in a clearing in the woods approximately 150 ft north of the BOMARC security fence. Lead, vanadium, methylene chloride, and TPH were detected at elevated concentrations in surface soil at this detail.
- Detail E consisted of surface soil and sediment contamination associated with the Southern Storm Sewer Outfall Drainage Ditch. One 24-inch-diameter storm sewer received runoff from southern portions of CS-10. In the past, effluent from the leaching wells and effluent from a waste oil interceptor also discharged at the Southern Storm Sewer Outfall. Surface soils contained pesticides, TPH, PCBs, PAHs, and inorganics (arsenic, chromium, copper, cyanide, lead, manganese (Mn), vanadium, and zinc).
- Detail F consisted of surface soil and sediment contamination associated with the Eastern Storm Sewer Outfall Drainage Impoundment. The drainage impoundment is located outside the UTES/BOMARC security fence northeast of the entrance from Greenway Road. Four storm water sewer outfalls located within the fenced UTES/BOMARC site discharge to this impoundment. In the past, effluent from the former Weapons Systems Electronics Shop's oil interceptor and from floor trench drains also discharged through this storm sewer system. PAHs, PCBs, pesticides, and several inorganics (aluminum, cadmium, chromium, copper, lead, Mn, vanadium, and zinc) were detected in soil and/or sediment at the Eastern Sewer Drainage Impoundment.
- Detail G, also known as FS-24, consisted of subsurface soil contamination associated with a former 25,000-gallon UST located in the center of the BOMARC site. Methylene chloride and TPH were detected in subsurface soils. Leaching of contaminants to groundwater was a concern for this detail.
- Detail H consisted of subsurface soil contamination associated with a former storage area that was located in the eastern portion of the BOMARC site. PCE and TPH were detected in subsurface soils. Leaching of contaminants to groundwater was a concern for this detail.
- Detail I consisted of surface and subsurface soil contamination associated with maintenance operations at Building 4601. PCE, inorganics (arsenic, chromium, lead, vanadium) and bis-2-ethylhexyl phthalate were detected in soils.

As part of the RI, risk assessments for CS-10 Operable Units A & B were performed. CS-10A and CS-10B Operable Units consisted of the following details: A, B, C, D, G, H, and I. Results of the preliminary risk assessment (PRA) for soil indicated that calculated carcinogenic and noncarcinogenic risk for all human health exposure scenarios (i.e., current worker, current trespasser, and potential future resident) did not exceed EPA risk management guidelines (i.e., risk range of 1×10^{-4} to 1×10^{-6} for carcinogens and hazard

index (HI) of less than 1.0 for non-carcinogens).

4.1.3 Remedial Actions

The final remedy for CS-10/FS-24 was presented in the *Record of Decision Area of Contamination CS-10/FS-24 Source Areas* which was signed on 16 August 1999. The RAOs established for CS-10/FS-24 were:

- To minimize adverse impacts to ecological receptors from source area contaminated soil, sediment, and surface water estimated to exceed a hazard index of 1 or exceed soil target cleanup levels (STCLs) based on ecological risk.
- To provide a source control alternative that minimized future migration of contaminants in soil/sediments to the underlying aquifer and to off-site locations as determined by exceedances of STCLs based on leaching.
- To the extent feasible, to reduce the concentration of the inorganic COCs in soil/sediments to achieve or approach STCLs based on background.

4.1.3.1 Remedy Selection and Implementation

The following subsections provide a summary of the remedy selected in the ROD, changes to the selected remedy through the issuance of ESDs, and an overview of the remedial actions completed at each of the CS-10/FS-24 details.

CS-10/FS-24 ROD: The selected remedy for CS-10/FS-24 presented in the ROD was Alternative 3: Excavation, On-site Asphalt Batching and Off-site Disposal/In Situ Thermally Enhanced SVE/Environmental Monitoring (AFCEE 1999). The major components of this alternative included: (1) the removal of contaminated surface water from the Eastern Storm Sewer Outfall Drainage Impoundment at Detail F; (2) excavation and dewatering (if necessary) and temporary on-site stockpiling of an estimated 3,400 cubic yards of contaminated surface soil and sediments from seven of the nine source areas (Details A through F and I); (3) installation of an in-situ, thermally-enhanced SVE and vapor collection system at Detail C; (4) implementation of a confirmatory sampling plan at Details G and H; and (5) implementation of institutional and engineering controls (e.g., site access restrictions) to limit exposure to site-related contaminants.

2003 Explanation of Significant Differences: The *Explanation of Significant Differences for Areas of Contamination CS-10 (A, B & E); CS-16/CS-17; FS-9; SD-2/FS-6/FS-8; SD-3/FTA-3/CY-4* finalized in January 2003 (AFCEE 2003a) was prepared to document changes to the selected remedy for several sites including Details A, B, and E of the CS-10/FS-24 ROD. Three changes were made to the selected remedy presented in the CS-10/FS-24 ROD: (1) establishment of remedial action levels (RALs) for certain inorganic chemicals, PCBs, and petroleum hydrocarbons at Details A, B, and E; (2) removal of the asphalt-batching component from the selected remedy of Details A and B; and (3) the expansion of offsite disposal options to include RCRA Subtitle D facilities.

CS-10 Details A, B, E, and H Soil Excavation and Disposal: AFCEE conducted remedial action activities in 2001 at CS-10 Details A, B, E, and H. Removal activities and results of confirmatory sampling were documented in a Remedial Action Report (RAR) (AFCEE 2003b). Approximately 250 cubic yards of contaminated soil were removed from the CS-10 Details A, B, E, and H. Confirmatory sampling results indicated that the contaminant concentrations in soil were below the RALs. Excavated soil was transported to a central bulking facility located on the JBCC. Soil from CS-10 was combined with soil from other sites excavated under AFCEE's Source Area Remedial Action Program. Composite sampling of the consolidated soil stockpiles determined that the consolidated soil was considered non-hazardous and suitable for reuse as daily cover at a RCRA Subtitle D Landfill. Soil from CS-10/FS-24 was disposed of at the Taunton Landfill in Massachusetts. Disposal activities were performed in compliance with the MassDEP *Reuse and Disposal of Contaminated Soil at Massachusetts Landfills Policy #COMM-97-001* (MassDEP 1997).

CS-10 Details D, G, and I Confirmatory Sampling: Analytical results from the pre-design and/or delineation sampling at CS-10 Details D, G, and I indicated that all COC concentrations were below RALs and consequently no soil removal was needed. A vadose zone characterization report employing VLEACH, an EPA-approved leaching model, was completed to address residual PCE contamination in subsurface vadose zone soils at CS-

10 Details C, H, and I. The report concluded that the PCE contamination in vadose zone soils would not impact groundwater (AFCEE 2002 and 2005).

CS-10 Detail C UST Removal: In 2000, AFCEE removed a UST which was designated as part of Detail C. The 300-gallon UST was reportedly used for the storage of jet fuel; however, the contents reportedly contained a PCE/water mixture. The tank was pumped out and the contents were disposed offsite as a RCRA hazardous listed waste. The tank was removed and sent offsite to a scrap yard. The UST removal was documented in the CS-10/FS-24 RAR (AFCEE 2003b). The UST removal was not part of the original remedy presented in the ROD but was addressed in the *Explanation of Significant Differences Areas of Contamination CS-10/FS-24, FS-1, and FS-9* (AFCEE 2011) described later in this section.

CS-10 Detail C SVE System: A pre-remedial action delineation program was performed to identify the boundaries of PCE and petroleum hydrocarbon contamination and to optimize placement of extraction wells associated with an SVE system at Detail C. PCE delineation results were compared to the ROD cleanup level of 10 micrograms per kilogram ($\mu\text{g/kg}$). Sampling was conducted in November 2000, December 2000, and December 2001 to determine the lateral and vertical extent of the Detail C PCE contamination. Fourteen locations were sampled prior to startup of the SVE system. The contamination was found to be located between 4 and 45 ft below ground surface (bgs) within the vadose zone. The CS-10 Detail C SVE system operated from February 2002 through June 2005. The SVE system consisted of three extraction wells, eight monitoring/observation wells, and a vapor treatment system (Figure 4-1). The hot air injection wells that were a component of the remedy identified in the ROD were not installed; this change was addressed in the 2011 ESD (AFCEE 2011). The vapor treatment system included two 300-lb GAC vessels, a moisture tank, and a thermal oxidizer. The thermal oxidizer was shut down in October 2003. The three extraction wells were shut down in March 2003, January 2004, and June 2005, respectively. The system was decommissioned in June 2005. A vadose zone characterization report employing VLEACH, an EPA-approved leaching model, was completed to address residual PCE

contamination in subsurface vadose zone soils at CS-10 Detail C. The report concluded that the PCE contamination in vadose zone soils would not impact groundwater (AFCEE 2005). An RAR summarizing the operation of the SVE system at Detail C was finalized in September 2009 (AFCEE 2009).

CS-10 Detail F Revised Screening Level Ecological Risk Assessment: The results of this Screening Level Ecological Risk Assessment (ERA) suggested that wetland receptors (e.g., plants and invertebrates), aquatic and benthic receptors (e.g., invertebrates) may potentially be at risk from exposure to several inorganic compounds in hydric soil/sediment and surface water in CS-10 Detail F (Eastern Storm Sewer Outfall Drainage Impoundment). However, it was determined that little to no significant potential risks to vertebrate wildlife was likely from exposure to contaminants of potential concern (COPCs) in hydric soil/sediment (AFCEE 2004a).

CS-10 Detail F Ecological Risk Assessment Addendum: The ERA Addendum was prepared to evaluate the potential ecological risks to lower trophic level receptors through the benchmark screening of additional surface water and hydric soil/sediment samples and the use of site-specific laboratory toxicity testing. The results of this ERA Addendum indicated that, although there were elevated levels of several inorganic and organic chemicals present in surface water, sediments and hydric soils in the wetland portion of CS-10 Detail F, these levels were not likely to have a significant negative impact on the wetland plant and invertebrate communities (AFCEE 2004b).

CS-10 Source Area Investigation Results: A source area groundwater and subsurface soil investigation was completed at the CS-10 source area in 2005 in the area immediately south of Building 4601 (AFCEE 2006). The primary objectives of this investigation were to determine:

- the extent of groundwater contamination in the source area,
- if contamination extended into the vadose zone and represented a continuing source for groundwater contamination; and,
- if groundwater contamination detected in the source area represented a continuous

plume from the source area to a downgradient CS-10 groundwater extraction well.

These objectives were addressed through the sampling of 27 existing monitoring wells, the completion of four groundwater vertical profile borings, and subsurface soil sampling. All groundwater and soil samples were analyzed for VOCs. For additional information on the status of CS-10 groundwater including near the CS-10, source area, refer to Section 5.3. PCE was detected in two samples at concentrations of 19 µg/kg (at 12 ft bgs) and 0.36 µg/kg (at 86 ft bgs). These concentrations are well below the Massachusetts Contingency Plan (MCP) S-1/GW-1 Standard of 1,000 µg/kg for PCE. PCE was not detected in any of the other soil samples collected and TCE was not detected in any of the soil samples collected. Other VOCs detected include toluene, ethylbenzene, and total xylenes. These fuel-related VOCs were detected at very low concentrations (less than 10 µg/kg) and well below the MCP S-1/GW-1 standards for these compounds (AFCEE 2006). It was concluded that the PCE detections in vadose zone soils did not represent a potential continuing source for the CS-10 groundwater plume.

2011 Explanation of Significant Differences: The *Explanation of Significant Differences Areas of Contamination CS-10/FS-24, FS-1, and FS-9* (AFCEE 2011) documents additional changes to the selected remedy presented in the CS-10/FS-24 Source Area ROD (AFCEE 1999) as follows:

- 1) Removal of site access control and allow property (0-15 ft bgs) for residential land use designated as Details A, B, D, E, G, H, and I as a result of comparison of data collected during the RI, remedial action delineation data, and/or remedial action confirmation data with May 2010 EPA residential risk-based Regional Screening Levels (RSLs) and MassDEP MCP S-1/GW-1 standards;
- 2) Revise the existing RALs for C₁₉-C₃₆ aliphatic hydrocarbons and C₁₁-C₂₂ aromatic hydrocarbons for Detail A, Detail B, Detail C, Detail G, and Detail H by incorporating MassDEP S-1/GW-1 standards promulgated in 2008;
- 3) Removal of the hot air injection wells as a component to the CS-10 Detail C treatment system and the addition of a thermal oxidizer to the CS-10 Detail C

treatment system;

- 4) Removal of the UST from CS-10 Detail C;
- 5) No remedial action required for CS-10 Detail F as a result of the findings of the ecological risk evaluation using new data performed in 2004; and
- 6) SVE system shutdown for CS-10 Detail C, limited remedial action for soil at CS-10 Detail H, and no further action for subsurface soil for CS-10 Detail I as a result of performing an impact to groundwater analysis for PCE in the unsaturated zone using the vadose zone modeling software (VLEACH).

2014 CS-10 Source Area Details C and F Vapor Intrusion Evaluation: The *Final 2014 CS-10 Source Area Details C and F Vapor Intrusion Evaluation Project Note* (AFCEC 2014) reports the results of a VI screening evaluation conducted to assess potential VI risks above target levels from VOCs that remain in CS-10 Source Area soils at Detail C and F. The project note was prepared to document the results of this assessment. The results indicated that, at both Details C and F, VI risk above target levels is unlikely for current use. However, that VI risk above target levels cannot be ruled out for future use at Details C and F (AFCEC 2014).

4.1.3.2 Remedy Operation & Maintenance

No ongoing O&M activities are being conducted at the CS-10 source area.

4.1.4 Progress Since Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior fourth CERCLA Five Year Review (AFCEC 2013). For the CS-10 source area, the recommendations and follow-up actions were:

- 1) Complete a reassessment of Detail C EPH/VPD data and Detail F PAH, PCB, inorganic data and pursue UU/UE closure; however, if this cannot be achieved, then

pursue a LUC which would be documented in an ESD.

- 2) The VI exposure pathway should be assessed at Detail C and Detail F. It is recommended that these sites be screened utilizing applicable EPA guidance including the *OSWER Guidance for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Sources to Indoor Air* and *Guidance for Addressing Petroleum Vapor at Leaking Underground Storage Tanks Sites* (EPA 2015).

Progress since the last Five Year Review against this recommendation is as follows:

- 1) A reassessment of Detail C EPH/VPD data and Detail F PAH, PCB, inorganic data to pursue UU/UE closure or a LUC has not been completed and is being recommended in Section 4.1.7.
- 2) As discussed in Section 4.1.3.1 and 4.1.5.1, a VI screening evaluation was conducted at CS-10 Detail C and Detail F (AFCEC 2014). The results indicated that, at both Details C and F, VI risk above target levels was found to be unlikely for current land use it could not be ruled out for future use. A recommendation is being made in Section 4.1.7 to pursue UU/UE closure or a LUC for these two sites.

4.1.5 Five Year Review Process

4.1.5.1 Data Review

Based on the VI assessment (AFCEC 2014) conducted at both Details C and F, VI risk above target levels was found to be unlikely for current land use. No buildings are present within 100 ft of detections of VOCs in soil. Furthermore, subsurface utilities within 100 ft of detections are deemed unlikely to serve as preferential pathways by which vapor-phase contaminants could migrate to nearby buildings.

At Detail C, 2012 post-remediation data indicates that VPD concentrations in a soil sample (less than 16 ft bgs) do not meet the criteria for “clean” soil presented in the draft EPA petroleum vapor intrusion (PVI) guidance. In addition, no post-remediation soil analytical

data exist for non-petroleum VOCs such as PCE. Therefore, VI risk above target levels cannot be ruled out for future use at Detail C.

At Detail F, soil VPH concentrations meet the criteria for clean soil presented in the draft EPA PVI guidance for depths up to 4 ft bgs; however, there are no VPH analytical data for soil deeper than 4 ft bgs. Predicted source vapor concentrations from historic concentrations of TCE and methylene chloride in soil exceed EPA VISLs for residential sub-slab air. The soil analytical data are more than 10 years old, and it is likely that concentrations have attenuated since that time. However, the extent of attenuation, if any, is unknown and not documented. Although VISL exceedances do not necessarily mean VI above target levels will occur, they suggest, together with the absence of sufficiently deep VPH and VOC concentration data, that VI risk above target levels cannot be ruled out for future use at Detail F (AFCEC 2014).

4.1.5.2 Site Inspections

An SI in support of this Five Year Review was completed for CS-10 on 14 June 2017. The SI form is included in Appendix B. Since the remedial actions conducted at CS-10 are complete and no actions require ongoing O&M and no formal LUCs are currently in place, the focus of the SI was to assess general site conditions and to determine whether the land use assumptions are still valid and do not affect protectiveness. Based on the SI, land use at the site remains consistent with the assumptions used in the risk assessment and no concerns regarding protectiveness were identified.

4.1.5.3 Interviews

Refer to Section 3.7.

4.1.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

4.1.6.1 Question A: Is the remedy functioning as intended by the decision document?

For CS-10 Detail C, the remedial action has been completed, an RAR has been prepared (AFCEE 2009), and the remedy is functioning as intended under current land use. However, residual EPH/VPH concentrations remain in vadose zone soils. A reassessment of soil data to determine whether UU/UE conditions exist should be conducted to determine whether UU/UE closure can be reasonably achieved. Collect additional data if warranted or evaluate applying institutional controls.

For CS-10 Detail F, no further remedial action is required based on the ecological risk analysis and the remedy is functioning as intended under current land use. However, residual PAH, PCB, and inorganic concentrations remain in soils/sediments. A reassessment of soil data to determine whether UU/UE conditions exist should be conducted to determine whether UU/UE closure can be reasonably achieved. Collect additional data if warranted or evaluate applying institutional controls.

4.1.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup level, and RAOs used at the time of remedy selection (current) still valid?

Changes in Standards and To-Be Considered: MassDEP has re-evaluated S-1/GW-1 soil standards for EPH/VPH since the last Five Year Review. The new S-1/GW-1 soil standards became effective on April 25, 2014 (see 310 Code of Massachusetts Regulations [CMR] 40.0975(6) (a)). The new MassDEP S-1/GW-1 soil standards do not change the protectiveness of the implemented remedy.

Changes in Exposure Pathways: There have been no changes in the physical conditions and land use of the site that would affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics: There were no changes in toxicity and other contaminant characteristics.

Changes in Risk Assessment Methods: There have been no changes in risk assessment

methodology that affect protectiveness.

Review of RAOs: RAOs are appropriate.

4.1.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information at this time that calls into question the short-term protectiveness of the remedy based on current land use. This IRP site is located within installation boundaries and exposure pathways for humans are currently controlled or mitigated by the DoD land use and management practices.

4.1.7 Issues, Recommendations, and Follow-Up Actions

Complete a reassessment of Detail C EPH/VPH data and Detail F PAH, PCB, inorganic data and pursue UU/UE closure; however, if this cannot be achieved, then pursue a LUC which would be documented in an ESD.

4.1.8 Protectiveness Determination

The remedies for CS-10 source area Details C and F are protective of human health and the environment in the short-term under the current land use scenario. The remedy is protective in the short term since access to the site is controlled by a fence that effectively limits potential human exposure. However, for the remedies to be protective in the long-term it is recommended that site characterization data be reevaluated to determine if UU/UE conditions can be met; if UU/UE closure cannot be supported for Details C and/or F, then either (i) conduct additional cleanup activities to levels that allow UU/UE; or (ii) issue a decision document implementing enforceable LUCs preventing uses for which the site may still pose an unacceptable risk under future uses that would ensure long-term protectiveness.

4.1.9 References

ABB-ES. 1992 (April). *Interim Remedial Investigation, UTES BOMARC and BOMARC Area Fuel Spill (AOC CS-10 and AOC FS-24)*. Prepared for HAZWRAP

(Hazardous Waste Remedial Actions Program) and ANG/MMR Installation Restoration Program and ANG, Otis Air National Guard Base, MA.

AFCEC. 2014 (July). *Final 2014 CS-10 Source Area Details C and F Vapor Intrusion Evaluation*, Otis Air National Guard Base, MA.

_____. 2013 (October). *Final 4th Five Year Review, 2007-2012, Massachusetts Military Superfund Site, Otis Air National Guard Base, MA*. 473147-SPEIM-Multiple-RPT-001. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

AFCEE. 2011 (September). *Explanation of Significant Differences Areas of Contamination CS-10/FS-24, FS-1, and FS-9, Massachusetts Military Reservation (MMR) Superfund Site*, Otis Air National Guard Base, MA.

_____. 2009 (September). *Chemical Spill 10 (CS-10) Detail C Remedial Action Report*. Prepared by Portage Environmental Inc. and Engineering Strategies Corporation for AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.

_____. 2008 (September). *Final 3rd Five-Year Review, 2002-2007 Massachusetts Military Reservation (MMR) Superfund Site, Otis Air National Guard Base, MA* Prepared by Engineering Strategies Corporation, Portage and CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

_____. 2006 (May). *Project Note: CS-10 Source Area Investigation Results*. Prepared by CH2M HILL for AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.

_____. 2005 (June). *Chemical Spill No. 10 Detail C Vadose Zone Characterization Report*. Prepared by Portage Environmental Inc. and Engineering Strategies Corporation for AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.

_____. 2004a (March). *Revised Screening Level Ecological Risk Assessment Area of Concern CS-10 Detail F*. Prepared by Environmental Chemical Corporation for AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.

_____. 2004b (October). *Ecological Risk Assessment-Addendum Area of Concern CS-10 Detail F*. Prepared by Environmental Chemical Corporation for AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.

- _____. 2003a (February). *Explanation of Significant Differences Areas of Contamination CS-10 (A, B, & E); CS-16/CS-17; FS-9; SD-2/FS-6/FS-8; and SD-3/FTA-3/CY-4*. Prepared by Portage Environmental Inc. and Engineering Strategies Corporation for AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.
- _____. 2003b (September). *Final Remedial Action Report Area of Contamination CS-10/FS-24*. Prepared by Environmental Chemical Corporation for AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.
- _____. 2002 (September). *Chemical Spill No. 10 (CS-10) Details H & I Vadose Zone Characterization Report*. Prepared by Portage Environmental Inc. and Engineering Strategies Corporation for AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.
- _____. 1999 (July). *Record of Decision Area of Contamination CS-10/FS-24 Source Areas*. Prepared by HAZWRAP for AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.
- _____. 1998 (September). Massachusetts Military Reservation Focused Feasibility Study AOC CS-10/FS-24 Source Operable Units. Prepared by HAZWRAP for AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.
- _____. 1997 (December). Final Remedial Investigation UTES/BOMARC, and BOMARC Area Fuel Spill (AOC CS-10 and AOC FS-24) Source Operable Unit: CS-10A and CS-10B. Prepared by CDM Federal Programs Corporation for AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.
- ANG. 1995 (September). Final Record of Decision Interim Remedial Action Containment of Seven Groundwater Plumes at MMR, Cape Cod MA. Prepared by Stone & Webster Environmental & Technology Services for ANG Readiness Center, Installation Restoration Program, Otis ANG Base, MA.
- CDM (Camp Dresser and McKee Federal Programs Corporation). 1997 (December). Final Remedial Investigation, UTES/BOMARC and BOMARC Area Fuel Spill, AOC CS-10/ FS-24 (AOC CS-10 and AOC FS-24) Source Operable Units: CS 10A and CS-10B. Prepared for AFCEE/MMR Installation Restoration Program and ANG, Otis Air National Guard Base, MA. Submitted by HAZWRAP (Hazardous Waste Remedial Actions Program), Oak Ridge, TN.
- _____. 1996 (July). *Final Remedial Investigation, UTES/BOMARC and BOMARC Area Fuel Spill, AOC CS-10 Groundwater Operable Unit: CS-10D and Hydrogeologic Region II Study, Volume I*. Prepared for AFCEE/MMR Installation Restoration Program and ANG, Otis Air National Guard Base, MA. Submitted by HAZWRAP (Hazardous Waste Remedial Actions Program), Oak Ridge, TN.
- E.C. Jordan. 1990 (March). *Task 2-3B Site Inspection, Field Investigation Work Conducted Spring-Summer 1988; Installation Restoration Program;*

Massachusetts Military Reservation. Prepared by E.C. Jordan Co. Prepared for HAZWRAP; Portland, Maine.

_____. 1989 (March). *Task 2-3A Site inspection, Field Investigation Work Conducted Fall 1987; Installation Restoration Program; Massachusetts Military Reservation*. Prepared by E.C. Jordan Co, Prepared for HAZWRAP; Portland, Maine.

_____. 1986 (March). *U.S. Air Force Installation Restoration Program, Phase I: Records Search, Air National Guard, Camp Edwards, U.S. Air Force, and Veterans Administration Facilities at Massachusetts Military Reservation*. Prepared by E.C. Jordan Co. Prepared for HAZWRAP; Portland, Maine.

EPA. 2015 (June) *OSWER Guidance for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Sources to Indoor Air and Guidance for Addressing Petroleum Vapor at Leaking Underground Storage Tanks Sites*

_____. 2001 (June). *Comprehensive Five-Year Review Guidance*, EPA 540R-01-007.

MassDEP. 1997. Reuse and Disposal of Contaminated Soil at Massachusetts Landfills Policy # COMM-97-001, Massachusetts Department of Environmental Protection.

Technical Review and Evaluation Team (TRET). 1996 (May). *Toward a Balanced Strategy to Address Contaminated Groundwater Plumes at the Massachusetts Military Reservation*.

4.2 LANDFILL-1 (LF-1) SOURCE AREA

The LF-1 source area is located in the southern portion of JBCC and is bounded by Turpentine Road to the east, Frank Perkins Road to the west, Herbert Road to the north, and Connery Avenue to the south (Figures 1-2 and 4-2). The LF-1 source area, which occupies approximately 100 acres of open to heavily wooded terrain, operated between 1941 and 1993 as the primary solid waste disposal facility at JBCC (AFCEE 2012b).

4.2.1 Site Chronology

1983: A records search identified the landfill as a potential source for the VOCs detected in June 1979 in a base water supply well (the G well) located approximately 6,000 ft downgradient of the landfill (ANG 1983).

1985 – 1996: Numerous investigations (ANG 1985, 1991, and 1992b; and E.C. Jordan 1988, 1990a, 1990b) were conducted which culminated in an RI report (AFCEE 1996).

1993: The interim ROD for the LF-1 landfill (ANG 1993c) was completed.

1995 to 1996: Closure activities at the landfill, including capping three cells and instituting post-closure monitoring (PCM), were completed in December 1995. Landfill caps on the three most recently used cells (1970, Post-1970, and Kettle Hole) were constructed because these cells were the apparent sources of groundwater contamination (AFCEE 2012b).

1997 to Present: PCM and maintenance of the cover system is ongoing and monitoring of groundwater quality is conducted. Since 2005, the PCM activities have been documented in the annual LF-1 SLRs (AFCEC 2017, 2016, 2015, 2014, 2013c; AFCEE 2012c, 2011, 2010, 2009, 2008, 2007b, 2006b); between 2000 and 2005, these activities were documented in annual LF-1 SPEIM reports (AFCEE 2005, 2004, 2003, 2002, and 2001); and prior to 2000, these activities were documented in PCM reports (AFCEE 2000, 1999, and 1998).

2006-2007: Preparation of the feasibility study (AFCEE 2006a) and ROD (AFCEE 2007a).

2011: A screening was completed at the LF-1 landfill in accordance with the VI screening process developed and presented in the 2012 VI technical memorandum for the PFSA and FTA-2 source areas (AFCEE 2012a).

2012: Update to LF-1 PCM Plan (AFCEE 2012b).

2013: Submittal of an ESD applying the LUCs documented in the 2007 ROD to the Northwest Operable Unit (NWOU) (AFCEC 2013b).

2014: A Record Notice of Landfill Operation for the LF-1 was filed at the Base Real Property office on 04 March 2014.

4.2.2 Background

4.2.2.1 History of Contamination

The LF-1 source area occupies approximately 100 acres of open to heavily wooded terrain and began operating in 1941 as the primary solid waste disposal facility at JBCC. From the late 1940s until 1984, unregulated disposal activities were conducted at the site. From 1984 to 1993, regulated disposal activities were conducted by the NGB at the LF-1 landfill as a component of the JBCC Hazardous Waste Management Plan. Disposal at the landfill occurred in six areas consisting of five distinct cells and a natural kettle hole. The cells are designated by the years representing the approximate end date of waste disposal activities. The six disposal areas include the 1947, 1951, and 1957 cells, referred to as NWOU, which occupy approximately 40 acres of the total LF-1 landfill area; and the 1970 and Post-1970 cells and the Kettle Hole, which occupy approximately 50 acres. The remaining 10 acres comprise the space between and surrounding the cells. The thickness of waste burial has not been accurately determined, but is estimated to be about 20 ft thick for the 1970 and Post-1970 cells; while the thickness of waste in the Kettle Hole is unknown (E.C. Jordan Co. 1988 and 1990b). Approximately 100 additional acres were used in and around the

site for construction soil material borrow pits, access roads, staging areas, and cross-gradient or downgradient surface water recharge areas (i.e., retention/detention basins).

Accurate documentation of the wastes disposed of at the LF-1 landfill does not exist. The wastes are believed to include general refuse, fuel tank sludge, herbicides, solvents, transformer oils, fire extinguisher fluids, blank small arms ammunition, paints, paint thinners, batteries, dichlorodiphenyltrichloroethane (DDT) powder, hospital wastes, municipal sewage sludge, coal ash, and possibly live ordnance (AFCEE 2012b).

4.2.2.2 Physical Characteristics, Land and Resource Use

The LF-1 source area is currently maintained as a controlled area. This use is not anticipated to change over time. The LF-1 cover system is composed of a low permeability cap built on top of the three cells, an associated cover drainage system, and 70 passive gas vents designed to release gas from the interior of the landfill and minimize the potential for lateral gas migration. Gas probes are located around the perimeter of the capped cells and NWOU to monitor subsurface vapor. A perimeter fence exists around the entire landfill (capped cells and NWOU) which controls access. The maximum and minimum ground surface elevations within the fenced area are 166 ft msl and 98 ft msl, respectively. LUCs are in place to protect human health by limiting exposure to the source area material and by preventing intrusive work in the area.

4.2.2.3 Initial Response

An initial SI of the landfill was conducted (ANG 1985) and indicated there was minor evidence of landfill-derived leachate based on the presence of VOCs detected during monitoring well installation and sampling. Magnetic anomalies and the disposal boundaries were delineated through magnetometer and radar surveys of the landfill (E.C. Jordan 1990b). Soil gas data indicated that waste buried in the landfill emitted a wide variety of VOCs and that landfill gases related to the degradation of organic material (including methane) were being released to the atmosphere (E.C. Jordan 1990b). These investigations confirmed that contamination leaching from the LF-1 landfill was

contributing to groundwater contamination.

4.2.2.4 Basis for Taking Action

The basis for taking action at the LF-1 source area is described in the following sections:

Interim Remedial Investigation: An interim RI was performed from 1987-1989 to further quantify the impact to groundwater downgradient of each landfill cell, to estimate the potential for each cell to be a continuing source of groundwater contamination, and to develop an initial CSM for the source area and associated groundwater plume. A risk assessment of the landfill (all six disposal areas) indicated that there was a potential for human health risks as a result of exposure to source area groundwater and that remedial action should be performed at the landfill to reduce contaminants leaching to groundwater (ANG 1992a). Groundwater data collected during 1989-1990 (ANG 1993a) indicated that significant contamination was not emanating from the older NWOU cells (1947, 1951, and 1957). An environmental justification report indicated that the NWOU was not a source of contamination and that it did not pose a public health risk or environmental hazard (ANG 1991). Hence, recommendations were made for no additional action (i.e., landfill cover) at the NWOU.

Remedial Investigation: From 1992 to 1994, the LF-1 RI was conducted and was intended to complete the characterization of the extent of subsurface contamination by defining the downgradient (horizontal and vertical) extent of the chlorinated solvent plume, and evaluating the stratigraphy and geology of the region (AFCEE 1996).

Focused Feasibility Study: A focused feasibility study (ANG 1992a) and final decision documents (ANG 1993c) addressed remedial objectives, remedial alternatives, alternatives analysis, and a detailed remedial design for the LF-1 source area. The design for contaminant source control was based on an interim remedial strategy to reduce contaminant leaching, limit migration of liquids through the landfill cells, and maintain compatibility with final remedial measures (ANG 1993c).

Feasibility Study: A feasibility study was completed in 2006 (AFCEE 2006a) to identify remedial alternatives for LF-1 groundwater. Nineteen alternatives were evaluated. As part of the feasibility study, a risk assessment was performed for groundwater and surface water (Buzzards Bay). Soil exposure pathways for humans and ecological receptors at the source area were not evaluated due to the cap and fence already installed at the landfill (interim remedial action described in Section 4.3.3.1).

4.2.3 Remedial Actions

The final remedy for the LF-1 source area was determined in the *Final Record of Decision for the LF-1 Source Area and Groundwater* (AFCEE 2007a) which was signed on 28 September 2007.

The RAOs for the LF-1 source area as presented in the ROD are as follows:

- Prevent the leaching from the source area of landfill contamination that would cause groundwater downgradient from the landfill to be unusable.
- Prevent risks to human health and the environment (if any) posed by the landfill.

4.2.3.1 Remedy Selection and Implementation

Interim Record of Decision: In 1993, EPA approved and MassDEP concurred with the *Record of Decision Interim Remedial Action, Main Base Landfill (AOC LF-1) Source Area Operable Unit* (ANG 1993c). The interim remedial plan, referred to as the preferred alternative, addressed LF-1 source control and recommended a method of minimizing further contamination from occurring using containment options evaluated during the focused feasibility study.

The interim remedial action for the landfill (ANG 1993c) consisted of the following actions:

1. Leaving NWOU wastes in place beneath the existing soil and vegetative cover and installing downgradient groundwater monitoring wells to assess any impacts from

the older cells and to determine if the interim remedial action is an appropriate long-term remedial action.

2. Construction of a landfill cover system over the 1970 Cell, Post-1970 Cell, and the Kettle Hole.
3. Preparation of a PCM Plan for the 1970 Cell, Post-1970 Cell, and Kettle Hole.

Final Record of Decision: A final remedy for the 1970 Cell, Post-1970 Cell, and Kettle Hole was selected and documented in the September 2007 ROD (AFCEE 2007a). The NWOU (the 1947, 1951, and 1957 cells) was not included in this decision document.

The remedy for the LF-1 source area (the 1970-Cell, Post-1970 Cell, and Kettle Hole) provides for continued monitoring and maintenance of the existing landfill cover system. The objective of the remedy is to maintain the integrity of the landfill cover system to prevent leaching of contamination that would cause downgradient groundwater to be unusable and implement LUCs to prevent exposure to landfill waste.

Closure activities at the landfill, including capping three cells (1970, Post-1970, and Kettle Hole) and instituting PCM, were completed in December 1995 (AFCEE 2007a). The primary purpose of the landfill cover and associated drainage structures was to minimize the amount of precipitation that infiltrates the landfill and produces leachate that drains into the aquifer. It is expected that with a properly functioning cover, landfill drainage will become negligible once moisture in excess of the waste's field capacity has drained. The LF-1 cover system is composed of low permeability caps constructed over the three cells, an associated drainage system, and 70 passive gas vents designed to release gas from the interior of the landfill. Gas probes are located around the perimeter of the caps to monitor subsurface vapor. A perimeter fence was already in place around the entire landfill (capped cells and NWOU) at the time the cap was installed in 1995.

Explanation of Significant Differences: The NWOU was not included in the LF-1 ROD due to EPA concerns regarding surface soil contamination related to former Gun Positions (Old GP-2 and Old GP-3) that were used on the NWOU after the landfill cells were closed.

The IAGWSP addressed EPA's concerns regarding the NWOU surface soil contamination, allowing a decision document to be completed for the NWOU. An ESD has been prepared that extends the applicable LUCs for the capped portion of the LF-1 landfill to the NWOU (AFCEC 2013b).

VI Screening Assessment: Due to increased concern related to the VI exposure pathway, a VI screening assessment was conducted for a number of sites at the MMR including LF-1 where the VI exposure pathway related to volatile contaminants in groundwater was determined to be incomplete and further evaluation of VI associated with the LF-1 plume was not necessary. However, the VI pathway associated with LF-1 source area material was not assessed during this 2012 MMR VI evaluation. A screening has been completed at the LF-1 landfill in accordance with the VI screening process developed and presented in the 2012 VI technical memorandum for the PFSA and FTA-2 source areas (AFCEE 2012a).

Deed Notification: A component of the institutional controls was to document the presence of a landfill at LF-1 through a deed notification per the MassDEP solid waste regulations (310 CMR 19.141). AFCEC, working with the base real estate office and the Commonwealth who owns the property, were unable to determine whether a deed for this parcel was in existence. Therefore, the deed notification was filed at the Base Real Property office which meets the intent of the deed notification regulatory requirement.

4.2.3.2 Remedy Operations & Maintenance

The Post-Closure Plan for Main Base Landfill (ANG 1993a), outlined the following actions:

1. PCM and maintenance of the cover system is to be conducted for a minimum of 30 years after the completion of cap construction. To verify that the cap maintains its structural integrity, it is inspected for animal burrows, erosion rills, settlement depressions, intrusive vegetation, seeps, and sedimentation in ditches and culverts.

Post-closure maintenance is performed any time a loss of integrity is noticed; landfill surveys are performed regularly.

2. Landfill gas and groundwater quality at the landfill were to be monitored as appropriate. The landfill interim remedial action will allow time to further evaluate the environmental impact of the 1947, 1951, and 1957 cells on groundwater quality.
3. The performance evaluation of the interim remedial action occurs regularly.

In 1996, the EPA and MassDEP approved the closure report for the landfill site (ANG 1996), thus initiating the LTM program as defined in the Post-Closure Plan. Ongoing PCM activities were eventually combined with the SPEIM program for the interim (now final) groundwater remedial action. These activities include sampling groundwater monitoring wells, SIs, settlement monitoring, periodic maintenance of the cover system (i.e., mowing, repairing animal burrow holes, cleaning out drainage swales, etc.), and LUCs (i.e., ensuring perimeter fence is functional, gates are locked and appropriate signage is maintained). The post-closure activities conducted during this Five Year Review period are documented in several annual summary letter reports (AFCEC 2017, 2016, 2015, 2014, 2013c; AFCEE 2012c, 2011, 2010, 2009, 2008, 2007b, 2006b).

4.2.4 Progress Since Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior fourth CERCLA Five Year Review (AFCEE 2013a). For the LF-1 source area, the recommendations and follow-up actions were:

- 1) Continue LTM and landfill cap O&M activities as required by the final ROD.

Progress since the last Five Year Review against these recommendations is as follows:

- 1) As discussed in Section 4.2.3.2, landfill cap operation and maintenance activities have been performed annually as required by the ROD.

4.2.5 Five Year Review Process

4.2.5.1 Data Review

Data collected at the LF-1 source area have been reported as part of the annual landfill inspection reporting and are documented in the LF-1 SLRs (AFCEC 2017, 2016, 2015, 2014, 2013c; AFCEE 2012c, 2011, 2010, 2009, 2008, 2007b, 2006b). In summary, minor maintenance and repairs to the landfill cap system (such as filling minor erosion rills and trimming vegetation) have been required and have been implemented by AFCEC following discovery during inspections. Landfill settlement survey results are within expected ranges and do not identify cause for concern or issues with the integrity of the cap.

4.2.5.2 Site Inspections

An SI in support of this Five Year Review was completed for the LF-1 source area on 14 June 2017. The SI form is included in Appendix B. Since the remedial actions conducted at the LF-1 source area are complete and annual landfill inspections are ongoing and well documented as discussed in Sections 4.2.3.2 and 4.2.5.1, the focus of the SI was to assess general site conditions and to determine whether the land use assumptions are still valid and do not affect protectiveness. Based on the SI, land use at the site remains consistent with the assumptions used in the risk assessment and no concerns regarding protectiveness were identified.

4.2.5.3 Interviews

Refer to Section 3.7.

4.2.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

4.2.6.1 Question A: Is the remedy functioning as intended by the decision document?

Based on a review of annual landfill inspection results and assessment of LF-1 groundwater plume remedial progress as discussed in Section 5.13, it can be concluded that the remedy is functioning as intended by the ROD and the RAOs (Section 4.2.3) are being achieved.

4.2.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup level, and RAOs used at the time of remedy selection (current) still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards and to-be considered guidance.

Changes in Exposure Pathways: There have been no changes in the physical conditions and land use of the site that would affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics: There have been no changes in the toxicity and other contaminant characteristics that would affect the protectiveness of the remedy.

Changes in Risk Assessment Methods: There have been no changes in risk assessment methodology that affect protectiveness.

Review of RAOs: RAOs are appropriate.

4.2.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

A solar photovoltaic array construction project is being considered on the capped portion of the LF-1 landfill. Preliminary discussions between AFCEC, EPA, and MassDEP have indicated that since the solar array will be constructed on the landfill cap that is part of CERCLA, issuance of a MassDEP Post-Closure Use Permit (typically issued under 310 CMR 19.143) is not required for this project. However, EPA approval is required after it has been demonstrated that the solar array project will not adversely impact the landfill cover and that the project will be maintained in a manner to protect the long term integrity

of the cover (i.e., the protectiveness of the remedy will be maintained). To receive approval, EPA has requested AFCEC prepare and submit a technical memorandum that includes the information required by MassDEP under their permitting process as described in the fact sheet *Developing Renewable Energy Facilities on Closed Landfill* (<http://www.mass.gov/eea/docs/dep/energy/fslfenergy.pdf>) for EPA and MassDEP review.

4.2.7 Issues, Recommendations, and Follow-Up Actions

No issues exist at the present time and the remedy continues to function as intended. Landfill cap operation and maintenance activities should continue as required in the Final ROD (AFCEE 2007a), the PCM Plan (AFCEE 2012b) and in accordance with any subsequent changes approved by EPA. Should the solar photovoltaic array construction project be awarded, a technical memorandum as described in Section 4.2.6.3 will be prepared for regulatory review and approval.

4.2.8 Protectiveness Determination

The remedy for the LF-1 source area is protective of human health and the environment in the short-term under the current land use scenario. Groundwater monitoring under the LF-1 SPEIM/LTM program (discussed in Section 5.13) does not indicate the LF-1 source area is acting as a continuing source of groundwater contamination for current COCs and prevents contact with contaminated soil. Therefore, the landfill cap system at LF-1 is operating as expected. In addition, the LUCs are in place and are functioning as intended. For the remedy to be protective in the long-term, additional activities to address ECs in groundwater are needed as discussed in Section 5.13.

4.2.9 References

AFCEC. 2017 (March). LF-1/CS-23 2016 Summary Letter Report. 652000-SPEIM-LF1/CS23-SLR-003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

_____. 2016 (March). *LF-1/CS-23 2015 Summary Letter Report*. 652000-SPEIM-LF1/CS23-SLR-002. Prepared by EA Engineering, Science and Technology and

CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

- _____. 2015 (March). *LF-1/CS-23 2014 Summary Letter Report*. 652000-SPEIM-LF1/CS23-SLR-001. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014 (March). *LF-1/CS-23 2013 Summary Letter Report*. 473147-SPEIM-LF1/CS23-SLR-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis ANG Base, MA
- _____. 2013a (October). *Final 4th Five-Year Review, 2007-2012 Massachusetts Military Reservation (MMR) Superfund Site, Otis Air National Guard Base, MA*. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2013b (September). *Final Explanation of Significant Differences for the Landfill 1 (LF-1) Source Area at the Massachusetts Military Reservation*. 437075-SPEIM-LF1-ESD-002. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013c (March). *LF-1/CS-23 2012 Summary Letter Report*. 437075-SPEIM-LF1/CS23-SLR-001. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- AFCEE. 2012a (August). *Final 2011 MMR Vapor Intrusion Evaluation Technical Memorandum*. 420005-SPEIM-MULTIPLE-TECHMEM-002. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012b (July). *Final LF-1 2011 Post-Closure Monitoring Plan Update*. 420005-SPEIM-LF1-RPT-002. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012c (March). *LF-1/CS-23 2011 Summary Letter Report*. 420005-SPEIM-LF1/CS23-SLR-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2011 (March). *LF-1/CS-23 2010 Summary Letter Report*. 404929-SPEIM-LF1/CS23-SLR-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2010 (March). *LF-1/CS-23 2009 Summary Letter Report*. 389849-SPEIM-LF1/CS23-SLR-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2009 (March). *LF-1/CS-23 2008 Summary Letter Report*. 371335-SPEIM-

LF1/CS23-SLR-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis ANG Base, MA.

- _____. 2008 (March). *LF-1/CS-23 2007 Summary Letter Report*. 337105-SPEIM-LF1/CS23-SLR-002. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis ANG Base, MA.
 - _____. 2007a (September). *Final Record of Decision for Landfill-1 Source Area and Groundwater*. A4P-J23-35BC02VA-M26-0007. Prepared by Jacobs Engineering for AFCEE/MMR, Installation Restoration Program, Otis ANG Base, MA.
 - _____. 2007b (February). *LF-1/CS-23 2006 Summary Letter Report*. 337105-SPEIM-LF1/CS23-SLR-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis ANG Base, MA.
 - _____. 2006a (May). *Final Landfill-1 Source Area and Groundwater Feasibility Study*. A4P-J23-35BC02VA-M16-0012. Prepared by Jacobs Engineering for AFCEE/MMR, Installation Restoration Program, Otis ANG Base, MA.
 - _____. 2006b (February). *Landfill-1 2005 Summary Letter Report*. 324146-SPEIM-LF1/CS23-SLR-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis ANG Base, MA.
 - _____. 2005 (July). *Final Landfill-1 2004 System Performance and Ecological Impact Monitoring Report*. 324146-SPEIM-LF1-ANRPT-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2004 (May). *Final Landfill-1 2003 Annual System Performance and Ecological Impact Monitoring Report*. 187615-SPEIM-LF1-ANRPT-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2003 (September). *Final Landfill-1 2002 Annual System Performance and Ecological Impact Monitoring Report*. ENR-J23-35Z15609-M31-0005. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2002 (July). *Final Landfill-1 2001 Annual System Performance and Ecological Impact Monitoring Report*. A3P-J23-35Z01509-M31-0007. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2001 (November). *Final Landfill-1 2000 Annual System Performance and Ecological Impact Monitoring Report*. A3P-J23-35Z01509-M31-0003. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
-

- _____. 2000 (June). *Final Landfill-1 Post-Closure Monitoring 1999 Annual Report*. AFC-J23-35U40511-M17-0002. Prepared by Jacobs Engineering Group, Inc., for AFCEE/MMR Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 1999 (September). *Final Landfill-1 Post-Closure Monitoring 1998 Annual Report*. AFC-J23-35S17901-M17-0007. Prepared by Jacobs Engineering Group, Inc., for AFCEE/MMR Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 1998 (August). *Final Landfill-1 Post-Closure Monitoring 1997 Annual Report*. AFC-J23-35G489000-M17-0004. Prepared by Jacobs Engineering Group, Inc., for AFCEE/MMR Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 1996 (April). *Final Remedial Investigation Main Base Landfill (AOC LF-1) and Hydrogeologic Region I Study*. Prepared by CDM Federal Programs Corporation for AFCEE/MMR Installation Restoration Program Otis ANG Base, MA.
- Air National Guard (ANG) 1996 (September). AOC LF-1 Main Base Landfill Site Closure Report. Installation Restoration Program, Massachusetts Military Reservation, Cape Cod, Massachusetts. Prepared for Hazardous Waste Remedial Actions Program, Oak Ridge, Tennessee, by ABB Environmental Services, Inc.
- _____. 1993a (September). Post-Closure Plan for Main Base Landfill (AOC LF-1). Massachusetts Military Reservation, Cape Cod, Massachusetts. Prepared for Hazardous Waste Remedial Actions Program, Oak Ridge, Tennessee, by ABB Environmental Services, Inc.
 - _____. 1993b (March). Closure Plan for Area of Contamination LF-1 1970 Cell, Post-1970 Cell, and Kettle Hole Technical Specifications. Massachusetts Military Reservation, Cape Cod, Massachusetts. Prepared for Hazardous Waste Remedial Actions Program, Oak Ridge, Tennessee, by ABB Environmental Services, Inc.
 - _____. 1993c (January). Record of Decision Interim Remedial Action Main Base Landfill (AOC LF-1) Source Area Operable Unit. Massachusetts Military Reservation, Cape Cod, Massachusetts. Prepared for Hazardous Waste Remedial Actions Program, Oak Ridge, Tennessee, by ABB Environmental Services, Inc.
 - _____. 1992a (June). Focused Feasibility Study for the Main Base Landfill (AOC LF-1). Massachusetts Military Reservation, Cape Cod, Massachusetts. Prepared for Hazardous Waste Remedial Actions Program, Oak Ridge, Tennessee, by ABB Environmental Services, Inc.
 - _____. 1992b (April). Closure Plan for Study Area LF-1 1970 Cell, Post-1970 Cell, and Kettle Hole Technical Specifications (90 Percent Design). Massachusetts Military Reservation, Cape Cod, Massachusetts. Prepared for Hazardous Waste Remedial Actions Program, Oak Ridge, Tennessee, by ABB Environmental

Services, Inc.

- _____. 1991 (May). Environmental Justification Report, Study Area LF-1 Northwest Operable Unit. Massachusetts Military Reservation, Cape Cod, Massachusetts. Prepared for Hazardous Waste Remedial Actions Program, Oak Ridge, Tennessee, by ABB Environmental Services, Inc.
- _____. 1985 (October). Installation Restoration Program Phase II – Confirmation/Quantification Stage 1. Prepared by Weston for the Otis ANG Base, MA.
- _____. 1983 (January). Phase I Records Search, Otis Air National Guard Base, Massachusetts. Prepared by Metcalf & Eddy, Inc. for the Otis ANG Base, MA.
- E.C. Jordan Co. 1990a (June). Final Remedial Investigation Field Sampling and Analysis Plan, Six Priority I Sites, Task 2-5. Prepared by E.C. Jordan Co. for HAZWRAP Support Contractor Office, Oak Ridge National Laboratory, Oak Ridge, TN.
- _____. 1990b (January). Final Report, Site Inspection Report, Field Investigation Work Conducted Spring-Summer 1988, Task 2-3B. Prepared by E.C. Jordan Co. for HAZWRAP Support Contractor Office, Oak Ridge National Laboratory, Oak Ridge, TN.
- _____. 1988 (July). *Field Investigations, Summer/Fall 1986; Task 2-1; Base Landfill, Petroleum Fuels Storage Area, and Fire-Training Area*; Prepared by E.C. Jordan Co. for HAZWRAP Support Contractor Office, Oak Ridge National Laboratory, Oak Ridge, TN.
- EPA. 2002. Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance). Washington D.C. Available at:

<http://www.epa.gov/osw/hazard/correctiveaction/eis/vapor.htm>.
- _____. 2001 (June). *Comprehensive Five-Year Review Guidance*, EPA 540R-01-007.

4.3 FIRE TRAINING AREA-2/LANDFILL-2 (FTA-2/LF-2)

FTA-2/LF-2 is located west of the southern end of Runway No. 5, within the flightline security area (Figure 4-3). The FTA-2/LF-2 area occupies approximately 25 acres, and includes a former FTA that was located on top of a buried industrial/municipal landfill. Landfill operations at LF-2 began in approximately 1940 and consisted of the disposal of solid waste (e.g., bottles, glass, ash, metal scrap, wood, concrete, and asphalt construction debris). The landfiling activities were discontinued in 1944 and the area was covered with fill material before the fire-training site was developed in 1948. Fire-training activities at FTA-2 began in an unlined depression on the southern part of the landfill that acted as a drainage swale. Sand, asphalt, and concrete rubble fill were apparently placed in the landfill swale before, during, and after fire-training activities. FTA-2 was covered with additional soil following its abandonment in 1956 (ANG 1996).

4.3.1 Site Chronology

1940 - 1944: LF-2 area used for disposal of solid waste.

1948 - 1956: FTA-2 was developed over a small portion of LF-2 and was used for fire training exercises during this period. The structure was abandoned and filled in 1956.

1986: A PA was completed which identifies FTA-2/LF-2 as a potential location of the disposal of hazardous materials (E.C. Jordan 1986).

1988: SIs confirm landfiling operations and evidence of the disposal of oil and hazardous materials at FTA-2/LF-2 (E.C. Jordan 1990).

1996: RIs at FTA-2/LF-2 completed (ANG 1996).

1997-1998: Completion of a feasibility study (AFCEE 1997) and a ROD (AFCEE 1998).

2001-2003: A biosparging system was installed and operated until STCL remedial goals were met. Before reaching final concurrence on the soil remediation, MassDEP required sampling of groundwater for extractable petroleum hydrocarbon (EPH) and volatile petroleum hydrocarbon (VPH) following MassDEP methods. Select EPH/VPH carbon ranges exceeded MCP Method 1 GW-1 groundwater standards (AFCEE 2005).

2004-2009: As part of groundwater monitoring associated with the nearby Western Aquafarm site in 2004, 1,2,4-trimethylbenzene (TMB) and 1,3,5-TMB were detected at two monitoring wells within the FTA-2/LF-2 area. In 2005, an interim groundwater LTM program was established within the FTA-2/LF-2 source area while other site characterization work was completed to evaluate the nature and extent of the groundwater contamination. Ten separate groundwater sampling events were conducted between 2004 and 2009. During this period, EPH/VPH carbon range concentrations were consistently reported above the MCP Method 1 GW-1 standards; however, current land use limits human exposure to the groundwater and the contamination does not appear to be migrating beyond the base boundary (AFCEE 2008).

2010: A project note was prepared that presents an historic overview of the groundwater data collected at FTA-2/LF-2 and also expands the FTA-2/LF-2 LTM network. In this project note, it was agreed by AFCEE, EPA, and MassDEP that groundwater contamination that could potentially be associated with the Western Aquafarm site (now closed), LF-2, and FTA-2 would be associated with the FTA-2 site going forward for reporting purposes (AFCEE 2011).

2010: A RAR (AFCEE 2010) was prepared to document that AFCEC completed remedial action activities (i.e., construction and operation of the biosparging treatment system) specified in the FTA-2/LF-2 remedy in the *Record of Decision for Areas of Contamination FTA-2/LF-2, PFSA/FS-10/FS-11, SD-2/FS-6/FS-8, SD-3/FTA-3/CY-4, SD-4, and SD-5/FS-5 Source Areas* (AFCEE 1998).

2011-Present: LTM events were completed annually at FTA-2. See section 5.15 for more information on the FTA-2/LF-2 groundwater plume.

2014: A Record Notice of Landfill Operation for the LF-2 source area was filed at the Base Real Property office on 04 March 2014.

2014: A Final Fire Training Area-2 (FTA-2) Groundwater Focused Feasibility Study (AFCEC 2014) was prepared and included an assessment of the remedial alternatives for FTA-2 groundwater.

2016: The selected alternative from the Final Fire Training Area-2 (FTA-2) Groundwater Focused Feasibility Study was then documented in the Final Fire Training Area-2/Landfill-2 Record of Decision Amendment (AFCEC 2016). The FTA-2 groundwater assessment can be found in Section 5.15.

4.3.2 Background

4.3.2.1 History of Contamination

Landfill operations at LF-2 began in approximately 1940 and were discontinued in 1944. LF-2 contains primarily solid waste (e.g., bottles, glass, ash, metal scrap, wood, concrete, and asphalt construction debris). However, analytical results from a test pit that was advanced approximately 350 ft south of the FTA-2 indicate the presence of localized areas of petroleum contaminated soil at LF-2 (ANG 1996). The landfill was covered with fill material before fire training activities were conducted at FTA-2 from 1948 to 1956. FTA-2 may have received up to 7,000 gallons per year of waste oil, aviation gasoline (AVGAS), JP-4 fuel, and solvents, which were ignited during fire training exercises (ANG 1996). Sand, asphalt, and concrete rubble fill were apparently placed in a drainage swale before, during, and after fire-training activities at FTA-2. The FTA-2 area was covered with additional soil following its abandonment in 1956.

4.3.2.2 Physical Characteristics, Land and Resource Use

The FTA-2/LF-2 area occupies approximately 25 acres and is located to the west of the runway No. 5 and contained within the flightline secure area. The generally flat surface with subtle surface drainage features consists of un-paved, grassed areas that are mowed and maintained adjacent to the airfield. The minimum and maximum ground surface elevations within the source area boundary are 90 ft msl and 108 ft msl, respectively. Roughly 10 to 20 percent of the source area has some larger scrub pine and vegetation typical of Cape Cod. The area will be maintained as open-space in the foreseeable future while the airfield and runways are in use.

Prior to landfilling in the 1940s, the topography of the FTA-2 area was characterized by a prominent north-south swale that connected to a drainage ditch just south of South Outer Road (Figure 4-3). As a result of landfilling operations that filled this drainage ditch, the FTA-2 area no longer provided effective surface drainage. Storm water drainage pipes were installed to carry runoff southward from the large nearby paved areas to the north and west. Surface soils consist of fill with construction debris and solid waste to a depth of up to approximately 16 ft bgs (ANG 1996). Below that, subsurface soils are predominantly well-graded medium-grained sand with small amounts of fine- to coarse-grained sand, and traces of fine- to coarse-grained gravel, cobbles, and silt. Soils at the FTA-2 area are characteristic of typical glacial outwash comprising the Mashpee Pitted Plain (AFCEE 2003). The depth to groundwater is approximately 45 to 50 ft bgs throughout the FTA-2 area. The groundwater flow direction at FTA-2 is in a southerly direction (AFCEE 2011).

4.3.2.3 Initial Response

No responses were initiated prior to the PA conducted as part of the CERCLA process.

4.3.2.4 Basis for Taking Action

The RI (ANG 1996) included a human-health PRA to evaluate potential human-health risks associated with exposure to contaminated soil under an occupational (worker) exposure scenario. The calculated cancer risk was within the EPA acceptable risk range and the

calculated noncancer hazard index was below one. An ecological PRA was also performed which concluded that there could be adverse effects to ecological receptors, however, because of current and anticipated land use of the site, no additional action was recommended. Cleanup at FTA-2/LF-2 was driven by the potential impact to groundwater by petroleum-related organic compounds in soils.

4.3.3 Remedial Actions

The PA conducted in 1986 identified FTA-2/LF-2 as a potential site of past uncontrolled disposal of hazardous substances (E.C. Jordan Co. 1986). An SI was completed in 1988 (E.C. Jordan Co. 1990). The SI consisted of a soil gas survey, excavation of 18 test pits, installation of two soil borings completed as monitoring wells, soil sampling, and groundwater sampling. The soil gas survey detected trace concentrations of chlorinated solvents. Test pits identified areas of burned refuse and stained soil. The RI (ANG 1996) included the excavation of four test pits, geophysical investigations, surface soil sampling, subsurface soil sampling, and groundwater sampling. Samples were analyzed for VOCs, semivolatile organic compounds (SVOCs), and inorganics. The supplemental RI focused on investigating subsurface soil associated with the firefighter training site. In summary, the RI data indicated that the primary soil contaminants of FTA-2/LF-2 were fuel-related VOCs and SVOCs. Inorganics are secondary contaminants in soil at the site. The highest concentrations of VOCs and SVOCs were observed at the FTA-2 burn pit area.

4.3.3.1 Remedy Selection and Implementation

A ROD was signed on 30 September 1998 (AFCEE 1998) which documented the decision to perform a remedial action at FTA-2/LF-2. The selected remedial alternative was biosparging with ambient air monitoring. In summary, the remedy provides for:

- Performance of baseline ambient air monitoring;
- Collecting confirmation soil samples to refine the horizontal and vertical delineation of the target contaminants ethylbenzene and total xylenes;
- Designing and installing a full-scale biosparging treatment system;
- Collecting ambient air samples to assess compliance with ARARs;

- Maintaining institutional controls that restrict site access and limit potential human exposure to contaminants.

Investigations conducted at FTA-2/LF-2 indicated that source area soil may be a source of ethylbenzene and total xylenes to groundwater through leaching. The presence of these compounds in soil could result in an unacceptable risk to those who drink groundwater at or downgradient of the source area. Therefore the JBCC-specific STCLs established for the DSRP (AFCEE 1996) were retained as RALs for the identified COCs (i.e., ethylbenzene and total xylenes). Specifically, the RAO for FTA-2/LF-2 as presented in the ROD is:

- Prevent organic compounds in soils associated with FTA-2 from being a source of groundwater contamination.

The RALs for ethylbenzene and total xylenes in soil were established as 700 µg/kg, and 10,000 µg/kg, respectively (AFCEE 1998).

A biosparge treatment system was installed at FTA-2/LF-2 and began operation in September 2001. The treatment system consisted of an air compressor, a regenerative blower, a moisture separator, a heat exchanger, carbon vessels and a condensate-holding tank. The system design combined 90 cubic feet per minute (cfm) of sparging capacity with 180 cfm of extraction capacity (AFCEE 2002). The biosparge treatment system was shut down in May 2003 after the remedial goals for soil were met (i.e., the RALs for ethylbenzene and total xylenes in soil were achieved) such that soils are no longer considered a potential source of groundwater contamination through leaching. Petroleum hydrocarbons do remain in soil, therefore, UU/UE conditions have not been met and the institutional controls specified as part of the remedy are required to maintain protectiveness (AFCEE 2010). In addition, a component of the institutional controls was to document the presence of a landfill at LF-2 through a deed notification per the MassDEP solid waste regulations (310 CMR 19.141). AFCEC, working with the base real estate office and the Commonwealth who owns the property, were unable to determine whether a deed for this parcel was in existence. Therefore, the deed notification was filed at the Base Real Property office which meets the intent of the deed notification regulatory requirement.

In order to obtain approval for a completed remedial action from the MassDEP, groundwater in the immediate vicinity of the biosparging system was sampled for EPH and VPH analysis by the MassDEP Method. Details of the groundwater sampling events completed since the shutdown of the biosparge treatment system in 2003 are presented in Section 5.15.

4.3.3.2 Remedy Operations & Maintenance

Not applicable since no active treatment is ongoing at FTA-2/LF-2.

4.3.4 Progress Since Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior fourth CERCLA Five Year Review (AFCEE 2013). For the FTA-2/LF-2 source area, the recommendations were:

- 1) Continue to monitor FTA-2/LF-2 groundwater under the current LTM plan defined in 2010 (AFCEE 2011). A focused feasibility study to assess remedial alternatives for FTA-2 groundwater should be developed. The focused feasibility study will include an updated conceptual exposure model and RAOs addressing the groundwater media for the petroleum-related compounds. AFCEC's preferred remedy for groundwater will be presented in a proposed plan available for public review and comment. The selected remedy for groundwater will be documented in an amendment to the existing ROD (AFCEE 1998). A component of the remedy for FTA-2 groundwater should include enforceable LUCs to ensure long-term protectiveness similar to the other IRP groundwater sites (see Section 5.0). In addition, and similar to the other IRP groundwater sites, the LUCs should adopt the administrative processes and procedures for on-base development activities, including the construction of new buildings, to provide long-term protectiveness for the VI exposure pathway. Future Five Year Reviews should include assessment of both the FTA-2/LF-2 source area and FTA-2 groundwater.

- 2) In addition, a component of the institutional controls was to document the presence of a landfill at LF-2 through a deed notification per the MassDEP solid waste regulations (310 CMR 19.141). AFCEC, working with the base real estate and the State who owns the property, have been unable to determine whether a deed for this parcel is in existence. Therefore, the deed notification will be filed at the Base Real Property office which will meet the intent of the deed notification regulatory requirement. This action will be documented in the ROD Amendment.

Progress since the last Five Year Review against these recommendations are as follows:

- 1) A *Final Fire Training Area-2 (FTA-2) Groundwater Focused Feasibility Study* (AFCEC 2014) was prepared and included an assessment of the remedial alternatives for FTA-2 groundwater. The selected alternative was then documented in the *Final Fire Training Area-2/Landfill-2 Record of Decision Amendment* (AFCEC 2016). The FTA-2 groundwater assessment can be found in Section 5.15.
- 2) A Notice of Landfill Operations for the LF-2 source area was filed with the base real property office on 04 March 2014.

4.3.5 Five Year Review Process

4.3.5.1 Data Review

The Final 4th Five Year Review identified the need for an amendment to the existing FTA-2/LF-2 site ROD to address the COPCs in groundwater and include a selected remedy for the FTA-2/LF-2 groundwater plume. Additional leading edge and source area soil and groundwater characterization work was completed in March 2015 to update the CSM and groundwater LTM network in support of the ROD Amendment, which was finalized in September 2016 (AFCEC 2016). MNA with LUCs was identified as the selected remedial action for the FTA-2/LF-2 groundwater plume. The LTM network is in place to monitor remedy protectiveness and remedial progress, and the LUC Program is currently in place to prevent the use of groundwater as a drinking source (AFCEC 2017). A Record Notice of Landfill Operation for the LF-2 source area was filed at the Base Real Property office

on 04 March 2014The FTA-2 groundwater is discussed further in Section 5.15.

4.3.5.2 Site Inspections

An SI in support of this Five Year Review was completed for FTA-2/LF-2 on 14 June 2017. The SI form is included in Appendix B. Since the remedial action conducted at FTA-2/LF-2 (i.e., operation of the biosparging treatment system) is complete, the focus of the SI was to assess general site conditions and to determine whether the land use assumptions are still valid and do not affect protectiveness. Based on the SI, land use at the site remains consistent with the assumptions used in the risk assessment, access to the site is restricted, and no concerns regarding protectiveness were identified.

4.3.5.3 Interviews

Refer to Section 3.7.

4.3.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

4.3.6.1 Question A: Is the remedy functioning as intended by the decision document?

Operation of the biosparging system has mitigated further impact to groundwater from the COCs identified in the ROD (i.e., ethylbenzene and total xylenes) and the soil remedial goals specified in the ROD have been met. However, petroleum hydrocarbon-related compounds do remain in soil at concentrations exceeding EPA Industrial/Residential RSLs so UU/UE conditions have not been met (AFCEE 2010). Petroleum hydrocarbon contamination (i.e., EPH/VPH, TMBs, and 2-methylnaphthalene) attributed to FTA-2 has been detected in groundwater above MCP Method 1 GW-1 cleanup standards in recent years. However, monitoring data from 2017 suggests that contamination is degrading. Current on-base land use management procedures and the flightline security measures,

which include fencing and 24-hour security, effectively limit potential human exposure to the site contaminants located on-base.

4.3.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup level, and RAOs used at the time of remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in MassDEP standards for soil.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics: There were no changes in toxicity and other contaminant characteristics.

Changes in Risk Assessment Methods: There have been no changes in risk assessment methodology that affect protectiveness.

Review of RAOs: RAOs are appropriate.

4.3.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information at this time that calls in to question of the short-term protectiveness of the remedy based on current land use. The FTA-2/LF-2 site is located within installation boundaries (and the flightline area) and exposure pathways for humans are currently controlled or mitigated by DoD land use and management practices.

4.3.7 Issues, Recommendations, and Follow-Up Actions

No issues exist at the present time and the remedy continues to function as intended.

4.3.8 Protectiveness Determination

The remedy for the FTA-2/LF-2 source area is protective of human health and the

environment. Access to the site is controlled by current flight line security measures which include fencing and 24-hour security that effectively limits potential human exposure to site contaminants. A deed restriction has been filed with the real property office.

4.3.9 References

- AFCEC. 2017 (April). *Final Fire Training Area-2/Landfill-2 2017 Annual Long Term Monitoring Results Project Note*. 473147-SPEIM-FTA2-PRJNOT-003. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016 (September). *Final Fire Training Area-2/Landfill-2 Record of Decision Amendment*. 473147-SPEIM-FTA2-RPT-004. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014 (April). *Final FTA-2 Groundwater Focused Feasibility Study*. 473147-SPEIM-FTA2-RPT-002. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013 (October). *Final 4th Five Year Review, 2007-2012, Massachusetts Military Reservation Superfund Site, Otis Air National Guard Base, MA*. 473147-SPEIM-Multiple-RPT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- AFCEE. 2011 (July). *Fire Training Area-2 2010 LTM Results and Monitoring Network Evaluation Project Note*. 404929-SPEIM-LF2-PROJNOT-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2010 (August). *Fire Training Area-2 (FTA-2)/Landfill-2 (LF-2) Remedial Action Report*. Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2008 (September). *Final 3rd Five-Year Review, 2002-2007 Massachusetts Military Reservation (MMR) Superfund Site, Otis Air National Guard Base, MA*. Prepared by Engineering Strategies Corporation, Portage and CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2005 (October). *Landfill-2/Fire Training Area-2 Monitoring Well and Biosparging Well Sampling*. Project Note No. 12. Prepared by Engineering Strategies Corporation for AFCEE/MMR IRP, Otis ANGB, Cape Cod, MA.

- _____. 2003 (May). *Confirmation Sampling Plan for FTA-2/LF-2 Source Area Remedial Systems Operations*. Project Note. Prepared by Environmental Chemical Corporation for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2002 (August). *Final Letter Work Plan SD-5A SVE Treatment Zone Addition to FTA-2/LF-2 System*. Prepared by Environmental Chemical Corporation for AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.
- _____. 1998 (September). *Record of Decision for Areas of Contamination FTA-2/LF-2, PFSA/FS-10/FS-11, SD-2/FS-6/FS-8, SD-3/FTA-3/CY-4, SD-4, and SD-5/FS-5 Source Areas*. Prepared by HLA for AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.
- _____. 1997 (November). *Final Six Areas of Contamination Source Area Feasibility Study*. Prepared by ABB-ES for AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.
- _____. 1996 (January). *Soil Target Cleanup Levels, DSRP*. Prepared by HAZWRAP for AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.
- ANG. 1996. *Remedial Investigation Report Fire-Training Area No.2 (FTA-2) and Landfill No.2 (LF-2)*. Prepared by ABB-ES for AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.
- E.C. Jordan Co., 1990 (June). *“Task 2-5B Site Inspection, Field Investigation Work Conducted Spring-Summer 1988”; Installation Restoration Program; Massachusetts Military Reservation*. Prepared for HAZWRAP; Portland, Maine.
- _____. 1986 (December). *U.S. Air Force Installation Restoration Program, Phase I: Records Search, Air National Guard, Camp Edwards, Air Force, and Veterans Administration Facilities at MMR, Task 6*. Prepared for Oak Ridge National Laboratory; Oak Ridge, Tennessee.
- EPA. 2001 (June). *Comprehensive Five-Year Review Guidance*, EPA 540R-01-007.
- Massachusetts Department of Environmental Protection (MassDEP). 1990 (October). *Massachusetts Solid Waste Regulations, 310 Code of Massachusetts Regulations 19.000*. Available at: <http://www.mass.gov/eea/docs/dep/service/regulations/310cmr19.pdf>.

4.4 LANDFILL-7 (LF-7)

LF-7 is approximately 400 square feet (ft²) and is located in a former gravel pit north of the LF-1 source area (Figures 1-2 and 4-4). It is an area where radioactive electron tubes, removed from EC-121 aircraft radar sets, were reportedly buried. The number buried is unknown, however, since approximately 200 tubes/year were removed from aircraft between 1955 and 1970, it is estimated that as many as 3,000 tubes may be buried (ANG 1993).

4.4.1 Site Chronology

1992: ANG investigation of radioactive isotopes used in radar tubes that were potentially disposed of at LF-7 (ANG 1993).

1993: The decision document concludes that the potential hazard from disposed radar tubes is negligible; however, in accordance with Air Force Office of Medical Support (AFOMS/SGPR) policy letter of August 9, 1988 areas used for disposal of low-level radioactive wastes are to be fenced to prevent unauthorized entry, marked with radioactive warning labels, and annual radiological surveys are to be conducted (ANG 1993).

1993 to Present: Annual inspections of the security fencing/signage and annual radiation surveys conducted.

2012: The Consultative Services Division of the U.S. Air Force School of Aerospace Medicine (USAFSAM/OEC) completed a radiation scoping survey (USAF 2013).

2013 - 2017: Annual visit to Radar Tube Burial Landfill (ANG 2017, 2016, 2015, 2014, 2013).

4.4.2 Background

4.4.2.1 History of Contamination

Burial of radar tubes is suspected to have occurred between 1955 and 1970 at LF-7.

4.4.2.2 Physical Characteristics, Land and Resource Use

The LF-7 area is located north of the LF-1 source area in a wooded buffer area adjacent to cleared training area of Camp Edwards. The grassed area inside the 400 ft² fenced area is located approximately 200 ft west of the intersection of Dolan Road and Turpentine Road (Figure 4-4). The approximate ground surface elevation at LF-7 is 130 ft msl.

4.4.2.3 Initial Response

Not applicable.

4.4.2.4 Basis for Taking Action

In response to discussions with the EPA on May 19, 1992, the ANG investigated the nature of the radioactive isotopes used in the radar tubes potentially disposed of at LF-7. Based on discussions with ANG and Air Force personnel, the most likely radioactive isotopes used in the electron tubes were Cesium-137, Tritium, Nickel-63, Cobalt-60, and Radium-226 (ANG 1993).

These radar electron tubes are believed to have contained very low, near background, levels of radioactive material ranging from 10⁻⁷ to 10⁻⁹ picoCuries (pCi). Using the estimated number of tubes and their pCi range, the total radioactivity at this study area was calculated to be in the 3 x 10⁻⁴ to 3 x 10⁻⁶ pCi range. It was concluded that were the entire amount of radioactivity to be contained in one liter of water, the level of radioactivity would be, at worst, 3 x 10⁻⁴ pCi/L. The Federal MCLs for radium and gross Alpha radioactivity in drinking water are 5 and 15 pCi/L, respectively (available at: <http://water.epa.gov/drink/contaminants/index.cfm#Radionuclides>). The worst-case concentrations calculated above are negligible compared to the MCLs (ANG 1993).

4.4.3 Remedial Actions

This section presents regulatory actions, a description of the selected remedy, and a summary of the remedy implementation at LF-7.

4.4.3.1 Remedy Selection and Implementation

The LF-7 decision document was signed on 17 November 1993. The decision document requires the construction of a fence surrounding the study area to prevent unauthorized entry and excavation activities, the posting of appropriate radioactive warning labels, and the conducting of annual radiological surveys (ANG 1993). The fence and signage was already in place at the time the decision document was completed and three annual inspections had already been completed in June 1991, June 1992, and June 1993. Reports for these annual inspections were appended to the decision document.

4.4.3.2 Remedy Operations & Maintenance

The study area has operated in full accordance with AFOMS/SGPR policy letter of August 9, 1988. This policy specifies that areas used for disposal of low-level radioactive wastes will be appropriately fenced to prevent unauthorized entry, marked with appropriate radioactive warning labels, and monitored annually to verify that actual levels of radioactivity remain acceptable. The annual radiological survey has been conducted since 1991 and reports are on file with the IRP at the JBCC and available on the Administrative Record. There has never been a radiation reading above background levels during these annual surveys. These surveys of the 20-ft by 20-ft area have been conducted at the ground surface and 3 ft above the ground surface. The Decision Document (ANG, 1993) states the institutional controls will be in place as long as JBCC remains a military base. It is MassDEP's understanding that the institutional controls will be in place until the remedy is changed or the Site is closed under CERCLA. Levels of radioactivity considered acceptable are (1) less than two times background; or (2) 2 milliRoentgen/hour, whichever is lower (Nuclear Regulatory Commission regulations 10 CFR 20.105).

4.4.4 Progress Since Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior fourth CERCLA Five Year Review (AFCEC 2013). For LF-7, the recommendations and follow-up actions were:

- 1) Identify a site closure plan.

Progress since the last Five Year Review against these recommendations is as follows:

- 1) The USAFSAM/OEC completed a radiological survey. The objective of the survey was to determine the presence of radioactive material contamination at the site. The results are described in Section 4.4.5.1. AFCEC/ANG will continue to conduct annual inspections and radiological surveys. AFCEC will include the LF-7 site closure in the program requirements development process as we have done in the past years but cannot guarantee funding. If funding becomes available we will then prepare a closure plan for EPA and MassDEP review.

4.4.5 Five Year Review Process

4.4.5.1 Data Review

In 2012, the USAFSAM/OEC completed a radiation scoping survey of the LF-7 site at the JBCC. The survey was completed between 09 and 13 July 2012 and was performed to confirm the existence of radioactive materials related to suspected disposal of radar tubes and involved very sensitive instrumentation for in situ scanning measurements, vegetation sampling to evaluate potential food chain impacts, and soil sampling. Vegetation and soil samples were submitted for laboratory analysis of radioactivity. The results from this survey will be used as a basis of information for future decisions to perform additional investigations and/or remediation of the site (if applicable) and to evaluate potential health hazards to hypothetical future site residents (USAF 2013).

The survey work concluded that no radioactive materials were found at LF-7 that indicate there is a widespread high level of contamination or contamination that poses an immediate threat to the environment and personnel. All detected levels of Cesium-137, Cobalt-60, Tritium, and Nickel-63 were well below the U.S. Nuclear Regulatory Commission's screening levels and indicate that there is no contamination from these radionuclides. Routine annual inspections are completed at LF-7 as part of the remedy. During this Five

Year Review Period, annual inspections were completed on 31 October 2012, 05 October 2014, 22 October 2015, 28 October 2016, and 24 October 2017.

4.4.5.2 Site Inspections

An SI was completed for LF-7 as part of this Five Year Review on 14 June 2017. The SI form is included in Appendix B. The focus of the SI was to assess general site conditions including the fence and signage and to determine whether the land use assumptions are still valid and do not affect protectiveness. Based on the SI, the fence and signage are present and in good condition and land use at the site remains consistent with the assumptions presented in the decision document and no concerns regarding protectiveness were identified.

4.4.5.3 Interviews

Refer to Section 3.7.

4.4.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

4.4.6.1 Question A: Is the remedy functioning as intended by the decision document?

The review of documents and the results of annual SIs and radiological surveys indicate that the remedy is functioning as intended by the decision document. Annual monitoring has been conducted since 1991 (26 years). There has never been a radiation reading above background levels during these annual surveys and the fence and signage is in good condition and performing as intended. Minor repairs to the fencing or signage have been conducted when necessary.

4.4.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup level, and RAOs used at the time of remedy selection (current) still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards and to-be considered.

Changes in Exposure Pathways: There have been no changes in the physical conditions and exposure pathways of the site that would affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics: There were no changes in toxicity and other contaminant characteristics.

Changes in Risk Assessment Methods: Not applicable.

Review of RAOs: Not applicable.

4.4.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information at this time that calls into question the short-term protectiveness of the remedy based on current land use. This IRP site is located within installation boundaries and exposure pathways for humans are currently controlled or mitigated by the DoD land use and management practices.

4.4.7 Issues, Recommendations, and Follow-Up Actions

There are no issues with regards to protectiveness at LF-7 and continued annual inspections and radiological surveys should be conducted per the Decision Document. AFCEC will include the LF-7 site closure in the program requirements development process as we have done in the past years but cannot guarantee funding. If funding becomes available we will then prepare a closure plan for EPA and MassDEP review.

4.4.8 Protectiveness Determination

The remedy for the LF-7 source area is protective of human health and the environment in the short-term under the current land use scenario. The remedy is protective in the short term since access to the site is controlled by a fence that effectively limits potential human exposure and marked with the appropriate warning signs. For long term protectiveness, annual monitoring is being conducted at the site to verify that radioactivity levels remain acceptable. Radiological surveys have been conducted since 1991 and reports are on file at IRP at the JBCC and available on the Administrative Record.

4.4.9 References

- AFCEC. 2013 (October). *Final 4th Five Year Review, 2007-2012, Massachusetts Military Reservation Superfund Site, Otis Air National Guard Base, MA*. 473147-SPEIM-Multiple-RPT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- ANG. 2017. (October). Annual visit to Radar Tube Burial Landfill (LF-7), Joint Base Cape Cod (JBCC), MA
- _____. 2016. (October). Annual visit to Radar Tube Burial Landfill (LF-7), Joint Base Cape Cod (JBCC), MA
- _____. 2015. (October). Annual visit to Radar Tube Burial Landfill (LF-7), Joint Base Cape Cod (JBCC), MA
- _____. 2014. (October). Annual visit to Radar Tube Burial Landfill (LF-7), Joint Base Cape Cod (JBCC), MA
- _____. 2012. (October). Annual visit to Radar Tube Burial Landfill (LF-7), Joint Base Cape Cod (JBCC), MA
- _____. 1993 (November). Decision Document Radar Tube Burial Landfill (LF-7 Study Area). Installation Restoration Program, Massachusetts Military Reservation, Cape Cod, Massachusetts. Prepared for Hazardous Waste Remedial Actions Program, Oak Ridge, Tennessee, by ABB Environmental Services, Inc.
- EPA. 2001 (June). *Comprehensive Five-Year Review Guidance*, EPA 540R-01-007.
- USAF. 2013 (March). Consultative Letter, AFRL-SA-WP-CL-2013-0003, Stored Radioactive Material Landfill Site #7 (LF-7), Massachusetts Military Reservation, Cape Cod, MA.

4.5 PETROLEUM FUELS STORAGE AREA (PFSA)

The PFSA is located on the north side of South Outer Road and served as the storage and distribution center for JP-4 jet fuel, AVGAS, motor gasoline, and No. 2 fuel oil for JBCC from the 1950s until 2009 (Figure 4-5). The PFSA has been the location of several fuel spills and has historically been referred to as PFSA (FS-10/FS-11) but will here-after be referred to as PFSA in this document. Demolition of the PFSA facility was completed in early 2011 (demolition areas shown on Figure 4-5). Over the years, the facility consisted of three above ground storage tanks (ASTs), several USTs, above ground and below ground fuel distribution lines, pump houses, and truck fill stands. Demolished ASTs (shown on Figure 4-5 as ASTs 15 and 16) were 0.5 and 1.2 million gallons in capacity. A third large AST (0.5 million gallons) was once present to the west of Tank 16 (Figure 4-5); this AST was removed in 1998 (AFCEE 2003). The USTs and other infrastructure related to the fuel distribution system were removed prior to 1998 as discussed in Section 4.5.2.1.

4.5.1 Site Chronology

The following major activities, investigations, and remedial actions were conducted at PFSA:

Early 1950s - 2009: The PFSA operated as the main fuel delivery and distribution area for the flightline.

1985 - 1986: Field investigations (R.F. Weston, Inc. 1985 and E.C. Jordan Co. 1988) identified the presence of soil and groundwater contamination at PFSA.

1987 - 1988: The “Mashpee Groundwater Study” (E.C. Jordan 1990) found soil contamination at the water table in a boring south of the PFSA across South Outer Road and identified fuel-related contamination in groundwater.

1994: An interim RI was performed to characterize groundwater contamination and evaluate potential site risks (ANG 1994).

1996: The Final RI Report (ANG 1996) was completed, with results of the SI, interim RI, and JBCC DSRP sampling at the PFSA forming the basis of the RI report.

1997-1998: Completion of a feasibility study (AFCEE 1997) and a ROD (AFCEE 1998).

2001–2012: A biosparge/vapor recovery (BSVR) treatment system was installed as part of the remedy presented in the ROD. The BSVR system started operation in October 2001 and was operated under an approved O&M Plan (AFCEE 2003). In support of treatment system optimizations and eventual shutdown of the BSVR system in April 2010, soil and groundwater samples were analyzed for the ROD COCs, ethylbenzene and total xylenes. Samples were also analyzed for EPH/VPH by the MassDEP Method. EPH/VPH were not identified as COCs in the ROD, but analysis of these compounds was requested by MassDEP.

2014: A Final PFSA Groundwater Focused Feasibility Study was completed (AFCEC 2014).

2015: A Final 2014 PFSA Source Area VI Evaluation Project Note was developed to document the results of the vapor intrusion evaluation (AFCEC 2015).

2016: The Final PFSA ROD Amendment was completed to document the selected remedy for groundwater (AFCEC 2016).

4.5.2 Background

4.5.2.1 History of Contamination

The PFSA (now demolished) served as the storage and distribution center for JP-4 jet fuel, AVGAS, motor gasoline, and No. 2 fuel oil for JBCC from the 1950s until 2009. Historically, fuel received or stored at the PFSA was transferred through underground pipelines to the fuel distribution pump houses. From 1955 to 1965 AVGAS and JP-4 were delivered to the PFSA from the railroad fuel pumping station at JBCC (located approximately 9,500 ft west of the PFSA near the intersection of Kittredge and Turpentine

Roads). From 1965 to 1973, AVGAS and JP-4 were delivered to the JBCC through a 3-inch-diameter underground pipeline extending from the Cape Cod Canal to the PFSA (AFCEE 2012a). Fuels were subsequently delivered by truck to the PFSA and then distributed by truck to aircraft or other points of use (ANG 1996).

Two of the ASTs (ASTs 15 and 16 shown on Figure 4-5) were constructed with floating lids, allowing rainwater and condensation to enter and migrate to the bottom of each of the tanks. This water was reportedly removed from the tank bottoms by opening drain valves and discharging the accumulated water to the containment berms that surrounded the ASTs until fuel product discharge was observed. The floating lids on the ASTs 15 and 16 were replaced with solid lids in 1977 and 1988, respectively (AFCEE 2012a).

Discharges from the AST containment berms and paved surfaces at fuel unloading areas typically entered storm drain catch basins via asphalt-lined ditches and then exited to the JBCC storm water sewer system and then ultimately to the oil-water separator (OWS) located on the southeast side of South Outer Road (Figure 4-5). The OWS discharged to a drainage ditch (referred to as SD-2) which lies south of the far eastern portion of PFSA source area boundary (Figure 1-2 and Figure 4-5). Two 42-inch-diameter storm drains and the OWS discharged to the upstream end of SD-2 until their removal in 2002 (AFCEC 2013). The SD-2 source area has achieved UU/UE status as presented in Table 1-1a.

Floor drains in the PFSA pump houses formerly discharged to two nearby French drains that were replaced in 1989 with a 2,000-gallon UST located east of former Building 173. Fuel-contaminated water was historically discharged from fuel/water separator equipment located in the pump houses to the floor drains when filters in the separators were changed (AFCEE 2012a). Four 50,000-gallon USTs were installed northwest of AST 15 in 1956 and were used to dispense AVGAS (that was received from the PFSA) via an underground pipeline to aircraft on the maintenance ramp. The fuel line from the PFSA to these USTs was abandoned in the early 1970s, and these USTs were removed in 1994 (ANG 1996, AFCEE 2008a).

The following summarizes the history of documented releases at PFSA.

1960s: Fuel spills, identified as FS-10 and FS-11, occurred at the PFSA. FS-10 consisted of a release of 2,000 gallons of JP-4 to a floor drain in one of the pump houses. FS-11 consisted of the release of approximately 2,000 gallons of jet fuel to the ground surface from overfilling one of the ASTs.

1996: In June 1996, heavy rain and a pump failure at the PFSA caused 6,000 gallons of fuel-contaminated water to spill from a fuel pump house (Building 173 on Figure 4-5). Of the 6,000 gallons, about 300 gallons was diesel and/or jet fuel. Because of high stormwater flows, some fuel discharged to the SD-2 drainage ditch located to the south of the PFSA.

4.5.2.2 Physical Characteristics, Land and Resource Use

The PFSA site occupies approximately 13 acres and is located on the southeast corner of the JBCC (Figure 1-2 and Figure 4-5) on-base property. The PFSA infrastructure (now demolished) occupied approximately five acres of relatively flat terrain; the minimum and maximum ground surface elevations within the source area boundary are 82 ft msl and 112 ft msl, respectively. The former PFSA infrastructure was located to the north of South Outer Road, which bisects the site. AFCEC's Sandwich Road Treatment Facility (SRTF) (Building 561) and O&M Building (Building 587) are located within the PFSA source area boundary to the south of South Outer Road. It is in this area where the PFSA BSVR treatment system (now shut down) is located. The former PFSA infrastructure (i.e., the area north of South Outer Road) is located inside the flightline security area which includes fencing and 24-hour security. The area to the south of South Outer Road is also fenced. Current land use in this area is expected to be maintained for the foreseeable future while the airfield and runways are in use and remedial actions are ongoing.

The depth to groundwater is approximately 40 to 55 ft bgs throughout the PFSA site. The PFSA site is approximately 3,800 ft north of Johns Pond (Figure 1-2), and groundwater flows from the PFSA in a south-southeast direction towards the northwest corner of the pond.

4.5.2.3 Initial Responses

Drainage Structure Removal Program (1993): As part of the DSRP, the pump house French drains, the storm-sewer catch basin, and associated contaminated soil were removed in 1993 (AFCEC 2013).

Fuel Distribution Line Realignment (1993): The fuel distribution lines at the PFSA were upgraded from below ground to an aboveground system in 1993. Approximately 10 cubic yards of fuel-contaminated soil was excavated from around the subsurface fuel lines during construction activities (AFCEE 2012b).

Demolition of Buildings and UST Removal (1994): Several pump house buildings were demolished and four associated 50,000-gallon USTs were removed from the PFSA in November 1994 (AFCEE 2012b).

Fuel Spill Cleanup (1996): In response to the release of approximately 6,000 gallons of oil/water mixture in 1996 as described in Section 4.6.2.1, 480 cubic yards of fuel-contaminated soil were removed from the PFSA, and 120 cubic yards of fuel-contaminated soil was excavated from the SD-2 drainage ditch as part of an Immediate Response Action performed under the MCP. The excavated soils were transported off site to Bardon Trimount of Stoughton, Massachusetts for asphalt-batching. An SVE system was installed as part of the Immediate Response Action to remove the remaining localized contamination associated with the release (AFCEE 1998). This SVE system was intended to only address the contamination north of Building 173 (Figure 4-5) and should not be confused with the larger PFSA BSVR system installed south of South Outer Road later as part of the selected remedy for PFSA as presented in the ROD.

AST Demolition (2010/2011): Although not considered initial responses, ASTs 15 and 16 and Buildings 171, 172, and 173 at the PFSA were removed in January/February 2011 as non-CERCLA related actions. The AST to the west of AST 16 had previously been removed in 1998 (AFCEE 2003). The buildings and AST 15 were removed with no evidence of contamination. Contaminated soil was encountered during the dismantling of

AST 16 and 1,056 gallons of fuel oil, 550 gallons of oily water, and 760 cubic yards of oil-impacted sand were removed for off-site disposal as part of an Immediate Response Action under the MCP (Horsley Witten 2011). Excavation activities were not successful in achieving background conditions in the entire AST 16 area, and additional SI was recommended to fully delineate the vertical and horizontal extent of the impacted soils (AFCEE 2012c). In February 2012, a soil boring was advanced from the ground surface to the water table within the footprint of the AST. The soil and groundwater vertical profiling data indicated that the 2011 release from AST 16 did not impact the groundwater at the PFSA (AFCEE 2012c).

4.5.2.4 Basis for Taking Action

The RI (ANG 1996) included a human-health PRA to evaluate potential human-health risks associated with exposure to contaminated soil under an occupational (worker) exposure scenario. The calculated cancer risk was within the EPA acceptable risk range and the calculated noncancer hazard index was below one. Because ecological receptors are not anticipated at the PFSA; a quantitative ecological PRA was not completed (AFCEC 2013). Cleanup at PFSA was driven by the potential impact to groundwater by petroleum-related organic compounds in soils.

4.5.3 Remedial Actions

The RI (ANG 1996) concluded that the highest concentrations of petroleum-related contamination at PFSA appeared to have originated from the area of the three ASTs and the two pump houses. It stated that fuel-related contamination leached from sources in a dissolved phase in percolating groundwater or via the downward migration of free-product releases, creating capillary fringe soil contamination. More recent data collected since the RI indicate that the capillary fringe soil contamination is present between approximately 54 and 64 ft bgs in the western portion of the PFSA, and between approximately 38 to 58 ft bgs in the eastern portion of the PFSA. The approximate extent of the soil contamination, based on a delineation completed in 2003 (AFCEE 2003), is shown on Figure 4-5. The typical depth to groundwater in the vicinity of this capillary fringe soil contamination is

approximately 40 to 55 ft bgs. The RI also indicated that most of the groundwater contamination resulted from direct leaching from capillary fringe soils. Near-surface soil sampling at the ASTs did detect contamination that was attributed to the discharge of petroleum-contaminated water and/or fuel product drained from tank bottoms and was estimated to impact a total of 2,100 cubic yards of soil. Soil sampling confirmed that the French drains at the pump house buildings had been sources of fuel-related contamination and also several chlorinated compounds. The total volume of fuel-contaminated soil at the capillary fringe beneath the PFSA was estimated at 69,000 cubic yards. The RI recommended a feasibility study to assess remedial options to address the shallow and deep contaminated soil.

A focused feasibility study (AFCEE 1997) was conducted to evaluate remedial options to address the PFSA contamination. Shallower soil contamination was determined to not pose a threat to future utility workers or to ecological receptors except in one area near the ASTs; subsequent soil sampling in this area indicated that contaminant concentrations were below applicable standards and remediation was not warranted. However, petroleum contamination in soils at the capillary fringe was determined to be an ongoing source of contamination to groundwater. Three alternatives were evaluated: no action, institutional controls, and biosparging with off-gas collection and treatment. The focused feasibility study concluded that only the biosparging alternative would achieve the remedial action objectives. The groundwater media was not directly assessed in the focused feasibility study.

4.5.3.1 Remedy Selection and Implementation

A ROD was signed on 30 September 1998 (AFCEE 1998) which documented the decision to perform a remedial action at PFSA. The selected remedial alternative was biosparging with off-gas collection and treatment to remediate the COCs ethylbenzene and total xylenes in soil. The selected remedial alternative for PFSA included the following components:

- Performance of baseline ambient air monitoring
- Collecting confirmation soil samples to refine the horizontal and vertical delineation of the target contaminants ethylbenzene and total xylenes
- Designing and installing a full-scale biosparging treatment system with off-gas collection and treatment for areas with capillary-fringe contamination
- Designing and installing a bioventing system for areas with shallow vadose zone contamination
- Collecting ambient air samples to assess compliance with ARARs
- Maintaining institutional controls that restrict site access and limit potential human exposure to contaminants

The presence of the COCs in soil could result in an unacceptable risk to those who drink groundwater at or downgradient of the PFSA source area. Therefore, the JBCC-specific STCLs established for the DSRP (AFCEE 1996) were retained as RALs for the identified COCs (i.e., ethylbenzene and total xylenes). Specifically, the RAO for the PFSA as presented in the ROD is:

- Prevent organic compounds in soils from being a source of groundwater contamination.

The RALs for ethylbenzene and total xylenes in soil were established as 700 µg/kg, and 10,000 µg/kg, respectively (AFCEE 1998).

A BSVR treatment system began operation in October 2001. The system consisted of a mechanical building and a wellfield. The mechanical building contained a central processing unit, air compressor, regenerative blower, moisture separator, heat exchanger, two 500-lb GAC vessels positioned in series, and a condensate-holding tank. The wellfield included a total of 54 biosparge wells, 22 nested monitoring/observation wells, and 29 extraction wells separated into six zones which encompass both areas of capillary fringe contamination (e.g., the Western Capillary Zone and the Eastern Capillary Zone). Soil vapor extraction wells were installed to a depth of approximately 30 ft bgs and had a 10-ft screened interval. Biosparge wells were installed to a depth ranging from 60 to 70 ft bgs and had a 2-ft screened interval.

For design optimization purposes, several subsurface soil and groundwater sampling events were completed within the PFSA. Samples were analyzed for VOCs including the ROD COCs ethylbenzene and total xylenes. Samples were also analyzed for EPH/VPH by the MassDEP Method although the EPH and VPH carbon ranges were not identified as COCs in the ROD. A summary of these optimization efforts follows:

2005 Western Capillary Zone Soil Sampling and shutdown of BSVR system Zones 1 and 2:

Fourteen borings were installed in 2005 and soil samples were collected to provide data to support the shut down the Western Capillary Zone of the BSVR system (AFCEE 2005, 2007). Total xylenes and ethylbenzene were not detected above the ROD RALs or MCP S-3/GW-1 standards; however, C₅-C₈ aliphatic hydrocarbons (under the MassDEP VPH Method) were detected at concentrations above the MCP Method 1 S-3/GW-1 standard at one location. In December 2005 Zones 1 and 2 of the BSVR system were shutdown with regulatory concurrence.

2006 Western Capillary Zone Soil Sampling: Soil samples were collected at 12 locations in 2006 (AFCEE 2008b). Ethylbenzene and total xylenes were not detected at concentrations above the ROD RALs. However C₉-C₁₀ aromatics (VPH), C₅-C₈ aliphatics (VPH) and C₁₁-C₂₂ aromatics (EPH) were detected above MCP Method 1 S-3/GW-1 standards.

2007 Eastern Capillary Zone Soil Sampling: Soil samples were collected at 23 locations in the Eastern Capillary zone of the BSVR system in 2007 (AFCEE 2008a). Ethylbenzene and total xylenes were detected at concentrations above the RALs (but at concentrations below the MCP Method 1 S-3/GW-1 soil standards) and C₉-C₁₀ aromatic (VPH) and C₅-C₈ aliphatic (VPH) hydrocarbons were detected at concentrations above the MCP S-3/GW-1 standards.

Groundwater Monitoring (2005-2007): Although the groundwater media was not directly addressed in the ROD, groundwater monitoring at PFSA was conducted to assess the progress of the remedial action. Groundwater sampling was completed at PFSA in 2005 and 2007 (AFCEE 2008c). Samples were submitted for VOC analysis by EPA method

8260B and EPH/VPH analysis by the MassDEP method. No ethylbenzene or total xylenes were detected in groundwater at concentrations above the MCP Method 1 GW-1 standards. However, the C₅-C₈ aliphatics (VPH), C₉-C₁₀ aromatic (VPH), and C₁₁-C₂₂ aromatic (EPH) carbon ranges were detected at concentrations above the MCP Method 1 GW-1 groundwater standards. Additional groundwater sampling was completed at PFSA during this Five Year Review period, which is discussed in Section 5.16.

In February 2008, the soil vapor recovery portion of the BSVR system was completely shut down due to low or negligible petroleum concentrations in the influent air samples. Between November 2008 and April 2010, the sparging portion of the system for select zones continued to operate to enhance aerobic degradation of the remaining petroleum compounds. Based on a review of both soil and groundwater data, it was determined that the intent of the remedy had been met and although ethylbenzene and total xylene concentrations in soil remained above the RALs, the soils were not acting as a continuing source of contamination to groundwater and the sparging system was shut down in April 2010 (AFCEE 2012b).

4.5.3.2 Remedy Operations & Maintenance

No ongoing O&M activities are being conducted at the PFSA source area.

4.5.4 Progress Since Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior fourth CERCLA Five Year Review (AFCEC 2013). For the PFSA source area, the recommendations and follow-up actions were:

- 1) Establish an interim LTM program that would be designed to monitor PFSA groundwater contamination (similar to the approach followed at FTA-2 described in Section 4.4). A focused feasibility study to assess remedial alternatives for PFSA groundwater should be developed. The focused feasibility study will include an updated conceptual exposure model and RAOs addressing the groundwater media

for the petroleum-related compounds. AFCEC's preferred remedy for groundwater will be presented in a proposed plan available for public review and comment. The selected remedy will be documented in an amendment to the existing ROD (AFCEE 1998). A component of the remedy for PFSA groundwater should include enforceable LUCs to ensure long-term protectiveness similar to the other IRP groundwater sites (see Section 5.0). Future Five Year Reviews should include assessment of both the PFSA source area and PFSA groundwater.

- 2) VI risks could not be ruled out during the VI screening assessment (AFCEE 2012a). It was recommended that VI be re-screened utilizing guidance being developed for petroleum release sites by EPA including the *OSWER Final Guidance for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Sources to Indoor Air* (Final VI Guidance) and *Guidance for Addressing Petroleum Vapor at Leaking Underground Storage Tanks Sites* (Petroleum VI Guidance).

Progress since the last Five Year Review against these recommendations is as follows:

- 1) A *Final PFSA Groundwater Focused Feasibility Study* (AFCEC 2014) was prepared and included an assessment of the remedial alternatives for PFSA groundwater. The selected alternative was then documented in the *Final PFSA Record of Decision Amendment* (AFCEC 2016). The PFSA groundwater assessment can be found in Section 5.16.
- 2) A VI evaluation was completed (AFCEC 2015). No further evaluations are needed relative to current land use because significant VI impacts above regulatory targets are not expected. However, as part of the ongoing groundwater remedial actions at PFSA, AFCEC will continue to monitor the nature and extent of the PFSA groundwater contamination under the LTM program, which is discussed in Section 5.16, and will re-evaluate the VI exposure pathway if conditions change such that VI could be a concern.

4.5.5 Five Year Review Process

4.5.5.1 Data Review

Based on the VI assessment (AFCEC 2015) it was determined that no further evaluations are needed relative to current land use because significant VI impacts above regulatory targets are not expected. However, as part of the ongoing groundwater remedial actions at PFSA, AFCEC will continue to monitor the nature and extent of the PFSA groundwater contamination under the LTM program and will re-evaluate the VI exposure pathway if conditions change such that VI could be a concern. PFSA groundwater is discussed further in Section 5.16.

4.5.5.2 Site Inspections

An SI was completed for PFSA on 14 June 2017. The SI form is included in Appendix B. Since the active component of the remedial action conducted at PFSA is complete and no ongoing O&M of remedial systems is occurring, the focus of the SI was to assess general site conditions and to determine whether the land use assumptions are still valid and do not affect protectiveness. Based on the SI, land use at the site remains consistent with the assumptions used in the risk assessment and no concerns regarding protectiveness were identified.

4.5.5.3 Interviews

Refer to Section 3.7.

4.5.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedial action. AFCEC performed the technical assessment based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

4.5.6.1 Question A: Is the remedy functioning as intended by the decision document?

Operation of the BSVR system has mitigated further impact to groundwater from the COCs identified in the ROD (i.e., ethylbenzene and total xylenes) and the soil remedial goals specified in the ROD have been met. However, petroleum hydrocarbon-related compounds potentially remain in soil at concentrations exceeding EPA Industrial/Residential RSLs so UU/UE conditions have not been met (AFCEE 2010). Petroleum hydrocarbon contamination (i.e., EPH/VPH, TMBs, and 2-methylnaphthalene) attributed to PFSA has been detected in groundwater above MCP Method 1 GW-1 cleanup standards in recent years. However, monitoring data, collected as part of the long term monitoring program, from 2017 suggests that contamination is degrading. Current on-base land use management procedures and the flightline security measures, which include fencing and 24-hour security, effectively limit potential human exposure to the site contaminants located on-base. PFSA groundwater is discussed further in Section 5.16.

4.5.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup level, and RAOs used at the time of remedy selection (current) still valid?

Changes in Standards and To-Be Considered: There have been no changes in MassDEP standards for soil.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics: There were no changes in

toxicity and other contaminant characteristics.

Changes in Risk Assessment Methods: There have been no changes in risk assessment methodology that affect protectiveness.

Review of RAOs: RAOs are appropriate.

4.5.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information at this time that calls into question the short-term protectiveness of the remedy based on current land use. The PFSA source area site is located within installation boundaries (and a portion within the flightline area) and exposure to on-base soil and groundwater is currently controlled or mitigated by DoD land use and management practices.

4.5.7 Issues, Recommendations, and Follow-Up Actions

No issues exist at the present time and the remedy continues to function as intended.

For future use, it is recommended that the potential for significant VI impacts be further evaluated prior to constructing any new buildings at PFSA. This requirement should be incorporated into enforceable LUCs that adopt the administrative processes and procedures for on-base development activities, including the construction of new buildings, to provide long-term protectiveness for the VI exposure pathway. This VI-related LUC requirement was incorporated into the ROD Amendment (AFCEC 2016) documenting the final remedy for PFSA groundwater. As part of the next five-year review, the VISLs used in the PFSA VI evaluation in 2014 will be re-evaluated at the next five year review to ensure continued protectiveness.

4.5.8 Protectiveness Determination

The remedy for the PFSA source area is protective of human health and the environment. Access to the site is controlled by current flight line security measures

which include fencing and 24-hour security that effectively limits potential human exposure to site contaminants.

4.5.9 References

- AFCEC. 2016 (January). *Final Petroleum Fuels Storage Area Record of Decision Amendment*. 473147-SPEIM-PFSA-RPT-004. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015 (January). *Final 2014 PFSA Source Area Vapor Intrusion Evaluation Project Note*. 473147-SPEIM-PFSA-PRJNOT-002. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2014 (April). *Final PFSA Groundwater Focused Feasibility Study*. 473147-SPEIM-PFSA-RPT-002. Prepared by Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2013 (October). *Final 4th Five-Year Review, 2007-2012 Massachusetts Military Reservation (MMR) Superfund Site, Otis Air National Guard Base, MA*. 473147-SPEIM-MULTIPLE-RPT-001. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis ANG Base, MA.
- AFCEE. 2012a (August). *Final 2011 JBCC Vapor Intrusion Evaluation Technical Memorandum*. 420005-SPEIM-MULTIPLE-TECHMEM-002. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012b (July). *Draft - Interim Remedial Action Report for the Petroleum Fuels Storage Area/FS-10/FS-11 at the Massachusetts Military Reservation*. Prepared by Portage, Inc. for AFCEE/JBCC.
- _____. 2012c (June). *Petroleum Fuel Storage Area (PFSA) Post Excavation Soil and Groundwater Sampling –February 2012*. Project Note 420005-SPEIM-PFSA-PRJNOT-001. Prepared by CH2M HILL for AFCEE/JBCC.
- _____. 2008a (November). *Petroleum Fuels Storage Area/Fuel Spill-10/Fuel Spill 11 (PFSA/FS-10/FS-11) Biosparge/Soil Vapor Recovery System 2007 Annual Report*. Prepared by Engineering Strategies Corporation and Portage Inc. for the AFCEE/JBCC Installation Restoration Program, Otis ANG Base, MA.
- _____. 2008b (May). *Petroleum Fuels Storage Area/Fuel Spill-10/Fuel Spill 11 (PFSA/FS-10/FS-11) Biosparge/Soil Vapor Recovery System 2006 Annual Report*. Prepared by Engineering Strategies Corporation and Portage Inc. for the AFCEE/JBCC Installation Restoration Program, Otis ANG Base, MA.

- _____. 2008c (February). *October 2007 Groundwater Sampling Event Analysis & Optimization of the Biosparge/Soil Vapor Recovery (BSVR) System, Project Note PFSAPN02272008*. Prepared by Engineering Strategies Corporation and Portage Inc. for the AFCEE/JBCC Installation Restoration Program, Otis ANG Base, MA.
- _____. 2003 (May). *Final Operations and Maintenance Manual Biosparge/Vapor Recovery System for PFSA FS-10/FS-11*. Prepared by Environmental Chemical Corporation for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 1998 (September). *Record of Decision for Areas of Contamination FTA-2/LF-2, PFSA/FS-10/FS-11, SD-2/FS-6/FS-8, SD-3/FTA-3/CY-4, SD-4, and SD-5/FS-5 Source Areas*. Prepared by HLA for AFCEE/JBCC Installation Restoration Program, Otis ANG Base, MA.
- _____. 1997 (November). *Final Six Areas of Contamination Source Area Feasibility Study*. Prepared by ABB-ES for AFCEE/JBCC Installation Restoration Program, Otis ANG Base, MA.
- _____. 1996 (January). *Soil Target Cleanup Levels, DSRP*. Prepared by HAZWRAP for AFCEE/JBCC Installation Restoration Program, Otis ANG Base, MA.
- ANG. 1996 (December). *Final Remedial Investigation Report Petroleum Fuel Storage Area (Including AOCs Fuel Spill No. 10 [FS-10] and Fuel Spill No. 11)*; Installation Restoration Program; Massachusetts Military Reservation. Prepared by ABB-ES Portland, Maine for HAZWRAP.
- _____. 1994 (August). *Southeast Region Groundwater Operable Unit Remedial Investigation Report (Including Region III)*; Installation Restoration Program; Massachusetts Military Reservation. Prepared by ABB-ES Portland, Maine for HAZWRAP.
- E.C. Jordan Co. 1990 (August). *Task 5 Mashpee Groundwater Study, Installation Restoration Program, Massachusetts Military Reservation*. Prepared for HAZWRAP; Portland, Maine.
- _____. 1988 (July). *Task 2-1 Field Investigations, Summer/Fall 1986; Base Landfill, Petroleum Fuels Storage Area, and Fire-Training Area, Installation Restoration Program, Massachusetts Military Reservation*. Prepared for HAZWRAP; Portland, Maine.
- EPA. 2001 (June). *Comprehensive Five-Year Review Guidance*, EPA 540R-01-007.
- Horsely Witten. 2011 (May). *Immediate Response Action Status Report, Otis Air National Guard Base, Bourne, MA – RTN 4-23047*. Prepared for 102nd Intelligence Wing, Massachusetts Air National Guard.

R.F. Weston, Inc. 1985 (October). *Installation Restoration Program -- Phase 11, Stage 1 -- Confirmation/Quantification* Otis Air National Guard Base, Massachusetts; prepared for the U.S. Air Force Occupational and Environmental Health Laboratory.

5.0 GROUNDWATER SITES REQUIRING FIVE YEAR REVIEW

This section presents groundwater sites for which a Five Year Review is required. Eighteen groundwater sites (Table 1-3) required a Five Year Review because of one of the following conditions:

- the remedy was in place at the start of this Five Year Review period and the site is in Remedial Action – Operation status; or
- the remedy decision was completed during this Five Year Review period (i.e., between 2012 and 2017), the remedy is in place, and the site is in Remedial Action – Operation status.

5.1 ASHUMET VALLEY (AV) GROUNDWATER

The AV plume is a dissolved-phase groundwater plume (Figure 5-1A) that is defined by the extent of groundwater containing the AV COCs PCE and TCE at concentrations exceeding the federal MCL of 5 µg/L for each compound. In addition, thallium and Mn are COCs at AV but are not used to define the extent of the AV plume. The cleanup level for thallium is the MCL of 2 µg/L; the cleanup level for Mn is the EPA HA of 300 µg/L. Thallium and Mn detections, which are limited to an area immediately downgradient of the former source areas and to the west of Ashumet Pond, are expected to decrease to concentrations below cleanup levels without active treatment.

5.1.1 Site Chronology

1979: Recognition of the AV plume began when the Massachusetts Department of Environmental Quality Engineering (DEQE, now MassDEP) ordered the Town of Falmouth to shut down a municipal well due to levels of methylene-blue-active-substances (detergents) detected during a U.S. Geological Survey (USGS) investigation that exceeded generally accepted standards at that time (AFCEE 2009a). This municipal water supply well is located near the western edge of the plume boundary in the central zone approximately 300 ft east of Sandwich Road and approximately 1,500 ft south of Ashumet Road (Figure 5-1A).

1983: During a records search conducted for the JBCC, FTA-1 was identified as a potentially hazardous site and a sewage plume associated with the JBCC sewage treatment plant (STP) (later referred to as CS-16/CS-17) was first characterized by the USGS in a number of studies during the 1980s (AFCEE 2009a).

Late 1980s - 1995: A detailed assessment of the migration of the plume and the potential risks to downgradient receptors was performed in the late 1980s and 1990. Additional RIs were conducted to address soil and groundwater contamination emanating from FTA-1 and CS-16/CS-17. The first RI report was completed in the late 1980s, with additional work completed in 1991 (ABB 1991). This investigative work was updated in November 1994, with an additional RI report completed in 1995 (ABB 1995).

1994-1995: The NGB, DoD, EPA, MassDEP, and local communities approved a Plume Response Plan that presented an accelerated effort toward "simultaneous containment" of seven groundwater plumes including AV. An Interim ROD (IROD) for the seven groundwater plumes emanating from the JBCC was signed on 25 September 1995 (ANG 1995). The IROD stated that groundwater extraction and treatment systems should be designed, installed, and operated until a final remedy for the site is chosen. For AV, the interim remedy consisted of extraction, treatment, and infiltration (ETI) technology to achieve a significant degree of plume capture.

1999: Completion of the final wellfield design for the AV VOC plume which consisted of three extraction wells, two treatment plants, and two infiltration trenches (AFCEE 1999). This ETI system was installed in 1999 under the IROD.

2006: Optimization of the ETI system resulting in discontinuing the operation of two of the three ETI system extraction wells and shutdown of one of the two treatment plants (AFCEE 2007b).

2007: Completion of a feasibility study (AFCEE 2007c) and proposed plan (AFCEE 2007a) for Ashumet Valley groundwater.

2009: Preparation of the final ROD for AV groundwater (AFCEE 2009a). As part of the final remedy and as described in the ROD, the IROD ETI system was expanded in 2009 by adding additional treatment for the southern portion of the plume. The expansion included one additional extraction well, a mobile treatment unit (MTU) for granular activated carbon (GAC) treatment, and a bubbler in the Backus River for the discharge of the treated water. Remedy in place was achieved in 2009 with the startup of the leading edge system (AFCEE 2010a).

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy and added text regarding the JBCC three-step process to achieve site closure (AFCEE 2011a).

2014: On 28 February 2014, the ETD system was shut down on an interim basis. Performance monitoring data collected at five nearby wells are being used to validate the shutdown of 95EW0704. The MTU has been moved and is being utilized for the CS-10 plume.

2014: Due to the discovery of 1, 4-dioxane and PFAS in the Ashumet Valley plume (AFCEC 2014a, b), supplemental RI/FS activities are currently being completed by AFCEC (AFCEC 2016b, 2017b). Additional data collection is planned in 2018, as detailed in the Final Supplemental Remedial Investigation Data Gap Work Plan for 1,4-Dioxane and Perfluorinated Compounds at Ashumet Valley (AFCEC 2018b), in order to complete the Supplemental RI. The emerging contaminants investigation activities are being performed and reported outside of the SPEIM program.

2015: On 29 September 2015, a flow test was initiated at 95EW0703 as part of a mitigation plan to address concerns about the discharge of Ashumet Valley ETI system effluent containing detectable levels of the emerging contaminants 1, 4-dioxane and PFAS to the aquifer via the Currier Road infiltration trench (AFCEC 2014a, b). Private residential wells located near and downgradient of the Currier Road trench contain detectable concentrations of 1, 4-dioxane and PFAS which are attributed to the discharge of treatment plant effluent via the infiltration trench.

The flow test was designed to assess the maximum capacity of the Sandwich Road infiltration trench in order to eliminate effluent discharge via the Currier Road trench. It is noted that there are residential wells that are used as a drinking water supply downgradient of the Sandwich Road infiltration trench but the collection of multiple rounds of monitoring data has shown there are no impacts from the effluent discharged through the infiltration trench. The flow test concluded that the Sandwich Road infiltration trench can receive up to 215 gpm. The ETI system extraction well 95EW0703 is currently operating at 215 gpm and the effluent is being returned to the aquifer via the Sandwich Road infiltration trench. No effluent has been discharged to the Currier Road trench since the initiation of the flow test on 29 September 2015. This interim operating condition will continue while supplemental RI/FS activities related to emerging contaminants proceed (AFCEC 2016b,

2017b). The emerging contaminants investigation activities are being performed and reported outside of the SPEIM program.

2017: Increasing PCE concentrations were observed in 2017 at monitoring well 95MW1232A, located near extraction well 95EW0703. The increasing PCE concentration trend indicates the potential loss of plume capture with 95EW0703 operating at the reduced interim flow rate of 215 gpm. AFCEC and the regulatory agencies will evaluate options to address this issue in 2018.

5.1.2 Background

5.1.2.1 History of Contamination

Firefighter-training exercises were held from 1958 to 1985 at FTA-1, during which time flammable waste liquids (e.g., VOCs) were burned and extinguished. Additionally, the former JBCC STP, which operated from 1936 to 1995, released treated wastewater to a series of sand infiltration beds (CS-16) while de-watered sewage sludge was disposed of in a nearby wooded area (CS-17). These two practices and locations (FTA-1 and STP) are considered to be the sources of contaminants that have resulted in the AV groundwater plume (Figure 5-1A). In addition, a phosphate plume, which originated from the discharge of treated wastewater from the JBCC STP, is located near the northwest shore of Ashumet Pond; this phosphate plume is being addressed by AFCEC but not under a CERCLA action.

The source of the thallium and Mn detected in groundwater is believed to be the native aquifer materials where these compounds are naturally present. The discharge of treated wastewater from the JBCC STP created reducing conditions in the aquifer that led to dissolved concentrations of these compounds above background levels and established cleanup standards. These concentrations are expected to decrease to background levels as the aquifer becomes re-oxygenated over time and the effects on groundwater quality due to the discharge from the STP diminish (AFCEE 2012d).

5.1.2.2 Physical Characteristics, Land and Resource Use

Based on the most recent groundwater monitoring data collected in 2017, the AV plume consists of three disconnected zones of contamination. The northernmost zone is approximately 3,200 ft long and 650 ft wide; the central zone is approximately 3,000 ft long and 1,000 ft wide; and the southern zone is approximately 7,650 ft long and 2,000 ft wide. The plume ranges up to 75 ft thick in the aquifer. The plan view extent of the AV plume is shown on Figure 5-1A. The footprint of the AV plume was approximately 487 acres in 2012 and approximately 349 acres in 2017. A LTM program for Mn and thallium was established (AFCEE 2011c); however, sampling completed in 2011 in the area where thallium and Mn are COCs indicated that thallium concentrations no longer remained so it is no longer included in the monitoring program (AFCEE 2012e). However, Mn is still detected at concentrations above the EPA HA of 300 µg/L in this area based on sampling conducted in 2016 (AFCEC 2017b).

Land above the AV plume is used for residential, limited commercial/industrial, agricultural, and recreational purposes including golf courses, and a wildlife area managed by the Massachusetts Division of Fisheries and Wildlife (MDFW) (Crane Wildlife Management Area [CWMA]). Agricultural use of land in the area of the plume is primarily in the south with the cultivation and harvesting of cranberries from the Backus River bogs (Figure 5-1A). The land above the AV plume can be characterized as a broad, flat, gently southward sloping glacial outwash plain. Within the footprint of the plume, the maximum and minimum ground surface elevations are 84 ft msl and 10 ft msl, respectively.

5.1.2.3 Initial Responses

A summary of the initial responses is as follows:

Non-CERCLA Actions

JBCC STP Upgrade Program: The ANG upgraded the STP to discharge effluent to new sand filter beds in the northwest portion of JBCC near the Cape Cod Canal. Demolition of the former STP concrete structures was completed in 1997. Remaining sludge in the tanks was removed and treated in 1996 before demolition (AFCEC 2013a).

1998: The AV interim remedy originally included an extraction fence on the shore of Ashumet Pond to mitigate the discharge of groundwater containing phosphate that originated from the former STP infiltration beds to the surface water of Ashumet Pond. Subsequent to the interim decision that was made in September 1997, additional data and analysis suggested that an extraction fence to protect Ashumet Pond from phosphate may not be the most effective or beneficial approach and could result in detrimental effects on pond health. AFCEE, in conjunction with the Technical Review and Evaluation Team (TRET), a prior technical and community advisory panel, convened several forums in which local and state experts in phosphate transport and phosphate remediation evaluated uncertainties concerning phosphate mobility, its effect on pond ecology, and potential implications for the overall remedial strategy for the AV plume. The following general conclusions were drawn from these meetings:

- An extraction, treatment, and reinjection (ETR) approach is very inefficient given that phosphate is largely bound (or adsorbed) to the aquifer media;
- USGS bench-scale and field scale tests (e.g., clean water injections) indicate that an operating ETR system may result in overall increases in phosphate loading to the pond rather than reductions;
- No imminent threat or emergency exists since aquifer/pond data collected over the six years prior to these meetings indicate that a steady state exists (i.e., phosphate concentrations in groundwater at wells near the pond have not changed).

Based on these conclusions, AFCEE recommended a revised approach for phosphate that did not include an extraction fence.

2001-2012: AFCEE implemented a three-pronged approach to address the phosphate associated with the STP. The first element was an in-pond alum treatment to bind

phosphate that had built up in the deep, anoxic portion of Ashumet Pond. This alum treatment was conducted in September 2001 and resulted in significant reductions of phosphate available for spring and fall algae blooms. The second element involves continued monitoring of surface water quality parameters to assess the health of the pond. The third element was the installation of a geochemical barrier at the plume-pond interface on the northwest shore of Ashumet Pond near Fisherman's Cove in 2004. Trophic health monitoring data collected since the installation of the barrier indicate the barrier has significantly reduced the phosphate load to the pond. However, increasing phosphate concentration trends observed between 2007 and 2009 led to the need to perform a second in-pond alum treatment in September 2010. Based on post-alum treatment monitoring data collected in 2010 and 2011, it was concluded that prior increasing eutrophication has been reversed, and a steady improvement in pond trophic health is being observed. It was also noted that because total phosphate concentrations in the groundwater plume discharging to the pond are gradually decreasing with time and the barrier is continuing to effectively reduce phosphate loading to the pond, the 2010 alum treatment may last significantly longer than the 2001 alum treatment (AFCEE 2012b). Continued surface water monitoring is planned to track the trophic health of the pond.

2012-2017: The Coastal Systems Program of UMass Dartmouth has been collecting water quality data and sediment flux data related to phosphorus loading for the past 19 years at Ashumet Pond. Since the last alum treatment in 2010 research has focused on three specific questions. 1.) How has the sediment release of phosphorus responded to the last alum application? 2.) How are changes in sediment release of phosphorus reflected in the water quality of the epilimnion as measured by continuous monitoring of chlorophyll concentrations? 3.) Has there been any impact of the alum treatment, short or long term, on the health of the pond's mussel population, in particular the Tidewater Mucket which has been identified as a species of special concern by The Natural Heritage & Endangered Species Program.

Sediment phosphorus release has been estimated annually (except in 2015) and shown similar release rates over the last five years at both the historic deep basin site and the

shallow 30-40 ft contour site which is representative of the extended alum application area from 2010. In both instances the reduction of phosphorus release remains at approximately 50% of the pre-alum application release. Water column monitoring of chlorophyll concentrations, conducted as a proxy measure for overall water quality, has shown similar reductions when the data are integrated to reflect total biomass during Fall and Spring phytoplankton blooms. Intensive monitoring of the mussel population was conducted immediately before and after the final alum application and included the analysis of video surveys conducted using autonomous underwater vehicles as well as direct counts of animals by divers and measures of mussel health. In 2017 divers again made direct counts of mussels and their health at the same locations as were occupied in 2010. There appeared to be no impact on the mussel population immediately following the alum application.

During 2012 through 2017, the USGS conducted monitoring at Ashumet Pond for the phosphate plume. Monitoring included continuous measurements of water levels and sampling in the phosphate plume, the discharge footprint, and at the permeable reactive barrier. Numerical modeling of vertical temperature profiles at and near the permeable reactive barrier was also completed to estimate water flux through the barrier. In addition, the USGS developed a three dimensional flow and reactive-transport computer code including statistical parameter estimation and conducted modeling runs to compare simulated and observed historical snapshots of the phosphate plume. The USGS also estimated phosphate fluxes to Ashumet Pond from measured concentrations and estimated water fluxes. A report on the three dimensional modeling is being prepared.

CERCLA Actions

The 1995 IROD, which included an interim remedy for AV, stated that extraction and treatment will continue until the final remedy for the site is chosen (ANG 1995). In summary, the interim remedy provided for:

- extracting contaminated groundwater at the leading edge of the contaminant plume and potentially extracting groundwater from hot spot areas identified during remedial design;
- pumping and conveying the extracted groundwater to a treatment system to remove

contaminants;

- discharging the treated water back to the groundwater and/or other beneficial use;
- installing monitoring wells, measuring water levels, and sampling groundwater to monitor the performance of the extraction system; and
- sampling the influent and effluent of the treatment system to monitor its performance.

In addition for AV, two other interim remedial measures to address the impact of the AV plume and to protect the public health of local residents were conducted. The Town of Falmouth was reimbursed for the cost of the water supply well that was shutdown and the Falmouth municipal water system was extended into the neighborhood north of Route 151.

The TRET, established in 1996 as part of a new IROD management process, reviewed wellfield designs and determined that the 60-percent design for containment of several of the IROD plumes would cause negative ecological impacts (TRET 1996). The proposed interim remedy for the AV groundwater plume was then revised to include the design and installation of an ETI remedial system to achieve a significant degree of plume capture. An axial extraction fence was proposed to be placed within the body of the AV plume to capture and treat VOCs. The fence would extend from just north of Route 151 to Hayway Road (Figure 5-1A). To help protect Ashumet Pond, an ETR fence to capture phosphate and VOCs would be located along the northwest shore of the pond near Fisherman's Cove. Modifications to the alternative included providing funds of \$8.5 million to the Town of Falmouth to address nitrate loading in surface waters near the southern leading edge of the AV plume, investigating the southeast portion of the plume between Hayway Road and Carriage Shop Road to determine if additional remediation would be required, and a decision not to install an axial fence south of Carriage Shop Road as originally planned. Under this modified alternative, AFCEE would monitor the uncaptured portion of the AV plume located to the south of Hayway Road as part of this interim remedy while additional information related to this area was gathered.

The design of an axial wellfield array removed the ETR system originally proposed near Ashumet Pond to capture the phosphate plume from the STP. The impact of the phosphate plume to Ashumet Pond was addressed in other non-CERCLA remedial actions (AFCEE

2009a). The final wellfield design (AFCEE 1999) for the AV VOC plume consisted of three extraction wells, two treatment plants, and two infiltration trenches. The ETI system was installed in 1999 under the IROD. As part of the final remedy and as described in the final ROD (AFCEE 2009a), the system was expanded in 2009 by adding additional treatment for the southern portion of the plume. The expansion included one additional extraction well, an MTU for GAC treatment, and a bubbler in the Backus River for discharge of the treated water (Figure 5-1A). Further details regarding the AV remedial system can be found in the 2017 O&M Plan (AFCEC 2017a).

FTA-1 Source Area: Remedial actions performed at the FTA-1 source area consisted of excavation and on-site thermal treatment of contaminated soil. The treatment of contaminated soils at FTA-1 began in June 1995 and was completed in September 1997. A total of 42,531 tons of soil were excavated, thermally treated, and backfilled. The *Final Closure Report for the FTA-1 Site* (AFCEE 2000) outlines the soil excavation, thermal treatment, and backfilling activities.

STP Source Area: Remedial actions at the CS-16/CS-17 source area consisted of excavation and off-site disposal of contaminated soil. The *Final Remedial Action Report Area of Contamination CS-16/CS-17* (AFCEE 2003) details the selected remedy for the CS-16/CS-17 source areas. Approximately 6,000 tons of soil were excavated for the CS-16/CS-17 source removal and disposed of off-site in fall 2001.

AV Groundwater Plume: The AV ETI system that was part of the interim remedy began operation on 22 November 1999 with three extraction wells, two treatment plants, and two infiltration trenches. The extraction wells (95EW0701, 95EW0702, and 95EW0703) are located along the axis of the plume between Route 151 and Hayway Road and were designed to extract 1,200 gallons per minute (gpm) of groundwater from the aquifer. The treatment plants are located along Sandwich Road and each house two 20,000-lb GAC vessels, arranged in series operation, to remediate the contaminated groundwater. The two infiltration trenches are aligned parallel to the long axis of the plume, each designed to return 600 gpm of treated water to the aquifer. One infiltration trench is located along Sandwich Road and the other trench is located on Currier Road (Figure 5-1A).

On 18 May 2007, the ETI system was optimized and the operation of the two northernmost extraction wells (95EW0701 and 95EW0702) was discontinued, having substantially remediated the COCs in the aquifer within their capture zones. From 18 May 2007 to 29 September 2015, the ETI system operated with one extraction well (95EW0703) processing 350 gpm through one of the two treatment plants (one treatment plant was taken out of service). The treated water was returned to the aquifer via the two infiltration trenches with approximately 140 gpm discharged through the Sandwich Road trench and approximately 210 gpm discharged through the Currier Road trench. On 24 August 2009, the leading edge ETD system began operation. It consisted of an extraction well (95EW0704) pumping at 175 gpm, a mobile treatment unit housing a GAC system, and a bubbler that discharged the treated water to the Backus River. Based on the results of a data gap investigation and an optimization evaluation the ETD system was shut down on an interim basis on 28 February 2014 (AFCEC 2014c). Performance monitoring data collected at five nearby wells is being used to validate the shutdown of 95EW0704. On 29 September 2015, a flow test was initiated at 95EW0703 as part of a mitigation plan to address concerns about the discharge of Ashumet Valley ETI system effluent containing detectable levels of the emerging contaminants 1,4-dioxane and PFAS to the aquifer via the Currier Road infiltration trench (AFCEC 2014a, 2014b). Private residential wells containing detectable concentrations of 1,4-dioxane and PFAS are located near and downgradient of the Currier Road trench. The flow test was designed to assess the maximum capacity of the Sandwich Road infiltration trench in order to eliminate effluent discharge via the Currier Road trench. It is noted that there are residential wells that are used as a drinking water supply downgradient of the Sandwich Road infiltration trench but the collection of multiple rounds of monitoring data has shown there are no impacts from the effluent discharged through the infiltration trench. The flow test concluded that the Sandwich Road infiltration trench can receive up to 215 gpm. The ETI system extraction well 95EW0703 is currently operating at 215 gpm, and the effluent is being returned to the aquifer via the Sandwich Road infiltration trench. No effluent has been discharged to the Currier Road trench since the initiation of the flow test on 29 September 2015. This interim operating condition will continue while supplemental RI/FS activities related to emerging contaminants proceed (AFCEC 2016b, 2017b).

5.1.2.4 Basis for Taking Action

Future residential exposure to the AV groundwater COCs presents an excess lifetime cancer risk greater than the acceptable EPA range of 1×10^{-4} to 1×10^{-6} . For Backus River surface water, potential cancer risks and non-cancer hazards associated with recreational exposures to the COCs were found to be acceptable (AFCEE 2009a).

An ecological risk assessment concluded that it is very unlikely that there are ecological risks associated with the AV groundwater plume COCs (AFCEE 2009a).

5.1.3 Remedial Actions

The final remedy for the AV plume was determined in the *Final Record of Decision for the Ashumet Valley Groundwater* (AFCEE 2009a) which was signed on 10 June 2009. The RAOs for the AV groundwater plume (AFCEE 2009a) are as follows:

- Prevent residential exposure to AV groundwater with TCE concentrations greater than the MCL of 5 µg/L.
- Prevent residential exposure to AV 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 AV plume and that contains Mn 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 AV 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 timeframe that is reasonable given the particular circumstances of the site.

5.1.3.1 Remedy Selection and Implementation

The selected remedy in the ROD (AFCEE 2009a) consists of the following:

- Continued operation of the existing optimized AV ETI system (one extraction well and two associated infiltration trenches) and treatment via GAC that was installed under the interim ROD. Additionally, the final remedy included a new extraction well installed in the southern portion of the plume to improve mass capture in that area. The additional flow from the southern extraction well was treated at an MTU using GAC

in close proximity to the extraction well and discharged through a bubbler to the Backus River. As noted in Section 5.1.1, the southern extraction well was shutdown in 2014 and the MTU was moved to the base to be used for the CS-10 plume.

- Chemical and hydraulic monitoring of the plume under the SPEIM program, as long as active remediation continues, and chemical monitoring of the plume until the RAOs are met. The chemical monitoring program will include LTM for Mn and thallium at wells in an area west of Ashumet Pond (Figure 5-1A). The objective of this thallium and Mn LTM program will confirm that concentrations of these COCs are decreasing. As noted in Section 4.2, monitoring for thallium was discontinued in 2012 (AFCEE 2012d).
- Implementation of LUCs with the performance objectives of:
 - preventing access to, or use of, contaminated groundwater from the AV plume until the groundwater no longer poses an unacceptable risk, and
 - maintaining the integrity of the current or future remedial or monitoring system such as the treatment systems and monitoring wells.

Since the final remedy was selected in 2009, the following changes have occurred:

- The 2011 ESD for the IRP groundwater plumes (AFCEE 2011a) clarified the inclusion of MNA as a component of the selected remedy for AV and added text regarding the JBCC three-step process to achieve site closure.
- The discovery of 1,4-dioxane and PFAS in the Ashumet Valley plume, Ashumet and Johns Ponds, and private wells in the LUC area. Supplemental RI/FS activities are currently being completed by AFCEC.

Remedial system performance monitoring data and long-term plume monitoring data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives and system performance metrics are being met; (ii) whether remediation is progressing as expected; and (iii) to identify and assess optimization opportunities. The data collected under the SPEIM program are presented to the regulatory agencies through the Technical Update meeting process and documented in the annual SLR.

As part of the LUC process specified in the ROD (AFCEE 2009a), a private well verification survey was completed at AV between April 2009 and June 2012. The private well verification survey completed at the AV LUC area consisted of outreach to 677 parcels. Two parcels were identified that have private wells that are used as a potable water supply but are outside of the AV plume footprint and are not anticipated to represent

complete exposure pathways to the AV plume. Technical evaluations were completed for each of these private wells to determine the sampling frequency and/or re-evaluation frequencies (if necessary), and those results are provided in the *Ashumet Valley Private Well Verification and Well Determination Project Note* (AFCEE 2013). No private wells that were identified present an unacceptable exposure risk from the AV groundwater.

One private residential irrigation well located in the northern portion of the AV plume area was determined to require annual monitoring due to uncertainty regarding the well depth, the proximity of contamination associated with the nearby CS-10 groundwater plume and lack of sampling result from this well (AFCEE 2013). Annual monitoring of this well was conducted during this five year review period and no plume COCs were detected. In addition, agricultural irrigation wells located near the Backus River cranberry bogs were monitored under AFCEC's LUC Program during this five year review period and no exposure concerns were identified. In the event that new private well information is obtained or plume monitoring data indicate a change to the CSM at AV, AFCEC will perform the necessary well determinations at the time the information becomes available.

A review of the data collected under the AV SPEIM program during this five-year review period (2012-2017) indicates that there were no changes to the plume CSM that warranted a revision to the private well LUC program with respect to the current COCs.

The status of non-operational private wells in the AV LUC area continue to be tracked. AFCEC distributed a mailing, on an annual basis, to property owners within the LUC area that have non-operational wells. The intent of the annual mailing was to remind these property owners that they should contact AFCEC for a technical evaluation, which may include sampling, in the event their well is put back into service. Annual mailings were distributed during this five year review period and reported in the SLRs (AFCEC 2018a, 2017c, 2016a, 2015g, 2014c, 2013e) and annual LUC reports. A summary of private wells that were restarted during this five year review period at Ashumet Valley is provided below:

2013: Two property owners indicated that they restarted their wells for use as a private

irrigation well. Technical evaluations were completed for both private wells and based upon a review of SPEIM data and private well sampling data there is no current risk of exposure to the AV groundwater plume through the intermittent use of these wells for outdoor purposes. The technical evaluations for the two private wells that were restarted in 2013 are included in Appendix C.

2014: No private wells restarted

2015: No private wells restarted

2016: One property owner responded that they were planning to restart a previously non-operational private well for use as private irrigation water well. The restarted private well on Regis Road was sampled in March 2017 and no AV COCs were detected. This private well was also sampled for 1,4-dioxane and PFAS. 1,4-Dioxane was detected but below the reporting limit of 0.20 µg/L. PFOS was detected at concentrations above the EPA HA but this result is not considered an exposure risk for non-consumptive use (Appendix C).

2017: Annual mailings were sent in August 2017 and results will be reported in the next five year review.

The status of non-operational private wells in the AV LUC area are continually tracked. AFCEC will distribute a mailing, on an annual basis, to property owners within the LUC area that have non-operational wells. The intent of the annual mailing is to remind these property owners that they should contact AFCEC for a technical evaluation, which may include sampling, in the event their well is put back into service. Annual mailings were distributed during this five year review period and reported in the SLRs (AFCEC 2018a, 2017c, 2016a, 2015g, 2014c, 2013e) and annual LUC reports.

5.1.3.2 Remedy Operation & Maintenance

The AV remedial system is operated and maintained under an approved O&M Plan (AFCEC 2017a). The O&M Plan is updated on an annual basis and includes operational

requirements, a summary of the operational history of the systems, and details of any system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and continue to be, addressed in a timely and effective manner such that O&M associated with the remedy is considered effective at achieving the remedial goals. Operational issues are identified in O&M monthly reports and system performance and reliability is reported in the annual SLRs.

The annual SPEIM/LTM/O&M costs associated with ongoing remedial actions at AV are generally consistent with those predicted at the time of remedy selections (with consideration for savings associated with optimization initiatives) and do not indicate potential remedy problems.

5.1.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior fourth CERCLA Five Year Review (AFCEE 2013b). For the AV groundwater plume, the recommendations was:

- 1) No specific recommendations or follow up actions were identified other than emerging contaminants. Specifically, for AV groundwater, a request for sampling and analysis plans to be submitted to the regulatory agencies to assess the possible presence of 1,4-dioxane and PFAS.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

- 1) The initial recommendation to perform sampling for 1,4-dioxane and PFAS at AV was presented in the Final 4th Five-Year Review (AFCEC 2013b). A presence/absence (CERCLA SI equivalent) 1,4-dioxane field investigation was completed between October 2013 and June 2014 and the results confirmed that 1,4-dioxane is present in AV groundwater at concentrations exceeding the MassDEP GW-1 standard of 0.3 µg/L (MassDEP 2014) and additional investigation was

recommended (AFCEC 2014b). A presence/absence (CERCLA SI equivalent) PFAS field investigation was completed between July 2014 and September 2014 and results confirmed that PFAS were present in AV groundwater at concentrations exceeding the EPA HA and additional investigation was recommended (AFCEC 2014a).

Given the confirmed presence of both 1,4-dioxane and PFAS in AV groundwater above applicable standards/HAs, a Supplemental RI was conducted under CERCLA. The initial scope of work for the Supplemental RI at AV was to evaluate the nature and extent of 1,4-dioxane and PFAS contamination in groundwater and surface water. It was assumed that the 1,4-dioxane and PFAS contamination would be generally contiguous with the existing extent of the AV PCE and TCE groundwater contamination. It was also assumed, given the high solubility of 1,4-dioxane and PFAS, that these contaminants would be detached from the source areas. This approach was presented in *the Final Supplemental Remedial Investigation/Feasibility Study Work Plan for 1,4-Dioxane and Perfluorinated Compounds at Ashumet Valley, Joint Base Cape Cod, MA* (AFCEC 2016b). However, based on an initial assessment of the characterization data collected under the Supplemental RI and the EPA May 2016 release of final HA values for two of the PFAS, PFOS and PFOA, it became evident that the extent of PFAS contamination is more widespread than originally anticipated and additional data collection was necessary.

Consequently, at a data review meeting on 25 August 2016, the regulatory agencies requested that an interim emerging contaminants CSM technical memorandum be prepared using the Supplemental RI data collected to date to support the planning of additional Supplemental RI activities that are now required to meet the Supplemental RI objectives (AFCEC 2017b).

The *Interim Ashumet Valley Emerging Contaminants Conceptual Site Model Technical Memorandum* (AFCEC 2017b) was submitted in March 2017 and included a summary of the nature and extent of the emerging contaminants based

on the Supplemental RI data collected through December 2016 and identified the data gaps that will need to be addressed to complete the Supplemental RI. A Supplemental RI data gap workplan was prepared (REF) and data collection activities are underway (AFCEC 2018b). The emerging contaminants investigation activities are being performed and reported outside of the SPEIM program.

5.1.5 Five Year Review Process

5.1.5.1 Data Review

The JBCC SPEIM program was developed to monitor plume changes and to ensure the effective operation of the AFCEC groundwater remediation systems at the JBCC. These objectives are met through monitoring of selected media (i.e., groundwater, surface water) within and outside the plume boundaries, treatment plant monitoring, and groundwater flow and transport modeling. The data collected under the SPEIM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being addressed through active treatment. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program. The SLRs also include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual reporting period as attachments or by reference. The SLRs are provided to the broad stakeholder group for each plume including Federal (EPA) and State (MassDEP, MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties. The SLRs are publically available in the IRP Administrative Record and copies are

maintained at the local town libraries.

In addition to the annual SLRs prepared for AV during this Five Year Review period (AFCEC 2018a, 2017c, 2016a, 2015g, 2014c, 2013e), the following technical deliverables were prepared that assessed system performance or presented the results of optimization evaluations:

- *Ashumet Valley 2013 Triennial SPEIM/LTM Data Presentation and Network Optimization Project Note* (AFCEC 2014e)
- *Ashumet Valley 2013 95EW0704 Interim Shutdown Project Note* (AFCEC 2014d)
- *Ashumet Pond 2013 - 2014 Trophic Health Project Note* (AFCEC 2015d).
- *Ashumet Valley 2014 Annual/Semiannual SPEIM Data Presentation Project Note* (AFCEC 2015e)
- *Ashumet Valley 2015 Annual/Semiannual SPEIM Data Presentation Project Note* (AFCEC 2015a)
- *Ashumet Valley 2016 Triennial SPEIM/LTM Data Presentation Project Note* (AFCEC 2016e)

5.1.5.2 Site Inspections

Refer to Section 3.6.

5.1.5.3 Interviews

Refer to Section 3.7.

5.1.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.1.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, for the current COCs. The completion of the ROD in 2009, construction and startup of the ETD system in 2009, the shutdown of the leading edge system in 2014, continued operation of the ETI remedial system, completion of the well verification/well determination portion of the LUCs in early 2013, and annual mailings have resulted in the remedy functioning as intended by the decision documents. The ETI remedial system is performing as expected for the current COCs. Plume and remedial system monitoring is being conducted under the SPEIM/LTM and LUC programs and risk management measures are in place to address discharge of the plume to the Backus River and associated cranberry bogs. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD for current COCs (i.e., 2021). Operational costs are appropriate for the remedy and a robust optimization program continues with the objective of reducing remedial system operational timeframes, the time to reach remedial goals (e.g., MCLs), and reducing future costs. Monitoring and evaluation activities are continual and well-documented for the current COCs.

On 29 September 2015, a flow test was initiated at 95EW0703 as part of a mitigation plan to address concerns about the discharge of Ashumet Valley ETI system effluent containing detectable levels of the emerging contaminants, 1,4-dioxane and PFAS, to the aquifer via the Currier Road infiltration trench (AFCEC 2014a, 2014b). Private residential wells containing detectable concentrations of 1,4-dioxane and PFAS are located near and downgradient of the Currier Road trench.

The flow test was designed to assess the maximum capacity of the Sandwich Road infiltration trench in order to eliminate effluent discharge via the Currier Road trench; it is noted that there are no residential wells that are used as a drinking water supply downgradient of the Sandwich Road infiltration trench. The flow test concluded that the Sandwich Road infiltration trench can receive up to 215 gpm. The ETI system extraction well 95EW0703 is currently operating at 215 gpm and the effluent is being returned to the aquifer via the Sandwich Road infiltration trench. No effluent has been discharged to the Currier Road trench since the initiation of the flow test on 29 September 2015. This interim

operating condition will continue while supplemental RI/FS activities related to emerging contaminants proceed (AFCEC 2016b, 2017b).

Increasing PCE concentrations were observed in late 2017 at monitoring well 95MW1232A, located near extraction well 95EW0703. The increasing PCE concentration trend indicates the potential loss of plume capture with 95EW0703 operating at the reduced interim flow rate of 215 gpm. AFCEC and the regulatory agencies will evaluate options to address this issue in 2018.

5.1.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To Be Considered: There have been no changes in standards or To Be Considered (TBC) guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site for the current COCs that would affect the protectiveness of the remedy.

However, potential risk of exposure to the emerging contaminants, 1,4-dioxane and PFAS, in groundwater and surface water at AV are being evaluated as part of the ongoing activities. Section 3.3 provides the GW-1 standard for 1,4-dioxane and the HAs for PFOS and PFOA.

Changes in Toxicity and Other Contaminant Characteristics. There have been no changes in toxicity factors that were in place since the last Five Year Review (i.e., 2012) or other contaminant characteristics for the AV groundwater COCs.

However, potential risk of exposure to the emerging contaminants, 1,4-dioxane and PFAS, in groundwater and surface water at AV are being evaluated as part of the ongoing activities. Section 3.3 provides the reference doses for PFOS and PFOA.

Changes in Risk Assessment Methods: There have been no changes in risk assessment methodology that affect protectiveness.

Review of RAOs: The RAOs developed for the final ROD (AFCEE 2009a) are appropriate and remain valid for current COCs.

5.1.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information during this Five Year Review timeframe that calls into question the protectiveness of the remedy for current COCs. However, increasing PCE concentrations were observed in late 2017 at monitoring well 95MW1232A, located near extraction well 95EW0703, and may need to be addressed.

For ECs, monitoring is in place and mitigation actions are being accomplished where necessary to manage any exposure risks while Supplemental RI/FS activities are ongoing.

5.1.7 Issues, Recommendations, and Follow-Up Actions

Increasing PCE concentrations were observed in 2017 at monitoring well 95MW1232A, located near extraction well 95EW0703. The increasing PCE concentration trend indicates the potential loss of plume capture with 95EW0703 operating at the reduced interim flow rate of 215 gpm. AFCEC and the regulatory agencies will evaluate options to address this potential loss in 2018.

The emerging contaminant investigation is ongoing at AV. The CERCLA process should be followed, an eventual ROD Amendment issued and LUC area developed as needed by the next five year review. An addendum to this Five Year Review will need to be developed once the Supplemental RI is completed which is tentatively scheduled for September 2019 and a protectiveness determination can be made.

5.1.8 Protectiveness Determination

The remedy for the AV groundwater plume is protective of human health and the environment for the COCs in the short-term; however, overall site protectiveness for the AV groundwater plume is being deferred due to the presence of the ECs PFAS and 1,4-dioxane. The LUCs are in place and are functioning as intended for the COCs.

Through the combination of the active treatment by the remedial system and natural attenuation processes, existing groundwater cleanup levels for the COCs are expected to be achieved within the timeframe approximated in the ROD, however, there is a potential loss of plume capture near extraction well 95EW0703 indicated by increasing PCE concentrations in a nearby monitoring well. In order for the remedy to be protective in the long-term for existing COCs, this potential issue needs to be evaluated. For ECs, particularly PFOS and PFOA, the Supplemental RI is ongoing and outreach activities are continuing to identify private wells that might be impacted by the PFOS and PFOA emanating from the JBCC. Mitigation activities including providing bottled water, filtration systems, and/or municipal water connections are being implemented for impacted drinking water supplies. In addition, there are plans to install wellhead treatment on the Mashpee Village Public Water Supply Well which has also been impacted by PFOS and PFOA from JBCC. Because there have been documented exposures, necessary mitigations, a potential for additional impacted water supplies, and LUCs have not been implemented, an overall protectiveness determination cannot be made for this site. Additional information is being collected through a Supplemental RI, tentatively scheduled for completion in September 2019 but dependent upon results obtained during the investigation, and is expected to be followed by an eventual ROD Amendment and development of a LUC area for ECs. Upon completion of the Supplemental RI, a Five-Year Review Addendum will be completed and a protectiveness determination will be made.

5.1.9 References

- ABB (ABB Environmental Services, Inc.). 1995 (April). *Ashumet Valley Groundwater Operable Unit Remedial Investigation Report*. Prepared by ABB Environmental Services Inc. for HAZWRAP Support Contractor Office, Oak Ridge National Laboratory, Oak Ridge, TN.
- _____. 1991 (September). *Phase I Study*. Installation Restoration Program, Massachusetts Military Reservation. Prepared by ABB Environmental Services Inc. for HAZWRAP Support Contractor Office, Oak Ridge National Laboratory, Oak Ridge, TN.
- AFCEC. 2018a (April). *Ashumet Valley 2017 Summary Letter Report*. 652000-SPEIM-AVP-SLR-004. Prepared by CH2M HILL for AFCEC/MMR, Installation

Restoration Program, Otis Air National Guard Base, MA.

- _____. 2018b (January). *Final Supplemental Remedial Investigation Data Gap Work Plan for 1,4-Dioxane and Perfluorinated Compounds at Ashumet Valley, Joint Base Cape Cod, MA*. 658003-EC-AV-QAPP-005. Prepared by CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2017a (November). *2017 Operations and Maintenance Plan for Groundwater Extraction and Treatment Systems and Wind Turbines*. 652000-O&M-OMPLN-003. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2017b (March). *Interim Ashumet Valley Emerging Contaminants Conceptual Site Model Technical Memorandum*. 658003-EC-AV-CSM-001. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2017c (March). *Ashumet Valley 2016 Summary Letter Report*. 652000-SPEIM-AVP-SLR-003. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2016a (March). *Ashumet Valley 2015 Summary Letter Report*. 652000-SPEIM-AVP-SLR-002. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2016b (February). *Final Supplemental Remedial Investigation/Feasibility Study Work Plan for 1,4-Dioxane and Perfluorinated Compounds at Ashumet Valley, Joint Base Cape Cod, MA*. 658003-EC-AV-QAPP-003. Prepared by CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2016c (September). *Annual Land Use Control Letter Report for 2015*. Prepared by AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2016d (November). *Draft Ashumet Valley Emerging Contaminants Residential Well Revisions Project Note*. 658003-EC-AV-PRJNOT-001. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2016e (December). *Ashumet Valley 2016 Triennial SPEIM/LTM Data Presentation*. 652000-SPEIM-AVP-PRJNOT-002. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2015a (September). *Ashumet Valley 2015 Annual/Semiannual SPEIM Data Presentation Project Note*. 652000-SPEIM-AVP-PRJNOT-001. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
-

- _____. 2015b (July). *Annual Land Use Control Letter Report for 2014*. Prepared by AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015c (June). *Draft Pre-Remedial Investigation Sampling and Analysis for Perfluorinated Compounds at Ashumet Valley, Joint Base Cape Cod, MA*. 658003-EC-AV-QAPP-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2015d (April). *Ashumet Pond 2013 - 2014 Trophic Health Project Note*. Prepared by AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015e (March). *Ashumet Valley 2014 Annual SPEIM Data Presentation Project Note*. 473147-SPEIM-AVP-PRJNOT-005. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015f (March). *Ashumet Valley 2014 Summary Letter Report*. 652000-SPEIM-AVP-SLR-001. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015g (March). *Final Supplemental Remedial Investigation/Feasibility Study Work Plan for 1,4-Dioxane at Ashumet Valley, Chemical Spill-10, Chemical Spill-20, and Landfill-1, Joint Base Cape Cod, MA*. 658003-EC-Multiple-QAPP-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2014a (November). *PFC Sample Results at Ashumet Valley Data Presentation Project Note*. 473147-SPEIM-AVP-PRJNOT-004. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014b (August). *1,4-Dioxane Monitoring Well Sample Results Data Presentation Project Note*. 473147-SPEIM-MULTIPLE-PRJNOT-007. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014c (March). *Ashumet Valley 2013 Summary Letter Report*. 473147-SPEIM-AVP-SLR-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

- _____. 2014d (February). *Ashumet Valley 2013 95EW0704 Interim Shutdown Project Note*. 473147-SPEIM-AVP-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014e (January). *Ashumet Valley 2013 Triennial SPEIM/LTM Data Presentation and Network Optimization Project Note*. 473147-SPEIM-AVP-PRJNOT-002. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013a (November). *Ashumet Valley 2013 Triennial SPEIM/LTM Data Presentation and Network Optimization Project Note*. 473147-SPEIM-AVP-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013b (October). *Final 4th Five Year Review, 2007-2012, Massachusetts Military Reservation Superfund Site, Otis Air National Guard Base, MA*. 473147-SPEIM-Multiple-RPT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013c (July). *AFCEC JBCC SPEIM/LTM/O&M Program Quality Assurance Project Plan*. 437075-Program-Multiple-QAPP-001. Prepared by CH2M HILL for AFCEC/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013d (June). *Confirmation of Private Well Operational Status: Installation Restoration Program Land Use Control Areas*. 437075-LUC-Multiple-PRJNOT-002. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013e (March). *Ashumet Valley 2012 Summary Letter Report*. 437075-SPEIM-AVP-SLR-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013f (January). *Ashumet Valley Groundwater Plume Conceptual Site Model*. 437075-SPEIMAVP-CSM-001. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- AFCEE. 2013 (January). *Ashumet Valley Private Well Verification and Well Determination Project Note*. 420005-LUC-MULTIPLE-PRJNOT-002. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

- _____. 2012a (August). *Final 2011 JBCC Vapor Intrusion Evaluation Technical Memorandum*. 420005-SPEIM-MULTIPLE-TECHMEM-002. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012b (July). *Ashumet Pond 2012 Trophic Health Monitoring Optimization Project Note*. 420005-SPEIM-ASHPO-PRJNOT-002. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012c (June). *June 2012 Operations and Maintenance Plan for Groundwater Extraction and Treatment Systems and Wind Turbine*. 425445-O&M-MULTIPLE-OMPLN-001. Prepared by Bhate Environmental Associates and CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2012d (March). *Ashumet Valley 2011 Triennial/Annual SPEIM Data Presentation Project Note*. 420005-SPEIM-AVP-PRJNOT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012e (March). *Ashumet Valley 2011 Summary Letter Report*. 420005-SPEIM-AVP-SLR-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2011a (September). *Final Explanation of Significant Differences for the Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation*. 404929-SPEIM-MULTIPLE-RPT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2011b (March). *Ashumet Valley 2010 Summary Letter Report*. 404929-SPEIM-AVP-SLR-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2011c (March). *Ashumet Valley 2010 Annual/Semiannual SPEIM Data Presentation Project Note*. 404929-SPEIM-AVP-PRJNOT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2010a (August). *Final Updated Interim Remedial Action Report for Chemical Spill-10 and Ashumet Valley Groundwater Plumes*. Prepared by ECC for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2010b (March). *Ashumet Valley 2009 Summary Letter Report*. 389849-SPEIM-AVP-SLR-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

- _____. 2010c (March). *Ashumet Valley 2009 Annual/Semiannual SPEIM Data Presentation Project Note*. 389849-SPEIM-AVP-PRJNOT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2009a (June). *Final Record of Decision for the Ashumet Valley Groundwater*. A4P-J23-35BC02VA-M26-0015. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2009b (March). *Ashumet Valley 2008 Summary Letter Report*. 371335-SPEIM-AVP-SLR-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2008a (September). *Final 3rd Five-Year Review, 2002-2007 Massachusetts Military Reservation (JBCC) Superfund Site, Otis Air National Guard Base, MA*. Prepared by Engineering Strategies Corporation, Portage and CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2008b (September). *Ashumet Valley 2007 Triennial SPEIM Data Presentation and Optimization Testing Project Note*. 371335-SPEIM-AVP-PRJNOT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2008c (June). *Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note*. 371335-SPEIM-AVP-PRJNOT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2008d (May). *Verification, Decommissioning, and Documentation Guidelines for Private Wells in Areas of Potential Concern*. Prepared by Air Force Center for Engineering and the Environment Massachusetts Military Reservation Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2008e (March). *Ashumet Valley 2007 Summary Letter Report*. 337105-SPEIM-AVP-SLR-002. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2007a (June). *Proposed Plan for Ashumet Valley Groundwater: Fact Sheet 2007-01*. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2007b (May). *Final Ashumet Valley 2006 Optimization Technical Memorandum*. 337105-SPEIM-AVP-TECHMEM-002. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis ANG Base, MA.

- _____. 2007c (March). *Final Ashumet Valley Groundwater Feasibility Study*. A4P-J23-35BC02VA-M16-0018. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2007d (March). *Ashumet Valley 2006 Summary Letter Report*. 337105-SPEIM-AVP-SLR-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2003 (April). *Final Remedial Action Report Area of Contamination CS-16/CS-17*. Prepared by Environmental Chemical Corporation for AFCEE/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2000 (July). *Final Closure Report FTA-1 Site*. Prepared by Jacobs Engineering Group Inc. for the AFCEE/JBCC Installation Restoration Program, Otis ANG Base, MA.
- _____. 1999 (October). *Final Ashumet Valley Axial Wellfield Design Report*. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- ANG. 1995 (September). *Final Record of Decision for Interim Action of Seven Groundwater Plumes at Massachusetts Military Reservation, Cape Cod, Massachusetts*. Prepared by Stone & Webster, Environmental Technology and Services for ANG JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- EPA. 2013 (March). Integrated Risk Information System (IRIS) database. [online]. Available: <http://www.epa.gov/iris/index.html>.
- _____. 2012 (November). Regional Screening Levels (RSLs). [online]. Available: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/.
- _____. 2008 (September). Risk-Based Concentration Table [online]. Available: <http://www.epa.gov/reg3hwmd/risk/human/index.htm>.
- _____. 2001 (June). *Comprehensive Five-Year Review Guidance*, EPA 540R-01-007.
- MassDPH, Center for Environmental Health. 2005 (August 24). Memorandum to Remedial Project Managers from Martha Steele. Re: Backus River.

5.2 CHEMICAL SPILL-4 (CS-4) GROUNDWATER

The CS-4 plume is a dissolved-phase groundwater plume (Figure 5-2A) that contains the following four COCs: PCE, TCE, 1,1,2,2-tetrachloroethane (1,1,2,2-TeCA), and ethylene dibromide (EDB). The CS-4 plume boundary is defined as the extent of groundwater containing the COC PCE at concentrations exceeding its MCL of 5 µg/L. The remaining three COCs are detected sporadically and are co-located with the PCE contamination. The cleanup levels for these COCs are as follows: MCL for TCE is 5 µg/L; the MCP Method 1 GW-1 standard for 1,1,2,2-TeCA is 2 µg/L; and the MMCL for EDB is 0.02 µg/L.

5.2.1 Site Chronology

1986: The IRP Phase I Records Search identified CS-4 as a JBCC site that required further investigation (E.C. Jordan Co., 1986).

1989: The Phase I MW-603 groundwater study concluded that chlorinated solvents were associated with soil contamination found at the CS-4 source area and had migrated off-JBCC toward potential groundwater receptors (E.C. Jordan Co. 1990a).

1992: A focused feasibility study was prepared (ANG 1992b), and the IROD remedy consisted of an ETI system with thirteen extraction wells intended to prevent further migration of the CS-4 plume (ANG 1992a).

1993: This ETI system began operation in September 1993.

1986 – mid 1990s: Other investigations (E.C. Jordan Co. 1990b, 1990c) were conducted which culminated in an RI report prepared in 1998 (AFCEE 1999c). Results of the RI and the *Final Technical Memorandum AOC CS-4 Hydraulic Performance Evaluation* (AFCEE 1997) indicated that the interim remedial system was not capturing the entire CS-4 plume.

1999: Following the RI, another feasibility study was completed in 1999 to assess remedial alternatives to replace the existing ineffective system (AFCEE 1999b) and the proposed plan was released to the public in June 1999 (AFCEE 1999a).

2000: Preparation of the ROD (AFCEE 2000).

2003: The original CS-4 treatment system was turned off in May 2003 because of its ineffectiveness (AFCEE 2003), and was decommissioned in 2004 (AFCEE 2004a).

2004: Completion of the final wellfield design consisting of three CS-4 extraction wells that were installed as part of the Southwest Plumes remedial system, which was designed to collectively remediate the CS-4, CS-20, CS-21, and FS-29 groundwater plumes (AFCEE 2004b) (Figure 5-2A).

2005: Remedy in place was achieved in November 2005 with the startup of the new CS-4 treatment system (AFCEE 2008c).

2008: An ESD was submitted to document changes to the selected remedy for CS-4 related to the expected extent of plume capture and to further describe the institutional controls associated with the remedy (AFCEE 2008b).

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and added text regarding the JBCC three-step process to achieve site closure (AFCEE 2011).

5.2.2 Background

5.2.2.1 History of Contamination

The source of the CS-4 groundwater plume is CS-4 West Truck Road Motor Pool. The source area included a former gasoline station, a former bus terminal, a suspected waste disposal pit, piles of sand and debris, a wetland, and two areas that receive storm-water runoff. CS-4 was operated for the maintenance of military vehicles by the U.S. Army from 1940 to 1946 and by the USAF from 1955 to 1973. Wastes generated and potentially spilled or dumped during this period included oils, solvents, antifreeze, battery electrolytes, paint, and waste fuels (ANG 1992a).

In addition to motor pool activities, the base Defense Property Disposal Office (DPDO) maintained a storage yard in the northern portion of CS-4 between 1965 and 1983. Wastes were transported to the DPDO from shops and laboratories operating at JBCC. Wastes and equipment handled at CS-4 included transformers, electrical equipment, waste oils, solvents, and waste fuels. Liquid wastes were stored in containers or tanks in an unbermed area, or deposited in six 5,000-gallon USTs installed to store motor gasoline when the motor pools were operational. The USTs were used until January 1984; in September 1984, the last USTs used for waste storage were emptied and removed. The area has been inactive since 1986 (ANG 1992a).

5.2.2.2 Physical Characteristics, Land and Resource Use

Based on the most recent groundwater monitoring data collected in 2017, the CS-4 plume is approximately 2,000 ft long, has a maximum width of approximately 500 ft, and is up to 60 ft thick in the aquifer (Figure 5-2A). The footprint of the CS-4 plume was approximately 48 acres in 2012, and was approximately 23 acres in 2017 (Figure 5-2B).

The land above the CS-4 plume is undeveloped woodlands used for recreational purposes (hiking, biking, hunting, etc.) within the CWMA, which is managed by the MDFW (Figure 5-2A). The CS-4 plume is located within a broad, flat, gently sloping glacial outwash plain. Within the footprint of the plume, the maximum and minimum ground surface elevations are 102 ft msl and 88 ft msl, respectively.

5.2.2.3 Initial Responses

A summary of the initial responses is as follows:

Non-CERCLA Actions: None.

CERCLA Actions:

CS-4 Source Area: AFCEE conducted several source removals at CS-4 West Truck Road Motor Pool. In 1994, more than 13,000 tons of contaminated soils at the CS-4 site were treated using an on-site thermal treatment unit. AFCEE removed 24 drainage structures

and 3,000 tons of contaminated soil from the CS-4 source area in 1996. In 2001, an additional 5,200 tons of contaminated soils, along with an old UST, were removed from the site (AFCEE 2008a). These removal actions resulted in a no further action decision for CS-4 (AFCEE 2005).

CS-4 Groundwater Plume: A focused feasibility study was prepared in 1992 to evaluate the interim remedial alternatives for containing the CS-4 groundwater plume (ANG 1992b). An IROD was developed to implement a remedy to address groundwater contamination at CS-4 (ANG 1992a). In 1993, an interim groundwater treatment system was installed and became operational. Thirteen extraction wells were installed with the goal of capturing the CS-4 plume and were arranged in a fence configuration perpendicular to the direction of groundwater flow (Figure 5-2A). Extracted groundwater was treated using GAC and then discharged to the subsurface via two infiltration trenches. However, results of the *Final Technical Memorandum AOC CS-4 Hydraulic Performance Evaluation* (AFCEE 1997) and the Southwest Operable Unit (SWOU) RI (AFCEE 1999c) indicated that the interim remedial system was not capturing the entire CS-4 plume.

Following the 1998 SWOU RI (AFCEE 1999c), another feasibility study was completed in 1999 (AFCEE 1999b). A proposed plan was released to the public in June 1999 (AFCEE 1999a) to solicit comments on the preferred alternative (Alternative 6). The selected remedy for CS-4 as specified in the ROD was Alternative 6; groundwater extraction and treatment through the installation of three new extraction wells, treatment at the original CS-4 treatment plant using GAC, performance monitoring of the CS-4 plume and remedial system, and institutional controls (AFCEE 2000). In May 2003 and subsequent to the issuance of the ROD, AFCEE, with concurrence from the EPA and the MassDEP, turned off the original CS-4 treatment system because of its ineffectiveness (AFCEE 2003). The original CS-4 treatment system was decommissioned in 2004 (AFCEE 2004a).

The final design for the new CS-4 remedial system consisted of three extraction wells (02EW0014, 02EW0015, and 02EW0016 shown on Figure 5-2A) and began operation on 28 November 2005 at a design extraction rate of 620 gpm (AFCEE 2008d). Extracted groundwater is treated by GAC in the centrally-located Hunter Avenue Treatment Facility

(HATF) and the treated water is returned to the aquifer through reinjection wells, an infiltration trench, and an infiltration gallery. Further details regarding the CS-4 remedial system can be found in the 2017 O&M Plan (AFCEC 2017a).

An ESD was submitted in 2008 to document changes to the selected remedy for CS-4 (AFCEE 2008b). The primary difference between the cleanup strategy identified in the ROD and the final design is that the selected alternative presented in the ROD anticipated that the entire CS-4 plume would be hydraulically captured by the remedial system; however, the final design allowed the groundwater contamination in the downgradient leading edge of CS-4 to reach cleanup levels through natural attenuation instead of through active treatment. While analyzing various designs for system performance, effectiveness, property access issues, and other constraints, the final design for CS-4 was developed to meet the RAOs described in Section 5.2.3, while allowing for a relatively small portion of the plume to attenuate naturally.

An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and updated the steps to achieve site closure (i.e., the three-step process) (AFCEE 2011).

5.2.2.4 Basis for Taking Action

The baseline cancer risk calculations in the SWOU RI indicated that unless remedial action is undertaken, future residential exposure to the CS-4 COCs in groundwater may present an excess lifetime cancer risk greater than the acceptable EPA range of 1×10^{-4} to 1×10^{-6} . Ecological risks associated with the CS-4 groundwater plume were evaluated during the RI and no significant risk was identified (AFCEE 1999c).

5.2.3 Remedial Actions

The final remedy for the CS-4 plume was determined in the *Final Record of Decision for the CS-4, CS-20, CS-21, and FS-13 Plumes* (AFCEE 2000) which was signed on 18 February 2000.

The RAOs for the CS-4 groundwater plume as presented in the ROD (AFCEE 2000) and modified in the ESD (AFCEE 2008b, AFCEE 2011) are as follows:

- Prevent residential exposure to CS-4 groundwater with PCE concentrations greater than the MCL of 5 µg/L.
- Prevent residential exposure to CS-4 groundwater with TCE concentrations greater than the MCL of 5 µg/L.
- Prevent residential exposure to CS-4 groundwater with 1,1,2,2-TeCA concentrations greater than the Massachusetts GW-1 standard of 2 µg/L.
- Prevent residential exposure to CS-4 groundwater with EDB concentrations greater than the MMCL of 0.02 µg/L.
- Restore useable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

5.2.3.1 Remedy Selection and Implementation

The selected remedy for CS-4 groundwater in the ROD (AFCEE 2000) included the following components:

- Discontinue operation of the existing CS-4 plume extraction well fence.
- Install new extraction wells and treat extracted water at the original CS-4 remedial plant with treatment via GAC.
- If additional treatment capacity is necessary, the extracted water will be treated at the HATF treatment plant.
- Institutional controls to mitigate exposure to humans from CS-4 groundwater contaminants. In 1999, the Falmouth BOH adopted water well regulations to minimize the risk of exposure to groundwater contamination.
- Engineering controls to mitigate exposure to humans from CS-4 groundwater contaminants. Residents potentially impacted by the plume are connected to a public water supply.

- Plume monitoring and performance monitoring of the treatment system.
- Completion of CERCLA reviews every five years throughout the lifetime of the remedial action.

Since the remedy was selected in 2000, the following changes have occurred:

- a) The Wellfield Design (AFCEE 2004b) presented the revised plan to treat the four Southwest Plumes (CS-4, CS-20, CS-21, and FS-29) via GAC at a centrally-located treatment plant (HATF) on the JBCC.
- b) The institutional controls described in the ROD were further developed as described in the Southwest Plumes ESD (AFCEE 2008b). The ESD provides a more thorough description of the LUC Program, including a private well verification program that is being instituted for all the JBCC groundwater sites.
- c) The 2011 ESD for the IRP groundwater plumes (AFCEE 2011) clarified the inclusion of MNA as a component of the selected remedy for CS-4, slightly modified the phrasing of the RAOs, and added text regarding the JBCC three-step process to achieve site closure.

The CS-4 remedial system was installed in 2005 and began operation on 28 November 2005 using three extraction wells at a total flow rate of 620 gpm.

Remedial system performance monitoring data and long-term plume monitoring data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives and system performance metrics are being met; (ii) whether remediation is progressing as expected; and (iii) to identify and assess optimization opportunities. The data collected under the SPEIM/LTM program are presented to the regulatory agencies through the Technical Update meeting process and documented in annual SLRs.

As part of the LUC process specified in the ROD and subsequent ESD (AFCEE 2000, 2008b), a private well verification survey was completed for the Southwest Plumes (including CS-4) between April 2009 and August 2011. This private well verification survey consisted of outreach to 497 parcels. No private wells identified on properties within the CS-4 LUC area (AFCEE 2012b).

The status of non-operational private wells in the CS-4 LUC area continue to be tracked. AFCEC distributed a mailing, on an annual basis, to property owners within the LUC area

that have non-operational wells. The intent of the annual mailing is to remind these property owners that they should contact AFCEC for a technical evaluation, which may include sampling, in the event their well is put back into service. Annual mailings were distributed during this five year review period and reported in the SLRs (AFCEC 2018, 2017c, 2016b, 2015b, 2014b, 2013c) and annual LUC reports. No property owners notified AFCEC that they intended to restart a non-operational private well within CS-4 LUC area during this five year review period (2012 -2017).

5.2.3.2 Remedy Operation & Maintenance

The CS-4 remedial system is operated and maintained under an approved O&M Plan (AFCEC 2017a). The O&M Plan is updated on an annual basis and includes operational requirements, a summary of the operational history of the systems, and details of any system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and continue to be, addressed in a timely and effective manner such that O&M associated with the remedy is considered effective at achieving the remedy goals. Operational issues are identified in O&M monthly reports and system performance and reliability is reported in the annual SLRs.

The annual SPEIM/LTM/O&M costs associated with ongoing remedial actions at CS-4 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives) and do not indicate potential remedy problems.

5.2.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior fourth CERCLA Five Year Review (AFCEE 2013b). For the CS-4 groundwater plume, the recommendations and follow-up actions were:

- 1) Current transport modeling projections predict a restoration timeframe (2029) beyond that predicted at the time of remedy selection (2017) and as discussed in

Section 5.2.5.1, a modeling-based remedial system optimization assessment will be completed for the CS-4 plume. In a manner similar to that performed at CS-20, the most recent CS-4 transport simulations will be rerun without loading PCE mass in the low hydraulic conductivity units (where supported by data) to provide a more accurate estimated aquifer restoration timeframe.

- 2) In addition, the topic of emerging contaminants should be monitored as it relates to groundwater at the JBCC. Specifically for CS-4 groundwater, a sampling and analysis plan shall be submitted to the regulatory agencies to assess the possible presence of 1,4-dioxane.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

- 1) As recommended in the 4th Five Year Review, the most recent CS-4 transport simulations were rerun in 2014 without loading PCE mass in the low hydraulic conductivity units (where supported by data) to provide a more accurate estimated aquifer restoration timeframe than was previously predicted (2029). Using the 2010 CS-4 PCE plume shell and assuming the system would operate continuously under 2010 Scenario 01 flow rates, the most recent transport model simulations predicted that the two remaining operational CS-4 extraction wells (02EW0014 and 02EW0015) would be shut down by approximately 2016, and all PCE concentrations are expected to decrease below the MCL by approximately 2018 (AFCEC 2014a). CS-4 extraction well 02EW0014 was shut down in September 2015, but a small area remains with PCE concentrations above the MCL that is located hydraulically upgradient of extraction well 02EW0015. The current SPEIM data indicate that CS-4 extraction well 02EW0015 is expected to operate a year or two beyond 2018 before PCE concentrations near the extraction well reduce to concentrations below the MCL. This timeframe is considered within the approximate aquifer restoration timeframe presented in the ROD (AFCEC 2016a). The remaining portion of the CS-4 plume is located entirely beneath the Crane Wildlife Area where there is no drinking water wells, indicating that the current

remedy remains protective.

- 2) The Final 4th Five Year Review (2007-2012) (AFCEC 2013b) provided the recommendation to monitor for emerging contaminants. A presence/absence (CERCLA SI equivalent) 1,4-dioxane field investigation was completed between October 2013 and June 2014 at seven IRP chlorinated solvent plumes (Ashumet Valley, CS-4, CS-10, CS-20, CS-21, CS-23, and LF-1) in response to the recommendation in the last five-year review. Sampling for 1,4-dioxane was completed at the treatment plant influent and effluent ports, operating extraction wells, selected monitoring wells, selected private wells, and selected PWS wells. The results of this investigation confirmed that 1,4-dioxane is present at four plumes (Ashumet Valley, CS-10, CS-20 and LF-1). Additional investigation at these four plumes was recommended (AFCEC 2014b) but nothing further for the CS-4 groundwater plume.

5.2.5 Five Year Review Process

5.2.5.1 Data Review

The JBCC SPEIM program was developed to monitor plume changes and to ensure the effective operation of the AFCEC groundwater remediation systems at the JBCC. These objectives are met through monitoring of selected media (i.e., groundwater, surface water) within and outside the plume boundaries, treatment plant monitoring, and groundwater flow and transport modeling. The data collected under the SPEIM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being addressed through active treatment. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program. The SLRs also

include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual reporting period as attachments or by reference. The SLRs are provided to the broad stakeholder group for each plume including Federal (EPA) and State (MassDEP, MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties. The SLRs are publically available in the IRP Administrative Record and copies are maintained at the local town libraries.

In addition to the annual SLRs prepared for the Southwest Plumes (including CS-4) during this Five Year Review period (AFCEC 2018, 2017c, 2016b, 2015b, 2014b, 2013c), the following technical deliverables were prepared that assessed system performance or presented the results of optimization evaluations:

- *Southwest Plumes 2012 Triennial SPEIM Data Presentation Project Note* (AFCEC 2012)
- *Southwest Plumes 2013 Annual SPEIM Data Presentation Project Note.* (AFCEC 2013a)
- *Southwest Plumes 2014 Annual SPEIM Data Presentation Project Note* (AFCEC 2014a)
- *Southwest Plumes 2015 Triennial SPEIM Data Presentation Project Note* (AFCEC 2015a)
- *Southwest Plumes 2016 Annual SPEIM Data Presentation Project Note* (AFCEC 2016a)
- *Southwest Plumes 2017 Annual SPEIM Data Presentation Project Note* (AFCEC 2017b)

5.2.5.2 Site Inspections

Refer to Section 3.6.

5.2.5.3 Interviews

Refer to Section 3.7.

5.2.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.2.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, the completion of the ROD in 2000, construction and startup of the remedial system in 2005, continued operation of the remedial system, and completion of the well verification/well determination portion of the LUCs have resulted in the remedy at CS-4 functioning as intended by the decision documents. The remedial system is performing as expected. Plume and remedial system monitoring is being conducted under the SPEIM/LTM and LUC programs and risk management measures are in place to ensure protection of human health and the environment. Operational costs are appropriate for the remedy and a robust optimization program continues with the objective of reducing remedial system operational timeframes, the time to reach remedial goals (e.g., MCLs), and reducing future costs. Monitoring and evaluation activities are continual and well-documented.

5.2.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics. There have been no changes in the toxicity factors or other contaminant characteristics for the CS-4 groundwater COCs during this Five Year Review period

Changes in Risk Assessment Methods: There have been no changes in risk assessment methodology that affect protectiveness.

Review of RAOs: The RAOs developed for the final ROD (AFCEE 2000) and revised in the 2011 ESD (AFCEE 2011) are appropriate and remain valid.

5.2.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information at this time that calls into question the protectiveness of the remedy.

5.2.7 Issues, Recommendations, and Follow-Up Actions

Given the plume delineation at the end of 2017, it is not likely that the aquifer restoration timeframe stated in the ROD (i.e. approximately 2018) will be met. The plume should continue to be monitored and the estimated aquifer restoration timeframe should be updated during the next five years. If the aquifer is not restored to an acceptable extent toward the end of the next five year period (i.e., by 2022), discussions should be held with EPA on whether an ESD is necessary to update the estimated aquifer restoration timeframe.

5.2.8 Protectiveness Determination

The remedy for the CS-4 groundwater plume is protective of human health and the environment in the short-term. The LUCs are in place and are functioning as intended. Current plume delineation indicates that the aquifer restoration timeframe identified in the ROD may not be met. For the remedy to be protective in the long-term, the aquifer restoration timeframe should be reassessed and an ESD issued, if necessary, to update the timeframe.

5.2.9 References

- AFCEC. 2018 (April). *Southwest Plumes 2017 Summary Letter Report*. 652000-SPEIM-SWP-SLR-004. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2017a (November). *2017 Operations and Maintenance Plan for Groundwater Extraction and Treatment Systems and Wind Turbine*. 652000-O&M-MULTIPLE-OMPLN-003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2017b (August). *Southwest Plumes 2017 Annual SPEIM Data Presentation Project Note*. 652000-SPEIM-SWP-PRJNOT-003. Prepared by EA Engineering and CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2017c (March). *Southwest Plumes 2016 Summary Letter Report*. 652000-SPEIM-SWP-SLR-003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016a (December). *Southwest Plumes 2016 Annual SPEIM Data Presentation Project Note*. 652000-SPEIM-SWP-PRJNOT-002. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016b (March). *Southwest Plumes 2015 Summary Letter Report*. 652000-SPEIM-SWP-SLR-002. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015a (September). *Southwest Plumes 2015 Triennial SPEIM Data Presentation Project Note*. 652000-SPEIM-SWP-PRJNOT-001. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015b (May). *Southwest Plumes 2014 Summary Letter Report*. 652000-SPEIM-SWP-SLR-001. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014a (July). *Southwest Plumes 2014 Annual SPEIM Data Presentation Project Note*. 473147-SPEIM-SWP-PRJNOT-003. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014b (March). *Southwest Plumes 2013 Summary Letter Report*. 473147-
-

- SPEIM-SWP-SLR-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013a (November). *Southwest Plumes 2013 Annual SPEIM Data Presentation Project Note*. 473147-SPEIM-SWP-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013b (October) *Final 4th Five-Year Review, 2012-2017 Massachusetts Military Reservation (JBCC) Superfund Site, Otis Air National Guard Base, MA*. 473147-SPEIM-Multiple-RPT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013c (March). *Southwest Plumes 2012 Summary Letter Report*. 437075-SPEIM-SWP-SLR-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012 (December). *Southwest Plumes 2012 Triennial SPEIM Data Presentation Project Note*. 437075-SPEIM-SWP-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- AFCEE. 2012a (August). *Final 2011 JBCC Vapor Intrusion Evaluation Technical Memorandum*. 420005-SPEIM-MULTIPLE-TECHMEM-002. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012b (February). *Fuel Spill-28 and Southwest Plumes 2011 Private Well Verification and Well Determination Project Note*. 420005-SPEIM-LUC-MULTIPLE-PRJNOT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2011 (September). *Final Explanation of Significant Differences for the Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation*. 404929-SPEIM-MULTIPLE-RPT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2008a (September). *Final 3rd Five-Year Review, 2002-2007 Massachusetts Military Reservation (JBCC) Superfund Site, Otis Air National Guard Base, MA*. Prepared by Engineering Strategies Corporation, Portage and CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2008b (September). *Final Explanation of Significant Differences for Chemical Spill-4, Chemical Spill-20, Chemical Spill-21, Fuel Spill-13, Fuel Spill-28, and Fuel Spill-29 Groundwater Plumes*. A4P-J23-35BC24VC-M26-0006. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

- _____. 2008c (September). *Final Interim Remedial Action Report for CS-4, CS-20, CS-21, and FS-29 (Southwest Plumes), and CS-23/LF-1 Groundwater Plumes*. Prepared by ECC for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2008d (May). *Final Chemical Spill-4, Chemical Spill-20, Chemical Spill-21 and Fuel Spill-29 Baseline System Performance and Ecological Impact Monitoring Report*. A4P-J23-35BC24VC-M22-0003. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2005 (September). *Chemical Spill 4 (CS-4) Removal Action Report*. Prepared by Engineering Strategies Corporation and Portage Environmental Inc. for AFCEE/JBCC Installation Restoration Program, Otis ANG Base, MA.
 - _____. 2004a (August). *System Decommissioning Summary Report, Volume I*. Prepared by Environmental Chemical Corporation for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2004b (August). *Final Chemical Spill-4, Chemical Spill-20, Chemical Spill-21 and Fuel Spill-29 Wellfield Design Report*. A3P-J23-35Z00102-M23-0004. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2003 (May). *Shutdown of the Chemical Spill-4 (CS-4) Treatment Plant Remedial Design Fact Sheet 2003-01*. Prepared by AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2000 (February). *Final Record of Decision for the CS-4, CS-20, CS-21 and FS-13 Plumes*. AFC-J23-35Q86101-M26-0004. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 1999a (June). *Proposed Plan for the Southwest Operable Unit (CS-4, CS-20, CS-21 and FS-13 plumes only)*. AFC-J23-35Q86101-M25-0004. Prepared by Jacobs Engineering Group Inc., for the AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 1999b (June). *Final Southwest Operable Unit Feasibility Study*. AFC-J23-35Q86101-M16-0006. Prepared by Jacobs Engineering Group Inc., for the AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 1999c (May). *Final Southwest Operable Unit Remedial Investigation*. AFC-J23-35Q86101-M14-0006. Prepared by Jacobs Engineering Group Inc., for the AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 1997 (June). *Final Technical Memorandum AOC CS-4 Hydraulic Performance Evaluation*. Prepared by CDM Federal Programs Corporation for AFCEE/JBCC,
-

Installation Restoration Program, Otis Air National Guard Base, MA.

- ANG. 1992a (May). *Record of Decision for Interim Remedial Action West Truck Road Motor Pool (AOC CS-4) Groundwater Operable Unit*. Prepared by ABB Environmental Services, Inc., for ANG Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 1992b (February). *Groundwater Focused Feasibility Study West Truck Road Motor Pool (AOC CS-4)*. Prepared by ABB Environmental Services, Inc., for ANG Installation Restoration Program, Otis Air National Guard Base, MA.
- E.C. Jordan Co. 1990a (March). *Technical Report, Phase I of the MW-603 Groundwater Study (Study Area CS-4, West Truck Motor Pool, Groundwater Operable Unit)*. Installation Restoration Program, Massachusetts Military Reservation, prepared for HAZWRAP, Portland, Maine.
- _____. 1990b (February). *Technical Memorandum, Phase II Investigations of the MW-603 Groundwater Study*. Installation Restoration Program, Massachusetts Military Reservation, prepared for HAZWRAP, Portland, Maine.
- _____. 1990c (February). *Site Inspection Report, Field Investigation Work Conducted Spring-Summer 1988, Task 2-3B*. Installation Restoration Program, Massachusetts Military Reservation, prepared for HAZWRAP, Portland, Maine.
- _____. 1986. *Task 6, Phase I Records Search: Air National Guard, Camp Edwards, U.S. Air Force, and Veterans Administration Facilities at Massachusetts Military Reservation*. Prepared for Oak Ridge National Laboratory; Oak Ridge, Tennessee.
- EPA. 2013 (March). Integrated Risk Information System (IRIS) database. [online]. Available: <http://www.epa.gov/iris/index.html>.
- _____. 2001 (June). *Comprehensive Five-Year Review Guidance*, EPA 540R-01-007.
- Technical Review and Evaluation Team (TRET). 1996 (May). *Toward a Balanced Strategy to Address Contaminated Groundwater Plumes at the Massachusetts Military Reservation*.

5.3 CHEMICAL SPILL-10 (CS-10) GROUNDWATER

The CS-10 plume is a dissolved-phase groundwater plume (Figure 5-3A) that is defined by the extent of groundwater containing the CS-10 plume COCs, TCE and PCE, at concentrations exceeding the federal MCL of 5 µg/L for each compound. There are four separate areas in the CS-10 plume: (1) the In-Plume (IP) area, (2) the Sandwich Road lobe, (3) the southern trench area, and (4) and the leading edge area which is comprised of three lobes: the Northern lobe (NL) (formerly known as the TCE plume); North-Central lobe (NCL); and Southern lobe (SL). Each of these areas is shown on Figure 5-3A.

5.3.1 Site Chronology

1985: The primary CS-10 source area, UTES/BOMARC, was investigated and several chlorinated organics were detected in the groundwater (E.C. Jordan Co. 1986).

1986–1988: An SI identified numerous contamination sources in the BOMARC area and detected contaminants in the soil and groundwater (E.C. Jordan Co. 1989 and 1990).

1989–1990: An interim RI was completed (ABB-ES 1992).

1992–1997: An RI report was completed for the potential source areas within the UTES/BOMARC area (CDM 1997). A separate RI report was completed for the groundwater plume (CDM 1996).

1994–1995: The NGB, DoD, EPA, MassDEP, and local communities approved a Plume Response Plan that presented an accelerated effort toward “simultaneous containment” of seven groundwater plumes including CS-10. An IROD for the seven groundwater plumes emanating from the JBCC was signed on 25 September 1995 (ANG 1995). The IROD stated that groundwater extraction and treatment systems should be designed, installed, and operated until a final remedy for the site is chosen. For CS-10, the interim remedy included active treatment for the plume upgradient of Ashumet Pond.

1997-2000: Completion of an RI which focused on the leading edge of the CS-10 plume located hydraulically downgradient of Sandwich Road (AFCEE 2001a).

1999-2000: The Sandwich Road ETR system and the CS-10 IP ETI system were installed under the IROD. The Sandwich Road ETR system began operation on 18 May 1999 and the CS-10 IP ETI system began operation on 24 June 1999. On 27 April 2000, the CS-10 IP system was supplemented with the start-up of the Southwest/Southern system (AFCEE 2001b).

2000: Completion of a time-critical removal action for the NL due to high TCE concentrations in groundwater potentially discharging to Johns Pond surface water. The action consisted of the installation of one extraction well which began operation in January 2000 to prevent discharge of TCE into Johns Pond (AFCEE 2000).

2004: Extraction well 03EW2111 was added to the CS-10 IP system in 2004 as part of an optimization effort (AFCEE 2005b).

2005-2007: A data gap investigation was completed in the southern trench area to delineate contamination located outside of the remedial system capture zone (AFCEE 2008c).

2008: Completion of a feasibility study for CS-10 groundwater (AFCEE 2008a).

2009: Completion of a proposed plan (AFCEE 2009c) and the final ROD for CS-10 groundwater (AFCEE 2009a). The final remedy included continued operation of the CS-10 interim remedial systems plus the installation of a new extraction well (03EW2112) at the leading edge of the Southern Trench lobe, the installation of a new reinjection well (03RI2112) southeast of 03EW2111, and modification of the Sandwich Road and CS-10 IP extraction and reinjection/infiltration well flow rates. The new extraction well (03EW2112) and reinjection well (03RI2112) were installed in 2008 and remedy in place was achieved by February 2009 (AFCEE 2010).

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and added text regarding the JBCC three-step process to achieve site closure (AFCEE 2011).

2008-2012: Data gap investigation activities were completed to further assess the extent of contamination in the IP areas and Sandwich Road lobe. Data were used to update the CSM which was the basis for a remedial system optimization evaluation (AFCEC 2013d, 2013e; AFCEE 2013).

2014: An optimization evaluation was completed in 2013 to improve plume capture and reduce aquifer restoration timeframe. Operational changes included the installation of a new deep-screened IP extraction well (03EW2113) to improve hydraulic capture of newly delineated deep contamination, installation of a new reinjection well (03RI2113) to accommodate increased flow from the CS-10 IP extraction wells and to improve hydraulic capture, installation of a new Eastern IP extraction well (03EW2114) to capture contamination in the Eastern IP lobe, an MTU to treat contamination from 03EW2114, and installation of a new reinjection well (03RI2114) to return treated water from the MTU (AFCEC 2014d).

2014: An ESD was prepared to document the changes to the CS-10 CSM, amend the estimate of aquifer restoration timeframe at CS-10 presented in the ROD, and modify the remedy to more aggressively remove contaminants from the aquifer so that cleanup levels can be achieved sooner (AFCEC 2014a).

2014: Due to the discovery of 1,4-dioxane in the CS-10 plume (AFCEC 2014b, 2014c), presence/absence (CERCLA SI equivalent) field investigation was performed by AFCEC.

2015 -2016: A Supplemental RI was completed by AFCEC for the emerging contaminant 1,4-dioxane at CS-10 (AFCEC 2017a).

2017: A Supplemental FS was completed at CS-10 to evaluate the remedial options for the emerging contaminant 1,4-dioxane. Two alternatives were evaluated in this

Supplemental FS: a no-action alternative for 1,4-dioxane and the existing remedy including 1,4-dioxane as a COC. Alternative 2 (existing remedy but adding 1,4-dioxane as a COC) is protective of human health and the environment and complies with ARARs and poses low risk to workers, the community, and the environment. This alternative would include continued implementation of the existing remedy presented in the ROD for the CS-10 plume COCs, TCE and PCE, and a monitoring program for 1,4-dioxane. Monitoring wells would be sampled to confirm that 1,4-dioxane groundwater contaminant concentrations at CS-10 continue to decrease through the processes of natural attenuation (i.e., the MNA component of the existing remedy). This alternative also includes adopting the existing on-base and off-base LUCs to prevent exposure to 1,4-dioxane contaminated groundwater until concentrations decrease below cleanup levels throughout the aquifer.

5.3.2 Background

5.3.2.1 History of Contamination

The main source of the CS-10 groundwater plume is referred to as CS-10/FS-24. CS-10/FS-24 occupies approximately 38 acres at the eastern boundary of the JBCC to the west of Snake and Weeks ponds. Originally, the CS-10/FS-24 consisted of a number of buildings constructed as part of the BOMARC site by the USAF.

Maintenance operations associated with the BOMARC systems involved the use of cleaning solvents (methylene chloride, 1,1,1-TCA, TCE, PCE, and Freon). BOMARC fuels included JP-4, Aerozine-50, red fuming nitric acid, and hydrazine. Fuels used for power and heat generation included No. 2 fuel oil and diesel fuel. Several buildings had floor drains connected to leaching wells, building sumps, oil interceptors, and other drainage structures; some of these drainage structures were connected to the site storm drain system. The facility was abandoned by the USAF in 1973 (AFCEE 2008b). Shelters utilized by the missile launcher systems along with a subsurface utility corridor connecting the shelters (utilidor system) were removed from the site in 2005. For more information regarding the CS-10 source area removal activities, refer to Section 4.1.

The UTES has been in operation at this site since 1978 and is currently used by the Massachusetts ARNG as the UTES facility for maintenance and storage of vehicles. UTES personnel are responsible for maintaining vehicles used for ARNG training activities. Motor oil, hydraulic fluid, battery electrolyte, PCE, PD-680 Safety Clean, paints, and paint removers have been used on-site (AFCEE 2008b). Although the BOMARC and UTES facilities are considered the primary sources of contamination to the CS-10 plume, numerous other sources of contamination are presumed to have contributed to the CS-10 plume as it traveled beneath the JBCC.

5.3.2.2 Physical Characteristics, Land and Resource Use

Based on the most recent groundwater monitoring data, the main body of the CS-10 plume (which includes the IP area, Sandwich Road Lobe, and Southern Trench area) is nearly three miles long and over one mile wide (Figure 5-3A). The most upgradient portion of the CS-10 NL is located approximately 550 ft downgradient of the JBCC base boundary, and is approximately 3,800 ft long and up to 660 ft wide. The NCL is approximately 3,600 ft long and up to 700 ft wide. The SL is approximately 1,600 ft long and up to 400 ft wide. The footprint of the four portions of the CS-10 plume was approximately 1,383 acres in 2012, and is approximately 1,302 acres in 2017 (Figure 5-3B). The data density increased significantly since 2007 and the plume footprint was expanded based on this new understanding of the plume nature and extent (AFCEC 2013e).

On-base land use in the vicinity of the CS-10 plume consists primarily of areas used for military operations. The area south of the base is characterized by residential areas, and undeveloped woodlands and wetlands used for recreation and conservation. Surface water bodies (known as kettle ponds) in the vicinity of the CS-10 plume (Ashumet Pond and Johns Pond [Figure 5-3A]) are recharged by groundwater and precipitation; and provide for recreational use such as fishing, swimming, and boating. The land above the CS-10 plume can be characterized as a broad, flat, gently southward sloping glacial outwash plain. Within the footprint of the plume, the maximum and minimum ground surface elevations are 144 ft msl and 38 ft msl, respectively.

5.3.2.3 Initial Responses

A summary of the initial responses is as follows:

Non- CERCLA Actions

Several non-CERCLA source removal activities occurred at the CS-10 source area in 1996. At the CS-10 source area, 16 drainage structures were removed as part of the DSRP. In addition, a leaking 25,000 gallon UST was removed. For more information regarding the CS-10 source area removal activities, refer to Section 4.1.

CERCLA Actions

The DoD and the EPA, with concurrence from the MassDEP, implemented an interim action for the CS-10 groundwater plume and six other JBCC plumes under an IROD (ANG 1995). The selected remedy involved extraction of contaminated groundwater, treatment of that water and subsequent discharge to the groundwater and institutional controls.

The TRET, established in 1996 as part of a new IROD management process, reviewed wellfield designs and determined that the 60-percent design for containment of several of the IROD plumes would cause negative ecological impacts (TRET 1996). The proposed interim remedy for the CS-10 groundwater plume was therefore revised and included active treatment for the plume upgradient of Ashumet Pond. The selected alternative relied on ETR and ETI technology to capture contaminated groundwater using an extraction fence along Sandwich Road and additional extraction wells within the body of the CS-10 plume.

The Sandwich Road ETR system began operation on 18 May 1999 and consisted of eight extraction wells and six reinjection wells. The water is processed through GAC units at the SRTF. The CS-10 IP groundwater remedial system was started up on 24 June 1999. On 27 April 2000, the CS-10 IP system was supplemented with the start-up of the Southwest/Southern system. The two systems were comprised of eight extraction wells and two infiltration trenches, with groundwater processed through GAC units at the CS-10 IP treatment plants (Figure 5-3A). A ninth extraction well (03EW2111) was added in 2004

as part of an optimization effort to address contamination in the southern trench area (AFCEE 2005b).

AFCEE also committed to further investigation of the area downgradient of Sandwich Road and the northwest shoreline of Ashumet Pond. As part of the investigations, the leading edge lobes of the CS-10 plume were delineated under Ashumet Pond and between Ashumet and Johns ponds. Due to the high concentrations of TCE detected in groundwater within the NL and the knowledge that it was discharging into Johns Pond surface water, remediation proceeded under a time-critical removal action (AFCEE 2000).

The time-critical removal action for the NL consisted of one extraction well which began operation in January 2000 to prevent discharge of TCE into Johns Pond by containing the plume at Hoophole Road. Extracted water is piped to the SRTF for treatment through GAC and is returned to the aquifer through reinjection wells.

Increasing concentrations in monitoring wells located in the Southern Trench area, outside of the interim remedial system capture zone, prompted the need for a data gap investigation that was conducted between January 2005 and June 2007 (AFCEE 2008c). The CS-10 2007 groundwater model (AFCEE 2008c) and the revised CS-10 2007 TCE plume shell were used in a remedial system optimization evaluation to predict the extent of hydraulic capture, assess system performance including contaminant mass removal and plume migration over time, and to assess the potential hydraulic impacts (AFCEE 2009b). The optimized pumping condition determined during this evaluation is presented as Alternative 10 in the *Final Supplement to the Chemical Spill-10 Groundwater Feasibility Study Addendum* (AFCEE 2008a) and became the operation configuration for the selected remedy in the *Final Record of Decision for Chemical Spill-10 Groundwater* (AFCEE 2009a). The selected remedy included the installation of a new extraction well (03EW2112) at the leading edge of the Southern Trench lobe and the installation of a new reinjection well (03RI2112) southeast of 03EW2111. The new extraction well (03EW2112) and reinjection well (03RI2112) were installed in 2008 and the system optimization was implemented in February 2009.

A Final ESD was submitted in September 2011 that clarified the inclusion of monitored natural attenuation as a component of the selected remedy, slightly modified the phrasing of the remedial action objectives, and updated the steps to achieve site closure (i.e., the three-step process) (AFCEE 2011). An ESD was prepared in 2014 to document the changes to the CS-10 CSM, amend the estimate of aquifer restoration timeframe at CS-10, and modify the remedy to more aggressively remove contaminants from the aquifer so that cleanup levels can be achieved sooner (AFCEC 2014a).

An optimization evaluation was completed by the AFCEC in 2013 to improve plume capture and reduce aquifer restoration timeframe. Operational changes included the installation of a new deep-screened IP extraction well (03EW2113) to improve hydraulic capture of newly delineated deep contamination, installation of a new reinjection well (03RI2113) to accommodate increased flow from the CS-10 IP extraction wells and to improve hydraulic capture, installation of a new Eastern IP extraction well (03EW2114) to capture contamination in the Eastern IP lobe, an MTU (moved from Ashumet Valley) with GAC to treat contamination from 03EW2114, and installation of a new reinjection well (03RI2114) to return treated water from the MTU (AFCEC 2014b). Further details regarding the CS-10 remedial system can be found in the 2017 O&M Plan (AFCEC 2017c).

5.3.2.4 Basis for Taking Action

Future residential exposure to CS-10 groundwater COCs present an excess lifetime cancer risk greater than the acceptable EPA range of 1×10^{-4} to 1×10^{-6} (CDM 1996 and AFCEE 2001a). An ecological risk assessment concluded that discharge of the CS-10 plume to surface waters does not pose a threat to ecological receptors (AFCEE 2009a).

5.3.3 Remedial Actions

The final remedy for the CS-10 plume was determined in the *Final Record of Decision for Chemical Spill-10 Groundwater* (AFCEE 2009a) which was signed in August 2009.

The RAOs for the CS-10 groundwater plume as presented in the ROD (AFCEE 2009a) and modified in the ESD (AFCEE 2011) are as follows:

- Prevent residential exposure to CS-10 groundwater with TCE concentrations greater than the MCL of 5 µg/L.
- Prevent residential exposure to CS-10 groundwater with PCE concentrations greater than the MCL of 5 µg/L.
- Restore usable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

5.3.3.1 Remedy Selection and Implementation

The selected remedy in the ROD (AFCEE 2009a) included the following components:

- Continued operation of the existing optimized IP ETI system, NL ETR system, and the Sandwich Road ETR system with system expansion into the Southern Trench area with an additional extraction well and an additional reinjection well to improve capture of the plume in that area. The flow from the new extraction well will be treated at the SRTF and returned to the aquifer through the CS-10 and SD-5 reinjection wells. The flow to the new reinjection well will come from the CS-10 IP treatment facility via the Southern Infiltration Trench. 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 reinjection wells.
- Implementation of LUCs with the performance objectives of:
 - Preventing access to, or use of, contaminated groundwater from the CS-10 plume (both off-site and on-site) until the groundwater no longer poses an unacceptable risk, and
 - Maintaining the integrity of the current or future remedial or monitoring system such as the treatment systems and monitoring wells.
- Chemical and hydraulic monitoring of the plume under the SPEIM program, as long as active remediation continues, and chemical monitoring of the plume until the RAOs are met.
- Completion of CERCLA reviews every five years throughout the lifetime of the remedial action.

Since the groundwater remedy was selected in 2009, the following changes have occurred:

- The 2011 ESD for the IRP groundwater plumes (AFCEE 2011) clarified the inclusion of MNA as a component of the selected remedy for CS-10, slightly modified the phrasing of the RAOs, and added text regarding the JBCC three-step process to achieve site closure.

- The 2014 ESD documented changes to the CS-10 CSM, modified the remedy to more aggressively remove contaminants from the aquifer, and amended the predicted aquifer restoration timeframe at the CS-10 groundwater site.

Remedial system performance monitoring data and long-term plume monitoring data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives and system performance metrics are being met; (ii) whether remediation is progressing as expected; and (iii) to identify and assess optimization opportunities. The data collected under the SPEIM/LTM program are presented to the regulatory agencies through the Technical Update meeting process and documented in annual SLRs.

A private well verification and well determination process was completed at CS-10 between January 2010 and August 2012 as part of the LUC process specified in the ROD (AFCEE 2009a). The private well verification survey completed at the CS-10 LUC area consisted of outreach to 336 parcels (AFCEC 2013b). Two private drinking water wells were identified but were determined to be sufficiently outside of the CS-10 plume footprint and are not anticipated to represent complete exposure pathways to the CS-10 (AFCEE 2013b). No private wells that were identified present an unacceptable exposure risk from the CS-10 groundwater. Note that private drinking water wells were subsequently connected to municipal water by AFCEC in 2018 in response to the ongoing JBCC emerging contaminants investigation.

A non-potable water supply well (B-well) is also located within the on-base portion of the CS-10 LUC area; this well is used to irrigate the base golf course and has been sampled annually during this five-year review period as part of the LUC Program starting in 2013. No CS-10 COCs were detected as reported in annual SLRs (AFCEC 2018a, 2017b, 2016b, 2015b, 2014e).

In the event that new private well information is obtained or plume monitoring data indicate a change to the CSM at CS-10, AFCEC will perform the necessary well determinations at the time the information becomes available. A review of the data collected under the CS-10 SPEIM program during this five-year review period (2012-2017) indicates that there were no changes to the plume CSM that warranted a revision to the private well LUC

program with respect to the current COCs.

The status of non-operational private wells in the CS-10 LUC area continue to be tracked. AFCEC distributed a mailing, on an annual basis, to property owners within the LUC area that have non-operational wells. The intent of the annual mailing is to remind these property owners that they should contact AFCEC for a technical evaluation, which may include sampling, in the event their well is put back into service. Annual mailings were distributed during this five year review period and reported in the SLRs (AFCEC 2018a, 2017b, 2016b, 2015b, 2014e) and annual LUC reports. A summary of private wells that were restarted during this five year review period at CS-10 is provided below:

2013: No private wells restarted.

2014: No private wells restarted.

2015: Two property owners responded that they were planning on restarting their previously non-operational private wells for irrigation/outdoor uses. Technical evaluations were completed for each well (Appendix C) and they were determined to be sufficiently outside of the CS-10 plume footprint and are not anticipated to represent complete exposure pathways to the CS-10 plume.

2016: No private wells restarted.

2017: Annual mailings were sent in August 2017 and results will be reported in the next five year review.

5.3.3.2 Remedy Operation & Maintenance

The CS-10 remedial systems are operated and maintained under an approved O&M Plan (AFCEC 2017c). The O&M Plan is updated on an annual basis and includes operational requirements, a summary of the operational history of the systems, and details of any system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and continue to be, addressed in a timely and

effective manner such that O&M associated with the remedy is considered effective at achieving the remedy goals. Operational issues are identified in O&M monthly reports and system performance and reliability is reported in the annual SLRs.

The annual SPEIM/LTM/O&M costs associated with ongoing remedial actions at CS-10 are generally consistent with those predicted at the time of remedy selections (with consideration for savings associated with optimization initiatives) and do not indicate potential remedy problems.

5.3.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior fourth CERCLA Five Year Review (AFCEC 2013a). For the CS-10 groundwater plume, the recommendations and follow-up actions were:

- 1) Contaminant transport modeling completed since the ROD indicate that the restoration timeframe predicted at the time of remedy selection (i.e., by 2094) may not be met. The longer model-predicted restoration timeframe (i.e., by 2112) is due to a change in the CSM related to the nature and extent of TCE contamination in the IP area of the plume.

An optimization assessment of the CS-10 remedial system is recommended to assess the performance of the remedial system, determine whether improvements can be made, and update the restoration timeframe prediction for comparison to the information presented in the ROD (AFCEC 2013d and AFCEE 2013). An ESD summarizing the updated CSM and the updated prediction for aquifer restoration timeframe should be completed for CS-10 following the completion of the optimization activities.

- 2) In addition, the topic of emerging contaminants should be monitored as it relates to groundwater at the JBCC. Specifically for CS-10 groundwater, a sampling and

analysis plan shall be submitted to the regulatory agencies to assess the possible presence of 1,4-dioxane.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

- 1) An ESD summarizing the updated CSM and the updated prediction for aquifer restoration timeframe was completed for CS-10 following the completion of the optimization activities (AFCEC 2014a).
- 2) The initial presence/absence (Site Inspection equivalent) investigation for 1,4-dioxane was completed between October 2013 and June 2014 (AFCEC 2014c) and the Supplemental RI field investigation was completed between December 2015 and April 2016 (AFCEC 2017a). 1,4-Dioxane was detected at concentrations exceeding the MCP GW-1 standard of 0.3 µg/L in eleven of the 69 monitoring wells sampled. These eleven monitoring wells are located in the northwestern portion of the CS-10 plume which is also where the highest TCE concentrations are currently detected (AFCEC 2017a). A Supplemental FS was completed at CS-10 to evaluate the remedial options for the emerging contaminant 1,4-dioxane (AFCEC 2018b). A monitoring program will be developed in consultation with the regulatory agencies after 1,4-dioxane is added as a groundwater COC through issuance of a decision document (i.e. an Explanation of Significant Differences). Monitoring for 1,4-dioxane will be incorporated into the CS-10 SPEIM Program and will include the sampling of monitoring wells, extraction wells, and the CS-10 In-Plume treatment plant; all with the goal of providing data to demonstrate remedial progress, protectiveness of the remedy, including the LUC Program, and compliance with ARARs.

Similar to the approach used for the current CS-10 groundwater COCs, routine monitoring for 1,4-dioxane will be conducted under the SPEIM program following the completion of the ESD to determine the extent of groundwater contamination and the effectiveness of the remedial action. The monitoring data will be presented

to the regulatory agencies during Technical Update Meetings and then in the annual SLRs. If the 1, 4-dioxane monitoring data indicate a change to the CS-10 CSM for 1, 4-dioxane is warranted and/or question the protectiveness of the remedy or remedial progress revisions to the monitoring program and/or remedial action will be assessed.

5.3.5 Five Year Review Process

5.3.5.1 Data Review

The JBCC SPEIM program was developed to monitor plume changes and to ensure the effective operation of the AFCEC groundwater remediation systems at the JBCC. These objectives are met through monitoring of selected media (i.e., groundwater, surface water) within and outside the plume boundaries, treatment plant monitoring, and groundwater flow and transport modeling. The data collected under the SPEIM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being addressed through active treatment. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program. The SLRs also include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual reporting period as attachments or by reference. The SLRs are provided to the broad stakeholder group for each plume including Federal (EPA) and State (MassDEP, MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties. The SLRs are publically available in the IRP Administrative Record and copies are

maintained at the local town libraries.

In addition to the annual SLRs prepared for CS-10 during this Five Year Review period (AFCEC 2018a, 2017b, 2016b, 2015b, 2014e), the following technical deliverables were prepared that assessed system performance or presented the results of optimization evaluations:

- *Chemical Spill-10 2013 Remedial System Optimization Project Note* (AFCEC 2014d)
- *CS-10 2013 Annual SPEIM Data Presentation (April 2013 through December 2013) Project Note.* (AFCEC 2014c)
- *CS-10 2014/2015 Annual SPEIM Data Presentation Project Note* (AFCEC 2015a)
- *CS-10 2015/2016 Triennial SPEIM/LTM Data Presentation Project Note* (AFCEC 2016a)

5.3.5.2 Site Inspections

Refer to Section 3.6.

5.3.5.3 Interviews

Refer to Section 3.7.

5.3.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.3.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, completion of the ROD in 2009 (AFCEE 2009a), construction and startup of the remedial system components added to the interim system as part of the final remedy in 2009, continued operation of the remedial systems, and completion of the well

verification/well determination portion of the LUCs in early 2013 have resulted in the remedy functioning as intended by the decision documents for the current COCs. However, based on results of a data gap investigation completed in 2012 that updated the CS-10 CSM, the timeframe for aquifer restoration was predicted to be longer than the timeframe presented in the ROD (i.e., 2112 instead of 2094) (AFCEC 2013e). The primary reason for this difference is due to a change in the CSM where previously uncharacterized TCE contamination has been identified in the IP area at higher concentrations and deeper in the aquifer where hydraulic conductivities are lower than previously depicted in the model simulations available at the time of remedy selection.

An optimization evaluation was completed by the AFCEC in 2013 to improve plume capture and reduce aquifer restoration timeframe. Operational changes included the installation of a new deep-screened IP extraction well (03EW2113) to improve hydraulic capture of newly delineated deep contamination, installation of a new reinjection well (03RI2113) to accommodate increased flow from the CS-10 IP extraction wells and to improve hydraulic capture, installation of a new Eastern IP extraction well (03EW2114) to capture contamination in the Eastern IP lobe, an MTU to treat contamination from 03EW2114, and installation of a new reinjection well (03RI2114) to return treated water from the MTU (AFCEC 2014b). An ESD was prepared in 2014 to document the changes to the CS-10 CSM, amend the estimate of aquifer restoration timeframe at CS-10, and modify the remedy to more aggressively remove contaminants from the aquifer so that cleanup levels can be achieved sooner (AFCEC 2014a). Aquifer restoration timeframe predictions under the selected optimized scenario identified in the ESD was reduced to 2060 compared to current operating conditions.

An initial presence/absence (CERCLA SI equivalent) investigation for 1,4-dioxane was completed between October 2013 and June 2014 (AFCEC 2014c) at CS-10 and the Supplemental RI field investigation was completed between December 2015 and April 2016. 1,4-Dioxane was detected at concentrations exceeding the MCP GW-1 standard of 0.3 µg/L in eleven of the 69 monitoring wells sampled. These eleven monitoring wells are located in the northwestern portion of the CS-10 plume which is also where the highest

TCE concentrations are currently detected. A Supplemental RI was completed by AFCEC for the emerging contaminant 1,4-dioxane at CS-10 (AFCEC 2017a). A Supplemental FS was completed at CS-10 to evaluate the remedial options for the emerging contaminant 1,4-dioxane (AFCEC 2018b). The 1,4-dioxane concentrations are confined within the footprint of the CS-10 plume and there are no complete exposure pathways.

A monitoring program will be developed in consultation with the regulatory agencies after 1,4-dioxane is added as a groundwater COC through issuance of a decision document (i.e. an ESD).

Plume and remedial system monitoring is being conducted under the SPEIM/LTM and LUC Programs and risk management measures are in place. Operational costs are appropriate for the remedy and a robust optimization program continues with the objective of reducing remedial system operational timeframes, the time to reach remedial goals (e.g., MCLs), and reducing future costs. Monitoring and evaluation activities are continual and well-documented.

5.3.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics: There have been no changes in the toxicity factors that were in place at the time of the last Five Year Review (i.e., 2012) for the CS-10 groundwater COCs PCE and TCE.

Changes in Risk Assessment Methods: There have been no changes in risk assessment methodology that affect protectiveness.

Review of RAOs: The RAOs developed for the ROD (AFCEE 2009a) and revised in the 2011 ESD (AFCEE 2011) are appropriate and remain valid for the current COCs.

5.3.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information at this time that calls into question the protectiveness of the remedy. 1,4-Dioxane has been addressed in a Supplemental FS completed at CS-10 to evaluate the remedial options (AFCEC 2018b). The 1,4-dioxane concentrations are confined within the footprint of the CS-10 plume and the selected remedial option ensures protection of human health and the environment through LUCs and monitoring for 1,4-dioxane.

5.3.7 Issues, Recommendations, and Follow-Up Actions

Prepare an ESD to include 1,4-dioxane as a COC and then develop a monitoring program for 1,4-dioxane.

5.3.8 Protectiveness Determination

The remedy for the CS-10 groundwater plume is protective of human health and the environment in the short-term. The remedial system is performing as expected and the LUCs are in place and are functioning as intended for current COCs and there are no current plans to use the portion of the aquifer where CS-10 contamination is located for water supply. Through the combination of the active treatment by the remedial systems and natural attenuation processes, existing groundwater cleanup levels are expected to be achieved. For the remedy to be protective in the long-term, an ESD should be issued and remedial actions implemented, as necessary, to address ECs.

5.3.9 References

- ABB-ES. 1992 (April). *Interim Remedial Investigation, UTES BOMARC and BOMARC Area Fuel Spill (AOC CS-10 and AOC FS-24)*. Prepared for HAZWRAP (Hazardous Waste Remedial Actions Program) and ANG/JBCC Installation Restoration Program and ANG, Otis Air National Guard Base, MA.
- AFCEC. 2018a (April). *Chemical Spill-10 2017 Summary Letter Report*. 652000-SPEIM-CS10-SLR-004. Prepared by EA Engineering, Science and Technology and CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2018b (January). *Final Supplemental Feasibility Study Report for 1,4-Dioxane at Chemical Spill-10, Joint Base Cape Cod, MA*. 658003-EC-CS10-RPT-004. Prepared by CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2017a (March). *Final Supplemental Remedial Investigation Report for 1,4-Dioxane at Chemical Spill-10, Joint Base Cape Cod, MA*. 658003-EC-CS10-RPT-002. Prepared by CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2017b (March). *Chemical Spill-10 2016 Summary Letter Report*. 652000-SPEIM-CS10-SLR-003. Prepared by EA Engineering, Science and Technology and CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2017c (November). *2017 Operations and Maintenance Plan for Groundwater Extraction and Treatment Systems and Wind Turbine*. 652000-O&M-MULTIPLE-OMPLN-003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016a (November). *CS-10 2015/2016 Triennial SPEIM/LTM Data Presentation Project Note*. 652000-SPEIM-CS10-PRJNOT-002. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016b (March). *Chemical Spill-10 2015 Summary Letter Report*. 652000-SPEIM-CS10-SLR-001. Prepared by EA Engineering, Science and Technology and CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015a (May). *Chemical Spill-10 2014/2015 Annual SPEIM Data Presentation Project Note*. 652000-SPEIM-CS10-PRJNOT-001. Prepared by EA Engineering, Science and Technology and CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

- _____. 2015b (March). *Chemical Spill-10 2014 Summary Letter Report. 652000-SPEIM-CS10- SLR-001*. Prepared by EA Engineering, Science and Technology and CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014a (September). *Final Chemical Spill-10 Groundwater Explanation of Significant Differences. 473147-SPEIM-CS10-ESD-002*. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2014b (August). *1,4-Dioxane Monitoring Well Sample Results Data Presentation Project Note. 473147-SPEIM-MULTIPLE-PRJNOT-007*. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014c (July). *CS-10 2013 Annual SPEIM Data Presentation (April 2013 through December 2013) Project Note. 473147-SPEIM-CS10-PRJNOT-003*. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2014d (March). *Chemical Spill-10 2013 Remedial System Optimization Project Note. 473147-SPEIM-CS10-PRJNOT-001*. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2014e (March). *Chemical Spill-10 2013 Summary Letter Report. 473147-SPEIM-CS10-SLR-001*. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013a (October) *Final 4th Five-Year Review, 2012-2017 Massachusetts Military Reservation (JBCC) Superfund Site, Otis Air National Guard Base, MA 473147-SPEIM-Multiple-RPT-001*. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013b (September). *Final Chemical Spill-10 Private Well Verification and Well Determination Project Note. 437075-SPEIM-LUC-CS10-PRJNOT-002*. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013c (June). *Confirmation of Private Well Operational Status: Installation Restoration Program Land Use Control Areas. 437075-LUC-Multiple-PRJNOT-002*. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013d (March). *CS-10 2012 Remedial System Optimization Workplan Project Note, Phase II Approach. 437075-SPEIM-CS10-PRJNOT-002*. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013e (January). *Final Chemical Spill-10 2012 Data Gap Investigation Technical Memorandum. 437075-SPEIM-CS10-TECHMEMO-001*. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air

National Guard Base, MA.

- AFCEE. 2013 (January). *CS-10 2012 Remedial System Optimization Workplan Project Note, Phase I Approach*. 437075-SPEIM-CS10-PRJNOT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2011 (September). *Final Explanation of Significant Differences for the Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation*. 404929-SPEIM-MULTIPLE-RPT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2010 (August). *Final Updated Interim Remedial Action Report for Chemical Spill-10 and Ashumet Valley Groundwater Plumes*. Prepared by ECC for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2009a (August). *Final Record of Decision for Chemical Spill-10 Groundwater*. A4P-J23-35BC02VA-M26-0018. Prepared by Jacobs Engineering Group for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2009b (March). *Final CS-10 2008 Southern Trench System Optimization Project Note*. 371335-SPEIM-CS10-PRJNOT-008. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2009c (January). *Proposed Plan for Groundwater at Chemical Spill-10*. Fact Sheet 2009-01.
- _____. 2008a (August). *Final Supplement to the Chemical Spill-10 Groundwater Feasibility Study Addendum*. A4P-J23-35BC02VA-M16-0025. Prepared by Jacobs Engineering Group for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2008b (May). *Verification, Decommissioning, and Documentation Guidelines for Private Wells in Areas of Potential Concern*. Prepared by Air Force Center for Engineering and the Environment Massachusetts Military Reservation Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2008c (January). *Final Chemical Spill-10 2007 Southern Trench Technical Memorandum*. 337105-SPEIM-CS10-TECHMEM-003. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

- _____. 2005a (October). *Final Chemical Spill-10 Leading Edge Technical Memorandum*. 324146-SPEIM-CS10-TECHMEM-002. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2005b (April). *Final Chemical Spill-10 2004 System Performance and Ecological Impact Monitoring Report*. 324146-SPEIM-CS10-ANRPT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2001a (September). *Final Chemical Spill-10 Remedial Investigation Report*. AFC-J23-35U40702-M14-0005. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2001b (May). *Final Chemical Spill-10 Interim Remedial Action Report*. Prepared by AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2000 (February). *Final SD-5 South Plume - Hoophole Road and TCE Plume Time Critical Removal Action Wellfield Design Report*. AFC-J23-35S18404-M23-0008. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- ANG. 1995 (September). *Final Record of Decision Interim Remedial Action Containment of Seven Groundwater Plumes at JBCC, Cape Cod MA*. Prepared by Stone & Webster Environmental & Technology Services for ANG Readiness Center, Installation Restoration Program, Otis ANG Base, MA.
- CDM (Camp Dresser and McKee Federal Programs Corporation). 1997 (December). *Final Remedial Investigation, UTES/BOMARC and BOMARC Area Fuel Spill, AOC CS-10/ FS-24 (AOC CS-10 and AOC FS-24) Source Operable Units: CS-10A and CS-10B*. Prepared for AFCEE/JBCC Installation Restoration Program and ANG, Otis Air National Guard Base, MA. Submitted by HAZWRAP (Hazardous Waste Remedial Actions Program), Oak Ridge, TN.
- _____. 1996 (July). *Final Remedial Investigation, UTES/BOMARC and BOMARC Area Fuel Spill, AOC CS-10 Groundwater Operable Unit: CS-10D and Hydrogeologic Region II Study, Volume I*. Prepared for AFCEE/JBCC Installation Restoration Program and ANG, Otis Air National Guard Base, MA. Submitted by HAZWRAP (Hazardous Waste Remedial Actions Program), Oak Ridge, TN.
- E.C. Jordan. 1990 (March). *Task 2-3B Site Inspection, Field Investigation Work Conducted Spring-Summer 1988*; Installation Restoration Program; Massachusetts Military Reservation. Prepared by E.C. Jordan Co. Prepared for HAZWRAP; Portland, Maine.

- _____. 1989 (March). *Task 2-3A Site Inspection, Field Investigation Work Conducted Fall 1987*; Installation Restoration Program; Massachusetts Military Reservation. Prepared by E.C. Jordan Co, Prepared for HAZWRAP; Portland, ME.
- _____. 1986 (March). *U.S. Air Force Installation Restoration Program, Phase I: Records Search, Air National Guard, Camp Edwards, U.S. Air Force, and Veterans Administration Facilities at Massachusetts Military Reservation*. Prepared by E.C. Jordan Co. Prepared for HAZWRAP; Portland, ME.
- EPA. 2013 (March). Integrated Risk Information System (IRIS) database. [online]. Available: <http://www.epa.gov/iris/index.html>.
- _____. 2001 (June). *Comprehensive Five-Year Review Guidance*, EPA 540R-01-007.
- Technical Review and Evaluation Team (TRET). 1996 (May). *Toward a Balanced Strategy to Address Contaminated Groundwater Plumes at the Massachusetts Military Reservation*.

5.4 CHEMICAL SPILL-19 (CS-19) GROUNDWATER

The CS-19 plume is a dissolved-phase groundwater plume defined as the extent of groundwater containing the COC, hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), at concentrations exceeding its EPA risk-based level of 0.6 µg/L (based on a 1×10^{-6} excess lifetime cancer risk calculation). The CS-19 plume is located near the Central Impact Area (CIA) plume within the west central region of the JBCC Impact Area (Figure 5-4). The CIA plume is located hydraulically upgradient, crossgradient, and beneath the CS-19 plume.

5.4.1 Site Chronology

1991: The CS-19 source area was identified as a potential disposal site (ABB-ES, 1992a).

1991-2003: A series of literature reviews and several field investigations were completed which culminated in the CS-19 RI report (ABB-ES 1992a and 1992b, ANG 1992, AFCEE 1999 and 2003, IAGWSP 2003, Ogden 1999, USACHPPM 1994).

2005: The IROD presented an interim remedy of LTM for the CS-19 plume (AFCEE 2005).

2009: The FS study was completed in April 2009 (AFCEE 2009d) and the proposed plan was released to the public in April 2009 (AFCEE 2009c). The selected remedy for CS-19 as specified in the ROD was MNA with LUCs (AFCEE 2009a).

2011: An ESD was prepared that slightly modified the phrasing of the RAOs and added text regarding the JBCC three-step process to achieve site closure (AFCEE 2011).

2014: Site Restoration was completed at CS-19 (AFCEC 2014a, 2015a).

5.4.2 Background

5.4.2.1 History of Contamination

The CS-19 source area was used historically for ordnance disposal, which resulted in explosives contamination in site soil and groundwater. The site was initially defined as approximately one acre in size, as outlined by a perimeter road with an approximate 125-ft radius. A later interpretation of geophysical and chemical data collected during the source area soil removal action, along with visual assessment of site debris, indicated that the CS-19 perimeter road was an artificial boundary and did not reflect the extent of disposal activities at the site. The boundary of the CS-19 disposal area was extended outward beyond the perimeter road in all directions to include an additional 1.1 acres known as the CS-19 expansion area (AFCEE 2009b).

The CS-19 site expanded into the Bunker Area, which was identified because of a large magnetic anomaly detected during an aerial survey, and due to the information identified in a witness interview summary (IAGWSP 2003). According to the witness, the area around the bunker was known as Range 11 and was used by contractors for ordnance testing in the 1950s through the 1960s. The area was also used by the Army and National Guard for ordnance detonation. The testing operations were moved to the J-1 Range sometime in the 1960s because it was too difficult to make arrangements to use Range 11 due to the Army and National Guard artillery training (AFCEE 2008).

5.4.2.2 Physical Characteristics, Land and Resource Use

Based on the most recent groundwater monitoring data, the CS-19 plume is approximately 2,800 ft long, has a maximum width of approximately 600 ft, and is up to 30 ft thick in the aquifer. The footprint of the CS-19 plume was approximately 64 acres in 2012, and was approximately 14 acres in 2017 (Figure 5-4).

The CS-19 site is presently inactive for military purposes, although the land use of the JBCC Impact Area is still considered military and is designated as an operational range. The land over the CS-19 plume is primarily forested, and the CS-19 site is within a

restricted area surrounded by fencing and guarded gates. The eastern portion of the CS-19 plume is located within a broad, flat, gently sloping glacial outwash plain, and the land over the western portion of the plume is a hummocky north-south trending ridge of moraine glacial deposits. Within the footprint of the plume, the maximum and minimum ground surface elevations are 258 ft msl and 180 ft msl, respectively.

5.4.2.3 Initial Responses

A summary of the initial responses is as follows:

Non-CERCLA Actions:

None.

CERCLA Actions:

CS-19 Source Area: Removal activities conducted at the CS-19 source area (including the CS-19 Bunker Area) between 2004 and 2006, and between 2007 and 2009 included the excavation of the top two to three ft of soil and the associated MEC. Based on confirmatory sampling, the EPA and the MassDEP agreed that the remaining RDX levels in soil are protective and that any leaching to groundwater would be well below risk-based levels (AFCEE 2009a).

CS-19 Groundwater Plume: The 2003 CS-19 RI (AFCEE 2003) concluded that active cleanup of the CS-19 plume was not necessary since the plume will attenuate naturally if the source is removed. AFCEE agreed to remove the source of the CS-19 plume, and an interim remedy of LTM was selected for the CS-19 plume in 2005 (AFCEE 2005). It was agreed that a final remedy would be evaluated in conjunction with the remedy selection process for the nearby CIA plume (EPA 2004). In 2008, AFCEE, EPA, and MassDEP agreed that the CS-19 and CIA plume remedy selection process could be conducted separately (AFCEE 2009a).

The CS-19 FS and proposed plan were completed in 2009 (AFCEE 2009c, 2009f). The selected remedy for CS-19 as specified in the ROD was MNA with LUCs (AFCEE 2009a).

An ESD was submitted for the IRP groundwater plumes in September 2011 that slightly modified the phrasing of the RAOs, and updated the steps to achieve site closure (i.e., the three-step process) (AFCEE 2011).

5.4.2.4 Basis for Taking Action

The baseline cancer risk calculations in the CS-19 RI indicated that future residential exposure to the RDX in groundwater from a water supply well installed in the CS-19 plume may present an excess lifetime cancer risk greater than the acceptable EPA range of 1×10^{-4} to 1×10^{-6} (AFCEE 2003). An ecological baseline risk assessment was not conducted for groundwater because the CS-19 plume is not currently discharging to any surface water bodies, nor is it expected to in the future.

5.4.3 Remedial Actions

The final remedy for the CS-19 plume was determined in the *Final Chemical Spill-19 Record of Decision* (AFCEE 2009a) which was signed on 30 September 2009.

The RAOs for the CS-19 groundwater plume as presented in the ROD (AFCEE 2009a) and modified in the ESD (AFCEE 2011) are as follows:

- Prevent residential exposure to CS-19 groundwater with RDX concentrations greater than the EPA risk-based level of 0.6 µg/L.
- Restore useable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

5.4.3.1 Remedy Selection and Implementation

The selected remedy for CS-19 groundwater in the ROD (AFCEE 2009a) was MNA with LUCs and plume monitoring. In addition, CERCLA reviews are to be completed every five years throughout the lifetime of the remedial action.

LTM data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives are being met; and (ii) to identify and assess optimization

opportunities. The data collected under the SPEIM/LTM program are presented to the regulatory agencies through the Technical Update meeting process.

As part of the LUC process specified in the ROD (AFCEE 2009a), a well verification survey was completed for CS-19 in January 2013. No active or inactive water-supply or irrigation wells were identified within the CS-19 LUC area. Additionally no private residential wells are known to exist within the CS-19 LUC area since the plume is located entirely within the boundary of the JBCC (AFCEC 2013c). In the event that new private well information is obtained or plume monitoring data indicate a change to the CSM at CS-19, AFCEC will perform the necessary well determinations at the time the information becomes available.

5.4.3.2 Remedy Operation & Maintenance

The periodic LTM costs associated with ongoing remedial action at CS-19 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives such as less frequent sampling as was assumed at the time of the remedy selection) and do not indicate potential remedy problems.

5.4.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior fourth CERCLA Five Year Review (AFCEE 2013a). For the CS-19 groundwater plume, the recommendations and follow-up actions were:

- 1) No specific recommendation or follow-up actions were identified. However, it was recommended that emerging contaminants should be monitored as it relates to groundwater at CS-19 and the JBCC.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

- 1) CS-19 was not sampled for 1,4-dioxane because there were no solvents associated with the groundwater plume. It was also not sampled for PFAS because there was no evidence of AFFF use at the site.

5.4.5 Five Year Review Process

5.4.5.1 Data Review

The data collected under the SPEIM/LTM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues. The following technical deliverables were prepared that assessed remedial progress:

- *CS-19 2012 Annual LTM Data Presentation Project Note* (AFCEC 2012)
- *CS-19 2013 Triennial LTM Data Presentation Project Note* (AFCEC 2013b)
- *CS-19 2014 Annual LTM Data Presentation Project Note* (AFCEC 2014b)
- *CS-19 2015 Annual LTM Data Presentation Project Note* (AFCEC 2015b)
- *CS-19 2016 Triennial LTM Data Presentation Project Note* (AFCEC 2016)
- *CS-19 2017 Annual LTM Data Presentation Project Note* (AFCEC 2017)

5.4.5.2 Site Inspections

Refer to Section 3.6.

5.4.5.3 Interviews

Refer to Section 3.7.

5.4.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.4.6.1 **Question A: Is the remedy functioning as intended by the decision documents?**

Yes, the LTM activities and the implementation of the LUCs at CS-19 have resulted in the remedy functioning as intended by the decision documents. Through natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD (i.e., by 2037). Operational costs are appropriate for the remedy. Monitoring and evaluation activities are continual and well-documented.

5.4.6.2 **Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?**

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics: There have been no changes in the toxicity factors that were in place at the time of the last Five Year Review (i.e., 2012) or other contaminant characteristics for the CS-19 groundwater COC, RDX.

Changes in Risk Assessment Methods: There were changes in risk assessment methodology. The EPA tap water screening level was changed from 0.6 µg/L to 0.7 µg/L (EPA 2017). The new screening level of 0.7 µg/L should be used for risk comparisons going forward.

Review of RAOs: The RAOs developed for the final ROD (AFCEE 2009a) are appropriate.

5.4.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information at this time that calls into question the protectiveness of the remedy.

5.4.7 Issues, Recommendations, and Follow-Up Actions

No specific recommendation or follow-up actions have been identified.

5.4.8 Protectiveness Determination

The remedy for the CS-19 groundwater plume is protective of human health and the environment. Remediation is progressing as expected. The LUCs are in place and are functioning as intended. Through natural attenuation processes groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.

5.4.9 References

ABB Environmental Services, Inc. (ABB-ES). 1992a (January). *Preliminary Assessment Report - Chemical Spill Site in Impact Area (Study Area CS-19)*. Prepared by HAZWRAP for the Installation Restoration Program, Otis Air National Guard Base, MA.

_____. 1992b. *Final Site Assessment Work Completion Report, Chemical Spill Site in Impact Area (Study area CS-19) Final*. Prepared by HAZWRAP for the Installation Restoration Program, Otis Air National Guard Base, MA.

AFCEC. 2017 (July). *CS-19 2017 Annual LTM Data Presentation Project Note*. 52000-SPEIM-CS19-PRJNOT-003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

_____. 2016 (September). *CS-19 2016 Triennial LTM Data Presentation Project Note*. 52000-SPEIM-CS19-PRJNOT-002. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

- _____. 2015a (August). *Final Technical Memorandum CS-18/CS-19 2015 Restoration*. Prepared by FPM Remediation, Inc. for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015b (July). *CS-19 2015 Annual LTM Data Presentation Project Note*. 52000-SPEIM-CS19-PRJNOT-001. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014a (August). *Final Work Plan CY-2 Removal Action, FS-12 Soil Vapor Extraction System Abandonment, and CS-18/CS-19 2015 Restoration*. Prepared by FPM Remediation, Inc. for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014b (May). *CS-19 2014 Annual LTM Data Presentation Project Note*. 473147-SPEIM-CS19-PRJNOT-002. Prepared by CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013a (October) *Final 4th Five-Year Review, 2012-2017 Massachusetts Military Reservation (JBCC) Superfund Site, Otis Air National Guard Base, MA* 473147-SPEIM-Multiple-RPT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013b (October). *CS-19 2013 Triennial LTM Data Presentation Project Note*. 473147-SPEIM-CS19-PRJNOT-001. Prepared by CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013c (May). *Chemical Spill-19 Groundwater Plume Land Use Control Project Note*. 437075-LUC-CS19-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012 (December). *CS-19 2012 Annual LTM Data Presentation Project Note*. 437075-SPEIM-CS19-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- AFCEE. 2012 (August). *Final 2011 JBCC Vapor Intrusion Evaluation Technical Memorandum*. 420005-SPEIM-MULTIPLE-TECHMEM-002. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2011 (September). *Final Explanation of Significant Differences for the Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation*. 404929-SPEIM-MULTIPLE-RPT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

- _____. 2009a (September). *Final Chemical Spill-19 Record of Decision*. A4P-J23-05PC0829-M26-0005. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2009b (September). *Final CS-19 Soil Removal Action Report*. Prepared by ECC for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2009c (April). *Proposed Plan for Chemical Spill-19 Groundwater*. Fact Sheet 2009-02. Prepared by Jacobs Engineering Group Inc., for the AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2009d (April). *Final Chemical Spill-19 Groundwater Feasibility Study*. A4P-J23-05PC0829-M16-0003. Prepared by Jacobs Engineering Group Inc., for the AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2008 (April). *Final Chemical Spill-19 Bunker Area Investigation Report*. Prepared by AMEC Earth and Environmental Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2005 (December). *Final Chemical Spill-19 Groundwater Plume Interim Record of Decision*. A3P-J23-35A01204-M26-0003. Prepared by Jacobs Engineering Group Inc., for the AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2003 (October). *Final Chemical Spill-19 Remedial Investigation Report*. A3P-J23-35Z01202-M14-0005. Prepared by Jacobs Engineering Group Inc., for the AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 1999 (July). *Final CS-19 Supplemental Groundwater Investigation Report*. AFC-J23-35G48400-M13-0009. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- ANG. 1992 (October). *Final Groundwater Remediation Strategy Report, First Edition*. Prepared for Hazardous Waste Remedial Actions Program, Oak Ridge, Tennessee by ABB Environmental Services, Inc.
- EPA. 2004 (December). Modification No. 56 to Safe Drinking Water Act Administrative Order No. 3 (SDWA-1-2000-0014, January 2000). *Memorandum of Understanding regarding Evaluation and Selection of Groundwater Remedies for the Central Impact Area and Chemical Spill-19 sites*.

_____. 2001 (June). *Comprehensive Five-Year Review Guidance*, EPA 540R-01-007.

IAGWSP. 2003 (June). Impact Area Groundwater Study Program, Archive Search Report, Witness Interviews.

Ogden Environmental and Energy Services, 1999 (November). *Interim Results Report for the Camp Edwards Impact Area Groundwater Quality Study*. Prepared by Ogden Environmental and Energy Services, Westford, MA.

USACHPPM. (U.S. Army Center for Health Promotion and Preventive Medicine). 1994. *Site Inspection No. 38-26-1339-95, Site CS-19*, Massachusetts Military Reservation, Cape Cod, Massachusetts.

5.5 CHEMICAL SPILL-20 (CS-20) GROUNDWATER

The CS-20 plume is a dissolved-phase groundwater plume (Figure 5-5A) that is defined by the extent of groundwater containing the CS-20 COC, PCE, at concentrations exceeding the federal MCL of 5 µg/L.

5.5.1 Site Chronology

1997: The CS-20 plume was discovered in March 1997 during the drilling program to define the trailing edge of the FS-28 plume (AFCEE 1999c).

1998: The RI report was completed (AFCEE 1999c).

1999: The FS was completed in June 1999 (AFCEE 1999b) and the proposed plan was released to the public in June 1999 (AFCEE 1999a).

2000: ROD finalized (AFCEE 2000).

2004: Completion of the final wellfield design consisting of two CS-20 extraction wells that were installed as part of the Southwest Plumes remedial system, which was designed to collectively remediate the CS-4, CS-20, CS-21, and FS-29 groundwater plumes (AFCEE 2004) (Figure 5-5A).

2006: Remedy in place achieved in January with the startup of the CS-20 treatment system (AFCEE 2008b).

2008: An ESD was submitted to document changes to the selected remedy for CS-20 related to the expected extent of plume capture and to further describe the institutional controls associated with the remedy (AFCEE 2008a).

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and added text regarding the JBCC three-step process to achieve site closure (AFCEE 2011).

2014: 81EW0001 was shut down on 11 July 2014.

2015: 81EW0002 was shut down on 25 September 2015.

2015: The CS-20 remedial system was shut down in September 2015 having substantially remediated the aquifer within its capture zone. The CS-20 extraction wells removed approximately 97 lbs of PCE through the treatment of approximately 2.8 billion gallons of contaminated groundwater from system startup in January 2006 through system shutdown in September 2015. SPEIM data will continue to be collected and evaluated at CS-20 to provide the data necessary to proceed with the three-step process to achieve site closure.

2016-2017: A Supplemental RI is currently being completed for the emerging contaminant 1,4-dioxane at CS-20. The Draft CS-20 Supplemental RI report was submitted for regulatory review on 27 June 2016 (AFCEC 2016d). As discussed with the regulatory agencies at the 14 July 2016 Technical Update Meeting, finalization of the Draft RI will be postponed until the CS-20 1,4-Dioxane Interim Monitoring Program (AFCEC 2017c) is completed and the data from the interim monitoring program will be used to determine next steps. Once the interim monitoring program is completed, the recommendations for next steps will be documented in the Final RI.

5.5.2 Background

5.5.2.1 History of Contamination

The CS-20 plume is detached from its source area which remains unidentified. It is speculated that contamination was released at the ground surface from a spill or release on the JBCC, migrated through the vadose zone, and entered the groundwater at the water table. The dissolved phase contamination was then carried downgradient in groundwater in a south-southwesterly direction.

5.5.2.2 Physical Characteristics, Land and Resource Use

The footprint of the CS-20 plume was approximately 68 acres in 2012, and is no longer

defined in 2017 (Figure 5-5B).

The land above the northern portion of the CS-20 plume (i.e., north of Route 151) is undeveloped woodlands used for recreational purposes (hiking, biking, hunting, etc.) within the CWMA, which is managed by the MDFW (Figure 5-5A). The land above the southern portion of the CS-20 plume is residential. The CS-20 plume is located within a broad, flat, gently sloping glacial outwash plain. Within the former footprint of the plume, the maximum and minimum ground surface elevations are 108 ft msl and 58 ft msl, respectively.

5.5.2.3 Initial Responses

A summary of the initial responses is as follows:

Non-CERCLA Actions: None.

CERCLA Actions:

CS-20 Groundwater Plume: Following the 1998 RI (AFCEE 1999c), a FS was completed in 1999 (AFCEE 1999b). A proposed plan was released to the public in June 1999 (AFCEE 1999a) to solicit comments on the preferred alternative (Alternative 5). The selected remedy for CS-20 as specified in the ROD was Alternative 5: design, construction, and operation of a treatment system to hydraulically capture and treat plume contaminants, performance monitoring of the CS-20 plume and remedial system, ecological sampling to monitor the impacts of the treatment system on the environment, and institutional controls (AFCEE 2000).

The CS-20 remedial system consists of two extraction wells that began operation on 11 January 2006 at a design extraction rate of 775 gpm (425 gpm at 81EW0001 and 350 gpm at 81EW0002) (Figure 5-5A). Extracted groundwater is treated by GAC in the centrally-located HATF and the treated water is returned to the aquifer through reinjection wells, an infiltration trench, and an infiltration gallery. Further details regarding the CS-20 remedial system can be found in the 2017 O&M Plan (AFCEC 2017a).

An ESD was submitted in 2008 to document changes to the selected remedy for CS-20 (AFCEE 2008a). The primary difference between the cleanup strategy identified in the ROD and the final design is that the selected alternative presented in the ROD anticipated that the entire CS-20 plume would be hydraulically captured by the remedial system; however, the final design allowed the groundwater contamination in the downgradient leading edge of CS-20 to reach cleanup levels through natural attenuation instead of through active treatment. A third leading edge extraction well was originally included for CS-20 in the SWOU Wellfield Design (AFCEE 2004) but, due to access issues, was not installed. While analyzing various designs for system performance, effectiveness, property access issues, and other constraints, the final design for CS-20 was developed to meet the RAOs described in Section 5.5.3, while allowing for a relatively small portion of the plume to attenuate naturally.

An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and updated the steps to achieve site closure (i.e., the three-step process) (AFCEE 2011).

5.5.2.4 Basis for Taking Action

The baseline cancer risk calculations in the SWOU RI indicated that unless remedial action is undertaken, future residential exposure to PCE in groundwater may present an excess lifetime cancer risk greater than the acceptable EPA range of 1×10^{-4} to 1×10^{-6} . Ecological risks associated with the CS-20 groundwater plume were evaluated during the RI and no significant risk was identified (AFCEE 1999c).

5.5.3 Remedial Actions

The final remedy for the CS-20 plume was determined in the *Final Record of Decision for the CS-4, CS-20, CS-21 and FS-13 Plumes* (AFCEE 2000) which was signed on 18 February 2000.

The RAOs for the CS-20 groundwater plume as presented in the ROD (AFCEE 2000) and

modified in the ESD (AFCEE 2011) are as follows:

- Prevent residential exposure to CS-20 groundwater with PCE concentrations greater than the MCL of 5 µg/L.
- Restore useable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

5.5.3.1 Remedy Selection and Implementation

The selected remedy for CS-20 groundwater in the ROD (AFCEE 2000) included the following components:

- The design, construction, and operation of a treatment system to hydraulically capture and treat plume contaminants,
- Institutional controls to mitigate exposure to humans from CS-20 groundwater contaminants. In 1999, the Falmouth BOH adopted water well regulations to minimize the risk of exposure to groundwater contamination,
- Engineering controls to mitigate exposure to humans from CS-20 groundwater contaminants. Residents potentially impacted by the plume are connected to a public water supply,
- Plume monitoring, performance monitoring of the treatment system, and ecological sampling to monitor the impacts of the system on the environment, and
- Completion of CERCLA reviews every five years throughout the lifetime of the remedial action.

Since the remedy was selected in 2000, the following changes have occurred:

- 1) The Wellfield Design (AFCEE 2004) presented the revised plan to treat the four Southwest Plumes (CS-4, CS-20, CS-21, and FS-29) via GAC at a centrally-located treatment plant (HATF) on the JBCC. The CS-20 leading edge extraction well originally included in the SWOU Wellfield Design was not installed due to access issues (AFCEE 2008a).
- 2) The institutional controls described in the ROD were further developed as described in the Southwest Plumes ESD (AFCEE 2008a). The ESD provides a more thorough description of the LUC Program, including a private well verification program that is being instituted for all the JBCC groundwater sites.

- 3) The 2011 ESD for the IRP groundwater plumes (AFCEE 2011) clarified the inclusion of MNA as a component of the selected remedy for CS-20, slightly modified the phrasing of the RAOs, and added text regarding the JBCC three-step process to achieve site closure.

The CS-20 remedial system was installed in 2005 and began operation on 11 January 2006 using two extraction wells at a total flow rate of 775 gpm.

Remedial system performance monitoring data and long-term plume monitoring data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives and system performance metrics are being met; (ii) whether remediation is progressing as expected; and (iii) to identify and assess optimization opportunities. The data collected under the SPEIM/LTM program are presented to the regulatory agencies through the Technical Update meeting process and documented in annual SLRs.

As part of the LUC process specified in the ROD and subsequent ESD (AFCEE 2000, 2008a, 2011), a private well verification survey was completed for the Southwest Plumes (including CS-20) and FS-28 between April 2009 and August 2011 (AFCEE 2012b). This private well verification survey consisted of outreach to 497 parcels. One well used for drinking water was identified (AFCEE 2012b). The private well used as a potable source that was identified will be sampled annually as part of the LUC monitoring program and no CS-20 COCs were detected. In the event that new private well information is obtained or plume monitoring data indicate a change to the CSM at CS-20, AFCEC will perform the necessary well determinations at the time the information becomes available.

A review of the data collected under the CS-20 SPEIM program in 2012-2017 indicates that there are no changes to the plume CSM that would warrant a revision to the private well LUC program with respect to the current COCs.

The status of non-operational private wells in the CS-20 LUC area continue to be tracked. AFCEC distributed a mailing, on an annual basis, to property owners within the LUC area that have non-operational wells. The intent of the annual mailing is to remind these

property owners that they should contact AFCEC for a technical evaluation, which may include sampling, in the event their well is put back into service. Annual mailings were distributed during this five year review period and reported in the SLRs (AFCEC 2018, 2017d, 2016e, 2015b, 2014b, 2012b) and annual LUC reports. No property owners notified AFCEC that they intended to restart a non-operational private well within CS-20 LUC area during this five year review period (2012 -2017).

5.5.3.2 Remedy Operation & Maintenance

The CS-20 remedial system is operated and maintained under an approved O&M Plan (AFCEC 2017a). The O&M Plan is updated on an annual basis and includes operational requirements, a summary of the operational history of the systems, and details of any system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and continue to be, addressed in a timely and effective manner such that O&M associated with the remedy is considered effective at achieving the remedy goals. Operational issues are identified in O&M monthly reports and system performance and reliability is reported in the annual SLRs.

The annual SPEIM/LTM/O&M costs associated with ongoing remedial actions at CS-20 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives) and do not indicate potential remedy problems.

5.5.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior fourth CERCLA Five Year Review (AFCEC 2013c). For the CS-20 groundwater plume, the recommendations and follow-up actions were:

- 1) No specific recommendation or follow-up actions have been identified. However, the topic of emerging contaminants should be monitored as it relates to groundwater at the JBCC. Specifically for CS-20 groundwater, a sampling and analysis plan

shall be submitted to the regulatory agencies to assess the possible presence of 1,4-dioxane.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

- 1) A Supplemental RI is currently being completed by AFCEC for the emerging contaminant 1,4-dioxane at CS-20. The Draft CS-20 RI report was submitted for regulatory review on 27 June 2016 (AFCEC 2016d). As discussed with the regulatory agencies at the 14 July 2016 Technical Update Meeting, finalization of the Draft RI will be postponed until the CS-20 1,4-Dioxane Interim Monitoring Program (AFCEC 2017c) is completed and the data from the interim monitoring program will be used to determine next steps. Once the interim monitoring program is completed, the recommendations for next steps will be documented in the Final RI.

5.5.5 Five Year Review Process

5.5.5.1 Data Review

The JBCC SPEIM program was developed to monitor plume changes and to ensure the effective operation of the AFCEC groundwater remediation systems at the JBCC. These objectives are met through monitoring of selected media (i.e., groundwater, surface water) within and outside the plume boundaries, treatment plant monitoring, and groundwater flow and transport modeling. The data collected under the SPEIM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being addressed through active treatment. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program. The SLRs also

include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual reporting period as attachments or by reference. The SLRs are provided to the broad stakeholder group for each plume including Federal (EPA) and State (MassDEP, MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties. The SLRs are publically available in the IRP Administrative Record and copies are maintained at the local town libraries.

In addition to the annual SLRs prepared for the Southwest Plumes (including CS-20) during this Five Year Review period (AFCEC 2018, 2017d, 2016e, 2015b, 2014b, 2012b), the following technical deliverables were prepared that assessed system performance or presented the results of optimization evaluations:

- *Southwest Plumes 2012 Triennial SPEIM Data Presentation Project Note* (AFCEC 2012a)
- *CS-20 2013 Semiannual SPEIM Data Presentation Project Note* (AFCEC 2013a)
- *Southwest Plumes 2013 Annual SPEIM Data Presentation Project Note*. (AFCEC 2013b)
- *Southwest Plumes 2014 Annual SPEIM Data Presentation Project Note* (AFCEC 2014a)
- *Southwest Plumes 2015 Triennial SPEIM Data Presentation Project Note* (AFCEC 2015a)
- *Southwest Plumes 2016 Annual SPEIM Data Presentation Project Note* (AFCEC 2016a)
- *Southwest Plumes 2017 Annual SPEIM Data Presentation Project Note* (AFCEC 2017b)

5.5.5.2 Site Inspections

Refer to Section 3.6.

5.5.5.3 Interviews

Refer to Section 3.7.

5.5.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.5.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, the completion of the ROD in 2000, construction and startup of the remedial system in 2005 and 2006, continued operation of the remedial system, and completion of the well verification/well determination portion of the LUCs in 2011 have resulted in the remedy at CS-20 functioning as intended by the decision documents. The CS-20 remedial system was shut down in September 2015 having substantially remediated the aquifer within its capture zone. The CS-20 extraction wells removed approximately 97 lbs of PCE through the treatment of approximately 2.8 billion gallons of contaminated groundwater from system startup in January 2006 through system shutdown in September 2015. SPEIM data will continue to be collected and evaluated at CS-20 to provide the data necessary to proceed with the three-step process to achieve site closure (AFCEE 2000, 2011). Plume cleanup is progressing faster than predicted at CS-20 (aquifer restoration date from the ROD is approximately 2030 and most recent modeling prediction was approximately 2024). SPEIM data indicate that cleanup standards (MCLs) have been achieved throughout the majority of the plume and aquifer restoration should be achieved within the next year or two (AFCEC 2017b).

5.5.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or

TBC guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics: There have been no changes in the toxicity factors that were in place at the time of the last Five Year Review (i.e., 2012) for the CS-20 groundwater COC, PCE.

Changes in Risk Assessment Methods: There have been no changes in risk assessment methodology that affect protectiveness.

Review of RAOs: The RAOs developed for the final ROD (AFCEE 2000) and revised in the 2011 ESD (AFCEE 2011b) are appropriate and remain valid.

5.5.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information at this time that calls into question the protectiveness of the remedy with respect to the COC. However, 1,4-dioxane in groundwater at CS-20 is being evaluated as part of the RI.

5.5.7 Issues, Recommendations, and Follow-Up Actions

Finalize the RI for 1,4-dioxane at CS-20. Plume cleanup is progressing faster than predicted at CS-20 (aquifer restoration date from the ROD is approximately 2030 and most recent modeling prediction was approximately 2024) for PCE. SPEIM data indicate that cleanup standards (MCLs) have been achieved throughout the majority of the plume and aquifer restoration should be achieved within the next year or two (AFCEC 2017b).

5.5.8 Protectiveness Determination

The remedy for the CS-20 groundwater plume is protective of human health and the environment in the short-term. The remedial system has performed as expected for

existing COCs. Through the combination of the active treatment by the remedial system and natural attenuation processes, existing groundwater cleanup levels may be met earlier than the timeframe approximated in the ROD. The LUCs are in place and are functioning as intended. For the remedy to be protective in the long-term, the Supplemental RI for 1,4-dioxane should be finalized.

5.5.9 References

- AFCEC. 2018 (April). *Southwest Plumes 2017 Summary Letter Report*. 652000-SPEIM-SWP-SLR-004. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2017a (November). *2017 Operations and Maintenance Plan for Groundwater Extraction and Treatment Systems and Wind Turbine*. 652000-O&M-MULTIPLE-OMPLN-003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2017b (August). *Southwest Plumes 2017 Annual SPEIM Data Presentation Project Note*. 652000-SPEIM-SWP-PRJNOT-003. Prepared by EA Engineering and CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2017c (March). *CS-20 1,4-Dioxane Interim Monitoring Program Project Note*. 658003-SPEIM-EC-CS20-PRJNOT-001. Prepared by CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2017d (March). *Southwest Plumes 2016 Summary Letter Report*. 652000-SPEIM-SWP-SLR-003. Prepared by CH2M for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016a (December). *Southwest Plumes 2016 Annual SPEIM Data Presentation Project Note*. 652000-SPEIM-SWP-PRJNOT-002. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016b (September). *Annual Land Use Control Letter Report for 2015*. Prepared by AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016d (June). *Draft Supplemental Remedial Investigation Report for 1,4-Dioxane at Chemical Spill-20, Joint Base Cape Cod, MA*. 658003-EC-CS20-RPT-001. Prepared by CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

- _____. 2016e (March). *Southwest Plumes 2015 Summary Letter Report*. 652000-SPEIM-SWPSLR- 003. Prepared by Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015a (September). *Southwest Plumes 2015 Triennial SPEIM Data Presentation Project Note*. 652000-SPEIM-SWP-PRJNOT-001. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015b (May). *Southwest Plumes 2014 Summary Letter Report*. 652000-SPEIM-SWP-SLR-001. Prepared by CH2M for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014a (July). *Southwest Plumes 2014 Annual SPEIM Data Presentation Project Note*. 473147-SPEIM-SWP-PRJNOT-003. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014b (March). *Southwest Plumes 2013 Summary Letter Report*. 473147-SPEIM-SWP-SLR-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013a (December). *CS-20 2013 Semiannual SPEIM Data Presentation*. 473147-SPEIM-CS20-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013b (November). *Southwest Plumes 2013 Annual SPEIM Data Presentation Project Note*. 473147-SPEIM-SWP-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013c (October) *Final 4th Five-Year Review, 2012-2017 Massachusetts Military Reservation (JBCC) Superfund Site, Otis Air National Guard Base, MA* 473147-SPEIM-Multiple-RPT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012a (December). *Southwest Plumes 2012 Triennial SPEIM Data Presentation Project Note*. 437075-SPEIM-SWP-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012b (March). *Southwest Plumes 2012 Summary Letter Report*. 437075-SPEIM-SWP-SLR-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- AFCEE. 2012a (August). *Final 2011 JBCC Vapor Intrusion Evaluation Technical Memorandum*. 420005-SPEIM-MULTIPLE-TECHMEM-002. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air

National Guard Base, MA.

- _____. 2012b (February). *Fuel Spill-28 and Southwest Plumes 2011 Private Well Verification and Well Determination Project Note*. 420005-SPEIM-LUC-MULTIPLE-PRJNOT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2011 (September). *Final Explanation of Significant Differences for the Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation*. 404929-SPEIM-MULTIPLE-RPT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2008a (September). *Final Explanation of Significant Differences for Chemical Spill-4, Chemical Spill-20, Chemical Spill-21, Fuel Spill-13, Fuel Spill-28, and Fuel Spill-29 Groundwater Plumes*. A4P-J23-35BC24VC-M26-0006. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2008b (September). *Final Interim Remedial Action Report for CS-4, CS-20, CS-21, and FS-29 (Southwest Plumes), and CS-23/LF-1 Groundwater Plumes*. Prepared by ECC for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2004 (August). *Final Chemical Spill-4, Chemical Spill-20, Chemical Spill-21 and Fuel Spill-29 Wellfield Design Report*. A3P-J23-35Z00102-M23-0004. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2000 (February). *Final Record of Decision for the CS-4, CS-20, CS-21 and FS-13 Plumes*. AFC-J23-35Q86101-M26-0004. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 1999a (June). *Proposed Plan for the Southwest Operable Unit (CS-4, CS-20, CS-21 and FS-13 plumes only)*. AFC-J23-35Q86101-M25-0004. Prepared by Jacobs Engineering Group Inc., for the AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.

- _____. 1999b (June). *Final Southwest Operable Unit Feasibility Study*. AFC-J23-35Q86101-M16-0006. Prepared by Jacobs Engineering Group Inc., for the AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 1999c (May). *Final Southwest Operable Unit Remedial Investigation*. AFC-J23-35Q86101-M14-0006. Prepared by Jacobs Engineering Group Inc., for the AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- EPA. 2013 (March). Integrated Risk Information System (IRIS) database. [online]. Available: <http://www.epa.gov/iris/index.html>.
- _____. 2001 (June). *Comprehensive Five-Year Review Guidance*, EPA 540R-01-007.

5.6 CHEMICAL SPILL-21 (CS-21) GROUNDWATER

The CS-21 plume is a dissolved-phase groundwater plume (Figure 5-6A) that is defined by the extent of groundwater containing the CS-21 COC, TCE, at concentrations exceeding the federal MCL of 5 µg/L.

5.6.1 Site Chronology

1998: The CS-21 plume was discovered during the RI (AFCEE 1999c).

1999: The FS was completed in June 1999 (AFCEE 1999b) and the proposed plan was released to the public in June 1999 (AFCEE 1999a).

2000: ROD finalized (AFCEE 2000).

2004: Completion of the final wellfield design consisting of four CS-21 extraction wells that were installed as part of the Southwest Plumes remedial system, which was designed to collectively remediate the CS-4, CS-20, CS-21, and FS-29 groundwater plumes (AFCEE 2004) (Figure 5-6A).

2006: Remedy in place was achieved in September 2006 with the startup of the CS-21 treatment system (AFCEE 2008b).

2008: An ESD was prepared to further describe the institutional controls associated with the remedy (AFCEE 2008a).

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and added text regarding the JBCC three-step process to achieve site closure (AFCEE 2011).

5.6.2 Background

5.6.2.1 History of Contamination

The CS-21 plume is detached from its source area which remains unidentified. It is speculated that contamination was released at the ground surface from a spill or release on the JBCC, migrated through the vadose zone, and entered the groundwater at the water table. The dissolved phase contamination was then carried downgradient in groundwater in a south-southwesterly direction.

5.6.2.2 Physical Characteristics, Land and Resource Use

Based on the most recent groundwater monitoring data collected, the CS-21 plume is approximately 5,000 ft long, has a maximum width of approximately 1,000 ft, and is up to 180 ft thick in the aquifer (Figure 5-6A). The footprint of the CS-21 plume was approximately 135 acres in 2012, and was approximately 40 acres in 2017 (Figure 5-6B).

The land above the northern portion of the CS-21 plume is undeveloped woodlands used for recreational purposes (hiking, biking, hunting, etc.) within the CWMA, which is managed by the MDFW (Figure 5-6A). The land above the southern portion of the CS-21 plume is residential and recreational (Ballymeade Golf Course). The Ballymeade Country Club has two private irrigation wells (69IG0015 and 69IG0016) located near the CS-21 plume. TCE has been detected in the irrigation wells when sampled in the past. In May 2015, TCE was not detected in the samples collected from 69IG0015 and 69IG0016. Sampling of these wells was discontinued in 2017.

The eastern portion of the CS-21 plume is located within a broad, flat, gently sloping glacial outwash plain. The western portion of the plume travels into a hummocky north-south trending ridge of moraine glacial deposits. Within the footprint of the plume, the maximum and minimum ground surface elevations are 170 ft msl and 80 ft msl, respectively.

5.6.2.3 Initial Responses

A summary of the initial responses is as follows:

Non-CERCLA Actions: None.

CERCLA Actions:

CS-21 Groundwater Plume: Following the 1998 RI (AFCEE 1999c), a FS was completed in 1999 (AFCEE 1999b). A proposed plan was released to the public in June 1999 (AFCEE 1999a) to solicit comments on the preferred alternative (Alternative 11). The selected remedy for CS-21 as specified in the ROD was Alternative 11: design, construction, and operation of a treatment system to hydraulically capture and treat plume contaminants, performance monitoring of the CS-21 plume and remedial system, ecological sampling to monitor the impacts of the treatment system on the environment, and institutional controls (AFCEE 2000).

The CS-21 remedial system consists of four extraction wells (82EW0001 through 82EW0004) that began operation on 11 September 2006 at a design extraction rate of 1,400 gpm (Figure 5-6A). Extracted groundwater is treated by GAC in the centrally-located HATF and the treated water is returned to the aquifer through reinjection wells, an infiltration trench, and an infiltration gallery. Further details regarding the CS-21 remedial system can be found in the 2017 O&M Plan (AFCEC 2017a).

An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and updated the steps to achieve site closure (i.e., the three-step process) (AFCEE 2011).

5.6.2.4 Basis for Taking Action

The baseline cancer risk calculations in the SWOU RI indicated that unless remedial action is undertaken, future residential exposure to TCE in groundwater may present an excess lifetime cancer risk greater than the acceptable EPA range of 1×10^{-4} to 1×10^{-6} . Ecological risks associated with the CS-21 groundwater plume were evaluated during the RI and no significant risk was identified (AFCEE 1999c).

5.6.3 Remedial Actions

The final remedy for the CS-21 plume was determined in the *Final Record of Decision for the CS-4, CS-20, CS-21 and FS-13 Plumes* (AFCEE 2000) which was signed on 18 February 2000.

The RAOs for the CS-21 groundwater plume as presented in the ROD (AFCEE 2000) and modified in the ESD (AFCEE 2011) are as follows:

- Prevent residential exposure to CS-21 groundwater with TCE concentrations greater than the MCL of 5 µg/L.
- Restore useable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

5.6.3.1 Remedy Selection and Implementation

The selected remedy for CS-21 groundwater in the ROD (AFCEE 2000) included the following components:

- The design, construction, and operation of a treatment system to hydraulically capture and treat plume contaminants.
- Institutional controls to mitigate exposure to humans from CS-21 groundwater contaminants. In 1999, the Falmouth BOH adopted water well regulations to minimize the risk of exposure to groundwater contamination.
- Engineering controls to mitigate exposure to humans from CS-21 groundwater contaminants. Residents potentially impacted by the plume are connected to a public water supply.
- Plume monitoring, performance monitoring of the treatment system, and ecological sampling to monitor the impacts of the system on the environment.
- Completion of CERCLA reviews every five years throughout the lifetime of the remedial action.

Since the remedy was selected in 2000, the following changes have occurred:

- 1) The Wellfield Design (AFCEE 2004) presented the revised plan to treat the four Southwest Plumes (CS-4, CS-20, CS-21, and FS-29) via GAC at a centrally-located treatment plant (HATF) on the JBCC.

- 2) The institutional controls described in the ROD were further developed as described in the Southwest Plumes ESD (AFCEE 2008a). The ESD provides a more thorough description of the LUC program, including a private well verification program that is being instituted for all the JBCC groundwater sites.
- 3) The 2011 ESD for the IRP groundwater plumes (AFCEE 2011) clarified the inclusion of MNA as a component of the selected remedy for CS-21, slightly modified the phrasing of the RAOs, and added text regarding the JBCC three-step process to achieve site closure.

The CS-21 remedial system was installed in 2006 and began operation on 11 September 2006 using four extraction wells at a total flow rate of 1,400 gpm.

Remedial system performance monitoring data and long-term plume monitoring data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives and system performance metrics are being met; (ii) whether remediation is progressing as expected; and (iii) to identify and assess optimization opportunities. The data collected under the SPEIM/LTM program are presented to the regulatory agencies through the Technical Update meeting process and documented in annual SLRs.

As part of the LUC process specified in the ROD and subsequent ESD (AFCEE 2000, 2008a), a private well verification survey was completed for the Southwest Plumes (including CS-21) and FS-28 between April 2009 and August 2011 (AFCEE 2012c). This private well verification survey consisted of outreach to 497 parcels. No private drinking water wells were identified and a total of 16 properties (including the Ballymeade Golf Course) associated with CS-21 have one or more private wells that are used as a non-potable water source. Technical evaluations were completed for each private well to determine the sampling frequency and/or re-evaluation frequencies (if necessary). The two irrigation wells at Ballymeade Golf Club were identified for annual sampling under the CS-21 LUC program because annual sampling was required per the water withdrawal permit with the Massachusetts Department of Environmental Protection.

A review of the data collected under the CS-21 SPEIM program during this five-year review period (2012-2017) indicates that there were no changes to the plume CSM that warranted a revision to the private well LUC program with respect to the current COCs.

The status of non-operational private wells in the CS-21 LUC area continued to be tracked. AFCEC distributed a mailing, on an annual basis, to property owners within the LUC area that have non-operational wells. The intent of the annual mailing is to remind these property owners that they should contact AFCEC for a technical evaluation, which may include sampling, in the event their well is put back into service. Annual mailings were distributed during this five year review period and reported in the SLRs (AFCEC 2018, 2017c, 2016b, 2015b, 2014c, 2013c) and annual LUC reports. A summary of private wells that were restarted during this five year review period at CS-21 is provided below:

2013: A property owner responded that they were planning to restart a previously non-operational private well for use as a private irrigation water well. A technical evaluation was completed for this private well (Appendix C) and based upon a review of SPEIM data and private well sampling data there is no current risk of exposure to the CS-21 groundwater plume through the intermittent use of this well for outdoor purposes.

2014: No private wells restarted

2015: No private wells restarted

2016: No private wells restarted

2017: Annual mailings were sent in August 2017 and results will be reported in the next five year review.

5.6.3.2 Remedy Operation & Maintenance

The CS-21 remedial system is operated and maintained under an approved O&M Plan (AFCEC 2017a). The O&M Plan is updated on an annual basis and includes operational requirements, a summary of the operational history of the systems, and details of any

system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and continue to be, addressed in a timely and effective manner such that O&M associated with the remedy is considered effective at achieving the remedy goals. Operational issues are identified in O&M monthly reports and system performance and reliability is reported in the annual SLRs.

The annual SPEIM/LTM/O&M costs associated with ongoing remedial actions at CS-21 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives) and do not indicate potential remedy problems.

5.6.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior forth CERCLA Five Year Review (AFCEC 2013b). For the CS-21 groundwater plume, the recommendations and follow-up actions were:

- 1) No specific recommendation or follow-up actions have been identified. However, the topic of emerging contaminants should be monitored as it relates to groundwater at the JBCC. Specifically for CS-21 groundwater, a sampling and analysis plan shall be submitted to the regulatory agencies to assess the possible presence of 1,4-dioxane.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

- 1) A presence/absence (CERCLA SI equivalent) 1,4-dioxane field investigation was completed between October 2013 and June 2014 at seven IRP chlorinated solvent plumes (Ashumet Valley, CS-4, CS-10, CS-20, CS-21, CS-23, and LF-1) in response to the recommendation in the last five-year review. Sampling for 1,4-dioxane was completed at the treatment plant influent and effluent ports, operating extraction wells, selected monitoring wells, selected private wells, and selected

PWS wells. The results of this investigation confirmed that 1,4-dioxane is present at four plumes (Ashumet Valley, CS-10, CS-20 and LF-1) at JBCC and additional sampling at these four plumes at concentrations exceeding the MCP GW-1 standard of 0.3 µg/L and additional investigation was recommended (AFCEC 2014a). The results at CS-21 indicate there is no 1,4-dioxane at CS-21.

5.6.5 Five Year Review Process

5.6.5.1 Data Review

The JBCC SPEIM program was developed to monitor plume changes and to ensure the effective operation of the AFCEC groundwater remediation systems at the JBCC. These objectives are met through monitoring of selected media (i.e., groundwater, surface water) within and outside the plume boundaries, treatment plant monitoring, and groundwater flow and transport modeling. The data collected under the SPEIM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being addressed through active treatment. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program. The SLRs also include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual reporting period as attachments or by reference. The SLRs are provided to the broad stakeholder group for each plume including Federal (EPA) and State (MassDEP, MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties.

The SLRs are publically available in the IRP Administrative Record and copies are maintained at the local town libraries.

In addition to the annual SLRs prepared for the Southwest Plumes (including CS-21) during this Five Year Review period (AFCEC 2018, 2017c, 2016b, 2015b, 2014c, 2013c), the following technical deliverables were prepared that assessed system performance or presented the results of optimization evaluations:

- *Chemical Spill-21 Remedial System Optimization Evaluation Project Note (AFCEE 2012b)*
- *Southwest Plumes 2012 Triennial SPEIM Data Presentation Project Note (AFCEC 2012)*
- *Southwest Plumes 2013 Annual SPEIM Data Presentation Project Note. (AFCEC 2013a)*
- *Southwest Plumes 2014 Annual SPEIM Data Presentation Project Note (AFCEC 2014b)*
- *Southwest Plumes 2015 Triennial SPEIM Data Presentation Project Note (AFCEC 2015a)*
- *Southwest Plumes 2016 Annual SPEIM Data Presentation Project Note (AFCEC 2016a)*
- *Southwest Plumes 2017 Annual SPEIM Data Presentation Project Note (AFCEC 2017b)*

5.6.5.2 Site Inspections

Refer to Section 3.6.

5.6.5.3 Interviews

Refer to Section 3.7.

5.6.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.6.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, the completion of the ROD in 2000, construction and startup of the remedial system in 2006, continued operation of the remedial system, and completion of the well verification/well determination portion of the LUCs have resulted in the remedy at CS-21 functioning as intended by the decision documents. The remedial system is performing as expected. CS-21 extraction well 82EW0004 was shut down on 23 June 2010 and extraction well 82EW0003 was shut down on 07 December 2016. Using the most recent CS-21 TCE plume shell and assuming the system will operate continuously under 2012 Scenario 01 flow rates, the most recent transport model simulations predicted that all of the CS-21 extraction wells can be turned off by approximately 2024. The modeling indicated that TCE concentrations in the CS-21 plume are expected to decline below the MCL by approximately 2026. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD (i.e., by 2025). Operational costs are appropriate for the remedy and a robust optimization program continues with the objective of reducing remedial system operational timeframes, the time to reach remedial goals (e.g., MCLs), and reducing future costs. Monitoring and evaluation activities are continual and well-documented.

5.6.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics: There has been no change in the toxicity factors that were in place at the time of the last Five Year Review (i.e., 2011) for the CS-21 groundwater COC, TCE.

Changes in Risk Assessment Methods: There have been no changes in risk assessment methodology that affect protectiveness.

Review of RAOs: The RAOs developed for the final ROD (AFCEE 2000) and revised in the 2011 ESD (AFCEE 2011) are appropriate and remain valid.

5.6.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information at this time that calls into question the protectiveness of the remedy.

5.6.7 Issues, Recommendations, and Follow-Up Actions

No specific recommendation or follow-up actions have been identified.

5.6.8 Protectiveness Determination

The remedy for the CS-21 groundwater plume is protective of human health and the environment. The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.

5.6.9 References

AFCEC. 2018 (April). *Southwest Plumes 2017 Summary Letter Report*. 652000-SPEIM-SWP-SLR-004. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

_____. 2017a (November). *2017 Operations and Maintenance Plan for Groundwater Extraction and Treatment Systems and Wind Turbine*. 652000-O&M-MULTIPLE-OMPLN-003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

_____. 2017b (August). *Southwest Plumes 2017 Annual SPEIM Data Presentation*

Project Note. 652000-SPEIM-SWP-PRJNOT-003. Prepared by EA Engineering and CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

- _____. 2017c (March). *Southwest Plumes 2016 Summary Letter Report.* 652000-SPEIM-SWP-SLR-003. Prepared by CH2M for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016a (December). *Southwest Plumes 2016 Annual SPEIM Data Presentation Project Note.* 652000-SPEIM-SWP-PRJNOT-002. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016b (March). *Southwest Plumes 2015 Summary Letter Report.* 652000-SPEIM-SWPSLR- 003. Prepared by Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015a (September). *Southwest Plumes 2015 Triennial SPEIM Data Presentation Project Note.* 652000-SPEIM-SWP-PRJNOT-001. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015b (May). *Southwest Plumes 2014 Summary Letter Report.* 652000-SPEIM-SWP-SLR-001. Prepared by CH2M for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014a (August). *1,4-Dioxane Monitoring Well Sample Results Data Presentation Project Note.* 473147-SPEIM-MULTIPLE-PRJNOT-007. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014b (July). *Southwest Plumes 2014 Annual SPEIM Data Presentation Project Note.* 473147-SPEIM-SWP-PRJNOT-003. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014c (March). *Southwest Plumes 2013 Summary Letter Report.* 473147-SPEIM-SWP-SLR-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013a (November). *Southwest Plumes 2013 Annual SPEIM Data Presentation Project Note.* 473147-SPEIM-SWP-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013b (October) *Final 4th Five-Year Review, 2012-2017 Massachusetts Military Reservation (JBCC) Superfund Site, Otis Air National Guard Base, MA* 473147-SPEIM-Multiple-RPT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

- _____. 2013c (March). *Southwest Plumes 2012 Summary Letter Report*. 437075-SPEIM-SWP-SLR-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012 (December). *Southwest Plumes 2012 Triennial SPEIM Data Presentation Project Note*. 437075-SPEIM-SWP-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- AFCEE. 2012a (August). *Final 2011 JBCC Vapor Intrusion Evaluation Technical Memorandum*. 420005-SPEIM-MULTIPLE-TECHMEM-002. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012b (June). Project Note: *Chemical Spill-21 Remedial System Optimization Evaluation*. 420005-SPEIM-SWP-PRJNOT-003. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012c (February). *Fuel Spill-28 and Southwest Plumes 2011 Private Well Verification and Well Determination Project Note*. 420005-SPEIM-LUC-MULTIPLE-PRJNOT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2011 (September). *Final Explanation of Significant Differences for the Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation*. 404929-SPEIM-MULTIPLE-RPT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2008a (September). *Final Explanation of Significant Differences for Chemical Spill-4, Chemical Spill-20, Chemical Spill-21, Fuel Spill-13, Fuel Spill-28, and Fuel Spill-29 Groundwater Plumes*. A4P-J23-35BC24VC-M26-0006. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2008b (September). *Final Interim Remedial Action Report for CS-4, CS-20, CS-21, and FS-29 (Southwest Plumes), and CS-23/LF-1 Groundwater Plumes*. Prepared by ECC for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2004 (August). *Final Chemical Spill-4, Chemical Spill-20, Chemical Spill-21 and Fuel Spill-29 Wellfield Design Report*. A3P-J23-35Z00102-M23-0004. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

- _____. 2000 (February). *Final Record of Decision for the CS-4, CS-20, CS-21 and FS-13 Plumes*. AFC-J23-35Q86101-M26-0004. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 1999a (June). *Proposed Plan for the Southwest Operable Unit (CS-4, CS-20, CS-21 and FS-13 plumes only)*. AFC-J23-35Q86101-M25-0004. Prepared by Jacobs Engineering Group Inc., for the AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 1999b (June). *Final Southwest Operable Unit Feasibility Study*. AFC-J23-35Q86101-M16-0006. Prepared by Jacobs Engineering Group Inc., for the AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 1999c (May). *Final Southwest Operable Unit Remedial Investigation*. AFC-J23-35Q86101-M14-0006. Prepared by Jacobs Engineering Group Inc., for the AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- EPA. 2001 (June). *Comprehensive Five-Year Review Guidance*, EPA 540R-01-007.

5.7 CHEMICAL SPILL-23 (CS-23) GROUNDWATER

The CS-23 plume is a dissolved-phase groundwater plume that is defined as the extent of groundwater containing TCE and carbon tetrachloride (CCl₄) at concentrations exceeding their respective MCL of 5 µg/L.

5.7.1 Site Chronology

2002: The CS-23 plume was discovered during the Southwest Plumes pre-design investigation (AFCEE 2003).

2003-2004: Completion of the RI (AFCEE 2005).

2006: The FS was completed (AFCEE 2006c) and the proposed plan was released to the public (AFCEE 2006b). The wellfield design (AFCEE 2006a) was completed which consisted of two extraction wells and two infiltration trenches that began operation in December 2006 (AFCEE 2008a).

2007: ROD finalized (AFCEE 2007).

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and added text regarding the JBCC three-step process to achieve site closure (AFCEE 2011b).

2017: Based on results from the 2016 annual SPEIM event and the 2014 LF-1/CS-23 remedial system optimization evaluation (AFCEC 2014e), a proposal to shut down CS-23 extraction well 27EW0008 was presented at the 07 December 2016 Technical Update Meeting. The regulatory agencies approved that recommendation on 19 January 2017. The lack of TCE detections exceeding the MCL of 5 µg/L in monitoring wells upgradient of 27EW0008, decreasing influent concentrations, and the predicted fate of upgradient contamination supported the shutdown of this extraction well (AFCEC 2017b).

5.7.2 Background

5.7.2.1 History of Contamination

The CS-23 plume is detached from its source area which remains unidentified. It is speculated that contamination was released at the ground surface from a spill or release on the JBCC, migrated through the vadose zone, and entered groundwater at the water table. The dissolved phase contamination was then carried downgradient in groundwater in a southwesterly direction.

5.7.2.2 Physical Characteristics, Land and Resource Use

Based on the most recent groundwater monitoring data collected in 2017, the CS-23 plume is approximately 1,000 ft long, has a maximum width of approximately 500 ft, and is up to 60 ft thick in the aquifer (Figure 5-7A). The footprint of the CS-23 plume was approximately 175 acres in 2012, and was approximately 40 acres in 2017 (Figure 5-7B).

The area above the on-base portions of the CS-23 plume consists primarily of a housing area operated by the USCG and four schools controlled by the Town of Bourne (one of which is actively used). The land above the relatively small portion of the CS-23 plume that is off-base is undeveloped woodlands used for recreational purposes (hiking, biking, hunting, etc.), and is managed by the MDFW (Figure 5-7A).

The eastern portion of the CS-23 plume is located within a broad, flat, gently sloping glacial outwash plain. The western portion of the plume travels into a hummocky north-south trending ridge of moraine glacial deposits. Within the footprint of the plume, the maximum and minimum ground surface elevations are 206 ft msl and 52 ft msl, respectively.

5.7.2.3 Initial Responses

A summary of the initial responses is as follows:

Non-CERCLA Actions:

None.

CERCLA Actions:

CS-23 Groundwater Plume: Following the 2005 CS-23 RI (AFCEE 2005), a FS was completed in 2006 (AFCEE 2006c). AFCEE began designing a remedial system to prevent further off-base migration of the CS-23 plume concurrently with the FS. A proposed plan was released to the public in June 2006 (AFCEE 2006b) to solicit comments on the preferred alternative (Alternative 3). The selected remedy for CS-23 as specified in the ROD was Alternative 3; continued operation and optimization of the existing remedial system, performance monitoring of the CS-23 plume and remedial system, and LUCs (AFCEE 2007).

The final design for the CS-23 remedial system consisted of two extraction wells (27EW0007 and 27EW0008), which were installed concurrently with a new LF-1 extraction well (27EW0006) (AFCEE 2006a). The extracted groundwater from the extraction wells in the southern portion of LF-1 (27EW0002 and 27EW0006) is combined with the extracted groundwater from 27EW0007 and 27EW0008, treated at the HATF by GAC, and is then returned to the aquifer through two infiltration trenches. The HATF was constructed as part of the remedial action for the CS-4, CS-20, CS-21, and FS-29 plumes (AFCEE 2008a). The CS-23 remedial system began operation on 05 December 2006 with two extraction wells (27EW0007 and 27EW0008) at a design extraction rate of 700 gpm. Further details regarding the LF-1/CS-23 HATF remedial system can be found in the 2017 O&M Plan (AFCEC 2017a).

An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and updated the steps to achieve site closure (i.e., the three-step process) (AFCEE 2011b).

5.7.2.4 Basis for Taking Action

The baseline cancer risk calculations in the CS-23 RI indicated that unless remedial action is undertaken, future residential exposure to the CS-23 COCs in groundwater may present

an excess lifetime cancer risk greater than the acceptable EPA range of 1×10^{-4} to 1×10^{-6} (AFCEE 2005). Ecological risks associated with the CS-23 groundwater plume were not evaluated because the CS-23 plume is not discharging to any surface water bodies (AFCEE 2007). It is noted that ecological monitoring is conducted to assess hydraulic effects to a nearby wetland and vernal pool due to the operation of the expanded remedial system (refer to Sections 5.7.4 and 5.7.5).

5.7.3 Remedial Actions

The final remedy for the CS-23 plume was determined in the *Final Record of Decision for the CS-23 Groundwater* (AFCEE 2007) which was signed on 28 September 2007.

The RAOs for the CS-23 groundwater plume as presented in the ROD (AFCEE 2007) and modified in the ESD (AFCEE 2011b) are as follows:

- Prevent residential exposure to CS-23 groundwater with TCE concentrations greater than the MCL of 5 µg/L.
- Prevent residential exposure to CS-23 groundwater with CCl₄ concentrations greater than the MCL of 5 µg/L.
- Restore useable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.
- Prevent exposure to CS-23 groundwater for human receptors under non-residential use scenarios (including dermal contact, ingestion, and inhalation), unless shown that such use does not present a carcinogenic risk in excess of the EPA target risk range of 10^{-4} to 10^{-6} or present a non-carcinogenic hazard index greater than 1.0.

5.7.3.1 Remedy Selection and Implementation

The selected remedy for CS-23 groundwater in the ROD (AFCEE 2007) included the following components:

- Continued operation and optimization of the existing CS-23 ETI system (two extraction wells and two infiltration trenches) and treatment via GAC.
- Implementation of LUCs for the CS-23 groundwater selected remedy with the performance objectives of:
 - Prevent access to or use of the groundwater from the CS-23 plume 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.
- Chemical and hydraulic monitoring of the plume, as long as active remediation continues, and chemical monitoring of the plume until the RAOs are met.
- Completion of CERCLA reviews every five years throughout the lifetime of the remedial action.

Since the groundwater remedy was selected in 2007, the following changes have occurred: the 2011 ESD for the IRP groundwater plumes (AFCEE 2011b) clarified the inclusion of MNA as a component of the selected remedy for CS-23, slightly modified the phrasing of the RAOs, and added text regarding the JBCC three-step process to achieve site closure.

The selected remedy presented in the ROD consisted of two CS-23 extraction wells which began operation on 05 December 2006.

Remedial system performance monitoring data and long-term plume monitoring data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives and system performance metrics are being met; (ii) whether remediation is progressing as expected; and (iii) to identify and assess optimization opportunities. The data collected under the SPEIM/LTM program are presented to the regulatory agencies through the Technical Update Meeting process and documented in annual SLRs.

The close proximity of the LF-1 and CS-23 plumes and remedial systems warrant that the LF-1 and CS-23 SPEIM programs be combined. Therefore, data collection, data assessment, groundwater modeling, and reporting are performed jointly under a combined LF-1/CS-23 SPEIM program.

As part of the LUC process specified in the ROD (AFCEE 2007), a private well verification survey was completed for the LF-1 and CS-23 plumes between November 2008 and August 2010. There were no private wells identified on properties within the CS-23 LUC area (AFCEE 2011c). A re-evaluation of the extent of the CS-23 plume and LUC area was completed based on the increase in TCE concentration at monitoring well 69MW1710A which is located hydraulically downgradient of the CS-23 remedial system extraction

wells. Based on the detection, the LF-1/CS-23 plume boundaries were revised in 2014. The LF-1 plume boundary changes were minor and did not result in a change in the LF-1 LUC boundary. The CS-23 LUC boundary was expanded as the result of a new plume boundary depiction in 2014 to include 180 new parcels, primarily located to the west of Route 28 (AFCEC 2014g). AFCEC completed outreach to 167 of those properties and identified nine private residential wells which are reportedly non-operational. All parcels with homes where outreach was completed have Town of Falmouth municipal water accounts. The remaining 13 properties are considered to be non-responsive after eight notification attempts at each location via mail and field visits. In the event that new private well information is obtained or plume monitoring data indicate a change to the CSM at CS-23, AFCEC will perform the necessary well determinations at the time the information becomes available. Annual mailings were distributed during this five year review period and reported in the SLRs (AFCEC 2018, 2017b, 2016, 2015a, 2014f, 2013b) and annual LUC reports.

5.7.3.2 Remedy Operation & Maintenance

The CS-23 remedial system is operated and maintained under an approved O&M Plan (AFCEC 2017a). The O&M Plan is updated on an annual basis and includes operational requirements, a summary of the operational history of the systems, and details of any system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and will continue to be, addressed in a timely and effective manner such that O&M associated with the remedy is considered effective at achieving the remedy goals. Operational issues are identified in O&M monthly reports and system performance and reliability is reported in the annual SLRs.

The annual SPEIM/LTM/O&M costs associated with ongoing remedial actions at CS-23 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives) and do not indicate potential remedy problems.

5.7.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior fourth CERCLA Five Year Review (AFCEC 2013a). For the CS-23 groundwater plume, the recommendations and follow-up actions were:

- 1) An optimization assessment of the LF-1/CS-23 remedial system should be performed with an updated plume shell to evaluate the performance of the remedial system and assess/update the model-predicted restoration timeframe versus that presented in the ROD.
- 2) AFCEC should continue to monitor the wetland and vernal pool near LF-1/CS-23 for potential ecological impacts associated with the surface water drawdown.
- 3) A re-evaluation of the extent of the CS-23 plume and LUC area should be completed based on the increase in TCE concentration at monitoring well 69MW1710A which is located hydraulically downgradient of the CS-23 remedial system extraction wells.
- 4) In addition, the topic of emerging contaminants should be monitored as it relates to groundwater at the JBCC. Specifically for CS-23 groundwater, a sampling and analysis plan shall be submitted to the regulatory agencies to assess the possible presence of 1,4-dioxane.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

- 1) A modeling-based optimization evaluation was completed for the LF-1/CS-23 remedial system in 2013, resulting in a new operational condition referred to as 2014 Scenario 01, and was implemented on 02 April 2014 (AFCEC 2014e). A hydraulic evaluation was completed in 2014 to determine the extent of hydraulic capture of the LF-1/CS-23 remedial system under 2014 Scenario 01 flow rates, and

to evaluate the ability of LF-1/CS-23 groundwater model to accurately simulate hydraulic capture and predict plume migration and capture (AFCEC 2015c). Assuming the system will operate continuously at 2014 Scenario 01 pumping flow rates, groundwater transport modeling results from the LF-1/CS-23 2013 Remedial System Optimization Evaluation Data Presentation Project Note (AFCEC 2014e) are as follows:

- all LF-1 extraction wells can be shut down by approximately 2043;
- all CS-23 extraction wells can be shut down by approximately 2023;
- TCE MCL exceedances are predicted to remain in the LF-1 southern plume lobe area upgradient of the LF-1 remedial system until approximately 2045;
- TCE MCL exceedances are predicted to remain in the area upgradient of the CS-23 remedial system until approximately 2034;
- PCE concentrations downgradient (i.e., west) of the base boundary in the LF-1 southern lobe decrease to below the MCL by approximately 2015; and
- TCE concentrations downgradient (i.e., west) of the base boundary in the LF-1 northern lobe decrease to below the MCL by approximately 2029; and
- TCE concentrations downgradient (i.e., west) of the base boundary in the CS-23 plume decrease below the MCL by approximately 2021.

2) Hydraulic monitoring data were collected through 2014 for an ecological evaluation of LF-1 and CS-23 wetlands and surface water bodies. A review of the data collected between 2006 and 2014 indicated that the critical period, where potential adverse impacts to the ecosystem may have occurred as a result of hydraulic drawdown from operation of the remedial system, has passed due to decreasing remedial system flow rates. Therefore, the ecological and hydrological data evaluation for Spectacle Wetland and Vernal Pool No. 651 was discontinued, with Regulatory Agency concurrence (AFCEC 2014b).

3) The CS-23 LUC boundary was expanded as the result of a new plume boundary depiction in 2014 to include 180 new parcels, primarily located to the west of Route 28 (AFCEC 2014g). AFCEC completed outreach to 167 of those properties and

identified nine private residential wells which are reportedly non-operational. All parcels with homes where outreach was completed have Town of Falmouth municipal water accounts. The remaining 13 properties are considered to be non-responsive after eight notification attempts at each location via mail and field visits.

- 4) A presence/absence (CERCLA SI equivalent) 1,4-dioxane field investigation was completed between October 2013 and June 2014 at seven IRP chlorinated solvent plumes (Ashumet Valley, CS-4, CS-10, CS-20, CS-21, CS-23, and LF-1) in response to the recommendation in the last five-year review. Sampling for 1,4-dioxane was completed at the treatment plant influent and effluent ports, operating extraction wells, selected monitoring wells, selected private wells, and selected PWS wells. The results of this investigation confirmed that 1,4-dioxane is present at four plumes (Ashumet Valley, CS-10, CS-20 and LF-1) at concentrations exceeding the MCP GW-1 standard of 0.3 µg/L and additional investigation was recommended (AFCEC 2014c). The results at CS-23 indicated there was no 1,4-dioxane found at CS-23.

5.7.5 Five Year Review Process

5.7.5.1 Data Review

The JBCC SPEIM program was developed to monitor plume changes and to ensure the effective operation of the AFCEC groundwater remediation systems at the JBCC. These objectives are met through monitoring of selected media (i.e., groundwater, surface water) within and outside the plume boundaries, treatment plant monitoring, and groundwater flow and transport modeling. The data collected under the SPEIM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being

addressed through active treatment. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program. The SLRs also include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual reporting period as attachments or by reference. The SLRs are provided to the broad stakeholder group for each plume including Federal (EPA) and State (MassDEP, MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties. The SLRs are publically available in the IRP Administrative Record and copies are maintained at the local town libraries.

In addition to the annual SLRs prepared for CS-23 during this Five Year Review period (AFCEC 2018, 2017b, 2016, 2015a, 2014f, 2013b), the following technical deliverables were prepared that assessed system performance, the potential hydrologic and ecological impacts of system operation, and presented the results of optimization evaluations:

- *LF-1/CS-23 2012 Wetland and Surface Water Ecological Evaluation Project Note* (AFCEE 2012b)
- *LF-1/CS-23 2012 Annual SPEIM Data Presentation Project Note* (AFCEC 2013c)
- *LF-1/CS-23 2013 Remedial System Optimization Evaluation Data Presentation Project Note* (AFCEC 2014e)
- *LF-1/CS-23 2014 Wetland and Surface Water Ecological Evaluation Project Note* (AFCEC 2014b)
- *LF-1/CS-23 2014 Triennial SPEIM Data Presentation Project Note* (AFCEC 2014d)
- *LF-1/CS-23 2015 Annual SPEIM Data Presentation Project Note* (AFCEC 2014a)
- *LF-1/CS-23 2014 Remedial System Hydraulic Evaluation Data Presentation Project Note* (AFCEC 2015c)
- *LF-1/CS-23 2016 Annual SPEIM Data Presentation Project Note* (AFCEC 2017c)

5.7.5.2 Site Inspections

Refer to Section 3.6.

5.7.5.3 Interviews

Refer to Section 3.7.

5.7.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.7.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, the completion of the ROD in 2007, construction and startup of the remedial system in 2006, continued operation of the remedial system, and completion of the well verification/well determination portion of the LUCs have resulted in the remedy at CS-23 functioning as intended by the decision documents. The remedial system is performing as expected. Monitoring well data show that concentrations in all the monitoring wells have decreased below MCLs and as of 2018 a plume is no longer delineated. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD (i.e., by 2048). Operational costs are appropriate for the remedy and a robust optimization program continues with the objective of reducing remedial system operational timeframes, the time to reach remedial goals (e.g., MCLs), and reducing future costs. Monitoring and evaluation activities are continual and well-documented.

5.7.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics: There have not been any changes in the toxicity factors that were in place at the time of the last Five Year Review (i.e., 2012) for the CS-23 groundwater COCs TCE and CCl₄.

Changes in Risk Assessment Methods: There have been no changes in risk assessment methodology that affect protectiveness.

Review of RAOs: The RAOs developed for the final ROD (AFCEE 2007) and revised in the 2011 ESD (AFCEE 2011b) are appropriate and remain valid.

5.7.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information at this time that calls into question the protectiveness of the remedy.

5.7.7 Issues, Recommendations, and Follow-Up Actions

No specific recommendation or follow-up actions have been identified. However, now that COC concentrations are below standards, the Three-Step Process should be initiated for the CS-23 plume.

5.7.8 Protectiveness Determination

The remedy for the CS-23 groundwater plume is protective of human health and the environment. The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.

5.7.9 References

AFCEC. 2018 (April). *LF-1/CS-23 2017 Summary Letter Report*. 652000-SPEIM-LF1/CS23-SLR-004. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

- _____. 2017a (November). *2017 Operations and Maintenance Plan for Groundwater Extraction and Treatment Systems and Wind Turbine*. 652000-O&M-MULTIPLE-OMPLN-003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2017b (March). *LF-1/CS-23 2016 Summary Letter Report*. 652000-SPEIM-LF1/CS23-SLR-003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2017c (January). *LF-1/CS-23 2016 Annual SPEIM Data Presentation Project Note*. 652000-SPEIM-LF1/CS23-PRJNOT-002. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2016 (March). *LF-1/CS-23 2015 Summary Letter Report*. 652000-SPEIM-LF1/CS23-SLR-002. Prepared by EA Engineering, Science and Technology and CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2015a (July). *LF-1/CS-23 2015 Annual SPEIM Data Presentation Project Note*. 652000-SPEIM-LF1/CS23-PRJNOT-001. Prepared by EA Engineering, Science and Technology and CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2015b (March). *Southwest Plumes 2014 Summary Letter Report*. 652000-SPEIM-SWP-SLR-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2015c (January). *LF-1/CS-23 2014 Remedial System Hydraulic Evaluation Data Presentation Project Note*. 473147-SPEIM-LF-1/CS-23-PRJNOT-004. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2014a (October). *LF-1/CS-23 2015 Triennial SPEIM Data Presentation Project Note*. 473147-SPEIM-LF1/CS23-PRJNOT-003. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2014b (September). *LF-1/CS-23 2014 Wetland and Surface Water Ecological Evaluation Project Note*. 473147-SPEIM-LF-1/CS-23-PRJNOT-002. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2014c (August). *1,4-Dioxane Monitoring Well Sample Results Data Presentation Project Note*. 473147-SPEIM-MULTIPLE-PRJNOT-007. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
-

- _____. 2014d (July). *LF-1/CS-23 2014 Triennial SPEIM Data Presentation Project Note*. 473147-SPEIM-LF1/CS23-PRJNOT-001. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014e (April). *LF-1/CS-23 2013 Remedial System Optimization Evaluation Data Presentation Project Note*. 473147-SPEIM-LF1/CS23-PRJNOT-001. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014f (March). *LF-1/CS-23 2013 Summary Letter Report*. 473147-SPEIM-LF1/CS23-SLR- 001. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014g (February). *1,4-Dioxane Extraction Well, LUC, and PWS Sample Results and Monitoring Well Sampling Plan Data Presentation Project Note*. 473147-SPEIM-MULTIPLE-PRJNOT- 004. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013a (October) *Final 4th Five-Year Review, 2012-2017 Massachusetts Military Reservation (JBCC) Superfund Site, Otis Air National Guard Base, MA* 473147-SPEIM-Multiple-RPT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013b (March). *LF-1/CS-23 2012 Summary Letter Report*. 437075-SPEIM-LF1/CS23-SLR-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013c (January). *LF-1/CS-23 2012 Annual SPEIM Data Presentation Project Note*. 437075-SPEIM-LF1/CS23-PRJNOT-002. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- AFCEE. 2012a (August). *Final 2011 JBCC Vapor Intrusion Evaluation Technical Memorandum*. 420005-SPEIM-MULTIPLE-TECHMEM-002. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012b (July). *LF-1/CS-23 2012 Wetland and Surface Water Ecological Evaluation Project Note*. 420005-SPEIM-LF1/CS23-PRJNOT-006. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

- _____. 2011a (October). *LF-1/CS-23 2011 Wetland and Surface Water Ecological Evaluation Project Note*. 420005-SPEIM-LF1/CS23-PRJNOT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2011b (September). *Final Explanation of Significant Differences for the Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation*. 404929-SPEIM-MULTIPLE-RPT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2011c (March). *LF-1/CS-23 2010 Private Well Verification and Well Determination Project Note*. 404929-LUC-MULTIPLE-PRJNOT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2008a (September). *Final Interim Remedial Action Report for CS-4, CS-20, CS-21, and FS-29 (Southwest Plumes), and CS-23/LF-1 Groundwater Plumes*. Prepared by ECC for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2008b (May). *Verification, Decommissioning, and Documentation Guidelines for Private Wells in Areas of Potential Concern*. Prepared by Air Force Center for Engineering and the Environment Massachusetts Military Reservation Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2007 (October). *Final Record of Decision for Chemical Spill-23 Groundwater*. A4P-J23-35BC02VA-M26-0008. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2006a (August). *Final Chemical Spill-23 Wellfield Design Report*. A4P-J23-35BC06VB-M23-0003. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2006b (June). *Proposed Plan for Landfill-1 (LF-1) Source Area and Groundwater and Chemical Spill 23 (CS-23) Groundwater: Fact Sheet 2006-01*. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2006c (January). *Final Chemical Spill-23 Plume Feasibility Study*. A4P-J23-35BC06VB-M16-0005. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

- _____. 2005 (March). *Final Chemical Spill-23 Remedial Investigation*. A4P-J23-35BC06VB-M14-0004. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2003 (July). *Final Chemical Spill-4, Chemical Spill-20, Chemical Spill-21, and Fuel Spill-29 Pre-Design Investigation Report*. A3P-J23-35Z00102-M17-0007. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- EPA. 2013 (March). Integrated Risk Information System (IRIS) database. [online]. Available: <http://www.epa.gov/iris/index.html>.
- _____. 2001 (June). *Comprehensive Five-Year Review Guidance*, EPA 540R-01-007.

5.8 FUEL SPILL-1 (FS-1) GROUNDWATER

The FS-1 site was originally comprised of two areas of impacted groundwater: the source area groundwater, which is located on-base, and a detached groundwater plume which is located primarily off-base (Figure 5-8A). The detached plume is defined as the extent of groundwater contaminated with the FS-1 COC, EDB, at concentrations exceeding the MMCL of 0.02 µg/L. The COCs for the source area groundwater are lead, thallium, and toluene (AFCEE 2000). The cleanup standards for the source area COCs are as follows: the EPA Treatment Technique of 15 µg/L for lead in drinking water in distribution systems; the MCL of 2 µg/L for thallium; and the MCL of 1,000 µg/L for toluene. Monitoring for toluene and thallium was discontinued in 2005 because toluene had not been detected at concentrations above the MCL of 1,000 µg/L since 1999 and thallium was not detected at source area groundwater monitoring wells during 12 sampling events completed between 2002 and 2005 (AFCEC 2017c). Monitoring for lead was discontinued in 2016 because the total lead concentrations at source area groundwater monitoring wells was consistently below the cleanup standard of 15 µg/L (AFCEC 2016a).

5.8.1 Site Chronology

1989: Fuel-related compounds, consisting of benzene, toluene, ethylbenzene, and xylene (BTEX) were first reported in groundwater during an SI (AFCEE 2000).

1990: An RI was completed in 1990 to delineate the extent of fuel related compounds in groundwater at, and downgradient of, the source area. At that time no BTEX compounds were detected at wells located downgradient of the source area and it was hypothesized that BTEX compounds, which may have been present in the groundwater downgradient of the source area in the past, had degraded (AFCEE 1999b).

1993: The FS-1 source area monitoring wells were sampled for EDB analysis as part of a base-wide EDB study and no EDB was detected (AFCEE 2000).

1995: Groundwater vertical profiling for BTEX was completed at 20 locations downgradient of the source area and no BTEX compounds were detected (AFCEE 2000).

1997-1998: Additional RI activities were completed along a flow path that had not previously been investigated (AFCEE 1999b), which resulted in the delineation of a dissolved-phase EDB plume that was attributed to past releases at the FS-1 source area.

1999: A FS and proposed plan were completed (AFCEE 1999c, AFCEE 1999a). A pilot study ETD remediation system was installed at the leading edge of the plume to treat groundwater.

2000: The ROD was completed (AFCEE 2000). The final remedy called for continued operation of the pilot study ETD system with the addition of more axial extraction wells.

2003: A final remedy was in place at FS-1 with construction and startup of the final ETD system on 30 September 2003 based on a post-ROD wellfield design (AFCEE 2001).

2007: 36EW0007 was shut down on 01 October 2007.

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy, added institutional controls, slightly modified the phrasing of the RAOs, and added text regarding the JBCC three-step process to achieve site closure (AFCEE 2011b).

2012-2014: The following FS-1 extraction wells have been turned off as a result of remedial system optimization evaluations (shutdown date in parentheses): 36EW0001 (18 May 2012), and 36EW0005 (27 February 2014). (AFCEC 2018b).

2015-2017: Due to the discovery of emerging contaminants a PA was performed (AFCEC 2015b) that included evaluation of the area near the FS-1 source area due to its proximity to the flightline. A Focused SI was completed by AFCEC to determine if the emerging contaminants, PFAS, are present in groundwater at flightline areas of the JBCC (AFCEC 2017b). As part of the SI, FS-1 source area wells 36MW0002 and 36MW0007 were sampled for PFAS analysis. The sum of PFOA and PFOS in groundwater at 36MW0007

was greater than the EPA HA of 0.07 µg/L, therefore the FS-1 source area was recommended for an RI; however, an expanded SI is being conducted prior to the RI to determine if PFAS contamination is migrating off base and impacting drinking water supplies (AFCEC 2018b) .

5.8.2 Background

5.8.2.1 History of Contamination

The source of the FS-1 groundwater plume was surficial releases of AVGAS at the Eastern and Western Aircraft Turnaround Areas within the flight line (Figure 5-8A). The site was used from 1955 to 1970 to test fuel dump valves on EC-121 Super Constellation aircraft. As part of the tests, fuel was released directly onto the ground. The exact quantity of fuels released onto the ground is unknown. Both the Eastern Aircraft Turnaround and Western Aircraft Turnaround Areas were investigated during the course of the SI (ASI 1995) and RI (AFCEE 1999b). No contaminants were present in the surface or subsurface soils at the FS-1 source area at concentrations that exceeded regulatory standards. However, fuel-related compounds such as BTEX and various metals were detected in groundwater on-base within 1,000 ft of the Aircraft Turnaround Areas. Only lead, thallium, and toluene were detected at concentrations above their respective standards. No EDB has ever been detected in the source area groundwater (AFCEE 2000).

The FS-1 ROD, signed in April 2000, stated that no further action was needed for source area soil contamination (AFCEE 2000). However, an LTM program for lead, thallium, and toluene in source area groundwater was established to confirm that these compounds would not migrate beyond the general vicinity of the FS-1 source area (i.e., area within 1,000 ft of the Eastern and Western Aircraft Turnaround Areas).

Groundwater monitoring data indicate that the FS-1 groundwater plume has fully detached from its source area and there is no evidence that there is a continuing source of contamination to the groundwater plume.

5.8.2.2 Physical Characteristics, Land and Resource Use

Based on the most recent groundwater monitoring data collected, the main body of the FS-1 EDB plume is approximately 300 ft long, up to 150 ft wide, and is approximately 70 ft thick in the aquifer (Figure 5-8A). The footprint of the FS-1 plume was approximately 32 acres in 2012 and was approximately one acre in 2017 (Figure 5-8B).

Land above the FS-1 source area on the JBCC is comprised of paved areas of the flight line that are bordered by sparsely vegetated land surface. Land above the FS-1 EDB plume is comprised of undeveloped forested land with wetland bogs (Quashnet bogs) at the most southern, downgradient extent of the plume. Land above the FS-1 plume is primarily owned by the Town of Mashpee Conservation Commission or the Orenda Wildlife Land Trust and it is anticipated that the land use in the FS-1 area will not significantly change over time. The Quashnet bog area is fed primarily by groundwater discharge and also by surface water from Johns Pond and serves as the headwaters for the Quashnet River, which originates in the bogs and flows south to Waquoit Bay. The Quashnet bogs were formerly cultivated as commercial cranberry bogs; however, the last cranberry crop was harvested at these bogs in 2006. In 2010, the Town of Mashpee officially decided to no longer cultivate cranberries from these bogs (AFCEE 2011a) and is exploring the possibility of returning the area to the original river/wetland ecosystem..

The topography of the land above the FS-1 plume can be characterized as a broad, flat, gently sloping glacial outwash plain that is pockmarked with glacial kettle holes such as the Quashnet Bog area or nearby Johns and Moody Ponds. Within the footprint of the plume, the maximum and minimum ground surface elevations are 105 ft msl and 30 ft msl, respectively.

5.8.2.3 Initial Responses

The summary of the initial responses is as follows:

Non-CERCLA Actions:

At the time of plume delineation and system startup in 1999, the Quashnet bogs were cultivated for a commercial cranberry crop. Detections of EDB in the Quashnet Bog surface water as a result of the plume discharge led to the cranberry farmers being compensated for lost crops by the DoD. In 2010, the property owner (Town of Mashpee) decided to no longer lease the bogs for cranberry cultivation and is returning the area to a natural state for natural resource habitat purposes.

CERCLA Actions:

Source Area Groundwater: The selected remedy for lead, thallium, and toluene in source area groundwater was LTM (AFCEE 2000).

EDB Groundwater Plume: In April 1999, a pilot study ETD remediation system was installed as an interim remedy in the area of groundwater upwelling at the Quashnet River bogs (AFCEE 1999a). The pilot study ETD system was designed to treat 750 gpm and consisted of the following components:

- Extraction of deep groundwater from one extraction well (36EW0005)
- Extraction of shallow groundwater from 175 shallow wellpoints (SWPs) along the Quashnet Bog boundary
- Treatment of extracted groundwater with GAC
- Reintroduction of treated water to the aquifer via an infiltration trench
- Discharge of treated water to surface water using vertical riser pipes (i.e., outflow bubblers)
- Construction and maintenance of earthen berms to isolate areas of potentially contaminated upwelling groundwater from other areas of the Quashnet bog system

The FS-1 ETD pilot system operated between 05 April 1999 and 13 October 2002 when a fire destroyed the treatment plant. A design concept for the selected remedy (axial and leading edge extraction) was presented in the final ROD (AFCEE 2000), with the final ETD system modified as described in the Final Wellfield Design Report (AFCEE 2001). The final ETD system (Figure 5-8A) was designed to treat 750 gpm and includes:

- Four deep extraction wells (36EW0001, 36EW0005, 36EW0007, and 36EW0011)
- Treatment of extracted groundwater with GAC
- Discharge of treated water to surface water through three vertical riser pipes (bubblers)

The ETD system began operation on 30 September 2003, at a design rate of 750 gpm. It has been optimized several times since start up and is currently operating with one extraction well at 75 gpm. Further details regarding the FS-1 ETD system can be found in the O&M Plan (AFCEC 2017a).

An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and updated the steps to achieve site closure (i.e., the three-step process) (AFCEE 2011b).

5.8.2.4 Basis for Taking Action

Future residential exposure to FS-1 groundwater COCs presents an excess lifetime cancer risk greater than the acceptable EPA range of 1×10^{-4} to 1×10^{-6} . In addition, the MassDEP target risk of 1×10^{-5} was exceeded for current and future recreational waders (adult) exposed to surface water, sediment, and fish ingestion (AFCEE 1999b).

An ecological risk assessment concluded that adverse effects to ecological receptors, birds, mammals, amphibians, fish, or benthic invertebrates are not likely from exposure to soil, surface water, or sediments at FS-1 (AFCEE 1999b).

5.8.3 Remedial Actions

The final remedy for the FS-1 plume was determined in the Final Record of Decision Area of Contamination FS-1 (AFCEE 2000) which was signed on 15 May 2000. The final design for the remedial system was presented and approved in the 2001 Final Wellfield Design Report (AFCEE 2001).

The RAOs for the FS-1 groundwater plume (AFCEE 2000) as modified by the global ESD (AFCEE 2011b) are as follows:

- Prevent residential exposure to FS-1 groundwater with EDB concentrations greater than the MMCL of 0.02 µg/L.
 - Prevent residential exposure to FS-1 groundwater with lead concentrations greater than EPA Treatment Technique action level of 15 µg/L.
 - Prevent residential exposure to FS-1 groundwater with thallium concentrations greater than the MCL of 2 µg/L.
 - Prevent residential exposure to FS-1 groundwater with toluene concentrations greater than the MCL of 1,000 µg/L.
 - Restore usable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.
 - Prevent worker, recreational youth and adult wader contact with Quashnet River water containing unacceptable concentrations of EDB and ingestion of fish exposed to Quashnet River water containing unacceptable concentrations of EDB*.
- * Note that subsequent to the completion of the ROD, a screening-level human health risk evaluation was conducted to examine the potential for imminent human health risks from exposure to surface water containing EDB (Appendix D of AFCEE 2003). This screening level evaluation for EDB resulted in the development of an RBC for EDB of 6.5 µg/L in surface water at a target risk of 1×10^{-3} (constituting the potential for “imminent human health risks”).

5.8.3.1 Remedy Selection and Implementation

The selected remedy for FS-1 groundwater in the ROD (AFCEE 2000) included the following components:

- continued operation of the pilot-test ETD system;
- installation of up to 17 additional deep extraction wells and 19 reinjection wells (final number to be based on additional plume characterization and optimization modeling to be completed subsequent to completion of the ROD);
- monitoring of source area groundwater for lead, thallium, and toluene;
- monitoring groundwater and surface water for EDB;
- restricting groundwater use within the areas contained by the treatment system through imposition of institutional controls (i.e., LUCs); and
- completion of CERCLA reviews every five years throughout the lifetime of the remedial action.

Modeling completed at the time of the ROD indicated that the MMCL of 0.02 µg/L for EDB would be achieved approximately seven years after the startup of the ETD system, at which time 83 percent of the plume was predicted to have been captured, 11 percent would discharge to the bogs, and six percent would remain in the aquifer (AFCEE 2000). However, this remedial timeframe was revised to 15 years after system startup (with regulatory agency approval) with the issuance of the Final Wellfield Design Report (AFCEE 2001) as described below.

Following the acceptance of the ROD and its associated conceptual design, an FS-1 pre-design data-gap investigation was completed in 2001 to obtain additional plume characterization data required to finalize the design of the final remedial system (AFCEE 2001). Findings obtained during this post-ROD data gap investigation resulted in refinements to the CSM for FS-1 including: (1) a definitive determination of the aquifer thickness and heterogeneity; (2) a refined understanding of the three-dimensional hydraulic conductivity field and groundwater flow characteristics; (3) detection of a previously uncharacterized area of elevated EDB mass in the southern third of the plume; (4) improved definition of the eastern plume boundary; and (5) the effect of convergent flow on the plume in the vicinity of the Quashnet River and bogs.

Therefore, the conceptual design specified in the ROD was modified based on analysis of field data and groundwater modeling conducted subsequent to issuance of the ROD and on input received from stakeholders (EPA, MassDEP, MDFW, Mashpee Conservation Commission). The final ETD system (Figure 5-8A) was designed to treat a combined extraction rate of 750 gpm and consisted of four deep extraction wells (36EW0001, 36EW0005, 36EW0007, and 36EW0011) that was predicted to remediate groundwater within a timeframe of 15 years after system startup. Extracted groundwater would be treated using GAC and treated water would be returned to surface water through three vertical riser pipes (bubblers) and the shallow aquifer through an infiltration gallery. EPA and MassDEP concurred with the final design on 10 May 2001 (AFCEE 2001).

Since the final ETD system came on line in 2003, the following changes to the remedy have occurred:

- 1) The institutional controls described in the ROD were further developed as described in the 2011 ESD for the IRP groundwater plumes (AFCEE 2011b). The ESD provides a more thorough description of the LUC program, including a private well verification program that is being instituted for all the JBCC groundwater plumes.
- 2) The 2011 ESD also clarified the inclusion of MNA as a component of the selected remedy for FS-1 and added text regarding the JBCC three-step process to achieve site closure.

Remedial system performance monitoring data and long-term plume monitoring data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives and system performance metrics are being met; (ii) whether remediation is progressing as expected; and (iii) to identify and assess optimization opportunities. The data collected under the SPEIM/LTM program are presented to the regulatory agencies through the Technical Update Meeting process and documented in annual SLRs.

As part of the LUC process specified in the ESD (AFCEE 2011b), a private well verification survey was completed at FS-1 between November 2012 and April 2013. The private well verification survey completed at the FS-1 LUC area consisted of outreach to nine parcels. No private wells were identified within the FS-1 LUC area. In the event that new private well information is obtained or plume monitoring data indicate a change to the CSM at FS-1, AFCEC will perform the necessary well determinations at the time the information becomes available (AFCEC 2013b). Annual mailings were distributed during this five year review period and reported in the SLRs (AFCEC 2018a, 2017c, 2016c, 2015d, 2014b, 2013c) and annual LUC reports.

5.8.3.2 Remedy Operation & Maintenance

The FS-1 remedial system is operated and maintained under an approved O&M Plan (AFCEC 2017a). The O&M Plan is updated on an annual basis and includes operational

requirements, a summary of the operational history of the systems, and details of any system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and continue to be, addressed in a timely and effective manner such that remedy O&M is considered effective at achieving the remedy goals. Operational issues are identified in O&M monthly reports and system performance and reliability is reported in the annual SLRs.

The annual SPEIM/LTM/O&M costs associated with ongoing remedial action at FS-1 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives) and do not indicate potential remedy problems.

5.8.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior fourth CERCLA Five Year Review (AFCEC 2013a). For the FS-1 groundwater plume, the recommendations and follow-up actions were:

- 1) No specific recommendation or follow-up actions have been identified. However, the topic of emerging contaminants should be monitored as it relates to groundwater at FS-1 and the JBCC.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

- 1) A Focused Site Inspection Report for Perfluorinated Compounds at the Flight Line Area was completed by AFCEC to determine if the emerging contaminants, PFAS, are present in groundwater at flight-line areas of the JBCC (AFCEC 2016b). As part of the site investigation, FS-1 source area wells 36MW0002 and 36MW0007 were sampled for PFAS analysis. The sum of PFOA and PFOS in groundwater at 36MW0007 was greater than the EPA HA level of 0.07 µg/L, therefore the FS-1 source area was recommended for a RI. However, an expanded SI is being

conducted prior to the RI to determine if PFAS contamination is migrating off base and impacting drinking water supplies (AFCEC 2018b) .

5.8.5 Five Year Review Process

5.8.5.1 Data Review

The JBCC SPEIM program was developed to monitor plume changes and to ensure the effective operation of the AFCEC groundwater remediation systems at the JBCC. These objectives are met through monitoring of selected media (i.e., groundwater, surface water) within and outside the plume boundaries, treatment plant monitoring, and groundwater flow and transport modeling. The data collected under the SPEIM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being addressed through active treatment. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program. The SLRs also include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual reporting period as attachments or by reference. The SLRs are provided to the broad stakeholder group for each plume including Federal (EPA) and State (MassDEP, MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties. The SLRs are publically available in the IRP Administrative Record and copies are maintained at the local town libraries.

In addition to the annual SLRs prepared for FS-1 during this Five Year Review period

(AFCEC 2018a, 2017c, 2016c, 2015d, 2014b, 2013c), the following technical deliverables were prepared that assessed system performance or presented the results of optimization evaluations:

- *FS-1 2012 Triennial SPEIM Data Presentation, Network Optimization, and Supplemental Monitoring Results Project Note.* (AFCEC 2012)
- *FS-1 2013 Annual SPEIM Data Presentation and Network Optimization Project Note* (AFCEC 2014a)
- *FS-1 2014 ETD System Optimization and 36EW0001 Monitoring Update Data Presentation Project Note* (AFCEC 2014c)
- *FS-1 2014 Biennial SPEIM Data Presentation Project Note* (AFCEC 2015c)
- *FS-1 2015 Annual SPEIM Data Presentation and Network Optimization Project Note* (AFCEC 2015a)
- *Fuel Spill-1 (FS-1) 2016 Biennial SPEIM Data Presentation, Surface Water Monitoring Update, and SPEIM Network Optimization Project Note* (AFCEC 2016a)

5.8.5.2 Site Inspections

Refer to Section 3.6.

5.8.5.3 Interviews

Refer to Section 3.7.

5.8.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.8.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, startup of the pilot ETD system in 1999, completion of the ROD in 2000, startup of the final ETD system in 2003, continued operation of the remedial system, and completion of the well verification/well determination portion of the LUCs in early 2013 have resulted in the remedy functioning for the COCs as intended by the decision documents. The remedial system is performing as expected. Through the combination of the active treatment by the remedial system and natural attenuation processes groundwater cleanup levels are expected to be achieved within the timeframe (i.e. 2018) approximated in the Wellfield Design Report (AFCEE 2001), which modified the remedial timeframes originally presented in the ROD (see Section 5.8.3.1). Operational costs are appropriate for the remedy and a robust optimization program continues to reduce future costs. Monitoring and evaluation activities are continual and well-documented.

5.8.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance with respect to the COCs.

However, PFOS and PFOA have been detected in groundwater at the source area and are being investigated. Section 3.3 provides the HAs for PFOS and PFOA.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics. There have been no changes in the toxicity factors or other contaminant characteristics for the FS-1 groundwater COCs EDB, toluene, thallium and lead since the last Five Year Review (i.e., 2012) and the cleanup levels remain 0.02 µg/L, 1,000 µg/L, 2 µg/L and 15 µg/L, respectively.

An oral non-cancer toxicity value for thallium was published by EPA in October 2012 (EPA 2012). The updated oral non-cancer toxicity value is seven times more conservative

than what was previously published by EPA Region 3 (EPA 2008). These toxicity changes for thallium did not lead to a change in the MCL of 2 µg/L. It is noted that thallium has not been detected in source area groundwater since 2002.

Since the RAOs and risk management decisions associated with FS-1 groundwater are based on MCL/MMCLs, this change in toxicity for thallium does not affect the protectiveness of the remedy. However, the updated toxicity values (or values derived from future updates) for the FS-1 COCs should be used when performing the residual risk assessment as part of the three-step process to achieve site closure (AFCEE 2011b).

The RBC for human health exposure to EDB in FS-1 surface water of 6.5 µg/L for a target risk of 1×10^{-3} (i.e., imminent human health risk) that was developed in 2003 (AFCEE 2003) has been recalculated using updated toxicity information. In 2004, the carcinogenic toxicity value for EDB for oral exposure was revised downward by more than an order of magnitude (EPA 2012). Therefore, the 2003 surface water RBC of 6.5 µg/L does not reflect the most recent EPA toxicity values for EDB. The RBC for EDB in surface water was recalculated for exposure to surface water containing EDB associated with the FS-28 groundwater plume (Coonamessett River) using exposure assumptions similar to those used for FS-1. The recalculated RBC for EDB in surface water at FS-28 increased from 7.71 µg/L to 328 µg/L (under the “imminent risk to human health” scenario). Risk calculations for FS-1 using the updated toxicity value from EPA (EPA 2017) also resulted in the same RBC (328 µg/L; Appendix E) as presented in the last Five Year Review (AFCEC 2013a) for human health exposure to EDB in Quashnet River surface water. These updated toxicity values (or values derived from future updates) should be used when performing the residual risk assessment as part of the three-step process to achieve site closure (AFCEE 2011b).

Changes in Risk Assessment Methods: There have been no changes in risk assessment methodology that affect protectiveness.

Review of RAOs: The RAOs developed for the final ROD (AFCEE 2000) and revised in the 2011 ESD (AFCEE 2011b) are appropriate and remain valid.

5.8.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

The FS-1 source area was identified as a potential PFAS site during a PA (AFCEC 2015b). A Focused SI Report for Perfluorinated Compounds at the Flight Line Area was completed by AFCEC to determine if the emerging contaminants, PFAS, are present in groundwater at flightline areas of the JBCC (AFCEC 2017b). As part of the Focused SI, FS-1 source area wells 36MW0002 and 36MW0007 were sampled for PFAS analysis. The sum of PFOA and PFOS in groundwater at 36MW0007 was greater than the EPA HA level of 0.07 µg/L, therefore the FS-1 source area was recommended for an RI; however, an expanded SI is being conducted prior to the RI to determine if PFAS contamination is migrating off base and impacting drinking water supplies (AFCEC 2018b) .

5.8.7 Issues, Recommendations, and Follow-Up Actions

The expanded SI for PFAS should be completed for FS-1. Once the ETD system is shut down and the SPEIM data indicate aquifer restoration has been achieved, the Three-Step Process should be initiated as long as PFAS are not an issue.

5.8.8 Protectiveness Determination

The remedy for the FS-1 groundwater plume is protective of human health and the environment in the short-term. The remedial system is performing as expected for the current COCs. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, existing groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD, and revised in the Wellfield Design Report, which was considered reasonable given the particular circumstances of the site. For the remedy to be protective in the long-term, the expanded SI for PFAS should be completed.

5.8.9 References

AFCEC. 2018a (April). *Fuel Spill-1 2017 Summary Letter Report*. 652000-SPEIM-FS1-SLR-003. Prepared by EA Engineering, Science and Technology and CH2M for

AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

- _____. 2018b (February). *Expanded Site Inspection Work Plan for Per- and Polyfluoroalkyl Substances at the Flight Line Area Sites, Joint Base Cape Cod, MA.* 658003-EC-FL-RPT-003. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2017a (November). *2017 Operations and Maintenance Plan for Groundwater Extraction and Treatment Systems and Wind Turbine.* 652000-O&M-MULTIPLE-OMPLN-003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2017b (April). *Final Focused Site Inspection Report for Perfluorinated Compounds at the Flight Line Area, Joint Base Cape Cod, MA.* 658003-EC-FL-RPT-002. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2017c (March). *Fuel Spill-1 2016 Summary Letter Report.* 652000-SPEIM-FS1-SLR-003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2016a (November). *Fuel Spill-1 2016 Biennial SPEIM Data Presentation, Surface Water Monitoring Update, and SPEIM Network Optimization Project Note.* 652000-SPEIM-FS1-PROJNOT-002. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2016b (January). *Final Focused Site Inspection Work Plan for Perfluorinated Compounds at the Flight Line Area, Joint Base Cape Cod, MA.* 658003-EC-FL-RPT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2016c (March). *Fuel Spill-1 2015 Summary Letter Report.* 652000-SPEIM-FS1-SLR-002. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2015a (September). *Fuel Spill-1 2015 Annual SPEIM Data Presentation and Network Optimization Project Note.* 652000-SPEIM-FS1-PRJNOT-001. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2015b (June). *Final Preliminary Assessment Report for Perfluorinated Compounds at Joint Base Cape Cod, Massachusetts.* Prepared by HGL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
-

- _____. 2015c (May). *Fuel Spill-1 2014 Biennial SPEIM Data Presentation Project Note*. 473147-SPEIM-FS1-PRJNOT-003. Prepared by CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015d (March). *Fuel Spill-1 2014 Summary Letter Report*. 652000-SPEIM-FS1-SLR-001. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014a (June). *Fuel Spill-1 2013 Biennial Project Note*. 473147-SPEIM-FS1-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014b (March). *Fuel Spill-1 2013 Summary Letter Report*. 437147-SPEIM-FS1-SLR-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014c (February). *Fuel Spill-1 2014 ETD System Optimization and 36EW0001 Monitoring Update Data Presentation Project Note*. 473147-SPEIM-FS1-PROJNOT-002. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013a (October) *Final 4th Five-Year Review, 2012-2017 Massachusetts Military Reservation (JBCC) Superfund Site, Otis Air National Guard Base, MA* 473147-SPEIM-Multiple-RPT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013b (June). *FS-1 Private Well Verification Project Note*. 437075-LUC-FS1-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013c (March) *FS-1 2012 Summary Letter Report*. 437075-SPEIM-FS1-SLR-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012 (December). *FS-1 2012 Triennial SPEIM Data Presentation, Network Optimization, and Supplemental Monitoring Results Project Note*. 437075-SPEIM-FS1-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- AFCEE 2012a (August). *Final 2011 JBCC Vapor Intrusion Evaluation Technical Memorandum*. 420005-SPEIM-MULTIPLE-TECHMEM-002. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2011a (September). *FS-1 2011 Surface Water Monitoring Network Optimization Project Note*. 404929-SPEIM-FS-1-PRJNOT-002. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2011b (September). *Final Explanation of Significant Differences for the*

- Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation.* 404929-SPEIM-Multiple-RPT-001. Prepared by CH2M HILL for AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2003 (May). *Final Fuel Spill-1 2002 Annual System Performance and Ecological Impact Monitoring Report.* ENR-J23-35Z15616-M31-0003. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation restoration Program, Otis Air National Guard Base, MA.
- _____. 2001 (December). *Final Fuel Spill-1 Wellfield Design Report.* AFC-J23-35S19902-M23-0005. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2000 (April). *Final Record of Decision Area of Contamination FS-1.* Submitted by Hazardous Waste Remedial Actions Program. Prepared for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 1999a (June). *Proposed Plan for Groundwater and Surface Water Cleanup Related to FS-1, Massachusetts Military Reservation.* Fact Sheet.
- _____. 1999b. (May) *Remedial Investigation Report. Area of Concern FS-1, Final.* Hazardous waste Remedial Actions Program, Lockheed Martin Energy Systems, Inc., Oakridge, Tennessee. Prepared for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 1999c. (May) *Feasibility Study, Area of Contamination FS-1, Final.* Hazardous waste Remedial Actions Program, Lockheed Martin Energy Systems, Inc., Oakridge, Tennessee. Prepared for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- ASI (Advanced Sciences, Inc.), 1995. (September). *Technical Memorandum, Site Investigation for Area of Contamination Fuel Spill-1 and Downgradient Areas.* Installation Restoration Program, Massachusetts Military Reservation, Cape Cod, Massachusetts.
- EPA. 2017 (November). Regional Screening Levels (RSLs) [online]. Available: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/.
- _____. 2012 (November). Regional Screening Levels (RSLs) [online]. Available: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/.
- _____. 2008 (September). Risk-Based Concentration Table [online]. Available: <http://www.epa.gov/reg3hwmd/risk/human/index.htm>.
- _____. 2001 (June). *Comprehensive Five-Year Review Guidance*, EPA 540R-01-007. <http://www.epa.gov/reg3hwmd/risk/human/index.htm>.

5.9 FUEL SPILL-12 (FS-12) GROUNDWATER

The FS-12 plume is a dissolved-phase groundwater plume (Figure 5-9A) that is defined as the extent of groundwater containing the primary FS-12 COC, EDB, at concentrations exceeding the MMCL of 0.02 µg/L. Benzene is also a COC for the FS-12 plume; however, benzene has not been detected at concentrations above the MCL of 5 µg/L within the plume monitoring network since 2006 or within the source area monitoring network since 2007.

5.9.1 Site Chronology

1990: Contaminants associated with the FS-12 plume were first detected in groundwater when the Sandwich Water District performed exploratory drilling for future municipal water supply wells (AFCEE 2006).

1992-1995: An SI and RI were completed (ANG 1992, 1995b).

1995: The NGB, DOD, EPA, MassDEP, and local communities approved a Plume Response Plan that presented an accelerated effort toward “simultaneous containment” of seven IRP groundwater plumes, including FS-12. An IROD for the seven groundwater plumes emanating from the JBCC was signed on 25 September 1995 (ANG 1995a). The IROD stated that groundwater extraction and treatment systems should be designed, installed, and operated until a final remedy for the site is chosen. For FS-12, the interim remedy consisted of an ETR system to capture the plume.

1996-1997: Installation and startup of an interim ETR system consisting of 25 extraction wells and 23 reinjection wells under the IROD (ANG 1995a).

2005: A FS and proposed plan were submitted (AFCEE 2005a, 2005b).

2006: ROD finalized (AFCEE 2006).

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy, revised the LUCs, slightly modified the phrasing of the RAOs, and added text regarding the JBCC three-step process to achieve site closure (AFCEE 2011).

5.9.2 Background

5.9.2.1 History of Contamination

The FS-12 groundwater plume originated from a break in an underground pipeline located along Greenway Road that was originally believed to be discovered in 1972 (Figure 5-9A). The operation of the pipeline was discontinued in 1973. In January 1992, the FS-12 RI was initiated. As a result of modeling conducted for the RI, the FS-12 release was estimated to be about 70,000 gallons of AVGAS and JP-4 (AFCEE 2006). At the time of the RI, dissolved phase groundwater contamination (BTEX and EDB) extended from the source area to approximately 5,000 ft downgradient (i.e., south-southwest).

5.9.2.2 Physical Characteristics, Land and Resource Use

Based on the most recent groundwater monitoring data collected in 2017, the main body of the FS-12 plume is approximately 1,900 ft long, up to 1,250 ft wide, and is approximately 45 ft thick. The plan view extent of the FS-12 plume is shown on Figure 5-9A. The footprint of the FS-12 plume was approximately 25 acres in 2012 and was approximately 25 acres in 2017 (Figure 5-9B).

Land above the FS-12 groundwater plume consists of undeveloped areas and a summer camp. It is anticipated that the land use over the FS-12 plume area will not significantly change over time. Snake Pond, a kettle pond that is fed by groundwater, is used for recreational purposes such as fishing, swimming, and boating. In addition, a public beach is located on the southeast side of Snake Pond. Within the footprint of the plume, the maximum and minimum ground surface elevations are 140 ft msl and 70 ft msl, respectively.

5.9.2.3 Initial Responses

A summary of the initial responses is as follows:

Non-CERCLA Actions:

Private residences and the nearby summer camp that are located in the vicinity of the FS-12 plume were connected to the municipal water supply.

CERCLA Actions:

The TRET, established in 1996 as part of a new IROD management process, reviewed wellfield designs and determined that the 60-percent design for containment of several of the IROD plumes would cause negative ecological impacts (TRET 1996). The proposed interim remedy for the FS-12 groundwater plume consisted of treatment using an ETR system with the goal of restoring the aquifer and preventing further downgradient migration of the plume. The approach for plume containment at FS-12 was revised, in part, as follows (AFCEE 2006):

- The treatment system would consist of 25 extraction wells¹.
- The extraction wells would be arranged across the toe of the southern extent of the FS-12 plume and in an axial arrangement intercepting the central portion of the plume with the highest contaminant concentrations.
- Treated water would be returned through 23 reinjection wells². These reinjection wells would be placed downgradient of the extraction toe fence and west of the axial wells near the eastern shore of Snake Pond.

¹ Extraction wells 90EW0004 and 90EW0005 were not installed because it was determined that, after installation of 90EW0001 through 90EW0003, these wells were not needed based on subsequent characterization of the FS-12 plume.

² Reinjection wells 90RIW0001, 90RIW0002, 90RIW0003, and 90RIW0004 were designed to be placed north of Snake Pond, but it was determined that these wells were not needed based on a subsequent characterization of the nature and extent of the FS-12 plume. Reinjection wells 90RIW0011 and 90RIW0012 were not installed at the landowner's request. Reinjection well 90RIW0019 was not installed because its position on the toe fence was believed to interfere with the nearby J. Braden Thompson groundwater plume, which is not associated with the JBCC. 90RIW0010 was converted to extraction well 90EW0031 in 2000 (AFCEE 2006).

The revised design was implemented and the FS-12 ETR system began operation on 18 September 1997 at a design flow rate of 772 gpm (Figure 5-9A). This ETR system became the selected remedy in the final ROD (AFCEE 2006). Further details regarding the FS-12 remedial system can be found in the 2017 O&M Plan (AFCEC 2017a).

An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy at FS-12, further described the institutional controls, slightly modified the phrasing of the RAOs, and updated the steps to achieve site closure (i.e., the three-step process) (AFCEE 2011).

5.9.2.4 Basis for Taking Action

Future residential exposure to the FS-12 groundwater COC (EDB and benzene) presents an excess lifetime cancer risk greater than the acceptable EPA range of 1×10^{-4} to 1×10^{-6} (AFCEE 2006).

An ecological baseline risk assessment was not conducted for FS-12 because of the lack of evidence of plume discharge to Snake Pond. Extensive sampling over 10 years has not detected any FS-12 contaminants in Snake Pond surface water. Therefore, it is not expected that contamination associated with the FS-12 groundwater plume would pose unacceptable ecological risk (AFCEE 2006).

5.9.3 Remedial Actions

The final remedy for the FS-12 plume was determined in the *Final Record of Decision for Fuel Spill-12 Groundwater* (AFCEE 2006) which was signed on 28 September 2006.

- The RAOs for the FS-12 groundwater plume as presented in the ROD (AFCEE 2006) and modified in the ESD (AFCEE 2011) are as follows:
 - Prevent residential exposure to FS-12 groundwater with benzene concentrations greater than the MCL of 5 µg/L.
 - Prevent residential exposure to FS-12 groundwater with EDB concentrations greater than the MMCL of 0.02 µg/L.

- Restore useable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

5.9.3.1 Remedy Selection and Implementation

The selected remedy in the ROD (AFCEE 2006) included the following components:

- Continued operation of the FS-12 ETR system.
- The selected remedy includes the possibility of modifying the treatment system to improve system operation and to accelerate the cleanup timeframe.
- Implementation of LUCs with the performance objectives of:
 - Preventing access to, or use of, contaminated groundwater from the FS-12 plume (both on-base and off-base) until the groundwater no longer poses an unacceptable risk, and
 - Maintaining the integrity of the current or future remedial or monitoring system such as the treatment systems and monitoring wells.
- Chemical and hydraulic monitoring of the plume, as long as active remediation continues, and chemical monitoring of the plume until the RAOs are met.
- Completion of CERCLA reviews every five years throughout the lifetime of the remedial action.

Since the final remedy was selected in 2006, the 2011 ESD for the IRP groundwater plumes (AFCEE 2011) clarified the inclusion of MNA as a component of the selected remedy for FS-12, further described the LUC requirements, modified the phrasing of the RAOs, and added text regarding the JBCC three-step process to achieve site closure.

Remedial system performance monitoring data and long-term plume monitoring data collected under the SPEIM program are used to assess: (i) whether the remedial objectives and system performance metrics are being met; (ii) whether remediation is progressing as expected; and (iii) to identify and assess optimization opportunities. The data collected under the SPEIM program are presented to the regulatory agencies through the Technical Update meeting process and documented in annual SLRs.

As part of the LUC process specified in the ESD (AFCEE 2011), a private well verification survey was completed at FS-12 between May 2011 and April 2013 (AFCEC 2013b). The

private well verification survey completed at the FS-12 LUC area consisted of outreach to 14 parcels. No active private wells were identified. One property (summer camp) indicated to AFCEC that they formerly used one or more wells for irrigation and potable water supplies prior to being connected to municipal water by AFCEE in 1993. However, the current operator of the camp verified that none of these former wells are in use (and in fact does not know the location of all the wells).

The status of these non-operational private wells at the summer camp continue to be tracked. AFCEC distributed a mailing, on an annual basis, to the property owner. The intent of the annual mailing is to remind the camp property owner that they should contact AFCEC for a technical evaluation, which may include sampling, in the event any of their wells are put back into service. Annual mailings were distributed during this five year review period and reported in the SLRs (AFCEC 2018, 2017b, 2016c, 2015b, 2014, 2013d) and annual LUC reports.

5.9.3.2 Remedy Operation & Maintenance

The FS-12 remedial system is operated and maintained under an approved O&M Plan (AFCEE 2017a). The O&M Plan is updated on an annual basis and includes operational requirements, a summary of the operational history of the systems, and details of any system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and will continue to be, addressed in a timely and effective manner such that O&M associated with the remedy is considered effective at achieving the remedy goals. Operational issues are identified in O&M monthly reports and system performance and reliability is reported in the annual SLRs.

The annual SPEIM/LTM/O&M costs associated with ongoing remedial action at FS-12 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives) and do not indicate potential remedy problems.

5.9.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior fourth CERCLA Five Year Review (AFCEC 2013a). For the FS-12 groundwater plume, the recommendations and follow-up actions were:

- 1) Contaminant transport modeling completed since the ROD indicate that the restoration timeframe predicted at the time of remedy selection (i.e., by 2030) may not be met. The longer model-predicted restoration timeframe is primarily due to a change in the CSM related to the nature and extent of EDB contamination in the core of the plume.

An optimization assessment of the FS-12 remedial system should be performed with an updated plume shell that more closely represents the current distribution of contamination based on the updated CSM. The optimization evaluation should assess the performance of the remedial system, determine whether improvements can be made, and update the restoration timeframe prediction for comparison to the information presented in the ROD. If necessary at the conclusion of the optimization assessment, an ESD presenting the updated CSM and/or the updated prediction for aquifer restoration timeframe should be completed for FS-12.

- 2) In addition, the topic of emerging contaminants should be monitored as it relates to groundwater at FS-12 and the JBCC.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

- 1) The plume shell for the FS-12 EDB plume was updated in 2016 and is based on monitoring data collected through December 2015 (AFCEC 2017c).

An optimization evaluation for the FS-12 remedial system and remedial strategy was started in 2014 and continued in 2016. Transport simulations previously

completed using the 2011 FS-12 EDB plume shell (AFCEC 2016d) predicted that EDB would remain in the core area of the plume well beyond the aquifer restoration date of 2030 that was presented in the ROD (AFCEE 2006). Augmentation of the existing pump and treat remedy with in-situ bioremediation was previously evaluated at FS-12 and was considered as an option to potentially accelerate the restoration timeframe. However, a review of SPEIM data collected through 2015 indicated that the EDB concentrations within the core area of the plume were decreasing at a rate faster than what was predicted with transport modeling completed with the 2011 EDB plume shell (AFCEC 2016d). Therefore, a recommendation to update the FS-12 plume shell using the most current data and conduct a modeling-based optimization evaluation for the existing ETR system was presented in the FS-12 2015 annual SPEIM data presentation (AFCEC 2016b) and completed in 2016 (AFCEC 2017c).

The modeling-based ETR system optimization was conducted using the 2015 EDB plume shell and the 2013 FS-12 groundwater model. An optimized well field pumping configuration, 2016 Scenario 01, was identified and entailed shutting down 90EW0019 and increasing flow at the southern toe fence (90EW0025 and 90EW0026) to 200 gpm to release the hydraulic stagnation zone at the core area of the plume. In addition, cyclic operation of 90EW0031 and 90EW0017 was proposed to more efficiently capture the small areas of EDB contamination that remain in the immediate vicinity of these two extraction wells. This optimization evaluation was presented to the regulatory agencies in July 2016 and the regulatory agencies provided approval to implement 2016 Scenario 01 in early January 2017 (AFCEC 2017c). The optimized pumping configuration 2016 Scenario 01 was fully implemented in June 2017.

- 2) FS-12 was not sampled for the emerging contaminant 1,4-dioxane because there were no solvents associated with the groundwater plume. It was also not sampled for PFAS because there was no evidence of AFFF use at the site.

5.9.5 Five Year Review Process

5.9.5.1 Data Review

The JBCC SPEIM program was developed to monitor plume changes and to ensure the effective operation of the AFCEC groundwater remediation systems at the JBCC. These objectives are met through monitoring of selected media (i.e., groundwater, surface water) within and outside the plume boundaries, treatment plant monitoring, and groundwater flow and transport modeling. The data collected under the SPEIM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being addressed through active treatment. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program. The SLRs also include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual reporting period as attachments or by reference. The SLRs are provided to the broad stakeholder group for each plume including Federal (EPA) and State (MassDEP, MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties. The SLRs are publically available in the IRP Administrative Record and copies are maintained at the local town libraries.

In addition to the annual SLRs prepared for FS-12 during this Five Year Review period (AFCEC 2018, 2017b, 2016c, 2015b, 2014, 2013d), the following technical deliverables were prepared that assessed system performance or presented the results of optimization evaluations:

- *Fuel Spill-12 2012 Annual SPEIM Data Presentation Project Note* (AFCEC 2013e)
- *Fuel Spill-12 Private Well Verification Project Note.* (AFCEC 2013b)
- *Fuel Spill-12 2013 Extraction, Treatment, and Reinjection System Optimization Project Note.* (AFCEC 2013c)
- *FS-12 2013 Biennial SPEIM Data Presentation Project Note.* (AFCEC 2013f)
- *FS-12 2014 Annual SPEIM Data Presentation Project Note.* (AFCEC 2015a)
- *FS-12 2014 Extraction, Treatment, and Reinjection System Optimization Results Project Note.* (AFCEC 2016d)
- *FS-12 2015 Annual SPEIM Data Presentation Project Note.* (AFCEC 2016b)
- *FS-12 2016 Triennial SPEIM Data Presentation Project Note.* (AFCEC 2016a)
- *FS-12 Plume Shell Update and Extraction, Treatment and Reinjection System Optimization Evaluation.* (AFCEC 2017c)

5.9.5.2 Site Inspections

Refer to Section 3.6.

5.9.5.3 Interviews

Refer to Section 3.7.

5.9.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.9.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, continued operation of the ETR system installed as the interim remedy in 1997, completion of the ROD in 2006, and completion of the well verification/well determination portion of the LUCs in early 2013 have resulted in the remedy functioning as intended by the decision documents.

Plume and remedial system monitoring is being conducted under the SPEIM/LTM and LUC programs and risk management measures are in place. Operational costs are appropriate for the remedy and a robust optimization program continues with the objective of reducing remedial system operational timeframes, the time to reach remedial goals (e.g., MMCLs), and reducing future costs. Monitoring and evaluation activities are continual and well-documented.

5.9.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics: There have been no changes in the toxicity factors or other contaminant characteristics for the FS-12 groundwater COCs, EDB and benzene.

Changes in Risk Assessment Methods: There have been no changes in risk assessment methodology that affect protectiveness.

Review of RAOs: The RAOs developed for the final ROD (AFCEE 2006) and revised in the 2011 ESD (AFCEE 2011) are appropriate and remain valid.

5.9.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information at this time that calls into question the protectiveness of the remedy.

5.9.7 Issues, Recommendations, and Follow-Up Actions

No specific recommendations or follow up actions have been identified for the current

COCs.

5.9.8 Protectiveness Determination

The remedy for the FS-12 groundwater plume is protective of human health and the environment. The remedial system is performing as expected and the LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved. Since the LUCs are in place and are functioning as intended to prevent exposure and there are no current plans to use the portion of the aquifer where FS-12 contamination remains for water supply, the remedy remains protective.

5.9.9 References

- AFCEC. 2018 (April). *Fuel Spill-12 2017 Summary Letter Report*. 652000-SPEIM-FS12-SLR-004. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA
- _____. 2017a (November). *2017 Operations and Maintenance Plan for Groundwater Extraction and Treatment Systems and Wind Turbine*. 652000-O&M-MULTIPLE-OMPLN-003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2017b (March). *Fuel Spill-12 2016 Summary Letter Report*. 652000-SPEIM-FS12-SLR-003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA
- _____. 2017c (January). *FS-12 Plume Shell Update and Extraction, Treatment and ReInjection System Optimization Evaluation*. 652000-SPEIMFS12- PRJNOT-003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016a (December). *FS-12 2016 Triennial SPEIM Data Presentation Project Note*. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016b (June). *FS-12 2015 Annual SPEIM Data Presentation Project Note*. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016c (March). *Fuel Spill-12 2015 Summary Letter Report*. 652000-SPEIM-FS12-SLR- 002. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016d (March). *FS-12 Plume Shell Update and Extraction, Treatment, and ReInjection System Optimization Evaluation Project Note*. 652000-SPEIM-FS12-PRJNOT-003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015a (May). *FS-12 2014 Annual SPEIM Data Presentation Project Note*. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

- _____. 2015b (March). *Fuel Spill-12 2014 Summary Letter Report*. 652000-SPEIM-FS12-SLR- 001. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014 (March). *Fuel Spill-12 2013 Summary Letter Report*. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013a (October). *Final 4th Five Year Review, 2007-2012, Massachusetts Military Reservation Superfund Site, Otis Air National Guard Base, MA*. 473147-SPEIM-Multiple-RPT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013b (July). *Fuel Spill-12 Private Well Verification Project Note*. 437075-LUC-FS12-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013c (June). *Fuel Spill-12 2013 Extraction, Treatment, and Reinjection System Optimization Project Note*. 437075-SPEIM-FS12-PRJNOT-002. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013d (March). *Fuel Spill-12 2012 Summary Letter Report*. 437075-SPEIM-FS12-SLR-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013e (March). *Fuel Spill-12 2012 Annual SPEIM Data Presentation Project Note*. 437075-SPEIM-FS12-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013f (March). *FS-12 2013 Biennial SPEIM Data Presentation Project Note*. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- AFCEE. 2012 (August). *Final 2011 JBCC Vapor Intrusion Evaluation Technical Memorandum*. 420005-PROGRAM-MULTIPLE-TECHMEM-002. Prepared by CH2M HILL for AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2011 (September). *Final Explanation of Significant Differences for the Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation*. 404929-SPEIM-MULTIPLE-RPT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2006 (September). *Final Record of Decision for Fuel Spill-12 Groundwater Report*. AFC-J23-35Z04802-M26-0010. Prepared by Jacobs Engineering Group
-

Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

_____. 2005a (October). *Proposed Plan for Groundwater at Fuel Spill-12 (FS-12)*. Fact Sheet 2005-10. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis ANG Base, MA.

_____. 2005b (September). *Final Fuel Spill-12 Groundwater Feasibility Study*. A3P-J23-35Z04802-M14-0010. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

Air National Guard (ANG). 1995a (September). *Final Record of Decision for Interim Action, Containment of Seven groundwater Plumes at Massachusetts Military Reservation*. Prepared by Stone and Webster Environmental Technology and Services for Air National Guard Readiness Center, Andrews AFB, Maryland.

_____. 1995b (January). *Final Installation Restoration Program Remedial Investigation Report – FS-12 Study Area*. Prepared by Martin Marietta Energy Systems, Inc. for the Hazardous Waste Remedial Actions Program, Oak ridge, Tennessee.

_____. 1992 (January). *Expanded Site Investigation Program Sandwich Groundwater Monitoring Study, Massachusetts Military Reservation, Cape Cod, Massachusetts*. Prepared by Martin Marietta Energy Systems, Inc. for the Hazardous Waste Remedial Actions Program, Oak ridge, Tennessee.

EPA. 2001 (June). *Comprehensive Five-Year Review Guidance*, EPA 540R-01-007.

TRET (Technical Review and Evaluation Team). 1996 (May). *Toward a Balanced Strategy to Address Contaminated Groundwater Plumes at the Massachusetts Military Reservation*.

5.10 FUEL SPILL-13 (FS-13) GROUNDWATER

The FS-13 groundwater plume was a dilute dissolved-phase groundwater plume located within the JBCC. The groundwater contamination at FS-13 has not been delineated as a contiguous plume since 2004 due to its limited extent. For reference, the 2004 FS-13 plume boundary is shown on Figure 5-10. The FS-13 plume area is located within the footprint of the CS-10 plume, although it is shallower in the aquifer than CS-10, with contamination located near the water table. The groundwater COCs for FS-13 are 1,2,4-TMB and 1,3,5-TMB, or TMBs collectively (AFCEE 2000). The RSL for 1,2,4-TMB is 56 µg/L and 60 µg/L for 1,3,5-TMB.

5.10.1 Site Chronology

1972: Discovery of a leaking underground fuel supply pipeline carrying JP-4 near the rotary at the east end of Connery Avenue during a routine walkover inspection. Subsequently, the area was investigated and excavated and a section of pipe was replaced (Aneptek 1996).

1995-1999: A SI at FS-13 was conducted in 1995, followed by an RI field program in 1996 consisting of drilling and groundwater sampling (Stone & Webster 1997). RI activities were completed in 1998 and documented in the SWOU RI Report (AFCEE 1999c).

1999: The feasibility study was completed in June 1999 (AFCEE 1999b) and the proposed plan was released to the public in June 1999 (AFCEE 1999a).

2000: A ROD was completed that identified the remedy for the FS-13 plume as Limited Action, consisting of LTM and institutional controls (AFCEE 2000).

2008: An ESD was submitted to further describe the institutional controls associated with the remedy (AFCEE 2008).

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the

selected remedy, slightly modified the phrasing of the RAOs, and added text regarding the JBCC three-step process to achieve site closure (AFCEE 2011).

5.10.2 Background

5.10.2.1 History of Contamination

The source of the FS-13 plume was a release of an estimated 2,000 gallons of JP-4 that is believed to have occurred near the rotary at the east end of Connery Avenue. The fuel spill was discovered in 1972 during a routine walkover inspection of an underground fuel supply pipeline. Subsequently, the area was investigated and excavated and a section of pipe was replaced. A Site Inspection Technical Memorandum (SITM) was completed in 1996 (Aneptek 1996) and a Supplemental Site Inspection (SSI) was completed in 2006 for the FS-13 source area (AFCEE 2006b). No further action was recommended for the FS-13 source area based on the evaluation of sampling data collected from the site characterization efforts of the 1996 SITM and 2006 SSI. A decision document was prepared to document the no further action decision for the FS-13 source area (AFCEE 2006a). In October 2007, the FS-13 source area was delisted as part of the partial deletion of sites from the Otis Air National Guard Base/Camp Edwards Superfund Site.

5.10.2.2 Physical Characteristics, Land and Resource Use

The ground surface elevation within the footprint of the historic plume boundary is approximately 130 ft msl. The topography of the land in this area is characterized as a broad, flat, and gently southward sloping glacial outwash plain. The land in the immediate vicinity of the FS-13 groundwater contamination is within the boundary of the JBCC and is undeveloped apart from some base roads (i.e., Richardson Road and West Inner Road).

5.10.2.3 Initial Responses

The area of the pipeline release was investigated upon discovery in 1972 and a section of pipe was replaced. There were no initial responses for FS-13 groundwater.

5.10.2.4 Basis for Taking Action

The baseline risk calculations in the RI indicated that unless remedial action is undertaken, future residential exposure to groundwater contaminated with TMBs may present an unacceptable non-cancer hazard greater than regulatory thresholds (i.e, HI >1) (AFCEE 1999c).

Since the extent of groundwater contamination in the FS-13 area is limited, the contaminants are not migrating (refer to Section 5.10.5.1), and no surface water bodies are located nearby, no ecological risks associated with FS-13 were identified in the RI (AFCEE 1999c).

5.10.3 Remedial Actions

The final remedy for the FS-13 plume was determined in the *Final Record of Decision for the CS-4, CS-20, CS-21 and FS-13 Plumes* (AFCEE 2000) which was signed on 18 February 2000.

The RAOs for the FS-13 groundwater plume as presented in the ROD (AFCEE 2000) and modified in the ESD (AFCEE 2011) are as follows:

- Prevent residential exposure to FS-13 groundwater with 1,2,4-TMB concentrations greater than the risk-based level of 17 µg/L.
- Prevent residential exposure to FS-13 groundwater with 1,3,5-TMB concentrations greater than the risk-based level of 17 µg/L.
- Restore usable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

5.10.3.1 Remedy Selection and Implementation

The selected remedy in the ROD (AFCEE 2000) included the following components:

- Long-term monitoring of groundwater.
- Institutional controls to prevent the use of groundwater contaminated with FS-13 plume contaminants.
- Completion of CERCLA reviews every five years throughout the lifetime of the remedial action.

Since the remedy was selected in 2000, the following changes have occurred:

1. The institutional controls described in the ROD were further developed as described in a 2008 ESD (AFCEE 2008). The ESD provides a more thorough description of the LUC Program, including a private well verification program that is being instituted for all the JBCC groundwater sites.
2. A 2011 ESD for the IRP groundwater plumes (AFCEE 2011) clarified the inclusion of MNA as a component of the selected remedy for FS-13, slightly modified the phrasing of the RAOs which is reflected in Section 5.10.3, and added text regarding the JBCC three-step process to achieve site closure.

Plume monitoring data collected under the LTM program are used to assess whether the remedial objectives are being met, remediation is progressing as expected, and to identify and assess optimization opportunities. The data collected under the FS-13 LTM program are presented to the regulatory agencies through the Technical Update meeting process and documented in project notes.

As part of the LUC process specified in the ROD and subsequent ESD (AFCEE 2000, 2008), a private well verification survey was completed for FS-13 in March 2013 (AFCEC 2013b). This private well verification survey concluded that no active or inactive water-supply or irrigation wells are located within the FS-13 LUC area. Additionally no private residential wells exist at FS-13. Therefore, there is no current or future risk of exposure to groundwater via actively used wells or wells that may be re-activated in the future. LUCs are in place to prevent the future installation of a water-supply well within the FS-13 LUC area without prior notification to the Air Force.

5.10.3.2 Remedy Operation & Maintenance

Prior evaluations have concluded that TMB contamination in FS-13 groundwater is not migrating (AFCEC 2017, AFCEE 2012b, 2005). However, direct push drilling is used to sample groundwater at FS-13 once every 5 years in order to evaluate if 1,2,4-TMB and 1,3,5-TMB concentrations in groundwater have reached cleanup levels and site closure can proceed (AFCEC 2017, AFCEE 2012b).

The periodic LTM costs associated with ongoing remedial action at FS-13 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives such as less frequent sampling as was assumed at the time of the remedy selection) and do not indicate potential remedy problems.

5.10.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior fourth CERCLA Five Year Review (AFCEC 2013a). For the FS-13 groundwater plume, the recommendations and follow-up actions were:

- 1) No specific recommendation or follow-up actions have been identified. However, the topic of emerging contaminants should be monitored as it relates to groundwater at FS-13 and the JBCC.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

- 1) FS-13 was not sampled for 1,4-dioxane because there were no solvents associated with the groundwater plume. It was also not sampled for PFAS because there was no evidence of AFFF use at the site.

5.10.5 Five Year Review Process

5.10.5.1 Data Review

The FS-13 LTM program formerly (through 2004) included annual sampling of six monitoring wells in and downgradient of the FS-13 plume to document the natural attenuation of plume contaminants. Data collected over the course of the LTM program indicated that the COCs were not mobile and contamination had not migrated downgradient. When the LTM network was last sampled in November 2004, the maximum concentrations of 1,2,4-TMB and 1,3,5-TMB in FS-13 groundwater were 383 µg/L and 143 µg/L, respectively (AFCEE 2005).

AFCEE submitted a request to the regulatory agencies on 08 June 2005 to discontinue groundwater monitoring on the basis of a decreasing trend over a period of five years, the immobility of TMBs, and because human exposure to contaminated groundwater is restricted by institutional controls on the base. The EPA granted a conditional approval to cease monitoring (EPA 2005) and the FS-13 monitoring wells were abandoned in 2006. In order to implement the first step in the three-step process, AFCEC must collect monitoring data to evaluate: (a) whether the plume is attenuating as predicted; (b) the potential for short-term health effects due to exposures, and (c) when the selected remedy will attain the remediation goals in the ROD and/or ESD.

In 2011, AFCEC collected groundwater samples at two direct push borings at FS-13 for TMB analysis to evaluate groundwater quality and assess remedial progress (AFCEE 2012b). COC concentrations were consistent with or lower than prior sampling results, and it was concluded that remedial progress was occurring while existing on-base LUCs remained protective for FS-13 contamination. A recommendation was made to reassess remedial progress and remedy protectiveness after approximately five years via direct push groundwater vertical profile sampling data. Two direct push borings were completed in January 2017 where elevated 1,2,4-TMB and 1,3,5-TMB concentrations were historically detected.

Groundwater analytical LTM data collected during the 2017 sampling event continue to support the FS-13 CSM. Based on the 2017 vertical profiling results, the contaminated zone is no greater than 10-ft thick at each location. COC concentrations in the upgradient boring exceeded the HEC; however, decreasing concentration trends indicate that attenuation is occurring. COC concentrations in the downgradient boring, have decreased below the HEC indicating that attenuation is occurring, particularly with distance from the source area (AFCEC 2017).

The LUC component of the selected remedy continues to remain in place and serves to reduce potential future exposure to FS-13 contamination by prohibiting the use of FS-13 groundwater as a source of drinking water until groundwater cleanup levels are achieved. LTM sampling and implementation of LUCs continue to demonstrate the protectiveness of the selected remedy (AFCEC 2017).

5.10.5.2 Site Inspections

Refer to Section 3.6.

5.10.5.3 Interviews

Refer to Section 3.7.

5.10.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.10.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, the LTM activities and the completion of the well verification/well determination portion of the LUCs have resulted in the remedy functioning as intended by the decision documents. Operational costs are appropriate for the remedy. Monitoring and evaluation

activities are conducted and will be assessed in future Five Year Reviews.

5.10.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been changes in standards or TBC guidance. Since there is no MCL, MMCL, or MCP GW-1 standard for either 1,2,4-TMB or 1,3,5-TMB, an RSL of 56 µg/L for 1,2,4-TMB and 60 µg/L for 1,3,5-TMB are used as a cleanup level for TMBs in FS-13 groundwater.

It is noted that MassDEP regulates TMBs as C₉-C₁₀ aromatic hydrocarbons using the MassDEP VPH analytical method (MassDEP 2002). The MassDEP GW-1 standard for C₉-C₁₀ aromatic hydrocarbons is 200 µg/L.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics. There has been a change to the toxicity factor used to calculate the cleanup levels at FS-13.

EPA has computed residential child noncancer tap water standards for 1,2,4-TMB and 1,3,5-TMB (EPA 2016). These are the most appropriate RBCs for the site. The updated RBC for 1,2,4-TMB is 56 µg/L and 60 µg/L for 1,3,5-TMB. These updated toxicity values for the TMBs (or values derived from future updates) should be used when performing the residual risk assessment as part of the three-step process to achieve site closure.

Changes in Risk Assessment Methods: There have been no changes in risk assessment methodology that affect protectiveness.

Review of RAOs: The RAOs developed for the final ROD (AFCEE 2000) and revised in the 2011 ESD (AFCEE 2011).

5.10.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information at this time that calls into question the protectiveness of the remedy.

5.10.7 Issues, Recommendations, and Follow-Up Actions

No specific recommendation or follow-up actions have been identified.

5.10.8 Protectiveness Determination

The remedy for the FS-13 groundwater plume is protective of human health and the environment. Remediation is progressing as expected. The LUCs are in place and are functioning as intended. Through natural attenuation processes, groundwater cleanup levels are expected to be reached over time and monitoring data indicate the contaminants are not migrating beyond the FS-13 area.

5.10.9 References

- AFCEC. 2017 (June). *Fuel Spill -13 2017 Long Term Monitoring Results Project Note*. 652000-SPEIM-FS13-PRJNOT-001. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013a (October). *Final 4th Five Year Review, 2007-2012, Massachusetts Military Reservation Superfund Site, Otis Air National Guard Base, MA*. 473147-SPEIM-Multiple- RPT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013b (May). *Fuel Spill -13 Land Use Control Project Note*. 437075-LUC-FS13-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- AFCEE. 2012a (August). *Final 2011 JBCC Vapor Intrusion Evaluation Technical Memorandum*. 420005-SPEIM-MULTIPLE-TECHMEM-002. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012b (January). *Fuel Spill-13 Field Investigation – Summary and Results Project Note*. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2011 (September). *Final Explanation of Significant Differences for the*
-

Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation. 389849-SPEIM-Multiple-RPT-001. Prepared by CH2M HILL for AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.

- _____. 2008 (September). *Final Explanation of Significant Differences for Chemical Spill-4, Chemical Spill-20, Chemical Spill-21, Fuel Spill-13, Fuel Spill-28 and Fuel Spill-29 Groundwater Plumes.* A4P-J23-35BC24VC-M26-0006. Prepared by Jacobs Engineering for AFCEE/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2006a (September). *Fuel Spill-13 (FS-13) Underground Fuel Line Cantonment Decision Document.* Prepared by Portage Environmental Inc. and Engineering Strategies Corporation for AFCEE/JBCC Installation Restoration Program, Otis ANG Base, MA.
- _____. 2006b (July). *Fuel Spill-13 (FS-13) Underground Fuel Line Cantonment Supplemental Site Inspection.* Prepared by Portage Environmental Inc. and Engineering Strategies Corporation for AFCEE/JBCC Installation Restoration Program, Otis ANG Base, MA.
- _____. 2005 (January). *Fuel Spill-13 Long-Term Monitoring Data Transmittal – November 2004 Results.* 176585-LTM-FS13-LRPT-001. Prepared by CH2M HILL for AFCEE/JBCC Installation Restoration Program, Otis ANG Base, MA.
- _____. 2000 (February). *Final Record of Decision for the CS-4, CS-20, CS-21, and FS-13 Plumes.* AFC-J23-35Q86101-M26-0004. Prepared by Jacobs Engineering Group Inc., for the AFCEE/JBCC IRP, Otis ANG Base, MA.
- _____. 1999a (June). *Proposed Plan for the Southwest Operable Unit (CS-4, CS-20, CS-21 and FS-13 plumes only).* AFC-J23-35Q86101-M25-0004. Prepared by Jacobs Engineering Group Inc., for the AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 1999b (June). *Final Southwest Operable Unit Feasibility Study.* AFC-J23-35Q86101-M16-0006. Prepared by Jacobs Engineering Group Inc., for the AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 1999c (May). *Final Southwest Operable Unit Remedial Investigation.* AFC-J23-35Q86101-M14-0006. Prepared by Jacobs Engineering Group Inc., for the AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- Aneptek. 1996 (March). *Site Inspection Technical Memorandum, Fuel Spill Site FS-13; IRP, JBCC Cape Cod, MA.* Prepared for ANG Readiness Center, Andrews Air Force, Maryland.

EPA. EPA. 2016 (September). Integrated Risk Information System (IRIS) database. [online]. Available:

https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/1037_summary.pdf

_____. 2005 (July). FS-13 Conditional Approval Letter to Discontinue Groundwater Monitoring. 25 July 2005.

_____. 2001 (June). *Comprehensive Five-Year Review Guidance*, EPA 540R-01-007.

Massachusetts Department of Environmental Protection (MassDEP). 2002 (October). *Characterizing Risks Posed by Petroleum Contaminated Sites: Implementation of the MADEP VPH/EPH Approach*. Final Policy #WSC-02-411. Available: <http://www.mass.gov/dep/cleanup/laws/02-411.pdf>.

Stone & Webster. 1997 (August). *FS-13 Remedial Investigation/Feasibility Study Data Package*. Prepared for Installation Restoration Program, Air National Guard Readiness Center, Andrews Air Force Base Maryland, by Stone & Webster Environmental Technology & Services, Boston, MA.

5.11 FUEL SPILL-28 (FS-28) GROUNDWATER

The FS-28 plume is a dissolved-phase groundwater plume (Figure 5-11A) that is defined as the extent of groundwater containing the FS-28 plume COC, EDB, at concentrations exceeding the MMCL of 0.02 µg/L.

5.11.1 Site Chronology

1993: The FS-28 plume was first discovered in 1993 beneath the leading edge of the CS-4 plume (AFCEE 1999c) and was subsequently investigated as a separate groundwater plume.

1996: EDB was found to be upwelling and discharging into the Coonamessett River at detectable levels (AFCEE 1999c).

1997: Completed the SWOU RI which included FS-28 (AFCEE 1999b).

1997-1999: Time-critical and non-time-critical removal actions were implemented to reduce the discharge of EDB in groundwater to the Coonamessett River surface water (AFCEE 1999a, 1999c).

2000: A FS, proposed plan, and ROD were completed (AFCEE 2000a, 2000b, 2000c). The final remedy consisted of continued operation of the existing remedial system installed under the time-critical and non-time-critical removal actions. Therefore, the remedy was in place at the time of the signature of the ROD.

2008: An ESD was prepared to further describe the institutional controls associated with the remedy (AFCEE 2008a)

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and added text regarding the JBCC three-step process to achieve site closure (AFCEE 2011)

5.11.2 Background

5.11.2.1 History of Contamination

The FS-28 plume is detached from its source area which remains unidentified. It is speculated that contamination was released at the ground surface from a fuel spill or spills on the JBCC, migrated through the vadose zone, and entered the groundwater at the water table. The dissolved phase contamination was then carried downgradient in groundwater in a southerly direction.

5.11.2.2 Physical Characteristics, Land and Resource Use

Based on the most recent groundwater monitoring data collected in 2017, the main body of the FS-28 plume is approximately 2,400 ft long, up to 1,200 ft wide, and up to 100 ft thick in the deeper portion of the aquifer. The plan view extent of the FS-28 plume is shown on Figure 5-11A. The footprint of the FS-28 plume was approximately 116 acres in 2012 and approximately 44 acres in 2017.

Land above the FS-28 plume is used for residential, limited commercial/industrial, agricultural, and recreational purposes. Recreational fishing is popular in this area, particularly in Coonamessett Pond, a portion of which is located above the plume footprint (Figure 5-11A). Agricultural use of land in the area of the FS-28 plume includes fruit and vegetable farms, and cultivation and harvesting of cranberries from the lowland bogs or river valleys. The Town of Falmouth Coonamessett Water Supply Well (CWSW) is located to the south of the western arm of Coonamessett Pond (Figure 5-11A). This well is a Public Water Supply Well (PWSW) that operates at approximately 550 gpm. The land above the FS-28 plume can be characterized as a broad, flat, gently southward sloping glacial outwash plain. Within the footprint of the plume, the maximum and minimum ground surface elevations are 82 ft msl and 18 ft msl, respectively.

5.11.2.3 Initial Responses

The summary of the initial responses is as follows:

Non-CERCLA Actions:

In 1996, AFCEE completed construction of a wellhead GAC system for the CWSW as a precaution, even though there was no evidence that this water supply well had been affected by the FS-28 plume. This wellhead GAC system was subsequently dismantled in 2004 when water from CWSW was connected to the Town of Falmouth's Crooked Pond treatment facility that is also installed with a wellhead carbon filtration system. In 1997 and 1998, in an effort to protect public health and eliminate the threat of EDB in private wells near homes above and/or near the FS-28 plume, AFCEE installed town water mains and piping to over 200 residents of the Hatchville area of Falmouth. Ten irrigation wells were also installed for cranberry growers along the river system to replace their previous use of surface water. Detectable levels of EDB in the Coonamessett River surface water as a result of the plume discharge led to the cranberry farmers being compensated for lost crops in 1997, 1998, 1999, and 2005 by the DoD. Based on an agreement that is in place with the FS-28 stakeholder group (comprised of EPA, MassDEP, MassDPH, and Cape Cod Cranberry Growers Association), the Coonamessett River cranberry crops will be considered suitable for market if EDB concentrations in surface water remain below the MMCL. The crops have been considered suitable for market since 2005.

CERCLA Actions:

AFCEE installed the FS-28 ETD system in 1997 (using a single deep extraction well – 69EW0001) under the CERCLA time-critical removal action process to capture the majority of the plume mass at Hatchville Road and to minimize upwelling of the plume into the Coonamessett River system (AFCEE 1999c).

In April 1999, AFCEE implemented a non-time-critical removal action which added additional extraction capacity to the system in the form of SWPs in an attempt to capture EDB-contaminated groundwater prior to its discharge to the Coonamessett River and neighboring cranberry bogs (AFCEE 1999a). Installation and operation of this SWP

system was successful in improving water quality in the river and bogs. In addition, AFCEE installed berms and sheet piles as part of this non-time critical removal action. The berms and sheet piles were designed to separate the Coonamessett River from the surrounding cranberry bogs.

During 2007, the FS-28 ETD system was further expanded through optimization with the installation of a second extraction well (69EW0002) to remediate a deeper leading edge lobe of the plume identified to the south of both 69EW0001 and the SWP system (AFCEC 2013a). Extraction well 69EW0002 came on-line on 11 December 2007 and was shut down on 12 June 2015 because the goal of aquifer restoration for the area upgradient of 69EW0002 had been achieved (AFCEC 2017c).

Since system startup in 1997, the operation of the FS-28 remedial system has been optimized several times and is currently operating at a total flow rate of 400 gpm from 69EW0001; the SWPs were permanently shutdown in 2010 because they were no longer contributing to aquifer restoration. Further details regarding the FS-28 remedial system can be found in the 2017 O&M Plan (AFCEC 2017a).

An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and updated the steps to achieve site closure (i.e., the three-step process) (AFCEE 2011).

5.11.2.4 Basis for Taking Action

The baseline cancer risk calculations in the RI indicated that unless remedial action is undertaken, future residential exposure to contaminated groundwater may present an excess lifetime cancer risk greater than the acceptable EPA range of 1×10^{-4} to 1×10^{-6} . In addition, acceptable risk thresholds were exceeded for cranberry workers and recreational waders (adult and child) exposed to surface water, and consumers of fish caught in the Coonamessett River (AFCEE 2000a).

Ecological risks associated with the FS-28 groundwater plume were evaluated during the RI and no significant risk was identified (AFCEE 2000a).

5.11.3 Remedial Actions

The final remedy for the FS-28 plume was determined in the *Final Record of Decision for the Fuel Spill-28 and Fuel Spill-29 Plumes* (AFCEE 2000a) which was signed on 23 October 2000.

The RAOs for the FS-28 groundwater plume as presented in the ROD (AFCEE 2000a) and modified in the ESD (AFCEE 2011) are as follows:

- Prevent residential exposure to FS-28 groundwater with EDB concentrations greater than the MMCL of 0.02 µg/L.
- Restore usable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.
- Prevent worker contact and child and adult wader contact with Coonamessett River water containing unacceptable concentrations of EDB*.
- Prevent ingestion of fish exposed to Coonamessett River water containing unacceptable concentrations of EDB*.

* Note that subsequent to the completion of the ROD, a screening-level human health risk evaluation was conducted to examine the potential for imminent human health risks from exposure to surface water containing EDB (Appendix D of AFCEE 2003). This screening level evaluation for EDB resulted in the development of an RBC for EDB of 7.71 µg/L in surface water at a target risk of 1×10^{-3} (constituting the potential for “imminent human health risks”).

5.11.3.1 Remedy Selection and Implementation

The selected remedy in the ROD (AFCEE 2000a) included the following components:

- Continued operation of the FS-28 ETD system including the deep extraction well (69EW0001), the 204 SWP system and the CWSW wellhead treatment system with treatment via GAC. At the time the ROD was prepared (2000), modeling indicated the aquifer restoration timeframe would be approximately 18 years (i.e., by 2018) through the operation of 69EW0001 and the SWPs.

- Extracted water would be treated with GAC. Treated water could be used, if necessary for cranberry operations in the upper bogs. Berms and vinyl sheet piles would separate cranberry bogs from the river.
- Continue to supply uncontaminated water to the agricultural users on the Coonamessett River.
- Institutional controls to mitigate exposure to humans from EDB-contaminated groundwater. In 1999, the Falmouth BOH adopted water well regulations to minimize the risk of exposure to groundwater contamination.
- Engineering controls to mitigate exposure to humans from EDB-contaminated groundwater. Residents potentially impacted by the plume are connected to a public water supply.
- Monitoring of the plume and performance monitoring of the treatment systems. Ecological sampling would also be conducted as part of the selected alternative.
- Completion of CERCLA reviews every five years throughout the lifetime of the remedial action.

Since the remedy was selected in 2000, the following changes have occurred:

- 1) A second extraction well (69EW0002) was added to the ETD system as an optimization initiative. This well was added in 2007 to contain and capture the deep leading edge plume lobe located to the south of the main EDB plume (Figure 5-11A). 69EW0002 was shutdown on 12 June 2015 because the goal of aquifer restoration for the area upgradient of 69EW0002 had been achieved.
- 2) The SWP system was shut down for an interim basis in November 2008 and permanently in February 2010. An optimization evaluation determined that the SWP system had been successful in remediating the portion of the plume it was intended to address and in reducing plume discharge to the river. Rather than continue to operate the SWP system inefficiently, it was agreed that the attenuation of the remaining residual EDB contamination will be monitored. The SWP system was permanently shut down on 25 February 2010 and decommissioned by February 2011.
- 3) The CWSW wellhead treatment system was shutdown and subsequently dismantled in 2004 when water from the CWSW was connected to the Town of Falmouth's Crooked Pond treatment facility.

- 4) The institutional controls described in the ROD were further developed as described in a 2008 ESD (AFCEE 2008a). The ESD provides a more thorough description of the LUC program, including a private well verification program that is being instituted for all the JBCC groundwater sites.
- 5) Removal of the vinyl sheet piles (475 linear ft) at a former cranberry bog owned by the Town of Falmouth (referred to as the 300 Committee Wetland) was completed in August 2010 at the request of the property owner since the bog is no longer used for cranberry farming.
- 6) A 2011 ESD for the IRP groundwater plumes (AFCEE 2011) clarified the inclusion of MNA as a component of the selected remedy for FS-28, slightly modified the phrasing of the RAOs, and added text regarding the JBCC three-step process to achieve site closure.

Remedial system performance monitoring data and long-term plume monitoring data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives and system performance metrics are being met; (ii) whether remediation is progressing as expected; and (iii) to identify and assess optimization opportunities. The data collected under the SPEIM/LTM program are presented to the regulatory agencies through the Technical Update meeting process and documented in annual SLRs.

As part of the LUC process specified in the ROD and subsequent ESD (AFCEE 2000a, 2008a), a private well verification survey was completed for FS-28 (and the Southwest Plumes) between April 2009 and August 2011 (AFCEE 2012c). This private well verification survey consisted of outreach to 497 parcels. No private wells that are used as a potable water supply were identified. One irrigation well located north of Hatchville Road, to the west of the FS-28 plume, has been regularly monitored by AFCEC since 1998 because it is used to supply irrigation water for hydroponic food cultivation. This well will continue to be monitored under AFCEC's LUC Program. No FS-28 COCs were detected at this irrigation well during this five-year review period. In the event that new private well information is obtained or plume monitoring data indicate a change to the CSM at FS-28, AFCEC will perform the necessary well determinations at the time the information

becomes available.

A review of the data collected under the FS-28 SPEIM program between 2012 and 2017 indicates that there are no changes to the plume CSM that would warrant a revision to the private well LUC monitoring program with respect to the current COC. However, due to a reduction in the plume footprint in 2015, the LUC area was reduced in size (AFCEC 2015a).

The status of non-operational private wells in the FS-28 LUC area continue to be tracked. AFCEC distributed a mailing, on an annual basis, to property owners within the LUC area that have non-operational wells. The intent of the annual mailing is to remind these property owners that they should contact AFCEC for a technical evaluation, which may include sampling, in the event their well is put back into service. Annual mailings were distributed during this five year review period and reported in the SLRs (AFCEC 2018, 2017c, 2016b, 2015c, 2014b, 2013c) and annual LUC reports. A summary of private wells that were restarted during this five year review period at FS-28 is provided below:

2013: One property owner responded that they were planning to restart a previously non-operational private well for use as private irrigation well. The restarted private well on Round Pond Road was sampled in July 2013 and no EDB was detected. A technical evaluation was completed on this well and based upon a review of SPEIM data and private well sampling data there is no current risk of exposure to the FS-28 groundwater plume through the intermittent use of these wells for outdoor purposes (AFCEC 2013a).

2014: No private wells restarted

2015: No private wells restarted

2016: No private wells restarted

2017: Annual mailings were sent in August 2017 and results will be reported in the next five year review.

5.11.3.2 Remedy Operation & Maintenance

The FS-28 remedial system is operated and maintained under an approved O&M Plan (AFCEC 2017a). The O&M Plan is updated on an annual basis and includes operational requirements, a summary of the operational history of the systems, and details of any system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and continue to be, addressed in a timely and effective manner such that O&M associated with the remedy is considered effective at achieving the remedy goals. Operational issues are identified in O&M monthly reports and system performance and reliability is reported in the annual SLRs.

The annual SPEIM/LTM/O&M costs associated with ongoing remedial action at FS-28 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives) and do not indicate potential remedy problems.

5.11.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior fourth CERCLA Five Year Review (AFCEC 2013a). For the FS-28 groundwater plume, the recommendations and follow-up actions were:

- 1) No specific recommendation or follow-up actions have been identified. However, the topic of emerging contaminants should be monitored as it relates to groundwater at FS-28 and the JBCC.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

- 1) FS-28 was not sampled for 1,4-dioxane because there were no solvents associated with the groundwater plume. It was also not sampled for PFAS because there was no evidence of AFFF use at the site.

5.11.5 Five Year Review Process

5.11.5.1 Data Review

The JBCC SPEIM program was developed to monitor plume changes and to ensure the effective operation of the AFCEC groundwater remediation systems at the JBCC. These objectives are met through monitoring of selected media (i.e., groundwater, surface water) within and outside the plume boundaries, treatment plant monitoring, and groundwater flow and transport modeling. The data collected under the SPEIM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being addressed through active treatment. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program. The SLRs also include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual reporting period as attachments or by reference. The SLRs are provided to the broad stakeholder group for each plume including Federal (EPA) and State (MassDEP, MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties. The SLRs are publically available in the IRP Administrative Record and copies are maintained at the local town libraries.

In addition to the annual SLRs prepared for FS-28 during this Five Year Review period (AFCEC 2018, 2017c, 2016b, 2015c, 2014b, 2013c), the following technical deliverables were prepared that assessed system performance or presented the results of optimization evaluations:

- *Fuel Spill-28 2012 Triennial SPEIM Data Presentation Project Note* (AFCEE 2012a)
- *Fuel Spill-28 2013 Annual SPEIM Data Presentation Project Note* (AFCEC 2013b)
- *Fuel Spill-28 2014 Annual SPEIM Data Presentation Project Note* (AFCEC 2014a)
- *Fuel Spill-28 2015 Triennial SPEIM Data Presentation Project Note* (AFCEE 2015a)
- *Fuel Spill-28 2015 69EW0002 Shutdown Project Note* (AFCEC 2015b)
- *Fuel Spill-28 2016 Annual and Semiannual SPEIM Data Presentation Project Note* (AFCEC 2016a)
- *Fuel Spill-28 2017 Annual SPEIM Data Presentation Project Note* (AFCEC 2017b)

5.11.5.2 Site Inspections

Refer to Section 3.6.

5.11.5.3 Interviews

Refer to Section 3.7.

5.11.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.11.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, the completion of the ROD in 2000, construction and startup of the remedial system in 2006, and completion of the well verification/well determination portion of the LUCs in 2011 have resulted in the remedy at FS-28 functioning as intended by the decision documents. However, given the plume delineation at the end of 2017, the plume should continue to be monitored and the aquifer restoration timeframe may need to be updated

during the next five years. If the aquifer is not restored to an acceptable extent toward the end of the next five year period, discussions should be held with EPA on whether an ESD is necessary to update the restoration timeframe.

5.11.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics: There have been no changes in the toxicity factors or other contaminant characteristics for the FS-28 groundwater COC (EDB) during this Five Year Review period and the MMCL remains at 0.02 µg/L.

The RBC for human health exposure to EDB in FS-28 surface water of 7.71 µg/L for a target risk of 1×10^{-3} (i.e., imminent human health risk) that was developed in 2003 (AFCEE 2003) was recalculated using updated toxicity information during the last Five Year Review (AFCEC 2013a). In 2004, the carcinogenic toxicity value for EDB for oral exposure was revised downward by more than an order of magnitude (EPA 2012). The recalculated RBC for EDB in surface water at FS-28 increased from 7.71 µg/L to 328 µg/L (under the “imminent risk to human health” scenario). The risk calculations have been again updated using the 2017 toxicity values from EPA (EPA 2017) and resulted in the same RBC (328 µg/L; Appendix E).

Changes in Risk Assessment Methods: There have been no changes in risk assessment methodology that affect protectiveness.

Review of RAOs: The RAOs developed for the final ROD (AFCEE 2000) and revised in the 2011 ESD (AFCEE 2011) are appropriate.

5.11.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information at this time that calls into question the protectiveness of the remedy.

5.11.7 Issues, Recommendations, and Follow-Up Actions

The updated toxicity values (or values derived from future updates) should be used when performing the residual risk assessment as part of the three-step process to achieve site closure.

The plume should continue to be monitored and the aquifer restoration timeframe should be updated during the next five years. If the aquifer is not restored to an acceptable extent toward the end of the next five year period (i.e., by 2022), discussions should be held with EPA on whether an ESD is necessary to update the restoration.

5.11.8 Protectiveness Determination

The remedy for the FS-28 groundwater plume is protective of human health and the environment in the short-term. The LUCs are in place and are functioning as intended. Current plume delineation indicates that the aquifer restoration timeframe identified in the ROD may not be met. For the remedy to be protective in the long-term, the aquifer restoration timeframe should be reassessed and an ESD issued, if necessary, to update the timeframe.

5.11.9 References

- AFCEC. 2018 (April). *Southwest Plumes 2017 Summary Letter Report*. 652000-SPEIM-SWP-SLR-004. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2017a (November). *2017 Operations and Maintenance Plan for Groundwater Extraction and Treatment Systems and Wind Turbine*. 652000-O&M-MULTIPLE-OMPLN-003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2017b (June). *Fuel Spill-28 2017 Annual SPEIM Data Presentation Project Note*. 652000-SPEIM-FS28-PRJNOT-004. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2017c (March). *Fuel Spill-28 2016 Summary Letter Report*. 652000-SPEIM-FS28-SLR- 002. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016a (December). *Fuel Spill-28 Annual and Semiannual SPEIM Data Presentation Project Note*. 652000-SPEIM-FS28-PRJNOT- 003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016b (March). *Fuel Spill-28 2015 Summary Letter Report*. 652000-SPEIM-FS28-SLR- 002. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015a (September). *Southwest Plumes 2015 Triennial SPEIM Data Presentation Project Note*. 652000-SPEIM-SWP-PRJNOT-001. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015b (June). *Fuel Spill-28 2015 69EW0002 Shutdown Project Note*. 652000-SPEIM-FS28- PRJNOT-001. Prepared by EA Engineering, Science and Technology and CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015c (March) *FS-28 2014 Summary Letter Report*. 652000-SPEIM-FS28-SLR-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014a (March). *Fuel Spill-28 2014 Annual SPEIM Data Presentation Project Note*. 473147-SPEIM-FS28-PRJNOT-001. Prepared by CH2M HILL for
-

- AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014b (March). *Fuel Spill-28 2013 Summary Letter Report*. 473147-SPEIM-FS28-SLR-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013a (October). *Final 4th Five Year Review, 2007-2012, Massachusetts Military Reservation Superfund Site, Otis Air National Guard Base, MA*. 473147-SPEIM-Multiple- RPT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013b (August). *Fuel Spill-28 2013 Annual SPEIM Data Presentation Project Note*. 437075-SPEIM-FS28-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013c (March) *FS-28 2012 Summary Letter Report*. 437075-SPEIM-FS28-SLR-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- AFCEE. 2012a (December). *Fuel Spill-28 2012 Triennial SPEIM Data Presentation Project Note*. 437075-SPEIM-FS28-PRJNOT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012b (August). *Final 2011 JBCC Vapor Intrusion Evaluation Technical Memorandum*. 420005-SPEIM-MULTIPLE-TECHMEM-002. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012c (February). *Fuel Spill-28 and Southwest Plumes 2011 Private Well Verification and Well Determination Project Note*. 420005-LUC-MULTIPLE-PRJNOT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2011 (September). *Final Explanation of Significant Differences for the Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation*. 404929-SPEIM-MULTIPLE-RPT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2008a (September). *Final Explanation of Significant Differences for Chemical Spill-4, Chemical Spill-20, Chemical Spill-21, Fuel Spill-13, Fuel Spill-28 and Fuel Spill-29 Groundwater Plumes*. A4P-J23-35BC24VC-M26-0006. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2003 (March). *Final Fuel Spill-28 2002 Annual System Performance and Ecological Impact Monitoring Report*. ENR-J23-35Z15614-M31-0003.
-

Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

- _____. 2000a (October). *Final Record of Decision for the Fuel Spill-28 and Fuel Spill-29 Plumes*. AFC-J23-35Q86101-M26-0009. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2000b (February). *Final Proposed Plan for the FS-28 and FS-29 Plumes in the Southwest Operable Unit*. AFC-J23-35Q86101-M25-0008. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2000c (January). *Final FS-28 and FS-29 Groundwater Feasibility Study*. AFC-J23-35Q86101-M16-0100. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 1999a (November). *Final FS-28 Non-Time-Critical Removal Action Memorandum*. AFC-J23-35S19002-M17-0014. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 1999b (May). *Final Southwest Operable Unit Remedial Investigation*. AFC-J23-35Q86101-M14-0006. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 1999c (March). *Final FS-28 Time Critical Action Memorandum*. AFC-J23-35K78408-M17-0024. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- EPA. 2017 (November). Integrated Risk Information System (IRIS) database. [online]. Available: <http://www.epa.gov/iris/index.html>.
- _____. 2001 (June). *Comprehensive Five-Year Review Guidance*, EPA 540R-01-007.

5.12 FUEL SPILL-29 (FS-29) GROUNDWATER

The FS-29 plume is a dissolved-phase groundwater plume that is defined as the extent of groundwater containing the COC, EDB, at concentrations exceeding its MMCL of 0.02 µg/L. The remaining COC, CCl₄, is detected sporadically at concentrations near its MCL of 5 µg/L, and is generally co-located with the EDB contamination. As of 2015, the plume is no longer defined as concentrations of COC are all below standards.

5.12.1 Site Chronology

1998: The FS-29 plume was discovered during the RI (AFCEE 1999b).

1999: The FS was completed in June 1999 (AFCEE 1999a).

2000: The proposed plan was released to the public in February 2000 (AFCEE 2000b), and the ROD was submitted in October 2000 (AFCEE 2000a).

2004: Completion of the final wellfield design consisting of two FS-29 extraction wells that were installed as part of the Southwest Plumes remedial system, which was designed to collectively remediate the CS-4, CS-20, CS-21, and FS-29 groundwater plumes (AFCEE 2004) (Figure 5-12A).

2006: Remedy in place was achieved in September 2006 with the startup of the FS-29 treatment system (AFCEE 2008b).

2008: An ESD was submitted to document changes to the selected remedy for FS-29 related to the expected extent of plume capture and further described the institutional controls associated with the remedy (AFCEE 2008a).

2010: The FS-29 remedial system was shut down in September 2010 having substantially remediated the aquifer within its capture zone (AFCEE 2010). The FS-29 extraction wells removed approximately 9 lbs of COCs from system startup in September 2006 through system shutdown in September 2010.

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and added text regarding the JBCC three-step process to achieve site closure (AFCEE 2011).

2017: The Final Fuel Spill-29 Three-Step Process Closure Work Plan was submitted and provides a detailed approach on how to complete the three-step process to site closure for the FS-29 groundwater plume (AFCEC 2017a).

5.12.2 Background

5.12.2.1 History of Contamination

When the FS-29 plume was delineated, it was detached from its source area which remains unidentified. It is speculated that contamination was released at the ground surface from a spill or release on the JBCC, migrated through the vadose zone, and entered groundwater at the water table. The dissolved phase contamination was then carried downgradient in groundwater in a south-southwesterly direction.

5.12.2.2 Physical Characteristics, Land and Resource Use

Based on groundwater monitoring data collected to date, the FS-29 plume is no longer delineated (Figure 5-12B).

The land above the former footprint of the FS-29 plume is undeveloped woodlands used for recreational purposes (hiking, biking, hunting, etc.) within the CWMA, which is managed by the MDFW (Figure 5-12A). The land above the majority of the former FS-29 plume is residential and recreational (The Golf Club of Cape Cod).

The eastern portion of the former FS-29 plume was located within a broad, flat, gently sloping glacial outwash plain. The western portion of the former plume travels into a hummocky north-south trending ridge of moraine glacial deposits. Within the former footprint of the plume, the maximum and minimum ground surface elevations are 154 ft msl and 52 ft msl, respectively.

5.12.2.3 Initial Responses

A summary of the initial responses is as follows:

Non-CERCLA Actions: None.

CERCLA Actions:

FS-29 Groundwater Plume: Following the 1998 RI (AFCEE 1999b), a FS was completed in 1999 (AFCEE 1999a). Following the FS, AFCEE and regulatory agencies agreed to present a new preferred alternative (Alternative 7) in the proposed plan issued in 2000 (AFCEE 2000b), which provided for expedited cleanup in the central portion of the plume. However, the preferred alternative for FS-29 was changed to Alternative 3 in response to public input. Therefore, the selected remedy for FS-29 as specified in the ROD was Alternative 3: conduct additional site characterization and groundwater modeling to better define the plume; design, construct, and operate a treatment system to hydraulically capture and treat plume contaminants; conduct performance monitoring of the FS-29 plume and remedial system and ecological sampling to monitor the impacts of the treatment system on the environment; and implement institutional controls (AFCEE 2000a).

The FS-29 remedial system consisted of two extraction wells (80EW0001 and 80EW0002) that began operation on 11 September 2006 at a design extraction rate of 525 gpm (Figure 5-12A). Extracted groundwater was treated by GAC in the centrally-located HATF and the treated water was returned to the aquifer through reinjection wells, an infiltration trench, and an infiltration gallery. The last operating FS-29 extraction well (80EW0001) was shut down in September 2010 because it was no longer contributing to cleanup of the FS-29 plume (AFCEE 2010) (i.e., no EDB was detected in the extraction well influent and CCl₄ concentrations were low). Further details regarding the FS-29 remedial system can be found in the 2017 O&M Plan (AFCEC 2017b).

An ESD was submitted in 2008 to document changes to the remedy for FS-29 (AFCEE 2008a) including the wellfield design/cleanup strategy; the ESD also further described the institutional controls (i.e., the private well verification program). The primary difference between the cleanup strategy identified in the ROD and the final design is that the selected alternative presented in the ROD anticipated that the entire FS-29 plume would be hydraulically captured by the remedial system; however, the final design allowed the groundwater contamination in the downgradient leading edge of FS-29 to reach cleanup levels through natural attenuation instead of through active treatment. While analyzing various designs for system performance, effectiveness, property access issues, and other constraints, the final design for FS-29 was developed to meet the RAOs described in Section 5.12.3, while allowing for a relatively small portion of the plume to attenuate naturally.

An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and updated the steps to achieve site closure (i.e., the three-step process) (AFCEE 2011).

A Final Fuel Spill-29 (FS-29) Three-Step Process Closure Work Plan (AFCEC 2017a) was submitted in December 2017. The three-step process is a requirement in all the JBCC IRP groundwater site RODs and associated ESDs and is intended to demonstrate that the RAOs for a given plume have been met, the site meets a condition of No Significant Risk for UU/UE, and to evaluate the feasibility of approaching or achieving background conditions. Note that sites that meet similar closure conditions under the MassDEP MCP are referred to as achieving a ‘Permanent Solution with No Conditions’. The JBCC RODs provided the basic framework for the three-step process to site closure, but the detailed actions required to complete the process were not defined. The FS-29 site will be the first JBCC IRP groundwater site to undergo the three-step process; therefore, the FS-29 Three-Step Process Closure Work Plan provides details on implementation and will be used as a general template for future site closure endeavors at the other JBCC IRP groundwater sites.

5.12.2.4 Basis for Taking Action

The baseline cancer risk calculations in the SWOU RI indicated that unless remedial action is undertaken, future residential exposure to EDB and CCl₄ in groundwater may present an excess lifetime cancer risk greater than the acceptable EPA range of 1×10^{-4} to 1×10^{-6} . Ecological risks associated with the FS-29 groundwater plume were evaluated during the RI and no significant risk was identified (AFCEE 1999b).

5.12.3 Remedial Actions

The final remedy for the FS-29 plume was determined in the *Final Record of Decision for the FS-28 and FS-29 Plumes* (AFCEE 2000a) which was signed on 23 October 2000. The RAOs for the FS-29 groundwater plume as presented in the ROD (AFCEE 2000a) and modified in the ESD (AFCEE 2011) are as follows:

- Prevent residential exposure to FS-29 groundwater with EDB concentrations greater than the MMCL of 0.02 µg/L.
- Prevent residential exposure to FS-29 groundwater with CCl₄ concentrations greater than the MCL of 5 µg/L.
- Restore useable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

5.12.3.1 Remedy Selection and Implementation

The selected remedy for FS-29 groundwater in the ROD (AFCEE 2000a) included the following components:

- The design, construction, and operation of a treatment system to hydraulically capture and treat plume contaminants,
- Institutional controls to mitigate exposure to humans from SWOU groundwater contaminants. In 1999, the Falmouth BOH adopted water well regulations to minimize the risk of exposure to groundwater contamination,
- Engineering controls to mitigate exposure to humans from SWOU groundwater contaminants. Residents potentially impacted by the plume are connected to a public water supply,
- Plume monitoring, performance monitoring of the treatment system, and ecological sampling to monitor the impacts of the system on the environment, and

- Completion of CERCLA reviews every five years throughout the lifetime of the remedial action.

Since the remedy was selected in 2000, the following changes have occurred:

- 1) The Wellfield Design (AFCEE 2004) presented the revised plan to treat the four Southwest Plumes (CS-4, CS-20, CS-21, and FS-29) via GAC at a centrally-located treatment plant (HATF) on the JBCC.
- 2) The institutional controls described in the ROD were further developed as described in the Southwest Plumes ESD (AFCEE 2008a). The ESD provides a more thorough description of the LUC Program, including a private well verification program that is being instituted for all the JBCC groundwater sites.
- 3) The 2011 ESD for the IRP groundwater plumes (AFCEE 2011) clarified the inclusion of MNA as a component of the selected remedy for FS-29, slightly modified the phrasing of the RAOs, and added text regarding the JBCC three-step process to achieve site closure.

The FS-29 remedial system was installed in 2006 and began operation on 11 September 2006 using two extraction wells at a total flow rate of 525 gpm. The last operating FS-29 extraction well (80EW0001) was shut down in September 2010 because it was no longer contributing to cleanup of the FS-29 plume (AFCEE 2010).

Remedial system performance monitoring data and long-term plume monitoring data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives are being met; (ii) whether remediation is progressing as expected; and (iii) to identify and assess optimization opportunities. The data collected under the SPEIM/LTM program are presented to the regulatory agencies through the Technical Update meeting process and documented in annual SLRs.

As part of the LUC process specified in the ROD and subsequent ESD (AFCEE 2000a, 2008a), a private well verification survey was completed for the Southwest Plumes (including FS-29) and FS-28 between April 2009 and August 2011 (AFCEE 2012b). This

private well verification survey consisted of outreach to 497 parcels. No private drinking water wells were identified within the FS-29 LUC area. A total of 40 properties associated with FS-29 were determined to have one or more private wells that are used as a non-potable water source. No private wells that were identified present an unacceptable exposure risk from FS-29 groundwater. Golf course irrigation well 69IG0018, has been monitored since 2005 but will be discontinued in 2018 once approval is final.

A review of the data collected under the FS-29 SPEIM program between 2012 and 2017 indicates that there are no changes to the plume CSM that would warrant a revision to the private well LUC program with respect to the current COCs.

The status of non-operational private wells in the FS-29 LUC area continue to be tracked. AFCEC distributed a mailing, on an annual basis, to property owners within the LUC area that have non-operational wells. The intent of the annual mailing is to remind these property owners that they should contact AFCEC for a technical evaluation, which may include sampling, in the event their well is put back into service. Annual mailings were distributed during this five year review period and reported in the SLRs (AFCEC 2018, 2017c, 2016b, 2015b, 2014b, 2013c) and annual LUC reports. No property owners notified AFCEC that they intended to restart a non-operational private well within FS-29 LUC area during this five year review period (2012 -2017).

5.12.3.2 Remedy Operation & Maintenance

When active groundwater extraction and treatment was ongoing at FS-29, the FS-29 remedial system was operated and maintained under an approved O&M Plan (AFCEC 2017b). The O&M Plan is updated on an annual basis and includes operational requirements, a summary of the operational history of the systems, and details of any system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and continue to be, addressed in a timely and effective manner such that O&M associated with the remedy is considered effective at achieving the remedy goals. Operational issues are identified in O&M monthly reports and system performance and reliability is reported in the annual SLRs.

The annual SPEIM/LTM/O&M costs associated with ongoing remedial actions at FS-29 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives) and do not indicate potential remedy problems. The cleanup of the FS-29 groundwater plume has transitioned from active treatment to natural attenuation only, and the three-step process to achieve site closure has begun at FS-29 (AFCEC 2017a).

5.12.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior fourth CERCLA Five Year Review (AFCEC 2013a). For the FS-29 groundwater plume, the recommendations and follow-up actions were:

- 1) No specific recommendation or follow-up actions have been identified. However, the topic of emerging contaminants should be monitored as it relates to groundwater at FS-29 and the JBCC.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

- 2) FS-29 was not sampled for 1,4-dioxane because there were no solvents associated with the groundwater plume. It was also not sampled for PFAS because there was no evidence of AFFF use at the site

5.12.5 Five Year Review Process

5.12.5.1 Data Review

The JBCC SPEIM program was developed to monitor plume changes and to ensure the effective operation of the AFCEC groundwater remediation systems at the JBCC. These objectives are met through monitoring of selected media (i.e., groundwater, surface water) within and outside the plume boundaries, treatment plant monitoring, and groundwater flow and transport modeling. The data collected under the SPEIM program are continually

assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being addressed through active treatment. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program. The SLRs also include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual reporting period as attachments or by reference. The SLRs are provided to the broad stakeholder group for each plume including Federal (EPA) and State (MassDEP, MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties. The SLRs are publically available in the IRP Administrative Record and copies are maintained at the local town libraries.

In addition to the annual SLRs prepared for the Southwest Plumes (including FS-29) during this Five Year Review period (AFCEC 2018, 2017c, 2016b, 2015b, 2014b, 2013c), the following technical deliverables were prepared that assessed system performance or presented the results of optimization evaluations:

- *Southwest Plumes 2012 Triennial SPEIM Data Presentation Project Note (AFCEC 2013d)*
- *Southwest Plumes 2013 Annual SPEIM Data Presentation Project Note (AFCEC 2013e)*
- *Southwest Plumes 2014 Annual SPEIM Data Presentation Project Note (AFCEE 2014a)*
- *Southwest Plumes 2015 Triennial SPEIM Data Presentation Project Note (AFCEC 2015a)*
- *Southwest Plumes 2016 Annual SPEIM Data Presentation Project Note (AFCEC 2016a)*

5.12.5.2 Site Inspections

Refer to Section 3.6.

5.12.5.3 Interviews

Refer to Section 3.7.

5.12.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.12.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, the completion of the ROD in 2000, construction and startup of the remedial system in 2006, and completion of the well verification/well determination portion of the LUCs in 2011 have resulted in the remedy at FS-29 functioning as intended by the decision documents. The remedial system performed as expected. Through the combination of the treatment by the remedial system (between system startup in 2006 and shutdown in 2010) and natural attenuation processes, groundwater cleanup levels were achieved within the timeframe approximated in the ROD (i.e., 2014).

5.12.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy. Since 2011, EDB at FS-

29 is either not detected or at concentrations below the MMCL, while CCl₄ concentrations have been below the MCL since 2015. As a result, a plume boundary is no longer depicted at FS-29.

Changes in Toxicity and Other Contaminant Characteristics: There have been no changes in the toxicity factors or other contaminant characteristics for the FS-29 groundwater COCs EDB and CC14 during this Five Year Review period and the MMCL remains at 0.02 µg/L for EDB and the MCL remains at 5 µg/L for CCl₄.

Changes in Risk Assessment Methods: There have been no changes in risk assessment methodology that affect protectiveness.

Review of RAOs: The RAOs developed for the final ROD (AFCEE 2000a) and revised in the 2011 ESD (AFCEE 2011) are appropriate and remain valid.

5.12.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information at this time that calls into question the protectiveness of the remedy.

5.12.7 Issues, Recommendations, and Follow-Up Actions

No specific recommendation or follow-up actions have been identified. However, the FS-29 plume is currently in the process of completing the Three-Step Process to site closure. In order to complete the site closure requirements presented in the ROD for the FS-29 groundwater plume (AFCEE 2000a), AFCEC prepared the *Final Fuel Spill- 29 (FS-29) Three-Step Process Closure Work Plan* (AFCEC 2017a) and collected the third and final round of data in 2017 to support the completion of the first step in the three-step process to site closure. AFCEC will prepare a Three-Step Process Step One Report for FS-29 in 2018 for regulatory review and continue with the rest of the process.

5.12.8 Protectiveness Determination

The remedy for the FS-29 groundwater plume is protective of human health and the environment. The remedial system performed for a shorter time than expected. The LUCs are in place and are functioning as intended. Groundwater cleanup has been achieved through active treatment and natural attenuation processes within the timeframe approximated in the ROD and the steps to achieve site closure are underway.

5.12.9 References

- AFCEC. 2018 (April). *Southwest Plumes 2017 Summary Letter Report*. 652000-SPEIM-SWP-SLR-004. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2017a (December). *Final Fuel Spill-29 Three-Step Process Closure Work Plan*. 652000-SPEIM-FS29-RPT-002. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2017b (November). *2017 Operations and Maintenance Plan for Groundwater Extraction and Treatment Systems and Wind Turbine*. 652000-O&M-MULTIPLE-OMPLN-003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2017c (March). *Southwest Plumes 2016 Summary Letter Report*. 652000-SPEIM-SWP-SLR-003. Prepared by CH2M for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016a (December). *Southwest Plumes 2016 Annual SPEIM Data Presentation Project Note*. 652000-SPEIM-SWP-PRJNOT-002. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016b (March). *Southwest Plumes 2015 Summary Letter Report*. 652000-SPEIM-SWPSLR- 003. Prepared by Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015a (September). *Southwest Plumes 2015 Triennial SPEIM Data Presentation Project Note*. 652000-SPEIM-SWP-PRJNOT-001. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015b (May). *Southwest Plumes 2014 Summary Letter Report*. 652000-SPEIM-
-

- SWP-SLR-001. Prepared by CH2M for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014a (July). *Southwest Plumes 2014 Annual SPEIM Data Presentation Project Note*. 473147-SPEIM-SWP-PRJNOT-003. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014b (March). *Southwest Plumes 2013 Summary Letter Report*. 473147-SPEIM-SWP-SLR-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013a (October). *Final 4th Five Year Review, 2007-2012, Massachusetts Military Reservation Superfund Site, Otis Air National Guard Base, MA*. 473147-SPEIM-Multiple-RPT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013b (June). *Confirmation of Private Well Operational Status: Installation Restoration Program Land Use Control Areas*. 437075-LUC-Multiple-PRJNOT-002. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013c (March). *Southwest Plumes 2012 Summary Letter Report*. 437075-SPEIM-SWP-SLR-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013d (December). *Southwest Plumes 2012 Triennial SPEIM Data Presentation Project Note*. 437075-SPEIM-SWP-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013e (November). *Southwest Plumes 2013 Annual SPEIM Data Presentation Project Note*. 473147-SPEIM-SWP-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- AFCEE 2012a (August). *Final 2011 MMR Vapor Intrusion Evaluation Technical Memorandum*. 420005-SPEIM-MULTIPLE-TECHMEM-002. Prepared by CH2M HILL for AFCEE/MMRJBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012b (February). *Fuel Spill-28 and Southwest Plumes 2011 Private Well Verification and Well Determination Project Note*. 420005-SPEIM-LUC-MULTIPLE-PRJNOT-001. Prepared by CH2M HILL for AFCEE/MMRJBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2011 (September). *Final Explanation of Significant Differences for the Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation*. 404929-SPEIM-MULTIPLE-RPT-001. Prepared by CH2M HILL for AFCEE/MMRJBCC, Installation Restoration Program, Otis Air

National Guard Base, MA.

- _____. 2010 (October). *Project Note: FS-29 Extraction Well 80EW0001 Interim Shut Down*. 404929-SPEIM-SWP-PRJNOT-002. Prepared by CH2M HILL for AFCEE/MMRJBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2008a (September). *Final Explanation of Significant Differences for Chemical Spill-4, Chemical Spill-20, Chemical Spill-21, Fuel Spill-13, Fuel Spill-28, and Fuel Spill-29 Groundwater Plumes*. A4P-J23-35BC24VC-M26-0006. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMRJBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2008b (September). *Final Interim Remedial Action Report for CS-4, CS-20, CS 21, and FS 29 (Southwest Plumes), and CS-23/LF-1 Groundwater Plumes*. Prepared by ECC for AFCEE/MMRJBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2004 (August). *Final Chemical Spill-4, Chemical Spill-20, Chemical Spill-21 and Fuel Spill-29 Wellfield Design Report*. A3P-J23-35Z00102-M23-0004. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMRJBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2000a (October). *Final Record of Decision for the FS-28 and FS 29 Plumes*. AFC-J23-35Q86101-M26-0009. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMRJBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2000b (February). *Proposed Plan for the FS-28 and FS-29 Plumes in the Southwest Operable Unit*. AFC-J23-35Q86101-M25-0008. Prepared by Jacobs Engineering Group Inc., for the AFCEE/MMRJBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 1999a (June). *Final Southwest Operable Unit Feasibility Study*. AFC-J23-35Q86101-M16-0006. Prepared by Jacobs Engineering Group Inc., for the AFCEE/MMRJBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 1999b (May). *Final Southwest Operable Unit Remedial Investigation*. AFC-J23-35Q86101-M14-0006. Prepared by Jacobs Engineering Group Inc., for the AFCEE/MMRJBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- EPA. 2013 (March). Integrated Risk Information System (IRIS) database. [online]. Available: <http://www.epa.gov/iris/index.html>.
- _____. 2001 (June). Comprehensive Five-Year Review Guidance, EPA 540R-01-007.

5.13 LANDFILL-1 (LF-1) GROUNDWATER

The LF-1 plume is a dissolved-phase groundwater plume (Figure 5-13A) that contains the following eight COCs: PCE, TCE, vinyl chloride (VC), CCl₄, 1,4-dichlorobenzene (1,4-DCB), 1,1,2,2-TeCA, EDB and Mn. The LF-1 plume boundary is defined as the extent of groundwater containing PCE and TCE at concentrations exceeding their MCL of 5 µg/L. The current distribution of the remaining six LF-1 COCs at concentrations exceeding their respective standards is contained within the area of the composite TCE/PCE plume boundary (Figure 5-13A). The cleanup levels for the remaining six LF-1 COCs are as follows: VC (MCL = 2 µg/L); CCl₄ (MCL = 5 µg/L); 1,4-DCB (MMCL = 5 µg/L); 1,1,2,2-TeCA (MCP GW-1 standard = 2 µg/L); EDB (MMCL = 0.02 µg/L); and Mn (EPA HA = 300 µg/L).

5.13.1 Site Chronology

1983: A records search identified the JBCC landfill as a potential source for the VOCs detected in June 1979 in a base water supply well (the G well) approximately 6,000 ft downgradient of the landfill (ANG 1983).

1985 - 1996: Numerous other investigations (ABB-ES 1992; ANG 1985 and 1991; and E.C. Jordan 1988, 1990a, 1990b) were conducted which culminated in an RI report (AFCEE 1996b).

1994 - 1995: The NGB, DOD, EPA, MassDEP, and local communities approved a Plume Response Plan that presented an accelerated effort toward “simultaneous containment” of seven groundwater plumes including LF-1. An IROD for the seven groundwater plumes emanating from the JBCC was signed on 25 September 1995 (ANG 1995). The IROD stated that groundwater extraction and treatment systems should be designed, installed, and operated until a final remedy for the site is chosen. The interim remedy for the LF-1 plume included extraction of contaminated groundwater and discharge of treated water to groundwater (and/or other beneficial use) and institutional controls.

1999: Completion of the wellfield design which consisted of five extraction wells and an infiltration gallery (AFCEE 1999) that began operation on 26 August 1999 (AFCEE 2002).

2006: The FS was completed (AFCEE 2006c) followed by the release of the proposed plan (AFCEE 2006b).

2006: As part of the final remedy, AFCEE expanded the remedial system by adding an extraction well (27EW0006) to meet the design objective of capturing the plume at the base boundary (AFCEE 2006a, 2007).

2007: ROD finalized (AFCEE 2007).

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and added text regarding the JBCC three-step process to achieve site closure (AFCEE 2011a).

2014: A presence/absence (Site Inspection equivalent) 1,4-dioxane field investigation at the LF-1 plume was completed between October 2013 and March 2014 (AFCEC 2014a,b).

2015: In October 2015, the EPA requested AFCEC sample the LF-1 extraction wells since PFAS contamination has been associated with landfills at other Department of Defense facilities (AFCEC 2015a).

2016: The initial presence/absence (Site Inspection equivalent) PFAS field effort for the LF-1 plume was completed between January and February 2016 and included the sampling of the LF-1 and CS-23 extraction wells, influent and effluent plant sampling ports at the LF-1 and HATF plants, and six LF-1 monitoring wells. (AFCEC 2017b).

2016: A Supplemental RI workplan was prepared that outlined the steps to determine the nature and extent of 1,4-dioxane groundwater contamination at LF-1, evaluate its fate and transport, and determine if potentially unacceptable risks to human health and the environment exist (AFCEC 2016b).

2017: A Supplemental RI was performed at LF-1 for PFAS and 1,4-dioxane (AFCEC 2018b).

5.13.2 Background

5.13.2.1 History of Contamination

The LF-1 source area is a solid waste landfill located in the southern portion of the JBCC and is bounded by Turpentine Road to the east, Frank Perkins Road to the west, Herbert Road to the north, and Connery Avenue to the south (Figure 5-13A). The LF-1 source area, which occupies approximately 100 acres of open to heavily wooded terrain, began operating in 1941 as the primary solid waste disposal facility at JBCC. From the late 1940s until 1984, unregulated disposal activities were conducted at the site; from 1984 to 1993, regulated disposal activities were conducted by the NGB at the LF-1 landfill as a component of the JBCC Hazardous Waste Management Plan. Disposal at the landfill occurred in six areas consisting of five distinct cells and a natural kettle hole. The cells are designated by the years representing the approximate end date of waste disposal activities. The six disposal areas include the 1947, 1951, and 1957 cells, referred to as the NWOU, which occupy approximately 40 acres of the total LF-1 landfill area; and the 1970 and Post-1970 cells and the Kettle Hole, which occupy approximately 50 acres. The remaining 10 acres comprise the space between and surrounding the cells. The thickness of waste burial has not been accurately determined, but is estimated to be about 20 ft thick for the 1970 and Post-1970 cells; while the thickness of waste in the Kettle Hole is unknown (E.C. Jordan Co. 1988 and 1990b). Approximately 100 additional acres were used in and around the site for construction soil material borrow pits, access roads, staging areas, and cross gradient or downgradient surface water recharge areas (i.e., retention/detention basins).

Accurate documentation of the wastes disposed of at the LF-1 landfill does not exist. The wastes are believed to include general refuse, fuel tank sludge, herbicides, solvents, transformer oils, fire extinguisher fluids, blank small arms ammunition, paints, paint thinners, batteries, DDT powder, hospital wastes, municipal sewage sludge, coal ash, and possibly live ordnance (AFCEE 2012c).

5.13.2.2 Physical Characteristics, Land and Resource Use

Based on the most recent groundwater monitoring data collected, the LF-1 plume has a maximum width of approximately 4,500 feet (ft) and a maximum vertical thickness in the aquifer of approximately 110 ft. The maximum depth to the bottom of the plume is approximately 290 ft bgs. The footprint of the LF-1 plume occupies approximately 771 acres (Figure 5-13B). While no longer a continuous plume, LF-1 extends approximately 3.5 miles from the trailing edge near the landfill source area (in the northeast) to the west-southwest where the leading edge uncaptured portions of the northern and southern lobes of the groundwater plume discharge to the surface waters of Red Brook Harbor and Squeteague Harbor, respectively (Figure 5-13A).

The area above the on-base portions of the LF-1 plume consists primarily of a housing area operated by the USCG and a cemetery operated by the U.S. Department of Veterans Affairs. The land use above the plume in the off-base area between the JBCC base boundary and Route 28 is characterized by undeveloped woodlands (Figure 5-13A). The off-base area west of Route 28 is primarily residential, with smaller areas characterized as recreational, conservation land, and limited industrial/commercial. The topography of the land at the far eastern and western portions of the LF-1 plume can be characterized as broad, flat, gently sloping glacial outwash plains. However, in the middle of the LF-1 plume area centering on the extraction well fence, the plume travels through and beneath a hummocky north-south trending ridge of moraine glacial deposits. Within the footprint of the plume, the maximum and minimum ground surface elevations are 259 ft msl and 0 ft msl, respectively.

The Town of Bourne operates two PWSWs (BOPWS0002 and BOPWS0005) that are located approximately 2,500 ft downgradient (i.e., west) of the base boundary and the LF-1 infiltration system (Figure 5-13A). The LF-1 remedial design (AFCEE 1999) included an infiltration system (later supplemented with a reinjection well) positioned upgradient of the PWSWs in order to deflect the plume away from the PWSWs and flood the zones of contribution of the water supply wells with treated water. Five sentry monitoring wells located between the PWSWs and the LF-1 infiltration system/reinjection well are

monitored on an annual basis to determine whether the LF-1 plume COCs are present in groundwater upgradient of the water supply wells. The analytical results are provided to the Bourne Water District and the regulatory agencies in annual letter reports.

5.13.2.3 Initial Responses

A summary of the initial responses is as follows:

Non-CERCLA Actions

None.

CERCLA Actions

The DoD and EPA, with concurrence from the MassDEP, implemented an interim action for the LF-1 groundwater plume and six other JBCC plumes under an IROD (ANG 1995). The selected remedy for the LF-1 plume included extraction of contaminated groundwater and discharge of treated water to groundwater (and/or other beneficial use) and institutional controls.

The TRET, established in 1996 as part of a new IROD management process, reviewed wellfield designs and determined that the 60-percent design for containment of several of the IROD plumes would cause negative ecological impacts (TRET 1996). The proposed interim remedy for the LF-1 groundwater plume was then revised to include the design and installation of an ETI remedial system to capture the LF-1 Northern and Southern lobes at the JBCC base boundary with MNA for the on-base Central lobe (AFCEE 1998). Downgradient (i.e., west) of the JBCC base boundary, the LF-1 plume was expected to naturally attenuate and/or discharge to Red Brook or Squeteague harbors. In addition, as part of the interim remedy, the Air Force agreed to complete a study to estimate the extent of natural resources damage; to work with the Natural Resources Trustees and regulators to develop the scope, schedule, oversight and review of this natural resources study; to provide funding to replace Bourne PWSWs BOPWS0002 and BOPWS0005 (referred to as the Bourne Water Provision); and to connect residents using private wells within the

footprint or path of the plume to municipal water supplies.

The interim LF-1 remedial system began operation on 26 August 1999 with five extraction wells at a design extraction rate of 700 gpm with treatment through GAC. Extracted groundwater is treated by GAC at the LF-1 treatment plant and is returned to the aquifer through a reinjection well (added in 2008), infiltration gallery and two infiltration trenches.

The U.S. Department of Veterans Affairs (VA) expanded their facility and grounds in 2008 and requested the use of LF-1 treated groundwater for irrigation of the expanded grounds. The AFCEE investigated the feasibility of that action using the LF-1/CS-23 groundwater model, assuming an average annualized effluent diversion of 135 gpm to the VA irrigation system. The modeling predictions indicated that the diversion of treated water will not adversely affect the LF-1 plume or system performance. Effluent water from the LF-1 treatment plant began to be diverted to the VA irrigation system in May 2008. Note that the VA irrigation system was offline through much of 2017, so the amount of effluent diverted to the VA during 2017 was much less than anticipated. Based on information provided by the VA, the average annualized effluent flow diversion from the LF-1 treatment plant to the VA irrigation system between January and December 2017 was estimated to be less than 1 gpm, which is well below the value used in the modeling evaluation (135 gpm). Therefore, it can be concluded that the diversion of effluent to the VA for irrigation continues to have no adverse effect on the remedial actions at LF-1.

Data collected after the interim LF-1 remedial system began operation indicated that a previously uncharacterized portion of the LF-1 plume would escape capture of the system and migrate off-base to such a degree as to not meet the system design goals (restoring the aquifer between the JBCC western base boundary and Route 28 within 20 years of remedial system start-up) (AFCEE 2005). As part of the final remedy AFCEE expanded the remedial system by adding an extraction well (27EW0006) along the southern plume boundary to meet the design objective of capturing the plume at the base boundary (AFCEE 2007). Extraction well 27EW0006 was installed concurrently with CS-23 extraction wells 27EW0007 and 27EW0008 (AFCEE 2006a); all three extraction wells began operation on 05 December 2006. The extracted groundwater from the extraction wells in the southern

portion of LF-1 (27EW0002 and 27EW0006) is combined with the extracted groundwater from 27EW0007 and 27EW0008, treated at the HATF by GAC, and is then returned to the aquifer through two infiltration trenches. The HATF was constructed as part of the remedial action for the CS-4, CS-20, CS-21, and FS-29 plumes (AFCEE 2008). Further details regarding the LF-1/CS-23 HATF remedial system can be found in the 2017 O&M Plan (AFCEC 2017a).

An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and updated the steps to achieve site closure (i.e., the three-step process) (AFCEE 2011a).

5.13.2.4 Basis for Taking Action

The baseline cancer risk calculations in the LF-1 RI indicated that unless remedial action is undertaken, future residential exposure to the LF-1 COCs in groundwater may present an excess lifetime cancer risk greater than the acceptable EPA range of 1×10^{-4} to 1×10^{-6} (AFCEE 1996b). Ecological risks associated with the LF-1 groundwater plume (AFCEE 1996b) as well as evaluations of contaminant body burdens in shellfish and sediment pore water (TRET 2001; ATSDR 2002) have indicated no significant risk was identified (AFCEE 2004).

5.13.3 Remedial Actions

The final remedy for the LF-1 plume was determined in the *Final Record of Decision for the LF-1 Source Area and Groundwater* (AFCEE 2007) which was signed on 28 September 2007.

The RAOs for the LF-1 groundwater plume as presented in the ROD (AFCEE 2007) and modified in the ESD (AFCEE 2011a) are as follows:

- Prevent residential exposure to LF-1 groundwater with TCE concentrations greater than the MCL of 5 µg/L.
- Prevent residential exposure to LF-1 groundwater with PCE concentrations greater than

the MCL of 5 µg/L.

- Prevent residential exposure to LF-1 groundwater with CCl₄ concentrations greater than the MCL of 5 µg/L.
- Prevent residential exposure to LF-1 groundwater with 1,1,2,2-TeCA concentrations greater than the Massachusetts GW-1 standard of 2 µg/L.
- Prevent residential exposure to LF-1 groundwater with VC concentrations greater than the MCL of 2 µg/L.
- Prevent residential exposure to LF-1 groundwater with EDB concentrations greater than the MMCL of 0.02 µg/L.
- Prevent residential exposure to LF-1 groundwater with 1,4-DCB concentrations greater than the MMCL of 5 µg/L.
- Prevent residential exposure to LF-1 groundwater with Mn concentrations greater than the HA of 300 µg/L.
- Restore useable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.
- Prevent exposure to LF-1 groundwater for human receptors under non-residential use scenarios (including dermal contact, ingestion, and inhalation), unless shown that such use does not present a carcinogenic risk in excess of the EPA target risk range of 10⁻⁴ to 10⁻⁶ or present a non-carcinogenic hazard index greater than 1.0.

5.13.3.1 Remedy Selection and Implementation

The selected remedy for the LF-1 groundwater operable unit in the ROD (AFCEE 2007) included the following components:

- Continued operation of the existing LF-1 ETI system (five extraction wells and an associated infiltration gallery), the installation of one additional extraction well (27EW0006) south of 27EW0002 to increase capture of the southern portion of the LF-1 plume, and the Bourne Water Provision (Note: the LF-1 infiltration gallery and trenches have since been supplemented with a reinjection well).
- Implementation of LUCs for the LF-1 groundwater selected remedy with the performance objectives of:
 - Prevent or reduce access to or use of the groundwater from the LF-1 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 landfill cover system, the treatment systems, and monitoring wells.
- Chemical and hydraulic monitoring of the plume, as long as active remediation continues, and chemical monitoring of the plume until the RAOs are met.

- Completion of CERCLA reviews every five years throughout the lifetime of the remedial action.

Since the groundwater remedy was selected in 2007, the following changes have occurred: the 2011 ESD for the IRP groundwater plumes (AFCEE 2011a) clarified the inclusion of MNA as a component of the selected remedy for LF-1, slightly modified the phrasing of the RAOs, and added text regarding the JBCC three-step process to achieve site closure.

Remedial system performance monitoring data and long-term plume monitoring data collected under the SPEIM program are used to: i) assess whether the remedial objectives and system performance metrics are being met; ii) assess whether remediation is progressing as expected, and; iii) identify and assess optimization opportunities. The data collected under the SPEIM program are presented to the regulatory agencies through the Technical Update meeting process and documented in annual SLRs.

The close proximity of the LF-1 and CS-23 plumes and remedial systems warrant that the LF-1 and CS-23 SPEIM programs be combined. Therefore, data collection, data assessment, groundwater modeling, and reporting are performed jointly under a combined LF-1/CS-23 SPEIM program.

As part of the LUC process specified in the ROD (AFCEE 2007), a private well verification survey was completed for the LF-1 and CS-23 plumes between November 2008 and August 2010. This private well verification survey consisted of outreach to 482 parcels. Two parcels were identified that have private wells used as a potable water supply. The private residential well at APEMS ID 84394 was determined to be sufficiently outside of the LF-1 plume footprint and is not anticipated to represent complete exposure pathway to the LF-1 plume; therefore routine monitoring is not required. Due to its location near a plume discharge area (Squeteague Harbor), the second private well was selected for annual sampling under AFCEC's LUC Program. In the event that new private well information is obtained or plume monitoring data indicate a change to the CSM at LF-1, AFCEC will perform the necessary well determinations at the time the information becomes available.

A review of the data collected under the LF-1 SPEIM program in 2012-2017 indicates that there are no changes to the plume CSM that would warrant a revision to the private well LUC program with respect to the current COCs.

The status of non-operational private wells in the LF-1 LUC area continue to be tracked. AFCEC distributes a mailing, on an annual basis, to property owners within the LUC area that have non-operational wells. The intent of the annual mailing is to remind these property owners that they should contact AFCEC for a technical evaluation, which may include sampling, in the event their well is put back into service. Annual mailings were distributed during this five year review period and reported in the SLRs (AFCEC 2018a, 2017b, 2016c, 2015c, 2014d, 2013d) and annual LUC reports. A summary of private wells that were restarted during this five year review period at LF-1 is provided below:

2012: No private wells restarted

2013: No private wells restarted

2014: No private wells restarted

2015: No private wells restarted

2016: No private wells restarted. The property with a private drinking water well monitored under AFCEC LUC Program was sold, redeveloped and connected to municipal water. The private well is no longer in service so monitoring has been discontinued; however annual mailings to determine whether the well becomes operational will continue.

2017: Annual mailings were sent in August 2017 and results will be reported in the next five year review.

5.13.3.2 Remedy Operation & Maintenance

The LF-1 remedial system is operated and maintained under an approved O&M Plan (AFCEC 2017a). The O&M Plan is updated on an annual basis and includes operational

requirements, a summary of the operational history of the systems, and details of any system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and continue to be, addressed in a timely and effective manner such that O&M associated with the remedy is considered effective at achieving the remedy goals. Operational issues are identified in O&M monthly reports and system performance and reliability is reported in the annual SLRs.

The annual SPEIM/LTM/O&M costs associated with ongoing remedial actions at LF-1 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives) and do not indicate potential remedy problems.

5.13.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior fourth CERCLA Five Year Review (AFCEC 2013a). For the LF-1 groundwater plume, the recommendations and follow-up actions were:

- 1) Contaminant transport modeling completed since the ROD indicate that the restoration timeframe predicted at the time of remedy selection (i.e., by 2045) may not be met, however the current estimates contain considerable uncertainty. An optimization assessment of the LF-1/CS-23 remedial system will be performed with an updated plume shell that more closely represents the current distribution of contamination within the plume. The optimization evaluation will assess the performance of the remedial system, determine whether improvements can be made, and update the restoration timeframe prediction for comparison to the information presented in the ROD. If necessary at the conclusion of the optimization assessment, an ESD presenting the updated prediction for aquifer restoration timeframe will be completed. AFCEC should continue to monitor the wetland and vernal pool near LF-1/CS-23 for potential ecological impacts associated with the surface water drawdown due to the operation of the remedial

system.

- 2) In addition, the topic of emerging contaminants should be monitored as it relates to groundwater at the JBCC. Specifically for LF-1 groundwater, a sampling and analysis plan shall be submitted to the regulatory agencies to assess the possible presence of 1,4-dioxane.

Progress since the last Five Year Review against these recommendations and follow-up actions are as follows:

- 1) A modeling-based optimization evaluation was completed for the LF-1/CS-23 remedial system in 2013, resulting in a new operational condition referred to as 2014 Scenario 01, was implemented on 02 April 2014 and meets remedial expectations presented in the RODs including the estimated restoration timeframe of approximately 2045 (AFCEC 2014c). A hydraulic evaluation was completed in 2014 to determine the extent of hydraulic capture of the LF-1/CS-23 remedial system under 2014 Scenario 01 flow rates, and to evaluate the ability of LF-1/CS-23 groundwater model to accurately simulate hydraulic capture and predict plume migration and capture (AFCEC 2015b).

Hydraulic monitoring data were collected through 2014 for an ecological evaluation of LF-1 and CS-23 wetlands and surface water bodies. A review of the data collected between 2006 and 2014 indicated that the critical period, where potential adverse impacts to the ecosystem may have occurred as a result of hydraulic drawdown from operation of the remedial system, has passed due to decreasing remedial system flow rates. Therefore, the ecological and hydrological data evaluation for Spectacle Wetland and Vernal Pool No. 651 was discontinued, with Regulatory Agency concurrence. Further details are provided in the LF-1/CS-23 2014 Wetland and Surface Water Ecological Evaluation Project Note (AFCEC 2014f).

- 2) A Supplemental RI has been completed by AFCEC for emerging contaminants at LF-1 (AFCEC 2018b). The initial recommendation to perform sampling for 1,4-dioxane at the LF-1 chlorinated solvent plume was presented in the *Final 4th Five-Year Review, 2007-2012 Massachusetts Military Reservation (MMR) Superfund Site Otis Air National Guard Base, MA* (AFCEC 2013a). A presence/absence (CERCLA SI equivalent) 1,4-dioxane field investigation at the LF-1 plume was completed between October 2013 and March 2014. The initial 1,4-dioxane field effort for the LF-1 plume included the sampling of the LF-1 extraction wells and influent and effluent plant sampling ports, 12 LF-1 monitoring wells that were selected based on historic 1,1,1-TCA and 1,1-DCE monitoring data, and the two Bourne PWSWs (AFCEC 2014a,b). In October 2015, the EPA requested AFCEC sample the LF-1 extraction wells for PFAS since PFAS contamination has been associated with landfills at other Department of Defense facilities (AFCEC 2015a). The initial presence/absence PFAS field effort for the LF-1 plume was completed between January and February 2016. Based on results, the LF-1 Supplemental RI sampling program was presented in the *Final Supplemental Remedial Investigation/Feasibility Study Work Plan for 1,4-Dioxane at Chemical Spill-10, Chemical Spill-20, and Landfill-1, Joint Base Cape Cod, MA* (AFCEC 2016b). The Supplemental RI field investigation was completed between September 2015 and March 2017. Results of the Supplemental RI investigation can be found in the *Final Supplemental Remedial Investigation for 1,4-Dioxane and Perfluorinated Compounds at Landfill-1, Joint Base Cape Cod, MA* (AFCEC 2018b).

5.13.5 Five Year Review Process

5.13.5.1 Data Review

The JBCC SPEIM program was developed to monitor plume changes and to ensure the effective operation of the AFCEC groundwater remediation systems at the JBCC. These objectives are met through monitoring of selected media (i.e., groundwater, surface water) within and outside the plume boundaries, treatment plant monitoring, and groundwater flow and transport modeling. The data collected under the SPEIM program are continually

assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being addressed through active treatment. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program. The SLRs also include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual reporting period as attachments or by reference. The SLRs are provided to the broad stakeholder group for each plume including Federal (EPA) and State (MassDEP, MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties. The SLRs are publically available in the IRP Administrative Record and copies are maintained at the local town libraries.

In addition to the annual SLRs prepared for LF-1 during this Five Year Review period (AFCEC 2018a, 2017b, 2016c, 2015c, 2014d, 2013d), the following technical deliverables were prepared that assessed system performance, the potential hydrologic and ecological impacts of system operation, and presented the results of optimization evaluations:

- *LF-1/CS-23 2012 Wetland and Surface Water Ecological Evaluation Project Note.* (AFCEC 2012b)
- *LF-1 Source Area Direct Push Sample Results and Continuing Source Evaluation Project Note* (AFCEC 2013b)
- *LF-1/CS-23 2012 Annual SPEIM Data Presentation Project Note.* (AFCEC 2013e)

- *LF-1/CS-23 2013 Remedial System Optimization Evaluation Data Presentation Project Note* (AFCEC 2014c)
- *LF-1/CS-23 2014 Triennial SPEIM Data Presentation Project Note* (AFCEC 2014e)
- *LF-1/CS-23 2014 Wetland and Surface Water Ecological Evaluation Project Note* (AFCEC 2014f)
- *LF-1/CS-23 2015 Annual SPEIM Data Presentation Project Note* (AFCEC 2015d)
- *Bourne Upgradient Groundwater Monitoring September 2016 Annual Results Letter Report.* (AFCEC 2016a)
- *LF-1/CS-23 2016 Annual SPEIM Data Presentation Project Note* (AFCEC 2017c)

5.13.5.2 Site Inspections

Refer to Section 3.6.

5.13.5.3 Interviews

Refer to Section 3.7.

5.13.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.13.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, the completion of the ROD in 2007, construction and startup of the remedial system in 1999, remedial system expansion and startup in 2006, continued operation of the remedial system, and completion of the well verification/well determination portion of the LUCs in 2011 have resulted in the remedy at LF-1 functioning as intended by the decision documents for COCs. The remedial system is performing as expected.

Plume and remedial system monitoring is being conducted under the SPEIM/LTM and LUC programs and risk management measures are in place to ensure protection of human health and the environment. Operational costs are appropriate for the remedy and a robust optimization program continues with the objective of reducing remedial system operational timeframes, the time to reach remedial goals (e.g., MCLs/MMCLs/GW-1 Standards), and reducing future costs. Monitoring and evaluation activities are continual and well-documented.

5.13.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics: There have been no changes in the toxicity factors that were in place at the time of the last Five Year Review (i.e., 2012) for the LF-1 groundwater COCs.

Changes in Risk Assessment Methods: There have been no changes in risk assessment methodology that affect protectiveness.

Review of RAOs: The RAOs developed for the ROD (AFCEE 2007) and revised in the 2011 ESD (AFCEE 2011a) are appropriate and remain valid.

5.13.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information during this Five Year Review timeframe that calls into question the protectiveness of the remedy for current COCs. However, an ongoing investigation is being conducted for emerging contaminants.

5.13.7 Issues, Recommendations, and Follow-Up Actions

Based on the presence of 1,4-dioxane, PFOS, and PFOA at concentrations exceeding standards/advisories within the existing LF-1 groundwater plume, it is recommended that a streamlined Supplemental FS be completed that evaluates remedial alternatives for groundwater.

5.13.8 Protectiveness Determination

The remedy for the LF-1 groundwater plume is protective of human health and the environment in the short-term. The remedial system is performing as expected and the LUCs are in place and are functioning as intended for current COCs. Through the combination of the active treatment by the remedial systems and natural attenuation processes, existing groundwater cleanup levels are expected to be achieved. Since the LUCs are in place and are functioning as intended to prevent exposure and there are no current plans to use the portion of the aquifer where LF-1 contamination remains for water supply, the remedy remains protective for current COCs. For the remedy to be protective in the long-term, a streamlined Supplemental FS should be completed that evaluates remedial alternatives for groundwater to address ECs, and remedial actions taken as necessary.

5.13.9 References

- ABB-ES. 1992 (June). *Final Focused Feasibility Study for the Main Base Landfill (AOC LF-1)*. Prepared by HAZWRAP for the Installation Restoration Program, Otis ANG Base, MA.
- AFCEC. 2018a (April). *LF-1/CS-23 2017 Summary Letter Report*. 652000-SPEIM-LF1/CS23-SLR-004. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2018b (January). *Final Supplemental Remedial Investigation for 1,4-Dioxane and Perfluorinated Compounds at Landfill-1, Joint Base Cape Cod, MA*. 658003-EC-LF1- RPT-002. Prepared by CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2017a (November). *2017 Operations and Maintenance Plan for Groundwater*

Extraction and Treatment Systems and Wind Turbine. 652000-O&M-MULTIPLE-OMPLN-003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

- _____. 2017b (March). *LF-1/CS-23 2016 Summary Letter Report.* 652000-SPEIMLF1/CS23-SLR-003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2017c (January). *LF-1/CS-23 2016 Annual SPEIM Data Presentation Project Note.* 652000-SPEIM-LF1/CS23-PRJNOT-002. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2016a (October). *Bourne Upgradient Groundwater Monitoring September 2016 Annual Results Letter Report.* 652000-SPEIM-BUG-LRPT-002. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2016b (March). *Final Supplemental Remedial Investigation/Feasibility Study Work Plan for 1,4-Dioxane at Chemical Spill-10, Chemical Spill-20, and Landfill-1, Joint Base Cape Cod, MA.* 658003-EC-Multiple-QAPP-001. Prepared by CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2016c (March). *LF-1/CS-23 2015 Summary Letter Report.* 652000-SPEIMLF1/CS23-SLR-002. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2015a (December). *Memorandum of Resolution on the Draft Focused Site Inspection Work Plan for Perfluorinated Compounds at the Flight Line Area, Joint Base Cape Cod, MA.* Prepared by CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2015b (January). *LF-1/CS-23 2014 Remedial System Hydraulic Evaluation Data Presentation Project Note.* 473147-SPEIM-LF-1/CS-23-PRJNOT-004. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2015c (March). *LF-1/CS-23 2014 Summary Letter Report.* 652000-SPEIM-LF1/CS23-SLR-001. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2015d (July). *LF-1/CS-23 2015 Annual SPEIM Data Presentation Project Note.* 652000-SPEIM-LF1/CS23-PRJNOT-001. Prepared by EA Engineering, Science and Technology and CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
-

- _____. 2014a (August). *1,4-Dioxane Monitoring Well Sample Results Data Presentation Project Note*. 473147-SPEIM-MULTIPLE-PRJNOT-007. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2014b (January). *1,4-Dioxane Extraction Well, LUC, and PWS Sample Results and Monitoring Well Sampling Plan Data Presentation Project Note*. 473147-SPEIM-MULTIPLE-PRJNOT-004. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2014c (April). *LF-1/CS-23 2013 Remedial System Optimization Evaluation Data Presentation Project Note*. 473147-SPEIM-LF1/CS23-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2014d (March). *LF-1/CS-23 2013 Summary Letter Report*. Prepared by CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2014e (July). *LF-1/CS-23 2014 Triennial SPEIM Data Presentation Project Note*. 473147-SPEIM-LF1/CS23-PRJNOT-001. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2014f (July). *LF-1/CS-23 2014 Wetland and Surface Water Ecological Evaluation Project Note*. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2013a (October). *Final 4th Five Year Review, 2007-2012, Massachusetts Military Reservation Superfund Site, Otis Air National Guard Base, MA*. 473147-SPEIMMultiple- RPT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2013b (July). *LF-1 Source Area Direct Push Sample Results and Continuing Source Evaluation Project Note*. 437075-SPEIM-LF1/CS23-PRJNOT-005. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2013c (June). *2012 Confirmation of Private Well Operational Status: LF-1/CS-23 Private Well Land Use Control Area Project Note*. 437075-LUC-MULTIPLE-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2013d (March). *LF-1/CS-23 2012 Summary Letter Report*. 437075-SPEIM-LF1/CS23-SLR-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
 - _____. 2013e (January). *LF-1/CS-23 2012 Annual SPEIM Data Presentation Project Note*. 437075-SPEIM-LF1/CS23-PRJNOT-002. Prepared by CH2M HILL for
-

AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

- AFCEE. 2012a (August). *Final 2011 JBCC Vapor Intrusion Evaluation Technical Memorandum*. 420005-SPEIM-MULTIPLE-TECHMEM-002. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012b (July). *LF-1/CS-23 2012 Wetland and Surface Water Ecological Evaluation Project Note*. 420005-SPEIM-LF1/CS23-PRJNOT-006. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012c (July). *Final LF-1 2011 Post-Closure Monitoring Plan Update*. 420005-SPEIM-LF1-RPT-002. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2011a (September). *Final Explanation of Significant Differences for the Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation*. 404929-SPEIM-MULTIPLE-RPT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2011b (March). *LF-1/CS-23 2010 Private Well Verification and Well Determination Project Note*. 404929-LUC-MULTIPLE-PRJNOT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2008 (September). *Final Interim Remedial Action Report for CS-4, CS-20, CS-21, and FS-29 (Southwest Plumes), and CS-23/LF-1 Groundwater Plumes*. Prepared by ECC for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2007 (October). *Final Record of Decision for Landfill-1 Source Area and Groundwater*. A4P-J23-35BC02VA-M26-0007. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2006a (August). *Final Chemical Spill-23 Wellfield Design Report*. A4P-J23-35BC06VB-M23-0003. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2006b (June). *Proposed Plan for Landfill 1 (LF-1) Source Area and Groundwater and Chemical Spill 23 (CS-23) Groundwater: Fact Sheet 2006-01*. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis ANG Base, MA.

- _____. 2006c (May). *Final Landfill-1 Source Area and Groundwater Feasibility Study*. A4P-J23-35BC02VA-M16-0012. Prepared by Jacobs Engineering for AFCEE/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2005 (July). *Final Landfill-1 2004 System Performance and Ecological Impact Monitoring Report*. 324146-SPEIM-LF1-ANRPT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2004 (March). *Final Work Plan for the Process Leading to Final Remedial Decisions for Ashumet Valley and Landfill-1*. A4P-J23-35C02VA-M27-0004. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2002 (March). *Final Landfill-1 Interim Remedial Action Report*. Prepared by AFCEE/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 1999 (October). *Final Landfill-1 Wellfield Design Report*. AFC-J23-35S18403-M23-0004. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 1998 (December). *Landfill-1 (LF-1) Plume Response Decision*. Fact Sheet.
- _____. 1996a (September). *AOC LF-1 Main Base Landfill Site Closure Report*. Prepared by ABB Environmental Services, Inc. for AFCEE/JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 1996b (April). *Final Remedial Investigation Main Base Landfill (AOC LF-1) and Hydrogeologic Region I Study*. Prepared by HAZWRAP for AFCEE/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- ANG. 1995 (September). *Final Record of Decision for Interim Action of Seven Groundwater Plumes at Massachusetts Military Reservation, Cape Cod, Massachusetts*. Prepared by Stone & Webster, Environmental Technology and Services for ANG JBCC Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 1991 (May). *Environmental Justification Report, Study Area LF-1 Northwest Operable Unit*. Prepared for the Otis Air National Guard Base, Massachusetts by HAZWRAP.
- _____. 1985 (October). *Installation Restoration Program Phase II – Confirmation/Quantification Stage I*. Prepared by Weston for the Otis ANG Base, MA.
- _____. 1983 (January). *Phase I Records Search, Otis Air National Guard Base, Massachusetts*. Prepared by Metcalf & Eddy, Inc. for the Otis ANG Base, MA.

- Agency for Toxic Substances and Disease Registry (ATSDR). 2002 (February). Health Consultation: Red Brook and Squeteague Harbors (a/k/a Otis Air National Guard Base/Camp Edwards) Falmouth, Barnstable County, MA. U.S. Department of Health and Human Services, Public Health Service, Agency of Toxic Substances and Disease Registry, Atlanta, GA.
- E.C. Jordan Co. 1990a (June). *Final Remedial Investigation Field Sampling and Analysis Plan, Six Priority I Sites, Task 2-5*. Prepared by E.C. Jordan Co. for HAZWRAP Support Contractor Office, Oak Ridge National Laboratory, Oak Ridge, TN.
- _____. 1990b (January). *Final Report, Site Inspection Report, Field Investigation Work Conducted Spring-Summer 1988, Task 2-3B*. Prepared by E.C. Jordan Co. for HAZWRAP Support Contractor Office, Oak Ridge National Laboratory, Oak Ridge, TN.
- _____. 1988 (July). *Field Investigations, Summer/Fall 1986; Task 2-1; Base Landfill, Petroleum Fuels Storage Area, and Fire-Training Area*; Prepared by E.C. Jordan Co. for HAZWRAP Support Contractor Office, Oak Ridge National Laboratory, Oak Ridge, TN.
- EPA. 2013 (March). Integrated Risk Information System (IRIS) database. [online]. Available: <http://www.epa.gov/iris/index.html>.
- _____. 2001 (June). *Comprehensive Five-Year Review Guidance*, EPA 540R-01-007.
- TRET. 2001. *Evaluation of Red Brook Harbor Pore Water Concentrations of Chemicals and Exposure Scenarios that Would Pose an Estimated Cancer Risk of One-in-a-Million*. TRET Memorandum, May 3, 2001.
- _____. 1996 (May). *Toward a Balanced Strategy to Address Contaminated Groundwater Plumes at the Massachusetts Military Reservation*.

5.14 STORM DRAIN-5 (SD-5) GROUNDWATER

The SD-5 groundwater plume was a dissolved-phase groundwater plume which was located in the southeast corner of the JBCC. The groundwater contamination at SD-5 has not been delineated as a contiguous plume since 2005 due to its limited extent. For reference, the 2005 SD-5 plume boundary is shown on Figure 5-14A. The SD-5 plume was defined as the extent of groundwater containing the COC TCE at concentrations greater than the MCL of 5 µg/L (AFCEE 2006).

5.14.1 Site Chronology

1983: SD-5 was first identified as a potentially hazardous site during the Phase I Records Search for the JBCC (ANG 1983).

1986: An expanded records search was completed that identified potential source areas in the area of SD-5 (ANG 1986).

1988: An SI was conducted (ANG 1990).

1990-1994: A DSRP was completed which included the SD-5 source area. In addition, vicinity buildings and structures were demolished (ANG 1994).

1989-1996: An interim RI was completed in 1992 (ANG 1992) which was supplemented with additional data in 1996 (AFCEE 1996).

1994-1995: The NGB, DOD, EPA, MassDEP, and local communities approved a Plume Response Plan that presented an accelerated effort toward simultaneous containment of seven groundwater plumes including SD-5. An IROD for the seven groundwater plumes emanating from the JBCC was signed on 25 September 1995 (ANG 1995). The IROD stated that groundwater extraction and treatment systems should be designed, installed, and operated until a final remedy for the site is chosen. The interim remedy for the SD-5 plume included extraction of contaminated groundwater and discharge of treated water to groundwater and institutional controls.

1996-2004: Installation and startup of the SD-5 interim remedial systems under the IROD (AFCEE 2006). The SD-5 system operated until February 2004.

2004: Completion of a FS for SD-5 groundwater (AFCEE 2004).

2005: Proposed Plan issued (AFCEE 2005b).

2006: Completion of a ROD for SD-5 groundwater (AFCEE 2006). The selected remedy for SD-5 groundwater as specified in the ROD was LTM with LUCs.

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy, revised the LUCs, slightly modified the phrasing of the RAOs, and added text regarding the JBCC three-step process to achieve site closure (AFCEE 2011).

2014: An ESD was prepared to update the aquifer restoration timeframe estimate for SD-5S (AFCEC 2014b).

5.14.2 Background

5.14.2.1 History of Contamination

The source of the SD-5 plume was the result of releases from a leaching well at the Non-Destructive Inspection Laboratory (NDIL), a Corrosion Control Shop, and sumps in two aircraft hangers (ANG 1994) located with the vicinity of Branshaw Street on the JBCC (Figure 5-14A).

Source area remedial actions including the demolition of buildings/hangers and removal of leaching wells and drainage structures were conducted between 1990 and 2003. The ANG removed approximately 700 gallons of contaminated fluid from an NDIL leaching well in 1990 and the NDIL leaching well was removed in 1996. This removal action was completed as part of the JBCC drainage structure removal program and also included the removal of four other drainage structures at SD-5 in 1996 (AFCEE 2006). Excavation of contaminated soils at the SD-5 source area began in April 2001. Approximately 6,500 tons of soil were removed and taken off-site for disposal at a state-permitted landfill. In August

2002, an SVE system was installed at the site to remediate VOCs in the subsurface. The SVE system removed approximately 5 lbs of VOCs and was shut down in August 2003 with concurrence from the regulatory agencies (AFCEE 2005a).

The DOD and EPA, with concurrence from the MassDEP, implemented an interim action for the SD-5 groundwater plume and six other MMR plumes under an Interim ROD (IROD) (ANG, 1995). The selected interim remedy for the SD-5 plume included extraction of contaminated groundwater and discharge of treated water to groundwater (and/or other beneficial use) and institutional controls. Based on the investigational history and nature of the SD-5 plume, a phased design and construction approach was adopted and three interim remedial systems were installed: SD-5 North (SD-5N) extraction, treatment, and reinjection (ETR) System, SD-5 South (SD-5S) Axial Recirculation Well System, and the SD-5S Hoopole Road Extraction Well System (Section 2.2). The SD-5 interim remedial systems operated under the IROD between August 1997 and February 2004 (AFCEE, 2006).

The ROD for SD-5 groundwater was completed in 2006. The selected remedy for SD-5 groundwater as specified in the ROD was LTM with LUCs (AFCEE, 2006). In 2011, an ESD was prepared that clarified the inclusion of monitored natural attenuation as a component of the selected remedy for SD-5 (AFCEC 2011).

5.14.2.2 Physical Characteristics, Land and Resource Use

As shown on Figure 5-14A, the SD-5 groundwater site was split into two areas, SD-5N which is located on-base and SD-5S which is located off-base. When last able to be delineated in 2005, the SD-5 plume consisted of a series of disconnected small zones of contamination where TCE concentrations remained above the MCL (Figure 5-14A) currently, MCL exceedances remain in two of the three wells still monitored at SD-5, these wells are off base (Figure 5-14B).

The area above the on-base portions of the SD-5 area consists primarily of the airfield and associated facilities. The off-base area south of the JBCC boundary is primarily residential

and undeveloped woodland. Ashumet Pond and Johns Pond to the south are used for fishing, swimming, and boating. The topography of the land above the historic SD-5 plume footprint is generally flat but slightly undulating in the area between Ashumet Pond and Johns Pond. Sub-regionally, the area is characterized by low rolling hills and flat areas on a gently southward-sloping glacial outwash plain (AFCEE 2006). Within the footprint of the historic plume, the maximum and minimum ground surface elevations are approximately 116 ft msl and 38 ft msl, respectively.

5.14.2.3 Initial Responses

A summary of the initial responses is as follows:

Non-CERCLA Actions

None.

CERCLA Actions

The DoD and EPA, with concurrence from the MassDEP, implemented an interim action for the SD-5 groundwater plume and six other JBCC plumes under an IROD (ANG 1995). The selected interim remedy for the SD-5 plume included extraction of contaminated groundwater and discharge of treated water to groundwater (and/or other beneficial use) and institutional controls.

The TRET, established in 1996 as part of a new IROD management process, reviewed wellfield designs and determined that the 60-percent design for containment of several of the IROD plumes would cause negative ecological impacts (TRET 1996). The proposed interim remedy for the LF-1 groundwater plume was then revised to include the design and installation of a remedial system to capture the SD-5N and SD-5S plumes.

Based on the investigational history and nature of the SD-5S plume, a phased design and construction approach was adopted. Phase I addressed the axial portion of the plume and included two recirculating wells. Phase II addressed the southernmost portion of the plume

and included one extraction well for the SD-5S plume with treatment at the SRTF.

The SD-5 groundwater contaminants were largely removed by the three interim remedial systems including: SD-5N ETR System; SD-5S Axial Recirculation Well System; and the SD-5S Hoophole Road Extraction Well System (Figure 5-14A). Descriptions of these systems are provided below and further details are included in the ROD (AFCEE 2006).

- **SD-5N ETR System:** The SD-5N ETR system began operation in August 1997 and consisted of 10 closely-spaced extraction wells, GAC, and eight reinjection wells. The extracted groundwater was treated at the SRTF. After treatment, the water was returned to the aquifer through a series of eight reinjection wells situated hydraulically crossgradient of the extraction wells along the JBCC boundary. The SD-5 North ETR system operated in various configurations until August 2003 when the final extraction well was shutdown.
- **SD-5S Axial System (Phase I):** The SD-5S Axial Recirculating Well Remedial System began operation in June 1999 and consisted of two recirculating wells located axially in the southern portion of the SD-5S plume. Water treatment consisted of air stripping within the wellhead vault, followed by filtration of the air stream by primary and secondary GAC units. The treatment systems were housed in below-grade vaults installed at each recirculating well location. The SD-5S Phase I Axial System operated until April 2003.
- **SD-5S Hoophole Road Extraction Well System (Phase II):** The SD-5S Hoophole Road remedial system consisted of one extraction well in the SD-5S plume. It should be noted that this system was constructed in conjunction with an extraction well for the CS-10 Northern lobe which was also located along Hoophole Road and is still in operation (Section 5.3). Extracted groundwater was pumped to the SRTF for treatment and the treated water was reinjected into the aquifer through a combination of the SD-5N reinjection wells and the CS-10 Sandwich Road reinjection wells. Phase II treatment began operation in January 2000. On 25 February 2004, the SD-5S Hoophole Road extraction well was turned off.

5.14.2.4 Basis for Taking Action

The baseline cancer risk calculations indicated that unless remedial action is undertaken, future residential exposure to contaminated groundwater at SD-5 may present an excess lifetime cancer risk greater than the acceptable EPA range of 1×10^{-4} to 1×10^{-6} (AFCEE 2006).

An ecological risk assessment was conducted for SD-5 groundwater and no ecological risks were identified (AFCEE 2006).

5.14.3 Remedial Actions

The final remedy for the SD-5 plume was determined in the *Final Record of Decision for Groundwater at Eastern Briarwood, Western Aquafarm, and Storm Drain-5* (AFCEE 2006) which was signed on 28 September 2006. The RAOs for the SD-5 groundwater plume as presented in the ROD (AFCEE 2006) and modified in the ESD (AFCEE 2011) are as follows:

- Prevent residential exposure to SD-5 groundwater with TCE concentrations greater than the MCL of 5 µg/L.
- Restore useable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

5.14.3.1 Remedy Selection and Implementation

The selected remedy for SD-5 groundwater in the ROD (AFCEE 2006) was LTM with LUCs. In addition, CERCLA reviews are to be completed every five years throughout the lifetime of the remedial action.

LTM data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives are being met, including determining whether plume concentrations are stable or reducing; and (ii) to identify and assess optimization opportunities. The data collected under the SPEIM/LTM program are presented to the regulatory agencies through the Technical Update meeting process and documented in project note submittals.

As part of the LUC process specified in the ROD (AFCEE 2006) and ESD (AFCEE 2011), a private well verification survey was completed at SD-5 between November 2012 and July 2013 (AFCEC 2013b). The private well verification survey completed at the SD-5 LUC area consisted of outreach to 31 parcels. No private drinking water wells were identified. Thirteen properties were determined to have a private well that is non-operational or has been disconnected. Technical evaluations were completed for each private well to determine whether these wells could represent a future exposure risk to SD-5 groundwater (should they be restarted by the property owner). No private wells that were identified present a current or future unacceptable exposure risk to the SD-5 groundwater

(AFCEC 2013b). In the event that new private well information is obtained or plume monitoring data indicate a change to the SD-5 CSM, AFCEC will perform the necessary well determinations at the time the information becomes available.

The status of non-operational private wells in the SD-5 LUC area continue to be tracked. AFCEC distributes a mailing, on an annual basis, to property owners within the LUC area that have non-operational wells. The intent of the annual mailing is to remind these property owners that they should contact AFCEC for a technical evaluation, which may include sampling, in the event their well is put back into service. Annual mailings were distributed during this five year review period and reported in the annual LUC reports. No property owners notified AFCEC that they intended to restart a non-operational private well within SD-5 LUC area during this five year review period (2012-2017).

5.14.3.2 Remedy Operation & Maintenance

The periodic LTM costs associated with ongoing remedial action at SD-5 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives such as less frequent sampling as was assumed at the time of the remedy selection) and do not indicate potential remedy problems.

5.14.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior fourth CERCLA Five Year Review (AFCEE 2013a). For the SD-5 groundwater, the recommendations and follow-up actions were:

- 1) An ESD should be prepared to update the aquifer restoration timeframe estimate for SD-5S.
- 2) In addition, the topic of emerging contaminants should be monitored as it relates to groundwater at the JBCC. Specifically for SD-5 groundwater, a sampling and

analysis plan shall be submitted to the regulatory agencies to assess the possible presence of 1,4-dioxane.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

- 1) An ESD was prepared to update the aquifer restoration timeframe (i.e., by 2022) estimate for SD-5S (AFCEC 2014b).
- 2) SD-5 was not sampled for 1,4-dioxane because there were no 1,1,1-TCA detections associated with the groundwater plume. It was also not sampled for PFAS because there was no evidence of AFFF use at the site.

5.14.5 Five Year Review Process

5.14.5.1 Data Review

The data collected under the SPEIM/LTM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues. The following technical deliverables were prepared that assessed remedial progress:

- *Storm Drain-5 Long Term Monitoring 2012 Biennial Project Note (AFCEC 2012)*
- *Storm Drain-5 Long Term Monitoring 2014 Biennial Project Note (AFCEC 2014a)*
- *Storm Drain-5 Long Term Monitoring 2016 Biennial Project Note (AFCEC 2016)*

5.14.5.2 Site Inspection

Refer to Section 3.6.

5.14.5.3 Interviews

Refer to Section 3.7.

5.14.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.14.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, the LTM activities and the implementation of the LUCs at SD-5 have resulted in the remedy functioning as intended by the decision documents. The restoration timeframe predicted in the ROD (2008) has been achieved at SD-5N; the restoration timeframe for SD-5S has been updated to 2022 via issuance of an ESD (AFCEC 2014b). Operational costs are appropriate for the remedy. Monitoring and evaluation activities are ongoing for SD-5S and well-documented and should continue.

5.14.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics: There has been no changes in the toxicity factors that were in place at the time of the last Five Year Review (i.e., 2012) for the SD-5 groundwater COC, TCE.

Changes in Risk Assessment Methods: There have been no changes in risk assessment methodology that affect protectiveness.

Review of RAOs: The RAOs developed for the final ROD (AFCEE 2006) and revised in the ESD (AFCEE 2011) are appropriate.

5.14.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information at this time that calls into question the protectiveness of the remedy.

5.14.7 Issues, Recommendations, and Follow-Up Actions

No specific recommendation or follow-up actions have been identified.

5.14.8 Protectiveness Determination

The remedy for the SD-5 groundwater plume is protective of human health and the environment. The LTM program is ongoing and the LUCs are in place and are functioning as intended. Through pre-ROD operation of the SD-5 remedial system and natural attenuation processes, groundwater cleanup levels have been achieved at SD-5N and are expected to be achieved at SD-5S. Since the LUCs are in place and are functioning as intended and there are no current plans to use this portion of the aquifer for water supply, the remedy remains protective.

5.14.9 References

AFCEC. 2017a (November). *2017 Operations and Maintenance Plan for Groundwater Extraction and Treatment Systems and Wind Turbine*. 652000-O&M-MULTIPLE-OMPLN-003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

_____. 2016 (December). *Storm Drain-5 Long Term Monitoring 2016 Biennial Project Note*. 652000-LUC-SD5-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.

_____. 2014a (October). *Storm Drain-5 Long Term Monitoring 2014 Biennial Project Note*. 437075-LUC-SD5-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base,

MA.

- _____. 2014b (September). *Final Storm Drain-5 Groundwater Explanation of Significant Differences*. 473147-SPEIM-SD5-ESD-002. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013a (October). *Final 4th Five Year Review, 2007-2012, Massachusetts Military Reservation Superfund Site, Otis Air National Guard Base, MA*. 473147-SPEIMMultiple- RPT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013b (September). *Storm Drain-5 Private Well Verification and Well Determination Project Note*. 437075-LUC-SD5-PRJNOT-002. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012 (December). *Storm Drain-5 Long Term Monitoring 2012 Biennial Project Note*. 437075-SPEIM-SD5-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- AFCEE. 2012 (August). *Final 2011 JBCC Vapor Intrusion Evaluation Technical Memorandum*. 420005-SPEIM-MULTIPLE-TECHMEM-002. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2011 (September). *Final Explanation of Significant Differences for the Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation*. 404929-SPEIM-MULTIPLE-RPT-001. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2008 (May). *Verification, Decommissioning, and Documentation Guidelines for Private Wells in Areas of Potential Concern*. Prepared by Air Force Center for Engineering and the Environment Massachusetts Military Reservation Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2006 (September). *Final Record of Decision for Groundwater at Eastern Briarwood, Western Aquafarm, and Storm Drain-5*. A3P-J23-35Z04802-M26-0008. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2005a (September). *Final AOC Storm Drain-5/Fuel Spill-5 Source Area Remedial Action Report*. AFCEE/JBCC Installation Restoration Program, Otis ANG Base, Massachusetts.

- _____. 2005b (July). *Proposed Plan for Groundwater at Eastern Briarwood, Western Aquafarm, and Storm Drain-5*. Fact Sheet 2005-06. Prepared by AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2004 (September). *Final Storm Drain-5 Groundwater Feasibility Study*. A3P-J23-35Z04802-M16-0006. Prepared by Jacobs Engineering Group Inc. for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 1996 (December). *Remedial Investigation Stormwater Drainage Disposal Site No. 5 (SD-5), Including Fuel Spill No.5 (FS-5)*. Vol. 1. Prepared by ABB Environmental Services, Inc. for AFCEE and ANG JBCC Installation Restoration Program, Otis ANG Base, MA.
- ANG. 1995 (September). *Final Record of Decision Interim Remedial Action Containment of Seven Groundwater Plumes at JBCC, Cape Cod MA*. Prepared by Stone & Webster Environmental & Technology Services for ANG Readiness Center, Installation Restoration Program, Otis ANG Base, MA.
- _____. 1994 (August). *Draft Southeast Region Groundwater Operable Unit Remedial Investigation Report (Including Region III)*. Prepared by ABB Environmental Services, Inc. for ANG JBCC Installation Restoration Program, Otis ANG Base, MA.
- _____. 1992 (January). *Interim Remedial Investigation for the Stormwater Drainage Disposal Site No. 5 (SD-5)*. Prepared by ABB Environmental Services, Inc. for ANG JBCC Installation Restoration Program, Otis ANG Base, MA.
- _____. 1990. (February). *Final Site Inspection report, Field Investigation Work Conducted Spring-Summer 1988 Task 2-3B*. Prepared by E.C. Jordan Co. for ANG JBCC Installation Restoration Program, Otis ANG Base, MA.
- _____. 1983. (January). *Installation Restoration Program, Phase I Records Search*. Otis ANG Base. Prepared by Metcalf and Eddy, Inc. for ANG JBCC Installation Restoration Program, Otis ANG Base, MA.
- EPA. 2013 (March). Integrated Risk Information System (IRIS) database. [online]. Available: <http://www.epa.gov/iris/index.html>.
- _____. 2001 (June). *Comprehensive Five-Year Review Guidance*, EPA 540R-01-007.
- Technical Review and Evaluation Team (TRET). 1996 (May). *Toward a Balanced Strategy to Address Contaminated Groundwater Plumes at the Massachusetts Military Reservation*

5.15 FIRE TRAINING AREA-2/LANDFILL-2 (FTA-2/LF-2)

The FTA-2/LF-2 groundwater plume is a dissolved-phase groundwater plume (Figure 5-15) that contains the following COCs; C5-C8 aliphatic, C9-C12 aliphatic, and C9-C10 aromatic VPH ranges; the C11-C22 aromatic EPH range; 1,2,4-TMB; 1,3,5-TMB; and 2-methylnaphthalene. The groundwater monitoring for EPH/VPH carbon ranges (including TMBs and 2-methylnaphthalene) at FTA-2/LF-2 has been ongoing since 2005 and data indicate that the current EPH/VPH, TMB, and 2-methylnaphthalene plume is the remnant of the dissolved-phase plume that was previously defined by the BTEX compounds that were monitored under the Western Aquafarm LTM program from 1996-2005. The Western Aquafarm plume was closed under an NFA decision in the ROD for Western Aquafarm because BTEX were no longer detected above MCLs (AFCEE 2006). AFCEC and the regulatory agencies agreed that the TMB and EPH/VPH groundwater contamination could be managed under the FTA-2/LF-2 groundwater program (AFCEC 2016a). The extent of EPH/VPH, TMB and 2-methylnaphthalene groundwater contamination (FTA-2/LF-2 plume boundary) is shown on Figure 5-15. The cleanup levels for the FTA-2/LF-2 groundwater COCs are as follows: 300 µg/L for C5-C8 aliphatic, 200 µg/L for C9-C12 aliphatic, and 700 µg/L for C9-C10 aromatic VPH ranges; 200 µg /L for the C11-C22 aromatic EPH range; an RSL of 56 µg/L for 1,2,4-TMB; 60 ug/L for 1,3,5-TMB; and 10 µg/L for 2-methylnaphthalene. The RBCs for 1,2,4-TMB and 1,3,5-TMB have been updated as part of this five-year review because EPA has released child noncancer RSLs for tap water since the last review (see Section 5.15.6.2 and Appendix E).

5.15.1 Site Chronology

1940 - 1944: LF-2 area used for disposal of solid waste.

1948 - 1956: FTA-2 was developed over a small portion of LF-2 and was used for fire training exercises during this period. The structure was abandoned and filled in 1956.

1986: A PA was completed which identifies FTA-2/LF-2 as a potential location of the disposal of hazardous materials (E.C. Jordan 1986).

1988: SIs confirm landfilling operations and evidence of the disposal of oil and hazardous materials at FTA-2/LF-2 (E.C. Jordan 1990).

1996: RIs at FTA-2/LF-2 completed (ANG 1996).

1997-1998: Completion of a FS (AFCEE 1997) and a ROD (AFCEE 1998).

2001-2003: A biosparging system was installed and operated until STCL remedial goals were met. Before reaching final concurrence on the soil remediation, MassDEP required sampling of groundwater for EPH and VPH following MassDEP methods. Select EPH/VPH carbon ranges exceeded MCP Method 1 GW-1 groundwater standards (AFCEE 2005a).

2004-2009: As part of groundwater monitoring associated with the nearby Western Aquafarm site in 2004, 1,2,4-TMB and 1,3,5-TMB were detected at two monitoring wells within the FTA-2/LF-2 area. A groundwater LTM program was established within the FTA-2/LF-2 source area. EPH/VPH carbon range concentrations were consistently reported above the MCP Method 1 GW-1 standards and TMBs above RBCs; however, current land use limits human exposure to the groundwater and the contamination does not appear to be migrating beyond the base boundary (AFCEE 2013a).

2010: A project note was prepared that presents an historic overview of the groundwater data collected at FTA-2/LF-2 and also expands the FTA-2/LF-2 LTM network. In this project note, it was agreed by AFCEE, EPA, and MassDEP that groundwater contamination that could potentially be associated with the Western Aquafarm site (now closed), LF-2, and FTA-2 would be associated with the FTA-2 site going forward for reporting purposes (AFCEE 2011).

2011-2014: LTM events were completed at the FTA-2/LF-2 site in December 2011, April 2012, and December 2012/January 2013 (AFCEE 2012b, AFCEC 2013c). Data obtained during these LTM events were used to define the FTA-2/LF-2 groundwater plume.

2013: The 4th Five Year Review for the IRP Sites at JBCC was completed (AFCEC 2013a). This review concluded that the remedy for FTA-2/LF-2, as selected in the 1998 ROD, is protective in the short-term under the current land use scenario. The remedy is protective in the short term since access to the source area is controlled by current flight line security measures that include fencing and 24-hour security that effectively limits potential human exposure to site contaminants. However, for the remedy to be protective in the long-term, EPH/VPH groundwater contamination at FTA-2/LF-2 should be addressed.

2014: A Focused FS and a Proposed Plan for FTA-2/LF-2 groundwater were completed (AFCEC 2014a, 2014b). Also, as recommended in the 4th Five Year Review (AFCEC 2013a), a Record Notice of Landfill Operation for the LF-2 source area was filed at the Base Real Property office on 04 March 2014.

2014-2015: Leading edge and source area investigations were completed to collect supplemental groundwater and soil data to define the downgradient extent of the FTA-2/LF-2 groundwater plume and/or confirm that capillary fringe soils at Western Aquafarm and LF-2 do not contain EPH/VPH carbon ranges at concentrations that pose a potential leaching threat to groundwater.

2016: Groundwater monitoring for COCs continued while a ROD Amendment was developed for FTA-2/LF-2 groundwater. The ROD amendment, finalized in September 2016, identifies MNA with LUCs as the selected remedy for FTA-2/LF-2 groundwater (AFCEC 2016a).

5.15.2 Background

5.15.2.1 History of Contamination

Landfill operations at LF-2 began in approximately 1940 and were discontinued in 1944. LF-2 contains primarily solid waste (e.g., bottles, glass, ash, metal scrap, wood, concrete, and asphalt construction debris). However, analytical results from a test pit that was

advanced approximately 350 ft south of the FTA-2 indicate the presence of localized areas of petroleum contaminated soil at LF-2 (ANG 1996). The landfill was covered with fill material before fire training activities were conducted at FTA-2 from 1948 to 1956. FTA-2 may have received up to 7,000 gallons per year of waste oil, aviation gasoline (AVGAS), JP-4 fuel, and solvents, which were ignited during fire training exercises (ANG 1996). Sand, asphalt, and concrete rubble fill were apparently placed in a drainage swale before, during, and after fire-training activities at FTA-2. The FTA-2 area was covered with additional soil following its abandonment in 1956.

The Western Aquafarm source area, which formerly housed underground storage tanks (USTs) containing various petroleum products, is located to the north of the LF-2 disposal area. A dissolved-phase groundwater plume of benzene, toluene, ethylbenzene and xylenes (BTEX) was formerly delineated in the area of Western Aquafarm, LF-2 and FTA-2. At the time of the Remedial Investigation for groundwater at the Western Aquafarm and FTA-2/LF-2 areas of concern (ANG 1994), separation of the impacts from UST operations at Western Aquafarm, landfilling activities at LF-2, and fire training activities at FTA-2 was difficult due to the co-located nature of source areas and similarity of released materials. Therefore, the BTEX plume in the area was monitored under the Western Aquafarm LTM program, while source area (soil) remedial actions at FTA-2/LF-2 were completed under the FTA-2/LF-2 source area program. A NFA determination was presented for the BTEX plume at Western Aquafarm in 2006 (AFCEE 2006) because BTEX concentrations in groundwater at Western Aquafarm, LF-2 and FTA-2 had decreased through the processes of natural attenuation to concentrations below the Maximum Contaminant Levels by 2000 and a contiguous plume could no longer be delineated.

The original ROD for the FTA-2/LF-2 source area documented ethylbenzene and total xylenes as the COCs for soil at the FTA-2 source area because these compounds were present at concentrations greater than the soil target cleanup levels (AFCEE 1996) and posed a potential leaching threat to groundwater (AFCEE 1998). A biosparge/soil vapor recovery system was installed at the FTA-2 source area and operated from 2001 to 2003, when it was shut down because the remedial goals for soil were met (i.e., the cleanup levels

for ethylbenzene and total xylenes in soil were achieved) such that soils at FTA-2 were no longer considered a potential leaching source of xylene and ethylbenzene to groundwater (AFCEE 2003).

In order to obtain concurrence for a completed source area remedial action from the MassDEP, groundwater and soil in the immediate vicinity of the biosparging system was sampled in 2004 for EPH and VPH analysis by the MassDEP method, which is a newer method of characterizing petroleum contamination that was not available at the time of initial site characterization in 1996. EPH and VPH carbon ranges were not detected in FTA-2 source area soils above MCP Method 1 S-3/ GW-1 soil standards indicating that soil at the FTA-2 source area does not represent a leaching threat for EPH and VPH carbon ranges to groundwater (AFCEC 2014c). However, VPH and EPH carbon ranges, including 2-methylnaphthalene, were detected in groundwater at concentrations greater than the MCP Method 1 GW-1 groundwater standards and an EPH/VPH groundwater monitoring program was initiated at FTA-2/LF-2 to define the nature and extent of groundwater contamination in the area. Additionally, 1,2,4-TMB and 1,3,5-TMB were added to the VOC analyte list for FTA-2/LF-2 groundwater due to detections of these compounds in two Western Aquafarm groundwater monitoring wells that were located near the FTA-2 source area (AFCEE 2005b).

Groundwater monitoring for EPH/VPH carbon ranges and/or TMBs has been completed at FTA-2/LF-2 since 2005 and the data collected through December 2012 were used to define an interim FTA-2/LF-2 groundwater plume. The COPCs in groundwater at FTA-2/LF-2 included the C5-C8 aliphatic, C9-C12 aliphatic, and C9-C10 aromatic VPH ranges; the C11-C22 aromatic EPH range; 1,2,4-TMB; 1,3,5-TMB; and 2-methylnaphthalene, as these compounds were present in groundwater at concentrations greater than applicable standards or RBCs.

In 2013, the Final 4th Five Year Review identified the need for an amendment to the existing FTA-2/LF-2 site ROD to address the COPCs in groundwater and include a selected remedy for the FTA-2/LF-2 groundwater plume (AFCEC 2013a). Additional leading edge and source area soil and groundwater characterization work was completed in March 2015

to update the CSM and groundwater LTM network (AFCEC 2015a) in support of the ROD Amendment, which was finalized in September 2016 (AFCEC 2016a).

5.15.2.2 Physical Characteristics, Land and Resource Use

The FTA-2/ LF-2 area occupies approximately 25 acres and is located to the west of the runway No. 5 and contained within the flightline secure area. The generally flat surface with subtle surface drainage features consists of un-paved, grassed areas that are mowed and maintained adjacent to the airfield. The minimum and maximum ground surface elevations within the source area boundary are 90 ft msl and 108 ft msl, respectively. Roughly 10 to 20 percent of the source area has some larger scrub pine and vegetation typical of Cape Cod. The area will be maintained as open-space in the foreseeable future while the airfield and runways are in use.

Prior to landfilling in the 1940s, the topography of the FTA-2 area was characterized by a prominent north-south swale that connected to a drainage ditch just south of South Outer Road (Figure 4-4). As a result of landfilling operations that filled this drainage ditch, the FTA-2 area no longer provided effective surface drainage. Storm water drainage pipes were installed to carry runoff southward from the large nearby paved areas to the north and west. Surface soils consist of fill with construction debris and solid waste to a depth of up to approximately 16 ft bgs (ANG 1996). Below that, subsurface soils are predominantly well-graded medium-grained sand with small amounts of fine- to coarse-grained sand, and traces of fine- to coarse-grained gravel, cobbles, and silt. Soils at the FTA-2 area are characteristic of typical glacial outwash comprising the Mashpee Pitted Plain (AFCEE 2003). The depth to groundwater is approximately 45 to 50 ft bgs throughout the FTA-2 area. The groundwater flow direction at FTA-2 is in a southerly direction (AFCEE 2011).

5.15.2.3 Initial Response

No responses were initiated prior to the PA conducted as part of the CERCLA process.

5.15.2.4 Basis for Taking Action

The RI (ANG 1996) included a human-health PRA to evaluate potential human-health risks associated with exposure to contaminated soil under an occupational (worker) exposure scenario. The calculated cancer risk was within the EPA acceptable risk range and the calculated noncancer hazard index was below one. An ecological PRA was also performed which concluded that there could be adverse effects to ecological receptors, however, because of current and anticipated land use of the site, no additional action was recommended. Cleanup at FTA-2/LF-2 was driven by the leaching potential to groundwater by petroleum-related organic compounds in soils.

5.15.3 Remedial Actions

A ROD for the FTA-2/LF-2 source areas was signed on 30 September 1998 (AFCEE 1998), which documented the decision to perform a remedial action for soil within the FTA-2 source area. Groundwater monitoring for petroleum constituents (i.e. BTEX) in the area would continue under the Western Aquafarm LTM program. A summary of site investigation activities and findings that resulted in the development of the original remedy is provided in the 1998 ROD for FTA-2 (AFCEE 1998).

A biosparge/soil vapor extraction system was installed at the FTA-2 source area and began operation in September 2001. The treatment system consisted of an air compressor, a regenerative blower, a moisture separator, a heat exchanger, carbon vessels and a condensate-holding tank. The system design combined 90 cfm of sparging capacity with 180 cfm of extraction capacity (AFCEE 2002). The biosparge treatment system was shut down in May 2003 after the remedial goals for soil were met (i.e., the RALs for ethylbenzene and total xylenes in soil were achieved) such that soils at FTA-2 were no longer considered a potential source of xylene and ethylbenzene groundwater contamination through leaching (AFCEE 2003).

In order to obtain concurrence for a completed source area remedial action from the MassDEP, groundwater and soil in the immediate vicinity of the biosparging system was

sampled in 2004 for EPH and VPH analysis by the MassDEP method, which was a newer method of characterizing petroleum contamination that was not available at the time of initial site characterization in 1996. EPH and VPH were not detected in FTA-2 soils above MCP Method 1 S-3/GW-1 soil standards indicating the success of the FTA-2 soil remedy (AFCEC 2014c). However, EPH and VPH carbon ranges were detected in groundwater at concentrations greater than the MCP Method 1 GW-1 groundwater standards and an EPH/VPH groundwater monitoring program was initiated at FTA-2/LF-2 to define the nature and extent of this groundwater contamination in the area .

Additionally, 1,2,4- TMB and 1,3,5-TMB were added to the VOC analyte list for FTA-2/LF-2 groundwater due to detections of these compounds in two Western Aquafarm groundwater monitoring wells that were located near the FTA-2 source area (AFCEE 2005b).

Groundwater monitoring for EPH/VPH carbon ranges and/or TMBs has been completed at FTA-2/LF-2 since 2005 and the data collected through December 2012 were used to define an interim FTA-2/LF-2 groundwater plume. The COPCs in groundwater at FTA-2/LF-2 included the C5-C8 aliphatic, C9-C12 aliphatic, and C9-C10 aromatic VPH ranges; the C11-C22 aromatic EPH range; 1,2,4-TMB; 1,3,5-TMB; and 2-methylnaphthalene, as these compounds were present in groundwater at concentrations greater than applicable standards or RBCs.

In 2013, the Final 4th Five Year Review identified the need for an amendment to the existing FTA-2/LF-2 site ROD to address the COPCs identified post-ROD in groundwater and identify a selected remedy for the FTA-2/LF-2 groundwater plume (AFCEC 2013a). Additional leading edge and source area soil and groundwater characterization work was completed in March 2015 to update the CSM and groundwater LTM network (AFCEC 2015a) in support of the ROD Amendment, which was finalized in September 2016 (AFCEC 2016a).

RAOs and alternative analysis for groundwater at FTA-2 were developed in the Final FTA-2 Groundwater Focused Feasibility Study (AFCEC 2014a). RAOs were designed to

prevent exposure to FTA-2/LF-2 groundwater that would result in an unacceptable risk (non-cancer greater than an HI of 1) through a residential exposure scenario. The COCs and associated RAOs for the FTA-2/LF-2 groundwater plume, as agreed upon by AFCEC, EPA, and MassDEP, are as follows:

- Prevent residential exposure to site groundwater with EPH/VPH concentrations greater than the MCP GW-1 cleanup standards of:
 - 300 µg/L for C5-C8 aliphatic hydrocarbons
 - 200 µg/L for C9-C10 aromatic hydrocarbons
 - 700 µg/L for C9-C12 aliphatic hydrocarbons
 - 200 µg/L for C11-C22 aromatic hydrocarbons
- Prevent residential exposure to site groundwater with 1,2,4-TMB concentrations greater than the RBC of 19 µg/L.
- Prevent residential exposure to site groundwater with 1,3,5-TMB concentrations greater than the RBC of 19 µg/L.
- Prevent residential exposure to site groundwater with 2-methylnaphthalene concentrations greater than the MCP GW-1 standard of 10 µg/L.
- Restore usable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

5.15.3.1 Remedy Selection and Implementation

The selected remedy for groundwater augments the existing remedy for soil (AFCEE 1998) by addressing potential future risk of residential exposure to groundwater and soil by providing a remedy for groundwater, incorporating the application of detailed LUCs, which have been developed at other IRP sites since issuance of the 1998 ROD, and documenting the filing of a Record Notice of Landfill Operation (for the LF-2 boundary as shown in the 4th Five-Year Review; AFCEC 2013a), which precludes use of the aquifer under LF-2 as a source of drinking water due to the presence of landfilled material. The combined remedies are deemed protective of human health and the environment. The remedial timeframe for groundwater is expected to be approximately 20 years and does not extend the timeframe for maintenance of institutional controls (i.e., LUCs) that was assumed in

the original ROD. In addition, CERCLA reviews are to be completed every five years throughout the lifetime of the remedial action.

LTM data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives are being met, including determining whether plume concentrations are stable or reducing; and (ii) to identify and assess optimization opportunities. The data collected under the SPEIM/LTM program are presented to the regulatory agencies through the Technical Update meeting process and documented in project note submittals.

A private well verification survey was completed for FTA-2/LF-2 in support of the ROD Amendment (AFCEC 2016a). No active or inactive water-supply or irrigation wells were identified within the FTA-2/LF-2 LUC area. Additionally no private residential wells are known to exist within the FTA-2/LF-2 LUC area since the plume is located entirely within the boundary of the JBCC (AFCEC 2016a). In the event that new private well information is obtained or plume monitoring data indicate a change to the CSM at FTA-2/LF-2, AFCEC will perform the necessary well determinations at the time the information becomes available.

The LUC component of the selected remedy is in place, is monitored throughout the year and serves to reduce potential future exposure to the FTA-2/LF-2 plume by prohibiting the use of FTA-2/LF-2 groundwater as a source of drinking water until groundwater cleanup levels are achieved. The implementation of routine LTM network sampling and existing LUCs continue to demonstrate the protectiveness of the selected remedy.

5.15.3.2 Remedy Operations & Maintenance

Not applicable since no active treatment is ongoing at FTA-2/LF-2.

5.15.4 Progress Since Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior fourth CERCLA Five Year Review (AFCEE 2013a). For the FTA-2/LF-2 site, the recommendations were:

- 1) Continue to monitor FTA-2 groundwater under the current LTM plan defined in 2010 (AFCEE 2011). A Focused FS to assess remedial alternatives for FTA-2 groundwater should be developed. The focused FS will include an updated conceptual exposure model and RAOs addressing the groundwater media for the petroleum-related compounds. AFCEC's preferred remedy for groundwater will be presented in a proposed plan available for public review and comment. The selected remedy for groundwater will be documented in an amendment to the existing ROD (AFCEE 1998). A component of the remedy for FTA-2 groundwater should include enforceable LUCs to ensure long-term protectiveness similar to the other IRP groundwater sites. In addition, and similar to the other IRP groundwater sites, the LUCs should adopt the administrative processes and procedures for on-base development activities, including the construction of new buildings, to provide long-term protectiveness for the VI exposure pathway. Future Five Year Reviews should include assessment of both the FTA-2/LF-2 source area and FTA-2 groundwater.
- 2) In addition, a component of the institutional controls was to document the presence of a landfill at LF-2 through a deed notification per the MassDEP solid waste regulations (310 CMR 19.141). AFCEC, working with the base real estate and the State who owns the property, have been unable to determine whether a deed for this parcel is in existence. Therefore, the deed notification will be filed at the Base Real Property office which will meet the intent of the deed notification regulatory requirement. This action will be documented in the ROD Amendment.

Progress since the last Five Year Review against these recommendations are as follows:

- 1) An LTM program has been in place at FTA-2/LF-2 since 2005. A Focused FS was completed in 2014 and included an updated CSM along with RAOs addressing the groundwater media for the petroleum-related compounds (AFCEC 2014a). A Proposed Plan, which presented AFCEC's preferred remedy, was made available for public review and comment and completed in 2014 (AFCEC 2014b). A ROD Amendment was completed in 2016 and identified MNA with LUCs as the selected remedy for FTA-2/LF-2 groundwater (AFCEC 2016a). A site visit at the FTA-2/LF-2 source area was conducted as part of this Five Year Review and the LF-2/FTA-2 groundwater was assessed as part of the LTM program.
- 2) A Record Notice of Landfill Operation for the LF-2 source area was filed at the Base Real Property office on 04 March 2014 and was documented in the ROD Amendment (AFCEC 2016a).

5.15.5 Five Year Review Process

5.15.5.1 Data Review

The data collected under the SPEIM/LTM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues. The following technical deliverables were prepared that assessed remedial progress:

- *FTA-2 2013 Long Term Monitoring Results Project Note* (AFCEC 2013b)
- *Final Fire Training Area-2 (FTA-2)/Landfill-2 (LF-2) Remedial Action Report*. (AFCEC 2014c)
- *FTA-2/LF-2 2015 Interim Long Term Monitoring Results Project* (AFCEC 2015b)

- *FTA-2/LF-2 Conceptual Site Model Update and Long Term Monitoring Network Revision Project Note* (AFCEC 2015a)
- *Fire Training Area-2 (FTA-2) / Landfill-2 (LF-2) 2016 Biennial Long Term Monitoring Results Project Note* (AFCEC 2016b)

5.15.5.2 Site Inspections

An SI was completed for FTA-2/LF-2 on 14 June 2017. The SI form is included in Appendix B. Since the remedial action conducted at FTA-2/LF-2 (i.e., operation of the biosparging treatment system) is complete, the focus of the SI was to assess general site conditions and to determine whether the land use assumptions are still valid and do not affect protectiveness. Based on the SI, land use at the site remains consistent with the assumptions used in the risk assessment, access to the site is restricted, and no concerns regarding protectiveness were identified.

5.15.5.3 Interviews

Refer to Section 3.7.

5.15.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.15.6.1 Question A: Is the remedy functioning as intended by the decision document?

Yes, the completion of the ROD Amendment in 2016 and the implementation of LUCs at FTA-2/LF-2 have resulted in the remedy at FTA-2/LF-2 functioning as intended by the decision documents. Operational costs are appropriate for the remedy. Monitoring and evaluation activities are continual and well-documented and should continue.

5.15.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup level, and RAOs used at the time of remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics: There has been a change to the toxicity factor used to calculate the cleanup levels at FTA-2/LF-2. The EPA has issued residential child noncancer tap water RSLs of 56 µg/L for 1,2,4-TMB and 60 µg/L for 1,3,5-TMB (EPA 2016). .

Changes in Risk Assessment Methods: There have been no changes in risk assessment methodology that affect protectiveness.

Review of RAOs: The RAOs developed for the ROD Amendment (AFCEC 2016a) are appropriate.

5.15.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information at this time that calls into question the protectiveness of the remedy.

FTA-2 was not investigated for PFAS because operations ceased in 1956 which predated the use of AFFF.

5.15.7 Issues, Recommendations, and Follow-Up Actions

No specific recommendation or follow-up actions have been identified. However, RSLs of 56 µg/L for 1,2,4-TMB and 60 µg/L for 1,3,5-TMB should be used going forward to evaluate data collected under AFCECs SPEIM/LTM program.

5.15.8 Protectiveness Determination

The remedy for the FTA-2/LF-2 is protective of human health and the environment.

The LTM program is in place and is being conducted to monitor remedial progress and the LUCs are in place and are functioning as intended.

5.15.9 References

- AFCEC. 2016a (September). *Final Fire Training Area-2/Landfill-2 Record of Decision Amendment*. 473147-SPEIM-FTA2-RPT-004. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016b (May). *Fire Training Area-2 (FTA-2) / Landfill-2 (LF-2) 2016 Biennial Long Term Monitoring Results Project Note*. 652000-SPEIM-FTA2-PRJNOT-002. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015a (December). *FTA-2/LF-2 Conceptual Site Model Update and LTM Network Revision Project Note*. 473147-SPEIM-FTA2-PRJNOT-003. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2015b (April). *FTA-2/LF-2 2015 Interim Long Term Monitoring Results Project Note*. 652000-SPEIM-FTA2-PRJNOT-001. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014a (April). *Final FTA-2 Groundwater Focused Feasibility Study*. 473147-SPEIM-FTA2-RPT-002. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2014b (April). *Final FTA-2 Proposed Plan*. 473147-SPEIM-FTA2-PP-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2014c (March). *Final Fire Training Area-2 (FTA-2)/Landfill-2 (LF-2) Remedial Action Report*. Prepared by Portage Inc. for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013a (October). *Final 4th Five-Year Review, 2007-2012 Massachusetts Military Reservation (MMR) Superfund Site, Otis Air National Guard Base, MA*. 473147-SPEIM-MULTIPLE-RPT-001. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2013b (May). *FTA-2 2013 Long Term Monitoring Results Project Note*. 473147-SPEIM-FTA2-PRJNOT-001. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2013c (March). *Fire Training Area-2 (FTA-2) Long Term Monitoring 2012 Project Note*. 437075-SPEIM-FTA2-PRJNOT-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
-

- AFCEE. 2012a (August). *Final 2011 MMR Vapor Intrusion Evaluation Technical Memorandum*. 420005-SPEIM-MULTIPLE-TECHMEM-002. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012b (July). *Fire Training Area-2 Long Term Monitoring 2011 Project Note*. 420005-SPEIM-FTA2-PRJNOT-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2011 (July). *Fire Training Area-2 2010 LTM Results and Monitoring Network Evaluation Project Note*. 404929-SPEIM-LF2-PROJNOT-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2006 (September). *Final Record of Decision for Groundwater at Eastern Briarwood, Western Aquafarm and Storm Drain-5*. A3P-J23-35Z04802-M26-0008. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.
- _____. 2005a (October). *Landfill-2/Fire Training Area-2 Monitoring Well and Biosparging Well Sampling*. Project Note No. 12. Prepared by Engineering Strategies Corporation for AFCEE/MMR IRP, Otis ANGB, Cape Cod, MA.
- _____. 2005b (July). *Project Note No. 11: LF-2 Groundwater Monitoring Plan Project Note*. Prepared by AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.
- _____. 2003 (May). *Confirmation Sampling Plan for FTA-2/LF-2 Source Area Remedial Systems Operations*. Project Note. Prepared by Environmental Chemical Corporation for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2002 (August). *Final Letter Work Plan SD-5A SVE Treatment Zone Addition to FTA-2/LF-2 System*. Prepared by Environmental Chemical Corporation for AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.
- _____. 1998 (September). *Record of Decision for Areas of Contamination FTA-2/LF-2, PFSA/FS-10/FS-11, SD-2/FS-6/FS-8, SD-3/FTA-3/CY-4, SD-4, and SD-5/FS-5 Source Areas*. Prepared by HLA for AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.
- _____. 1997 (November). *Final Six Areas of Contamination Source Area Feasibility Study*. Prepared by ABB-ES for AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.
- _____. 1996 (January). *Soil Target Cleanup Levels, DSRP*. Prepared by HAZWRAP for AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.
-

- ANG. 1996. *Remedial Investigation Report Fire-Training Area No.2 (FTA-2) and Landfill No.2 (LF-2)*. Prepared by ABB-ES for AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.
- _____. 1994 (August). *Southeast Region Groundwater Operable Unit Remedial Investigation Report (Including Region III); Installation Restoration Program; Massachusetts Military Reservation*. Prepared by ABB-ES Portland, Maine for HAZWRAP.
- E.C. Jordan Co., 1990 (June). *“Task 2-5B Site Inspection, Field Investigation Work Conducted Spring-Summer 1988”; Installation Restoration Program; Massachusetts Military Reservation*. Prepared for HAZWRAP; Portland, Maine.
- _____. 1986 (December). *U.S. Air Force Installation Restoration Program, Phase I: Records Search, Air National Guard, Camp Edwards, Air Force, and Veterans Administration Facilities at MMR, Task 6*. Prepared for Oak Ridge National Laboratory; Oak Ridge, Tennessee.
- EPA. 2016 (September). Integrated Risk Information System (IRIS) database. [online]. Available:
https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/1037_summary.pdf
- 2001 (June). *Comprehensive Five-Year Review Guidance*, EPA 540R-01-007.

5.16 PETROLEUM FUELS STORAGE AREA (PFSA)

The PFSA groundwater plume is a dissolved-phase groundwater plume (Figure 5-16) that contains the following COCs: C11-C22 (EPH) carbon ranges, the C5-C8, C9-C12, and C9-C10 (VPH) carbon ranges, and VOCs (2-methylnaphthalene, 1,2,4-TMB, and 1,3,5-TMB). The groundwater monitoring for COCs has been ongoing since 2005 and data indicate that the current EPH/VPH, TMB, and 2-methylnaphthalene plume is the remnants of the dissolved-phase plume that was previously defined by the BTEX compounds, which had already attenuated to below MCLs at the time of the RI (AFCEE 1996). Therefore, the need for a groundwater remedy was not included in the 1998 ROD.

Recharacterization of groundwater by the MassDEP EPH/VPH method, which is a newer method of characterizing petroleum contamination that was not available at the time of initial site characterization in 1996, determined that select EPH and VPH carbon ranges, 1,2,4- and 1,3,5-TMB and 2-methylnaphthalene remain in groundwater above clean up levels at and downgradient of the PFSA. The PFSA plume boundary is shown on Figure 5-16. The cleanup levels for the PFSA groundwater COCs are as follows: 300 µg/L for C5-C8 aliphatic, 200 µg/L for C9-C12 aliphatic, and 700 µg/L for C9-C10 aromatic VPH ranges; 200 µg/L for the C11-C22 aromatic EPH range; an RBC of 57 µg/L for 1,2,4-TMB and 60 µg/L for 1,3,5-TMB; and 10 µg/L for 2-methylnaphthalene. EPA released noncancer child resident RSLs for tap water for 1,2,4-TMB and 1,3,5-TMB since the last five year review (see Section 5.16.6.2 and Appendix E).

5.16.1 Site Chronology

The following major activities, investigations, and remedial actions were conducted at PFSA:

Early 1950s - 2009: The PFSA operated as the main fuel delivery and distribution area for the flightline.

1960s: FS-10 and FS-11 occurred at the PFSA. FS-10 was a 2,000-gallon jet fuel spill in one of the pumphouses. FS-11 was an approximate 2,000-gallon fuel spill from overfilling

one of the tanks.

1985 - 1986: Field investigations (R.F. Weston, Inc. 1985 and E.C. Jordan Co. 1988) identified the presence of soil and groundwater contamination at PFSA.

1987 - 1988: The “Mashpee Groundwater Study” (E.C. Jordan 1990) found soil contamination at the water table in a boring south of the PFSA across South Outer Road and identified fuel-related contamination in groundwater.

1993: The fuel distribution lines at the PFSA were upgraded from below ground to an aboveground system. Approximately 11 cubic yards of fuel-contaminated soil were excavated from around the below-ground fuel lines during construction activities.

1994: An interim RI was performed to characterize groundwater contamination and evaluate potential site risks (ANG 1994).

1994: Four 50,000-gallon underground storage tanks were removed from the PFSA.

1996: Heavy rain and pump failure at the PFSA caused an estimated 6,000 gallons of fuel-contaminated water to spill from a fuel pumphouse building (Building 172). Of the 6,000 gallons, about 300 gallons were diesel and/or jet fuel. Because of high stormwater flows, some fuel discharged to Storm Drain-2 south of the PFSA. In response to this spill, 480 cubic yards of fuel-contaminated soil was excavated from the Storm Drain-2 drainage ditch as part of an Immediate Response Action performed under the MCP. The excavated soils were transported to an off-site facility for disposal and a soil vapor extraction system was installed to the north of the pumphouse as part of the Immediate Response Action to remove additional contamination associated with this spill.

1996: The Final RI Report (ANG 1996) was completed, with results of the SI, interim RI, and JBCC DSRP sampling at the PFSA forming the basis of the RI report.

1997-1998: Completion of a FS (AFCEE 1997) and a ROD (AFCEE 1998).

2001–2010: A BSVR treatment system was installed as part of the remedy for soil presented in the ROD. The BSVR system started operation in October 2001 and was operated under an approved O&M Plan (AFCEE 2003). In support of treatment system optimizations and eventual shutdown of the BSVR system in April 2010, soil and groundwater samples were analyzed for the ROD COCs, ethylbenzene and total xylenes. Samples were also analyzed for EPH/VPH by the MassDEP Method. EPH/VPH were not identified as COCs in the ROD, but analysis of these compounds was requested by MassDEP.

2011: ASTs 15 and 16 and Buildings 171, 172, and 173 at the PFSA were removed in January/February 2011 as non-CERCLA related actions. The AST to the west of AST 16 had previously been removed in 1998. The buildings and AST 15 were removed with no evidence of contamination. Contaminated soil was encountered during the dismantling of AST 16 and 1,056 gallons of fuel oil, 550 gallons of oily water, and 760 cubic yards of oil-impacted sand were removed for off-site disposal as part of an Immediate Response Action under the MCP (Horsley Witten 2011). Excavation activities were not successful in achieving background conditions for soils in the AST 16 area, and additional site investigation was recommended to fully delineate the vertical and horizontal extent of the impacted soils (AFCEE 2012c). In February 2012, a soil boring was advanced from the ground surface to the water table within the footprint of the AST. The soil and groundwater vertical profiling data indicated that the 2011 release from AST 16 did not impact the groundwater at the PFSA (AFCEE 2012c).

2013: A 4th Five Year Review for the IRP sites at JBCC (including PFSA) was completed (AFCEC 2013a). This review concluded that the PFSA remedy, as selected in the 1998 ROD, is protective in the short-term under the current land use scenario. The remedy is protective in the short term since access to the site is controlled by current flight line security measures that include fencing and 24-hour security that effectively limits potential human exposure to site contaminants. Although groundwater contamination has been detected off-base, no active private or municipal wells are currently known to be located on the off-base properties, which are located in the Town of Mashpee. The Mashpee BOH

has regulations in place that prohibit the use of existing and future private residential wells located in documented or anticipated areas of contamination. However, for the remedy to be protective in the long-term, the EPH/VPH, TMB, and 2-methylnaphthalene groundwater contamination at the PFSA should be addressed.

2014: A Focused FS and Proposed Plan for PFSA groundwater was completed (AFCEC 2014a, 2014b).

2015: A field data gap investigation was completed to characterize the downgradient extent of the PFSA plume, update the CSM and revise the PFSA plume boundary (AFCEC 2015a).

2015: Final LTM network was established in July 2015.

2016: The ROD Amendment, finalized in September 2016, identifies MNA with LUCs as the selected remedy for PFSA groundwater (AFCEC 2016a).

5.16.2 Background

5.16.2.1 History of Contamination

The PFSA (now demolished) served as the storage and distribution center for JP-4 jet fuel, AVGAS, motor gasoline, and No. 2 fuel oil for JBCC from the 1950s until 2009. Historically, fuel received or stored at the PFSA was transferred through underground pipelines to the fuel distribution pump houses. From 1955 to 1965 AVGAS and JP-4 were delivered to the PFSA from the railroad fuel pumping station at JBCC (located approximately 9,500 ft west of the PFSA near the intersection of Kittredge and Turpentine Roads). From 1965 to 1973, AVGAS and JP-4 were delivered to the JBCC through a 3-inch-diameter underground pipeline extending from the Cape Cod Canal to the PFSA (AFCEE 2012a). Fuels were subsequently delivered by truck to the PFSA and then distributed by truck to aircraft or other points of use (ANG 1996).

Two of the ASTs (ASTs 15 and 16 shown on Figure 4-5) were constructed with floating

lids, allowing rainwater and condensation to enter and migrate to the bottom of each of the tanks. This water was reportedly removed from the tank bottoms by opening drain valves and discharging the accumulated water to the containment berms that surrounded the ASTs until fuel product discharge was observed. The floating lids on the ASTs 15 and 16 were replaced with solid lids in 1977 and 1988, respectively (AFCEE 2012a).

Discharges from the AST containment berms and paved surfaces at fuel unloading areas typically entered storm drain catch basins via asphalt-lined ditches and then exited to the JBCC storm water sewer system and then ultimately to the OWS located on the southeast side of South Outer Road. The OWS discharged to a drainage ditch (referred to as SD-2) which lies south of the far eastern portion of PFSA source area boundary (Figure 1-2). Two 42-inch-diameter storm drains and the OWS discharged to the upstream end of SD-2 until their removal in 2002 (AFCEE 2008b). The SD-2 source area has achieved UU/UE status as presented in Table 1-1a.

Floor drains in the PFSA pump houses formerly discharged to two nearby French drains that were replaced in 1989 with a 2,000-gallon UST located east of former Building 173. Fuel-contaminated water was historically discharged from fuel/water separator equipment located in the pump houses to the floor drains when filters in the separators were changed (AFCEE 2012a). Four 50,000-gallon USTs were installed northwest of AST 15 in 1956 and were used to dispense AVGAS (that was received from the PFSA) via an underground pipeline to aircraft on the maintenance ramp. The fuel line from the PFSA to these USTs was abandoned in the early 1970s, and these USTs were removed in 1994 (ANG 1996, AFCEE 2008a).

5.16.2.2 Physical Characteristics, Land and Resource Use

The PFSA source area occupies approximately 13 acres and is located on the southeast corner of the JBCC (Figure 1-2) on-base property. All of the PFSA infrastructure located to the north of South Outer Road has been removed. The PFSA area to the north of South Outer Road (within the flight-line security area) is characterized by generally flat topography consisting of grassed areas that are mowed and maintained adjacent to the

airfield. The area across South Outer Road (outside the flight-line security area) nearby is occupied by the AFCEC Sandwich Road Treatment Facility, the O&M Building, paved parking areas, and forested land. Ground surface in this area generally slopes downward to the south, from a maximum elevation of 100 ft above msl at the PFSA to a minimum elevation of 30 ft msl at Johns Pond.

The depth to groundwater is approximately 40-55 ft bgs at the PFSA. Groundwater flows from the PFSA in a southeast direction toward Johns Pond, which is located approximately 3,800 ft south of the PFSA (Figure 3). Land located between PFSA and Johns Pond is primarily undeveloped protected open space (Orenda Wildlife Trust and Mashpee Conservation Commission). A residential area, commonly referred to as Briarwood, is located downgradient of the open space, to the north of Johns Pond. Land use at and to the south of PFSA is expected to be maintained for the foreseeable future while the airfield and runways are in use.

5.16.2.3 Initial Responses

Drainage Structure Removal Program (1993): As part of the DSRP, the pump house French drains, the storm-sewer catch basin, and associated contaminated soil were removed in 1993 (AFCE 2008b).

Fuel Distribution Line Realignment (1993): The fuel distribution lines at the PFSA were upgraded from below ground to an aboveground system in 1993. Approximately 10 cubic yards of fuel-contaminated soil was excavated from around the subsurface fuel lines during construction activities (AFCEE 2012b).

Demolition of Buildings and UST Removal (1994): Several pump house buildings were demolished and four associated 50,000-gallon USTs were removed from the PFSA in November 1994 (AFCEE 2012b).

Fuel Spill Cleanup (1996): In response to the release of approximately 6,000 gallons of oil/water mixture in 1996 as described in Section 4.6.2.1, 480 cubic yards of fuel-

contaminated soil were removed from the PFSA, and 120 cubic yards of fuel-contaminated soil was excavated from the SD-2 drainage ditch as part of an Immediate Response Action performed under the MCP. The excavated soils were transported off site to Bardon Trimount of Stoughton, Massachusetts for asphalt-batching. An SVE system was installed as part of the Immediate Response Action to remove the remaining localized contamination associated with the release (AFCEE 1998). This SVE system was intended to only address the contamination north of Building 173 (Figure 4-6) and should not be confused with the larger PFSA BSVR system installed south of South Outer Road later as part of the selected remedy for PFSA as presented in the ROD (AFCEE 1998).

AST Demolition (2010/2011): Although not considered initial responses, ASTs 15 and 16 and Buildings 171, 172, and 173 at the PFSA were removed in January/February 2011 as non-CERCLA related actions. The AST to the west of AST 16 had previously been removed in 1998 (AFCEE 2003). The buildings and AST 15 were removed with no evidence of contamination. Contaminated soil was encountered during the dismantling of AST 16 and 1,056 gallons of fuel oil, 550 gallons of oily water, and 760 cubic yards of oil-impacted sand were removed for off-site disposal as part of an Immediate Response Action under the MCP (Horsley Witten 2011). Excavation activities were not successful in achieving background conditions in the entire AST 16 area, and additional SI was recommended to fully delineate the vertical and horizontal extent of the impacted soils (AFCEE 2012c). In February 2012, a soil boring was advanced from the ground surface to the water table within the footprint of the AST. The soil and groundwater vertical profiling data indicated that the 2011 release from AST 16 did not impact the groundwater at the PFSA (AFCEE 2012c).

5.16.2.4 Basis for Taking Action

BTEX contamination in groundwater associated with historic releases from the PFSA had already attenuated to concentrations less than MCLs at the time of the RI (AFCEE 1996). The RI included a human-health PRA to evaluate potential human-health risks associated with exposure to contaminated soil under an occupational (worker) exposure scenario. The calculated cancer risk was within the EPA acceptable risk range and the calculated

noncancer hazard index was below one. Because ecological receptors are not anticipated at the PFSA; a quantitative ecological PRA was not completed (AFCEE 2008b). Cleanup of contaminated soil at PFSA was driven by the potential leaching threat to groundwater from the soil COCs, xylene and ethylbenzene.

Recharacterization of the site by the MassDEP EPH/VPH analytical method, which is a newer method of characterizing petroleum contamination that was not available at the time of the 1996 RI, indicated that select EPH/VPH carbon ranges, 1,2,4-TMB, 1,3,5-TMB and 2-methylnaphthalene were present in PFSA groundwater at concentrations greater than GW-1 standards or RBCs. Therefore a ROD Amendment to incorporate a remedy for the groundwater contamination identified at PFSA was finalized in 2016 (AFCEC 2016a).

5.16.3 Remedial Actions

A remedy for PFSA groundwater contamination was determined in the *Final Petroleum Fuels Storage Area Record of Decision Amendment* (AFCEC 2016a). RAOs and alternative analysis for groundwater at PFSA were developed in the *Final PFSA Groundwater Focused Feasibility Study* (AFCEC 2014a). RAOs were designed to prevent exposure to PFSA groundwater that would result in unacceptable risk (non-cancer greater than an HI of 1) through residential exposure. The COCs and associated RAOs for the PFSA groundwater plume, as agreed upon by AFCEC, EPA, and MassDEP, are as follows:

- Prevent residential exposure to site groundwater with EPH/VPH concentrations greater than the MCP GW-1 cleanup standards of:
 - 300 µg/L for C5-C8 aliphatic hydrocarbons
 - 200 µg/L for C9-C10 aromatic hydrocarbons
 - 700 µg/L for C9-C12 aliphatic hydrocarbons
 - 200 µg/L for C11-C22 aromatic hydrocarbons
- Prevent residential exposure to site groundwater with 1,2,4-TMB concentrations greater than the RBC of 19 µg/L.
- Prevent residential exposure to site groundwater with 1,3,5-TMB concentrations

greater than the RBC of 19 µg/L.

- Prevent residential exposure to site groundwater with 2-methylnaphthalene concentrations greater than the MCP GW-1 standard of 10 µg/L.
- Restore usable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

5.16.3.1 Remedy Selection and Implementation

The selected remedy for the PFSA Groundwater in the ROD Amendment (AFCEC 2016a) was MNA with LUCs. The selected remedy amends the original remedy (AFCEE 1998) by addressing future risk associated with potential residential exposure to groundwater. The combined remedies are deemed protective of human health and the environment. The remedial timeframe for the groundwater is expected to be approximately 20 years and does not extend the timeframe for maintenance of the institutional controls that was assumed in the original ROD. In addition, CERCLA reviews are to be completed every five years throughout the lifetime of the remedial action.

LTM data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives are being met, including determining whether plume concentrations are stable or reducing; and (ii) to identify and assess optimization opportunities. The data collected under the SPEIM/LTM program are presented to the regulatory agencies through the Technical Update meeting process and documented in project note submittals.

As part of the LUC process specified in the ROD (AFCEE 2016a), a well verification survey was completed at PFSA. No active or inactive water-supply or irrigation wells were identified within the PFSA LUC area and no private residential wells were identified (AFCEC 2016a). In the event that new private well information is obtained or plume monitoring data indicate a change to the CSM at PFSA, AFCEC will perform the necessary well determinations at the time the information becomes available.

In 2017, the PFSA LUC area was expanded to the south to Johns Pond due to detections of COCs at concentrations greater than cleanup standards at a downgradient LTM well.

Private well research and outreach was completed in the neighborhood located between the PFSA plume and Johns Pond as part of the Storm Drain-5 (SD-5) LUC Evaluation (AFCEC 2013b) and the Briarwood emerging contaminant outreach (AFCEC 2015b). Based on a review of this prior outreach, no active drinking water wells were identified in the expanded PFSA LUC area. Two active private irrigation wells were identified. Technical evaluations for these wells were completed (Appendix C) and based upon a review of SPEIM data and private well sampling data, there is no current risk of exposure to the PFSA groundwater plume through the intermittent use of these wells for outdoor purposes (AFCEC 2017a).

The status of non-operational private wells in the PFSA LUC will continue to be tracked. AFCEC will distribute a mailing, on an annual basis, to property owners within the LUC area that have non-operational wells. The intent of the annual mailing is to remind these property owners that they should contact AFCEC for a technical evaluation, which may include sampling, in the event their well is put back into service. The first annual mailing for the PFSA LUC area was sent in August 2017 and the results of the mailing will be summarized in the next five-year review.

The LUC component of the selected remedy is in place, is monitored throughout the year and serves to reduce potential future exposure to the PFSA plume by prohibiting the use of PFSA groundwater as a source of drinking water until groundwater cleanup levels are achieved. The implementation of routine LTM network sampling and existing LUCs continue to demonstrate the protectiveness of the selected remedy.

5.16.3.2 Remedy Operations & Maintenance

Not applicable since no active treatment is ongoing at PFSA.

5.16.4 Progress Since Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior fourth CERCLA Five Year Review (AFCEC 2013a). For the PFSA site, the recommendations

and follow-up actions were:

- 1) Establish an interim LTM program that would be designed to monitor PFSA groundwater contamination. A focused FS to assess remedial alternatives for PFSA groundwater should be developed. The focused FS will include an updated conceptual exposure model and RAOs addressing the groundwater media for the petroleum-related compounds. AFCEC's preferred remedy for groundwater will be presented in a proposed plan available for public review and comment. The selected remedy will be documented in an amendment to the existing ROD (AFCEE 1998). A component of the remedy for PFSA groundwater should include enforceable LUCs to ensure long-term protectiveness similar to the other IRP groundwater sites. Future Five Year Reviews should include assessment of both the PFSA source area and PFSA groundwater.
- 2) VI risks could not be ruled out during the VI screening assessment (AFCEE 2012a). It is recommended that VI be re-screened utilizing guidance being developed for petroleum release sites by EPA including the *OSWER Final Guidance for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Sources to Indoor Air* (Final VI Guidance) and *Guidance for Addressing Petroleum Vapor at Leaking Underground Storage Tanks Sites* (Petroleum VI Guidance), both released for external review in 2013 and due to be released final soon.

Progress since the last Five Year Review against these recommendations is as follows:

- 1) Additional leading edge groundwater characterization work was completed between June 2014 and March 2015; the data were used to update the CSM, plume boundary, and groundwater LTM network (AFCEC 2015a) in support of the ROD Amendment, which was finalized in September 2016 (AFCEC 2016a). MNA with LUCs was identified as the selected remedial action for the PFSA groundwater plume. The LTM network is in place to monitor remedy protectiveness and remedial progress, and the LUC Program is currently in place to prevent the use of

groundwater until COC concentrations decrease below cleanup levels.

- 2) VI was re-screened utilizing guidance developed for petroleum release sites by EPA including the *OSWER Final Guidance for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Sources to Indoor Air* (Final VI Guidance) and *Guidance for Addressing Petroleum Vapor at Leaking Underground Storage Tanks Sites* (Petroleum VI Guidance) at PFSA and were reported in the Final 2014 PFSA Source Area Vapor Intrusion Evaluation (AFCEC 2015d). VI risks were ruled out for current land use at PFSA, but potential risks remain for an assumed unrestricted future use. A component of the remedy for PFSA groundwater documented in the ROD Amendment includes enforceable LUCs to ensure long-term protectiveness similar to the other IRP groundwater sites including the administrative processes and procedures for on-base development activities, such as the construction of new buildings, to provide long-term protectiveness for the VI exposure pathway.

5.16.5 Five Year Review Process

5.16.5.1 Data Review

The data collected under the SPEIM/LTM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues. The following technical deliverables were prepared that assessed remedial progress:

- *PFSA 2015 Interim Long Term Monitoring Results Project Note* (AFCEC 2015c)
- *PFSA Conceptual Site Model Update and Long Term Monitoring Network Revision Project Note* (AFCEC 2015a)
- *PFSA 2016 Long Term Monitoring Results Project Note* (AFCEC 2016b)

- *Petroleum Fuel Storage Area 2017 Annual Long Term Monitoring Results and Network Revision Project Note.* (AFCEC 2017a)

5.16.5.2 Site Inspections

An SI was completed for PFSA on 14 June 2017. The SI form is included in Appendix B. Since the active component of the remedial action conducted at PFSA is complete and no ongoing O&M of remedial systems is occurring, the focus of the SI was to assess general site conditions and to determine whether the land use assumptions are still valid and do not affect protectiveness. Based on the SI, land use at the site remains consistent with the assumptions used in the risk assessment and no concerns regarding protectiveness were identified.

5.16.5.3 Interviews

Refer to Section 3.7.

5.16.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedial action. AFCEC performed the technical assessment based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.16.6.1 Question A: Is the remedy functioning as intended by the decision document?

Yes, the LTM activities and the implementation of the LUCs at PFSA have resulted in a remedy functioning as intended by the decision documents. Operational costs are appropriate for the remedy, monitoring and evaluation activities are continual and well-documented and should continue.

5.16.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup level, and RAOs used at the time of remedy selection (current) still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics: EPA issued noncancer child resident tap water RSLs for 1,2,4-TMB and 1,3,5-TMB since the last five year review (EPA 2016). The RSL for 1,2,4-TMB is 56 ug/L and 60 ug/L for 1,3,5-TMB. These values should be used as the RBCs for risk assessment in lieu of the levels in the previous five year plan.

Changes in Risk Assessment Methods: There have been no changes in risk assessment methodology that affect protectiveness.

Review of RAOs: The RAOs developed for the ROD Amendment (AFCEC 2016) are appropriate.

5.16.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information at this time that calls into question the protectiveness of the remedy.

5.16.7 Issues, Recommendations, and Follow-Up Actions

No specific recommendations or follow up actions have been identified. However, RSLs of 56 µg/L for 1,2,4-TMB and 60 µg/L for 1,3,5-TMB should be used going forward to evaluate data collected under AFCECs SPEIM/LTM program.

5.16.8 Protectiveness Determination

The remedy for the PFSA groundwater is protective of human health and the environment. The LTM program is in place and is being conducted to monitor remedial progress and the LUCs are in place and are functioning as intended.

5.16.9 References

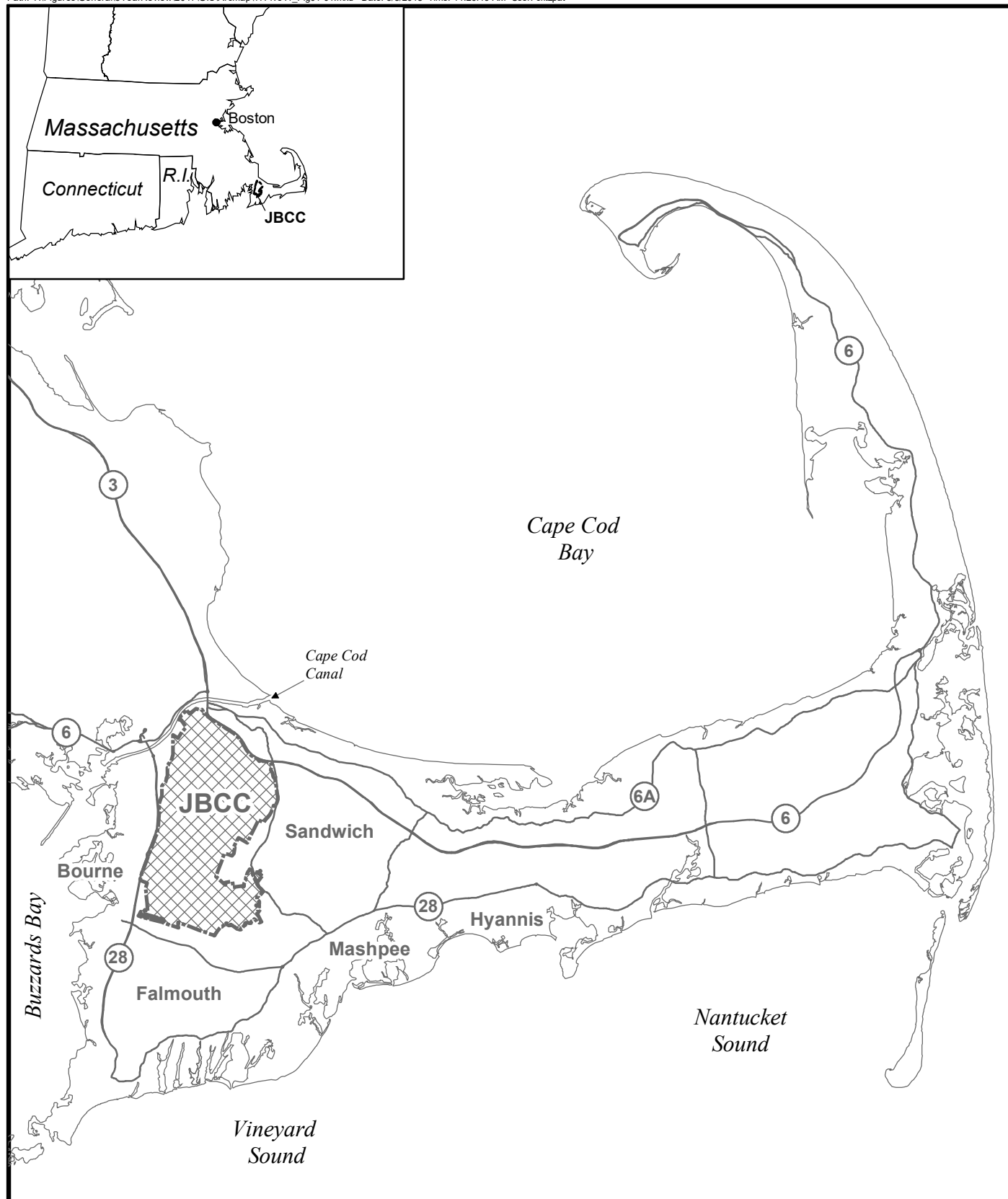
- AFCEC. 2017a (August). *Petroleum Fuel Storage Area 2017 Annual Long Term Monitoring Results and Network Revision Project Note*. 652000-SPEIM-PFSA-PRJNOT-003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA
- _____. 2017b (November). *2017 Operations and Maintenance Plan for Groundwater Extraction and Treatment Systems and Wind Turbine*. 652000-O&M-MULTIPLE-OMPLN-003. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA
- _____. 2016a (September). *Final Petroleum Fuels Storage Area Record of Decision Amendment*. 473147-SPEIM-PFSA-RPT-004. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2016b (May). *Petroleum Fuel Storage Area 2016 Long Term Monitoring Network Project Note*. 652000-SPEIM-PFSA-PRJNOT-002. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA
- _____. 2015a (July). *Petroleum Fuel Storage Area Conceptual Site Model Update and Long Term Monitoring Network Revision Project Note*. 473147-SPEIM-PFSA-PRJNOT-003. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015b (July). *2014 Land Use Controls Letter Report*. AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2015c (March). *Petroleum Fuel Storage Area 2015 Interim Long Term Monitoring Network Project Note*. 652000-SPEIM-PFSA-PRJNOT-001. Prepared by EA Engineering, Science and Technology and CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA
- _____. 2015d (January). *Final 2014 Petroleum Fuel Storage Area Source Area Vapor Intrusion Evaluation Project Note*. 473147-SPEIM-PFSA-PRJNOT-002. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014a (April). *Final Petroleum Fuel Storage Area Groundwater Focused Feasibility Study*. 473147-SPEIM-PFSA-RPT-002. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
-

- _____. 2014b (April). *Proposed Plan for Petroleum Fuel Storage Area Groundwater Remedy*. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2014c (March). *Petroleum Fuel Storage Area Interim Monitoring Network Evaluation and Baseline Data Presentation*. 473147-SPEIM-PFSA-PRJNOT-001. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2013a (October). *Final 4th Five-Year Review, 2007-2012 Massachusetts Military Reservation (MMR) Superfund Site, Otis Air National Guard Base, MA*. 473147-SPEIM-MULTIPLE-RPT-001. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2013b (September). Storm Drain-5 Private Well Verification and Well Determination Project Note. 437075-LUC-SD5-PRJNOT-002. Prepared by CH2M HILL for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- AFCEE. 2012a (August). *Final 2011 JBCC Vapor Intrusion Evaluation Technical Memorandum*. 420005-SPEIM-MULTIPLE-TECHMEM-002. Prepared by CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2012b (July). *Interim Remedial Action Report for the Petroleum Fuels Storage Area/FS-10/FS-11 at the Massachusetts Military Reservation*. Prepared by Portage, Inc. for AFCEE/JBCC.
- _____. 2012c (June). *Petroleum Fuel Storage Area (PFSA) Post Excavation Soil and Groundwater Sampling –February 2012*. Project Note 420005-SPEIM-PFSA-PRJNOT-001. Prepared by CH2M HILL for AFCEE/JBCC.
- _____. 2010 (April). “PFSA Air Off” E-mail correspondence titled dated 22 April 2010 from Jon Davis/AFCEE to EPA and MassDEP.
- _____. 2008a (November). *Petroleum Fuels Storage Area/Fuel Spill-10/Fuel Spill 11 (PFSA/FS-10/FS-11) Biosparge/Soil Vapor Recovery System 2007 Annual Report*. Prepared by Engineering Strategies Corporation and Portage Inc. for the AFCEE/JBCC Installation Restoration Program, Otis ANG Base, MA.
- _____. 2008b (September). *Final 3rd Five-Year Review, 2002-2007 Massachusetts Military Reservation (JBCC) Superfund Site, Otis Air National Guard Base, MA*. Prepared by Engineering Strategies Corporation, Portage and CH2M HILL for AFCEE/JBCC, Installation Restoration Program, Otis ANG Base, MA.
- _____. 2003 (May). *Final Operations and Maintenance Manual Biosparge/Vapor Recovery System for PFSA FS-10/FS-11*. Prepared by Environmental Chemical Corporation for AFCEE/JBCC, Installation Restoration Program, Otis Air
-

National Guard Base, MA.

- _____. 1998 (September). *Record of Decision for Areas of Contamination FTA-2/ LF-2, PFSA/FS-10/FS-11, SD-2/FS-6/FS-8, SD-3/FTA-3/CY-4, SD-4, and SD-5/FS-5 Source Areas*. Prepared by HLA for AFCEE/JBCC Installation Restoration Program, Otis ANG Base, MA.
- _____. 1997 (November). *Final Six Areas of Contamination Source Area Feasibility Study*. Prepared by ABB-ES for AFCEE/JBCC Installation Restoration Program, Otis ANG Base, MA.
- _____. 1996 (January). *Soil Target Cleanup Levels, DSRP*. Prepared by HAZWRAP for AFCEE/JBCC Installation Restoration Program, Otis ANG Base, MA.
- ANG. 1996 (December). *Final Remedial Investigation Report Petroleum Fuel Storage Area (Including AOCs Fuel Spill No. 10 [FS-10] and Fuel Spill No. 11)*; Installation Restoration Program; Massachusetts Military Reservation. Prepared by ABB-ES Portland, Maine for HAZWRAP.
- _____. 1994 (August). *Southeast Region Groundwater Operable Unit Remedial Investigation Report (Including Region III)*; Installation Restoration Program; Massachusetts Military Reservation. Prepared by ABB-ES Portland, Maine for HAZWRAP.
- E.C. Jordan Co. 1990 (August). *Task 5 Mashpee Groundwater Study, Installation Restoration Program, Massachusetts Military Reservation*. Prepared for HAZWRAP; Portland, Maine.
- _____. 1988 (July). *Task 2-1 Field Investigations, Summer/Fall 1986; Base Landfill, Petroleum Fuels Storage Area, and Fire-Training Area, Installation Restoration Program, Massachusetts Military Reservation*. Prepared for HAZWRAP; Portland, Maine.
- EPA. 2001 (June). *Comprehensive Five-Year Review Guidance*, EPA 540R-01-007.
- Horsely Witten. 2011 (May). *Immediate Response Action Status Report, Otis Air National Guard Base, Bourne, MA – RTN 4-23047*. Prepared for 102nd Intelligence Wing, Massachusetts Air National Guard.
- R.F. Weston, Inc. 1985 (October). *Installation Restoration Program -- Phase 11, Stage 1 -- Confirmation/Quantification* Otis Air National Guard Base, Massachusetts; prepared for the U.S. Air Force Occupational and Environmental Health Laboratory.

FIGURES



Legend



Joint Base Cape Cod

Data Source: AFCEC, April 2018
JBCC Boundary from Massachusetts Air National Guard 2011

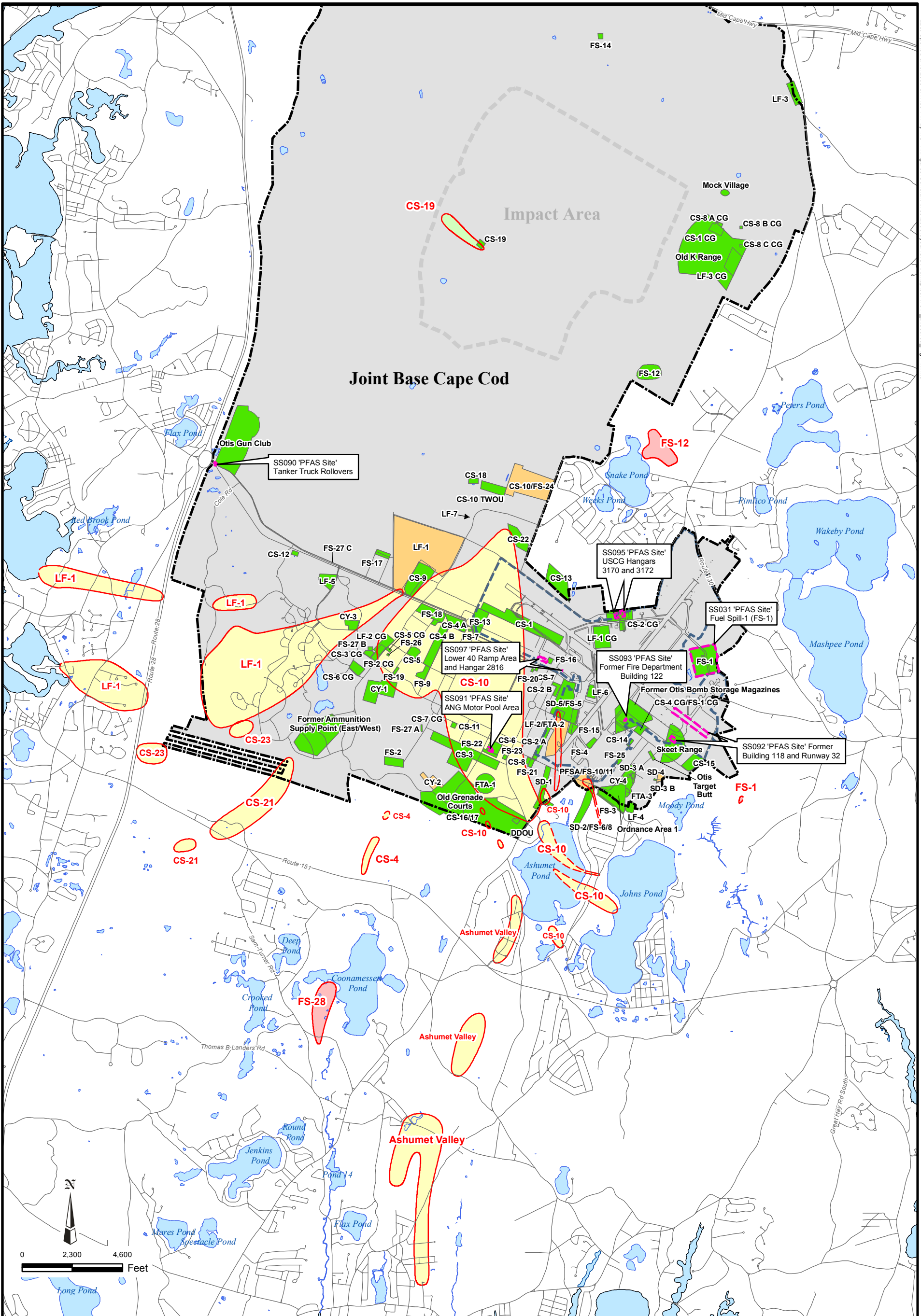


0 3 6
Miles

FIGURE 1-1

JOINT BASE CAPE COD CAPE COD, MASSACHUSETTS

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Last Opened 8/19/2008 3:47:05 PM by MC_V:\Figures\General\Aves\2008\5yearGIS\Acomp08\Fig1- allsource_Fig1-1.mxd

Legend

- Joint Base Cape Cod Boundary
- Plume Boundary (Dashed Where Inferred)
- Impact Area
- JBCC Flight Line
- Source Areas Undergoing Five-Year Review*
- Source Areas Not Subject to Five-Year Review
- Approximate PFAS Site Boundary

Data Source: AFCEC, April 2018, JBCC Boundary from Massachusetts Air National Guard 2011

Groundwater Plumes

- EDB Plume - Represent an exceedance of Ethylene Dibromide (1,2-dibromoethane), EDB MMCL = 0.02 µg/L
- TCE/PCE Plume - Represent an exceedance of Trichloroethene (TCE) and/or Tetrachloroethene (PCE), TCE and PCE MCL = 5.0 µg/L
- Explosives Plume Concentrations Above EPA Risk Based Concentration = 0.6 µg/L, Royal Demolition Explosive (RDX)

*Coal Yard-2 not subject to Five Year review - see Section 4.2 for explanation.

FIGURE 1-2

ALL JBCC - IRP SITE LOCATIONS

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017

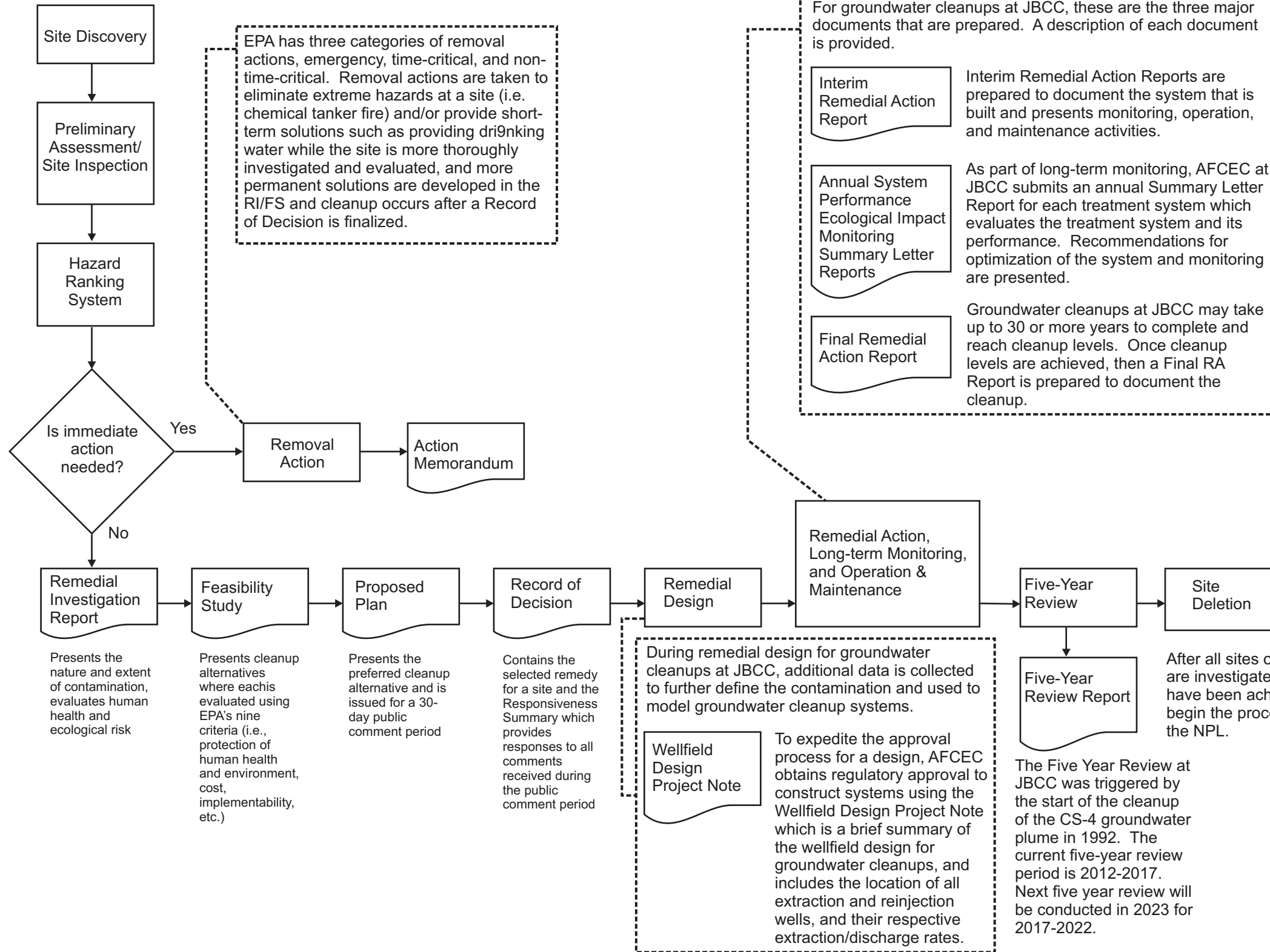
*Plume Boundaries No Longer Defined

What is Superfund?

Superfund is the nickname for the environmental cleanup program legally known as the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), a federal law, enacted in 1980. Superfund provides the authority through which the Federal government can compel people or companies responsible for creating hazardous waste sites to clean them up. It also created a public trust fund, known as the Superfund, to assist with the cleanup of inactive and abandoned hazardous waste sites or accidentally spilled or illegally dumped hazardous materials.

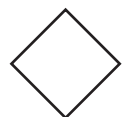
See also EPA's Superfund Internet Resources

Superfund Process:
<http://www.epa.gov/superfund/action/process/sfprocess.htm>
General Superfund:
<http://www.epa.gov/superfund/index.htm>



This flowchart begins in the upper left with "Site Discovery" and is an overview of the Superfund process. A site is added to the National Priorities List and is called a Superfund Site if it has a score of 28.5 or greater using a scoring system which is called the Hazard Ranking System. Since the investigation and cleanup process takes several years, sites are evaluated early in the process to determine if any short-term actions or removal actions need to be taken. Details are provided in comments associated with certain steps in the flowchart. Typical Superfund sites have only one to three operable units and are smaller in comparison to federal facility sites such as the Joint Base Cape Cod (JBCC) which has over 80 sites in its Installation Restoration Program (IRP).

Legend



Decision Point



Document

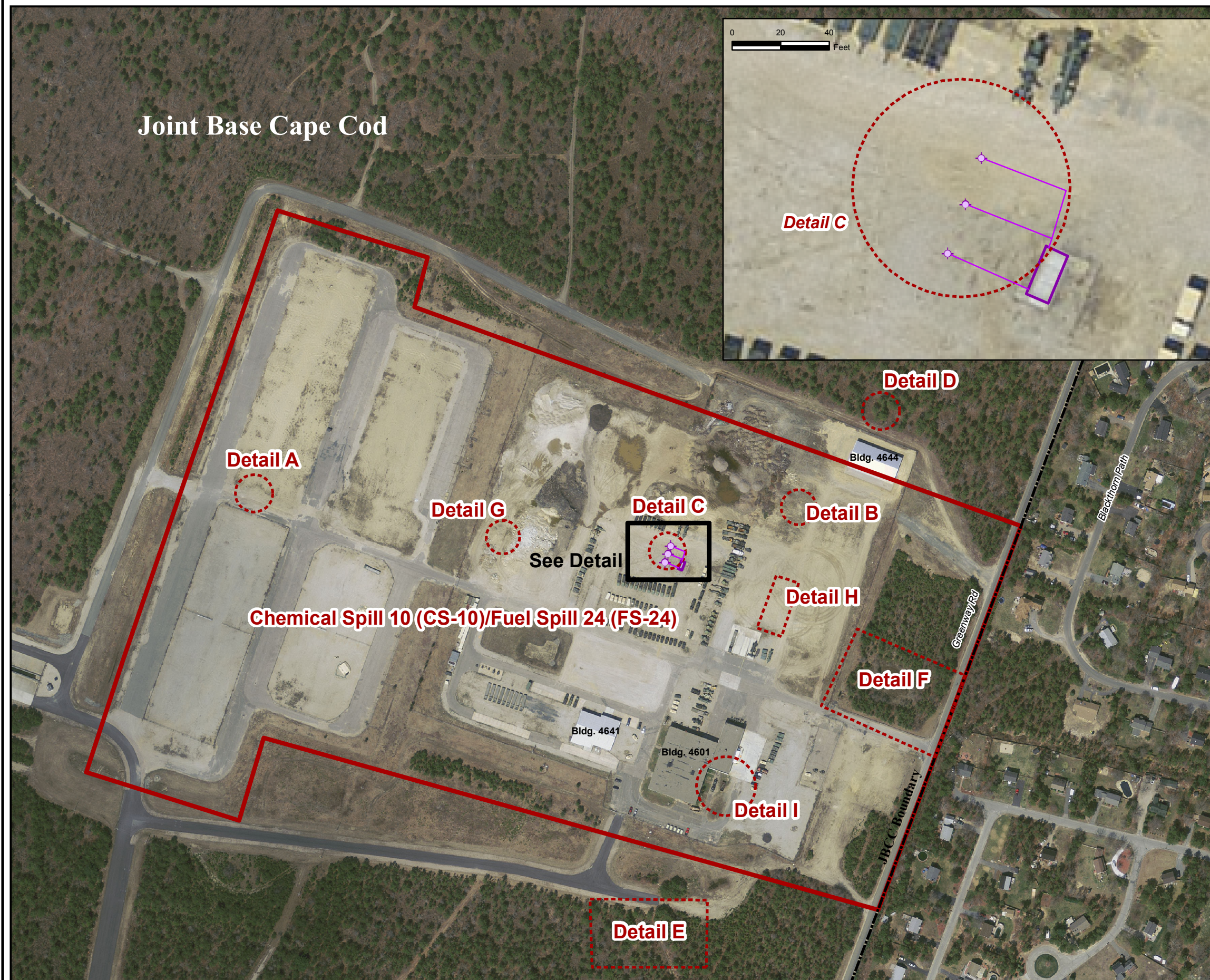


Process

FIGURE 1-4

OVERVIEW OF THE SUPERFUND INVESTIGATION AND CLEANUP PROCESS

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Legend

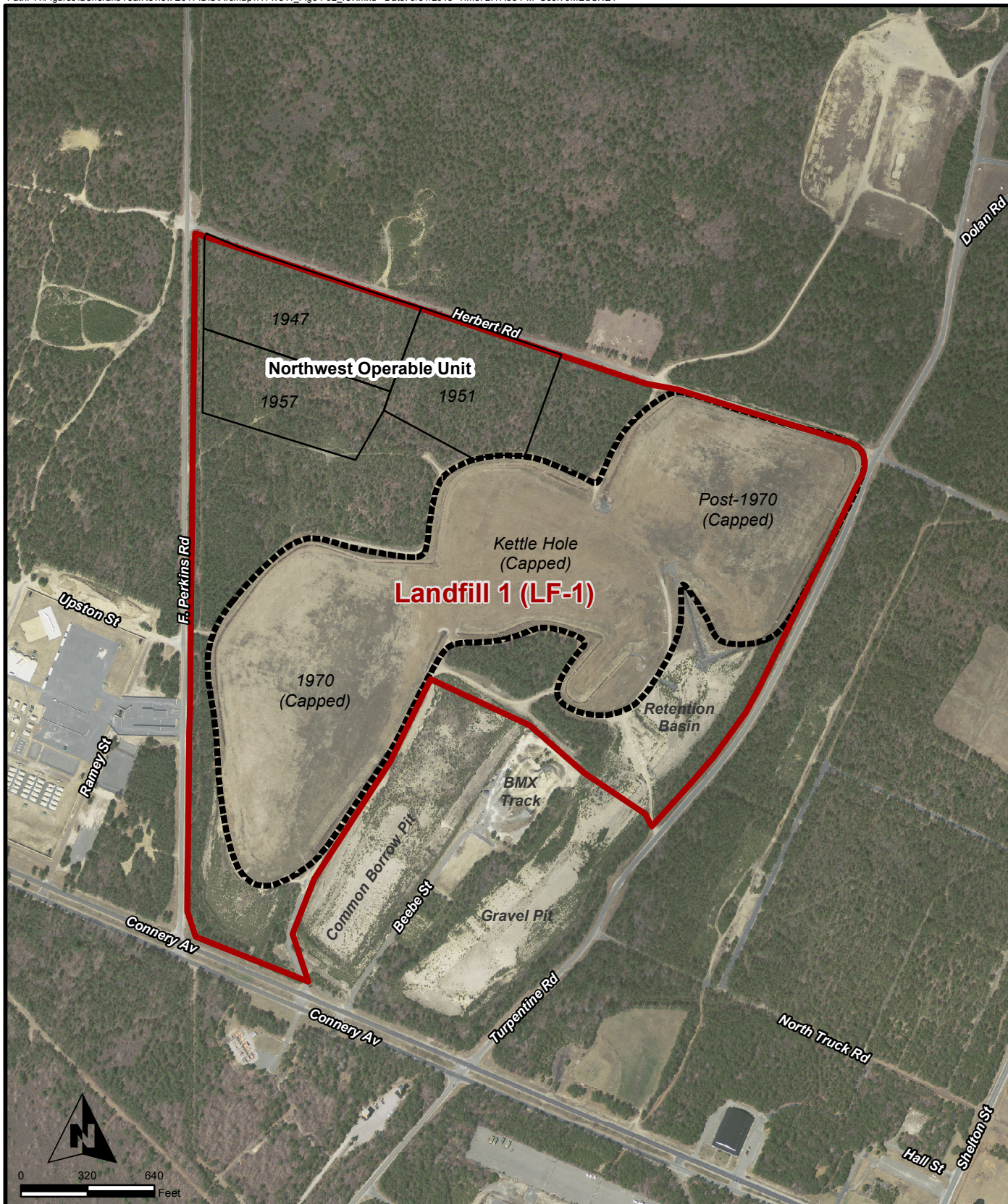
- Soil Vapor Extraction Well
- Joint Base Cape Cod Boundary
- Soil Vapor Extraction System Pipeline
- Source Area
- Source Area Detail
- Soil Vapor Extraction System Treatment Facility

Data Source: AFCEC, April 2018
JBCC Boundary from Massachusetts Air National Guard 2011
2009 Aerial Photography from MassGIS

FIGURE 4-1

CS-10 SOURCE AREA

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Legend

- Source Area Boundary
- - - Capped Area
- Northwest Operable Unit

Data Source: AFCEC, April 2018
2009 Aerial Photography from MassGIS

FIGURE 4-2

LF-1 SOURCE AREA

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Legend

- Joint Base Cape Cod Boundary
- Source Area Boundary

Data Source: AFCEC, April 2018
JBCC Boundary from Massachusetts Air National Guard 2011
2009 Aerial Photography from MassGIS

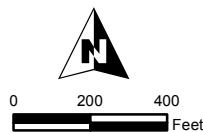


FIGURE 4-3

FTA-2/LF-2 SOURCE AREA

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Legend

 Source Area Boundary

Data Source: AFCEC, April 2018
2009 Aerial Photography from MassGIS

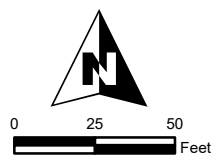
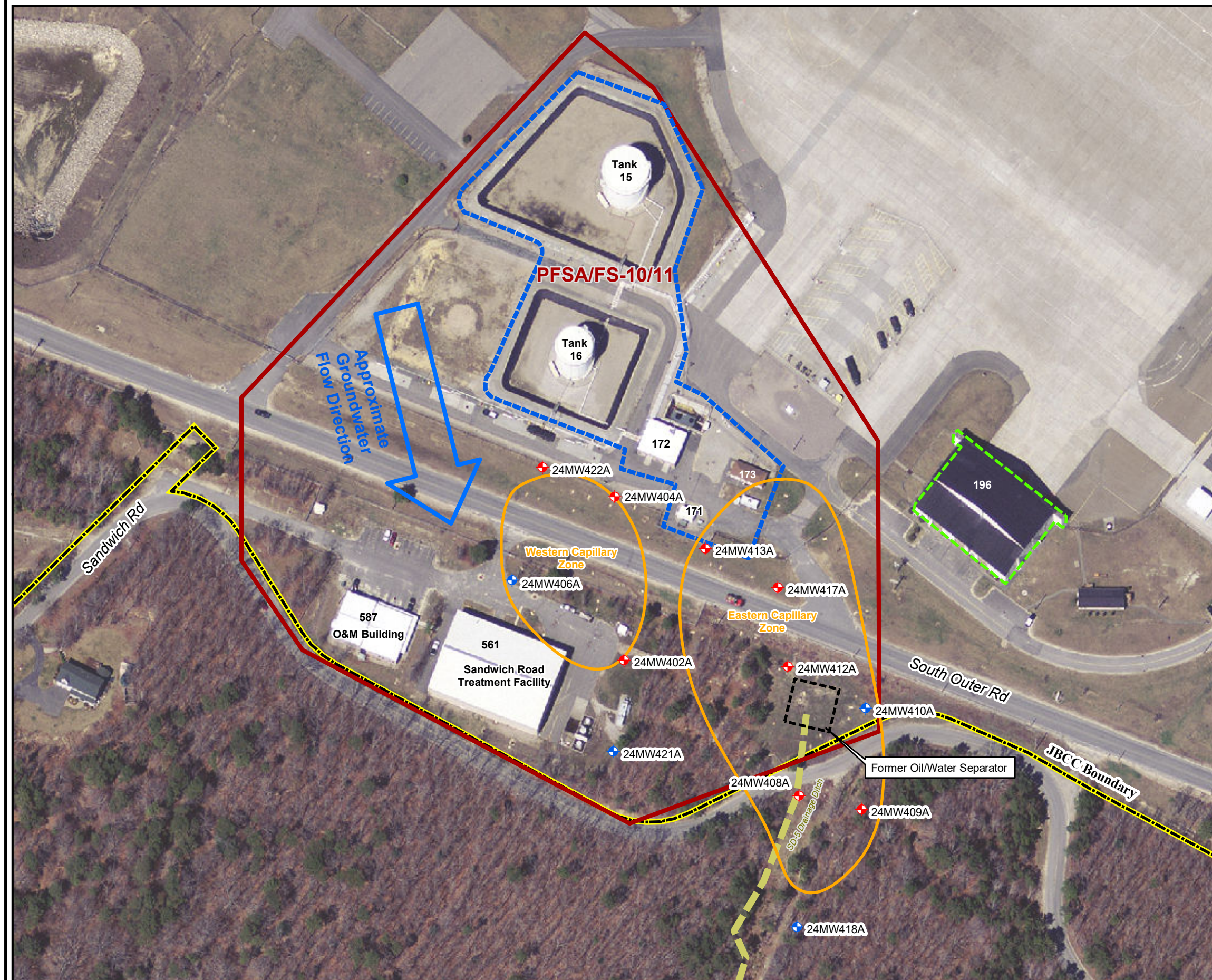


FIGURE 4-4

LF-7 SOURCE AREA

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017

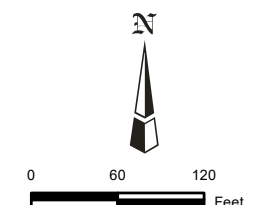


Legend

- Joint Base Cape Cod Boundary
- Source Area Boundary
- PFSA Structures Demolished January/February 2011
- Building 196 Demolished Summer 2011
- Building Number
- Approximate Historic Extent of Soil Contamination*
- Drainage Ditch
- Petroleum-related Compounds in Groundwater Exceeded MCL, RBC, or MCP Method-1 GW-1 Standard
- Petroleum-related Compounds in Groundwater Do Not Exceed MCL, RBC, or MCP Method-1 GW-1 Standard

Note: GW1 = Groundwater-1
MCL = Maximum Contaminant Level
MCP = Massachusetts Contingency Plan
RBC = Risk-Based Concentration

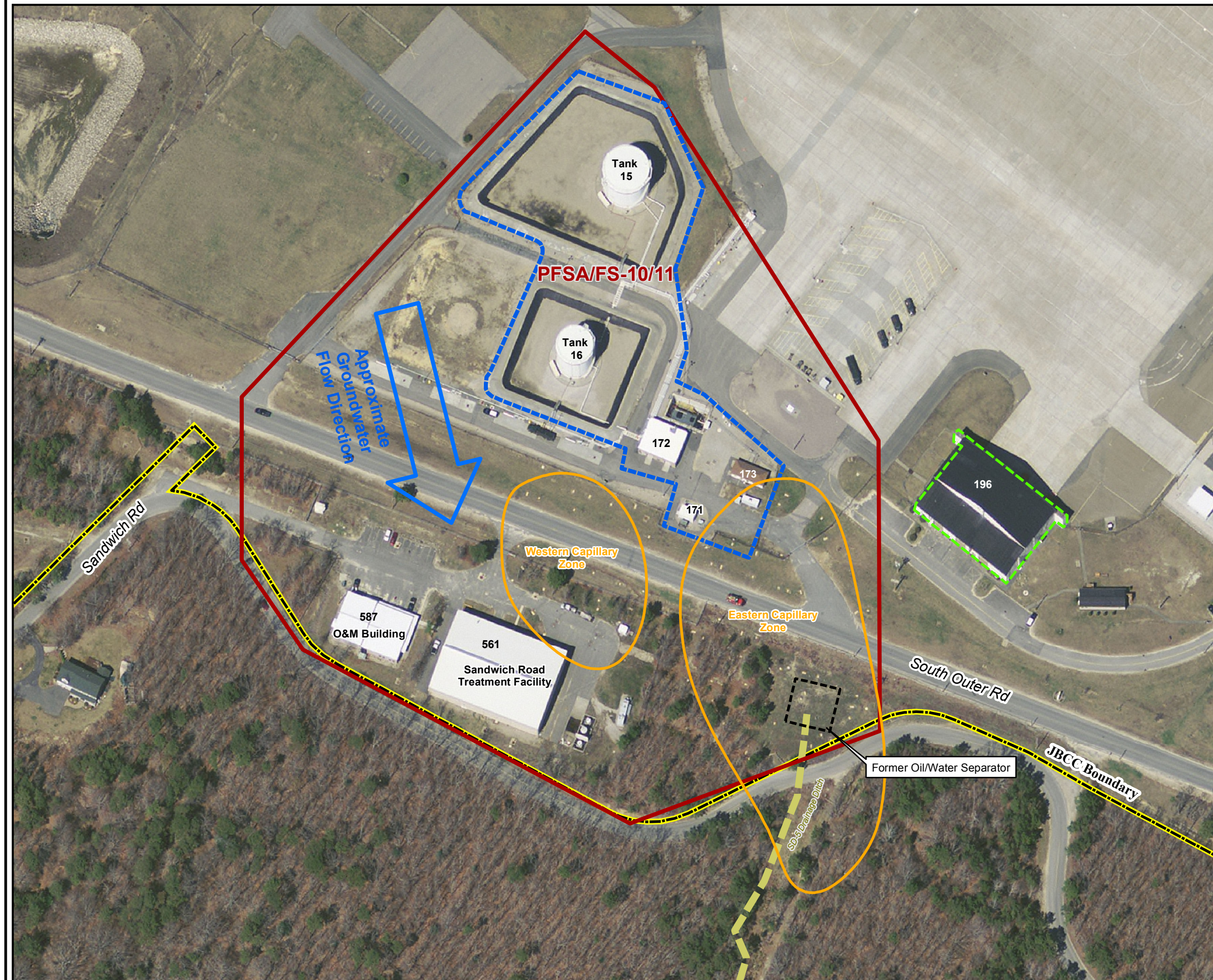
*Defined in *Operations and Maintenance Manual Biosparge/Vapor Recovery System for PFSA*. Prepared by Environmental Chemical Corporation for AFCEE/MMR Installation Restoration Program, Massachusetts Military Reservation, Cape Cod, MA, May 2003.



Data Source:
AFCEC, April 2018
2009 Aerial Photography from MassGIS
JBCC Boundary from Massachusetts Air National Guard 2011
Numbers for Historic Tanks from Overall Demolition Plan OTS-120-104, Date May 22, 2009

FIGURE 4-5

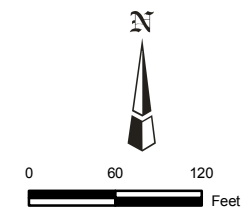
PFSA (FS-10/FS-11) SOURCE AREA
AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Legend

- Joint Base Cape Cod Boundary
- Source Area Boundary
- PFSA Structures Demolished January/February 2011
- Building 196 Demolished Summer 2011
- 587 Building Number
- Approximate Historic Extent of Soil Contamination*
- Drainage Ditch

*Defined in *Operations and Maintenance Manual Biosparge/Vapor Recovery System for PFSA*. Prepared by Environmental Chemical Corporation for AFCEE/MMR Installation Restoration Program, Massachusetts Military Reservation, Cape Cod, MA, May 2003.

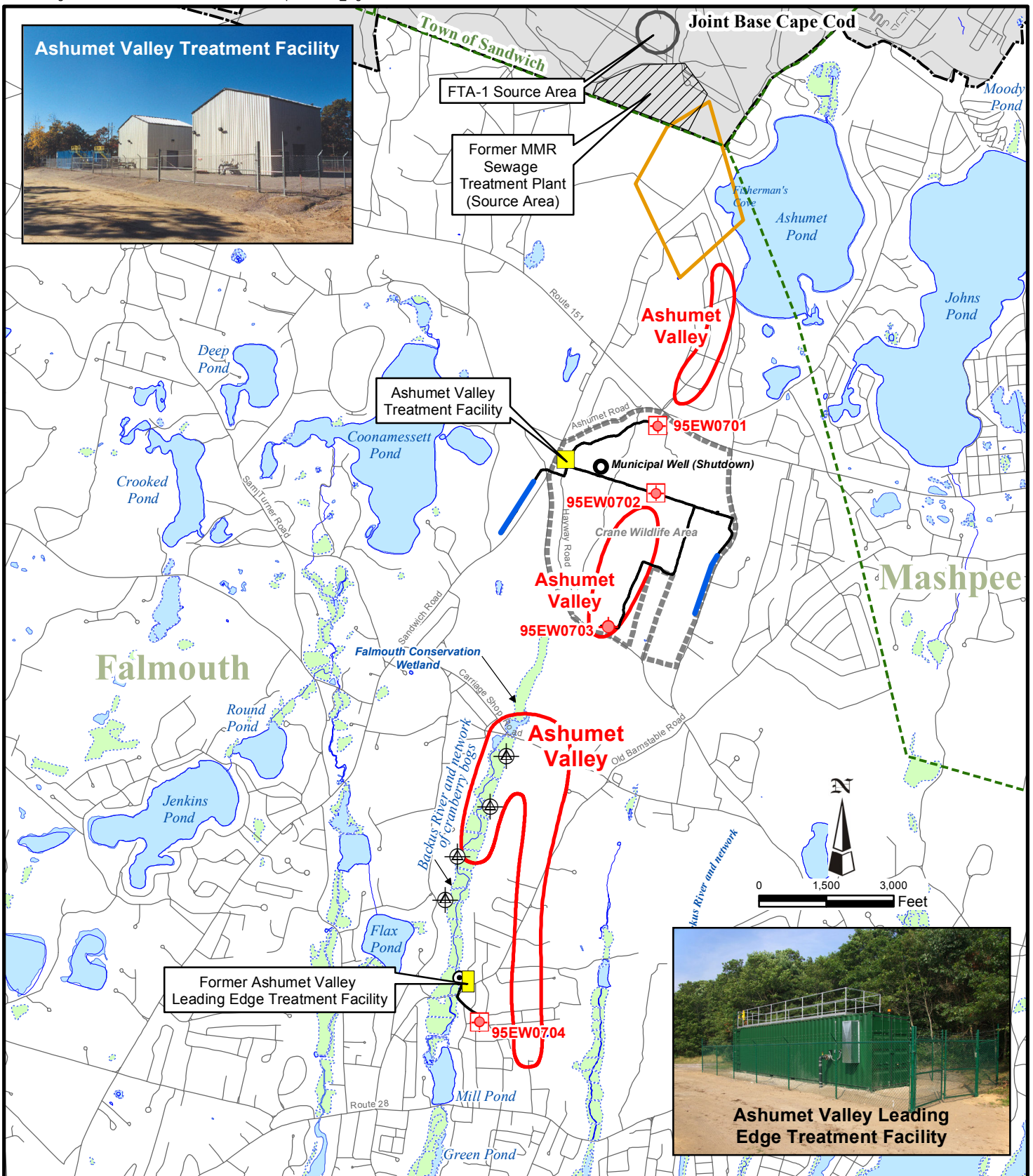


Data Source:
AFCEC, April 2018
2009 Aerial Photography from MassGIS
JBCC Boundary from Massachusetts Air National Guard 2011
Numbers for Historic Tanks from Overall Demolition Plan OTS-120-104, Date May 22, 2009

FIGURE 4-5

PFSA (FS-10/FS-11) SOURCE AREA

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Legend

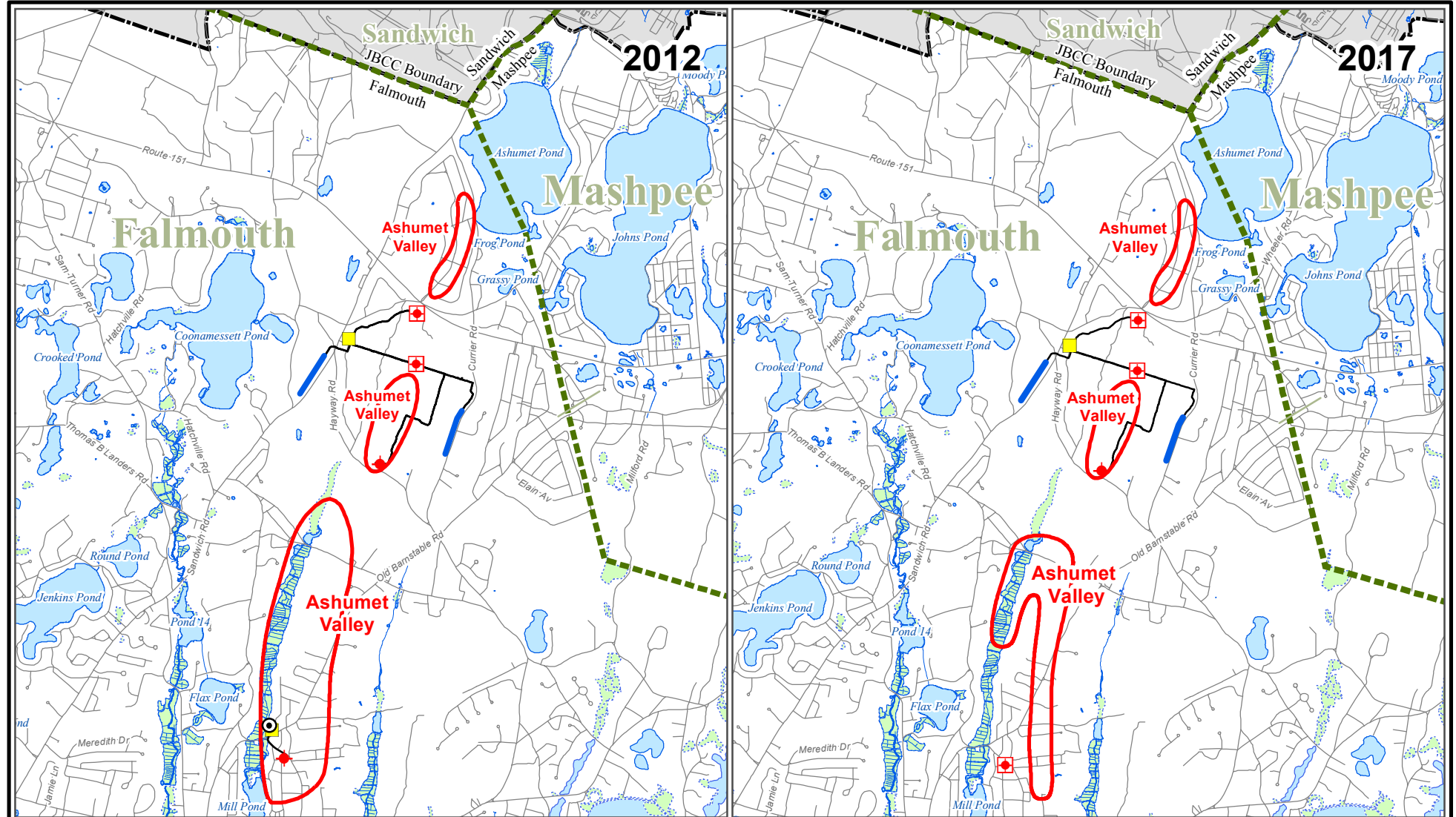
- Ashumet Valley Plume Boundary = Concentrations exceeding drinking water standards or Maximum Contaminant Level (MCL), dashed where inferred. Represents an exceedance of trichloroethene (TCE) and/or perchloroethene (PCE) (TCE MCL = 5 µg/L) (PCE MCL = 5 µg/L)
- Treatment System Piping
- Manganese LTM Area
- Infiltration Trench
- - - Town Boundary
- - - Crane Wildlife Area Boundary
- Extraction Well (On)
- ◻ Extraction Well (Off)
- ⊗ Irrigation Well
- Treatment Facility
- Public Water Supply Well
- - - Joint Base Cape Cod Boundary
- Bog/Wetland

Data Source: AFCEC, April 2018
JBCC Boundary from Massachusetts Air National Guard 2011

FIGURE 5-1A

ASHUMET VALLEY GROUNDWATER PLUME AND TREATMENT SYSTEMS

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Legend

- Town Boundary
- Joint Base Cape Cod Boundary
- Plume Boundary (Dashed Where Inferred)
- Treatment System Pipeline
- Infiltration Trench
- Bog/Wetland
- Bubbler
- Treatment Facility
- ◆ Extraction Well
- ◆ Extraction Well (Off)

Data Source: AFCEC, April 2018
JBCC Boundary from Massachusetts Air National Guard 2011

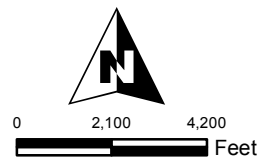
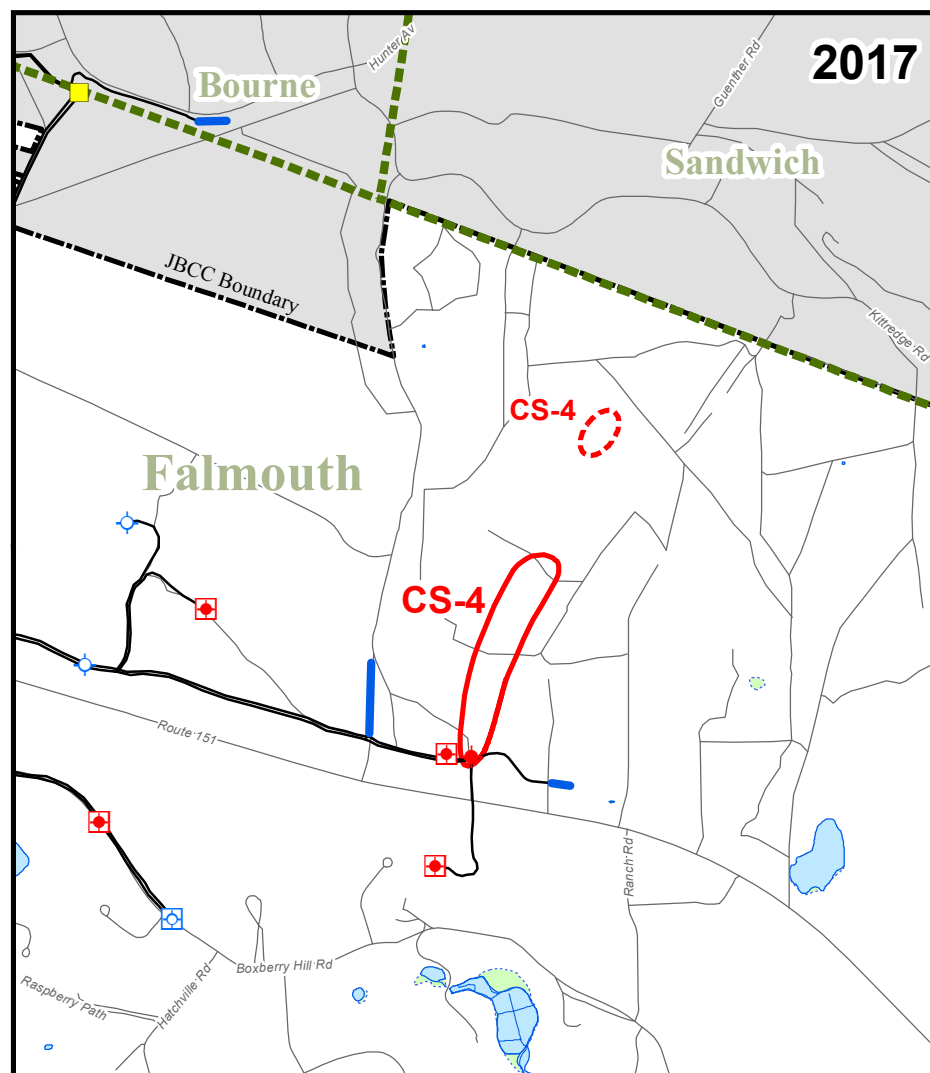
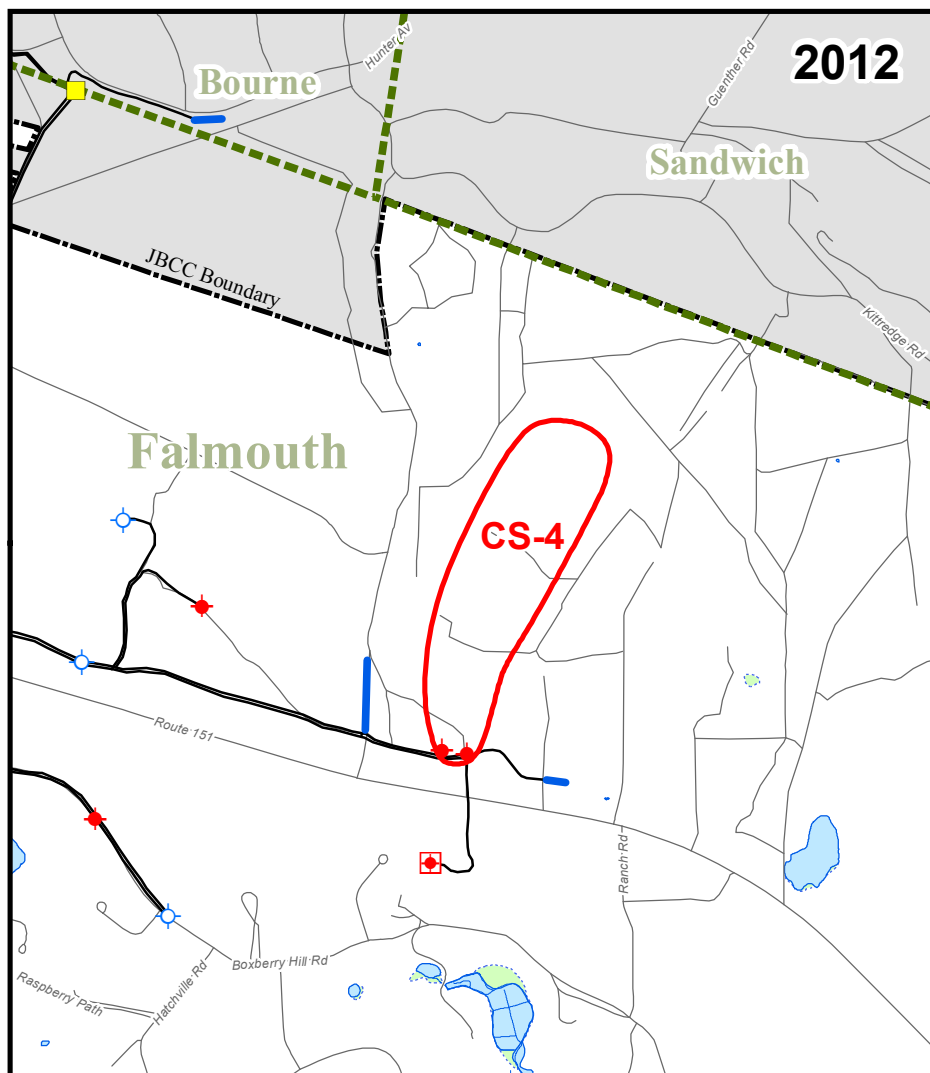


FIGURE 5-1B

ASHUMET VALLEY GROUNDWATER PLUME 2012 AND 2017 COMPARISON

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Legend

- Town Boundary
- Joint Base Cape Cod Boundary
- Plume Boundary
- Treatment System Pipeline
- Infiltration Trench
- Bog/Wetland
- ★ Extraction Well
- ★ Extraction Well (Off)
- ⊕ Reinjection Well
- Treatment Facility

Data Source: AFCEC, April 2018
JBCC Boundary from Massachusetts Air National Guard 2011

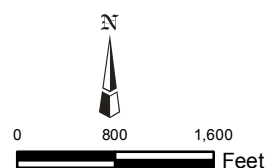


FIGURE 5-2B

CS-4 GROUNDWATER PLUME 2012 AND 2017 COMPARISON

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017

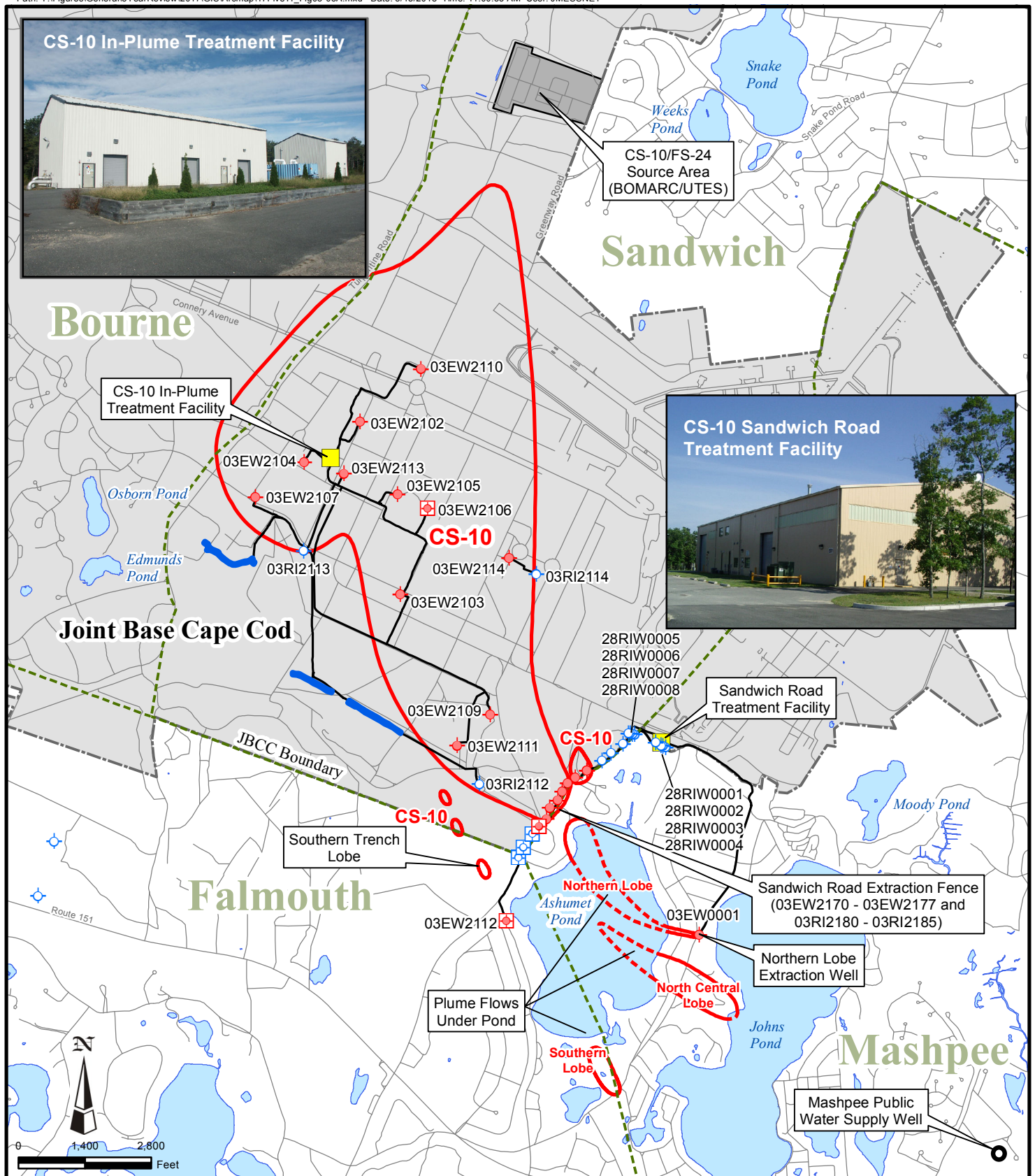
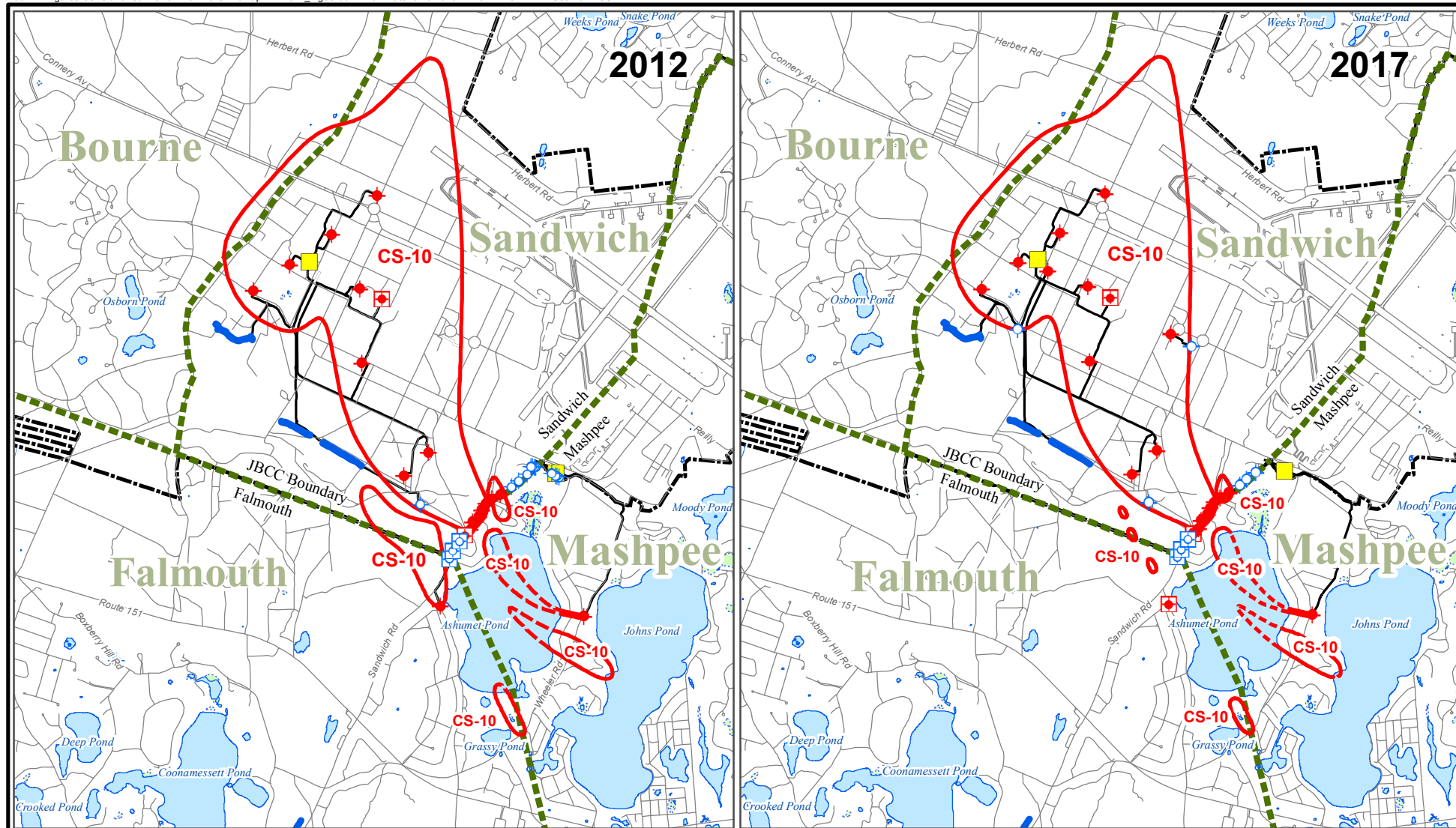


FIGURE 5-3A

CS-10 GROUNDWATER PLUME AND TREATMENT SYSTEMS

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Legend

- Town Boundary
- Joint Base Cape Cod Boundary
- Plume Boundary (Dashed Where Inferred)
- Treatment System Pipeline
- Infiltration Trench
- Bog/Wetland
- ◆ Extraction Well
- ◆ Extraction Well (Off)
- ⊕ Reinjection Well (On)
- ⊕ Reinjection Well (Off)
- Treatment Facility

Data Source: AFCEC, April 2018
JBCC Boundary from Massachusetts Air National Guard 2011

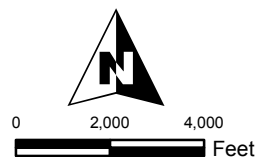
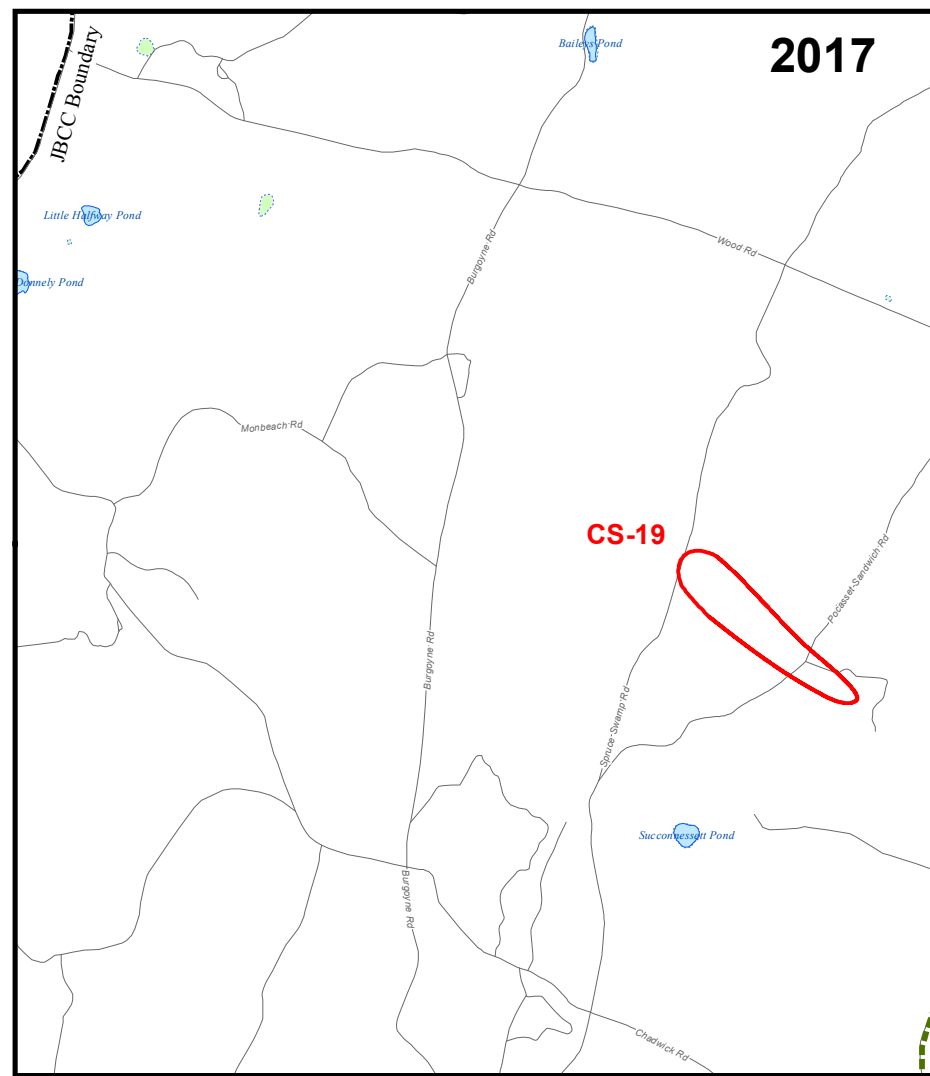
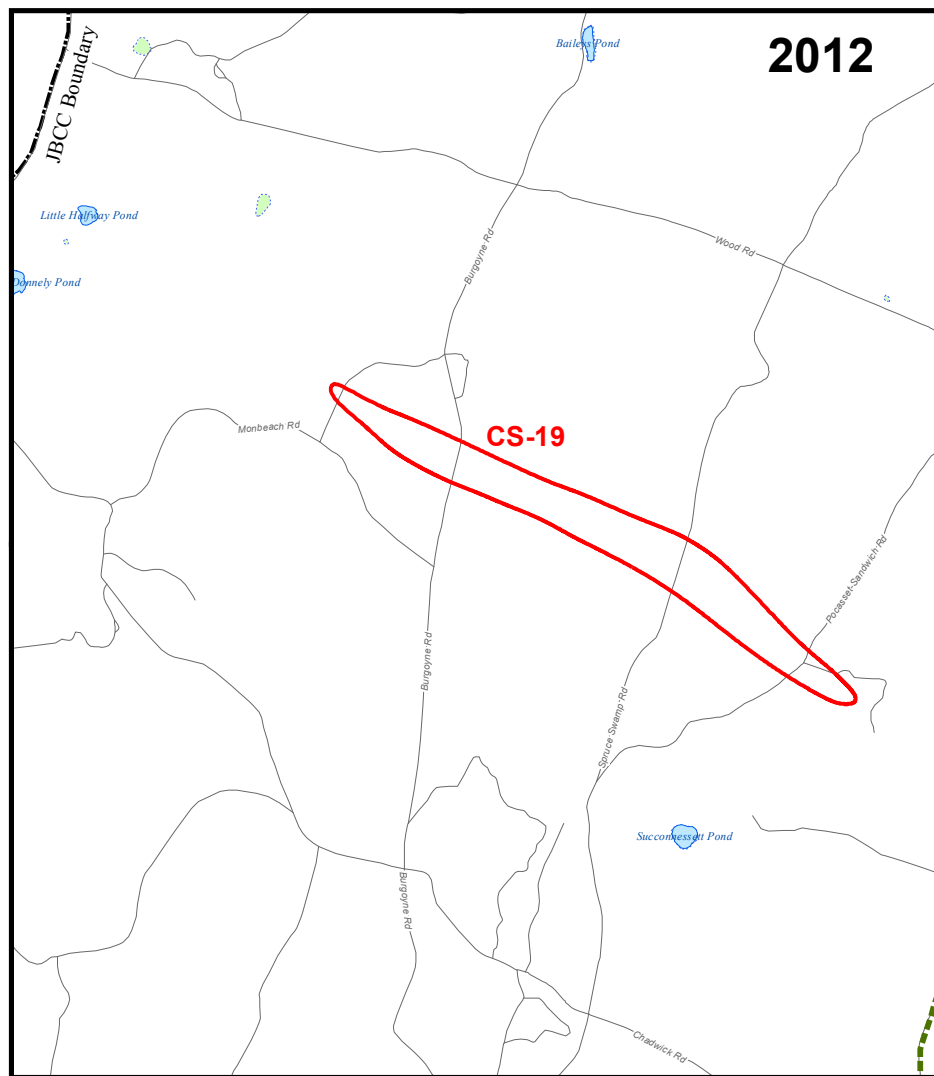


FIGURE 5-3B

CS-10 GROUNDWATER PLUME 2012 AND 2017 COMPARISON

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Legend

- Town Boundary
- Joint Base Cape Cod Boundary
- Plume Boundary
- Bog/Wetland

Data Source: AFCEC, April 2018
JBCC Boundary from Massachusetts Air National Guard 2011

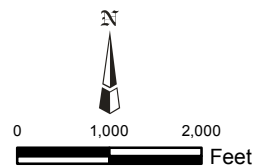
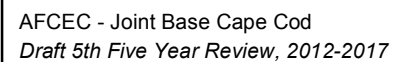
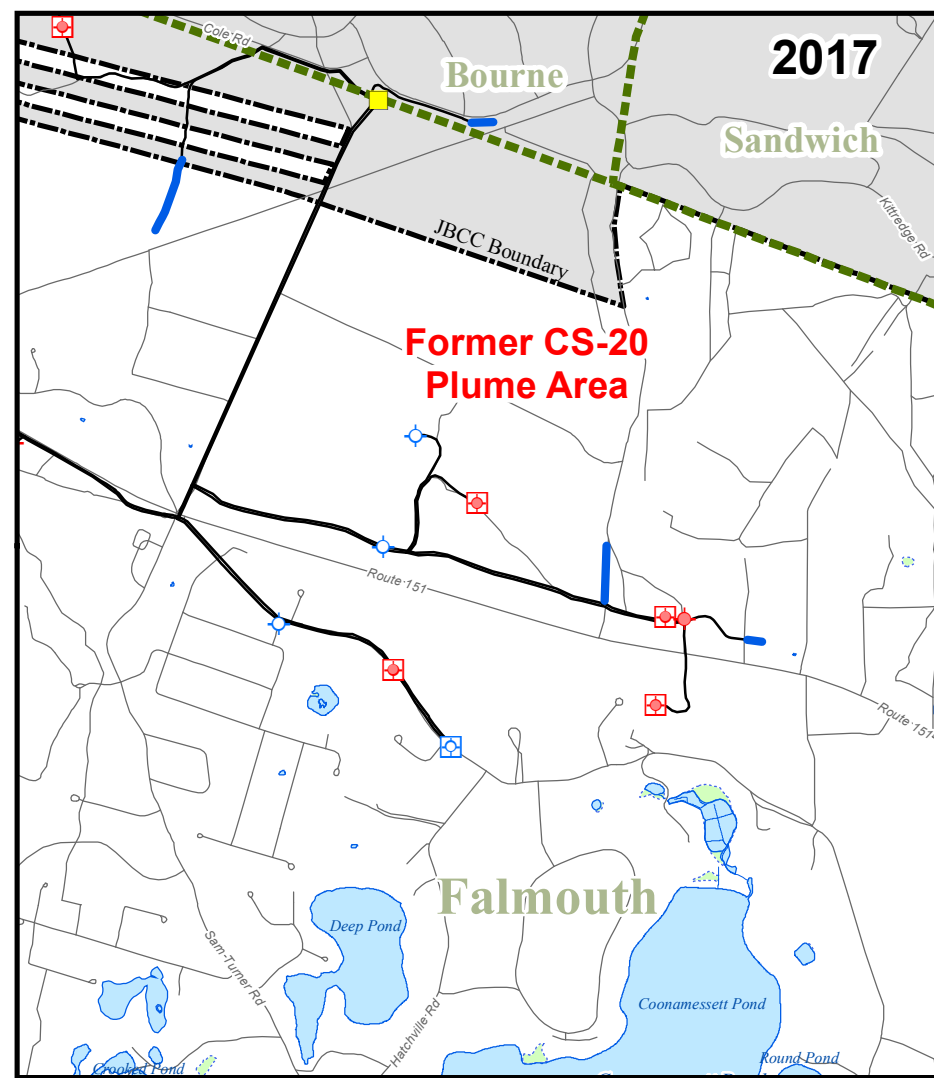
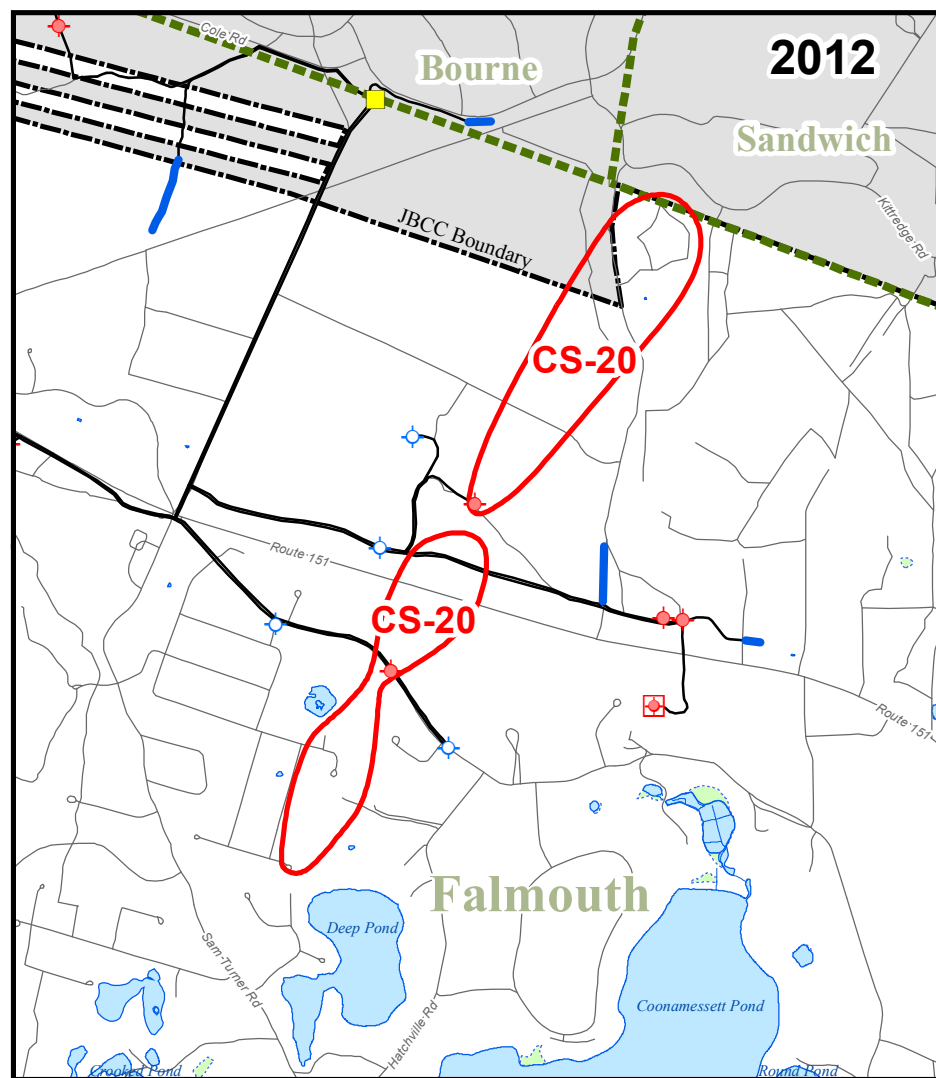


FIGURE 5-4

CS-19 GROUNDWATER PLUME 2012 AND 2017 COMPARISON

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017





Legend

- | | | | |
|--|------------------------------|--|------------------------|
| | Town Boundary | | Extraction Well |
| | Joint Base Cape Cod Boundary | | Extraction Well (Off) |
| | Plume Boundary | | Reinjection Well |
| | Treatment System Pipeline | | Reinjection Well (Off) |
| | Infiltration Trench | | Treatment Facility |
| | Bog/Wetland | | |

Data Source: AFCEC, April 2018
JBCC Boundary from Massachusetts Air National Guard 2011

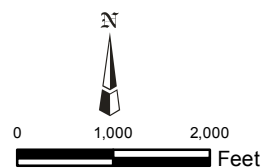
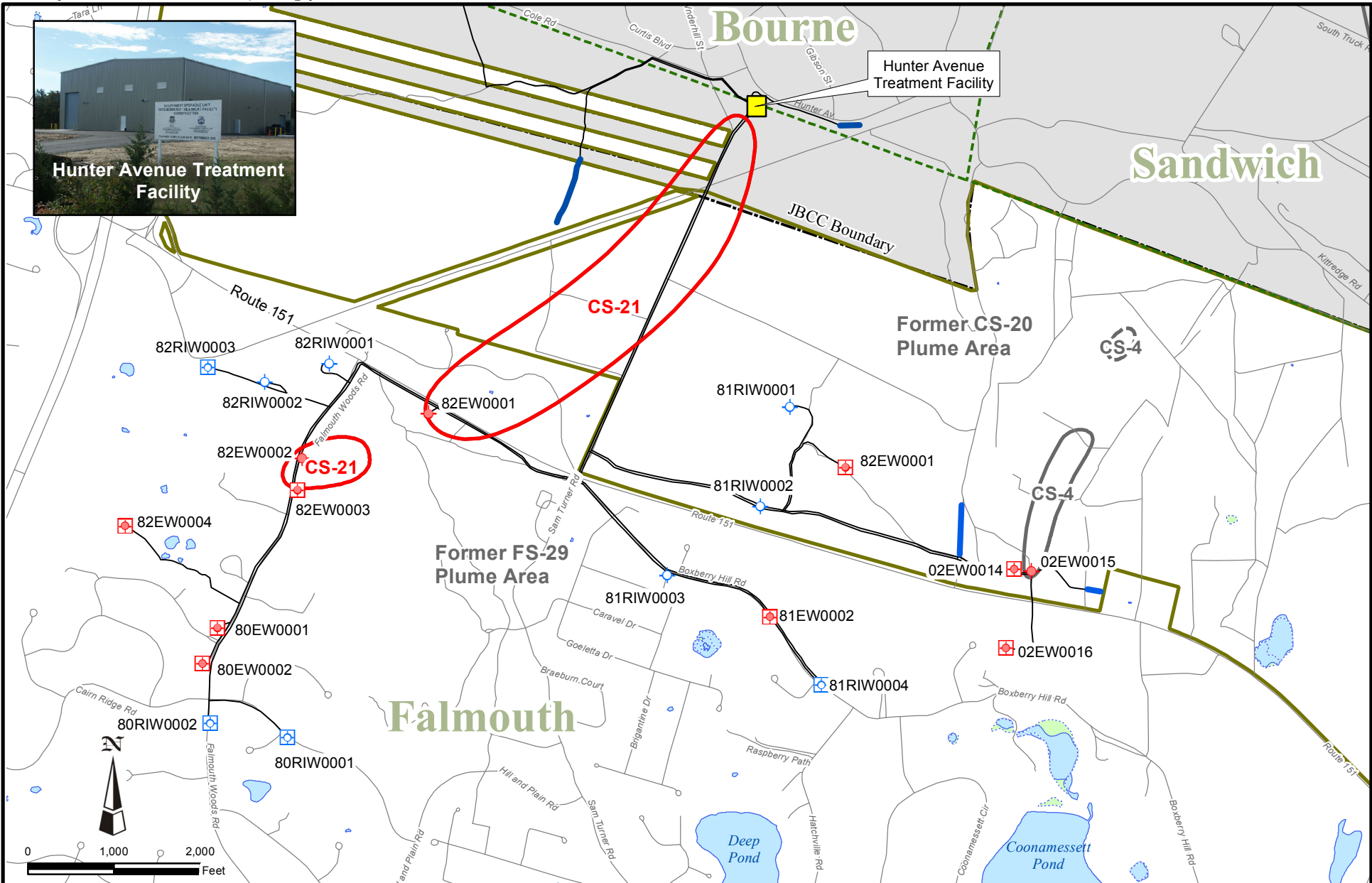


FIGURE 5-5B

CS-20 GROUNDWATER PLUME 2012 AND 2017 COMPARISON

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Legend

- CS-21 Plume Boundary = Concentrations exceeding drinking water standards. Represents an exceedance of tetrachloroethene (TCE); (TCE MCL = 5 µg/L)
- Other Plume Boundary
- - - Joint Base Cape Cod Boundary
- - - Town Boundary

- Infiltration Gallery/Trench
- Treatment System Pipeline
- Treatment Facility
- Bog/Wetland
- Crane Wildlife Management Area

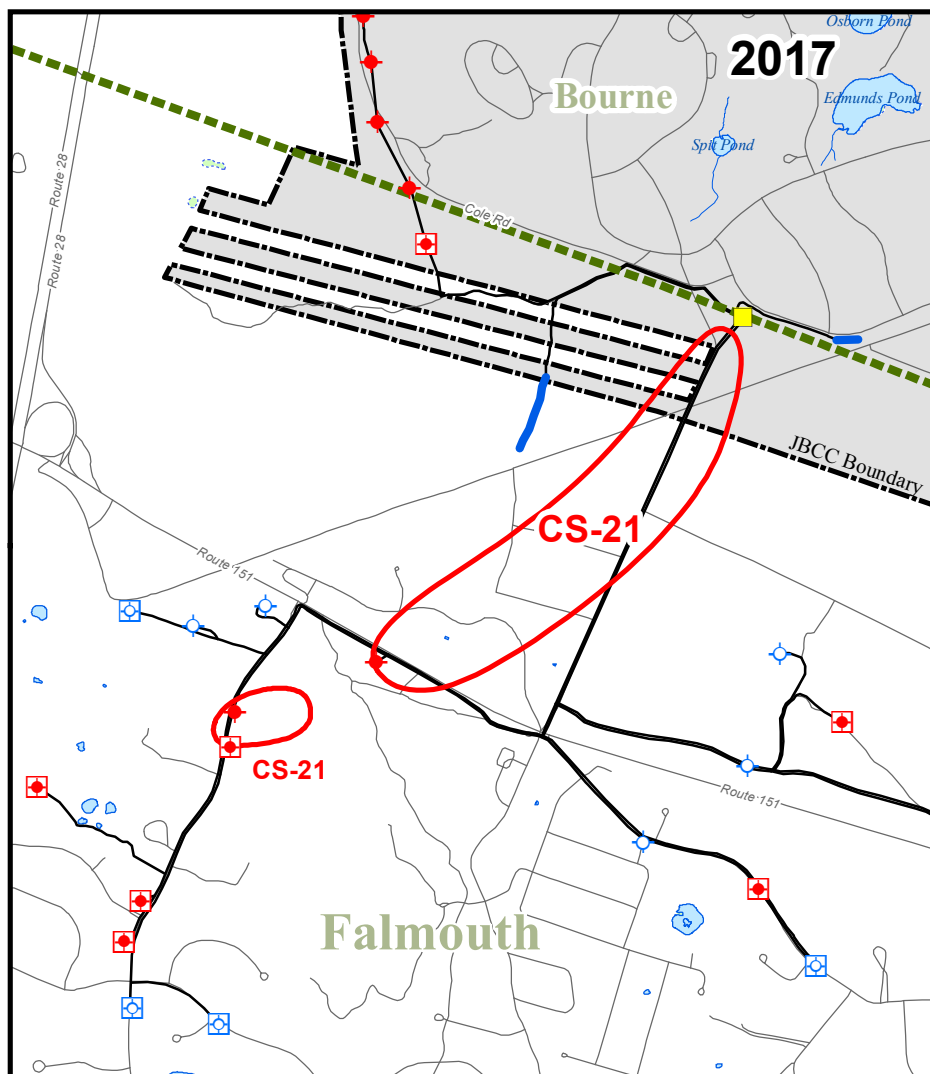
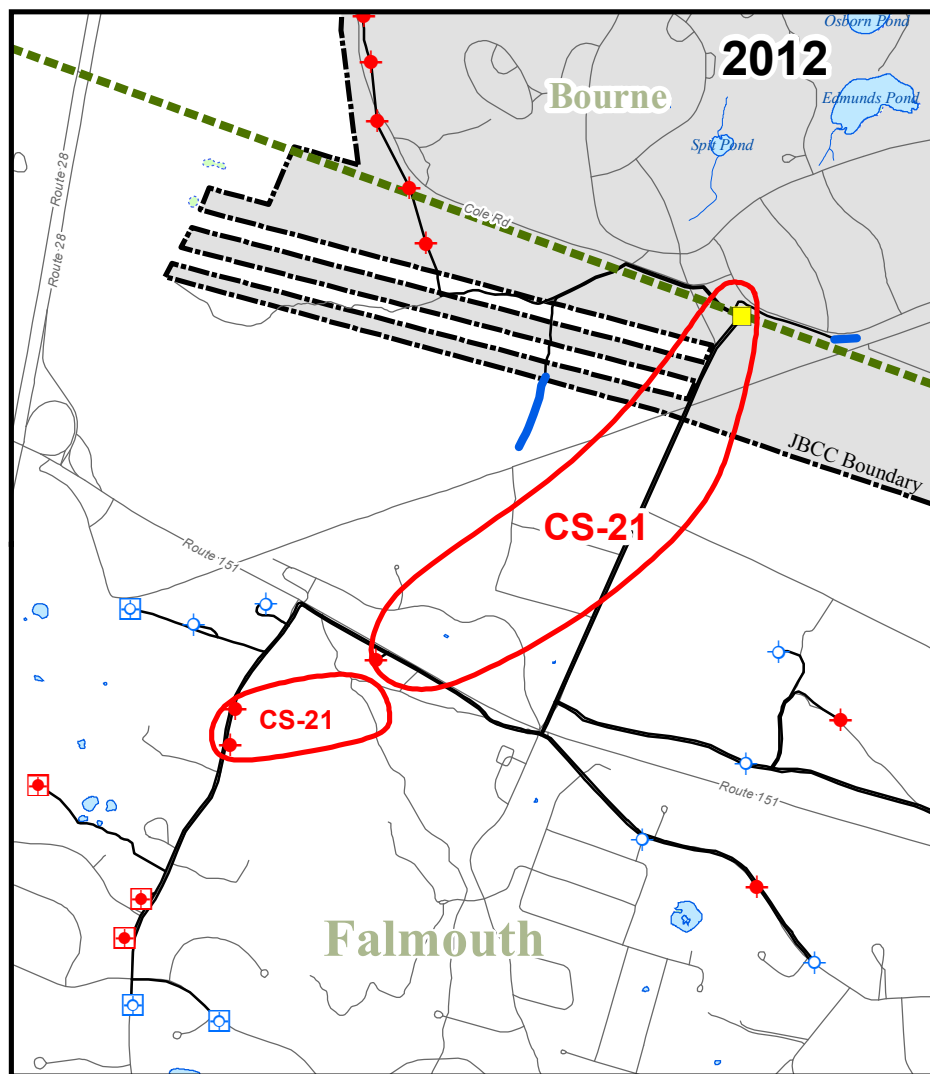
Data Source: AFCEC, April 2018
JBCC Boundary from Massachusetts Air National Guard 2011

- Extraction Well (On)
- Extraction Well (Off)
- ReInjection Well (On)
- ReInjection Well (Off)

FIGURE 5-6A

CS-21 GROUNDWATER PLUME AND TREATMENT SYSTEM

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Legend

- Town Boundary
- Joint Base Cape Cod Boundary
- Plume Boundary
- Treatment System Pipeline
- Infiltration Trench
- Bog/Wetland
- ◆ Extraction Well
- ◆ Extraction Well (Off)
- ◆ ReInjection Well
- ◆ ReInjection Well (Off)
- Treatment Facility

Data Source: AFCEC, April 2018
JBCC Boundary from Massachusetts Air National Guard 2011

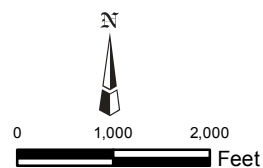
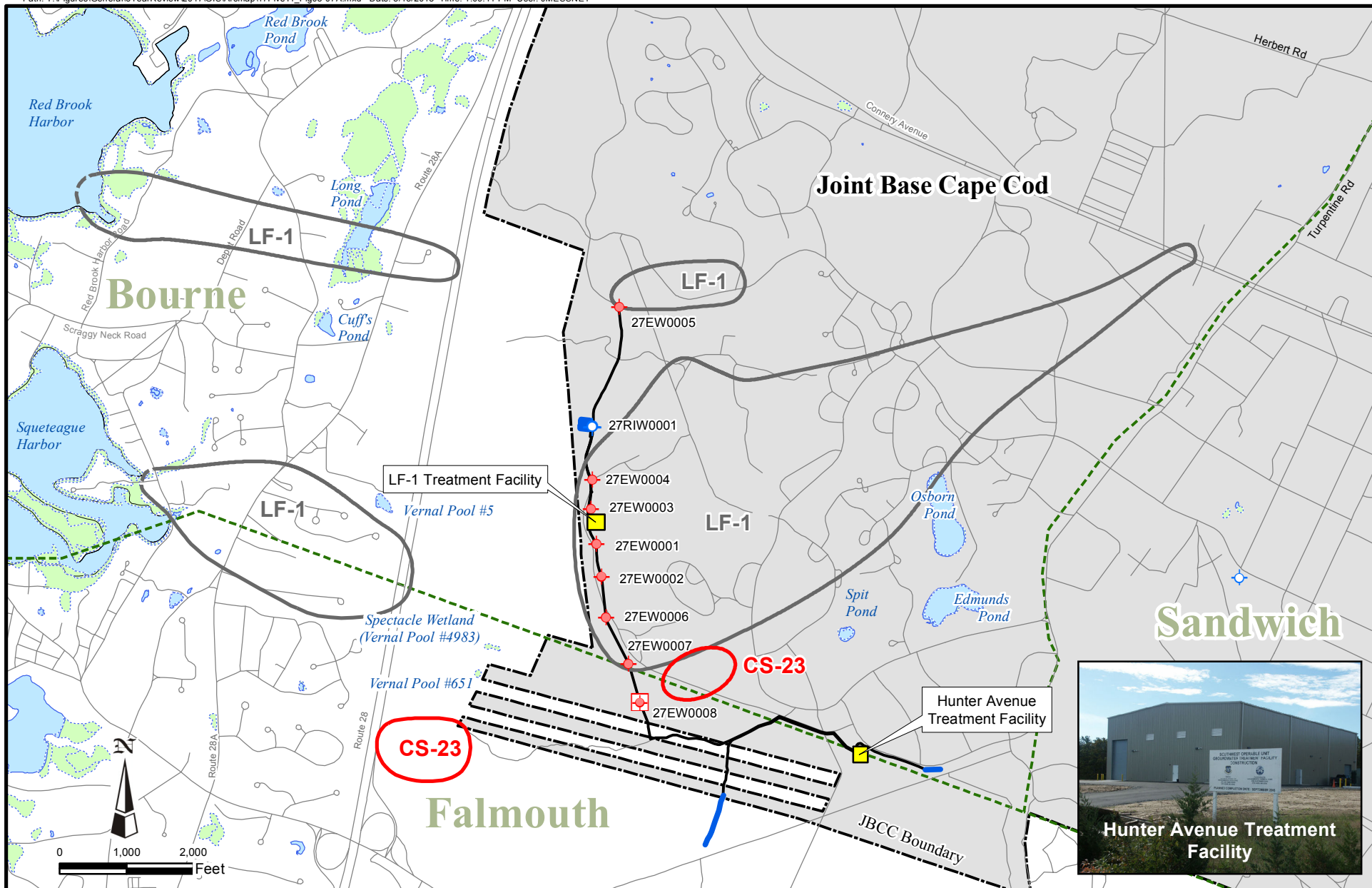


FIGURE 5-6B

CS-21 GROUNDWATER PLUME 2012 AND 2017 COMPARISON

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Legend

- CS-23 Plume Boundary = Concentrations exceeding drinking water standards or Maximum Contaminant Level (MCL). (Dashed where inferred.) Represents an exceedance of:
Trichloroethene (TCE): MCL = 5 µg/L
Carbon Tetrachloride (CCl₄): MCL = 5 µg/L
- Other Plume Boundary (Dashed Where Inferred)
- Joint Base Cape Cod Boundary

- Town Boundary
- Infiltration Gallery/Trench
- Treatment Facility
- Bog/Wetland

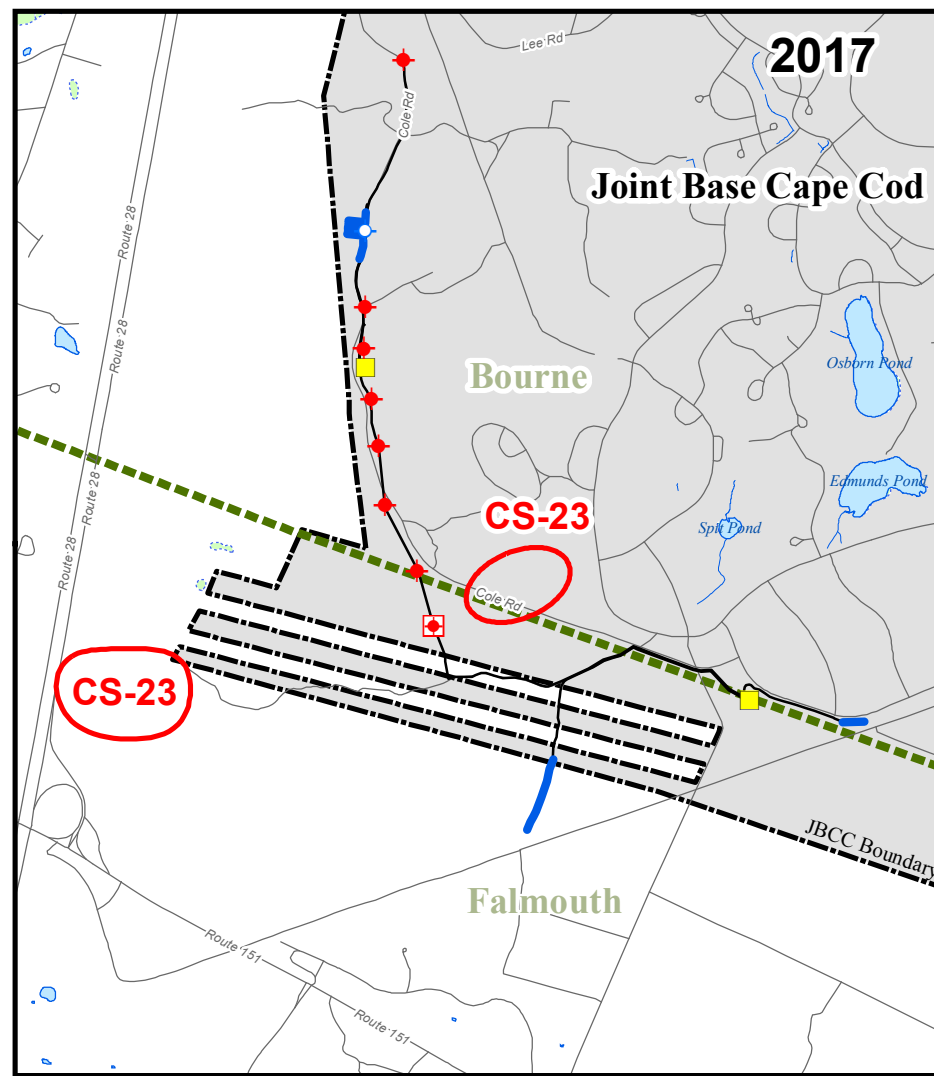
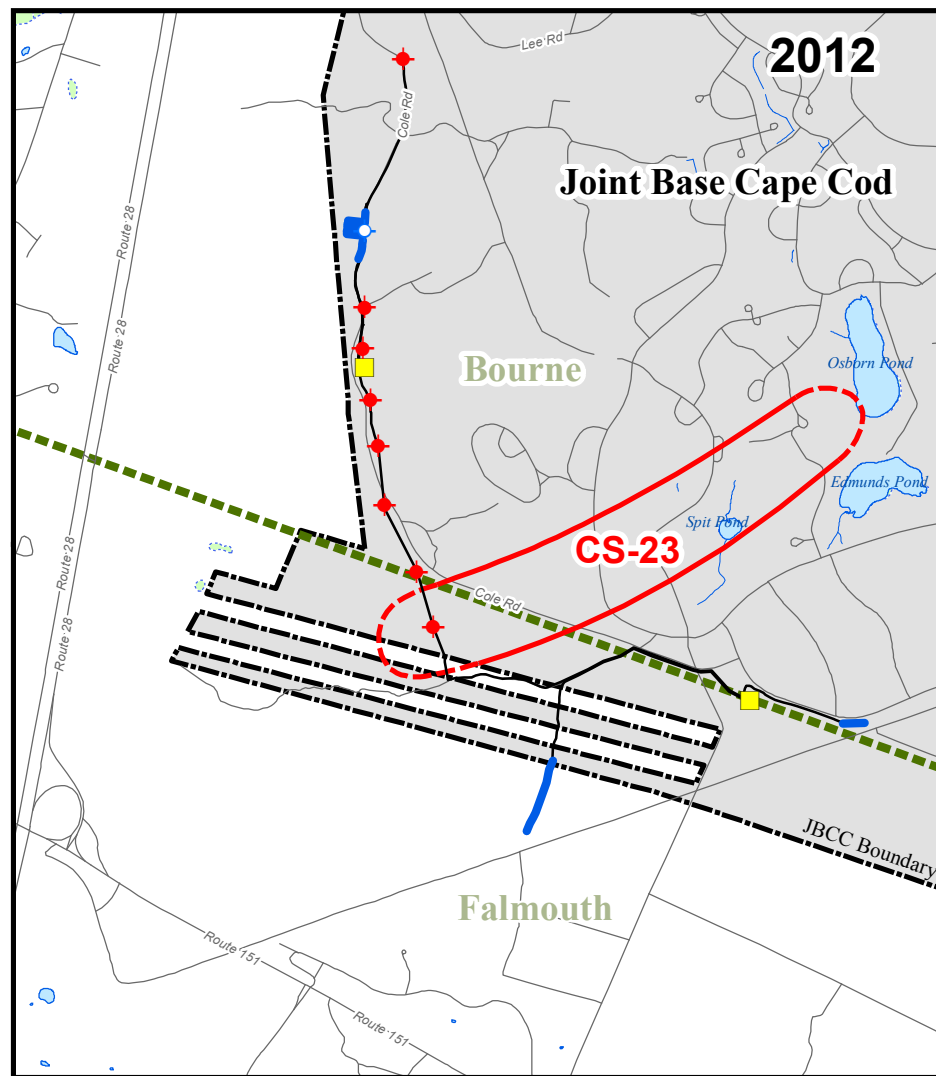
Data Source: AFCEC, April 2018

- ◆ Extraction Well (On)
- ◆ Reinjection Well (On)
- Extraction Well (Off)

FIGURE 5-7A

CS-23 GROUNDWATER PLUME AND TREATMENT SYSTEM

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Legend

- | | |
|--|--|
|  Town Boundary |  Extraction Well |
|  Joint Base Cape Cod Boundary |  Extraction Well |
|  Plume Boundary (Dashed Where Inferred) |  Reinjection Well |
|  Treatment System Pipeline |  Treatment Facility |
|  Infiltration Trench |  Bog/Wetland |

Data Source: AFCEC, April 2018
JBCC Boundary from Massachusetts Air National Guard 2011

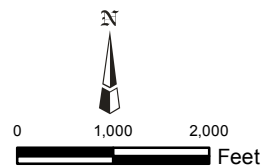
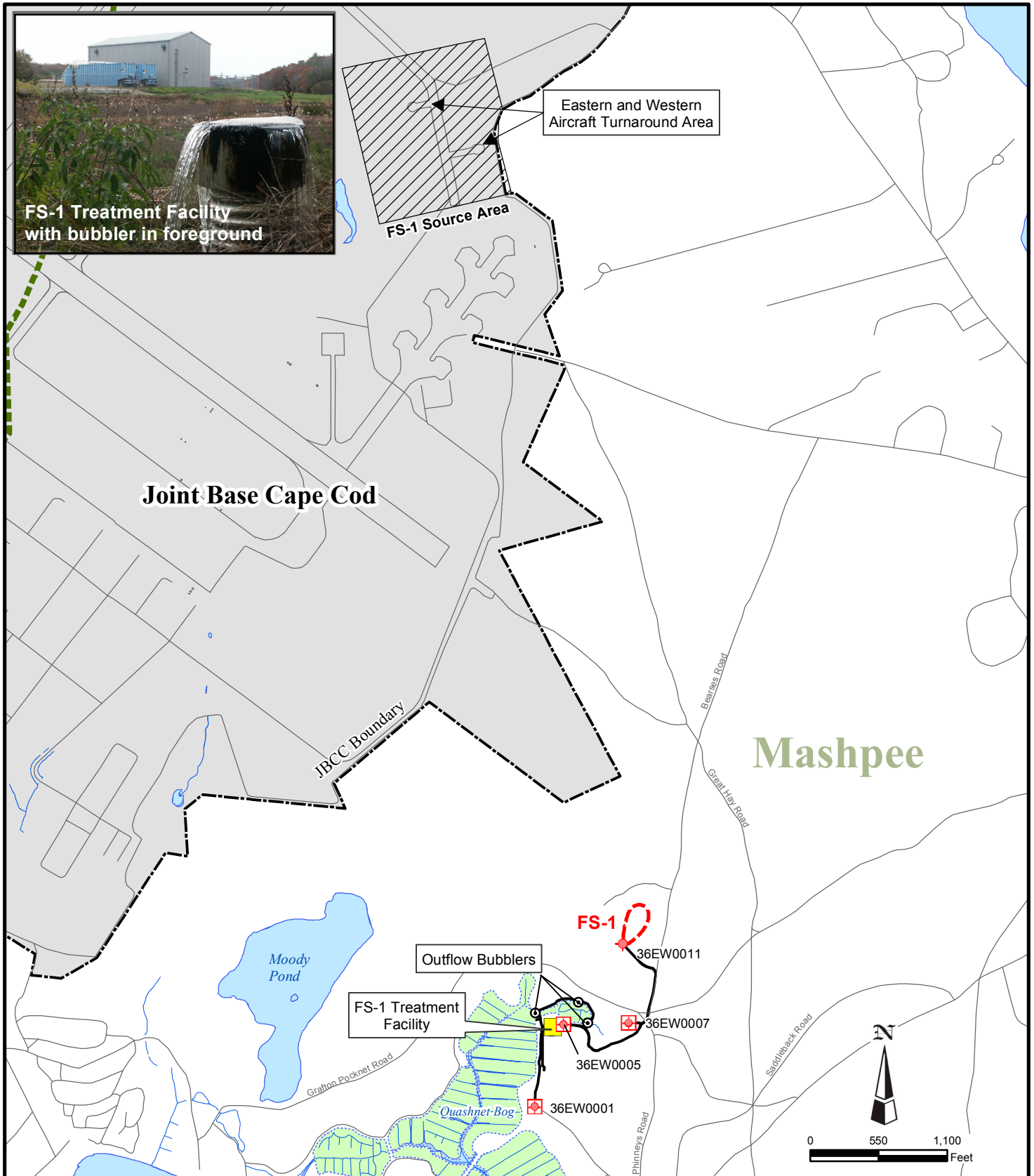


FIGURE 5-7B

CS-23 GROUNDWATER PLUME 2012 AND 2017 COMPARISON

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Legend

- FS-1 Plume Boundary = Concentrations exceeding drinking water standards or Massachusetts Maximum Contaminant Level (MMCL). Represents an exceedance of ethylene dibromide (EDB) (EDB MMCL = 0.02 µg/L) (Dashed Where Inferred)
- Joint Base Cape Cod Boundary
- Town Boundary
- Treatment System Piping

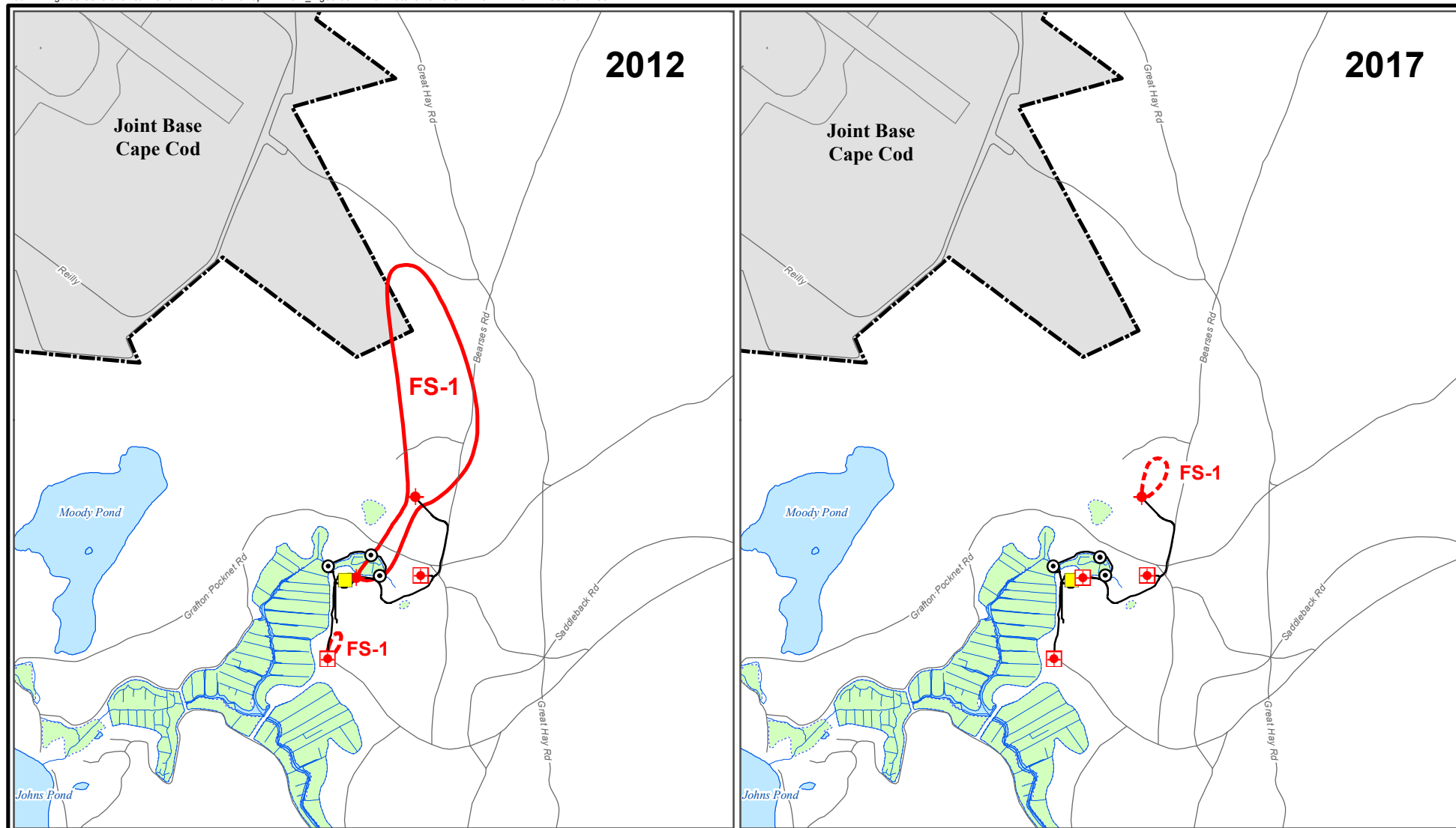
- Outflow Bubbler
- ◆ Extraction Well (On)
- ◆ Extraction Well (Off)
- Treatment Facility
- Source Area
- Bog/Wetland

Data Source: AFCEC, April 2018
JBCC Boundary from Massachusetts Air National Guard 2011

FIGURE 5-8A

FS-1 GROUNDWATER PLUME AND TREATMENT SYSTEM

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Legend

- Joint Base Cape Cod Boundary
- Plume Boundary (Dashed Where Inferred)
- Treatment System Pipeline
- ♦ Extraction Well
- ◻ Extraction Well (Off)
- Bubbler
- Treatment Facility
- ▤ Bog/Wetland

Data Source: AFCEC, April 2018
JBCC Boundary from Massachusetts Air National Guard 2011

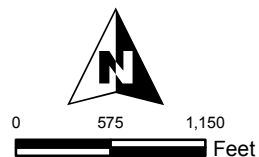
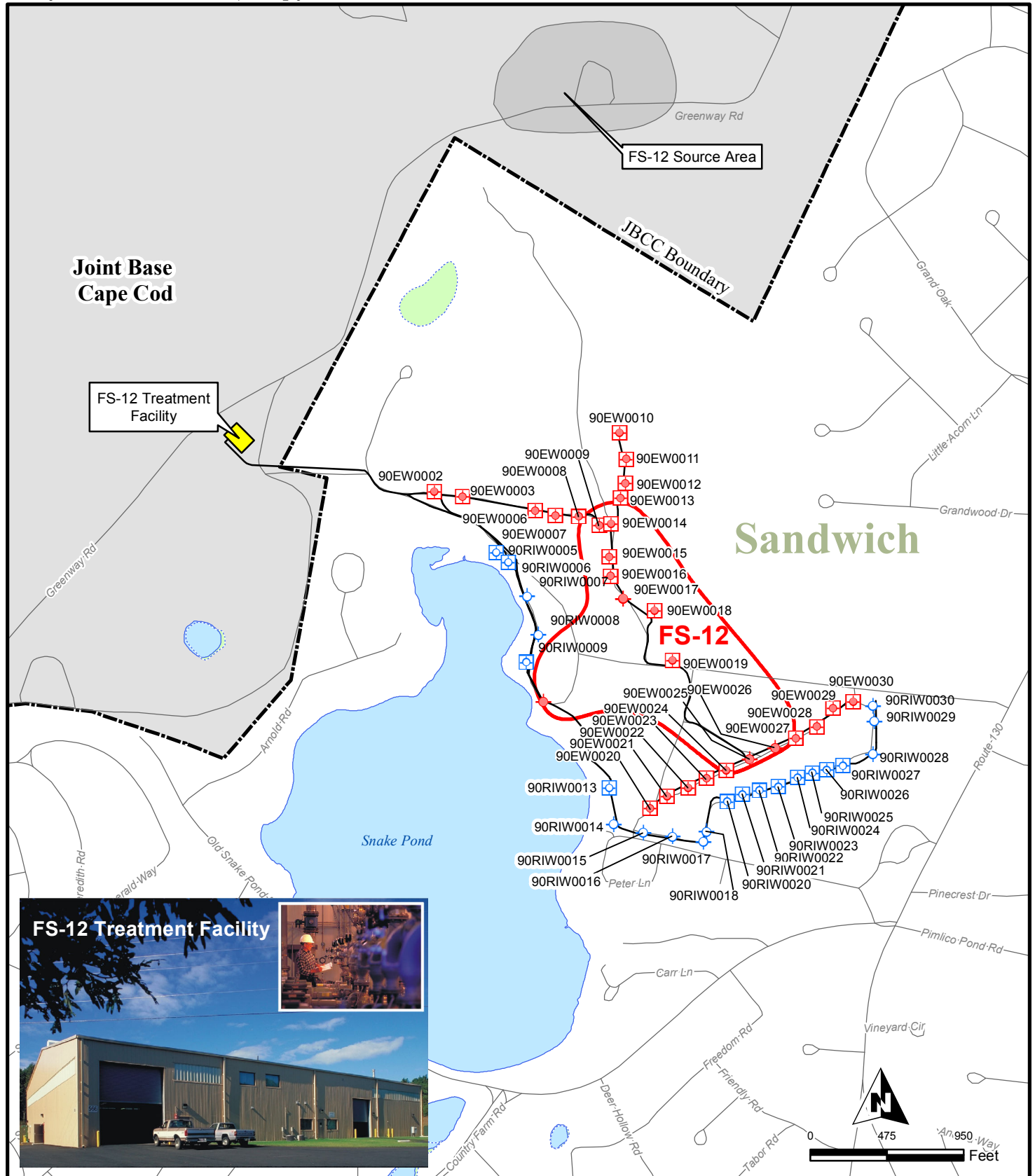


FIGURE 5-8B

FS-1 GROUNDWATER PLUME 2012 AND 2017 COMPARISON

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



FS-12 Treatment Facility



Legend

- FS-12 Plume Boundary = Concentrations exceeding drinking water standards or Massachusetts Maximum Contaminant Level (MMCL). Represents an exceedance of ethylene dibromide (EDB). (EDB MMCL = 0.02 µg/L)
- Treatment System Piping

Note: µg/L = micrograms per liter and is a measure of concentration. It is approximately equivalent to parts per billion (ppb).

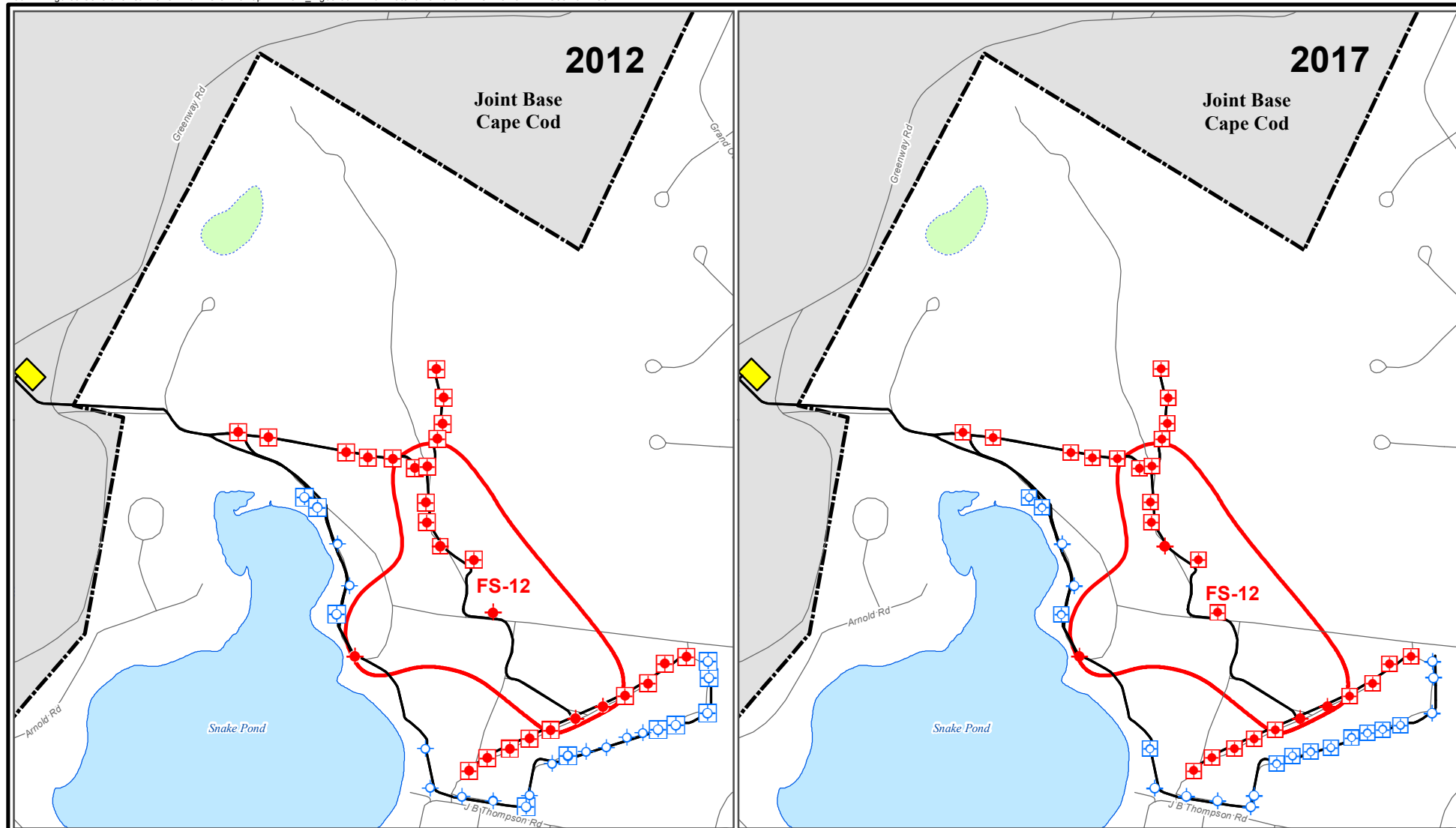
- Joint Base Cape Cod Boundary
- Treatment Facility
- Extraction Well (on)
- Extraction Well (off)
- Reinjection Well (on)
- Reinjection Well (off)
- Bog/Wetland
- Source Area

Data Source: AFCEC, April 2018
JBCC Boundary from Massachusetts Air National Guard 2011

FIGURE 5-9A

FS-12 GROUNDWATER PLUME AND TREATMENT SYSTEM

AFCEC - Joint Base Cape Cod
Draft 4th Five Year Review, 2012-2017



Legend

- Treatment System Pipeline
- - - Joint Base Cape Cod Boundary
- Plume Boundary (Dashed Where Inferred)
- Bog/Wetland
- Treatment Plant
- ◆ Extraction Well
- ◆ Extraction Well (Off)
- ◆ ReInjection Well
- ◆ ReInjection Well (Off)

Data Source: AFCEC, April 2018
JBCC Boundary from Massachusetts Air National Guard 2011

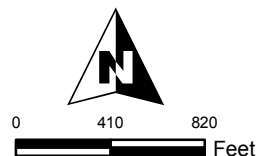
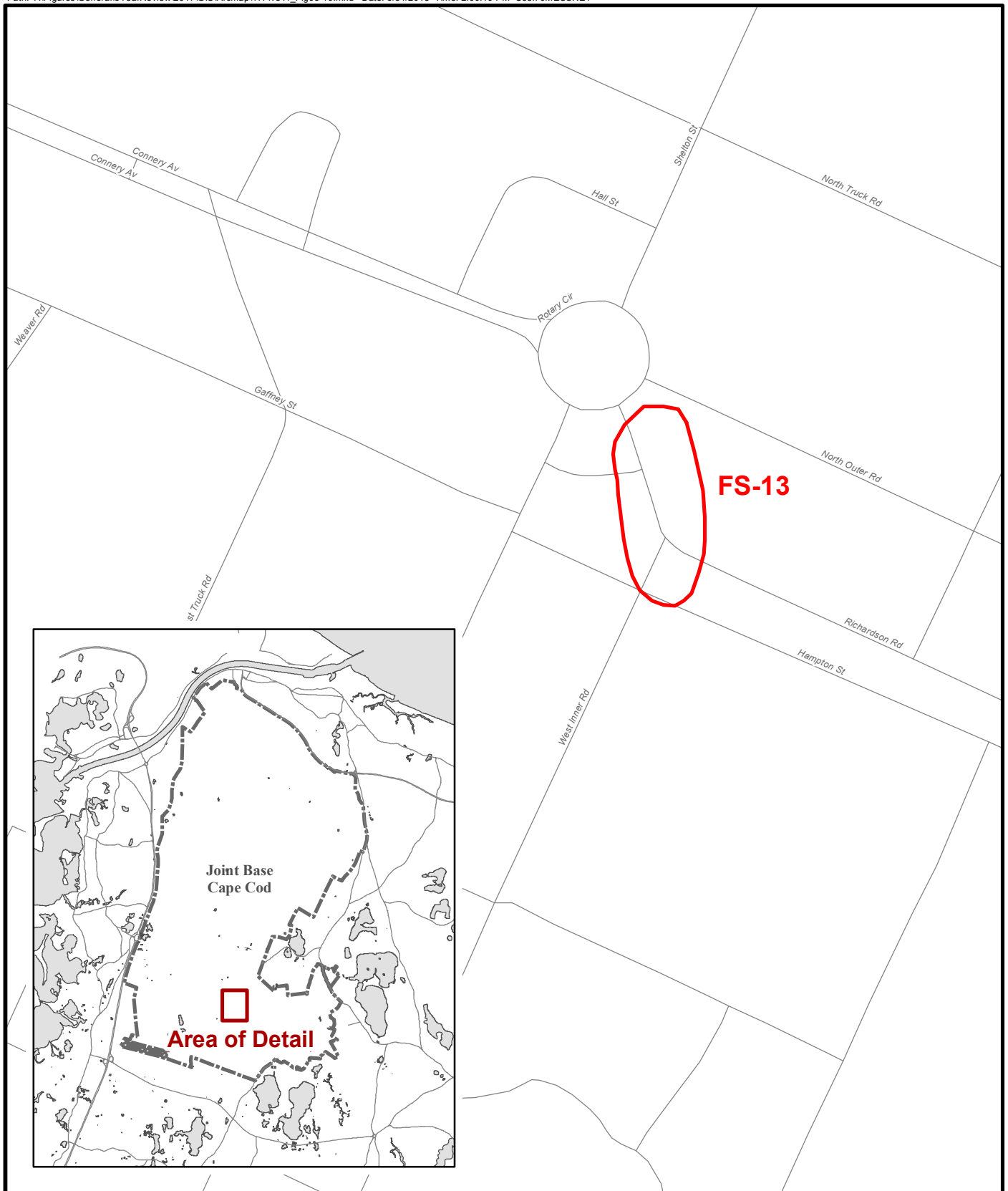


FIGURE 5-9B

FS-12 GROUNDWATER PLUME 2012 AND 2017 COMPARISON

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Legend

- Joint Base Cape Cod Boundary
- Plume Boundary (Dashed Where Inferred)

Data Source: AFCEC, April 2018
JBCC Boundary from Massachusetts Air National Guard 2011

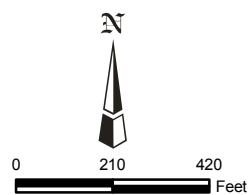
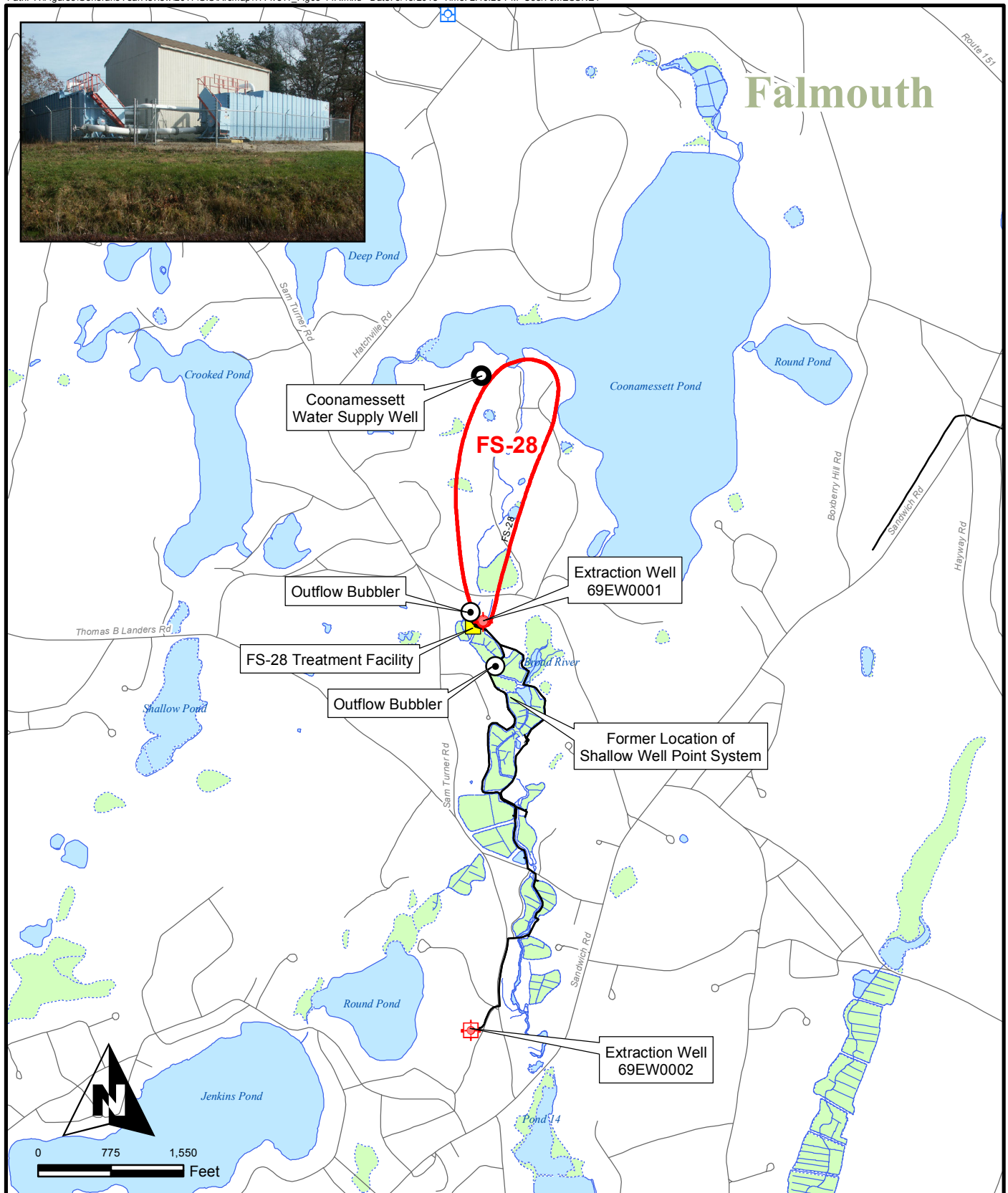


FIGURE 5-10

FS-13 GROUNDWATER PLUME (2004 DELINEATION)

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Legend

- FS-28 Plume Boundary = Concentrations exceeding drinking water standards or Massachusetts Maximum Contaminant Level (MMCL), dashed where inferred. Represents an exceedance of ethylene dibromide (EDB) (EDB MMCL = 0.02 µg/L)
- Bog/Wetland
- Treatment System Piping

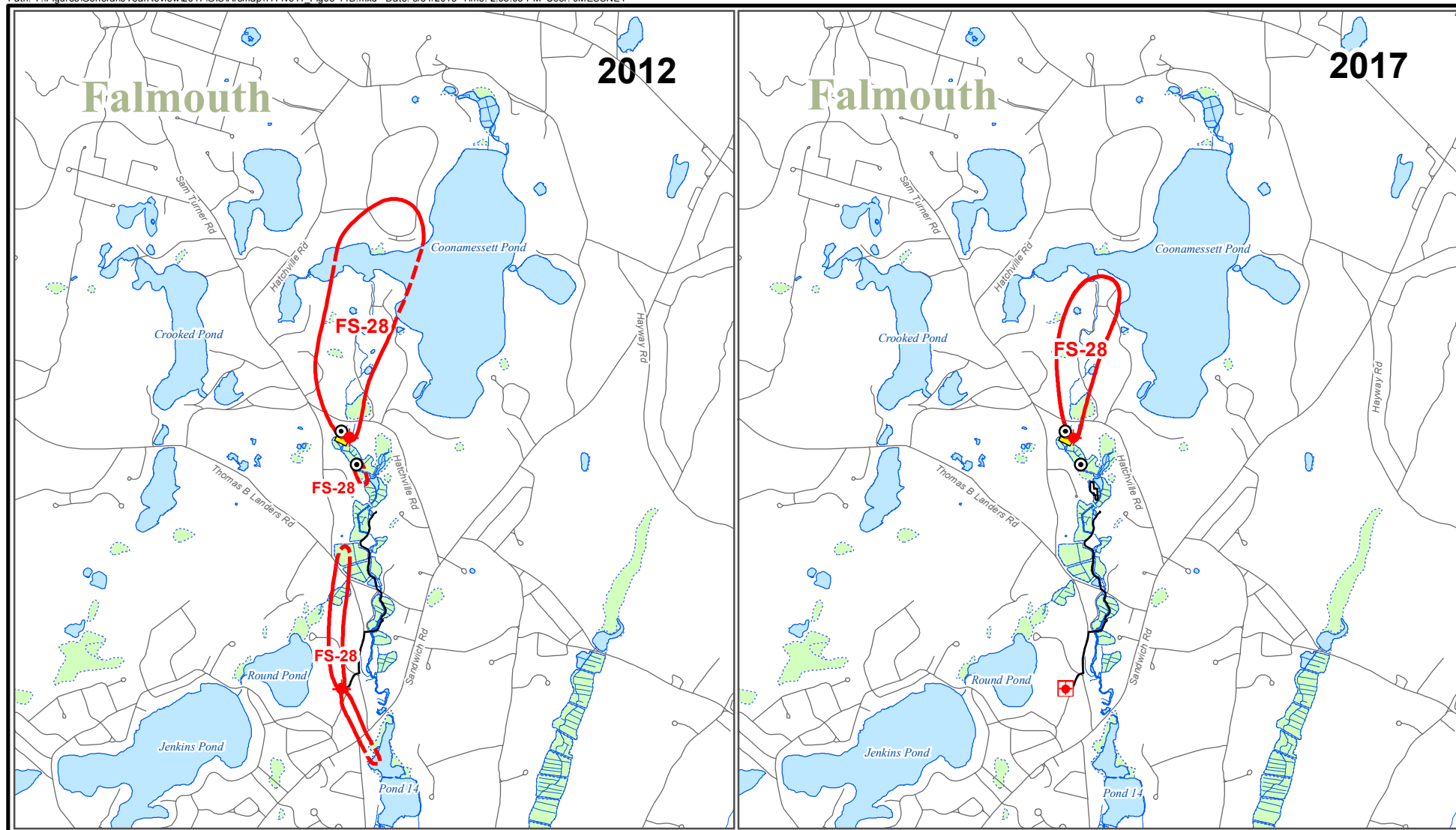
Data Source: AFCEC, April 2018

- ⬮ Extraction Well
- ⬮ Extraction Well (off)
- Outflow Bubbler
- Public Drinking Water Supply Well
- Treatment Facility

FIGURE 5-11A

FS-28 GROUNDWATER PLUME AND TREATMENT SYSTEM

AFCEC- Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Legend

- | | | | |
|--|--|--|-----------------------|
| | Joint Base Cape Cod Boundary | | Bubbler |
| | Plume Boundary (Dashed Where Inferred) | | Extraction Well |
| | Treatment System Pipeline | | Extraction Well (Off) |
| | Bog/Wetland | | |
| | Treatment Facility | | |

Data Source: AFCEC, April 2018
JBCC Boundary from Massachusetts Air National Guard 2011

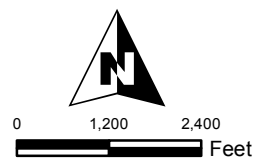
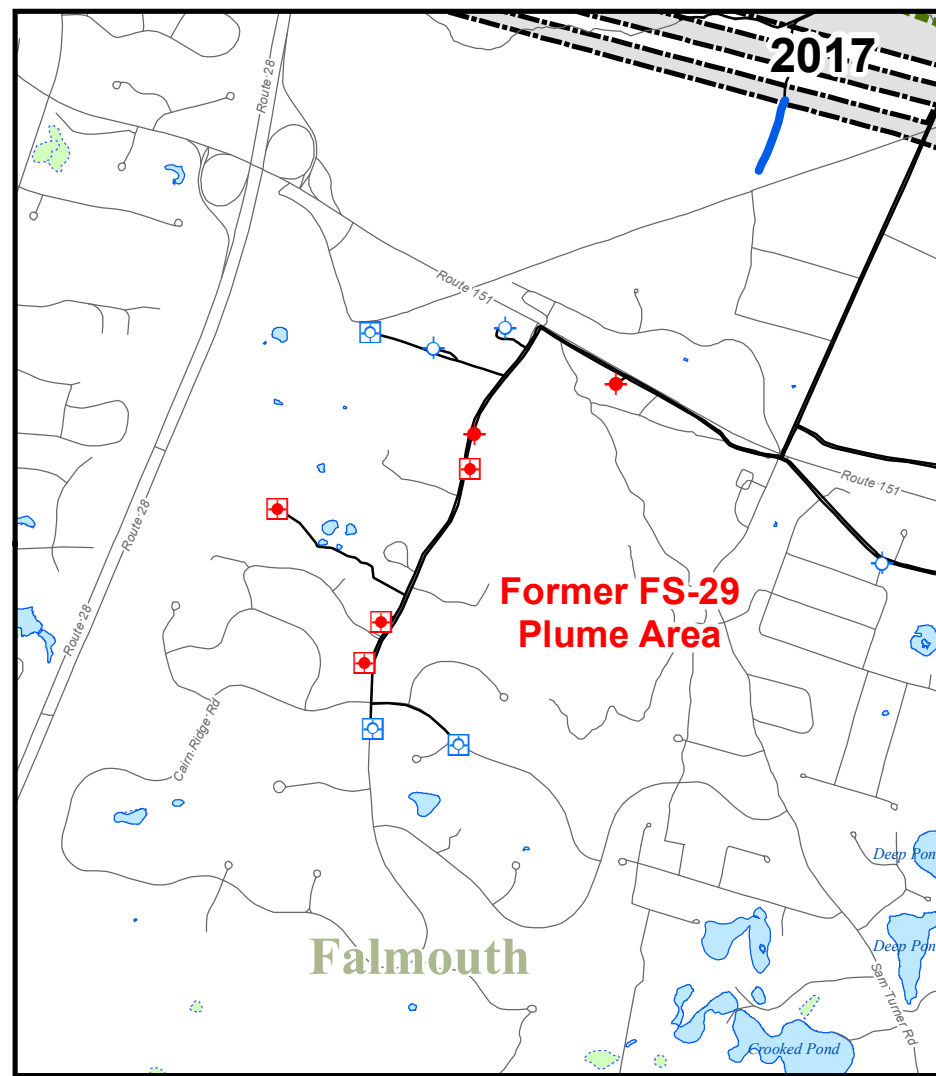
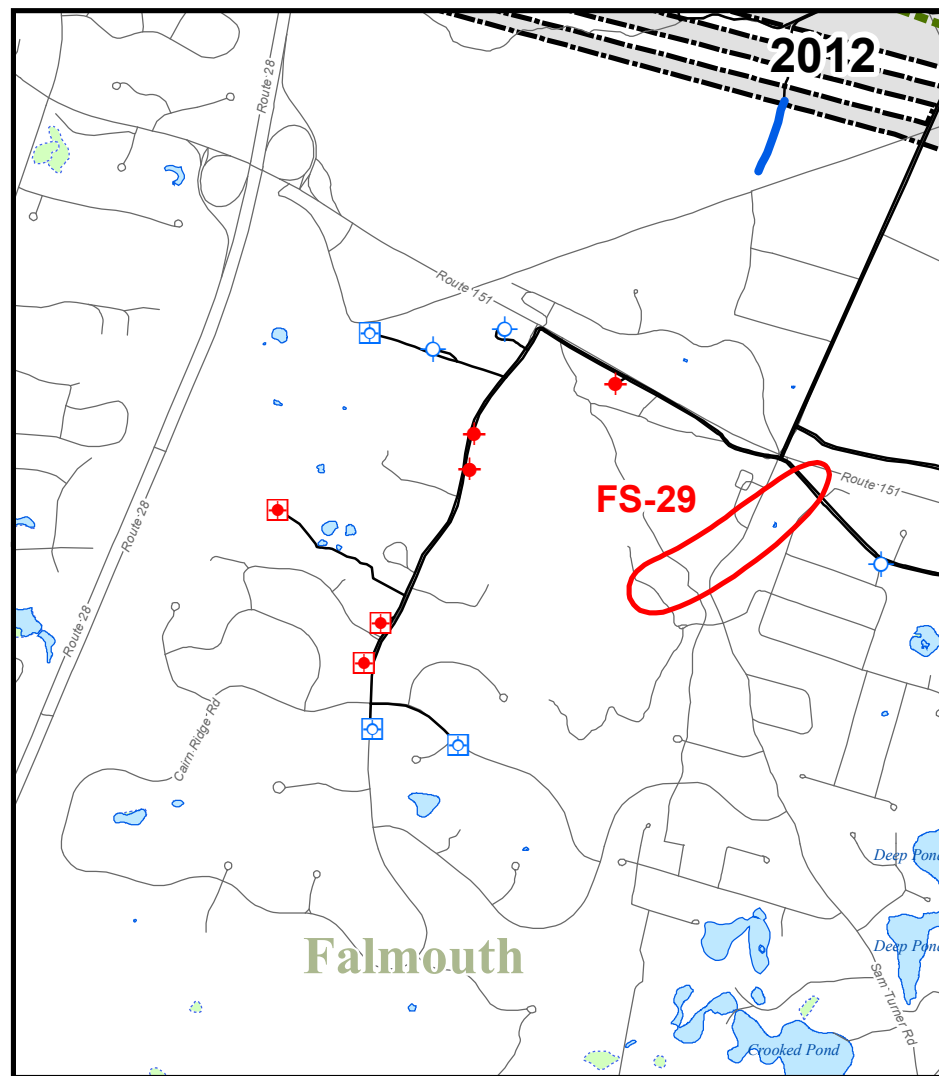


FIGURE 5-11B

FS-28 GROUNDWATER PLUME 2012 AND 2017 COMPARISON

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Legend

- | | | | |
|--|------------------------------|--|------------------------|
| | Town Boundary | | Extraction Well |
| | Joint Base Cape Cod Boundary | | Extraction Well (Off) |
| | Plume Boundary | | Reinjection Well |
| | Treatment System Piping | | Reinjection Well (Off) |
| | Infiltration Trench | | |
| | Bog/Wetland | | |

Data Source: AFCEC, April 2018
JBCC Boundary from Massachusetts Air National Guard 2011

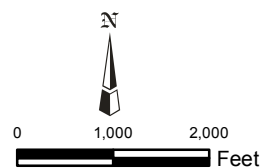


FIGURE 5-12B

FS-29 GROUNDWATER PLUME 2012 AND 2017 COMPARISON

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017

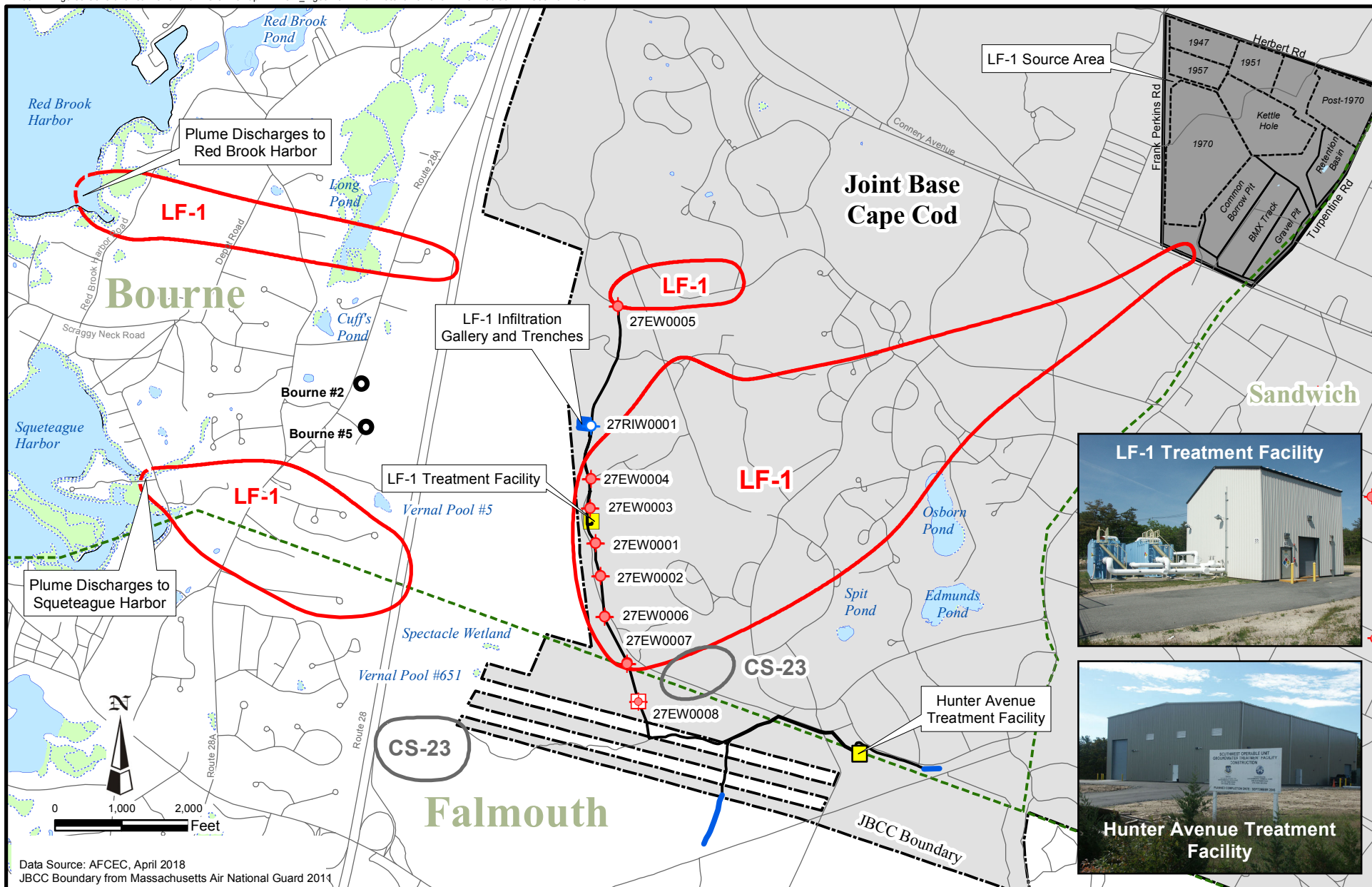
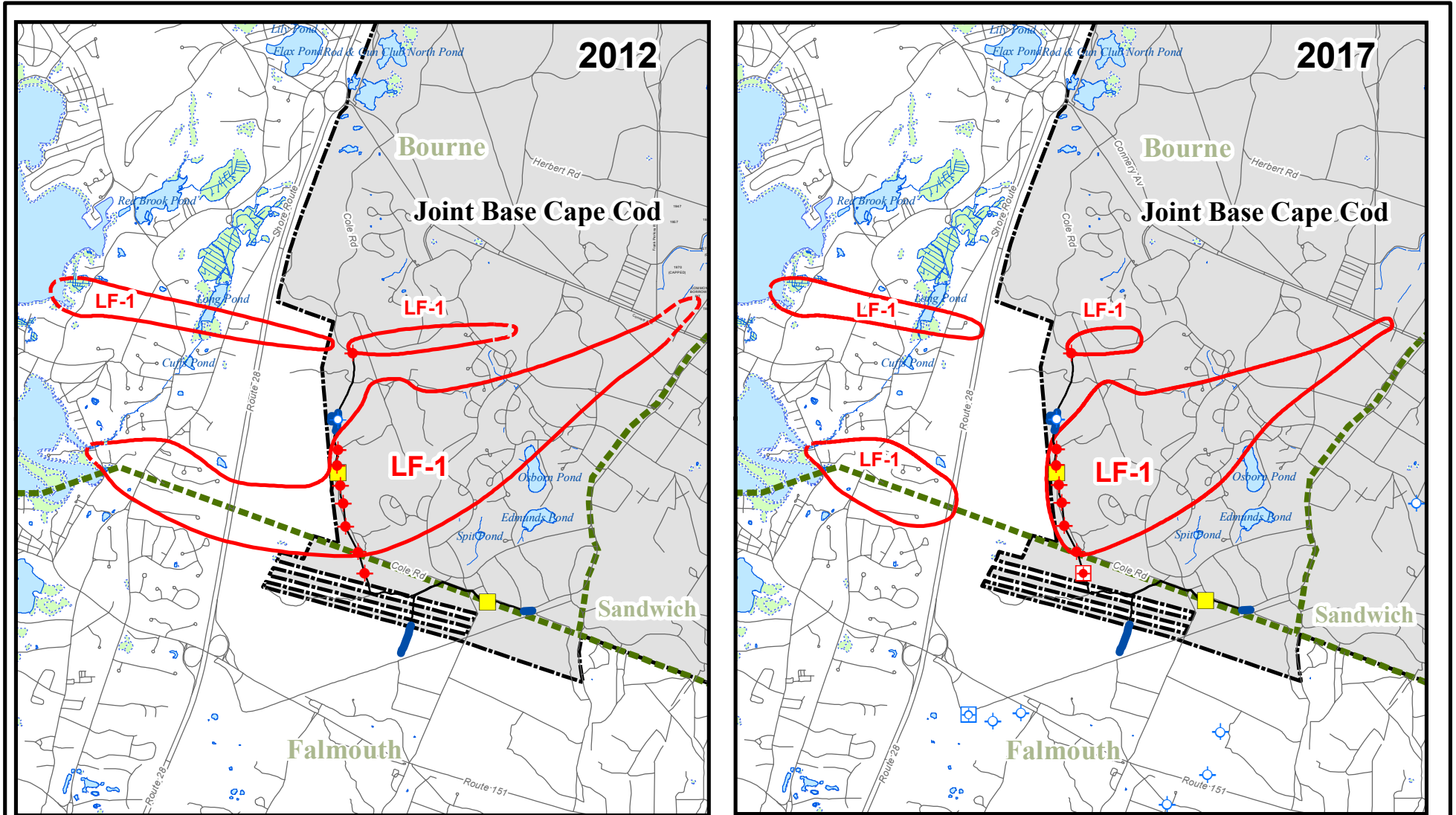


FIGURE 5-13A

LF-1 GROUNDWATER PLUME AND TREATMENT SYSTEMS

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Legend

- Town Boundary
- Joint Base Cape Cod Boundary
- Plume Boundary (Dashed Where Inferred)
- Treatment System Pipeline
- Infiltration Trench
- Bog/Wetland
- ◆ Extraction Well
- ◆ Extraction Well (Off)
- ◆ Reinjection Well
- Treatment Facility

Data Source: AFCEC, April 2018
JBCC Boundary from Massachusetts Air National Guard 2011

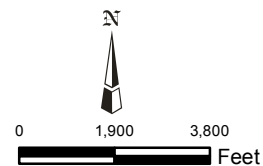
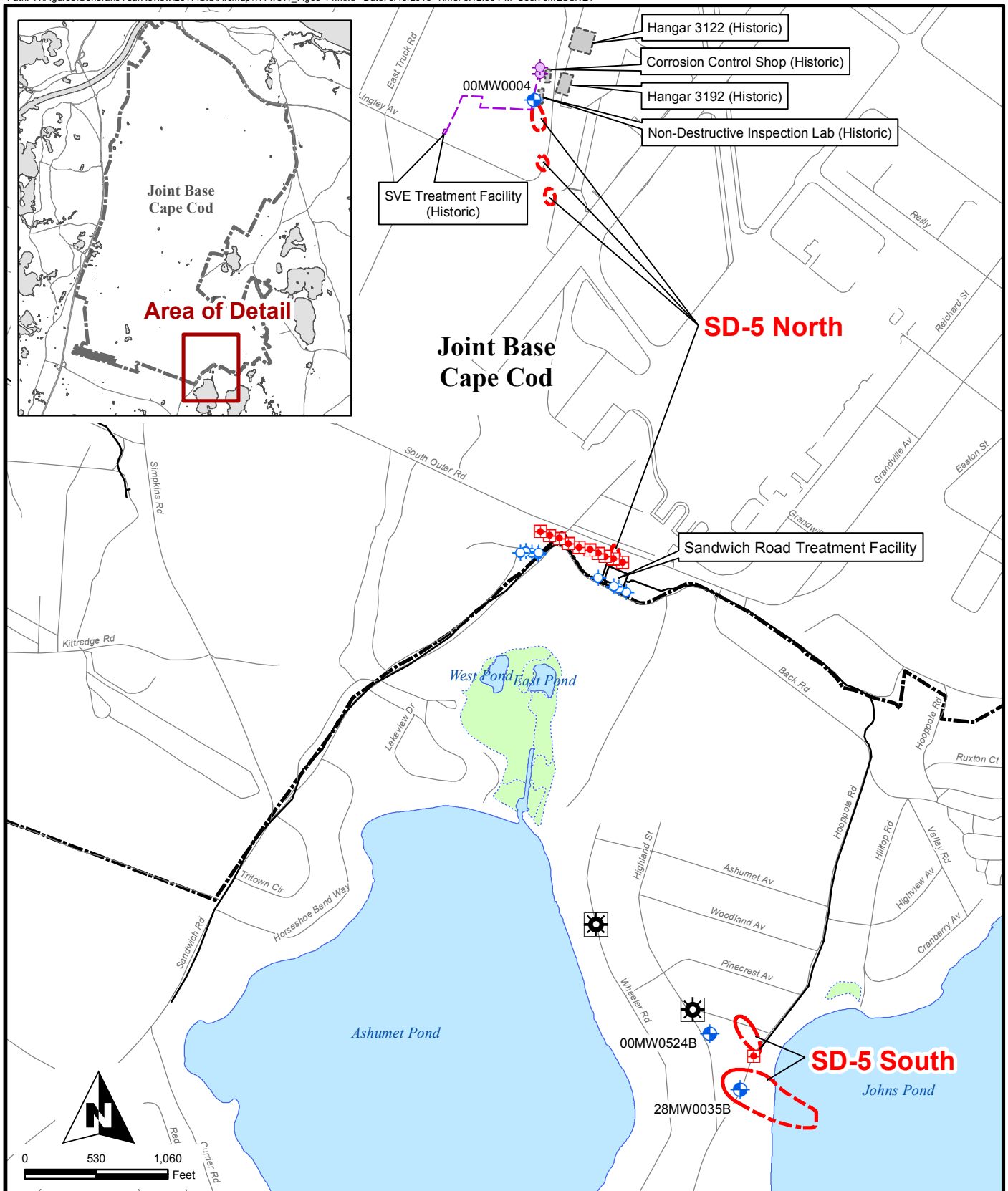


FIGURE 5-13B

LF-1 GROUNDWATER PLUME 2012 AND 2017 COMPARISON

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017

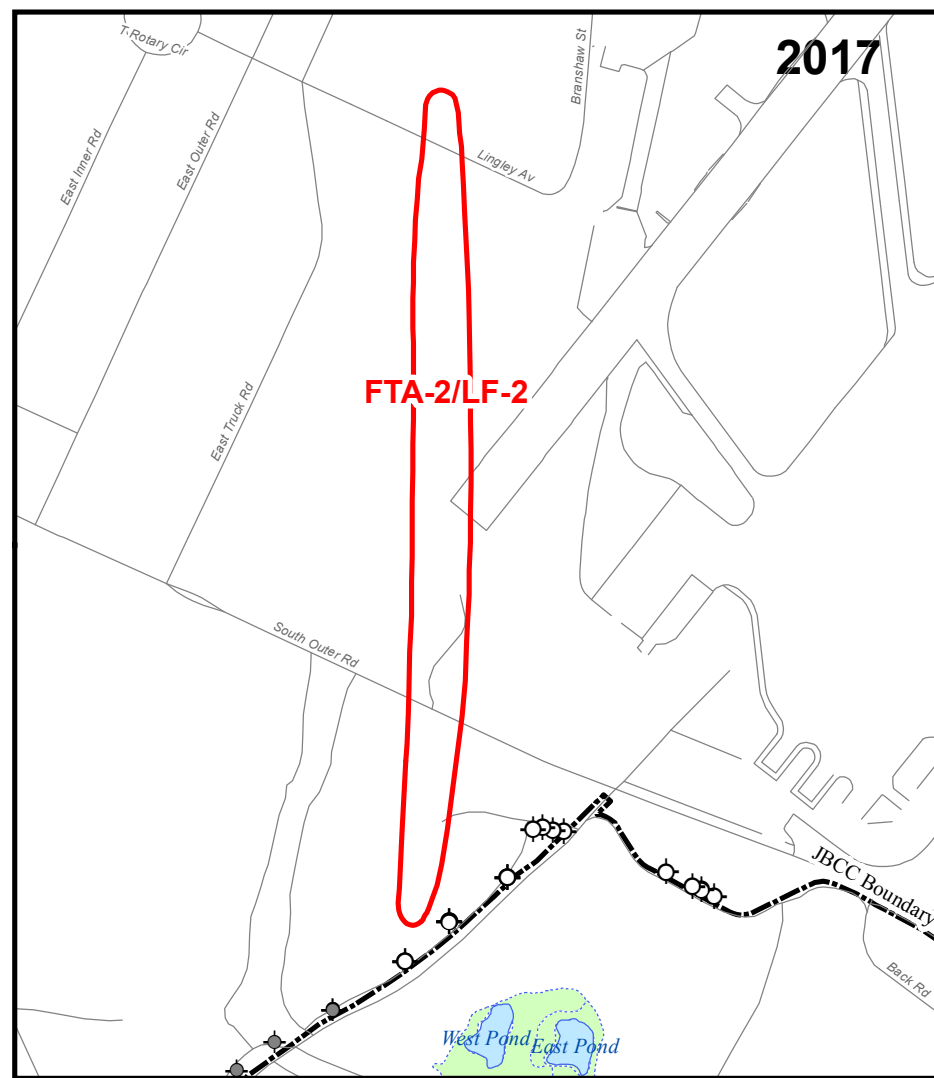
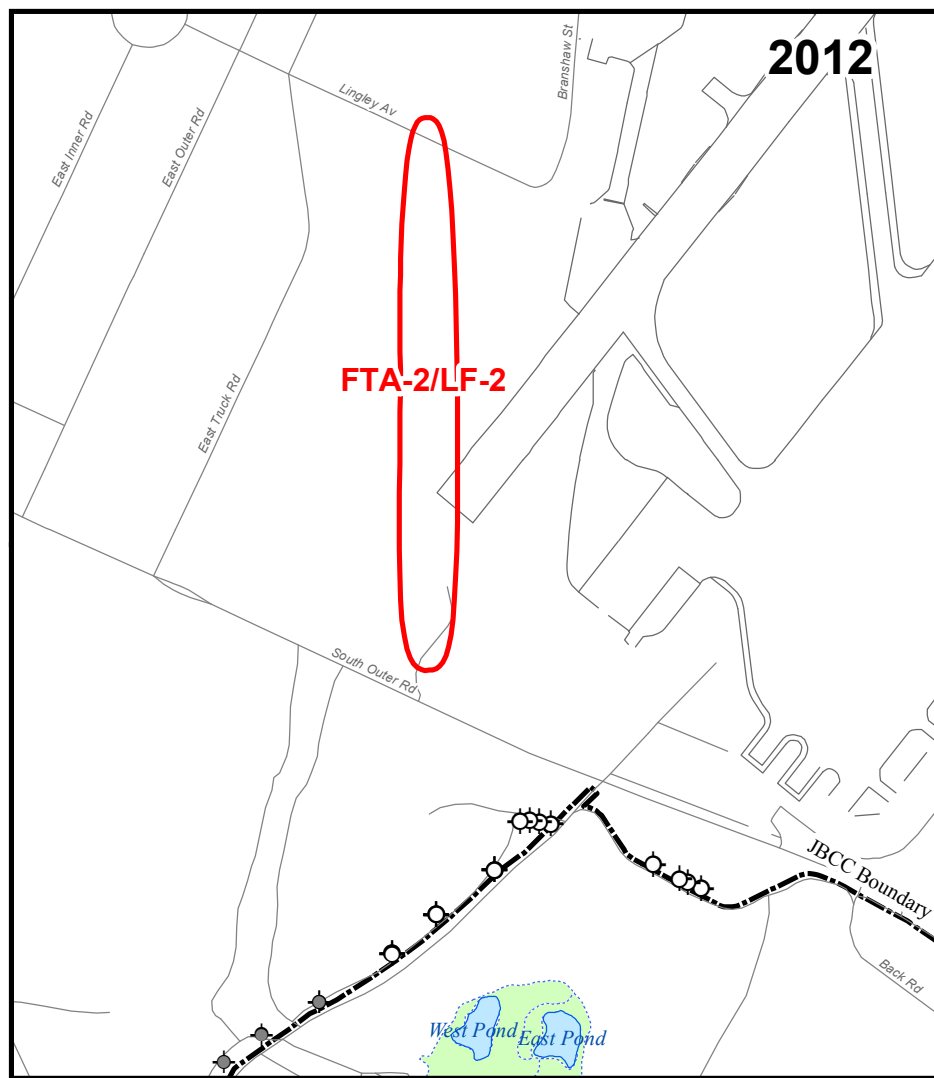


Data Source: AFCEC, April 2018
JBCC Boundary from Massachusetts Air National Guard 2011

FIGURE 5-14

**SD-5 GROUNDWATER PLUME
(2005 DELINEATION)**

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Legend

- Joint Base Cape Cod Boundary
- Plume Boundary
- Bog/Wetland

CS-10 Sandwich Road Treatment Facility Wells:

- Reinjection Well (On)
- ⊗ Extraction Well (On)

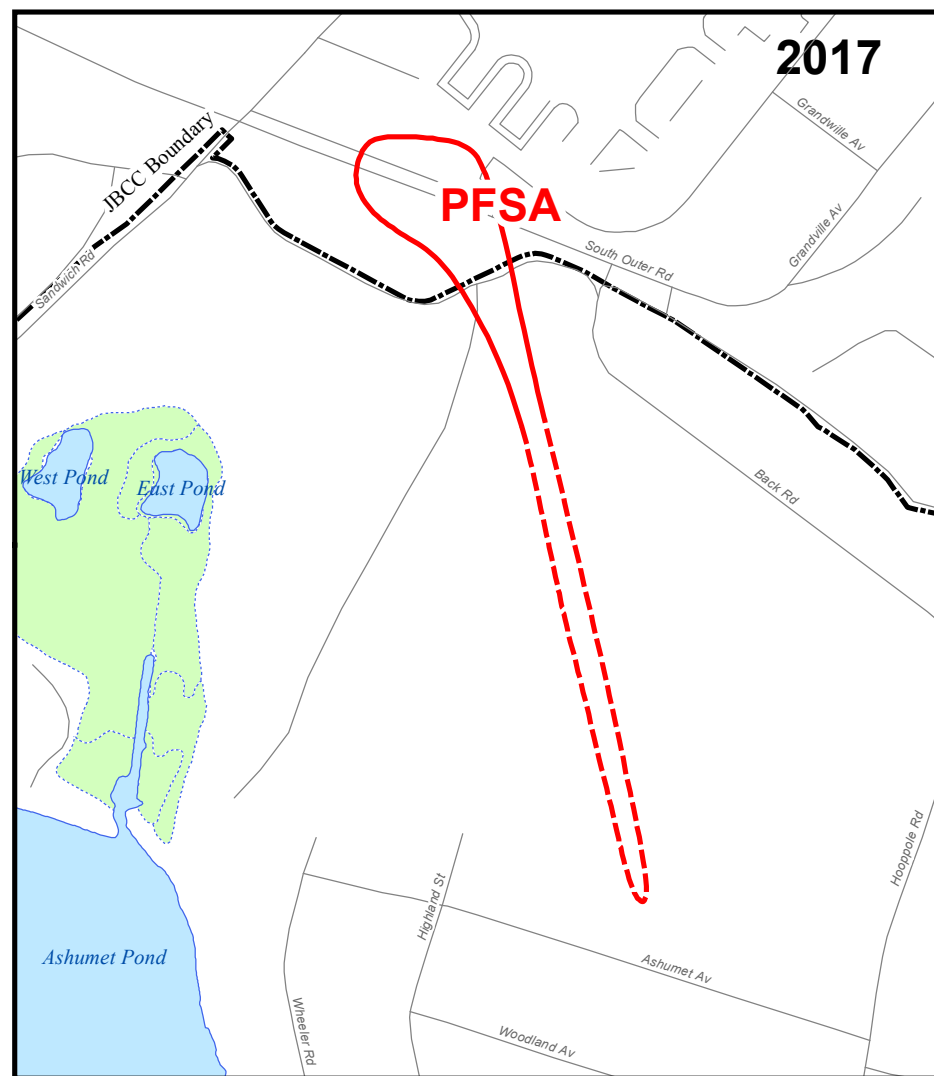
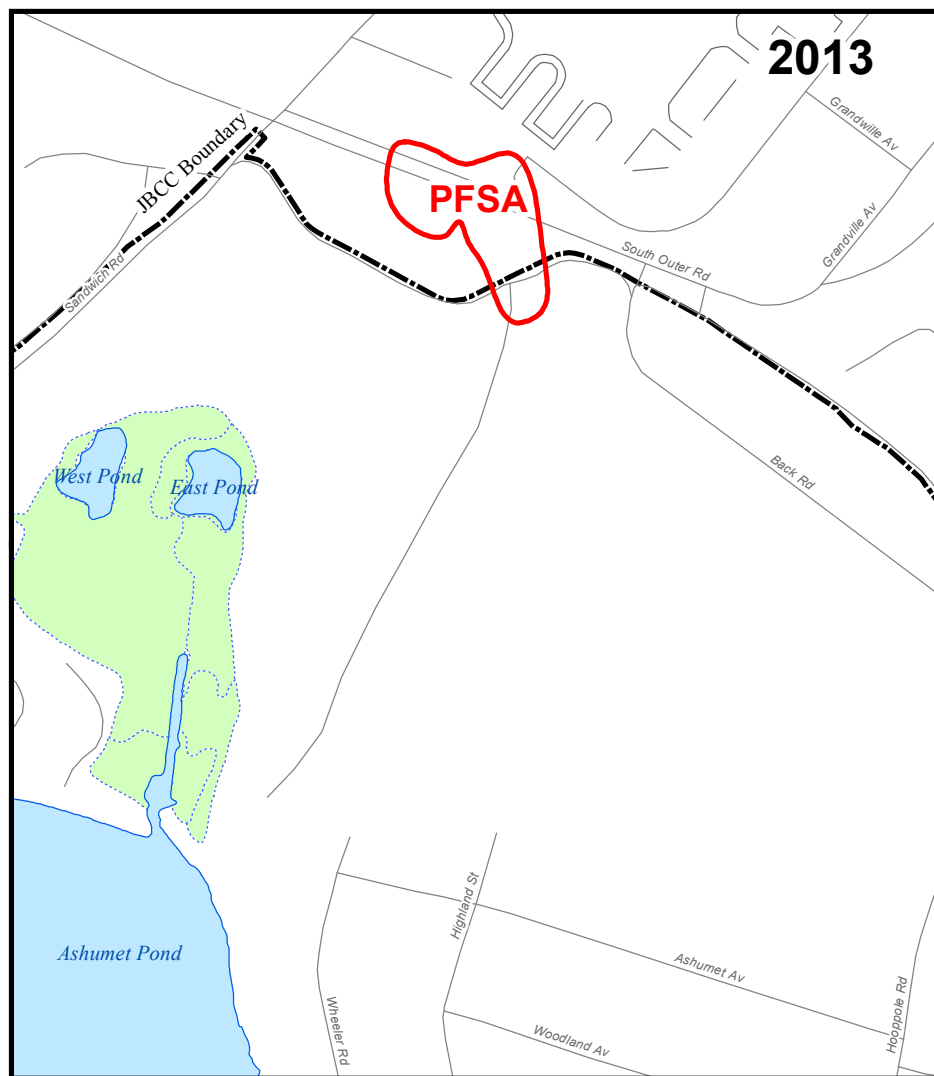
Data Source: AFCEC, April 2018
JBCC Boundary from Massachusetts Air National Guard 2011



FIGURE 5-15

FTA-2/LF-2 GROUNDWATER PLUME 2012 AND 2017 COMPARISON

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017



Legend

- Joint Base Cape Cod Boundary
- Plume Boundary (Dashed Where Inferred)
- Bog/Wetland

Note: 2013 plume based on groundwater data collected through November 2013.

Data Source: AFCEC, April 2018
JBCC Boundary from Massachusetts Air National Guard 2011

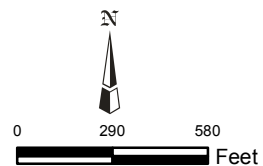


FIGURE 5-16

PFSA GROUNDWATER PLUME 2013 AND 2017 COMPARISON

AFCEC - Joint Base Cape Cod
Draft 5th Five Year Review, 2012-2017

TABLES

Table 1-1a
IRP Source Area Sites No Longer Requiring a Five Year Review
Final 5th Five-Year Review, 2012-2017

IRP Source Area Site	Reference Document	Summary rationale why UU/UE was appropriate and/or why Five-Year Reviews are no longer required
CY-2	<i>Final Coal Yard 2 (CY-2) Non-Time Critical Removal Action Completion Report and Technical Memorandum (AFCEC 2015a)</i>	The post-excavation confirmation sampling results for arsenic support unrestricted use of subsurface soils at CY-2 relative to the current RALs, MCP S-1/GW-1 standards (MassDEP 2014), and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 05 November 2015.
SD-4	<i>Final Storm Drain-4 2015 Risk Assessment and UU/UE Site Closure Evaluation Technical Memorandum (AFCEC 2015b)</i>	A review of the site data and a VI screening evaluation for SD-4 was completed and support unrestricted use of surface and subsurface soils relative to the current RALs, MCP S-1/GW-1 standards (MassDEP 2014), and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 02 September 2015.
CD-500	<i>No Further Action Planned Decision Document Dump Area UK-C500 (AFCEC 2016e)</i>	Based on the findings of the investigation, there is no evidence of releases of contaminants from Dump Area UK-C500 to groundwater, surface water, soil, or air and that the site does not represent a risk to human health or the environment. No further action required CERCLA. NFA (UU/UE) was approved by EPA and MassDEP on 12 October 2016.
OW-C524-OWS 6165	<i>Site Closure under Massachusetts Underground Storage Tank (UST) Program (AFCEC 2016d)</i>	To achieve site closeout under the UST program, the UST removal and closure of associated piping and floor drain activities were performed in accordance with the MassDEP UST Regulations 310 Code of Massachusetts Regulation (CMR) 80 (80.43 Requirements for Removal and Permanent Closure In-Place and 80.47 Standards for Cleaning and Closure, which address closure and removal of UST systems used to store petroleum fuels and hazardous substances), and the Massachusetts Comprehensive Fire Safety Code 527 CMR 1.00 (66.21.7.4.3.1 and 66.21.7.4.3.4). NFA (UU/UE) was approved by EPA and MassDEP on 14 July 2016.
CS-1	<i>Final Decision Document Addendum (AFCEC 2016a)</i>	The delineation and post-excavation sampling results for VOCs, SVOCs, PAHs, pesticides/PCBs, and inorganics support unrestricted use of surface and subsurface soils at CS-1 relative to the current RALs, MCP S-1/GW-1 standards (MassDEP 2014), and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 5 May 2016.
CS-14	<i>Final Decision Document Addendum (AFCEC 2016a)</i>	The post-excavation sampling results for methylene chloride support unrestricted use of surface and subsurface soils at CS-14, relative to the current MCP S-1/GW-1 standards (MassDEP 2014) and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 5 May 2016.
CS-15	<i>Final Decision Document Addendum (AFCEC 2016a)</i>	The characterization and post-excavation sampling results for VOCs, SVOCs, PAHs, pesticides/PCBs, and inorganics support unrestricted use of subsurface soils at CS-15 relative to the current RALs, MCP S-1/GW-1 standards (MassDEP 2012), and EPA residential RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 5 May 2016.
CS-2CG	<i>Final Decision Document Addendum (AFCEC 2016a)</i>	The characterization and post-excavation sampling results for PAHs support UU/UE of surface and subsurface soils at CS-2 CG relative to the current MCP S-1/GW-1 standards (MassDEP 2014) and EPA residential RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 5 May 2016.

Table 1-1a
IRP Source Area Sites No Longer Requiring a Five Year Review
Final 5th Five-Year Review, 2012-2017

IRP Source Area Site	Reference Document	Summary rationale why UU/UE was appropriate and/or why Five-Year Reviews are no longer required
CS-6	<i>Final Decision Document Addendum</i> (AFCEC 2016a)	The characterization sampling results for SVOCs, pesticides/PCBs, and inorganics support unrestricted use of subsurface soils at CS-6 relative to the current MCP S-1/GW-1 standards (MassDEP 2014) and EPA residential RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 5 May 2016.
CS-6CG	<i>Final Decision Document Addendum</i> (AFCEC 2016a)	The characterization and post-excavation sampling results for VOCs, SVOCs, PAHs, pesticides/PCBs, and inorganics support UU/UE of surface and subsurface soils at CS-6 CG relative to the current MCP S-1/GW-1 standards (MassDEP 2014) and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 5 May 2016.
CY-1	<i>Final Decision Document Addendum</i> (AFCEC 2016a)	The characterization sampling results for inorganics support unrestricted use of subsurface soils at CY-1 relative to the current RALs, MCP S-1/GW-1 standards (MassDEP 2014), and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 5 May 2016.
CY-3	<i>Final Decision Document Addendum</i> (AFCEC 2016a)	The characterization sampling results for inorganics support unrestricted use of subsurface soils at CY-3 relative to the current RALs, MCP S-1/GW-1 standards (MassDEP 2014), and EPA residential based RSLs (EPA 2012).
FS-22	<i>Final Decision Document Addendum</i> (AFCEC 2016a)	The characterization sampling results for SVOCs, pesticides/PCBs, and inorganics support unrestricted use of subsurface soils at FS-22 relative to the current MCP S-1/GW-1 standards (MassDEP 2014) and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 5 May 2016.
FS-25	<i>Final Decision Document Addendum</i> (AFCEC 2016a)	The post-excavation confirmation sampling results for metals and petroleum hydrocarbons support unrestricted use of FS-25 soils relative to the current RALs, the current MCP S-1/GW-1 standards (MassDEP 2014), and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 5 May 2016.
FS-2CG	<i>Final Decision Document Addendum</i> (AFCEC 2016a)	The characterization sampling results for VOCs, SVOCs, and inorganics support unrestricted use of subsurface soils at FS-2CG relative to the current RALs, MCP S-1/GW-1 standards (MassDEP 2014), and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 5 May 2016.
FS-3	<i>Final Decision Document Addendum</i> (AFCEC 2016a)	The characterization sampling results for VOCs and inorganics support unrestricted use of subsurface soils at FS-3 relative to the current MCP S-1/GW-1 standards (MassDEP 2014) and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 5 May 2016.
SD-1	<i>Final Decision Document Addendum</i> (AFCEC 2016a)	The characterization sampling results for SVOCs, pesticides/PCBs, and inorganics support unrestricted use of subsurface soils at SD-1 relative to the current MCP S-1/GW-1 standards (MassDEP 2014) and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 5 May 2016.
CS-11	<i>Action Memorandum Technical Memorandum</i> (AFCEC 2014)	The post-excavation confirmation sampling results for metals and the primary COC dieltrin support unrestricted use of CS-11 soils relative to the AM addendum RALs, the current MCP S-1/GW-1 standards (MassDEP 2014), and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 7 May 2014.

Table 1-1a
IRP Source Area Sites No Longer Requiring a Five Year Review
Final 5th Five-Year Review, 2012-2017

IRP Source Area Site	Reference Document	Summary rationale why UU/UE was appropriate and/or why Five-Year Reviews are no longer required
CS-4CG	<i>Action Memorandum Technical Memorandum</i> (AFCEC 2014)	The delineation and post-excavation confirmation sampling results for residual PAHs and metals support unrestricted use of CS-4 CG surface and subsurface soils relative to the AM and AM addendum RALs, the current MCP S-1/GW-1 standards and background values (MassDEP 2014). Results for COCs present at concentrations above background also support unrestricted use relative to EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 7 May 2014.
CS-5	<i>Action Memorandum Technical Memorandum</i> (AFCEC 2014)	The delineation and post-excavation confirmation sampling results for aliphatic and aromatic petroleum hydrocarbon fractions, aroclor-1242, and lead were below RALs established in the AM addendum to be protective of human health and the environment for all exposure scenarios. Concentrations are also lower than current MCP S-1/GW-1 standards (MassDEP 2014) and the EPA Region 9 RSL for lead (EPA 2011). EPA Region 9 RSLs are not available for petroleum hydrocarbons. NFA (UU/UE) was approved by EPA and MassDEP on 7 May 2014.
DDOU	<i>Action Memorandum Technical Memorandum</i> (AFCEC 2014)	The delineation and post-excavation confirmation sampling results for SVOCs, metals and pesticides support unrestricted use of DDOU surface and subsurface soils relative to the AM RALs, MMR background values, and the current MCP S-1/GW-1 standards (MassDEP 2014) and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 7 May 2014.
FS-12	<i>Action Memorandum Technical Memorandum</i> (AFCEC 2014)	The post-treatment residual exposure point concentrations for all hydrocarbon fractions and ethylbenzene are below the AM RALs, the current MCP S-3/GW-1 and S-3/GW-3 standards (MassDEP 2014), and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 7 May 2014.
FS-18	<i>Action Memorandum Technical Memorandum</i> (AFCEC 2014)	The delineation and post-excavation confirmation sampling results for petroleum hydrocarbons support unrestricted use of FS-18 surface and subsurface soils relative to the AM RALs and current MCP S-1/GW-1 standards (MassDEP 2014). NFA (UU/UE) was approved by EPA and MassDEP on 7 May 2014.
FS-1CG	<i>Action Memorandum Technical Memorandum</i> (AFCEC 2014)	The delineation and post-excavation confirmation sampling results for residual PAHs and metals support unrestricted use of FS-1 CG surface and subsurface soils relative to the AM and AM addendum RALs, the current MCP S-1/GW-1 standards (MassDEP 2014), and background values. Results for COCs present at concentrations above background also support unrestricted use relative to EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 7 May 2014.
FS-4	<i>Action Memorandum Technical Memorandum</i> (AFCEC 2014)	The remedial design sampling results for petroleum hydrocarbons support unrestricted use of FS-4 surface and subsurface soils relative to the AM RALs, current MCP S-1/GW-1 standards (MassDEP 2014), and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 7 May 2014.
FS-7	<i>Action Memorandum Technical Memorandum</i> (AFCEC 2014)	The delineation and post-excavation confirmation sampling results for PAHs support unrestricted use of FS-7 surface and subsurface soils relative to the AM and AM addendum RALs and the current MCP S-1/GW-1 standards and background values (MassDEP 2014). NFA (UU/UE) was approved by EPA and MassDEP on 7 May 2014.

Table 1-1a
IRP Source Area Sites No Longer Requiring a Five Year Review
Final 5th Five-Year Review, 2012-2017

IRP Source Area Site	Reference Document	Summary rationale why UU/UE was appropriate and/or why Five-Year Reviews are no longer required
FTA-1	<i>Action Memorandum Technical Memorandum</i> (AFCEC 2014)	The post-excavation confirmation sampling results for VOCs and petroleum hydrocarbons support unrestricted use of FTA-1 surface and subsurface soils relative to the STCLs, current MCP S-1/GW-1 standards (MassDEP 2014), and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 7 May 2014.
CS-16	<i>Chemical Spill-16/Chemical Spill-17 Technical Memorandum</i> (AFCEC 2016b)	The delineation and post-excavation confirmation sampling results for metals and pesticides/PCBs support unrestricted use of CS-16 surface and subsurface soils relative to the ROD and ESD RALs, the current MCP S-1/GW-1 standards (MassDEP 2014), and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 6 January 2016.
CS-17	<i>Chemical Spill-16/Chemical Spill-17 Technical Memorandum</i> (AFCEC 2016b)	The delineation and post-excavation confirmation sampling results for metals and pesticides/PCBs support unrestricted use of CS-17 surface and subsurface soils relative to the 2003 ESD and 2013 ESD RALs, the current MCP S-1/GW-1 standards (MassDEP 2014), and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 6 January 2016.
CY-4	<i>Six Area of Concern Technical Memorandum</i> (AFCEC 2016c)	The delineation and post-excavation confirmation sampling results for metals, SVOCs and PCBs support unrestricted use of CY-4 surface and subsurface soils relative to the 2003 ESD and 2013 ESD RALs, the current MCP S-1/GW-1 standards (MassDEP 2014), and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 1 December 2016.
FS-5	<i>Six Area of Concern Technical Memorandum</i> (AFCEC 2016c)	The delineation and post-excavation confirmation sampling results for metals, VOCs and petroleum hydrocarbons support unrestricted use of FS-5 surface and subsurface soils relative to the 2003 ESD and 2013 ESD RALs, the current MCP S-1/GW-1 standards (MassDEP 2014), and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 1 December 2016.
FS-6	<i>Six Area of Concern Technical Memorandum</i> (AFCEC 2016c)	The delineation and post-excavation confirmation sampling results for metals support unrestricted use of FS-6 surface and subsurface soils relative to the 2003 ESD RALs, the current MCP S-1/GW-1 standards (MassDEP 2014), and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 1 December 2016.
FS-8	<i>Six Area of Concern Technical Memorandum</i> (AFCEC 2016c)	The delineation and post-excavation confirmation sampling results for metals support unrestricted use of FS-8 surface and subsurface soils relative to the 2003 ESD RALs, the current MCP S-1/GW-1 standards (MassDEP 2014), and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 1 December 2016.
FTA-3	<i>Six Area of Concern Technical Memorandum</i> (AFCEC 2016c)	The delineation and post-excavation confirmation sampling results for metals, SVOCs and PCBs support unrestricted use of FTA-3 surface and subsurface soils relative to the 2003 ESD and 2013 ESD RALs, the current MCP S-1/GW-1 standards (MassDEP 2014), and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 1 December 2016.
SD-2	<i>Six Area of Concern Technical Memorandum</i> (AFCEC 2016c)	The delineation and post-excavation confirmation sampling results for metals support unrestricted use of SD-2 surface and subsurface soils relative to the 2003 ESD RALs, the

Table 1-1a
IRP Source Area Sites No Longer Requiring a Five Year Review
Final 5th Five-Year Review, 2012-2017

IRP Source Area Site	Reference Document	Summary rationale why UU/UE was appropriate and/or why Five-Year Reviews are no longer required
		current MCP S-1/GW-1 standards (MassDEP 2014), and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 1 December 2016.
SD-3	<i>Six Area of Concern Technical Memorandum</i> (AFCEC 2016c)	The delineation and post-excavation confirmation sampling results for metals, SVOCs and PCBs support unrestricted use of SD-3 surface and subsurface soils relative to the 2003 ESD and 2013 ESD RALs, the current MCP S-1/GW-1 standards (MassDEP 2014), and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 1 December 2016.
SD-5	<i>Six Area of Concern Technical Memorandum</i> (AFCEC 2016c)	The delineation and post-excavation confirmation sampling results for metals, VOCs and petroleum hydrocarbons support unrestricted use of SD-5 surface and subsurface soils relative to the 2003 ESD and 2013 ESD RALs, the current MCP S-1/GW-1 standards (MassDEP 2014), and EPA residential based RSLs (EPA 2012). NFA (UU/UE) was approved by EPA and MassDEP on 1 December 2016.

Key:

AFCEC = Air Force Civil Engineer Center
AFCEE = Air Force Center for Engineering and the Environment
AM = Action Memorandum
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
COC = contaminant of concern
CG = U.S. Coast Guard
CS = Chemical Spill
CY = Coal Yard
DDOU = Drum Disposal Operable Unit
EPA = U.S. Environmental Protection Agency
EPH/VPH = extractable/volatile petroleum hydrocarbons
ESD = Explanation of Significant Differences
FS = Fuel Spill
FTA = Fire Training Area

IRP = Installation Restoration Program

MassDEP = Massachusetts Department of Environmental Protection

MCP = Massachusetts Contingency Plan

MMR = Massachusetts Military Reservation

PAH = polycyclic aromatic hydrocarbon

PCB = polychlorinated biphenyl

RAL = remedial action level

ROD = Record of Decision

RSL = Regional Screening Level

S-1/GW-1 = surface water-1/ groundwater-1

S-3/GW-1 = surface water-3/ groundwater-1

S-3/GW-3 = surface water-3/ groundwater-3

SD = Storm Drain

SVOC = semivolatile organic compound

UU/UE = unlimited use and unrestricted exposure

VOC = volatile organic compound

References:

AFCEC. 2016a (May). Final Decision Document Addendum for Study Areas CS-1, CS-2 (USCG), CS-6/FS-22, CS-6 (USCG), CS-14, CS-15, CY-1/CY-3, FS-2 (USCG), FS-3, FS-25, and SD-1. Prepared by AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA

_____. 2016b (February). *Chemical Spill-16/Chemical Spill-17 Technical Memorandum*. Prepared by AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA

Table 1-1a
IRP Source Area Sites No Longer Requiring a Five Year Review
Final 5th Five-Year Review, 2012-2017

- _____. 2016c (January). Final Technical Memorandum for Areas of Contamination SD-2/FS-6/FS-8, SD-3/FTA-3/CY-4, and SD-5/FS-5. Prepared by AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA
- _____. 2016d (June). Letter Report for the OWC524-OWS 6165 site. Prepared by EA Engineering for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA
- _____. 2016e (September). No Further Action Planned Decision Document Dump Area UK-C500. Prepared by EA Engineering for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA
- _____. 2015a (November). Final Coal Yard 2 (CY-2) Non-Time Critical Removal Action Completion Report and Technical Memorandum. Prepared by FPM for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA
- _____. 2015b (September). Final Storm Drain-4 2015 Risk Assessment and UU/UE Site Closure Evaluation Technical Memorandum. Prepared by CH2M for AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA
- _____. 2014 (May). *Action Memorandum Technical Memorandum for Areas of Concern (AOCs) CS-4 (USCG)/FS-1 (USCG), CS-5, CS-11, FS-7, FS-18, DDOU, FS-4, FTA-1, and FS-12.* Prepared by AFCEC/JBCC, Installation Restoration Program, Otis Air National Guard Base, MA
- AFCEE. 2011 (September). *Explanation of Significant Differences Areas of Contamination CS-10/FS-24, FS-1, and FS-9, Massachusetts Military Reservation (MMR) Superfund Site,* Otis Air National Guard Base, MA.
- _____. 2009a (September). *Final Chemical Spill-18 (CS-18) Soil Removal Action Report.* Prepared by ECC for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- _____. 2009b (September). *Final CS-19 Soil Removal Action Report.* Prepared by ECC for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- EPA. 2012. *Regional Screening Level (RSL) Resident Soil Supporting Table,* May 2012, <http://www.epa.gov/region9/superfund/prgl/>, Web page accessed May 2012.
- MassDEP. 2014, *MCP Method 1 Soil and Groundwater Standards,* 310 CMR 40.0975(6) (a), http://www.mass.gov/dep/cleanup/laws/0975_6a.htm. Web page accessed June 2014.

Table 1-1b
Summary of All IRP Source Area Sites No Longer Requiring a Five Year Review
Final 5th Five Year Review, 2012-2017

IRP Source Area Site	Reference Document
2nd Five Year Review	
CS-2	2nd Five Year Review (1998-2002), AFCEE 2003
CS-3	2nd Five Year Review (1998-2002), AFCEE 2003
CS-3 CG	2nd Five Year Review (1998-2002), AFCEE 2003
CS-5CG	2nd Five Year Review (1998-2002), AFCEE 2003
CS-7	2nd Five Year Review (1998-2002), AFCEE 2003
CS-7 CG	2nd Five Year Review (1998-2002), AFCEE 2003
CS-8	2nd Five Year Review (1998-2002), AFCEE 2003
CS-9	2nd Five Year Review (1998-2002), AFCEE 2003
CS-10 Tank Wash OU	2nd Five Year Review (1998-2002), AFCEE 2003
CS-12	2nd Five Year Review (1998-2002), AFCEE 2003
FS-2	2nd Five Year Review (1998-2002), AFCEE 2003
FS-14	2nd Five Year Review (1998-2002), AFCEE 2003
FS-15	2nd Five Year Review (1998-2002), AFCEE 2003
FS-16	2nd Five Year Review (1998-2002), AFCEE 2003
FS-17	2nd Five Year Review (1998-2002), AFCEE 2003
FS-19	2nd Five Year Review (1998-2002), AFCEE 2003
FS-20	2nd Five Year Review (1998-2002), AFCEE 2003
FS-21	2nd Five Year Review (1998-2002), AFCEE 2003
FS-23	2nd Five Year Review (1998-2002), AFCEE 2003
FS-26	2nd Five Year Review (1998-2002), AFCEE 2003
FS-27	2nd Five Year Review (1998-2002), AFCEE 2003
LF-1 CG	2nd Five Year Review (1998-2002), AFCEE 2003
LF-2 CG	2nd Five Year Review (1998-2002), AFCEE 2003
LF-3	2nd Five Year Review (1998-2002), AFCEE 2003
LF-3 CG	2nd Five Year Review (1998-2002), AFCEE 2003
LF-4	2nd Five Year Review (1998-2002), AFCEE 2003
LF-5	2nd Five Year Review (1998-2002), AFCEE 2003
LF-6	2nd Five Year Review (1998-2002), AFCEE 2003
3rd Five Year Review	
CS-1 CG	3rd Five Year Review (2002-2007), AFCEE 2008
CS-4	3rd Five Year Review (2002-2007), AFCEE 2008
CS-8 CG	3rd Five Year Review (2002-2007), AFCEE 2008
CS-22	3rd Five Year Review (2002-2007), AFCEE 2008
FS-13	3rd Five Year Review (2002-2007), AFCEE 2008
4th Five Year Review	
CS-18	4th Five Year Review (2007-2012), AFCEC 2013
CS-19	4th Five Year Review (2007-2012), AFCEC 2013
FS-1	4th Five Year Review (2007-2012), AFCEC 2013
FS-9	4th Five Year Review (2007-2012), AFCEC 2013
5th (current) Five Year Review	
CS-1	5th Five Year Review (2012-2017)
CS-11	5th Five Year Review (2012-2017)
CS-14	5th Five Year Review (2012-2017)
CS-15	5th Five Year Review (2012-2017)
CS-16	5th Five Year Review (2012-2017)
CS-17	5th Five Year Review (2012-2017)
CS-2 CG	5th Five Year Review (2012-2017)
CS-4 CG	5th Five Year Review (2012-2017)
CS-5	5th Five Year Review (2012-2017)
CS-6	5th Five Year Review (2012-2017)
CS-6 CG	5th Five Year Review (2012-2017)
CY-1	5th Five Year Review (2012-2017)
CY-2	
CY-3	5th Five Year Review (2012-2017)
CY-4	5th Five Year Review (2012-2017)
DDOU	5th Five Year Review (2012-2017)
FS-1 CG	5th Five Year Review (2012-2017)
FS-2 CG	5th Five Year Review (2012-2017)

Table 1-1b
Summary of All IRP Source Area Sites No Longer Requiring a Five Year Review
Final 5th Five Year Review, 2012-2017

IRP Source Area Site	Reference Document
FS-3	5th Five Year Review (2012-2017)
FS-4	5th Five Year Review (2012-2017)
FS-5	5th Five Year Review (2012-2017)
FS-6	5th Five Year Review (2012-2017)
FS-7	5th Five Year Review (2012-2017)
FS-8	5th Five Year Review (2012-2017)
FS-12	5th Five Year Review (2012-2017)
FS-18	5th Five Year Review (2012-2017)
FS-22	5th Five Year Review (2012-2017)
FS-25	5th Five Year Review (2012-2017)
FTA-1 *	5th Five Year Review (2012-2017)
FTA-3	5th Five Year Review (2012-2017)
SD-1	5th Five Year Review (2012-2017)
SD-2	5th Five Year Review (2012-2017)
SD-3	5th Five Year Review (2012-2017)
SD-4	5th Five Year Review (2012-2017)
SD-5	5th Five Year Review (2012-2017)
CD-500	5th Five Year Review (2012-2017)
OWS C524-6165	5th Five Year Review (2012-2017)

* = Closed for existing COCs. Currently being investigated under a Supplemental RI for emerging contaminants.

Key:

COC = contaminant of concern

CG = U.S. Coast Guard

CS = Chemical Spill

CY = Coal Yard

DDOU = Drum Disposal Operable Unit

FS = Fuel Spill

FTA = Fire Training Area

IRP = Installation Restoration Program

MMR = Massachusetts Military Reservation

OU = operable unit

OWS= oil water separator

SD = Storm Drain

Air Force Center for Engineering and the Environment (AFCEE) 2003 (May). Final 2nd Five-Year Review, 1998-2002 Massachusetts Military Reservation (MMR) Superfund Site, Otis Air National Guard Base, MA. Prepared by AFCEE/MMR and Portage Environmental, Inc. for AFCEE/MMR, Installation Restoration Program, Otis ANG Base, MA.

AFCEE 2008 (September). Final 3rd Five-Year Review, 2002-2007 Massachusetts Military Reservation (MMR) Superfund Site, Otis Air National Guard Base, MA. Prepared by Engineering Strategies Corporation, Portage and CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis ANG Base, MA.

AFCEE 2013 (September). Final 4th Five-Year Review, 2007-2012 Massachusetts Military Reservation (MMR) Superfund Site, Otis Air National Guard Base, MA. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis ANG Base, MA.

Table 1-1c
Summary of Future IRP Sites Requiring a Five Year Review
Final 5th Five Year Review, 2012-2017

IRP Source Area Site	Site ID
Sites Identified for the next Five Year Review	
MMRP	
Former Otis Bomb Storage Magazines	MB701
Ordnance Area 1	MB702
Otis Target Butt	ML701
Skeet Range	TS701
Mock Village	MMR-001-R-01
Old Grenade Courts	MMR-003-R-01
Former Ammunition Supply Point - West	MMR-010-R-01
Former Ammunition Supply Point - East	MMR-011-R-01
Old K Range	MMR-004-R-01
Otis Gun Club	MMR-009-R-01
PFAS Sites	
Tanker Truck Rollovers	SS090
ANG Motor Pool Area	SS091
Former Building 118	SS092
Former Fire Department Building 122	SS093
Wastewater Treatment Plant Infiltration Beds	SS094
USCG Hangars 3170 and 3172	SS095
Lower 40 Ramp Area/Helicopter Hangar	SS097
FS-1	SS031
FTA-1 *	FT055

* = Closed for existing COCs. Currently being investigated under a Supplemental RI for emerging contaminants.

Key:

FTA = Fire Training Area

IRP = Installation Restoration Program

MMRP = Military Munitions Response Program

PFAS = per- and polyfluoroalkyl substances

Table 1-2
Decision Summary of Source Area Sites Addressed in this Five-Year Review
Final 5th Five-Year Review, 2012-2017

IRP Number or Site Name	Final Decision Document			ESDs or Amendments?	Remedy Components
	Title	Issue Date	AR #		
CS-10/FS-24 (Details C and F)	Record of Decision Area of Contamination CS-10/FS-24 Source Areas	1999	12435	2003 ESD 2011 ESD	Detail C: Soil Vapor Extraction System Detail F: Institutional Controls
LF-1	Final Record of Decision for the LF-1 Source Area and Groundwater	2007	18664	2013 ESD	Landfill Cap and Institutional Controls
FTA-2/LF-2	Record of Decision for Areas of Contamination FTA-2/LF-2, PFSA/FS-10/FS-11, SD-2/FS-6/FS-8, SD-3/FTA-3/CY-4, and SD-5/FS-5 Source Areas	1998	11609	2016a Amendment	Biosparge Treatment System and Institutional Controls
LF-7	Decision Document Radar Tube Burial Landfill (LF-7 Study Area)	1993	6581	none	Institutional Controls
PFSA (FS-10/FS-11)	Record of Decision for Areas of Contamination FTA-2/LF-2, PFSA/FS-10/FS-11, SD-2/FS-6/FS-8, SD-3/FTA-3/CY-4, and SD-5/FS-5 Source Areas	1998	11609	2016b Amendment	Biosparge Vapor Recover Treatment System and Institutional Controls

Key:

AR = Administrative Record

CS = Chemical Spill

ESD = Explanation of Significant Differences

FS = Fuel Spill

FTA-2 = Fire Training Area 2

IRP = Installation Restoration Program

LF = Landfill

PFSA = Petroleum Fuel Storage Area

SD = Storm Drain

TBD = To Be Determined

UU/UE = unlimited use/unrestricted exposure

2016 Amendment = AFCEC. 2016a (September). *Final Fire Training Area-2/Landfill-2 (FTA-2/LF-2) Record of Decision Amendment*. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

2016 Amendment = AFCEC. 2016b (September). *Final Petroleum Fuel Storage Area (PFSA) Record of Decision Amendment*. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

2013 ESD = AFCEC. 2013 (anticipated July). *Final Explanation of Significant Differences for the Landfill-1 (LF-1) Source Area at the Massachusetts Military Reservation*. 437075-SPEIM-LF1-ESD-001. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

2011 ESD = AFCEE. 2011 (September). *Explanation of Significant Differences Areas of Contamination CS-10/FS-24, FS-1, and FS-9, Massachusetts Military Reservation (MMR) Superfund Site*, Otis Air National Guard Base, MA.

2003 ESD = AFCEE. 2003a (February). *Explanation of Significant Differences Areas of Contamination CS-10 (A, B, & E); CS-16/CS-17; FS-9; SD-2/FS-6/FS-8; and SD-3/FTA-3/CY-4*. Prepared by Portage Environmental Inc. and Engineering Strategies Corporation.

Table 1-3
Decision Summary of Groundwater Sites Addressed in this Five-Year Review
Final 5th Five-Year Review, 2012-2017

Site	Final Decision Document			ESDs or Amendments?	Remedy Components
	Title	Issue Date	AR #		
FTA-2/LF-2	Final Fire Training Area-2/Landfill-2 (FTA-2/LF-2) Record of Decision Amendment	2016	540120	2016 Amendment	LTM, LUCs, MNA, 5YR
PFSA (FS-10/FS-11)	Final Petroleum Fuel Storage Area (PFSA) Record of Decision Amendment	2016	540119	2016 Amendment	LTM, LUCs, MNA, 5YR
Ashumet Valley	Final Record of Decision for the Ashumet Valley Groundwater	2009	18977	2011 ESD	ETI/ETD, SPEIM, LUCs, MNA, 5YR, 3-STEP
CS-4	Final Record of Decision for the CS-4, CS-20, CS-21, and FS 13 Plumes	2000	13425	2008 ESD 2011 ESD	ETI, SPEIM, LUCs, MNA, 5YR, 3-STEP
CS-10	Final CS-10 Explanation of Significant Differences	2014	421436	2014 ESD	LTM, LUCs, MNA, 5YR, 3-STEP
CS-10	Final Record of Decision for Chemical Spill-10 Groundwater	2009	18995	2011 ESD	ETI/ETR, SPEIM, LUCs, MNA, 5YR, 3-STEP
CS-19	Final Chemical Spill-19 Record of Decision	2009	19039	2011 ESD	Final Fire Training Area-2/Landfill-2 (FTA-2/LF-2) Record of Decision Amendment
CS-20	Final Record of Decision for the CS-4, CS-20, CS-21, and FS 13 Plumes	2000	13425	2008 ESD 2011 ESD	ETR, SPEIM, LUCs, MNA, 5YR, 3-STEP
CS-21	Final Record of Decision for the CS-4, CS-20, CS-21, and FS 13 Plumes	2000	13425	2008 ESD 2011 ESD	ETR, SPEIM, LUCs, MNA, 5YR, 3-STEP
CS-23	Final Record of Decision for Chemical Spill-23 Groundwater	2007	18665	2011 ESD	ETI, SPEIM, LUCs, MNA, 5YR, 3-STEP
FS-1	Final Record of Decision Area of Contamination FS-1*	2000	13245	2011 ESD	ETD, SPEIM, LUCs, MNA, 5YR, 3-STEP
FS-12	Final Record of Decision for Fuel Spill-12 Groundwater	2006	18419	2011 ESD	ETR, SPEIM, LUCs, MNA, 5YR, 3-STEP
FS-13	Final Record of Decision for the CS-4, CS-20, CS-21, and FS 13 Plumes	2000	13425	2008 ESD 2011 ESD	LTM, LUCs, MNA, 5YR, 3-STEP
FS-28	Final Record of Decision for the Fuel Spill-28 and Fuel Spill 29 Plumes	2000	13649	2008 ESD 2011 ESD	ETD, SPEIM, LUCs, MNA, 5YR, 3-STEP
FS-29	Final Record of Decision for the Fuel Spill-28 and Fuel Spill 29 Plumes	2000	13649	2008 ESD 2011 ESD	ETI/ETR, SPEIM, LUCs, MNA, 5YR, 3-STEP
LF-1	Final LF-1 Explanation of Significant Differences	2013	421627	2013 ESD	LTM, LUCs, MNA, 5YR, 3-STEP
LF-1	Final Record of Decision for Landfill-1 Source Area and Groundwater	2007	18664	2011 ESD	ETI/ETR, SPEIM, LUCs, MNA, 5YR, 3-STEP
SD-5	Final SD-5 Explanation of Significant Differences	2014	421437	2014 ESD	LTM, LUCs, MNA, 5YR, 3-STEP

Key:

AR = Administrative Record (legacy number at MMR)

CS = Chemical Spill

ESD = Explanation of Significant Differences

FS = Fuel Spill

LF = Landfill

LUC = Land Use Control

MNA = monitored natural attenuation

SD = Storm Drain

SPEIM = system performance and ecological impact monitoring

3-STEP = Three-step process to achieve site closure

5YR = Five-Year Review

2016 Amendment = AFCEC. 2016a (September). *Final Fire Training Area-2/Landfill-2 (FTA-2/LF-2) Record of Decision Amendment*. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

2016 Amendment = AFCEC. 2016b (September). *Final Petroleum Fuel Storage Area (PFSA) Record of Decision Amendment*. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

2014 ESD = AFCEC. 2014 (September). *Explanation of Significant Differences Areas of Contamination SD-5, Joint Base Cape Cod*, Otis Air National Guard Base, MA. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

2014 ESD = AFCEC. 2014 (September). *Explanation of Significant Differences Areas of Contamination CS-10, Joint Base Cape Cod*, Otis Air National Guard Base, MA. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

2013 ESD = AFCEC. 2013 (anticipated July). *Final Explanation of Significant Differences for the Landfill 1 (LF-1) Source Area at the Massachusetts Military Reservation*. 437075-SPEIM-LF1-ESD-001. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

2011 ESD = AFCEE. 2011 (September). *Final Explanation of Significant Differences for the Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation (MMR) Superfund Site*, Otis Air National Guard Base, MA. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

2008 ESD = AFCEE. 2008 (September). *Explanation of Significant Differences Areas of Contamination Chemical Spill-20, Chemical Spill-21, Fuel Spill-13, Fuel Spill-28, and Fuel Spill-29 Groundwater Plumes*. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

Table 1-4
Issue Description and Recommendations/Follow-Up Actions
Final 5th Five-Year Review, 2012-2017

Site Name	Issue Description	Issue Summary	Recommendation/ Follow-Up Actions	Recommendation/Follow-Up Action Summary	Recommended Implementation Date	Recommended Completion Date	Responsible Party
Source Area Sites							
CS-10/FS-24 Detail C and F	LUC/long-term protectiveness	Residual contaminant concentrations remain in soils/sediments.	Reassess soil data for UU/UE.	Complete an assessment of Detail C EPH/VPH data and Detail F PAH, PCB, inorganic data and pursue UU/UE closure. If UU/UE closure cannot be achieved, then document LUC plan in an ESD.	November 2019	November 2020	AFCEC
Groundwater Sites							
Ashumet Valley	Emerging contaminants	Emerging contaminants, specifically 1,4- dioxane and PFAS. For existing COCs, potential loss of plume capture.	Complete Supplemental RI and develop Supplemental FS report; prepare an addendum to this FYR once investigation is complete. Address potential loss of PCE capture by 95EW0703	Follow CERCLA process for emerging contaminants. An addendum to this FYR will need to be developed once the Supplemental RI for ECs is completed, tentatively scheduled for September 2019, depending on investigation results. For existing COCs, evaluate potential loss of plume capture.	NA (already ongoing)	June 2020 (FYR Addendum) 'December 2019 (Evaluate plume)	AFCEC
CS-10	Emerging contaminants	Emerging contaminants, specifically 1,4- dioxane	Prepare an ESD documenting 1,4-dioxane as a COC and develop an LTM Plan	Follow CERCLA process for emerging contaminants	NA (already ongoing)	December 2020	AFCEC
LF-1	Emerging contaminants	Emerging contaminants, specifically 1,4- dioxane and PFAS	Develop a Supplemental FS report (current Milestone of 31 October 2018)	Follow CERCLA process for emerging contaminants	NA (already ongoing)	December 2021	AFCEC
CS-4	Restoration timeframe reassessment	The most recent groundwater estimated restoration timeframe (approximately 2020) is longer than that presented in the ROD (2017).	Reassess aquifer restoration timeframe and present results	Given the plume delineation at the end of 2017, it is not likely that the aquifer restoration timeframe stated in the ROD (i.e. 2017) will be met. The plume should continue to be monitored and the aquifer restoration timeframe should be updated during the next five years. If the aquifer is not restored to an acceptable extent toward the end of the next five year period, discussions should be held with EPA on whether an ESD is necessary to update the restoration timeframe.	May 2019	September 2022	AFCEC
CS-20	Restoration timeframe and emerging contaminants	Plume cleanup is progressing faster than predicted at CS-20 (aquifer restoration date from the ROD is approximately 2030 and most recent modeling prediction was approximately 2024). 1,4-Dioxane identified in plume during sampling but at low concentrations.	Reassess aquifer restoration timeframe and present results	Finalize the Supplemental RI for 1,4-dioxane at CS 20. Plume cleanup is progressing faster than predicted at CS-20 (aquifer restoration date from the ROD is approximately 2030 and most recent modeling prediction was approximately 2024). SPEIM data indicate that cleanup standards (MCLs) have been achieved throughout the majority of the plume and aquifer restoration should be achieved within the next year or two. Begin the Three-Step Process to site closure for the CS-20 plume.	November 2019	September 2022	AFCEC
FS-1	Emerging Contaminants and Restoration timeframe	Plume cleanup is on track and the Three Step Process should proceed when the remedial system is shutdown. PFAS detected at source area groundwater needs to be further addressed.	Reassess aquifer restoration timeframe and present results	The Expanded SI for PFAS should be completed for FS-1. Once the ETD system is shut down and the SPEIM data indicate aquifer restoration has been achieved, the Three-Step Process should be initiated as long as PFAS are not an issue.	November 2019 (expanded SI)	September 2022	AFCEC
FS-28	Restoration timeframe reassessment	The restoration timeframe presented in the ROD (approximately 2018) may not be achieved given a review of the SPEIM data.	Reassess aquifer restoration timeframe and present results	Given the plume delineation at the end of 2017, the plume should continue to be monitored and the aquifer restoration timeframe may need to be updated during the next five years. If the aquifer is not restored to an acceptable extent toward the end of the next five year period, discussions should be held with EPA on whether an ESD is necessary to update the restoration timeframe.	May 2019	September 2022	AFCEC

Key:

AFCEC = Air Force Civil Engineer Center
CS = Chemical Spill
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of
COC = contaminant of concern
EPH = extractable petroleum hydrocarbon
ESD = explanation of significant difference
EPA = Environmental Protection Agency
FS = Fuel Spill; Feasibility Study
LF = Landfill
LUC = Land Use Control
MCL = Maximum Contaminant Level
PAH = polynuclear aromatic hydrocarbon
PFAS = per- and polyfluorinated alkyl substances
PFSA = Petroleum Fuel Storage Area

RAR = remedial action report
RI = remedial investigation
ROD = Record of Decision
SD = Storm Drain
SI = Site Investigation
RAR = remedial action report
ROD = Record of Decision
SD = Storm Drain
VPH = volatile petroleum hydrocarbon
UU/UE = unlimited use/unrestricted exposure

Table 1-5
Summary of Protectiveness Determinations
Final 5th Five-Year Review, 2012-2017

Site Name	Section Number	Summary of Protectiveness Determination
Source Area Sites		
CS-10/FS-24 Detail C and F	4.1	The remedies for CS-10 source area Details C and F are protective of human health and the environment in the short-term under the current land use scenario. The remedy is protective in the short term since access to the site is controlled by a fence that effectively limits potential human exposure. However, for the remedies to be protective in the long-term it is recommended that site characterization data be reevaluated to determine if UU/UE conditions can be met; if UU/UE closure cannot be supported for Details C and/or F, then either (i) conduct additional cleanup activities to levels that allow UU/UE; or (ii) issue a decision document implementing enforceable LUCs preventing uses for which the site may still pose an unacceptable risk under future uses that would ensure long-term protectiveness.
LF-1	4.2	The remedy for the LF-1 source area is protective of human health and the environment in the short-term under the current land use scenario. Groundwater monitoring under the LF-1 SPEIM/LTM program (discussed in Section 5.13) does not indicate the LF-1 source area is acting as a continuing source of groundwater contamination for current COCs and prevents contact with contaminated soil. Therefore, the landfill cap system at LF-1 is operating as expected. In addition, the LUCs are in place and are functioning as intended. For the remedy to be protective in the long-term, additional activities to address ECs in groundwater are needed as discussed in Section 5.13.
FTA-2/LF-2	4.3	The remedy for the FTA-2/LF-2 source area is protective of human health and the environment. Access to the site is controlled by current flight line security measures which include fencing and 24-hour security that effectively limits potential human exposure to site contaminants. A deed restriction has been filed with the real property office.
LF-7	4.4	The remedy for the LF-7 source area is protective of human health and the environment in the short-term under the current land use scenario. The remedy is protective in the short term since access to the site is controlled by a fence that effectively limits potential human exposure and marked with the appropriate warning signs. For long term protectiveness, annual monitoring is being conducted at the site to verify that radioactivity levels remain acceptable. Radiological surveys have been conducted since 1991 and reports are on file at IRP at the JBCC and available on the Administrative Record.
PFSA (FS-10/FS-11)	4.5	The remedy for the PFSA source area is protective of human health and the environment. Access to the site is controlled by current flight line security measures which include fencing and 24-hour security that effectively limits potential human exposure to site contaminants.
Groundwater Sites		
AV	5.1	The remedy for the AV groundwater plume is protective of human health and the environment for the COCs in the short-term; however, overall site protectiveness for the AV groundwater plume is being deferred due to the presence of the ECs PFAS and 1,4-dioxane. The LUCs are in place and are functioning as intended for the COCs. Through the combination of the active treatment by the remedial system and natural attenuation processes, existing groundwater cleanup levels for the COCs are expected to be achieved within the timeframe approximated in the ROD, however, there is a potential loss of plume capture near extraction well 95EW0703 indicated by increasing PCE concentrations in a nearby monitoring well. In order for the remedy to be protective in the long-term for existing COCs, this potential issue needs to be evaluated. For ECs, particularly PFOS and PFOA, the Supplemental RI is ongoing and outreach activities are continuing to identify private wells that might be impacted by the PFOS and PFOA emanating from the JBCC. Mitigation activities including providing bottled water, filtration systems, and/or municipal water connections are being implemented for impacted drinking water supplies. In addition, there are plans to install wellhead treatment on the Mashpee Village Public Water Supply Well which has also been impacted by PFOS and PFOA from JBCC. Because there have been documented exposures, necessary mitigations, a potential for additional impacted water supplies, and LUCs have not been implemented, an overall protectiveness determination cannot be made for this site. Additional information is being collected through a Supplemental RI, tentatively scheduled for completion in September 2019 but dependent upon results obtained during the investigation, and is expected to be followed by an eventual ROD Amendment and development of a LUC area for ECs. Upon completion of the Supplemental RI, a Five-Year Review Addendum will be completed and a protectiveness determination will be made.

Table 1-5
Summary of Protectiveness Determinations
Final 5th Five-Year Review, 2012-2017

Site Name	Section Number	Summary of Protectiveness Determination
CS-4	5.2	The remedy for the CS-4 groundwater plume is protective of human health and the environment in the short-term. The LUCs are in place and are functioning as intended. Current plume delineation indicates that the aquifer restoration timeframe identified in the ROD may not be met. For the remedy to be protective in the long-term, the aquifer restoration timeframe should be reassessed and an ESD issued, if necessary, to update the timeframe.
CS-10	5.3	The remedy for the CS-10 groundwater plume is protective of human health and the environment in the short-term. The remedial system is performing as expected and the LUCs are in place and are functioning as intended for current COCs and there are no current plans to use the portion of the aquifer where CS-10 contamination is located for water supply. Through the combination of the active treatment by the remedial systems and natural attenuation processes, existing groundwater cleanup levels are expected to be achieved. For the remedy to be protective in the long-term, an ESD should be issued and remedial actions implemented, as necessary, to address ECs.
CS-19	5.4	The remedy for the CS-19 groundwater plume is protective of human health and the environment. Remediation is progressing as expected. The LUCs are in place and are functioning as intended. Through natural attenuation processes groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.
CS-20	5.5	The remedy for the CS-20 groundwater plume is protective of human health and the environment in the short-term. The remedial system has performed as expected for existing COCs. Through the combination of the active treatment by the remedial system and natural attenuation processes, existing groundwater cleanup levels may be met earlier than the timeframe approximated in the ROD. The LUCs are in place and are functioning as intended. For the remedy to be protective in the long-term, the Supplemental RI for 1,4-dioxane should be finalized.
CS-21	5.6	The remedy for the CS-21 groundwater plume is protective of human health and the environment. The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.
CS-23	5.7	The remedy for the CS-23 groundwater plume is protective of human health and the environment. The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.
FS-1	5.8	The remedy for the FS-1 groundwater plume is protective of human health and the environment in the short-term. The remedial system is performing as expected for the current COCs. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, existing groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD, and revised in the Wellfield Design Report, which was considered reasonable given the particular circumstances of the site. For the remedy to be protective in the long-term, the expanded SI for PFAS should be completed.
FS-12	5.9	The remedy for the FS-12 groundwater plume is protective of human health and the environment. The remedial system is performing as expected and the LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved. Since the LUCs are in place and are functioning as intended to prevent exposure and there are no current plans to use the portion of the aquifer where FS-12 contamination remains for water supply, the remedy remains protective.
FS-13	5.10	The remedy for the FS-13 groundwater plume is protective of human health and the environment. Remediation is progressing as expected. The LUCs are in place and are functioning as intended. Through natural attenuation processes, groundwater cleanup levels are expected to be reached over time and monitoring data indicate the contaminants are not migrating beyond the FS-13 area.
FS-28	5.11	The remedy for the FS-28 groundwater plume is protective of human health and the environment in the short-term. The LUCs are in place and are functioning as intended. Current plume delineation indicates that the aquifer restoration timeframe identified in the ROD may not be met. For the remedy to be protective in the long-term, the aquifer restoration timeframe should be reassessed and an ESD issued, if necessary, to update the timeframe.

Table 1-5
Summary of Protectiveness Determinations
Final 5th Five-Year Review, 2012-2017

Site Name	Section Number	Summary of Protectiveness Determination
FS-29	5.12	The remedy for the FS-29 groundwater plume is protective of human health and the environment. The remedial system performed for a shorter time than expected. The LUCs are in place and are functioning as intended. Groundwater cleanup has been achieved through active treatment and natural attenuation processes within the timeframe approximated in the ROD and the steps to achieve site closure are underway.
LF-1	5.13	The remedy for the LF-1 groundwater plume is protective of human health and the environment in the short-term. The remedial system is performing as expected and the LUCs are in place and are functioning as intended for current COCs. Through the combination of the active treatment by the remedial systems and natural attenuation processes, existing groundwater cleanup levels are expected to be achieved. Since the LUCs are in place and are functioning as intended to prevent exposure and there are no current plans to use the portion of the aquifer where LF-1 contamination remains for water supply, the remedy remains protective for current COCs. For the remedy to be protective in the long-term, a streamlined Supplemental FS should be completed that evaluates remedial alternatives for groundwater to address ECs, and remedial actions taken as necessary.
SD-5	5.14	The remedy for the SD-5 groundwater plume is protective of human health and the environment. The LTM program is ongoing and the LUCs are in place and are functioning as intended. Through pre-ROD operation of the SD-5 remedial system and natural attenuation processes, groundwater cleanup levels have been achieved at SD-5N and are expected to be achieved at SD-5S. Since the LUCs are in place and are functioning as intended and there are no current plans to use this portion of the aquifer for water supply, the remedy remains protective.
FTA-2/LF-2	5.15	The remedy for the FTA-2/LF-2 is protective of human health and the environment. The LTM program is in place and is being conducted to monitor remedial progress and the LUCs are in place and are functioning as intended.
PFSA	5.16	The remedy for the PFSA groundwater is protective of human health and the environment. The LTM program is in place and is being conducted to monitor remedial progress and the LUCs are in place and are functioning as intended.

Key:

AV = Ashumet Valley
CS = Chemical Spill
COC = contaminant of concern
CSM = conceptual site model
CY = Coal Yard
EC= emerging contaminants
FS = Fuel Spill
FTA = Fire Training Area
LF = Landfill
LTM = long term monitoring

LUC = Land Use Control
PFSA = Petroleum Fuels Storage Area
PFOA = Perfluorooctanoic Acid
PFOS = Perfluorooctance Sulfonic Acid
RAL = remedial action level
RAO = remedial action objective
ROD = Record of Decision
SD = Storm Drain
SPEIM = System Performance and Ecological Impact Monitoring
UU/UE = unlimited use and unrestricted exposure

Table 1-6
EPA CERCLIS Operable Unit Number and Document Section
Final 5th Five-Year Review, 2012-2017

OU#	Site Name	Document Section
1	FS-12	5.9
2	CS-4	5.2
3	CS-3 (USCG)	NA
4	CS-1 (USCG)	NA
5	FTA-2/LF-2, PFSA/FS-10/FS-11	4.3, 4.5, 5.15, 5.16
6	FS-1	5.8
7	LF-1 Landfill Cap	4.2
8	CS-10 Source Area	4.1
9	Southwest Operable Unit	5.2, 5.5, 5.6
10	FS-9	NA
11	CS-16/CS-17	NA
12	FS-17/FS-19	NA
13	SD-5 North	5.14
14	CS-10 Sandwich Road	5.3
15	Ashumet Valley Groundwater	5.1
16	LF-1 Groundwater	5.13
17	Eastern Briarwood	NA
18	Western Aquafarm	NA
19	FS-28 & FS-29	5.11 & 5.12
20	SD-5 South	5.14
21	CS-10 In-Plume	5.3
22	CS-10 Southwest	5.3
23	FS-2	NA
24	CS-19	5.4
25	CS-23	5.7

Key:

CERCLIS = Comprehensive Environmental Response, Compensation, and Liability Information System

CS = Chemical Spill

CY = Coal Yard

EPA = U.S. Environmental Protection Agency

FS = Fuel Spill

FTA = Fire Training Area

LF = Landfill

NA = Not applicable – Five Year Review not needed since site meets unrestricted use/unlimited exposure –
(See Table 1-1b).

OU = Operable Unit

PFSA = Petroleum Fuel Storage Area

SD = Storm Drain

USCG = U.S. Coast Guard

Table 3-1
Summary of Site Inspections
Final 5th Five-Year Review, 2012-2017

IRP Source Area Site	Issues	Schedule for Corrective Actions	Responsible Party	Does Issue Affect Remedy Protectiveness?
CS-10	None	N/A	N/A	No
FTA-2/LF-2	None	N/A	N/A	No
LF-1	None	N/A	N/A	No
LF-7	None	N/A	N/A	No
PFSA	None	N/A	N/A	No

Key:

FTA = Fire Training Area

LF = Landfill

N/A = not applicable

PFSA = Petroleum Fuel Storage Area

SD = Storm Drain

APPENDICES

APPENDIX A

PUBLIC NOTICE

2012-2017 Five Year Review underway for the Installation Restoration Program (IRP) at Joint Base Cape Cod (JBCC)

The Air Force Civil Engineer Center (AFCEC) manages the IRP which is charged with investigating and cleaning up hazardous waste conditions at the base. A draft Five Year Review (FYR) has been prepared and was submitted on June 4, 2018 to the U.S. Environmental Protection Agency and Massachusetts Department of Environmental Protection.

The draft FYR (for 2012-2017) is the fifth review and documents all of the cleanup actions at source areas and groundwater plumes, and evaluates their status in terms of effectiveness and the protection of public health and the environment. The majority of contaminants are chlorinated solvents and fuel constituents.

An overview on the FYR will be given at a future meeting of the JBCC Cleanup Team which is an advisory committee to the Air Force and Army. Team meetings are open to the public and announced in the Upper Cape Enterprise Newspapers.

The FYR is expected to be finalized in September 2018. A copy of the final FYR will be placed in the main Upper Cape libraries and will be available on AFCEC's administrative record located at:

<http://afcec.publicadmin-record.us.af.mil/Search.aspx>

A fact sheet summarizing the FYR will be produced and issued to the libraries and administrative record. Availability of the final Review and fact sheet will be announced at a later date.

For more information please contact Doug Karson
(508) 968-4678, ext. 2

APPENDIX B

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: Chemical Spill-10 Source Area	Date of inspection: 6/14/17
Location and Region: Eastern boundary of MMR	EPA ID: MA2570024487
Agency, office, or company leading the five-year review: AFCEC	Weather/temperature: sunny, clear, 70s
Remedy Includes: (Check all that apply) ☐ Landfill cover/containment ☐ Access controls ☐ Institutional controls ☐ Groundwater pump and treatment ☐ Surface water collection and treatment ☐ Other - Not Applicable ☐ Monitored natural attenuation ☐ Groundwater containment ☐ Vertical barrier walls	
Attachments: ☐ Inspection team roster attached ☐ Site map attached See Figure 4-1	
II. INTERVIEWS Not conducted since no ongoing O&M (See Section 3.6)	
1. O&M site manager _____ Name Title Date Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _____ Problems, suggestions; ☐ Report attached ☐ _____ _____	
2. O&M staff _____ Name Title Date Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _____ Problems, suggestions; ☐ Report attached _____ _____	

3.	Local regulatory authorities and response agencies (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.			
	Agency _____			
	Contact _____			
	Name	Title	Date	Phone no.
	Problems; suggestions; ☐ Report attached _____			

	Agency _____			
	Contact _____			
	Name	Title	Date	Phone no.
	Problems; suggestions; ☐ Report attached _____			

	Agency _____			
	Contact _____			
	Name	Title	Date	Phone no.
	Problems; suggestions; ☐ Report attached _____			

	Agency _____			
	Contact _____			
	Name	Title	Date	Phone no.
	Problems; suggestions; ☐ Report attached _____			

4.	Other interviews (optional) ☐ Report attached.			
	none			

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	O&M Documents ☐ O&M manual ☐ As-built drawings ☐ Maintenance logs Remarks_____	☐ Readily available ☐ Readily available ☐ Readily available	☐ Up to date ☐ Up to date ☐ Up to date	x N/A x N/A x N/A
2.	Site-Specific Health and Safety Plan ☐ Contingency plan/emergency response plan Remarks_____	x Readily available x Readily available	x Up to date x Up to date	☐ N/A ☐ N/A
3.	O&M and OSHA Training Records Remarks_____	☐ Readily available	☐ Up to date	x N/A
4.	Permits and Service Agreements ☐ Air discharge permit ☐ Effluent discharge ☐ Waste disposal, POTW ☐ Other permits_____ Remarks_____	☐ Readily available ☐ Readily available ☐ Readily available ☐ Readily available	☐ Up to date ☐ Up to date ☐ Up to date ☐ Up to date	x N/A x N/A x N/A x N/A
5.	Gas Generation Records Remarks_____	☐ Readily available	☐ Up to date	x N/A
6.	Settlement Monument Records Remarks_____	☐ Readily available	☐ Up to date	x N/A
7.	Groundwater Monitoring Records Remarks_____	☐ Readily available	☐ Up to date	x N/A
8.	Leachate Extraction Records Remarks_____	☐ Readily available	☐ Up to date	x N/A
9.	Discharge Compliance Records ☐ Air ☐ Water (effluent) Remarks_____	☐ Readily available ☐ Readily available	☐ Up to date ☐ Up to date	x N/A x N/A
10.	Daily Access/Security Logs Remarks_____	☐ Readily available	☐ Up to date	x N/A

IV. O&M COSTS Not Applicable																																																													
1.	O&M Organization ☐ State in-house ☐ Contractor for State ☐ PRP in-house ☐ Contractor for PRP ☐ Federal Facility in-house ☐ Contractor for Federal Facility ☐ Other _____ _____ _____																																																												
2.	O&M Cost Records ☐ Readily available ☐ Up to date ☐ Funding mechanism/agreement in place Original O&M cost estimate _____ ☐ Breakdown attached Total annual cost by year for review period if available <table style="width: 100%; border: none;"> <tr> <td style="width: 20%;">From _____</td> <td style="width: 10%;">To _____</td> <td style="width: 20%;"></td> <td style="width: 10%;"></td> <td style="width: 10%;"></td> <td style="width: 25%;">☐ Breakdown attached</td> </tr> <tr> <td style="text-align: center;">Date</td> <td style="text-align: center;">Date</td> <td style="text-align: center;">Total cost</td> <td colspan="3"></td> </tr> <tr> <td>From _____</td> <td>To _____</td> <td></td> <td></td> <td></td> <td>☐ Breakdown attached</td> </tr> <tr> <td style="text-align: center;">Date</td> <td style="text-align: center;">Date</td> <td style="text-align: center;">Total cost</td> <td colspan="3"></td> </tr> <tr> <td>From _____</td> <td>To _____</td> <td></td> <td></td> <td></td> <td>☐ Breakdown attached</td> </tr> <tr> <td style="text-align: center;">Date</td> <td style="text-align: center;">Date</td> <td style="text-align: center;">Total cost</td> <td colspan="3"></td> </tr> <tr> <td>From _____</td> <td>To _____</td> <td></td> <td></td> <td></td> <td>☐ Breakdown attached</td> </tr> <tr> <td style="text-align: center;">Date</td> <td style="text-align: center;">Date</td> <td style="text-align: center;">Total cost</td> <td colspan="3"></td> </tr> <tr> <td>From _____</td> <td>To _____</td> <td></td> <td></td> <td></td> <td>☐ Breakdown attached</td> </tr> <tr> <td style="text-align: center;">Date</td> <td style="text-align: center;">Date</td> <td style="text-align: center;">Total cost</td> <td colspan="3"></td> </tr> </table>	From _____	To _____				☐ Breakdown attached	Date	Date	Total cost				From _____	To _____				☐ Breakdown attached	Date	Date	Total cost				From _____	To _____				☐ Breakdown attached	Date	Date	Total cost				From _____	To _____				☐ Breakdown attached	Date	Date	Total cost				From _____	To _____				☐ Breakdown attached	Date	Date	Total cost			
From _____	To _____				☐ Breakdown attached																																																								
Date	Date	Total cost																																																											
From _____	To _____				☐ Breakdown attached																																																								
Date	Date	Total cost																																																											
From _____	To _____				☐ Breakdown attached																																																								
Date	Date	Total cost																																																											
From _____	To _____				☐ Breakdown attached																																																								
Date	Date	Total cost																																																											
From _____	To _____				☐ Breakdown attached																																																								
Date	Date	Total cost																																																											
3.	Unanticipated or Unusually High O&M Costs During Review Period Describe costs and reasons: _____ _____ _____ _____ _____ _____																																																												
V. ACCESS AND INSTITUTIONAL CONTROLS ☐ Applicable x N/A																																																													
A. Fencing																																																													
1.	Fencing damaged ☐ Location shown on site map ☐ Gates secured ☐ N/A Remarks _____ _____ _____																																																												
B. Other Access Restrictions																																																													
1.	Signs and other security measures ☐ Location shown on site map ☐ N/A Remarks _____ _____ _____																																																												

C. Institutional Controls (ICs)			
1.	Implementation and enforcement Site conditions imply ICs not properly implemented ☐ Yes ☐ No ☐ N/A Site conditions imply ICs not being fully enforced ☐ Yes ☐ No ☐ N/A Type of monitoring (<i>e.g.</i> , self-reporting, drive by) _____ Frequency _____ Responsible party/agency _____ Contact _____ Name Title Date Phone no. Reporting is up-to-date ☐ Yes ☐ No ☐ N/A Reports are verified by the lead agency ☐ Yes ☐ No ☐ N/A Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ☐ N/A Violations have been reported ☐ Yes ☐ No ☐ N/A Other problems or suggestions: ☐ Report attached _____ _____ _____ _____		
2.	Adequacy ☐ ICs are adequate ☐ ICs are inadequate ☐ N/A Remarks _____ _____ _____		
D. General			
1.	Vandalism/trespassing ☐ Location shown on site map ☐ No vandalism evident Remarks _____ _____		
2.	Land use changes on site ☐ N/A Remarks _____ _____		
3.	Land use changes off site ☐ N/A Remarks _____ _____		
VI. GENERAL SITE CONDITIONS			
A. Roads x Applicable ☐ N/A			
1.	Roads damaged ☐ Location shown on site map x Roads adequate ☐ N/A Remarks _____ _____		

B. Other Site Conditions			
Remarks _____ _____ _____ _____ _____			
VII. LANDFILL COVERS ☐ Applicable ☒ N/A			
A. Landfill Surface			
1.	Settlement (Low spots) Areal extent _____ Remarks _____	☐ Location shown on site map Depth _____	☐ Settlement not evident
2.	Cracks Lengths _____ Widths _____ Depths _____ Remarks _____	☐ Location shown on site map	☐ Cracking not evident
3.	Erosion Areal extent _____ Remarks _____	☐ Location shown on site map Depth _____	☐ Erosion not evident
4.	Holes Areal extent _____ Remarks _____	☐ Location shown on site map Depth _____	☐ Holes not evident
5.	Vegetative Cover ☐ Grass ☐ Cover properly established ☐ No signs of stress ☐ Trees/Shrubs (indicate size and locations on a diagram) Remarks _____		
6.	Alternative Cover (armored rock, concrete, etc.) ☐ N/A Remarks _____		
7.	Bulges Areal extent _____ Remarks _____	☐ Location shown on site map Height _____	☐ Bulges not evident

8.	Wet Areas/Water Damage ☐ Wet areas ☐ Ponding ☐ Seeps ☐ Soft subgrade Remarks_____	☐ Wet areas/water damage not evident ☐ Location shown on site map Areal extent_____ ☐ Location shown on site map Areal extent_____ ☐ Location shown on site map Areal extent_____ ☐ Location shown on site map Areal extent_____
9.	Slope Instability ☐ Slides ☐ Location shown on site map ☐ No evidence of slope instability Areal extent_____ Remarks_____	
B. Benches ☐ Applicable ☐ N/A (Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)		
1.	Flows Bypass Bench Remarks_____	☐ Location shown on site map ☐ N/A or okay
2.	Bench Breached Remarks_____	☐ Location shown on site map ☐ N/A or okay
3.	Bench Overtopped Remarks_____	☐ Location shown on site map ☐ N/A or okay
C. Letdown Channels ☐ Applicable ☐ N/A (Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)		
1.	Settlement Areal extent_____ Depth_____ Remarks_____	☐ Location shown on site map ☐ No evidence of settlement
2.	Material Degradation ☐ Location shown on site map ☐ No evidence of degradation Material type_____ Areal extent_____ Remarks_____	
3.	Erosion Areal extent_____ Depth_____ Remarks_____	☐ Location shown on site map ☐ No evidence of erosion

4.	Undercutting	☐ Location shown on site map	☐ No evidence of undercutting
	Areal extent_____	Depth_____	
	Remarks_____		

5.	Obstructions	Type_____	☐ No obstructions
	☐ Location shown on site map	Areal extent_____	
	Size_____		
	Remarks_____		

6.	Excessive Vegetative Growth	Type_____	
	☐ No evidence of excessive growth		
	☐ Vegetation in channels does not obstruct flow		
	☐ Location shown on site map	Areal extent_____	
	Remarks_____		

D. Cover Penetrations ☐ Applicable ☐ N/A			
1.	Gas Vents	☐ Active ☐ Passive	
	☐ Properly secured/locked	☐ Functioning	☐ Routinely sampled
	☐ Evidence of leakage at penetration	☐ Needs Maintenance	☐ Good condition
	☐ N/A		
	Remarks_____		

2.	Gas Monitoring Probes	☐ Properly secured/locked ☐ Functioning	☐ Routinely sampled
	☐ Evidence of leakage at penetration	☐ Needs Maintenance	☐ Good condition
			☐ N/A
	Remarks_____		

3.	Monitoring Wells (within surface area of landfill)	☐ Properly secured/locked ☐ Functioning	☐ Routinely sampled
	☐ Evidence of leakage at penetration	☐ Needs Maintenance	☐ Good condition
			☐ N/A
	Remarks_____		

4.	Leachate Extraction Wells	☐ Properly secured/locked ☐ Functioning	☐ Routinely sampled
	☐ Evidence of leakage at penetration	☐ Needs Maintenance	☐ Good condition
			☐ N/A
	Remarks_____		

5.	Settlement Monuments	☐ Located	☐ Routinely surveyed
	☐ N/A		
	Remarks_____		

E. Gas Collection and Treatment			☐ Applicable	☐ N/A
1.	Gas Treatment Facilities ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse ☐ Good condition ☐ Needs Maintenance Remarks _____ _____			
2.	Gas Collection Wells, Manifolds and Piping ☐ Good condition ☐ Needs Maintenance Remarks _____ _____			
3.	Gas Monitoring Facilities (<i>e.g.</i> , gas monitoring of adjacent homes or buildings) ☐ Good condition ☐ Needs Maintenance ☐ N/A Remarks _____ _____			
F. Cover Drainage Layer			☐ Applicable	☐ N/A
1.	Outlet Pipes Inspected ☐ Functioning ☐ N/A Remarks _____ _____			
2.	Outlet Rock Inspected ☐ Functioning ☐ N/A Remarks _____ _____			
G. Detention/Sedimentation Ponds			☐ Applicable	☐ N/A
1.	Siltation Areal extent _____ Depth _____ ☐ N/A ☐ Siltation not evident Remarks _____ _____			
2.	Erosion Areal extent _____ Depth _____ ☐ Erosion not evident Remarks _____ _____			
3.	Outlet Works ☐ Functioning ☐ N/A Remarks _____ _____			
4.	Dam ☐ Functioning ☐ N/A Remarks _____ _____			

H. Retaining Walls		☐ Applicable	☐ N/A
1.	Deformations	☐ Location shown on site map	☐ Deformation not evident
	Horizontal displacement_____	Vertical displacement_____	
	Rotational displacement_____		
	Remarks_____		
2.	Degradation	☐ Location shown on site map	☐ Degradation not evident
	Remarks_____		
I. Perimeter Ditches/Off-Site Discharge		☐ Applicable	☐ N/A
1.	Siltation	☐ Location shown on site map	☐ Siltation not evident
	Areal extent_____	Depth_____	
	Remarks_____		
2.	Vegetative Growth	☐ Location shown on site map	☐ N/A
	☐ Vegetation does not impede flow		
	Areal extent_____	Type_____	
	Remarks_____		
3.	Erosion	☐ Location shown on site map	☐ Erosion not evident
	Areal extent_____	Depth_____	
	Remarks_____		
4.	Discharge Structure	☐ Functioning	☐ N/A
	Remarks_____		
VIII. VERTICAL BARRIER WALLS			
		☐ Applicable	☒ N/A
1.	Settlement	☐ Location shown on site map	☐ Settlement not evident
	Areal extent_____	Depth_____	
	Remarks_____		
2.	Performance Monitoring	Type of monitoring_____	
	☐ Performance not monitored		
	Frequency_____	☐ Evidence of breaching	
	Head differential_____		
	Remarks_____		

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable ☒ N/A	
A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☐ N/A	
1.	Pumps, Wellhead Plumbing, and Electrical ☐ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A Remarks _____ _____ _____
2.	Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances ☐ Good condition ☐ Needs Maintenance Remarks _____ _____
3.	Spare Parts and Equipment ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks _____ _____
B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☐ N/A	
1.	Collection Structures, Pumps, and Electrical ☐ Good condition ☐ Needs Maintenance Remarks _____ _____
2.	Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances ☐ Good condition ☐ Needs Maintenance Remarks _____ _____
3.	Spare Parts and Equipment ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks _____ _____

C. Treatment System ☐ Applicable ☐ N/A			
1.	Treatment Train (Check components that apply) ☐ Metals removal ☐ Oil/water separation ☐ Bioremediation ☐ Air stripping ☐ Carbon adsorbers ☐ Filters _____ ☐ Additive (<i>e.g.</i> , chelation agent, flocculent) _____ ☐ Others _____ ☐ Good condition ☐ Needs Maintenance ☐ Sampling ports properly marked and functional ☐ Sampling/maintenance log displayed and up to date ☐ Equipment properly identified ☐ Quantity of groundwater treated annually _____ ☐ Quantity of surface water treated annually _____ Remarks _____ _____		
2.	Electrical Enclosures and Panels (properly rated and functional) ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks _____ _____		
3.	Tanks, Vaults, Storage Vessels ☐ N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs Maintenance Remarks _____ _____		
4.	Discharge Structure and Appurtenances ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks _____ _____		
5.	Treatment Building(s) ☐ N/A ☐ Good condition (<i>esp.</i> roof and doorways) ☐ Needs repair ☐ Chemicals and equipment properly stored Remarks _____ _____		
6.	Monitoring Wells (pump and treatment remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks _____ _____		
D. Monitoring Data			
1.	Monitoring Data ☐ Is routinely submitted on time ☐ Is of acceptable quality		
2.	Monitoring data suggests: ☐ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining		

D. Monitored Natural Attenuation			
1.	Monitoring Wells (natural attenuation remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks _____ _____		
X. OTHER REMEDIES			
If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.			
XI. OVERALL OBSERVATIONS			
A. Implementation of the Remedy			
Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). Former SVE system for CS-10 Detail C now removed, no active treatment for CS-10 Detail F			
B. Adequacy of O&M			
Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. Not Applicable			
C. Early Indicators of Potential Remedy Problems			
Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. None			
D. Opportunities for Optimization			
Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. None			

CS-10 Photo 1: CS-10 Detail C



CS-10 Photo 2: CS-10 Detail C



CS-10 Photo 3: CS-10 Detail F
(wetland located in depression behind guardrail)



Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: Landfill-1 Source Area	Date of inspection: 6/14/17
Location and Region: Southern portion of MMR and is bounded by Turpentine Road to the east, Frank Perkins Road to the west, Herbert Road to the north, and Connery Avenue to the south	EPA ID: MA2570024487
Agency, office, or company leading the five-year review: AFCEC	Weather/temperature: Sunny, clear, 70's
Remedy Includes: (Check all that apply)	
☒ Landfill cover/containment ☐ Access controls ☒ Institutional controls ☐ Groundwater pump and treatment ☐ Surface water collection and treatment ☒ Other: Fence and Annual Inspections ☐ Monitored natural attenuation ☐ Groundwater containment ☐ Vertical barrier walls	
Attachments: ☐ Inspection team roster attached ☐ Site map attached See Figure 4-2	
II. INTERVIEWS Not conducted since no ongoing O&M (See Section 3.6)	
1. O&M site manager _____	
Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _____ Problems, suggestions; ☐ Report attached ☐ _____ _____	Name Title Date
2. O&M staff _____	
Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _____ Problems, suggestions; ☐ Report attached _____ _____	Name Title Date

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency _____
 Contact _____

Name	Title	Date	Phone no.
Problems; suggestions; ☐ Report attached _____			

Agency _____
 Contact _____
 Name _____ Title _____ Date _____ Phone no. _____
 Problems; suggestions; ☐ Report attached _____

Agency _____
 Contact _____
 Name _____ Title _____ Date _____ Phone no. _____
 Problems; suggestions; ☐ Report attached _____

Agency _____
 Contact _____
 Name _____ Title _____ Date _____ Phone no. _____
 Problems; suggestions; ☐ Report attached _____

4. **Other interviews** (optional) ☐ Report attached.

None

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	O&M Documents ☐ O&M manual ☐ As-built drawings ☐ Maintenance logs Remarks_____	☐ Readily available ☐ Readily available ☐ Readily available	☐ Up to date ☐ Up to date ☐ Up to date	x N/A x N/A x N/A
2.	Site-Specific Health and Safety Plan ☐ Contingency plan/emergency response plan Remarks_____	x Readily available x Readily available	x Up to date x Up to date	☐ N/A ☐ N/A
3.	O&M and OSHA Training Records Remarks_____	☐ Readily available	☐ Up to date	x N/A
4.	Permits and Service Agreements ☐ Air discharge permit ☐ Effluent discharge ☐ Waste disposal, POTW ☐ Other permits_____ Remarks_____	☐ Readily available ☐ Readily available ☐ Readily available ☐ Readily available	☐ Up to date ☐ Up to date ☐ Up to date ☐ Up to date	x N/A x N/A x N/A x N/A
5.	Gas Generation Records Remarks_____	x Readily available	☐ Up to date	x N/A
6.	Settlement Monument Records Remarks_____	x Readily available	☐ Up to date	x N/A
7.	Groundwater Monitoring Records Remarks_____	x Readily available	☐ Up to date	x N/A
8.	Leachate Extraction Records Remarks_____	☐ Readily available	☐ Up to date	x N/A
9.	Discharge Compliance Records ☐ Air ☐ Water (effluent) Remarks_____	☐ Readily available ☐ Readily available	☐ Up to date ☐ Up to date	x N/A x N/A
10.	Daily Access/Security Logs Remarks_____	☐ Readily available	☐ Up to date	x N/A

IV. O&M COSTS: Not Applicable

1.	O&M Organization
----	-----------------------------

- | | |
|--|--|
| ☐ State in-house | ☐ Contractor for State |
| ☐ PRP in-house | ☐ Contractor for PRP |
| ☐ Federal Facility in-house | ☐ Contractor for Federal Facility |
| ☐ Other _____ | |

2.	O&M Cost Records
----	-----------------------------

- ☐ Readily available ☐ Up to date
☐ Funding mechanism/agreement in place
 Original O&M cost estimate_____ ☐ Breakdown attached

Total annual cost by year for review period if available	
--	--

From _____ To _____ _____ ☐ Breakdown attached
Date Date Total cost

From _____ To _____ _____ ☐ Breakdown attached
Date Date Total cost

From _____ To _____ _____ ☐ Breakdown attached
Date Date Total cost

From _____ To _____ _____ ☐ Breakdown attached
Date Date Total cost

From _____ To _____ _____ ☐ Breakdown attached
Date Date Total cost

3. Unanticipated or Unusually High O&M Costs During Review Period

Describe costs and reasons:

V. ACCESS AND INSTITUTIONAL CONTROLS x Applicable ☐ N/A	
---	--

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☒ Gates secured ☐ N/A

1. **Fencing damaged** ☐ Location shown on site map ☒ Gates secured ☐ N/A

Remarks: **Fence in good condition (see photo #1)**

B. Other Access Restrictions

1.	Signs and other security measures	☐ Location shown on site map	☐ N/A
----	--	---	------------------------------

- | | | | |
|----|--|---|------------------------------|
| 1. | Signs and other security measures | ☐ Location shown on site map | ☐ N/A |
|----|--|---|------------------------------|

Remarks: **Signs in place (see photo #2)**

C. Institutional Controls (ICs)			
1.	Implementation and enforcement		
	Site conditions imply ICs not properly implemented	☐ Yes ☒ No	☐ N/A
	Site conditions imply ICs not being fully enforced	☐ Yes ☒ No	☐ N/A
	Type of monitoring (<i>e.g.</i> , self-reporting, drive by): Post-closure monitoring activities include Landfill Cap Inspections, Settlement Surveys, Topographic Surveys		
	Frequency: Semiannual Gas Vent Monitoring, Annual Landfill Cap Inspections and Settlement Surveys, Topo surveys every 5 years.		
	Responsible party/agency AFCEC		
	Contact Rose Forbes	AFCEC PM	6/14/17 (508) 968-4670 (ext 5613)
	Name	Title	Date Phone no.
	Reporting is up-to-date	☒ Yes ☐ No	☐ N/A
	Reports are verified by the lead agency	☒ Yes ☐ No	☐ N/A
	Specific requirements in deed or decision documents have been met	☒ Yes ☐ No	☐ N/A
	Violations have been reported	☐ Yes ☐ No	☒ N/A
	Other problems or suggestions: ☐ Report attached		
	Landfill Monitoring Results are provided to the regulatory agencies annually in LF-1/CS-23 Summary Letter Reports		
2.	Adequacy	☒ ICs are adequate	☐ ICs are inadequate ☐ N/A
	Remarks _____		

D. General			
1.	Vandalism/trespassing	☐ Location shown on site map	☒ No vandalism evident
	Remarks _____		

2.	Land use changes on site	☐ N/A	
	Remarks: None		

3.	Land use changes off site	☒ N/A	
	Remarks _____		

VI. GENERAL SITE CONDITIONS			
A. Roads ☒ Applicable ☐ N/A			
1.	Roads damaged	☐ Location shown on site map	☒ Roads adequate ☐ N/A
	Remarks _____		

B. Other Site Conditions			
Remarks ___None_____			

VII. LANDFILL COVERS ☒ Applicable ☐ N/A			
A. Landfill Surface LF-1 landfill cap photos attached (photos #2-5)			
1.	Settlement (Low spots) Areal extent_____	☐ Location shown on site map ☒ Settlement not evident Depth_____	Remarks_____
2.	Cracks Lengths_____	☐ Location shown on site map ☒ Cracking not evident Widths_____ Depths_____	Remarks_____
3.	Erosion Areal extent_____	☐ Location shown on site map ☐ Erosion not evident Depth_____	Remarks Minor erosion rills were repaired with hand tools during this 5-year review period
4.	Holes Areal extent_____	☐ Location shown on site map ☒ Holes not evident Depth_____	Remarks_____
5.	Vegetative Cover ☒ Grass ☐ Cover properly established ☐ No signs of stress ☐ Trees/Shrubs (indicate size and locations on a diagram)	Remarks: Grass is mowed annually as required by post-closure monitoring plan	
6.	Alternative Cover (armored rock, concrete, etc.) ☒ N/A	Remarks_____	
7.	Bulges Areal extent_____	☐ Location shown on site map ☒ Bulges not evident Height_____	Remarks_____

8.	Wet Areas/Water Damage ☐ Wet areas ☐ Ponding ☐ Seeps ☐ Soft subgrade Remarks _____	☒ Wet areas/water damage not evident ☐ Location shown on site map Areal extent _____ ☐ Location shown on site map Areal extent _____ ☐ Location shown on site map Areal extent _____ ☐ Location shown on site map Areal extent _____
9.	Slope Instability ☐ Slides ☐ Location shown on site map Areal extent _____ Remarks _____	☒ No evidence of slope instability
B. Benches ☐ Applicable ☒ N/A (Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)		
1.	Flows Bypass Bench Remarks _____	☐ Location shown on site map ☐ N/A or okay
2.	Bench Breached Remarks _____	☐ Location shown on site map ☐ N/A or okay
3.	Bench Overtopped Remarks _____	☐ Location shown on site map ☐ N/A or okay
C. Letdown Channels ☐ Applicable ☒ N/A (Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)		
1.	Settlement Areal extent _____ Depth _____ Remarks _____	☐ Location shown on site map ☐ No evidence of settlement
2.	Material Degradation Material type _____ Areal extent _____ Remarks _____	☐ Location shown on site map ☐ No evidence of degradation
3.	Erosion Areal extent _____ Depth _____ Remarks _____	☐ Location shown on site map ☐ No evidence of erosion

4.	Undercutting Areal extent _____ Depth _____ Remarks _____	☐ Location shown on site map ☐ No evidence of undercutting
5.	Obstructions Type _____ ☐ Location shown on site map Areal extent _____ Size _____ Remarks _____	☐ No obstructions
6.	Excessive Vegetative Growth Type _____ ☐ No evidence of excessive growth ☐ Vegetation in channels does not obstruct flow ☐ Location shown on site map Areal extent _____ Remarks _____	
D. Cover Penetrations ☒ Applicable ☐ N/A		
1.	Gas Vents ☐ Properly secured/locked ☒ Functioning ☐ Evidence of leakage at penetration ☐ N/A Remarks _____	☐ Active ☒ Passive ☐ Routinely sampled ☒ Good condition ☐ Needs Maintenance
2.	Gas Monitoring Probes ☒ Properly secured/locked ☒ Functioning ☐ Evidence of leakage at penetration Remarks _____	☐ Routinely sampled ☒ Good condition ☐ Needs Maintenance ☐ N/A
3.	Monitoring Wells (within surface area of landfill) ☒ Properly secured/locked ☒ Functioning ☐ Evidence of leakage at penetration Remarks _____	☒ Routinely sampled ☒ Good condition ☐ Needs Maintenance ☐ N/A
4.	Leachate Extraction Wells ☐ Properly secured/locked ☐ Functioning ☐ Evidence of leakage at penetration Remarks _____	☐ Routinely sampled ☐ Good condition ☐ Needs Maintenance ☒ N/A
5.	Settlement Monuments Remarks _____	☐ Located ☒ Routinely surveyed ☐ N/A

E. Gas Collection and Treatment				☐ Applicable	☒ N/A
1.	Gas Treatment Facilities				
	☐ Flaring	☐ Thermal destruction	☐ Collection for reuse		
	☐ Good condition	☐ Needs Maintenance			
	Remarks_____				
2.	Gas Collection Wells, Manifolds and Piping				
	☐ Good condition	☐ Needs Maintenance			
	Remarks_____				
3.	Gas Monitoring Facilities (e.g., gas monitoring of adjacent homes or buildings)				
	☐ Good condition	☐ Needs Maintenance	☐ N/A		
	Remarks_____				
F. Cover Drainage Layer					
				☐ Applicable	☒ N/A
1.	Outlet Pipes Inspected		☐ Functioning	☐ N/A	
	Remarks_____				
2.	Outlet Rock Inspected		☐ Functioning	☐ N/A	
	Remarks_____				
G. Detention/Sedimentation Ponds					
				☒ Applicable	☐ N/A
1.	Siltation Areal extent_____		Depth_____	☒ N/A	
	☐ Siltation not evident				
	Remarks_____				
2.	Erosion Areal extent_____		Depth_____		
	☒ Erosion not evident				
	Remarks_____				
3.	Outlet Works		☐ Functioning	☒ N/A	
	Remarks_____				
4.	Dam		☐ Functioning	☒ N/A	
	Remarks_____				

H. Retaining Walls		☐ Applicable	☒ N/A
1.	Deformations ☐ Location shown on site map ☐ Deformation not evident Horizontal displacement_____ Vertical displacement_____ Rotational displacement_____ Remarks_____		
2.	Degradation ☐ Location shown on site map ☐ Degradation not evident Remarks_____		
I. Perimeter Ditches/Off-Site Discharge		☒ Applicable	☐ N/A
1.	Siltation ☐ Location shown on site map ☒ Siltation not evident Areal extent_____ Depth_____ Remarks_____		
2.	Vegetative Growth ☐ Location shown on site map ☐ N/A ☒ Vegetation does not impede flow Areal extent_____ Type_____ Remarks_____		
3.	Erosion ☐ Location shown on site map ☒ Erosion not evident Areal extent_____ Depth_____ Remarks_____		
4.	Discharge Structure ☐ Functioning ☒ N/A Remarks_____		
VIII. VERTICAL BARRIER WALLS			
		☐ Applicable	☒ N/A
1.	Settlement ☐ Location shown on site map ☐ Settlement not evident Areal extent_____ Depth_____ Remarks_____		
2.	Performance Monitoring Type of monitoring_____ ☐ Performance not monitored Frequency_____ ☐ Evidence of breaching Head differential_____ Remarks_____		

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable ☒ N/A	
A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☐ N/A	
1.	Pumps, Wellhead Plumbing, and Electrical ☐ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A Remarks _____ _____ _____
2.	Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances ☐ Good condition ☐ Needs Maintenance Remarks _____ _____
3.	Spare Parts and Equipment ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks _____ _____
B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☐ N/A	
1.	Collection Structures, Pumps, and Electrical ☐ Good condition ☐ Needs Maintenance Remarks _____ _____
2.	Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances ☐ Good condition ☐ Needs Maintenance Remarks _____ _____
3.	Spare Parts and Equipment ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks _____ _____

C. Treatment System ☐ Applicable ☐ N/A			
1.	Treatment Train (Check components that apply) ☐ Metals removal ☐ Oil/water separation ☐ Bioremediation ☐ Air stripping ☐ Carbon adsorbers ☐ Filters _____ ☐ Additive (e.g., chelation agent, flocculent) _____ ☐ Others _____ ☐ Good condition ☐ Needs Maintenance ☐ Sampling ports properly marked and functional ☐ Sampling/maintenance log displayed and up to date ☐ Equipment properly identified ☐ Quantity of groundwater treated annually _____ ☐ Quantity of surface water treated annually _____ Remarks _____ _____		
2.	Electrical Enclosures and Panels (properly rated and functional) ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks _____ _____		
3.	Tanks, Vaults, Storage Vessels ☐ N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs Maintenance Remarks _____ _____		
4.	Discharge Structure and Appurtenances ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks _____ _____		
5.	Treatment Building(s) ☐ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair ☐ Chemicals and equipment properly stored Remarks _____ _____		
6.	Monitoring Wells (pump and treatment remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks _____ _____		
D. Monitoring Data			
1.	Monitoring Data ☐ Is routinely submitted on time ☐ Is of acceptable quality		
2.	Monitoring data suggests: ☐ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining		

D. Monitored Natural Attenuation			
1.	Monitoring Wells (natural attenuation remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks _____ _____		
X. OTHER REMEDIES			
If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction. Not Applicable			
XI. OVERALL OBSERVATIONS			
A. Implementation of the Remedy			
Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). Annual Landfill inspections are being conducted, no change in land use, minor fence repair and landfill cap erosion repair has been performed, fence and signs are in good condition, landfill cap has not settled and is in good condition.			
B. Adequacy of O&M			
Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. Not Applicable			
C. Early Indicators of Potential Remedy Problems			
Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. None			
D. Opportunities for Optimization			
Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. None			

LF-1 Photo 1: LF-1 landfill fence



LF-1 Photo 2: LF-1 landfill sign



LF-1 photo 3: LF-1 landfill cap



LF-1 Photo 4: LF-1 landfill cap



LF-1 Photo 5: LF-1 landfill cap



Five-Year Review Site Inspection Checklist

I. SITE INFORMATION													
Site name: Fire Training Area-2/Landfill-2	Date of inspection: 6/14/17												
Location and Region: Approximately 250 feet west of the southern end of Runway No. 5, within the flightline security area.	EPA ID: MA2570024487												
Agency, office, or company leading the five-year review: AFCEC	Weather/temperature: sunny, clear, 70s												
Remedy Includes: (Check all that apply) <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> ☐ Landfill cover/containment ☐ Access controls ☒ Institutional controls ☐ Groundwater pump and treatment ☐ Surface water collection and treatment ☐ Other _____ </td> <td style="width: 50%; vertical-align: top;"> ☐ Monitored natural attenuation ☐ Groundwater containment ☐ Vertical barrier walls </td> </tr> </table>		☐ Landfill cover/containment ☐ Access controls ☒ Institutional controls ☐ Groundwater pump and treatment ☐ Surface water collection and treatment ☐ Other _____	☐ Monitored natural attenuation ☐ Groundwater containment ☐ Vertical barrier walls										
☐ Landfill cover/containment ☐ Access controls ☒ Institutional controls ☐ Groundwater pump and treatment ☐ Surface water collection and treatment ☐ Other _____	☐ Monitored natural attenuation ☐ Groundwater containment ☐ Vertical barrier walls												
Attachments: ☐ Inspection team roster attached ☐ Site map attached See Figure 4-3													
II. INTERVIEWS (Check all that apply) Not conducted since no ongoing O&M (See Section 3.6)													
1. O&M site manager _____ <table style="width: 100%; border: none; margin-top: 5px;"> <tr> <td style="width: 30%;"></td> <td style="width: 20%; text-align: center;">Name</td> <td style="width: 20%; text-align: center;">Title</td> <td style="width: 30%; text-align: center;">Date</td> </tr> <tr> <td>Interviewed</td> <td>☐ at site ☐ at office</td> <td>☐ by phone</td> <td>Phone no. _____</td> </tr> <tr> <td colspan="4">Problems, suggestions; ☐ Report attached ☐ _____</td> </tr> </table>			Name	Title	Date	Interviewed	☐ at site ☐ at office	☐ by phone	Phone no. _____	Problems, suggestions; ☐ Report attached ☐ _____			
	Name	Title	Date										
Interviewed	☐ at site ☐ at office	☐ by phone	Phone no. _____										
Problems, suggestions; ☐ Report attached ☐ _____													
2. O&M staff _____ <table style="width: 100%; border: none; margin-top: 5px;"> <tr> <td style="width: 30%;"></td> <td style="width: 20%; text-align: center;">Name</td> <td style="width: 20%; text-align: center;">Title</td> <td style="width: 30%; text-align: center;">Date</td> </tr> <tr> <td>Interviewed</td> <td>☐ at site ☐ at office</td> <td>☐ by phone</td> <td>Phone no. _____</td> </tr> <tr> <td colspan="4">Problems, suggestions; ☐ Report attached _____</td> </tr> </table>			Name	Title	Date	Interviewed	☐ at site ☐ at office	☐ by phone	Phone no. _____	Problems, suggestions; ☐ Report attached _____			
	Name	Title	Date										
Interviewed	☐ at site ☐ at office	☐ by phone	Phone no. _____										
Problems, suggestions; ☐ Report attached _____													

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency _____
 Contact _____

Name	Title	Date	Phone no.
Problems; suggestions; ☐ Report attached _____			

Agency _____
 Contact _____
 Name _____ Title _____ Date _____ Phone no. _____
 Problems; suggestions; ☐ Report attached _____

Agency _____
 Contact _____
 Name _____ Title _____ Date _____ Phone no. _____
 Problems; suggestions; ☐ Report attached _____

Agency _____
 Contact _____
 Name _____ Title _____ Date _____ Phone no. _____
 Problems; suggestions; ☐ Report attached _____

4. **Other interviews** (optional) ☐ Report attached.

None

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	O&M Documents ☐ O&M manual ☐ As-built drawings ☐ Maintenance logs Remarks_____	☐ Readily available ☐ Readily available ☐ Readily available	☐ Up to date ☐ Up to date ☐ Up to date	x N/A x N/A x N/A
2.	Site-Specific Health and Safety Plan ☐ Contingency plan/emergency response plan Remarks_____	x Readily available x Readily available	x Up to date x Up to date	☐ N/A ☐ N/A
3.	O&M and OSHA Training Records Remarks_____	☐ Readily available	☐ Up to date	x N/A
4.	Permits and Service Agreements ☐ Air discharge permit ☐ Effluent discharge ☐ Waste disposal, POTW ☐ Other permits_____ Remarks_____	☐ Readily available ☐ Readily available ☐ Readily available ☐ Readily available	☐ Up to date ☐ Up to date ☐ Up to date ☐ Up to date	x N/A x N/A x N/A x N/A
5.	Gas Generation Records Remarks_____	☐ Readily available	☐ Up to date	x N/A
6.	Settlement Monument Records Remarks_____	☐ Readily available	☐ Up to date	x N/A
7.	Groundwater Monitoring Records Remarks_____	☐ Readily available	☐ Up to date	x N/A
8.	Leachate Extraction Records Remarks_____	☐ Readily available	☐ Up to date	x N/A
9.	Discharge Compliance Records ☐ Air ☐ Water (effluent) Remarks_____	☐ Readily available ☐ Readily available	☐ Up to date ☐ Up to date	x N/A x N/A
10.	Daily Access/Security Logs Remarks_____	☐ Readily available	☐ Up to date	x N/A

IV. O&M COSTS Not Applicable																																																													
1.	O&M Organization ☐ State in-house ☐ Contractor for State ☐ PRP in-house ☐ Contractor for PRP ☐ Federal Facility in-house ☐ Contractor for Federal Facility ☐ Other _____ _____ _____																																																												
2.	O&M Cost Records ☐ Readily available ☐ Up to date ☐ Funding mechanism/agreement in place Original O&M cost estimate _____ ☐ Breakdown attached Total annual cost by year for review period if available <table style="width: 100%; border: none;"> <tr> <td style="width: 20%;">From _____</td> <td style="width: 10%;">To _____</td> <td style="width: 20%;"></td> <td style="width: 10%;"></td> <td style="width: 10%;"></td> <td style="width: 25%;">☐ Breakdown attached</td> </tr> <tr> <td style="text-align: center;">Date</td> <td style="text-align: center;">Date</td> <td style="text-align: center;">Total cost</td> <td colspan="3"></td> </tr> <tr> <td>From _____</td> <td>To _____</td> <td></td> <td></td> <td></td> <td>☐ Breakdown attached</td> </tr> <tr> <td style="text-align: center;">Date</td> <td style="text-align: center;">Date</td> <td style="text-align: center;">Total cost</td> <td colspan="3"></td> </tr> <tr> <td>From _____</td> <td>To _____</td> <td></td> <td></td> <td></td> <td>☐ Breakdown attached</td> </tr> <tr> <td style="text-align: center;">Date</td> <td style="text-align: center;">Date</td> <td style="text-align: center;">Total cost</td> <td colspan="3"></td> </tr> <tr> <td>From _____</td> <td>To _____</td> <td></td> <td></td> <td></td> <td>☐ Breakdown attached</td> </tr> <tr> <td style="text-align: center;">Date</td> <td style="text-align: center;">Date</td> <td style="text-align: center;">Total cost</td> <td colspan="3"></td> </tr> <tr> <td>From _____</td> <td>To _____</td> <td></td> <td></td> <td></td> <td>☐ Breakdown attached</td> </tr> <tr> <td style="text-align: center;">Date</td> <td style="text-align: center;">Date</td> <td style="text-align: center;">Total cost</td> <td colspan="3"></td> </tr> </table>	From _____	To _____				☐ Breakdown attached	Date	Date	Total cost				From _____	To _____				☐ Breakdown attached	Date	Date	Total cost				From _____	To _____				☐ Breakdown attached	Date	Date	Total cost				From _____	To _____				☐ Breakdown attached	Date	Date	Total cost				From _____	To _____				☐ Breakdown attached	Date	Date	Total cost			
From _____	To _____				☐ Breakdown attached																																																								
Date	Date	Total cost																																																											
From _____	To _____				☐ Breakdown attached																																																								
Date	Date	Total cost																																																											
From _____	To _____				☐ Breakdown attached																																																								
Date	Date	Total cost																																																											
From _____	To _____				☐ Breakdown attached																																																								
Date	Date	Total cost																																																											
From _____	To _____				☐ Breakdown attached																																																								
Date	Date	Total cost																																																											
3.	Unanticipated or Unusually High O&M Costs During Review Period Describe costs and reasons: _____ _____ _____ _____ _____ _____																																																												
V. ACCESS AND INSTITUTIONAL CONTROLS ☐ Applicable x N/A																																																													
A. Fencing																																																													
1.	Fencing damaged ☐ Location shown on site map ☐ Gates secured ☐ N/A Remarks _____ _____ _____																																																												
B. Other Access Restrictions																																																													
1.	Signs and other security measures ☐ Location shown on site map ☐ N/A Remarks _____ _____ _____																																																												

C. Institutional Controls (ICs)				
1.	Implementation and enforcement Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A Site conditions imply ICs not being fully enforced ☐ Yes ☒ No ☐ N/A Type of monitoring (<i>e.g.</i> , self-reporting, drive by) _____ Frequency _____ Responsible party/agency _____ Contact _____ Name Title Date Phone no. Reporting is up-to-date ☐ Yes ☐ No ☐ N/A Reports are verified by the lead agency ☐ Yes ☐ No ☐ N/A Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ☐ N/A Violations have been reported ☐ Yes ☐ No ☐ N/A Other problems or suggestions: ☐ Report attached _____ _____ _____ _____			
2.	Adequacy ☐ ICs are adequate ☐ ICs are inadequate ☐ N/A Remarks _____ _____ _____			
D. General				
1.	Vandalism/trespassing ☐ Location shown on site map ☐ No vandalism evident Remarks _____ _____			
2.	Land use changes on site ☐ N/A Remarks _____ _____			
3.	Land use changes off site ☐ N/A Remarks _____ _____			
VI. GENERAL SITE CONDITIONS				
A. Roads ☐ Applicable ☐ N/A				
1.	Roads damaged ☐ Location shown on site map ☐ Roads adequate ☒ N/A Remarks _____ _____			

B. Other Site Conditions			
Remarks _____ _____ _____ _____ _____ _____			
VII. LANDFILL COVERS ☐ Applicable ☒ N/A			
A. Landfill Surface			
1.	Settlement (Low spots) Areal extent _____ Depth _____ Remarks _____ _____	☐ Location shown on site map ☐ Settlement not evident	
2.	Cracks Lengths _____ Widths _____ Depths _____ Remarks _____ _____	☐ Location shown on site map ☐ Cracking not evident	
3.	Erosion Areal extent _____ Depth _____ Remarks _____ _____	☐ Location shown on site map ☐ Erosion not evident	
4.	Holes Areal extent _____ Depth _____ Remarks _____ _____	☐ Location shown on site map ☐ Holes not evident	
5.	Vegetative Cover ☐ Grass ☐ Cover properly established ☐ No signs of stress ☐ Trees/Shrubs (indicate size and locations on a diagram) Remarks _____ _____		
6.	Alternative Cover (armored rock, concrete, etc.) ☐ N/A Remarks _____ _____		
7.	Bulges Areal extent _____ Height _____ Remarks _____ _____	☐ Location shown on site map ☐ Bulges not evident	

8.	Wet Areas/Water Damage ☐ Wet areas ☐ Ponding ☐ Seeps ☐ Soft subgrade Remarks _____ _____	☐ Wet areas/water damage not evident ☐ Location shown on site map Areal extent _____ ☐ Location shown on site map Areal extent _____ ☐ Location shown on site map Areal extent _____ ☐ Location shown on site map Areal extent _____
9.	Slope Instability ☐ Slides ☐ Location shown on site map ☐ No evidence of slope instability Areal extent _____ Remarks _____ _____	
B. Benches ☐ Applicable ☐ N/A (Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)		
1.	Flows Bypass Bench Remarks _____ _____	☐ Location shown on site map ☐ N/A or okay
2.	Bench Breached Remarks _____ _____	☐ Location shown on site map ☐ N/A or okay
3.	Bench Overtopped Remarks _____ _____	☐ Location shown on site map ☐ N/A or okay
C. Letdown Channels ☐ Applicable ☐ N/A (Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)		
1.	Settlement Areal extent _____ Depth _____ Remarks _____ _____	☐ Location shown on site map ☐ No evidence of settlement
2.	Material Degradation Material type _____ Areal extent _____ Remarks _____ _____	☐ Location shown on site map ☐ No evidence of degradation
3.	Erosion Areal extent _____ Depth _____ Remarks _____ _____	☐ Location shown on site map ☐ No evidence of erosion

4.	Undercutting ☐ Location shown on site map ☐ No evidence of undercutting Areal extent _____ Depth _____ Remarks _____ _____
5.	Obstructions Type _____ ☐ No obstructions ☐ Location shown on site map Areal extent _____ Size _____ Remarks _____ _____
6.	Excessive Vegetative Growth Type _____ ☐ No evidence of excessive growth ☐ Vegetation in channels does not obstruct flow ☐ Location shown on site map Areal extent _____ Remarks _____ _____
D. Cover Penetrations ☐ Applicable ☐ N/A	
1.	Gas Vents ☐ Active ☐ Passive ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks _____ _____
2.	Gas Monitoring Probes ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks _____ _____
3.	Monitoring Wells (within surface area of landfill) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks _____ _____
4.	Leachate Extraction Wells ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks _____ _____
5.	Settlement Monuments ☐ Located ☐ Routinely surveyed ☐ N/A Remarks _____ _____

E. Gas Collection and Treatment			☐ Applicable	☐ N/A
1.	Gas Treatment Facilities ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse ☐ Good condition ☐ Needs Maintenance Remarks _____ _____			
2.	Gas Collection Wells, Manifolds and Piping ☐ Good condition ☐ Needs Maintenance Remarks _____ _____			
3.	Gas Monitoring Facilities (<i>e.g.</i> , gas monitoring of adjacent homes or buildings) ☐ Good condition ☐ Needs Maintenance ☐ N/A Remarks _____ _____			
F. Cover Drainage Layer			☐ Applicable	☐ N/A
1.	Outlet Pipes Inspected ☐ Functioning ☐ N/A Remarks _____ _____			
2.	Outlet Rock Inspected ☐ Functioning ☐ N/A Remarks _____ _____			
G. Detention/Sedimentation Ponds			☐ Applicable	☐ N/A
1.	Siltation Areal extent _____ Depth _____ ☐ N/A ☐ Siltation not evident Remarks _____ _____			
2.	Erosion Areal extent _____ Depth _____ ☐ Erosion not evident Remarks _____ _____			
3.	Outlet Works ☐ Functioning ☐ N/A Remarks _____ _____			
4.	Dam ☐ Functioning ☐ N/A Remarks _____ _____			

H. Retaining Walls		☐ Applicable	☐ N/A
1.	Deformations	☐ Location shown on site map	☐ Deformation not evident
	Horizontal displacement_____	Vertical displacement_____	
	Rotational displacement_____		
	Remarks_____		
2.	Degradation	☐ Location shown on site map	☐ Degradation not evident
	Remarks_____		
I. Perimeter Ditches/Off-Site Discharge		☐ Applicable	☐ N/A
1.	Siltation	☐ Location shown on site map	☐ Siltation not evident
	Areal extent_____	Depth_____	
	Remarks_____		
2.	Vegetative Growth	☐ Location shown on site map	☐ N/A
	☐ Vegetation does not impede flow		
	Areal extent_____	Type_____	
	Remarks_____		
3.	Erosion	☐ Location shown on site map	☐ Erosion not evident
	Areal extent_____	Depth_____	
	Remarks_____		
4.	Discharge Structure	☐ Functioning	☐ N/A
	Remarks_____		
VIII. VERTICAL BARRIER WALLS			
		☐ Applicable	☒ N/A
1.	Settlement	☐ Location shown on site map	☐ Settlement not evident
	Areal extent_____	Depth_____	
	Remarks_____		
2.	Performance Monitoring	Type of monitoring_____	
	☐ Performance not monitored		
	Frequency_____	☐ Evidence of breaching	
	Head differential_____		
	Remarks_____		

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable x N/A	
A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☐ N/A	
1.	Pumps, Wellhead Plumbing, and Electrical ☐ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A Remarks _____ _____ _____
2.	Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances ☐ Good condition ☐ Needs Maintenance Remarks _____ _____
3.	Spare Parts and Equipment ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks _____ _____
B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☐ N/A	
1.	Collection Structures, Pumps, and Electrical ☐ Good condition ☐ Needs Maintenance Remarks _____ _____
2.	Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances ☐ Good condition ☐ Needs Maintenance Remarks _____ _____
3.	Spare Parts and Equipment ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks _____ _____

C. Treatment System ☐ Applicable ☐ N/A			
1.	Treatment Train (Check components that apply) ☐ Metals removal ☐ Oil/water separation ☐ Bioremediation ☐ Air stripping ☐ Carbon adsorbers ☐ Filters _____ ☐ Additive (e.g., chelation agent, flocculent) _____ ☐ Others _____ ☐ Good condition ☐ Needs Maintenance ☐ Sampling ports properly marked and functional ☐ Sampling/maintenance log displayed and up to date ☐ Equipment properly identified ☐ Quantity of groundwater treated annually _____ ☐ Quantity of surface water treated annually _____ Remarks _____ _____		
2.	Electrical Enclosures and Panels (properly rated and functional) ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks _____ _____		
3.	Tanks, Vaults, Storage Vessels ☐ N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs Maintenance Remarks _____ _____		
4.	Discharge Structure and Appurtenances ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks _____ _____		
5.	Treatment Building(s) ☐ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair ☐ Chemicals and equipment properly stored Remarks _____ _____		
6.	Monitoring Wells (pump and treatment remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks _____ _____		
D. Monitoring Data			
1.	Monitoring Data ☐ Is routinely submitted on time ☐ Is of acceptable quality		
2.	Monitoring data suggests: ☐ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining		

D. Monitored Natural Attenuation			
1.	Monitoring Wells (natural attenuation remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks _____ _____		
X. OTHER REMEDIES			
If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction. Not Applicable			
XI. OVERALL OBSERVATIONS			
A.	Implementation of the Remedy		
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). Former SVE system to remediate petroleum contamination in soil (now shutdown).		
B.	Adequacy of O&M		
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. Not Applicable		
C.	Early Indicators of Potential Remedy Problems		
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. Not Applicable		
D.	Opportunities for Optimization		
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. Not Applicable		

FTA-2/LF-2 Photo 1



Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: Landfill-7	Date of inspection: 6/14/17
Location and Region: In a former gravel pit north of the LF-1 source area	EPA ID: MA2570024487
Agency, office, or company leading the five-year review: AFCEC	Weather/temperature: Sunny, clear, 70s
Remedy Includes: (Check all that apply) ☐ Landfill cover/containment ☐ Access controls ☒ Institutional controls ☐ Groundwater pump and treatment ☐ Surface water collection and treatment ☒ Other: Fence and Annual Inspections ☐ Monitored natural attenuation ☐ Groundwater containment ☐ Vertical barrier walls	
Attachments: ☐ Inspection team roster attached ☐ Site map attached See Figure 4-4	
II. INTERVIEWS Not conducted since no ongoing O&M (See Section 3.6)	
1. O&M site manager _____ Name Title Date Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _____ Problems, suggestions; ☐ Report attached ☐ _____ _____	
2. O&M staff _____ Name Title Date Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _____ Problems, suggestions; ☐ Report attached _____ _____	

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency _____
 Contact _____

Name	Title	Date	Phone no.
Problems; suggestions; ☐ Report attached _____			

Agency _____
 Contact _____
 Name _____ Title _____ Date _____ Phone no. _____
 Problems; suggestions; ☐ Report attached _____

Agency _____
 Contact _____
 Name _____ Title _____ Date _____ Phone no. _____
 Problems; suggestions; ☐ Report attached _____

Agency _____
 Contact _____
 Name _____ Title _____ Date _____ Phone no. _____
 Problems; suggestions; ☐ Report attached _____

4. **Other interviews** (optional) ☐ Report attached.

None

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	O&M Documents ☐ O&M manual ☐ As-built drawings ☐ Maintenance logs Remarks_____	☐ Readily available ☐ Readily available ☐ Readily available	☐ Up to date ☐ Up to date ☐ Up to date	x N/A x N/A x N/A
2.	Site-Specific Health and Safety Plan ☐ Contingency plan/emergency response plan Remarks_____	x Readily available x Readily available	x Up to date x Up to date	☐ N/A ☐ N/A
3.	O&M and OSHA Training Records Remarks_____	☐ Readily available	☐ Up to date	x N/A
4.	Permits and Service Agreements ☐ Air discharge permit ☐ Effluent discharge ☐ Waste disposal, POTW ☐ Other permits_____ Remarks_____	☐ Readily available ☐ Readily available ☐ Readily available ☐ Readily available	☐ Up to date ☐ Up to date ☐ Up to date ☐ Up to date	x N/A x N/A x N/A x N/A
5.	Gas Generation Records Remarks_____	☐ Readily available	☐ Up to date	x N/A
6.	Settlement Monument Records Remarks_____	☐ Readily available	☐ Up to date	x N/A
7.	Groundwater Monitoring Records Remarks_____	☐ Readily available	☐ Up to date	x N/A
8.	Leachate Extraction Records Remarks_____	☐ Readily available	☐ Up to date	x N/A
9.	Discharge Compliance Records ☐ Air ☐ Water (effluent) Remarks_____	☐ Readily available ☐ Readily available	☐ Up to date ☐ Up to date	x N/A x N/A
10.	Daily Access/Security Logs Remarks_____	☐ Readily available	☐ Up to date	x N/A

IV. O&M COSTS: Not Applicable																																																																									
1.	O&M Organization ☐ State in-house ☐ PRP in-house ☐ Federal Facility in-house ☐ Other _____ ☐ Contractor for State ☐ Contractor for PRP ☐ Contractor for Federal Facility																																																																								
2.	O&M Cost Records ☐ Readily available ☐ Up to date ☐ Funding mechanism/agreement in place Original O&M cost estimate _____ ☐ Breakdown attached Total annual cost by year for review period if available <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%;">From _____</td> <td style="width: 10%;">To _____</td> <td style="width: 20%;"></td> <td style="width: 10%;"></td> <td style="width: 10%;"></td> <td style="width: 25%;"></td> <td style="width: 10%; text-align: right;">☐ Breakdown attached</td> </tr> <tr> <td style="text-align: center;">Date</td> <td style="text-align: center;">Date</td> <td></td> <td style="text-align: center;">Total cost</td> <td></td> <td></td> <td></td> </tr> <tr> <td>From _____</td> <td>To _____</td> <td></td> <td></td> <td></td> <td></td> <td>☐ Breakdown attached</td> </tr> <tr> <td style="text-align: center;">Date</td> <td style="text-align: center;">Date</td> <td></td> <td style="text-align: center;">Total cost</td> <td></td> <td></td> <td></td> </tr> <tr> <td>From _____</td> <td>To _____</td> <td></td> <td></td> <td></td> <td></td> <td>☐ Breakdown attached</td> </tr> <tr> <td style="text-align: center;">Date</td> <td style="text-align: center;">Date</td> <td></td> <td style="text-align: center;">Total cost</td> <td></td> <td></td> <td></td> </tr> <tr> <td>From _____</td> <td>To _____</td> <td></td> <td></td> <td></td> <td></td> <td>☐ Breakdown attached</td> </tr> <tr> <td style="text-align: center;">Date</td> <td style="text-align: center;">Date</td> <td></td> <td style="text-align: center;">Total cost</td> <td></td> <td></td> <td></td> </tr> <tr> <td>From _____</td> <td>To _____</td> <td></td> <td></td> <td></td> <td></td> <td>☐ Breakdown attached</td> </tr> <tr> <td style="text-align: center;">Date</td> <td style="text-align: center;">Date</td> <td></td> <td style="text-align: center;">Total cost</td> <td></td> <td></td> <td></td> </tr> </table>			From _____	To _____					☐ Breakdown attached	Date	Date		Total cost				From _____	To _____					☐ Breakdown attached	Date	Date		Total cost				From _____	To _____					☐ Breakdown attached	Date	Date		Total cost				From _____	To _____					☐ Breakdown attached	Date	Date		Total cost				From _____	To _____					☐ Breakdown attached	Date	Date		Total cost			
From _____	To _____					☐ Breakdown attached																																																																			
Date	Date		Total cost																																																																						
From _____	To _____					☐ Breakdown attached																																																																			
Date	Date		Total cost																																																																						
From _____	To _____					☐ Breakdown attached																																																																			
Date	Date		Total cost																																																																						
From _____	To _____					☐ Breakdown attached																																																																			
Date	Date		Total cost																																																																						
From _____	To _____					☐ Breakdown attached																																																																			
Date	Date		Total cost																																																																						
3.	Unanticipated or Unusually High O&M Costs During Review Period Describe costs and reasons: _____ _____ _____ _____ _____ _____																																																																								
V. ACCESS AND INSTITUTIONAL CONTROLS x Applicable ☐ N/A																																																																									
A. Fencing																																																																									
1.	Fencing damaged ☐ Location shown on site map x Gates secured ☐ N/A Remark: Fence in good condition (see photo #1) _____																																																																								
B. Other Access Restrictions																																																																									
1.	Signs and other security measures ☐ Location shown on site map ☐ N/A Remarks: Signs in place (see photo #2) _____																																																																								

C. Institutional Controls (ICs)			
1.	Implementation and enforcement Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A Site conditions imply ICs not being fully enforced ☐ Yes ☒ No ☐ N/A Type of monitoring (<i>e.g.</i> , self-reporting, drive by): Inspections and Radiological Surveys Frequency: Annual Responsible party/agency: AFCEC Contact: Rose Forbes AFCEC PM 6/14/17 (508) 968-4670 (ext 5613) Name Title Date Phone no. Reporting is up-to-date ☒ Yes ☐ No ☐ N/A Reports are verified by the lead agency ☒ Yes ☐ No ☐ N/A Specific requirements in deed or decision documents have been met ☒ Yes ☐ No ☐ N/A Violations have been reported ☐ Yes ☐ No ☒ N/A Other problems or suggestions: ☐ Report attached 		
2.	Adequacy ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A Remarks: _____ 		
D. General			
1.	Vandalism/trespassing ☐ Location shown on site map ☒ No vandalism evident Remarks: _____ 		
2.	Land use changes on site ☐ N/A Remarks: None 		
3.	Land use changes off site ☒ N/A Remarks: _____ 		
VI. GENERAL SITE CONDITIONS			
A. Roads ☐ Applicable ☒ N/A			
1.	Roads damaged ☐ Location shown on site map ☐ Roads adequate ☒ N/A Remarks: _____ 		

B. Other Site Conditions			
Remarks <u>None</u>			
VII. LANDFILL COVERS ☐ Applicable ☒ N/A			
A. Landfill Surface			
1.	Settlement (Low spots) Areal extent _____ Depth _____ Remarks _____	☐ Location shown on site map ☐ Settlement not evident	
2.	Cracks Lengths _____ Widths _____ Depths _____ Remarks _____	☐ Location shown on site map ☐ Cracking not evident	
3.	Erosion Areal extent _____ Depth _____ Remarks _____	☐ Location shown on site map ☐ Erosion not evident	
4.	Holes Areal extent _____ Depth _____ Remarks _____	☐ Location shown on site map ☐ Holes not evident	
5.	Vegetative Cover ☐ Grass ☐ Cover properly established ☐ No signs of stress ☐ Trees/Shrubs (indicate size and locations on a diagram) Remarks _____		
6.	Alternative Cover (armored rock, concrete, etc.) ☐ N/A Remarks _____		
7.	Bulges Areal extent _____ Height _____ Remarks _____	☐ Location shown on site map ☐ Bulges not evident	

8.	Wet Areas/Water Damage ☐ Wet areas ☐ Ponding ☐ Seeps ☐ Soft subgrade Remarks _____ _____	☐ Wet areas/water damage not evident ☐ Location shown on site map Areal extent _____ ☐ Location shown on site map Areal extent _____ ☐ Location shown on site map Areal extent _____ ☐ Location shown on site map Areal extent _____
9.	Slope Instability ☐ Slides ☐ Location shown on site map ☐ No evidence of slope instability Areal extent _____ Remarks _____ _____	
B. Benches ☐ Applicable ☐ N/A (Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)		
1.	Flows Bypass Bench Remarks _____ _____	☐ Location shown on site map ☐ N/A or okay
2.	Bench Breached Remarks _____ _____	☐ Location shown on site map ☐ N/A or okay
3.	Bench Overtopped Remarks _____ _____	☐ Location shown on site map ☐ N/A or okay
C. Letdown Channels ☐ Applicable ☐ N/A (Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)		
1.	Settlement Areal extent _____ Depth _____ Remarks _____ _____	☐ Location shown on site map ☐ No evidence of settlement
2.	Material Degradation ☐ Location shown on site map ☐ No evidence of degradation Material type _____ Areal extent _____ Remarks _____ _____	
3.	Erosion Areal extent _____ Depth _____ Remarks _____ _____	☐ Location shown on site map ☐ No evidence of erosion

4.	Undercutting ☐ Location shown on site map ☐ No evidence of undercutting Areal extent _____ Depth _____ Remarks _____ _____
5.	Obstructions Type _____ ☐ No obstructions ☐ Location shown on site map Areal extent _____ Size _____ Remarks _____ _____
6.	Excessive Vegetative Growth Type _____ ☐ No evidence of excessive growth ☐ Vegetation in channels does not obstruct flow ☐ Location shown on site map Areal extent _____ Remarks _____ _____
D. Cover Penetrations ☐ Applicable ☐ N/A	
1.	Gas Vents ☐ Active ☐ Passive ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks _____ _____
2.	Gas Monitoring Probes ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks _____ _____
3.	Monitoring Wells (within surface area of landfill) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks _____ _____
4.	Leachate Extraction Wells ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks _____ _____
5.	Settlement Monuments ☐ Located ☐ Routinely surveyed ☐ N/A Remarks _____ _____

E. Gas Collection and Treatment			☐ Applicable	☐ N/A
1.	Gas Treatment Facilities ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse ☐ Good condition ☐ Needs Maintenance Remarks _____ _____			
2.	Gas Collection Wells, Manifolds and Piping ☐ Good condition ☐ Needs Maintenance Remarks _____ _____			
3.	Gas Monitoring Facilities (<i>e.g.</i> , gas monitoring of adjacent homes or buildings) ☐ Good condition ☐ Needs Maintenance ☐ N/A Remarks _____ _____			
F. Cover Drainage Layer			☐ Applicable	☐ N/A
1.	Outlet Pipes Inspected ☐ Functioning ☐ N/A Remarks _____ _____			
2.	Outlet Rock Inspected ☐ Functioning ☐ N/A Remarks _____ _____			
G. Detention/Sedimentation Ponds			☐ Applicable	☐ N/A
1.	Siltation Areal extent _____ Depth _____ ☐ N/A ☐ Siltation not evident Remarks _____ _____			
2.	Erosion Areal extent _____ Depth _____ ☐ Erosion not evident Remarks _____ _____			
3.	Outlet Works ☐ Functioning ☐ N/A Remarks _____ _____			
4.	Dam ☐ Functioning ☐ N/A Remarks _____ _____			

H. Retaining Walls		☐ Applicable	☐ N/A
1.	Deformations	☐ Location shown on site map	☐ Deformation not evident
	Horizontal displacement_____	Vertical displacement_____	
	Rotational displacement_____		
	Remarks_____		
2.	Degradation	☐ Location shown on site map	☐ Degradation not evident
	Remarks_____		
I. Perimeter Ditches/Off-Site Discharge		☐ Applicable	☐ N/A
1.	Siltation	☐ Location shown on site map	☐ Siltation not evident
	Areal extent_____	Depth_____	
	Remarks_____		
2.	Vegetative Growth	☐ Location shown on site map	☐ N/A
	☐ Vegetation does not impede flow		
	Areal extent_____	Type_____	
	Remarks_____		
3.	Erosion	☐ Location shown on site map	☐ Erosion not evident
	Areal extent_____	Depth_____	
	Remarks_____		
4.	Discharge Structure	☐ Functioning	☐ N/A
	Remarks_____		
VIII. VERTICAL BARRIER WALLS			
		☐ Applicable	☒ N/A
1.	Settlement	☐ Location shown on site map	☐ Settlement not evident
	Areal extent_____	Depth_____	
	Remarks_____		
2.	Performance Monitoring	Type of monitoring_____	
	☐ Performance not monitored		
	Frequency_____	☐ Evidence of breaching	
	Head differential_____		
	Remarks_____		

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable ☒ N/A	
A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☐ N/A	
1.	Pumps, Wellhead Plumbing, and Electrical ☐ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A Remarks _____ _____ _____
2.	Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances ☐ Good condition ☐ Needs Maintenance Remarks _____ _____
3.	Spare Parts and Equipment ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks _____ _____
B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☐ N/A	
1.	Collection Structures, Pumps, and Electrical ☐ Good condition ☐ Needs Maintenance Remarks _____ _____
2.	Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances ☐ Good condition ☐ Needs Maintenance Remarks _____ _____
3.	Spare Parts and Equipment ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks _____ _____

C. Treatment System ☐ Applicable ☐ N/A			
1.	Treatment Train (Check components that apply) ☐ Metals removal ☐ Oil/water separation ☐ Bioremediation ☐ Air stripping ☐ Carbon adsorbers ☐ Filters _____ ☐ Additive (e.g., chelation agent, flocculent) _____ ☐ Others _____ ☐ Good condition ☐ Needs Maintenance ☐ Sampling ports properly marked and functional ☐ Sampling/maintenance log displayed and up to date ☐ Equipment properly identified ☐ Quantity of groundwater treated annually _____ ☐ Quantity of surface water treated annually _____ Remarks _____ _____		
2.	Electrical Enclosures and Panels (properly rated and functional) ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks _____ _____		
3.	Tanks, Vaults, Storage Vessels ☐ N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs Maintenance Remarks _____ _____		
4.	Discharge Structure and Appurtenances ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks _____ _____		
5.	Treatment Building(s) ☐ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair ☐ Chemicals and equipment properly stored Remarks _____ _____		
6.	Monitoring Wells (pump and treatment remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks _____ _____		
D. Monitoring Data			
1.	Monitoring Data ☐ Is routinely submitted on time ☐ Is of acceptable quality		
2.	Monitoring data suggests: ☐ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining		

D. Monitored Natural Attenuation			
1.	Monitoring Wells (natural attenuation remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks _____ _____		
X. OTHER REMEDIES			
If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction. Not Applicable			
XI. OVERALL OBSERVATIONS			
A. Implementation of the Remedy			
Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). Annual Inspections being conducted, no change in land use, no issues with fence, signage in place.			
B. Adequacy of O&M			
Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. Not Applicable			
C. Early Indicators of Potential Remedy Problems			
Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future. None			
D. Opportunities for Optimization			
Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. None			

LF-7 photo #1: LF-7 Fence



LF-7 Photo #2: LF-7 Sign



Five-Year Review Site Inspection Checklist

I. SITE INFORMATION													
Site name: Petroleum Fuel Storage Area (PFSa)	Date of inspection: 6/14/17												
Location and Region: North side of South Outer Road.	EPA ID: MA2570024487												
Agency, office, or company leading the five-year review: AFCEC	Weather/temperature: sunny, clear, 70s												
Remedy Includes: (Check all that apply) <table style="width: 100%; border: none;"> <tr> <td>☐ Landfill cover/containment</td> <td>☐ Monitored natural attenuation</td> </tr> <tr> <td>☐ Access controls</td> <td>☐ Groundwater containment</td> </tr> <tr> <td>☒ Institutional controls</td> <td>☐ Vertical barrier walls</td> </tr> <tr> <td>☐ Groundwater pump and treatment</td> <td></td> </tr> <tr> <td>☐ Surface water collection and treatment</td> <td></td> </tr> <tr> <td>☐ Other _____</td> <td></td> </tr> </table>		☐ Landfill cover/containment	☐ Monitored natural attenuation	☐ Access controls	☐ Groundwater containment	☒ Institutional controls	☐ Vertical barrier walls	☐ Groundwater pump and treatment		☐ Surface water collection and treatment		☐ Other _____	
☐ Landfill cover/containment	☐ Monitored natural attenuation												
☐ Access controls	☐ Groundwater containment												
☒ Institutional controls	☐ Vertical barrier walls												
☐ Groundwater pump and treatment													
☐ Surface water collection and treatment													
☐ Other _____													
Attachments: ☐ Inspection team roster attached ☐ Site map attached See Figure 4-5													
II. INTERVIEWS (Check all that apply) Not conducted since no ongoing O&M (See Section 3.6)													
1. O&M site manager _____ <table style="width: 100%; border: none; margin-top: 5px;"> <tr> <td style="text-align: center;">Name</td> <td style="text-align: center;">Title</td> <td style="text-align: center;">Date</td> </tr> <tr> <td>Interviewed ☐ at site ☐ at office ☐ by phone</td> <td>Phone no. _____</td> <td></td> </tr> <tr> <td colspan="3">Problems, suggestions; ☐ Report attached ☐ _____</td> </tr> </table>		Name	Title	Date	Interviewed ☐ at site ☐ at office ☐ by phone	Phone no. _____		Problems, suggestions; ☐ Report attached ☐ _____					
Name	Title	Date											
Interviewed ☐ at site ☐ at office ☐ by phone	Phone no. _____												
Problems, suggestions; ☐ Report attached ☐ _____													
2. O&M staff _____ <table style="width: 100%; border: none; margin-top: 5px;"> <tr> <td style="text-align: center;">Name</td> <td style="text-align: center;">Title</td> <td style="text-align: center;">Date</td> </tr> <tr> <td>Interviewed ☐ at site ☐ at office ☐ by phone</td> <td>Phone no. _____</td> <td></td> </tr> <tr> <td colspan="3">Problems, suggestions; ☐ Report attached _____</td> </tr> </table>		Name	Title	Date	Interviewed ☐ at site ☐ at office ☐ by phone	Phone no. _____		Problems, suggestions; ☐ Report attached _____					
Name	Title	Date											
Interviewed ☐ at site ☐ at office ☐ by phone	Phone no. _____												
Problems, suggestions; ☐ Report attached _____													

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency _____
 Contact _____
 Name _____ Title _____ Date _____ Phone no. _____
 Problems; suggestions; ☐ Report attached _____

Agency _____
 Contact _____
 Name _____ Title _____ Date _____ Phone no. _____
 Problems; suggestions; ☐ Report attached _____

Agency _____
 Contact _____
 Name _____ Title _____ Date _____ Phone no. _____
 Problems; suggestions; ☐ Report attached _____

Agency _____
 Contact _____
 Name _____ Title _____ Date _____ Phone no. _____
 Problems; suggestions; ☐ Report attached _____

4. **Other interviews** (optional) ☐ Report attached.

None

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	O&M Documents ☐ O&M manual ☐ As-built drawings ☐ Maintenance logs Remarks_____	☐ Readily available ☐ Readily available ☐ Readily available	☐ Up to date ☐ Up to date ☐ Up to date	x N/A x N/A x N/A
2.	Site-Specific Health and Safety Plan ☐ Contingency plan/emergency response plan Remarks_____	x Readily available x Readily available	x Up to date x Up to date	☐ N/A ☐ N/A
3.	O&M and OSHA Training Records Remarks_____	☐ Readily available	☐ Up to date	x N/A
4.	Permits and Service Agreements ☐ Air discharge permit ☐ Effluent discharge ☐ Waste disposal, POTW ☐ Other permits_____ Remarks_____	☐ Readily available ☐ Readily available ☐ Readily available ☐ Readily available	☐ Up to date ☐ Up to date ☐ Up to date ☐ Up to date	x N/A x N/A x N/A x N/A
5.	Gas Generation Records Remarks_____	☐ Readily available	☐ Up to date	x N/A
6.	Settlement Monument Records Remarks_____	☐ Readily available	☐ Up to date	x N/A
7.	Groundwater Monitoring Records Remarks_____	☐ Readily available	☐ Up to date	x N/A
8.	Leachate Extraction Records Remarks_____	☐ Readily available	☐ Up to date	x N/A
9.	Discharge Compliance Records ☐ Air ☐ Water (effluent) Remarks_____	☐ Readily available ☐ Readily available	☐ Up to date ☐ Up to date	x N/A x N/A
10.	Daily Access/Security Logs Remarks_____	☐ Readily available	☐ Up to date	x N/A

IV. O&M COSTS	Not Applicable
---------------	----------------

1.	O&M Organization
----	-----------------------------

- | | |
|--|--|
| ☐ State in-house | ☐ Contractor for State |
| ☐ PRP in-house | ☐ Contractor for PRP |
| ☐ Federal Facility in-house | ☐ Contractor for Federal Facility |
| ☐ Other _____ | |

2.	O&M Cost Records
----	-----------------------------

- ☐ Readily available ☐ Up to date
☐ Funding mechanism/agreement in place
 Original O&M cost estimate_____ ☐ Breakdown attached

Total annual cost by year for review period if available	
--	--

From _____ To _____ _____ ☐ Breakdown attached
Date Date Total cost

From _____ To _____ _____ ☐ Breakdown attached
Date Date Total cost

From _____ To _____ _____ ☐ Breakdown attached
Date Date Total cost

From _____ To _____ ☐ Breakdown attached
Date Date Total cost

From _____ To _____ ☐ Breakdown attached
Date Date Total cost

3. Unanticipated or Unusually High O&M Costs During Review Period

Describe costs and reasons:

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A	
---	--

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☒ Gates secured ☐ N/A

- Remarks_____

B. Other Access Restrictions

1.	Signs and other security measures	☐ Location shown on site map	☐ N/A
----	--	---	------------------------------

Remarks	
---------	--

-

C. Institutional Controls (ICs)			
1.	Implementation and enforcement		
	Site conditions imply ICs not properly implemented	☐ Yes ☒ No ☐ N/A	
	Site conditions imply ICs not being fully enforced	☐ Yes ☒ No ☐ N/A	
	Type of monitoring (<i>e.g.</i> , self-reporting, drive by) _____		
	Frequency _____		
	Responsible party/agency _____		
	Contact _____		
	Name	Title	Date Phone no.
	Reporting is up-to-date	☒ Yes ☐ No ☐ N/A	
	Reports are verified by the lead agency	☒ Yes ☐ No ☐ N/A	
	Specific requirements in deed or decision documents have been met	☐ Yes ☐ No ☒ N/A	
	Violations have been reported	☐ Yes ☐ No ☒ N/A	
	Other problems or suggestions: ☐ Report attached		

2.	Adequacy	☐ ICs are adequate ☐ ICs are inadequate ☐ N/A	
	Remarks _____		

D. General			
1.	Vandalism/trespassing	☐ Location shown on site map ☒ No vandalism evident	
	Remarks _____		

2.	Land use changes on site	N/A	
	Remarks _____		

3.	Land use changes off site	N/A	
	Remarks _____		

VI. GENERAL SITE CONDITIONS			
A. Roads ☒ Applicable ☐ N/A			
1.	Roads damaged	☐ Location shown on site map ☒ Roads adequate ☒ N/A	
	Remarks _____		

B. Other Site Conditions			
Remarks None			
VII. LANDFILL COVERS ☐ Applicable x N/A			
A. Landfill Surface			
1.	Settlement (Low spots) Areal extent _____ Depth _____ Remarks _____	☐ Location shown on site map ☐ Settlement not evident	
2.	Cracks Lengths _____ Widths _____ Depths _____ Remarks _____	☐ Location shown on site map ☐ Cracking not evident	
3.	Erosion Areal extent _____ Remarks _____	☐ Location shown on site map ☐ Erosion not evident	
4.	Holes Areal extent _____ Remarks _____	☐ Location shown on site map ☐ Holes not evident	
5.	Vegetative Cover ☐ Grass ☐ Cover properly established ☐ No signs of stress ☐ Trees/Shrubs (indicate size and locations on a diagram) Remarks _____		
6.	Alternative Cover (armored rock, concrete, etc.) ☐ N/A Remarks _____		
7.	Bulges Areal extent _____ Remarks _____	☐ Location shown on site map ☐ Bulges not evident	
8.	Wet Areas/Water Damage ☐ Wet areas ☐ Location shown on site map Areal extent _____ ☐ Ponding ☐ Location shown on site map Areal extent _____ ☐ Seeps ☐ Location shown on site map Areal extent _____ ☐ Soft subgrade ☐ Location shown on site map Areal extent _____ Remarks _____		

9.	Slope Instability	☐ Slides	☐ Location shown on site map	☐ No evidence of slope instability
Areal extent_____				
Remarks_____				
B. Benches ☐ Applicable ☐ N/A (Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)				
1.	Flows Bypass Bench	☐ Location shown on site map	☐ N/A or okay	
Remarks_____				
2.	Bench Breached	☐ Location shown on site map	☐ N/A or okay	
Remarks_____				
3.	Bench Overtopped	☐ Location shown on site map	☐ N/A or okay	
Remarks_____				
C. Letdown Channels ☐ Applicable ☐ N/A (Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)				
1.	Settlement	☐ Location shown on site map	☐ No evidence of settlement	
Areal extent_____ Depth_____				
Remarks_____				
2.	Material Degradation	☐ Location shown on site map	☐ No evidence of degradation	
Material type_____ Areal extent_____				
Remarks_____				
3.	Erosion	☐ Location shown on site map	☐ No evidence of erosion	
Areal extent_____ Depth_____				
Remarks_____				

4.	Undercutting	☐ Location shown on site map	☐ No evidence of undercutting
	Areal extent_____	Depth_____	
	Remarks_____		

5.	Obstructions	Type_____	☐ No obstructions
	☐ Location shown on site map	Areal extent_____	
	Size_____		
	Remarks_____		

6.	Excessive Vegetative Growth	Type_____	
	☐ No evidence of excessive growth		
	☐ Vegetation in channels does not obstruct flow		
	☐ Location shown on site map	Areal extent_____	
	Remarks_____		

D. Cover Penetrations ☐ Applicable ☐ N/A			
1.	Gas Vents	☐ Active ☐ Passive	
	☐ Properly secured/locked	☐ Functioning	☐ Routinely sampled
	☐ Evidence of leakage at penetration	☐ Needs Maintenance	☐ Good condition
	☐ N/A		
	Remarks_____		

2.	Gas Monitoring Probes	☐ Properly secured/locked ☐ Functioning	☐ Routinely sampled
	☐ Evidence of leakage at penetration	☐ Needs Maintenance	☐ Good condition
	☐ N/A		
	Remarks_____		

3.	Monitoring Wells (within surface area of landfill)	☐ Properly secured/locked ☐ Functioning	☐ Routinely sampled
	☐ Evidence of leakage at penetration	☐ Needs Maintenance	☐ Good condition
	☐ N/A		
	Remarks_____		

4.	Leachate Extraction Wells	☐ Properly secured/locked ☐ Functioning	☐ Routinely sampled
	☐ Evidence of leakage at penetration	☐ Needs Maintenance	☐ Good condition
	☐ N/A		
	Remarks_____		

5.	Settlement Monuments	☐ Located	☐ Routinely surveyed
	☐ N/A		
	Remarks_____		

E. Gas Collection and Treatment			☐ Applicable	☐ N/A
1.	Gas Treatment Facilities ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse ☐ Good condition ☐ Needs Maintenance Remarks _____ _____			
2.	Gas Collection Wells, Manifolds and Piping ☐ Good condition ☐ Needs Maintenance Remarks _____ _____			
3.	Gas Monitoring Facilities (e.g., gas monitoring of adjacent homes or buildings) ☐ Good condition ☐ Needs Maintenance ☐ N/A Remarks _____ _____			
F. Cover Drainage Layer			☐ Applicable	☐ N/A
1.	Outlet Pipes Inspected ☐ Functioning ☐ N/A Remarks _____ _____			
2.	Outlet Rock Inspected ☐ Functioning ☐ N/A Remarks _____ _____			
G. Detention/Sedimentation Ponds			☐ Applicable	☐ N/A
1.	Siltation Areal extent _____ Depth _____ ☐ N/A ☐ Siltation not evident Remarks _____ _____			
2.	Erosion Areal extent _____ Depth _____ ☐ Erosion not evident Remarks _____ _____			
3.	Outlet Works ☐ Functioning ☐ N/A Remarks _____ _____			
4.	Dam ☐ Functioning ☐ N/A Remarks _____ _____			

H. Retaining Walls		☐ Applicable	☐ N/A
1.	Deformations	☐ Location shown on site map	☐ Deformation not evident
	Horizontal displacement_____	Vertical displacement_____	
	Rotational displacement_____		
	Remarks_____		
2.	Degradation	☐ Location shown on site map	☐ Degradation not evident
	Remarks_____		
I. Perimeter Ditches/Off-Site Discharge		☐ Applicable	☐ N/A
1.	Siltation	☐ Location shown on site map	☐ Siltation not evident
	Areal extent_____	Depth_____	
	Remarks_____		
2.	Vegetative Growth	☐ Location shown on site map	☐ N/A
	☐ Vegetation does not impede flow		
	Areal extent_____	Type_____	
	Remarks_____		
3.	Erosion	☐ Location shown on site map	☐ Erosion not evident
	Areal extent_____	Depth_____	
	Remarks_____		
4.	Discharge Structure	☐ Functioning	☐ N/A
	Remarks_____		
VIII. VERTICAL BARRIER WALLS			
		☐ Applicable	☒ N/A
1.	Settlement	☐ Location shown on site map	☐ Settlement not evident
	Areal extent_____	Depth_____	
	Remarks_____		
2.	Performance Monitoring	Type of monitoring_____	
	☐ Performance not monitored		
	Frequency_____	☐ Evidence of breaching	
	Head differential_____		
	Remarks_____		

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable x N/A	
A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☐ N/A	
1.	Pumps, Wellhead Plumbing, and Electrical ☐ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A Remarks _____ _____ _____
2.	Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances ☐ Good condition ☐ Needs Maintenance Remarks _____ _____
3.	Spare Parts and Equipment ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks _____ _____
B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☐ N/A	
1.	Collection Structures, Pumps, and Electrical ☐ Good condition ☐ Needs Maintenance Remarks _____ _____
2.	Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances ☐ Good condition ☐ Needs Maintenance Remarks _____ _____
3.	Spare Parts and Equipment ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks _____ _____

C. Treatment System ☐ Applicable x N/A			
1.	Treatment Train (Check components that apply) ☐ Metals removal ☐ Oil/water separation ☐ Bioremediation ☐ Air stripping ☐ Carbon adsorbers ☐ Filters _____ ☐ Additive (e.g., chelation agent, flocculent) _____ ☐ Others _____ ☐ Good condition ☐ Needs Maintenance ☐ Sampling ports properly marked and functional ☐ Sampling/maintenance log displayed and up to date ☐ Equipment properly identified ☐ Quantity of groundwater treated annually _____ ☐ Quantity of surface water treated annually _____ Remarks _____ _____		
2.	Electrical Enclosures and Panels (properly rated and functional) ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks _____ _____		
3.	Tanks, Vaults, Storage Vessels ☐ N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs Maintenance Remarks _____ _____		
4.	Discharge Structure and Appurtenances ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks _____ _____		
5.	Treatment Building(s) ☐ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair ☐ Chemicals and equipment properly stored Remarks _____ _____		
6.	Monitoring Wells (pump and treatment remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks _____ _____		
D. Monitoring Data			
1.	Monitoring Data ☐ Is routinely submitted on time ☐ Is of acceptable quality		
2.	Monitoring data suggests: ☐ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining		

D. Monitored Natural Attenuation			
1.	Monitoring Wells (natural attenuation remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks _____ _____		
X. OTHER REMEDIES			
If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction. Not Applicable			
XI. OVERALL OBSERVATIONS			
A.	Implementation of the Remedy		
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). Former BSVR system to remediate petroleum contamination in soil (now shutdown).		
B.	Adequacy of O&M		
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. Not Applicable.		
C.	Early Indicators of Potential Remedy Problems		
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. Not Applicable		
D.	Opportunities for Optimization		
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. Not Applicable		

PFSA Photo 1



APPENDIX C

WELL DETERMINATION

ADDRESS: 3 Pinecrest Avenue, Mashpee MA

APEMS ID: 30130

WELL STATUS: ACTIVE

WELL USE: Outdoor uses

SUMMARY: According to information summarized in the parcel summary report (attached), this residence is connected to the Mashpee municipal water supply. This residence receives a water bill from the Mashpee Water District. However, there is a private well located on this property that is used for outdoor purposes. The depth of this well is unknown. Depth to water at this property is approximately 13 feet below ground surface (ft bgs) or an elevation of 39 feet mean sea level (ft msl).

DATA REVIEW:

- ☒ Monitoring data are available for the PFSA plume [see attached map and data table].
 - 00MW0523B [monitoring data]
 - 00MW0560 [sampling data]
 - 24DP0504 [vertical profiling]
 - 24DP0505 [vertical profiling]
 - 24DP0506 [vertical profiling]
- ☒ The leading edge of the PFSA plume is located in the vicinity of monitoring well 00MW0523, which is located approximately 950 feet northwest and hydraulically upgradient of 3 Pinecrest Avenue (location map attached). A review of analytical data obtained from groundwater vertical profiling in 2015 at 24DP0504, 24DP0505, and 24DP0506 indicates that the leading edge of the PFSA plume is narrow (less than 350 ft wide) and thin (52-62 ft bgs or 23-13 ft msl) and overlain by approximately 10 feet of clean water (data table attached). The vertical profiling data collected in January 2015 and subsequent groundwater sampling at monitoring well 00MW0523B in 2015 and 2016 indicated that the leading edge of the PFSA plume was located to the north of Ashumet Avenue, over 1,000 feet upgradient of 3 Pinecrest Avenue. However, sampling of leading edge well 00MW0523B in 2017 indicated that the concentrations of some PFSA COCs increased above groundwater standards/risk based concentrations at this well. In response to this increase at 00MW0523B, the PFSA Land Use Control (LUC) area was expanded to the south to include the area between Ashumet Avenue and the shore of Johns Pond and a one-time sampling of 00MW0560 for Extractable Petroleum Hydrocarbon (EPH)/Volatile Petroleum Hydrocarbon (VPH) and trimethylbenzene (TMB) analysis was conducted to assess water quality in the immediate vicinity of active irrigation wells within the expanded PFSA LUC area. The screen depth for 00MW0560 is 39 ft bgs, which is similar to the average depth of 35 ft bgs for private residential wells in this area of Pinecrest Avenue (as reported in the MassDEP WellSearch database, which was accessed on 11 July 2017 at <http://public.dep.state.ma.us/searchwell/>). No PFSA COCs were detected in the groundwater sample collected from 00MW0560 on 28 April 2017.
- ☒ **DETERMINATION:** Groundwater monitoring data at PFSA indicates that the leading edge of the PFSA plume is located near Ashumet Avenue, approximately 950 feet northwest and upgradient of the private well at 3 Pinecrest Avenue. Sampling of monitoring well 00MW0560 in 2017, which is located approximately 100 feet from 3 Pinecrest Avenue, confirms that PFSA COCs are not present in shallow

WELL DETERMINATION

groundwater near this private well. Therefore, intermittent use of this well for outdoor irrigation purposes is not expected to result in exposure to COC concentrations greater than the GW-1 standards and/or risk based concentrations. This finding is supported by monitoring data at the PFSA plume and a one-time sampling of nearby shallow groundwater at 00MW0560.

PATH FORWARD: No sampling needed.

SAMPLING NEEDED: ☐Yes ☒No

RE-EVALUATE IN NEXT 5-YEAR REVIEW: ☒Yes ☐No



AFCEE JBCC Briarwood Supplemental Parcel Summary

Report Produced: 7/11/2017

Name: BARRY LORRAINE E & JOHN L

Plume:

Telephone No.

Mailing Address

Town Numbers

AFCEE Plume:

Map: 49

Section:

Parcel: 168

Lot:

Mailing PO:

Mailing Street: 3 PINECREST AV

Residential Well Notes:

Mailing City: MASHPEE

Mailing State: MA

Mailing ZIP: 02649

Irrigation Well Notes:

Parcel Address

Town Water Notes: Mashpee Water District verified on 7-23-14 that a water account exists for this parcel.

APEMS ID: 30130

Parcel Street: PINECREST AV 3

Parcel City:

Other Notes:

Parcel State:

Parcel ZIP:

☐ Checked if the parcel respond to the state's 5-Star survey.

☐ Checked if AFCEE has been in contact with the parcel and no contact is needed.

Initial Mailing Sent? ☒

Date Sent: 7/14/2014

Date Returned:

Second Mailing Sent? ☒

Date Sent: 8/12/2014

Date Returned:

Third Mailing Sent? ☒

Date Sent: 8/22/2014

Date Returned:

Contacted by Phone? ☐

Date Contacted:

Contact Note:

Contacted by Email? ☐

Email Date:

Date Returned::

Contacted In-Person? ☒

Date Contacted: 8/31/2014

Field Visit Performed? ☒

Field Visit Date: 8/31/2014

Field Visit Note: Functional well exists per owner during field visit. Used only for outside watering.

Other Contact Notes: Left notice during field visit on 7-14-14.
Left notice during field visit on 8-12-14.
Left notice 8-22-14 during field visit.
No answer, 8-23-14 field visit (Saturday morning).

Wells associated with this parcel:

LocID

Functional? ☒

Depth 0

Decomissioned? ☐

Well Deemed Safe? ☐

Non-Functional? ☐

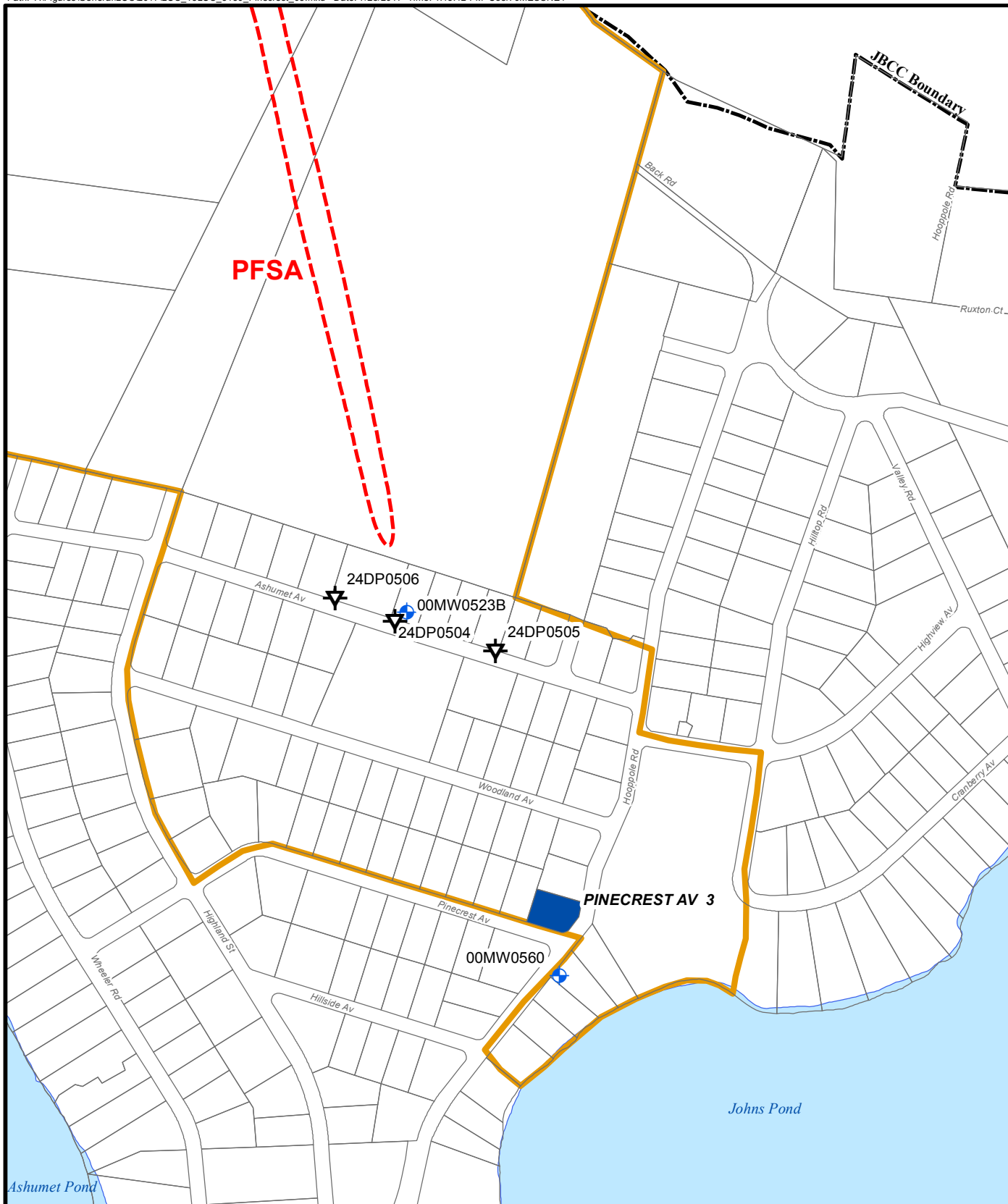
Pump Rate 0

Decomission Offer Made? ☐

Date:

Other Status?

Decomission Offer Received? ☐

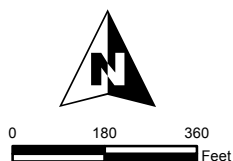


Legend

- Plume Boundary
- LUC Boundary
- Parcel of Interest
- Other Parcel
- Joint Base Cape Cod Boundary

- + Monitoring Well
- + Direct Push/Borehole
- + Irrigation Well

Data Source: AFCEC, July 2017



LOCATION: 3 PINECREST AV.
AFCEC - Joint Base Cape Cod
PFSA Land Use Control

Summary of COC Results at Groundwater Vertical Profiling Locations

Location	Depth (ft bgs)	Matrix	Test	Analyte	Date	Result	DL	RL	Standard	Type ^{1,2}	Exceeded
						All units - µg/L					
24DP0504	42.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	1/13/2015	ND	0.19	1	19	RBC	No
24DP0504	42.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	1/13/2015	ND	0.17	1	19	RBC	No
24DP0504	42.5	WA	MADEPEP	2-METHYLNAPHTHALENE	1/13/2015	ND	0.108	0.4	10	GW-1	No
24DP0504	42.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	1/13/2015	ND	100	100	200	GW-1	No
24DP0504	42.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	1/13/2015	ND	50	50	300	GW-1	No
24DP0504	42.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	1/13/2015	ND	50	50	200	GW-1	No
24DP0504	42.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	1/13/2015	ND	50	50	700	GW-1	No
24DP0504	52.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	1/14/2015	BRL	0.19	1	19	RBC	No
24DP0504	52.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	1/14/2015	ND	0.17	1	19	RBC	No
24DP0504	52.5	WA	MADEPEP	2-METHYLNAPHTHALENE	1/14/2015	ND	0.108	0.4	10	GW-1	No
24DP0504	52.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	1/14/2015	ND	100	100	200	GW-1	No
24DP0504	52.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	1/14/2015	176	50	50	300	GW-1	No
24DP0504	52.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	1/14/2015	66.9	50	50	200	GW-1	No
24DP0504	52.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	1/14/2015	118	50	50	700	GW-1	No
24DP0504	62.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	1/14/2015	BRL	0.19	1	19	RBC	No
24DP0504	62.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	1/14/2015	ND	0.17	1	19	RBC	No
24DP0504	62.5	WA	MADEPEP	2-METHYLNAPHTHALENE	1/14/2015	ND	0.108	0.4	10	GW-1	No
24DP0504	62.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	1/14/2015	ND	100	100	200	GW-1	No
24DP0504	62.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	1/14/2015	ND	50	50	300	GW-1	No
24DP0504	62.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	1/14/2015	ND	50	50	200	GW-1	No
24DP0504	62.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	1/14/2015	65.7	50	50	700	GW-1	No
24DP0504	72.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	1/14/2015	ND	0.19	1	19	RBC	No
24DP0504	72.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	1/14/2015	ND	0.17	1	19	RBC	No
24DP0504	72.5	WA	MADEPEP	2-METHYLNAPHTHALENE	1/14/2015	ND	0.108	0.4	10	GW-1	No
24DP0504	72.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	1/14/2015	ND	100	100	200	GW-1	No
24DP0504	72.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	1/14/2015	ND	50	50	300	GW-1	No
24DP0504	72.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	1/14/2015	ND	50	50	200	GW-1	No
24DP0504	72.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	1/14/2015	ND	50	50	700	GW-1	No
24DP0504	82.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	1/15/2015	ND	0.19	1	19	RBC	No
24DP0504	82.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	1/15/2015	ND	0.17	1	19	RBC	No
24DP0504	82.5	WA	MADEPEP	2-METHYLNAPHTHALENE	1/15/2015	ND	0.108	0.4	10	GW-1	No
24DP0504	82.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	1/15/2015	ND	100	100	200	GW-1	No
24DP0504	82.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	1/15/2015	ND	50	50	300	GW-1	No
24DP0504	82.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	1/15/2015	ND	50	50	200	GW-1	No
24DP0504	82.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	1/15/2015	ND	50	50	700	GW-1	No
24DP0504	92.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	1/15/2015	ND	0.19	1	19	RBC	No
24DP0504	92.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	1/15/2015	ND	0.17	1	19	RBC	No
24DP0504	92.5	WA	MADEPEP	2-METHYLNAPHTHALENE	1/15/2015	ND	0.108	0.4	10	GW-1	No
24DP0504	92.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	1/15/2015	ND	100	100	200	GW-1	No
24DP0504	92.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	1/15/2015	ND	50	50	300	GW-1	No
24DP0504	92.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	1/15/2015	ND	50	50	200	GW-1	No
24DP0504	92.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	1/15/2015	ND	50	50	700	GW-1	No
24DP0505	42.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	2/26/2015	ND	0.19	1	19	RBC	No
24DP0505	42.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	2/26/2015	ND	0.17	1	19	RBC	No
24DP0505	42.5	WA	MADEPEP	2-METHYLNAPHTHALENE	2/26/2015	ND	0.108	0.4	10	GW-1	No
24DP0505	42.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	2/26/2015	ND	100	100	200	GW-1	No
24DP0505	42.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	2/26/2015	ND	50	50	300	GW-1	No
24DP0505	42.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	2/26/2015	ND	50	50	200	GW-1	No
24DP0505	42.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	2/26/2015	ND	50	50	700	GW-1	No
24DP0505	52.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	2/26/2015	ND	0.19	1	19	RBC	No
24DP0505	52.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	2/26/2015	ND	0.17	1	19	RBC	No
24DP0505	52.5	WA	MADEPEP	2-METHYLNAPHTHALENE	2/26/2015	ND	0.108	0.4	10	GW-1	No
24DP0505	52.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	2/26/2015	ND	100	100	200	GW-1	No
24DP0505	52.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	2/26/2015	ND	50	50	300	GW-1	No
24DP0505	52.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	2/26/2015	ND	50	50	200	GW-1	No
24DP0505	52.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	2/26/2015	ND	50	50	700	GW-1	No
24DP0505	62.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	2/26/2015	ND	0.19	1	19	RBC	No
24DP0505	62.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	2/26/2015	ND	0.17	1	19	RBC	No
24DP0505	62.5	WA	MADEPEP	2-METHYLNAPHTHALENE	2/26/2015	ND	0.108	0.4	10	GW-1	No
24DP0505	62.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	2/26/2015	ND	100	100	200	GW-1	No
24DP0505	62.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	2/26/2015	ND	50	50	300	GW-1	No
24DP0505	62.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	2/26/2015	ND	50	50	200	GW-1	No
24DP0505	62.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	2/26/2015	ND	50	50	700	GW-1	No

Summary of COC Results at Groundwater Vertical Profiling Locations

Location	Depth (ft bgs)	Matrix	Test	Analyte	Date	Result	DL	RL	Standard	Type ^{1,2}	Exceeded
						All units - µg/L					
24DP0505	62.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	2/26/2015	ND	50	50	700	GW-1	No
24DP0505	72.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	2/26/2015	ND	0.19	1	19	RBC	No
24DP0505	72.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	2/26/2015	ND	0.17	1	19	RBC	No
24DP0505	72.5	WA	MADEPEP	2-METHYLNAPHTHALENE	2/26/2015	ND	0.108	0.4	10	GW-1	No
24DP0505	72.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	2/26/2015	ND	100	100	200	GW-1	No
24DP0505	72.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	2/26/2015	ND	50	50	300	GW-1	No
24DP0505	72.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	2/26/2015	ND	50	50	200	GW-1	No
24DP0505	72.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	2/26/2015	ND	50	50	700	GW-1	No
24DP0505	82.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	2/26/2015	ND	0.19	1	19	RBC	No
24DP0505	82.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	2/26/2015	ND	0.17	1	19	RBC	No
24DP0505	82.5	WA	MADEPEP	2-METHYLNAPHTHALENE	2/26/2015	ND	0.108	0.4	10	GW-1	No
24DP0505	82.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	2/26/2015	ND	100	100	200	GW-1	No
24DP0505	82.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	2/26/2015	ND	50	50	300	GW-1	No
24DP0505	82.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	2/26/2015	ND	50	50	200	GW-1	No
24DP0505	82.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	2/26/2015	ND	50	50	700	GW-1	No
24DP0506	42.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	3/9/2015	ND	0.19	1	19	RBC	No
24DP0506	42.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	3/9/2015	ND	0.17	1	19	RBC	No
24DP0506	42.5	WA	MADEPEP	2-METHYLNAPHTHALENE	3/9/2015	ND	0.108	0.4	10	GW-1	No
24DP0506	42.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	3/9/2015	ND	100	100	200	GW-1	No
24DP0506	42.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	3/9/2015	ND	50	50	300	GW-1	No
24DP0506	42.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	3/9/2015	ND	50	50	200	GW-1	No
24DP0506	42.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	3/9/2015	ND	50	50	700	GW-1	No
24DP0506	52.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	3/9/2015	ND	0.19	1	19	RBC	No
24DP0506	52.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	3/9/2015	ND	0.17	1	19	RBC	No
24DP0506	52.5	WA	MADEPEP	2-METHYLNAPHTHALENE	3/9/2015	ND	0.108	0.4	10	GW-1	No
24DP0506	52.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	3/9/2015	ND	100	100	200	GW-1	No
24DP0506	52.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	3/9/2015	ND	50	50	300	GW-1	No
24DP0506	52.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	3/9/2015	ND	50	50	200	GW-1	No
24DP0506	52.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	3/9/2015	ND	50	50	700	GW-1	No
24DP0506	62.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	3/9/2015	ND	0.19	1	19	RBC	No
24DP0506	62.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	3/9/2015	ND	0.17	1	19	RBC	No
24DP0506	62.5	WA	MADEPEP	2-METHYLNAPHTHALENE	3/9/2015	ND	0.108	0.4	10	GW-1	No
24DP0506	62.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	3/9/2015	ND	100	100	200	GW-1	No
24DP0506	62.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	3/9/2015	ND	50	50	300	GW-1	No
24DP0506	62.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	3/9/2015	ND	50	50	200	GW-1	No
24DP0506	62.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	3/9/2015	ND	50	50	700	GW-1	No
24DP0506	72.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	3/10/2015	ND	0.19	1	19	RBC	No
24DP0506	72.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	3/10/2015	ND	0.17	1	19	RBC	No
24DP0506	72.5	WA	MADEPEP	2-METHYLNAPHTHALENE	3/10/2015	ND	0.108	0.4	10	GW-1	No
24DP0506	72.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	3/10/2015	ND	100	100	200	GW-1	No
24DP0506	72.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	3/10/2015	ND	50	50	300	GW-1	No
24DP0506	72.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	3/10/2015	ND	50	50	200	GW-1	No
24DP0506	72.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	3/10/2015	ND	50	50	700	GW-1	No
24DP0506	82.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	3/10/2015	ND	0.19	1	19	RBC	No
24DP0506	82.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	3/10/2015	ND	0.17	1	19	RBC	No
24DP0506	82.5	WA	MADEPEP	2-METHYLNAPHTHALENE	3/10/2015	ND	0.108	0.4	10	GW-1	No
24DP0506	82.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	3/10/2015	ND	100	100	200	GW-1	No
24DP0506	82.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	3/10/2015	ND	50	50	300	GW-1	No
24DP0506	82.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	3/10/2015	ND	50	50	200	GW-1	No
24DP0506	82.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	3/10/2015	ND	50	50	700	GW-1	No

Data Source: AFCEC, 2017

Notes:

- GW-1 = MassDEP MCP Method 1 Groundwater-1 Standards from MassDEP web page http://www.mass.gov/dep/cleanup/laws/0974_2.htm.
- RBC = Site Specific Risk Based Concentration from *Final PFSA Focused Feasibility Study* (AFCEC 2014).

Key:

BRL = below reporting limit

DL = detection limit

ft bgs = feet below ground surface

GW-1 = MCP Method 1 Groundwater-1 standard

J = estimated value

MassDEP = Massachusetts Department of Environmental Protection

MCP = Massachusetts Contingency Plan

ND = nondetect

RBC = risk-based concentration

RL = reporting limit

WA = borehole water

µg/L = micrograms per liter

PFSA LTM Groundwater Network COC Sampling Results

Location	Date	1,2,4- Trimethylbenzene (µg/L) RBC = 19	1,3,5- Trimethylbenzene (Mesitylene) (µg/L) RBC = 19	2-Methylnaphthalene (µg/L) GW-1 = 10	C ₁₁ -C ₂₂ Aromatic Hydrocarbons (µg/L) GW-1 = 200	C ₅ -C ₈ Aliphatic Hydrocarbons (µg/L) GW-1 = 300	C ₉ -C ₁₀ Aromatic Hydrocarbons (µg/L) GW-1 = 200	C ₉ -C ₁₂ Aliphatic Hydrocarbons (µg/L) GW-1 = 700
00MW0523B	1/5/2016	ND	ND	ND	ND	ND	ND	ND
	12/7/2016	19.9	ND	BRL	BRL	274	220	75
	Resample 2/3/2017	34.1	ND	BRL	106	457	254	111
00MW560	4/28/2017	ND	ND	ND	ND	ND	ND	ND

Data Source: AFCEC, June 2017

Notes:

BOLD values indicate a RBC or GW-1 exceedance.

Analytical methods for the specified parameters: 1,2,4- and 1,3,5-TMBs (SW8260C); 2-methylnaphthalene and C₁₁-C₂₂ hydrocarbons (MADEPEP); C₅-C₈, C₉-C₁₀, and C₉-C₁₂ hydrocarbons (MADEPVP) .

GW-1 = MassDEP MCP Method 1 Groundwater-1 Standards from MassDEP web page http://www.mass.gov/dep/cleanup/laws/0974_2.htm.

No federal cleanup standard for either of the isomers of trimethylbenzene (TMB) has been developed. However, an RBC of 19 µg/L was established for FS-13 as part of the *Final 4th Five-Year Review, 2007-2012 Massachusetts Military Reservation (MMR) Superfund Site* (AFCEC 2013).

MassDEP MCP Method 1 Groundwater 2 Standards: 2-methylnaphthalene (2,000 µg/L); C₁₁-C₂₂ hydrocarbons (50,000 µg/L); C₅-C₈ hydrocarbons (3,000 µg/L); C₉-C₁₀ hydrocarbons (4,000 µg/L); C₉-C₁₂ hydrocarbons (5,000 µg/L) from MassDEP web page <http://www.mass.gov/eea/agencies/massdep/cleanup/regulations/mcp-method-1-groundwater-standards.html>

Key:

BRL = below reporting limits

EPH = extractable petroleum hydrocarbons

GW-1 = Groundwater-1

J = estimated value

MADEPEP = MassDEP method for determination of extractable petroleum hydrocarbons

MADEPVP = MassDEP method for determination of volatile petroleum hydrocarbons

ND = not detected

NR = not reported

NS = not sampled

MassDEP = Massachusetts Department of Environmental Protection

MCP = Massachusetts Contingency Plan

PFSA = Petroleum Fuel Storage Area

RBC = risk-based concentration

SW8060C = analytical sampling method for volatile organic compounds

VPH = volatile petroleum hydrocarbons

µg/L = micrograms per liter

WELL DETERMINATION

ADDRESS: 247 Hooppole Road, Mashpee MA

APEMS ID: 30149

WELL STATUS: ACTIVE

WELL USE: Outdoor uses

SUMMARY: According to information summarized in the parcel summary report (attached), this residence is connected to the Mashpee municipal water supply. This residence receives a water bill from the Mashpee Water District. However, there is a private well located on this property that is used for outdoor purposes. The depth of this well is unknown. Depth to water at this property is approximately 13 feet below ground surface (ft bgs) or an elevation of 39 feet mean sea level (ft msl).

DATA REVIEW:

- ☒ Monitoring data are available for the PFSA plume [see attached map and data table].
 - 00MW0523B [monitoring data]
 - 00MW0560 [sampling data]
 - 24DP0504 [vertical profiling]
 - 24DP0505 [vertical profiling]
 - 24DP0506 [vertical profiling]
- ☒ The leading edge of the PFSA plume is located in the vicinity of monitoring well 00MW0523, which is located approximately 1,000 feet northwest and hydraulically upgradient of 247 Hooppole Road (location map attached). A review of analytical data obtained from groundwater vertical profiling in 2015 at 24DP0504, 24DP0505, and 24DP0506 indicates that the leading edge of the PFSA plume is narrow (less than 350 ft wide) and thin (52-62 ft bgs or 23-13 ft msl) and overlain by approximately 10 feet of clean water (data table attached). The vertical profiling data collected in January 2015 and subsequent groundwater sampling at monitoring well 00MW0523B in 2015 and 2016 indicated that the leading edge of the PFSA plume was located to the north of Ashumet Avenue, over 1,000 feet upgradient of 247 Hooppole Road. However, sampling of leading edge well 00MW0523B in 2017 indicated that the concentrations of some PFSA COCs increased above groundwater standards/risk based concentrations at this well. In response to this increase at 00MW0523B, the PFSA Land Use Control (LUC) area was expanded to the south to include the area between Ashumet Avenue and the shore of Johns Pond and a one-time sampling of 00MW0560 for Extractable Petroleum Hydrocarbon (EPH)/Volatile Petroleum Hydrocarbon (VPH) and trimethylbenzene (TMB) analysis was conducted to assess water quality in the immediate vicinity of active irrigation wells within the expanded PFSA LUC area. The screen depth for 00MW0560 is 39 ft bgs, which is similar to the average depth of 35 ft bgs for private residential wells in this area of Hooppole Road (as reported in the MassDEP WellSearch database, which was accessed on 11 July 2017 at <http://public.dep.state.ma.us/searchwell/>). No PFSA COCs were detected in the groundwater sample collected from 00MW0560 on 28 April 2017.
- ☒ **DETERMINATION:** Groundwater monitoring data at PFSA indicates that the leading edge of the PFSA plume is located near Ashumet Avenue, approximately 1,000 feet northwest and upgradient of the private well at 247 Hooppole Road. Sampling of monitoring well 00MW0560 in 2017, which is located approximately 100 feet from 247 Hooppole Road, confirms that PFSA COCs are not present in shallow

WELL DETERMINATION

groundwater near this private well. Therefore, intermittent use of this well for outdoor irrigation purposes is not expected to result in exposure to COC concentrations greater than the GW-1 standards and/or risk based concentrations. This finding is supported by monitoring data at the PFSA plume and a one-time sampling of nearby shallow groundwater at 00MW0560.

PATH FORWARD: No sampling needed.

SAMPLING NEEDED: ☐Yes ☒No

RE-EVALUATE IN NEXT 5-YEAR REVIEW: ☒Yes ☐No



AFCEC JBCC Briarwood Supplemental Parcel Summary

Report Produced: 7/11/2017

Name: MCGRATH ROSS L & SYLVIA TRS MC

Plume:

Telephone No.

Mailing Address

Town Numbers

AFCEE Plume:

Map: 49

Section:

Parcel: 201

Lot:

Mailing PO:

Mailing Street: C/O SYLVIA MCGRATH
EXEC.

Residential Well Notes:

Mailing City: WEYMOUTH

Mailing State: MA

Mailing ZIP: 02189

Irrigation Well Notes:

Parcel Address

Town Water Notes: Mashpee Water District verified on 7-23-14 that
a water account exists for this parcel.

APEMS ID: 30149

Parcel Street: HOOPPOLE RD 247

Parcel City:

Other Notes:

Parcel State:

Parcel ZIP:

☐ Checked if the parcel respond to the state's 5-Star survey.

☐ Checked if AFCEE has been in contact with the parcel and no contact is needed.

Initial Mailing Sent? ☒

Date Sent: 7/14/2014

Date Returned:

Second Mailing Sent? ☐

Date Sent:

Date Returned:

Third Mailing Sent? ☐

Date Sent:

Date Returned:

Contacted by Phone? ☒

Date Contacted: 7/24/2014

Contact Note: Functional well for outside use per call 7-24-14.

Contacted by Email? ☐

Email Date:

Date Returned::

Contacted In-Person? ☐

Date Contacted:

Field Visit Performed? ☒

Field Visit Date:

Field Visit Note:

Other Contact Notes: Left notice 7-14-14.

Functional well for outside use per call 7-24-14.

Wells associated with this parcel:

LocID

Functional? ☒

Depth 0

Decomissioned? ☐

Well Deemed Safe? ☐

Non-Functional? ☐

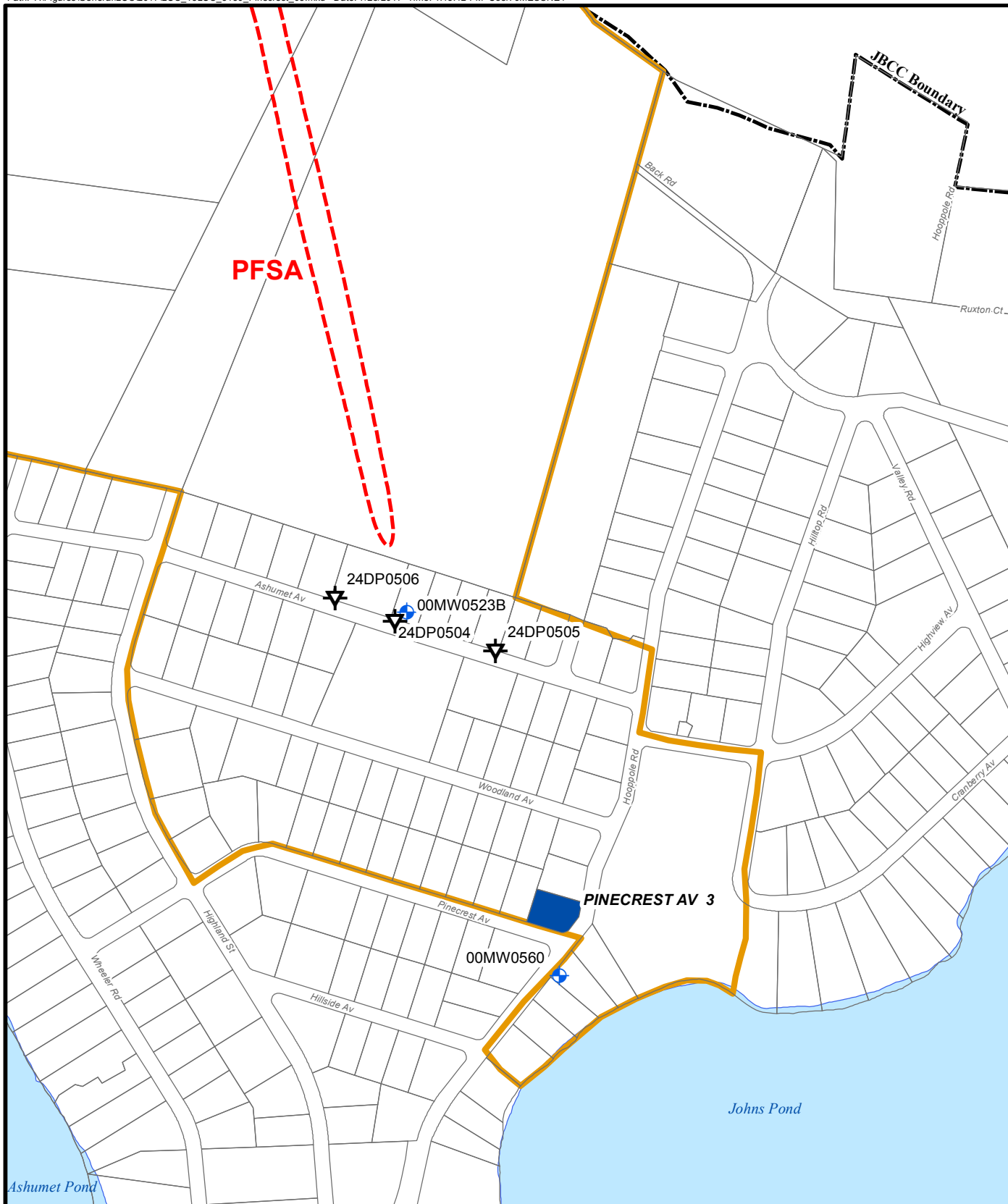
Pump Rate 0

Decomission Offer Made? ☐

Date:

Other Status?

Decomission Offer Received? ☐

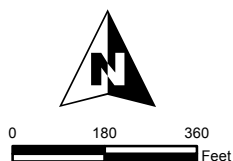


Legend

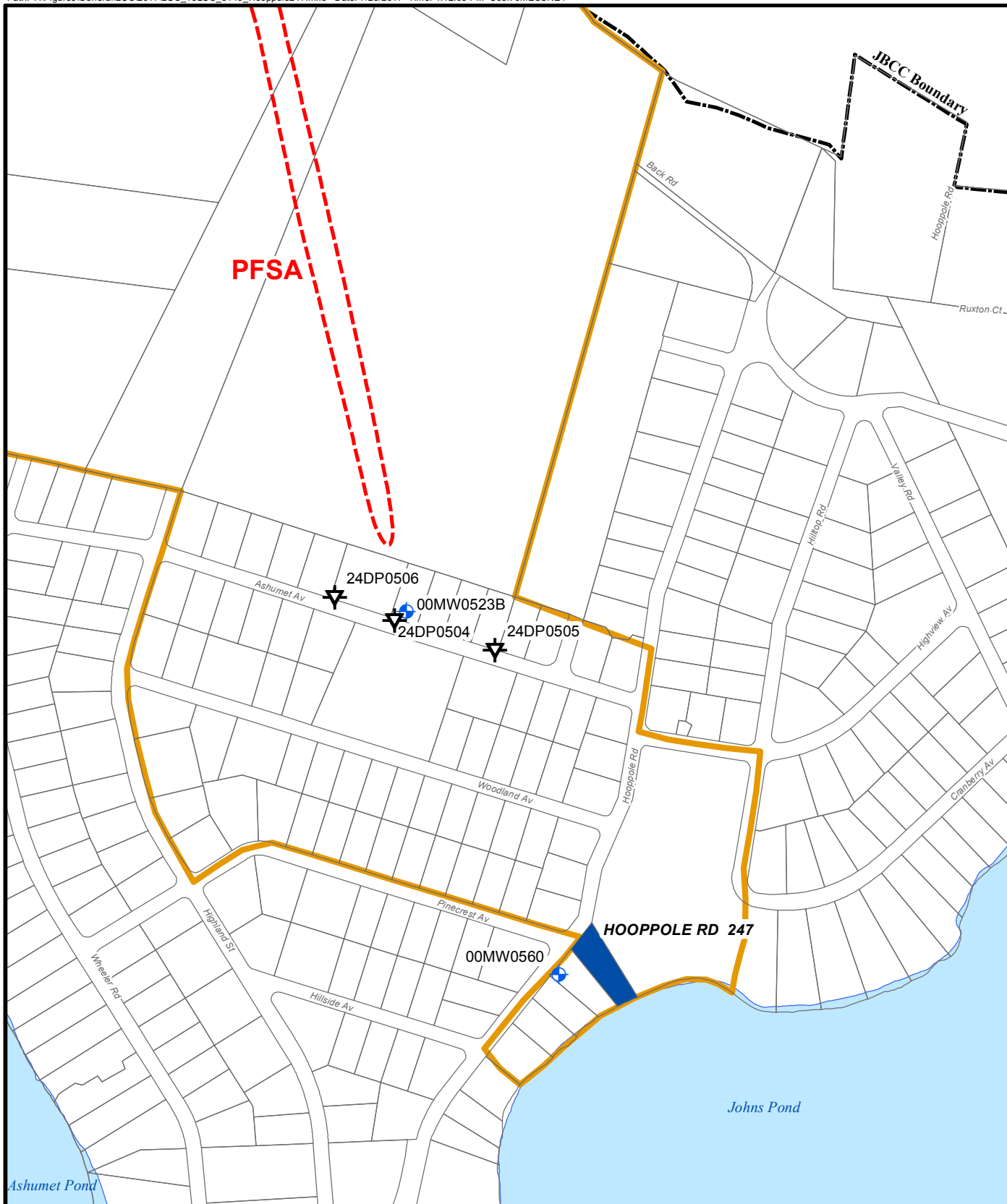
- Plume Boundary
- LUC Boundary
- Parcel of Interest
- Other Parcel
- Joint Base Cape Cod Boundary

- + Monitoring Well
- ▼ Direct Push/Borehole
- ⊗ Irrigation Well

Data Source: AFCEC, July 2017



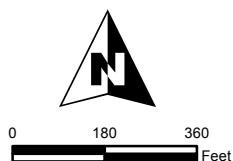
LOCATION: 3 PINECREST AV.
AFCEC - Joint Base Cape Cod
PFSA Land Use Control



Legend

- Plume Boundary
- LUC Boundary
- Parcel of Interest
- Other Parcel
- Joint Base Cape Cod Boundary
- + Monitoring Well
- + Direct Push/Borehole
- + Irrigation Well

Data Source: AFCEC, July 2017



LOCATION: 247 HOOPPOLE RD.
 AFCEC - Joint Base Cape Cod
 PFSA Land Use Control

PFSA LTM Groundwater Network COC Sampling Results

Location	Date	1,2,4- Trimethylbenzene (µg/L) RBC = 19	1,3,5- Trimethylbenzene (Mesitylene) (µg/L) RBC = 19	2-Methylnaphthalene (µg/L) GW-1 = 10	C ₁₁ -C ₂₂ Aromatic Hydrocarbons (µg/L) GW-1 = 200	C ₅ -C ₈ Aliphatic Hydrocarbons (µg/L) GW-1 = 300	C ₉ -C ₁₀ Aromatic Hydrocarbons (µg/L) GW-1 = 200	C ₉ -C ₁₂ Aliphatic Hydrocarbons (µg/L) GW-1 = 700
00MW0523B	1/5/2016	ND	ND	ND	ND	ND	ND	ND
	12/7/2016	19.9	ND	BRL	BRL	274	220	75
	Resample 2/3/2017	34.1	ND	BRL	106	457	254	111
00MW560	4/28/2017	ND	ND	ND	ND	ND	ND	ND

Data Source: AFCEC, June 2017

Notes:

BOLD values indicate a RBC or GW-1 exceedance.

Analytical methods for the specified parameters: 1,2,4- and 1,3,5-TMBs (SW8260C); 2-methylnaphthalene and C₁₁-C₂₂ hydrocarbons (MADEPEP); C₅-C₈, C₉-C₁₀, and C₉-C₁₂ hydrocarbons (MADEPVP) .

GW-1 = MassDEP MCP Method 1 Groundwater-1 Standards from MassDEP web page http://www.mass.gov/dep/cleanup/laws/0974_2.htm.

No federal cleanup standard for either of the isomers of trimethylbenzene (TMB) has been developed. However, an RBC of 19 µg/L was established for FS-13 as part of the *Final 4th Five-Year Review, 2007-2012 Massachusetts Military Reservation (MMR) Superfund Site* (AFCEC 2013).

MassDEP MCP Method 1 Groundwater 2 Standards: 2-methylnaphthalene (2,000 µg/L); C₁₁-C₂₂ hydrocarbons (50,000 µg/L); C₅-C₈ hydrocarbons (3,000 µg/L); C₉-C₁₀ hydrocarbons (4,000 µg/L); C₉-C₁₂ hydrocarbons (5,000 µg/L) from MassDEP web page <http://www.mass.gov/eea/agencies/massdep/cleanup/regulations/mcp-method-1-groundwater-standards.html>

Key:

BRL = below reporting limits

EPH = extractable petroleum hydrocarbons

GW-1 = Groundwater-1

J = estimated value

MADEPEP = MassDEP method for determination of extractable petroleum hydrocarbons

MADEPVP = MassDEP method for determination of volatile petroleum hydrocarbons

ND = not detected

NR = not reported

NS = not sampled

MassDEP = Massachusetts Department of Environmental Protection

MCP = Massachusetts Contingency Plan

PFSA = Petroleum Fuel Storage Area

RBC = risk-based concentration

SW8060C = analytical sampling method for volatile organic compounds

VPH = volatile petroleum hydrocarbons

µg/L = micrograms per liter

Summary of COC Results at Groundwater Vertical Profiling Locations

Location	Depth (ft bgs)	Matrix	Test	Analyte	Date	Result	DL	RL	Standard	Type ^{1,2}	Exceeded
						All units - µg/L					
24DP0504	42.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	1/13/2015	ND	0.19	1	19	RBC	No
24DP0504	42.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	1/13/2015	ND	0.17	1	19	RBC	No
24DP0504	42.5	WA	MADEPEP	2-METHYLNAPHTHALENE	1/13/2015	ND	0.108	0.4	10	GW-1	No
24DP0504	42.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	1/13/2015	ND	100	100	200	GW-1	No
24DP0504	42.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	1/13/2015	ND	50	50	300	GW-1	No
24DP0504	42.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	1/13/2015	ND	50	50	200	GW-1	No
24DP0504	42.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	1/13/2015	ND	50	50	700	GW-1	No
24DP0504	52.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	1/14/2015	BRL	0.19	1	19	RBC	No
24DP0504	52.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	1/14/2015	ND	0.17	1	19	RBC	No
24DP0504	52.5	WA	MADEPEP	2-METHYLNAPHTHALENE	1/14/2015	ND	0.108	0.4	10	GW-1	No
24DP0504	52.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	1/14/2015	ND	100	100	200	GW-1	No
24DP0504	52.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	1/14/2015	176	50	50	300	GW-1	No
24DP0504	52.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	1/14/2015	66.9	50	50	200	GW-1	No
24DP0504	52.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	1/14/2015	118	50	50	700	GW-1	No
24DP0504	62.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	1/14/2015	BRL	0.19	1	19	RBC	No
24DP0504	62.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	1/14/2015	ND	0.17	1	19	RBC	No
24DP0504	62.5	WA	MADEPEP	2-METHYLNAPHTHALENE	1/14/2015	ND	0.108	0.4	10	GW-1	No
24DP0504	62.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	1/14/2015	ND	100	100	200	GW-1	No
24DP0504	62.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	1/14/2015	ND	50	50	300	GW-1	No
24DP0504	62.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	1/14/2015	ND	50	50	200	GW-1	No
24DP0504	62.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	1/14/2015	65.7	50	50	700	GW-1	No
24DP0504	72.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	1/14/2015	ND	0.19	1	19	RBC	No
24DP0504	72.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	1/14/2015	ND	0.17	1	19	RBC	No
24DP0504	72.5	WA	MADEPEP	2-METHYLNAPHTHALENE	1/14/2015	ND	0.108	0.4	10	GW-1	No
24DP0504	72.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	1/14/2015	ND	100	100	200	GW-1	No
24DP0504	72.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	1/14/2015	ND	50	50	300	GW-1	No
24DP0504	72.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	1/14/2015	ND	50	50	200	GW-1	No
24DP0504	72.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	1/14/2015	ND	50	50	700	GW-1	No
24DP0504	82.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	1/15/2015	ND	0.19	1	19	RBC	No
24DP0504	82.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	1/15/2015	ND	0.17	1	19	RBC	No
24DP0504	82.5	WA	MADEPEP	2-METHYLNAPHTHALENE	1/15/2015	ND	0.108	0.4	10	GW-1	No
24DP0504	82.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	1/15/2015	ND	100	100	200	GW-1	No
24DP0504	82.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	1/15/2015	ND	50	50	300	GW-1	No
24DP0504	82.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	1/15/2015	ND	50	50	200	GW-1	No
24DP0504	82.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	1/15/2015	ND	50	50	700	GW-1	No
24DP0504	92.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	1/15/2015	ND	0.19	1	19	RBC	No
24DP0504	92.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	1/15/2015	ND	0.17	1	19	RBC	No
24DP0504	92.5	WA	MADEPEP	2-METHYLNAPHTHALENE	1/15/2015	ND	0.108	0.4	10	GW-1	No
24DP0504	92.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	1/15/2015	ND	100	100	200	GW-1	No
24DP0504	92.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	1/15/2015	ND	50	50	300	GW-1	No
24DP0504	92.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	1/15/2015	ND	50	50	200	GW-1	No
24DP0504	92.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	1/15/2015	ND	50	50	700	GW-1	No
24DP0505	42.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	2/26/2015	ND	0.19	1	19	RBC	No
24DP0505	42.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	2/26/2015	ND	0.17	1	19	RBC	No
24DP0505	42.5	WA	MADEPEP	2-METHYLNAPHTHALENE	2/26/2015	ND	0.108	0.4	10	GW-1	No
24DP0505	42.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	2/26/2015	ND	100	100	200	GW-1	No
24DP0505	42.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	2/26/2015	ND	50	50	300	GW-1	No
24DP0505	42.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	2/26/2015	ND	50	50	200	GW-1	No
24DP0505	42.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	2/26/2015	ND	50	50	700	GW-1	No
24DP0505	52.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	2/26/2015	ND	0.19	1	19	RBC	No
24DP0505	52.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	2/26/2015	ND	0.17	1	19	RBC	No
24DP0505	52.5	WA	MADEPEP	2-METHYLNAPHTHALENE	2/26/2015	ND	0.108	0.4	10	GW-1	No
24DP0505	52.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	2/26/2015	ND	100	100	200	GW-1	No
24DP0505	52.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	2/26/2015	ND	50	50	300	GW-1	No
24DP0505	52.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	2/26/2015	ND	50	50	200	GW-1	No
24DP0505	52.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	2/26/2015	ND	50	50	700	GW-1	No
24DP0505	62.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	2/26/2015	ND	0.19	1	19	RBC	No
24DP0505	62.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	2/26/2015	ND	0.17	1	19	RBC	No
24DP0505	62.5	WA	MADEPEP	2-METHYLNAPHTHALENE	2/26/2015	ND	0.108	0.4	10	GW-1	No
24DP0505	62.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	2/26/2015	ND	100	100	200	GW-1	No
24DP0505	62.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	2/26/2015	ND	50	50	300	GW-1	No
24DP0505	62.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	2/26/2015	ND	50	50	200	GW-1	No
24DP0505	62.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	2/26/2015	ND	50	50	700	GW-1	No

Summary of COC Results at Groundwater Vertical Profiling Locations

Location	Depth (ft bgs)	Matrix	Test	Analyte	Date	Result	DL	RL	Standard	Type ^{1,2}	Exceeded
						All units - µg/L					
24DP0505	62.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	2/26/2015	ND	50	50	700	GW-1	No
24DP0505	72.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	2/26/2015	ND	0.19	1	19	RBC	No
24DP0505	72.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	2/26/2015	ND	0.17	1	19	RBC	No
24DP0505	72.5	WA	MADEPEP	2-METHYLNAPHTHALENE	2/26/2015	ND	0.108	0.4	10	GW-1	No
24DP0505	72.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	2/26/2015	ND	100	100	200	GW-1	No
24DP0505	72.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	2/26/2015	ND	50	50	300	GW-1	No
24DP0505	72.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	2/26/2015	ND	50	50	200	GW-1	No
24DP0505	72.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	2/26/2015	ND	50	50	700	GW-1	No
24DP0505	82.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	2/26/2015	ND	0.19	1	19	RBC	No
24DP0505	82.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	2/26/2015	ND	0.17	1	19	RBC	No
24DP0505	82.5	WA	MADEPEP	2-METHYLNAPHTHALENE	2/26/2015	ND	0.108	0.4	10	GW-1	No
24DP0505	82.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	2/26/2015	ND	100	100	200	GW-1	No
24DP0505	82.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	2/26/2015	ND	50	50	300	GW-1	No
24DP0505	82.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	2/26/2015	ND	50	50	200	GW-1	No
24DP0505	82.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	2/26/2015	ND	50	50	700	GW-1	No
24DP0506	42.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	3/9/2015	ND	0.19	1	19	RBC	No
24DP0506	42.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	3/9/2015	ND	0.17	1	19	RBC	No
24DP0506	42.5	WA	MADEPEP	2-METHYLNAPHTHALENE	3/9/2015	ND	0.108	0.4	10	GW-1	No
24DP0506	42.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	3/9/2015	ND	100	100	200	GW-1	No
24DP0506	42.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	3/9/2015	ND	50	50	300	GW-1	No
24DP0506	42.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	3/9/2015	ND	50	50	200	GW-1	No
24DP0506	42.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	3/9/2015	ND	50	50	700	GW-1	No
24DP0506	52.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	3/9/2015	ND	0.19	1	19	RBC	No
24DP0506	52.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	3/9/2015	ND	0.17	1	19	RBC	No
24DP0506	52.5	WA	MADEPEP	2-METHYLNAPHTHALENE	3/9/2015	ND	0.108	0.4	10	GW-1	No
24DP0506	52.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	3/9/2015	ND	100	100	200	GW-1	No
24DP0506	52.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	3/9/2015	ND	50	50	300	GW-1	No
24DP0506	52.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	3/9/2015	ND	50	50	200	GW-1	No
24DP0506	52.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	3/9/2015	ND	50	50	700	GW-1	No
24DP0506	62.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	3/9/2015	ND	0.19	1	19	RBC	No
24DP0506	62.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	3/9/2015	ND	0.17	1	19	RBC	No
24DP0506	62.5	WA	MADEPEP	2-METHYLNAPHTHALENE	3/9/2015	ND	0.108	0.4	10	GW-1	No
24DP0506	62.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	3/9/2015	ND	100	100	200	GW-1	No
24DP0506	62.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	3/9/2015	ND	50	50	300	GW-1	No
24DP0506	62.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	3/9/2015	ND	50	50	200	GW-1	No
24DP0506	62.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	3/9/2015	ND	50	50	700	GW-1	No
24DP0506	72.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	3/10/2015	ND	0.19	1	19	RBC	No
24DP0506	72.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	3/10/2015	ND	0.17	1	19	RBC	No
24DP0506	72.5	WA	MADEPEP	2-METHYLNAPHTHALENE	3/10/2015	ND	0.108	0.4	10	GW-1	No
24DP0506	72.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	3/10/2015	ND	100	100	200	GW-1	No
24DP0506	72.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	3/10/2015	ND	50	50	300	GW-1	No
24DP0506	72.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	3/10/2015	ND	50	50	200	GW-1	No
24DP0506	72.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	3/10/2015	ND	50	50	700	GW-1	No
24DP0506	82.5	WA	SW8260C	1,2,4-TRIMETHYLBENZENE	3/10/2015	ND	0.19	1	19	RBC	No
24DP0506	82.5	WA	SW8260C	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	3/10/2015	ND	0.17	1	19	RBC	No
24DP0506	82.5	WA	MADEPEP	2-METHYLNAPHTHALENE	3/10/2015	ND	0.108	0.4	10	GW-1	No
24DP0506	82.5	WA	MADEPEP	C11-C22 AROMATIC HYDROCARBONS	3/10/2015	ND	100	100	200	GW-1	No
24DP0506	82.5	WA	MADEPVP	C5-C8 ALIPHATIC HYDROCARBONS	3/10/2015	ND	50	50	300	GW-1	No
24DP0506	82.5	WA	MADEPVP	C9-C10 AROMATIC HYDROCARBONS	3/10/2015	ND	50	50	200	GW-1	No
24DP0506	82.5	WA	MADEPVP	C9-C12 ALIPHATIC HYDROCARBONS	3/10/2015	ND	50	50	700	GW-1	No

Data Source: AFCEC, 2017

Notes:

1. GW-1 = MassDEP MCP Method 1 Groundwater-1 Standards from MassDEP web page http://www.mass.gov/dep/cleanup/laws/0974_2.htm.
2. RBC = Site Specific Risk Based Concentration from *Final PFSA Focused Feasibility Study* (AFCEC 2014).

Key:

BRL = below reporting limit

DL = detection limit

ft bgs = feet below ground surface

GW-1 = MCP Method 1 Groundwater-1 standard

J = estimated value

MassDEP = Massachusetts Department of Environmental Protection

MCP = Massachusetts Contingency Plan

ND = nondetect

RBC = risk-based concentration

RL = reporting limit

WA = borehole water

µg/L = micrograms per liter

WELL DETERMINATION

ADDRESS: 57 Duck Blind Road, Mashpee MA

APEMS ID: 30643

WELL STATUS: ACTIVE

WELL USE: Outdoor uses

SUMMARY: According to the e-mail notification from the property owner (attached), a private well on this property is currently being used for outdoor irrigation use. The residence is connected to the Mashpee municipal water supply and receives a bill from the Mashpee Water District. The depth of the private well on this property is reportedly 27 feet below ground surface (ft bgs) for an approximate screen-bottom elevation of 15 feet mean sea level (ft msl). Depth to water in this area is approximately 4 ft bgs (+40 ft msl). This property is located over the leading edge of the Chemical Spill-10 (CS-10) North Central lobe. Intermittent use of this well for outdoor irrigation purposes is not expected to result in exposure to COC concentrations greater than the MCL from the CS-10 North Central lobe.

DATA REVIEW:

- ☒ Monitoring data are available for the CS-10 North Central lobe [see attached map, cross section, concentration trend figure and table]. Data from the following select locations in the area were used to define the extent of the plume in the vicinity of 57 Duck Blind Road.
 - 03DP0014 [vertical profiling]
 - 00MW0608A,B [monitoring data]
 - 03MW1009A,B [monitoring data]
 - 03IG0002 [monitoring data]
- ☒ The CS-10 North Central lobe is a northwest-southeast trending plume lobe that is migrating in a southeasterly direction between Ashumet and Johns Ponds. The North Central lobe is defined by trichloroethene (TCE) concentrations that are above the maximum contaminant level (MCL) of 5 micrograms per liter ($\mu\text{g/L}$) in drinking water. Tetrachloroethene (PCE) is also a contaminant of concern (COC) at the CS-10 North Central lobe but it is generally detected at lower concentrations than TCE. The top of the North Central lobe has been delineated at an elevation of approximately -75 ft msl at Wheeler Road (near 03MW1008A on Cross Section G-G') and becomes progressively deeper to the east, toward Johns Pond and 57 Duck Blind Road (approximately -180 ft msl at 00MW0608A; See cross section G-G'). The top of the plume near 57 Duck Blind Road has been monitored through routine sampling at 03MW1009A,B and 00MW0608A,B. The most current monitoring results for these wells are included in the attached table and TCE concentration trend plots at each well are presented in the attached figure. The North Central lobe is predicted to stay at depth in the aquifer between Ashumet and Johns Ponds, slowly migrate to the southeast, and eventually attenuate at depth in the aquifer to the southeast.
- ☒ No historic sample results are available for the private irrigation well on 57 Duck Blind Road and a request to sample the well was not made at this time because enough plume characterization and monitoring data exist to determine that this private irrigation well is screened above the CS-10 North Central lobe and it is not expected to draw in contaminated water associated with the CS-10 plume. In addition PCE and TCE have not been detected in samples collected at a nearby private irrigation well that is located on an abutting property (see location map).

WELL DETERMINATION

DETERMINATION: The bottom elevation of the private irrigation well on 57 Duck Blind Road is reportedly at 15 ft msl. The top of the North Central lobe in the vicinity of 57 Duck Blind Road is approximately -180 ft msl. Therefore the top of the CS-10 North Central lobe is approximately 195 feet below the bottom of this private irrigation well. Intermittent use of this well for outdoor irrigation purposes is not expected to result in exposure to COC concentrations greater than the MCL from the CS-10 North Central lobe. This finding is supported historic sampling at other nearby private wells located near the CS-10 North Central lobe.

PATH FORWARD: No sampling needed.

SAMPLING NEEDED: ☐ Yes ☒ No

RE-EVALUATE IN NEXT 5-YEAR REVIEW: ☒ Yes ☐ No

Hilyard, Mark/MMR

Subject: FW: Well on property of 57 Duck Blind Rd (ID# 30643)

> -----Original Message-----

> From: Sarah Brunell [mailto:sarahbrunell@yahoo.com]

> Sent: Thursday, July 23, 2015 4:57 PM

> To: KARSON, DOUGLAS C GS-11 USAF AFCEC AFCEC/CZOE

> Subject: Re: Well on property of 57 Duck Blind Rd (ID# 30643)

>

> Yes we have a new well for irrigation only.

>

> Sent from my iPhone

>

>> On Jul 23, 2015, at 2:49 PM, KARSON, DOUGLAS C GS-11 USAF AFCEC AFCEC/CZOE <douglas.karson@us.af.mil> wrote:

>>

>> Ms. Brunell,

>>

>> Our records indicate your previous response was that Nanthan Brunell (3-6-10 form submitted) and he checked that he did not know if a well exists at your property. I have updated your file to reflect active well status. I assume that is for irrigation only not drinking water but please confirm. Your file indicates an account with the Mashpee Water District. Thanks.

>>

>> //SIGNED//

>> DOUGLAS C. KARSON, GS-11, DAF

>> Community Involvement Lead, Joint Base Cape Cod Air Force Civil

>> Engineer Center DSN 557-4678, x2; Comm (508) 968-4678, x2

>> Cell: (508) 566-6628

>> douglas.karson@us.af.mil

>>

>>

>> -----Original Message-----

>> From: Sarah Brunell [mailto:sarahbrunell@yahoo.com]

>> Sent: Thursday, July 23, 2015 2:41 PM

>> To: KARSON, DOUGLAS C GS-11 USAF AFCEC AFCEC/CZOE

>> Subject: Well on property of 57 Duck Blind Rd (ID# 30643)

>>

>> Hi, We received your letter in reference to a non functioning well at our property. This well has been restarted and is currently in use this summer.

>> Please let me know if you need any further information.

>> Thank you,

>> Sarah Brunell

>> 770-366-5733

Hilyard, Mark/MMR

Subject: FW: #57 Duck Blind Rd, Mashpee

-----Original Message-----

From: Glen E. Harrington [mailto:gharrington@mashpeema.gov]
Sent: Wednesday, July 29, 2015 1:27 PM
To: KARSON, DOUGLAS C GS-11 USAF AFCEC AFCEC/CZOE
Subject: FW: #57 Duck Blind Rd, Mashpee

Hi Doug,
Fred Clifford has the below info on the well at 57 Duck Blind Rd, Mashpee.

Thanks,

Glen

-----Original Message-----

From: wells53@verizon.net [mailto:wells53@verizon.net]
Sent: Wednesday, July 29, 2015 1:01 PM
To: Glen E. Harrington
Subject: Duck pond

4" well 27' deep, 4x36" stainless steel well point, 15 slot, static water @ 3'6" drawdown @ 15 gpm is to 8'3". Soil was grey sand to 24", dark brown sand to 10', light brown sand to 20', yellowish light brown sand to 30'

Sent from my Fred



COMMONWEALTH OF MASSACHUSETTS

Town of Mashpee

Board of Health

NUMBER
BHP-2010-0206

FEE
\$50.00

ANZALONE, MARGERY KISTEN ET AL

FRED CLIFFORD

NAME

57 DUCK BLIND RD

ADDRESS

IS HEREBY GRANTED A PERMIT

To install a well in the town of Mashpee

Irrigation well

This permit is granted in conformity with the Statutes and ordinances relating thereto, and
expires unless sooner suspended or revoked.

June 07, 2010

Health Agent

Veronica Warden

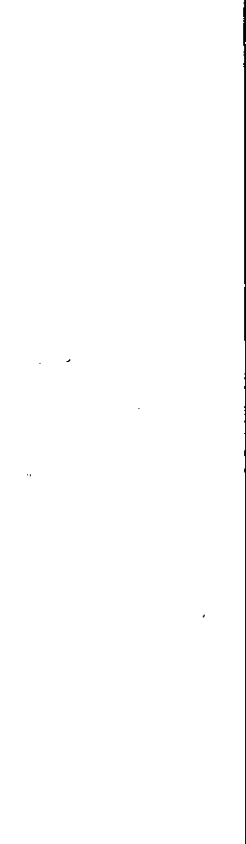
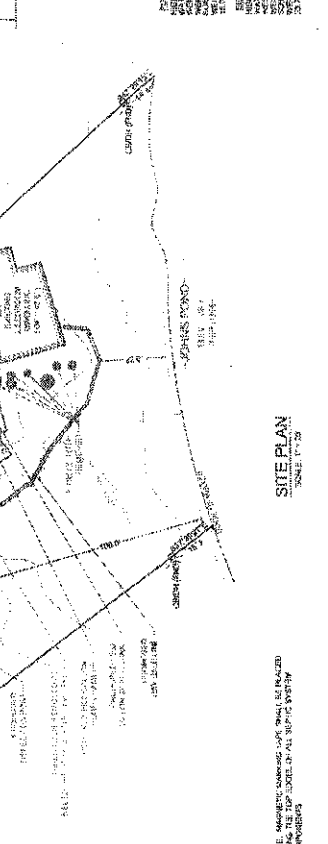
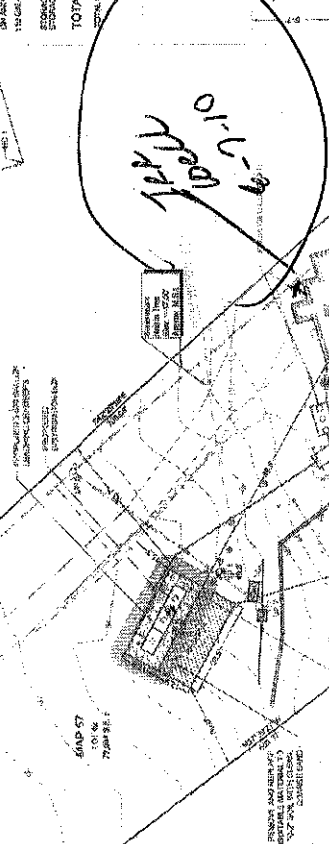
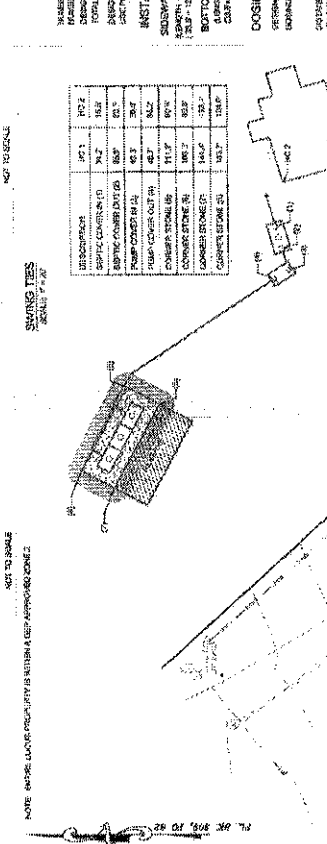
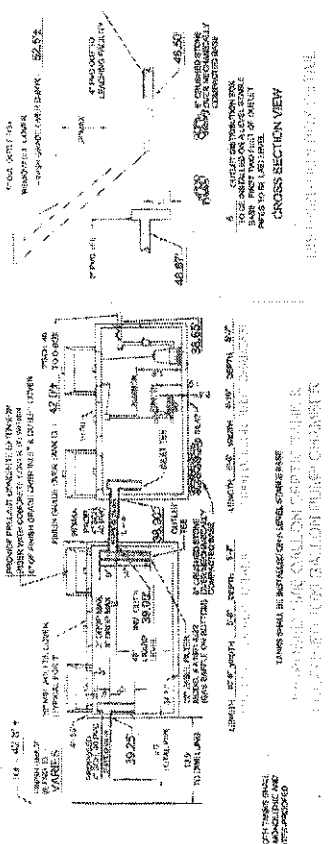
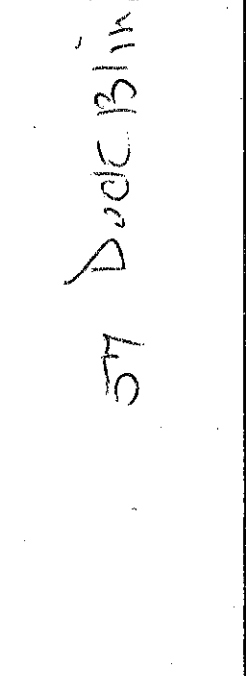
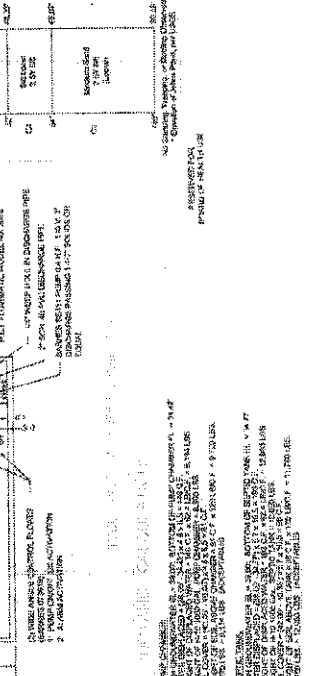
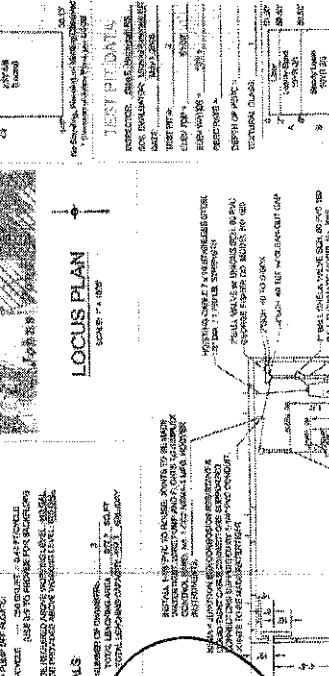
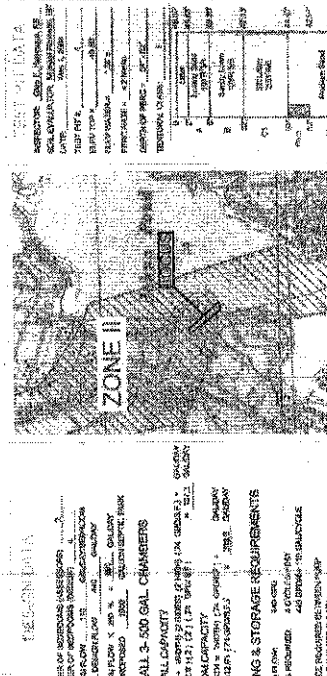
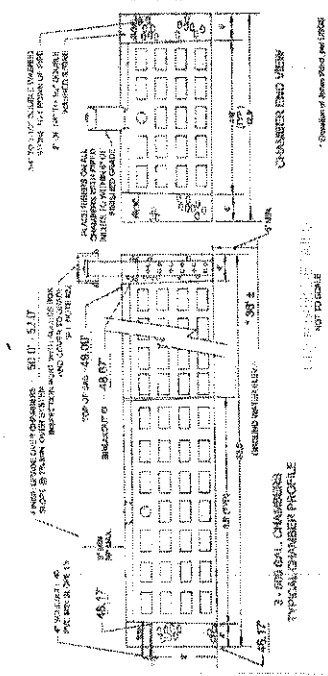
Burton Kaplan, Chair
Kalliope Egloff Co-Chair
Lucy B. Burton, Clerk

Board of
Health

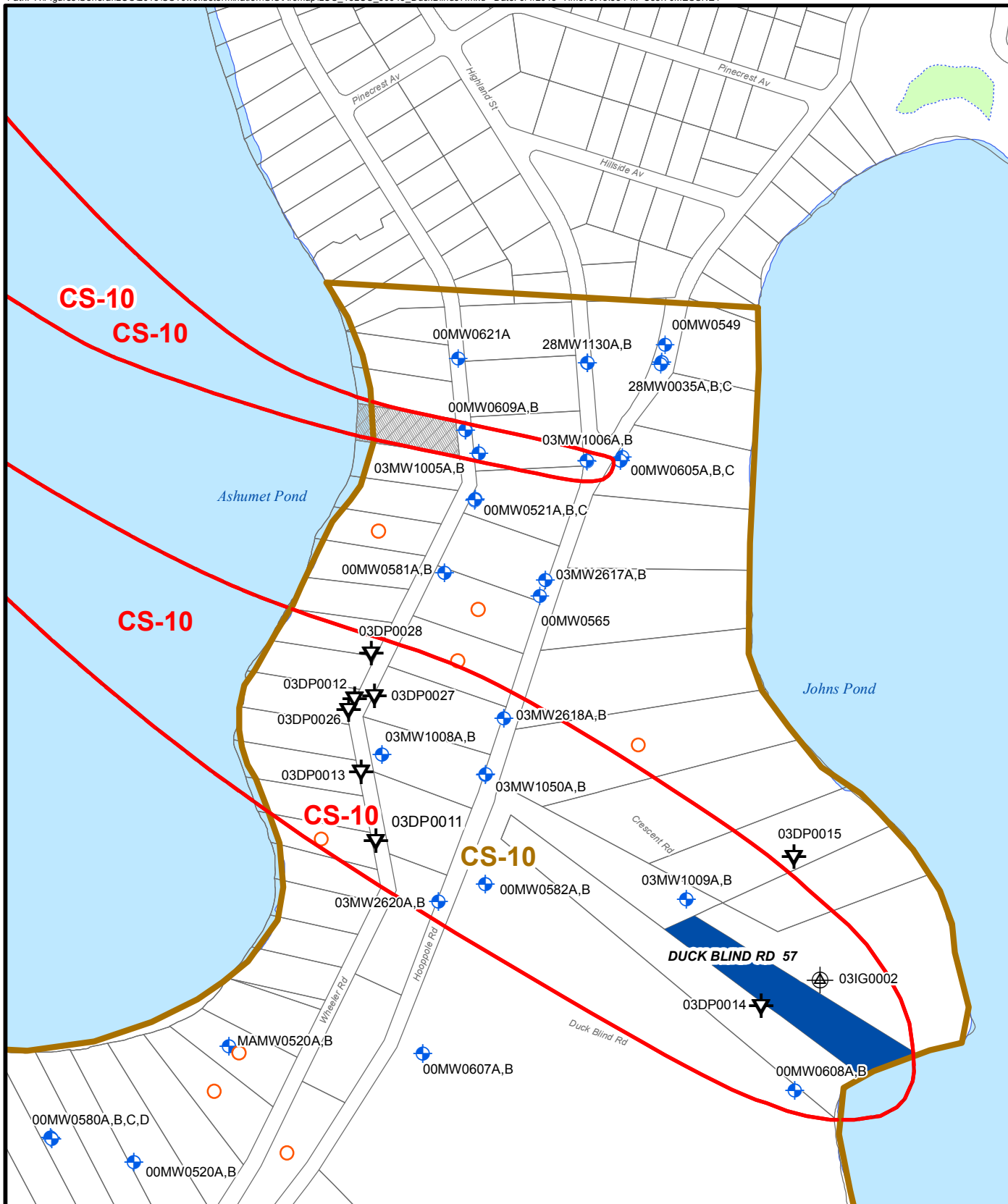
57 Duck Blind Road

57 Duck Blind

57 Duck Blind



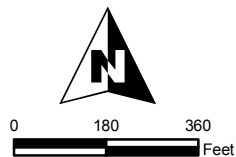
NOTES: 1. ALL CONSTRUCTION SHALL BE IN ACCORDANCE WITH THE LATEST EDITIONS OF THE INTERNATIONAL BUILDING CODE (IBC) AND THE INTERNATIONAL PLUMBING CODE (IPC). 2. THE SEPTIC SYSTEM SHALL BE DESIGNED TO SERVE THE MAXIMUM ANTICIPATED FUTURE DEVELOPMENT OF THE PROPERTY. 3. THE SEPTIC SYSTEM SHALL BE INSTALLED IN ACCORDANCE WITH THE LATEST EDITIONS OF THE INTERNATIONAL BUILDING CODE (IBC) AND THE INTERNATIONAL PLUMBING CODE (IPC). 4. THE SEPTIC SYSTEM SHALL BE MAINTAINED AND REPAIRED AS NEEDED. 5. THE SEPTIC SYSTEM SHALL BE REMOVED AND REPLACED AS NEEDED. 6. THE SEPTIC SYSTEM SHALL BE REPAIRED AND MAINTAINED AS NEEDED. 7. THE SEPTIC SYSTEM SHALL BE REMOVED AND REPLACED AS NEEDED. 8. THE SEPTIC SYSTEM SHALL BE REPAIRED AND MAINTAINED AS NEEDED. 9. THE SEPTIC SYSTEM SHALL BE REMOVED AND REPLACED AS NEEDED. 10. THE SEPTIC SYSTEM SHALL BE REPAIRED AND MAINTAINED AS NEEDED.



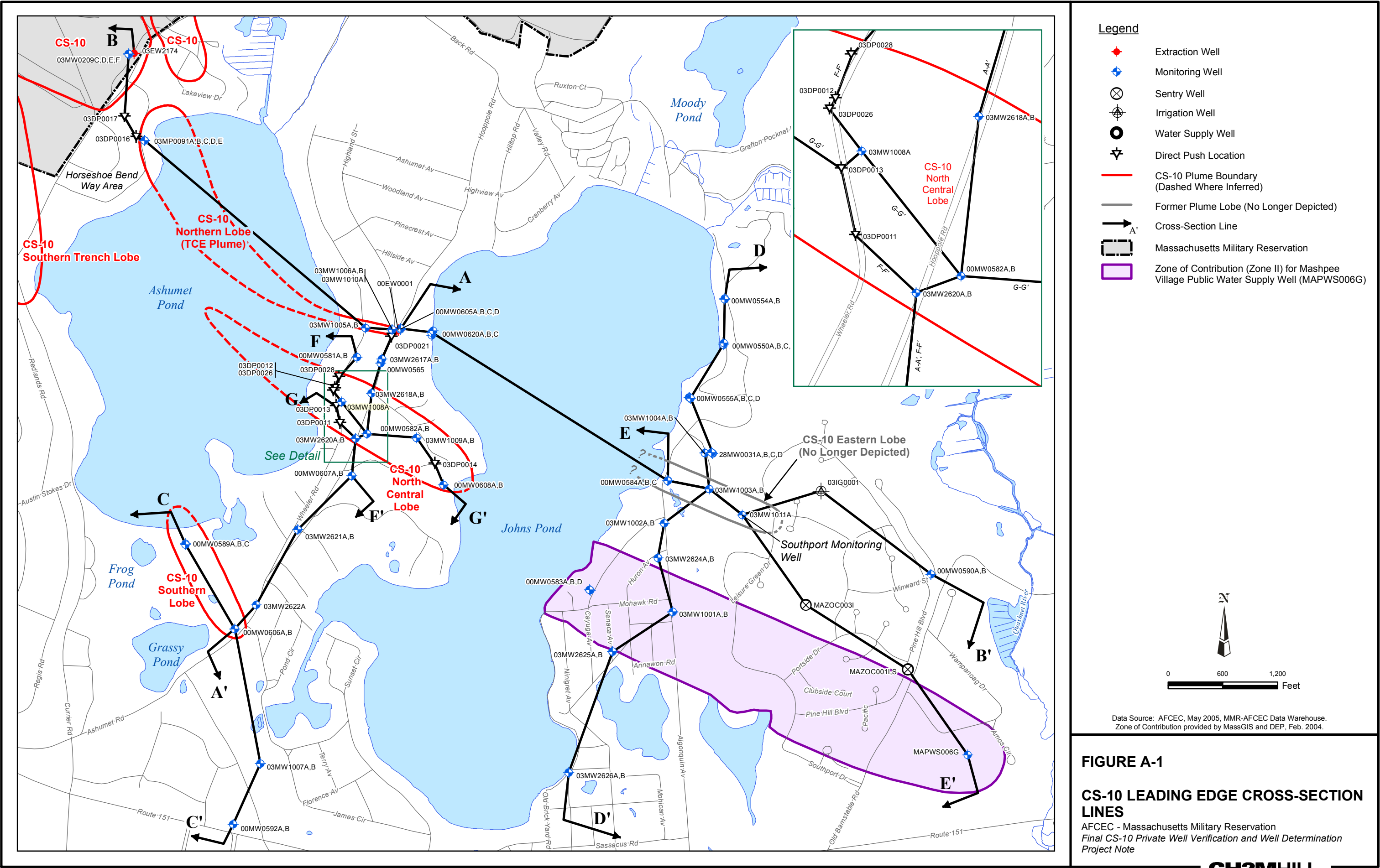
Data Source: AFCEC, September 2015

Legend

- Plume Boundary
- LUC Boundary
- Parcel of Interest
- Other Parcel
- Private Well Sampled in 2012
- ◆ Monitoring Well
- Private Well (Historic Sampling)
- ⊕ Irrigation Well
- ✱ Direct Push
- Wetland Boundary



LOCATION: 57 DUCK BLIND RD
 AFCEC - Joint Base Cape Cod
 CS-10 2015 Land Use Control



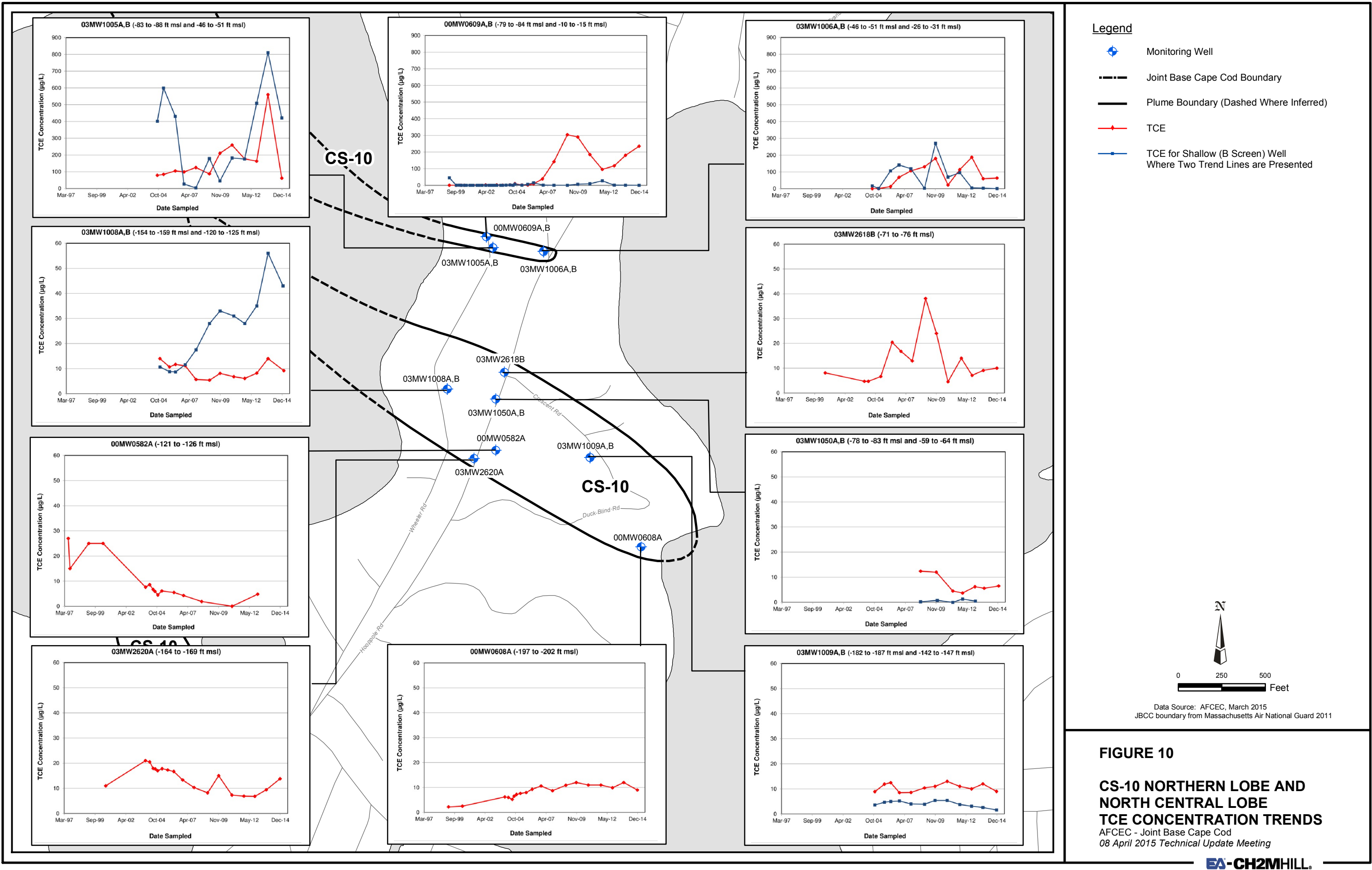


FIGURE 10

CS-10 NORTHERN LOBE AND NORTH CENTRAL LOBE TCE CONCENTRATION TRENDS

AFCEC - Joint Base Cape Cod
08 April 2015 Technical Update Meeting

**Summary of Groundwater TCE and PCE Data
Near 57 Duck Blind Road, Mashpee MA**

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
00MW0608A	WG	CVOL	TETRACHLOROETHENE (PCE)	242	3/22/1999	ND	0.1	1	µg/L
00MW0608A	WG	CVOL	TETRACHLOROETHENE (PCE)	242	5/16/2000	ND	0.11	1	µg/L
00MW0608A	WG	SW8260B	TETRACHLOROETHENE (PCE)	242	11/24/2003	ND	0.421	1	µg/L
00MW0608A	WG	SW8260B	TETRACHLOROETHENE (PCE)	242	3/10/2004	BRL	0.08	1	µg/L
00MW0608A	WG	SW8260B	TETRACHLOROETHENE (PCE)	242	7/7/2004	BRL	0.08	1	µg/L
00MW0608A	WG	SW8260B	TETRACHLOROETHENE (PCE)	242	9/1/2004	BRL	0.18	1	µg/L
00MW0608A	WG	SW8260B	TETRACHLOROETHENE (PCE)	242	11/11/2004	BRL	0.18	1	µg/L
00MW0608A	WG	SW8260B	TETRACHLOROETHENE (PCE)	242	3/9/2005	BRL	0.18	1	µg/L
00MW0608A	WG	SW8260B	TETRACHLOROETHENE (PCE)	242	9/1/2005	BRL	0.27	1	µg/L
00MW0608A	WG	SW8260B	TETRACHLOROETHENE (PCE)	242	3/1/2006	BRL	0.27	1	µg/L
00MW0608A	WG	SW8260B	TETRACHLOROETHENE (PCE)	242	11/27/2006	BRL	0.15	1	µg/L
00MW0608A	WG	SW8260B	TETRACHLOROETHENE (PCE)	242	11/7/2007	BRL	0.18	1	µg/L
00MW0608A	WG	SW8260B	TETRACHLOROETHENE (PCE)	242	12/17/2008	BRL	0.18	1	µg/L
00MW0608A	WG	SW8260B	TETRACHLOROETHENE (PCE)	242	10/29/2009	1.8	0.18	1	µg/L
00MW0608A	WG	SW8260B	TETRACHLOROETHENE (PCE)	242	10/29/2010	1.2	0.19	1	µg/L
00MW0608A	WG	SW8260B	TETRACHLOROETHENE (PCE)	242	11/14/2011	1.8	0.19	1	µg/L
00MW0608A	WG	SW8260B	TETRACHLOROETHENE (PCE)	242	10/31/2012	1.7	0.19	1	µg/L
00MW0608A	WG	SW8260C	TETRACHLOROETHENE (PCE)	242	10/9/2013	3	0.18	1	µg/L
00MW0608A	WG	SW8260C	TETRACHLOROETHENE (PCE)	242	11/24/2014	3.2	0.5	1	µg/L
00MW0608A	WG	CVOL	TRICHLOROETHENE (TCE)	242	3/22/1999	2.2	0.12	1	µg/L
00MW0608A	WG	CVOL	TRICHLOROETHENE (TCE)	242	5/16/2000	2.5	0.09	1	µg/L
00MW0608A	WG	SW8260B	TRICHLOROETHENE (TCE)	242	11/24/2003	6.2 J	0.241	1	µg/L
00MW0608A	WG	SW8260B	TRICHLOROETHENE (TCE)	242	3/10/2004	6	0.09	1	µg/L
00MW0608A	WG	SW8260B	TRICHLOROETHENE (TCE)	242	7/7/2004	5.2	0.08	1	µg/L
00MW0608A	WG	SW8260B	TRICHLOROETHENE (TCE)	242	9/1/2004	6.5	0.11	1	µg/L
00MW0608A	WG	SW8260B	TRICHLOROETHENE (TCE)	242	11/11/2004	7.2	0.11	1	µg/L
00MW0608A	WG	SW8260B	TRICHLOROETHENE (TCE)	242	3/9/2005	7.6	0.11	1	µg/L
00MW0608A	WG	SW8260B	TRICHLOROETHENE (TCE)	242	9/1/2005	8	0.27	1	µg/L
00MW0608A	WG	SW8260B	TRICHLOROETHENE (TCE)	242	3/1/2006	9.3	0.21	1	µg/L
00MW0608A	WG	SW8260B	TRICHLOROETHENE (TCE)	242	11/27/2006	10.6	0.15	1	µg/L
00MW0608A	WG	SW8260B	TRICHLOROETHENE (TCE)	242	11/7/2007	8.7	0.15	1	µg/L
00MW0608A	WG	SW8260B	TRICHLOROETHENE (TCE)	242	12/17/2008	10.9	0.15	1	µg/L
00MW0608A	WG	SW8260B	TRICHLOROETHENE (TCE)	242	10/29/2009	12	0.17	1	µg/L
00MW0608A	WG	SW8260B	TRICHLOROETHENE (TCE)	242	10/29/2010	11	0.2	1	µg/L
00MW0608A	WG	SW8260B	TRICHLOROETHENE (TCE)	242	11/14/2011	11	0.2	1	µg/L
00MW0608A	WG	SW8260B	TRICHLOROETHENE (TCE)	242	10/31/2012	9.9	0.2	1	µg/L
00MW0608A	WG	SW8260C	TRICHLOROETHENE (TCE)	242	10/9/2013	12	0.17	1	µg/L
00MW0608A	WG	SW8260C	TRICHLOROETHENE (TCE)	242	11/24/2014	9	0.5	1	µg/L
00MW0608B	WG	CVOL	TETRACHLOROETHENE (PCE)	171.7	3/22/1999	ND	0.1	1	µg/L
00MW0608B	WG	CVOL	TETRACHLOROETHENE (PCE)	171.7	5/16/2000	ND	0.11	1	µg/L
00MW0608B	WG	SW8260B	TETRACHLOROETHENE (PCE)	171.7	11/24/2003	ND	0.421	1	µg/L
00MW0608B	WG	SW8260B	TETRACHLOROETHENE (PCE)	171.7	3/10/2004	ND	0.08	1	µg/L
00MW0608B	WG	SW8260B	TETRACHLOROETHENE (PCE)	171.7	3/9/2005	ND	0.18	1	µg/L
00MW0608B	WG	SW8260B	TETRACHLOROETHENE (PCE)	171.7	3/1/2006	ND	0.27	1	µg/L
00MW0608B	WG	SW8260B	TETRACHLOROETHENE (PCE)	171.7	11/27/2006	ND	0.15	1	µg/L
00MW0608B	WG	SW8260B	TETRACHLOROETHENE (PCE)	171.7	7/2/2008	ND	0.18	1	µg/L
00MW0608B	WG	SW8260B	TETRACHLOROETHENE (PCE)	171.7	10/29/2010	ND	0.19	1	µg/L
00MW0608B	WG	SW8260B	TETRACHLOROETHENE (PCE)	171.7	10/31/2012	ND	0.19	1	µg/L
00MW0608B	WG	CVOL	TRICHLOROETHENE (TCE)	171.7	3/22/1999	1	0.12	1	µg/L
00MW0608B	WG	CVOL	TRICHLOROETHENE (TCE)	171.7	5/16/2000	2.1	0.09	1	µg/L
00MW0608B	WG	SW8260B	TRICHLOROETHENE (TCE)	171.7	11/24/2003	2.3 J	0.241	1	µg/L
00MW0608B	WG	SW8260B	TRICHLOROETHENE (TCE)	171.7	3/10/2004	ND	2	2	µg/L

**Summary of Groundwater TCE and PCE Data
Near 57 Duck Blind Road, Mashpee MA**

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
00MW0608B	WG	SW8260B	TRICHLOROETHENE (TCE)	171.7	3/9/2005	1.6	0.11	1	µg/L
00MW0608B	WG	SW8260B	TRICHLOROETHENE (TCE)	171.7	3/1/2006	1.3	0.21	1	µg/L
00MW0608B	WG	SW8260B	TRICHLOROETHENE (TCE)	171.7	11/27/2006	1.1	0.15	1	µg/L
00MW0608B	WG	SW8260B	TRICHLOROETHENE (TCE)	171.7	7/2/2008	BRL	0.15	1	µg/L
00MW0608B	WG	SW8260B	TRICHLOROETHENE (TCE)	171.7	10/29/2010	BRL	0.2	1	µg/L
00MW0608B	WG	SW8260B	TRICHLOROETHENE (TCE)	171.7	10/31/2012	BRL	0.2	1	µg/L
03DP0014	WA	SW8260B	TETRACHLOROETHENE (PCE)	134.44	2/19/2004	ND	0.421	1	µg/L
03DP0014	WA	SW8260B	TETRACHLOROETHENE (PCE)	154.44	2/20/2004	ND	0.421	1	µg/L
03DP0014	WA	SW8260B	TETRACHLOROETHENE (PCE)	174.44	2/20/2004	ND	0.421	1	µg/L
03DP0014	WA	SW8260B	TRICHLOROETHENE (TCE)	134.44	2/19/2004	ND	0.241	1	µg/L
03DP0014	WA	SW8260B	TRICHLOROETHENE (TCE)	154.44	2/20/2004	BRL	0.241	1	µg/L
03DP0014	WA	SW8260B	TRICHLOROETHENE (TCE)	174.44	2/20/2004	BRL	0.241	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	72.5	9/17/2004	ND	0.18	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	82.5	9/17/2004	ND	0.18	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	92.5	9/17/2004	ND	0.18	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	102.5	9/17/2004	ND	0.18	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	112.5	9/20/2004	ND	0.18	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	122.5	9/20/2004	ND	0.18	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	132.5	9/20/2004	ND	0.18	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	142.5	9/20/2004	ND	0.18	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	152.5	9/20/2004	ND	0.18	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	162.5	9/20/2004	ND	0.18	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	232.5	9/21/2004	1	0.18	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	182.5	9/21/2004	ND	0.18	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	192.5	9/21/2004	ND	0.18	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	202.5	9/21/2004	ND	0.18	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	212.5	9/21/2004	ND	0.18	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	222.5	9/21/2004	ND	0.18	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	252.5	9/22/2004	BRL	0.18	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	292.5	9/22/2004	BRL	0.18	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	282.5	9/22/2004	1.7	0.18	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	272.5	9/22/2004	2.4	0.18	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	262.5	9/22/2004	2.7	0.18	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	242.5	9/22/2004	ND	0.18	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	302.5	9/23/2004	ND	0.18	1	µg/L
03MW1009A	WA	SW8260B	TETRACHLOROETHENE (PCE)	312.5	9/23/2004	ND	0.18	1	µg/L
03MW1009A	WG	SW8260B	TETRACHLOROETHENE (PCE)	272.5	11/16/2004	2	0.08	1	µg/L
03MW1009A	WG	SW8260B	TETRACHLOROETHENE (PCE)	272.5	9/1/2005	2.4	0.27	1	µg/L
03MW1009A	WG	SW8260B	TETRACHLOROETHENE (PCE)	272.5	3/7/2006	2.5	0.27	1	µg/L
03MW1009A	WG	SW8260B	TETRACHLOROETHENE (PCE)	272.5	11/27/2006	BRL	0.15	1	µg/L
03MW1009A	WG	SW8260B	TETRACHLOROETHENE (PCE)	272.5	11/7/2007	BRL	0.18	1	µg/L
03MW1009A	WG	SW8260B	TETRACHLOROETHENE (PCE)	272.5	12/17/2008	BRL	0.18	1	µg/L
03MW1009A	WG	SW8260B	TETRACHLOROETHENE (PCE)	272.5	10/29/2009	1.5	0.18	1	µg/L
03MW1009A	WG	SW8260B	TETRACHLOROETHENE (PCE)	272.5	10/29/2010	1.5	0.19	1	µg/L
03MW1009A	WG	SW8260B	TETRACHLOROETHENE (PCE)	272.5	11/14/2011	1.7	0.19	1	µg/L
03MW1009A	WG	SW8260B	TETRACHLOROETHENE (PCE)	272.5	10/31/2012	1.6	0.19	1	µg/L
03MW1009A	WG	SW8260C	TETRACHLOROETHENE (PCE)	272.5	10/9/2013	2.2	0.18	1	µg/L
03MW1009A	WG	SW8260C	TETRACHLOROETHENE (PCE)	272.5	11/24/2014	2.1	0.5	1	µg/L
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	72.5	9/17/2004	ND	0.11	1	µg/L
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	82.5	9/17/2004	ND	0.11	1	µg/L
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	92.5	9/17/2004	ND	0.11	1	µg/L
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	102.5	9/17/2004	ND	0.11	1	µg/L

**Summary of Groundwater TCE and PCE Data
Near 57 Duck Blind Road, Mashpee MA**

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	112.5	9/20/2004	ND	0.11	1	µg/L
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	122.5	9/20/2004	ND	0.11	1	µg/L
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	132.5	9/20/2004	ND	0.11	1	µg/L
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	142.5	9/20/2004	ND	0.11	1	µg/L
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	152.5	9/20/2004	ND	0.11	1	µg/L
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	162.5	9/20/2004	ND	0.11	1	µg/L
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	192.5	9/21/2004	2.6	0.11	1	µg/L
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	202.5	9/21/2004	3.2	0.11	1	µg/L
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	222.5	9/21/2004	3.7	0.11	1	µg/L
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	182.5	9/21/2004	5.2	0.11	1	µg/L
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	212.5	9/21/2004	6.4	0.11	1	µg/L
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	232.5	9/21/2004	11.5	0.11	1	µg/L
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	242.5	9/22/2004	BRL	0.11	1	µg/L
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	292.5	9/22/2004	2.8	0.11	1	µg/L
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	282.5	9/22/2004	8	0.11	1	µg/L
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	252.5	9/22/2004	8.7	0.11	1	µg/L
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	262.5	9/22/2004	11.5	0.11	1	µg/L
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	272.5	9/22/2004	16.2	0.11	1	µg/L
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	302.5	9/23/2004	BRL	0.11	1	µg/L
03MW1009A	WA	SW8260B	TRICHLOROETHENE (TCE)	312.5	9/23/2004	ND	0.11	1	µg/L
03MW1009A	WG	SW8260B	TRICHLOROETHENE (TCE)	272.5	11/16/2004	8.9	0.08	1	µg/L
03MW1009A	WG	SW8260B	TRICHLOROETHENE (TCE)	272.5	9/1/2005	11.9	0.27	1	µg/L
03MW1009A	WG	SW8260B	TRICHLOROETHENE (TCE)	272.5	3/7/2006	12.5	0.21	1	µg/L
03MW1009A	WG	SW8260B	TRICHLOROETHENE (TCE)	272.5	11/27/2006	8.5	0.15	1	µg/L
03MW1009A	WG	SW8260B	TRICHLOROETHENE (TCE)	272.5	11/7/2007	8.6	0.15	1	µg/L
03MW1009A	WG	SW8260B	TRICHLOROETHENE (TCE)	272.5	12/17/2008	10.4	0.15	1	µg/L
03MW1009A	WG	SW8260B	TRICHLOROETHENE (TCE)	272.5	10/29/2009	11	0.17	1	µg/L
03MW1009A	WG	SW8260B	TRICHLOROETHENE (TCE)	272.5	10/29/2010	13	0.2	1	µg/L
03MW1009A	WG	SW8260B	TRICHLOROETHENE (TCE)	272.5	11/14/2011	11	0.2	1	µg/L
03MW1009A	WG	SW8260B	TRICHLOROETHENE (TCE)	272.5	10/31/2012	10	0.2	1	µg/L
03MW1009A	WG	SW8260C	TRICHLOROETHENE (TCE)	272.5	10/9/2013	12	0.17	1	µg/L
03MW1009A	WG	SW8260C	TRICHLOROETHENE (TCE)	272.5	11/24/2014	9	0.5	1	µg/L
03MW1009B	WG	SW8260B	TETRACHLOROETHENE (PCE)	232.5	11/16/2004	ND	0.08	1	µg/L
03MW1009B	WG	SW8260B	TETRACHLOROETHENE (PCE)	232.5	9/1/2005	ND	0.27	1	µg/L
03MW1009B	WG	SW8260B	TETRACHLOROETHENE (PCE)	232.5	3/7/2006	ND	0.27	1	µg/L
03MW1009B	WG	SW8260B	TETRACHLOROETHENE (PCE)	232.5	11/27/2006	ND	0.15	1	µg/L
03MW1009B	WG	SW8260B	TETRACHLOROETHENE (PCE)	232.5	11/7/2007	ND	0.18	1	µg/L
03MW1009B	WG	SW8260B	TETRACHLOROETHENE (PCE)	232.5	12/17/2008	ND	0.18	1	µg/L
03MW1009B	WG	SW8260B	TETRACHLOROETHENE (PCE)	232.5	10/29/2009	BRL	0.18	1	µg/L
03MW1009B	WG	SW8260B	TETRACHLOROETHENE (PCE)	232.5	10/29/2010	BRL	0.19	1	µg/L
03MW1009B	WG	SW8260B	TETRACHLOROETHENE (PCE)	232.5	11/14/2011	BRL	0.19	1	µg/L
03MW1009B	WG	SW8260B	TETRACHLOROETHENE (PCE)	232.5	10/31/2012	BRL	0.19	1	µg/L
03MW1009B	WG	SW8260C	TETRACHLOROETHENE (PCE)	232.5	10/9/2013	BRL	0.18	1	µg/L
03MW1009B	WG	SW8260C	TETRACHLOROETHENE (PCE)	232.5	11/24/2014	ND	0.5	1	µg/L
03MW1009B	WG	SW8260B	TRICHLOROETHENE (TCE)	232.5	11/16/2004	3.6	0.08	1	µg/L
03MW1009B	WG	SW8260B	TRICHLOROETHENE (TCE)	232.5	9/1/2005	4.7	0.27	1	µg/L
03MW1009B	WG	SW8260B	TRICHLOROETHENE (TCE)	232.5	3/7/2006	5	0.21	1	µg/L
03MW1009B	WG	SW8260B	TRICHLOROETHENE (TCE)	232.5	11/27/2006	5.2	0.15	1	µg/L
03MW1009B	WG	SW8260B	TRICHLOROETHENE (TCE)	232.5	11/7/2007	4	0.15	1	µg/L
03MW1009B	WG	SW8260B	TRICHLOROETHENE (TCE)	232.5	12/17/2008	3.9	0.15	1	µg/L
03MW1009B	WG	SW8260B	TRICHLOROETHENE (TCE)	232.5	10/29/2009	5.4	0.17	1	µg/L
03MW1009B	WG	SW8260B	TRICHLOROETHENE (TCE)	232.5	10/29/2010	5.4	0.2	1	µg/L

**Summary of Groundwater TCE and PCE Data
Near 57 Duck Blind Road, Mashpee MA**

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
03MW1009B	WG	SW8260B	TRICHLOROETHENE (TCE)	232.5	11/14/2011	3.8	0.2	1	µg/L
03MW1009B	WG	SW8260B	TRICHLOROETHENE (TCE)	232.5	10/31/2012	3.1	0.2	1	µg/L
03MW1009B	WG	SW8260C	TRICHLOROETHENE (TCE)	232.5	10/9/2013	2.6	0.17	1	µg/L
03MW1009B	WG	SW8260C	TRICHLOROETHENE (TCE)	232.5	11/24/2014	1.6	0.5	1	µg/L

Data Source: AFCEC-JBCC, September 2015

Key:

BRL = below reporting limit

DL = detection limit

J = estimated value

µg/L = micrograms per liter

ND = not detected

RL = reporting limit

WA = borehole water (vertical profiling)

WG = groundwater sample

WELL DETERMINATION

ADDRESS: 1 Sunset Circle, Mashpee MA

APEMS ID: 31704

WELL STATUS: ACTIVE

WELL USE: Outdoor uses

SUMMARY: According to the e-mail notification (attached), a private well on this property was restarted in 2015 for outdoor irrigation purposes. This residence is connected to the Mashpee municipal water supply and receives a water bill from the Mashpee Water District. The total depth of this well is unknown. The property is located adjacent to Johns Pond and the depth to water in this area is approximately 5 feet below ground surface (ft bgs) for an estimated elevation of 40 feet mean sea level (ft msl). This property is located approximately 1,350 feet to the southeast of the Chemical Spill-10 (CS-10) Southern lobe leading edge. Intermittent use of this well for outdoor irrigation purposes is not expected to result in exposure to COC concentrations greater than the MCL from the CS-10 Southern lobe.

DATA REVIEW:

- ☒ Monitoring data are available for the CS-10 Southern lobe [see attached map, cross section, table and trend plots].
 - 00MW0589A,B,C [monitoring data]
 - 00MW0606A,B [vertical profiling and monitoring data]
 - 03MW1014A,B [vertical profiling and monitoring data]
 - 03MW1015A,B [vertical profiling and monitoring data]
 - 03MW2622A [vertical profiling and monitoring data]
- ☒ The CS-10 Southern lobe is located close to the top of bedrock, deep in the aquifer at an elevation range of approximately -180 to -260 ft msl (230-310 ft bgs; see cross section C-C' showing plume monitoring data as of 2005). The CS-10 Southern lobe is currently defined primarily by trichloroethene (TCE) concentrations that are greater than the maximum contaminant level (MCL) of 5 micrograms per liter ($\mu\text{g/L}$) at monitoring wells 03MW1014A (-235 ft msl), 00MW0606A (-256 ft msl), and 03MW2622A (-225 ft msl). Tetrachloroethene (PCE) is also a contaminant of concern (COC) at the CS-10 Southern lobe but it is generally detected at lower concentrations than TCE. The top of the plume was delineated using groundwater vertical profiling results from 03MW1014A and 03MW1015A (see attached table). The CS-10 Southern lobe is predicted to stay at depth in the aquifer, slowly migrate to the south-southeast, and eventually attenuate at depth in the aquifer. This prediction is supported by monitoring data from 00MW0589B and 00MW0606B, which indicate that the plume is staying at depth.
- ☒ No historic sample results are available for the private well on this property. A request to sample the well on 1 Sunset Circle was not made at this time because enough plume characterization data exists to determine that this well is vertically and laterally distant from the CS-10 Southern lobe and is not expected to draw in contaminated water associated with the CS-10 plume. PCE and TCE were not detected in tap water samples collected from nearby private residential wells in 2012 or in previous years (see location map).

DETERMINATION: The private well at this property is likely to be screened well above the top of the CS-10 Southern lobe. Although the depth of the private well on this property is unknown, it is likely screened within 30 feet of the

WELL DETERMINATION

water table, resulting in a screen-bottom elevation of approximately +40 ft msl. The assumption of well depth at this property is based on conversations with local well drillers, private well depths reported in the MassDEP well database for this area of Mashpee, and reported depths of private wells identified within other plume land use control areas. The top of the CS-10 Southern lobe is at an approximate elevation of -180 ft msl. Therefore the bottom of this private well is likely to be 220 feet above the CS-10 Southern lobe in addition to being approximately 1,350 feet southeast of the plume boundary (See cross section C-C'). Intermittent use of this well for outdoor irrigation purposes is not expected to result in exposure to COC concentrations greater than the MCL from the CS-10 Southern lobe. This finding is supported by historic and current sampling of private residential wells located near the CS-10 Southern lobe.

PATH FORWARD: No sampling needed.

SAMPLING NEEDED: ☐Yes ☒No

RE-EVALUATE IN NEXT 5-YEAR REVIEW: ☒Yes ☐No

Hilyard, Mark/MMR

Subject: FW: Active well 1 Sunset Circle, Mashpee

-----Original Message-----

From: KARSON, DOUGLAS C GS-11 USAF AFCEC AFCEC/CZOE [mailto:douglas.karson@us.af.mil]

Sent: Friday, July 10, 2015 9:10 AM

To: Hilyard, Mark/MMR; Tindall, Nigel/MMR; Forbes, Rose/EXT

Subject: Active well 1 Sunset Circle, Mashpee

As a result of the annual reswell mailing to non-functional well owners I received a call from the owner of 1 Sunset Circle, APEMS# 31704. This well was previously identified as category A3 based on his returned form. He stated that the well was restarted in May 2015 and is used only for IG use thus it moves to category A2. Is a tech eval in order? I updated the database to reflect operational status for IG use.

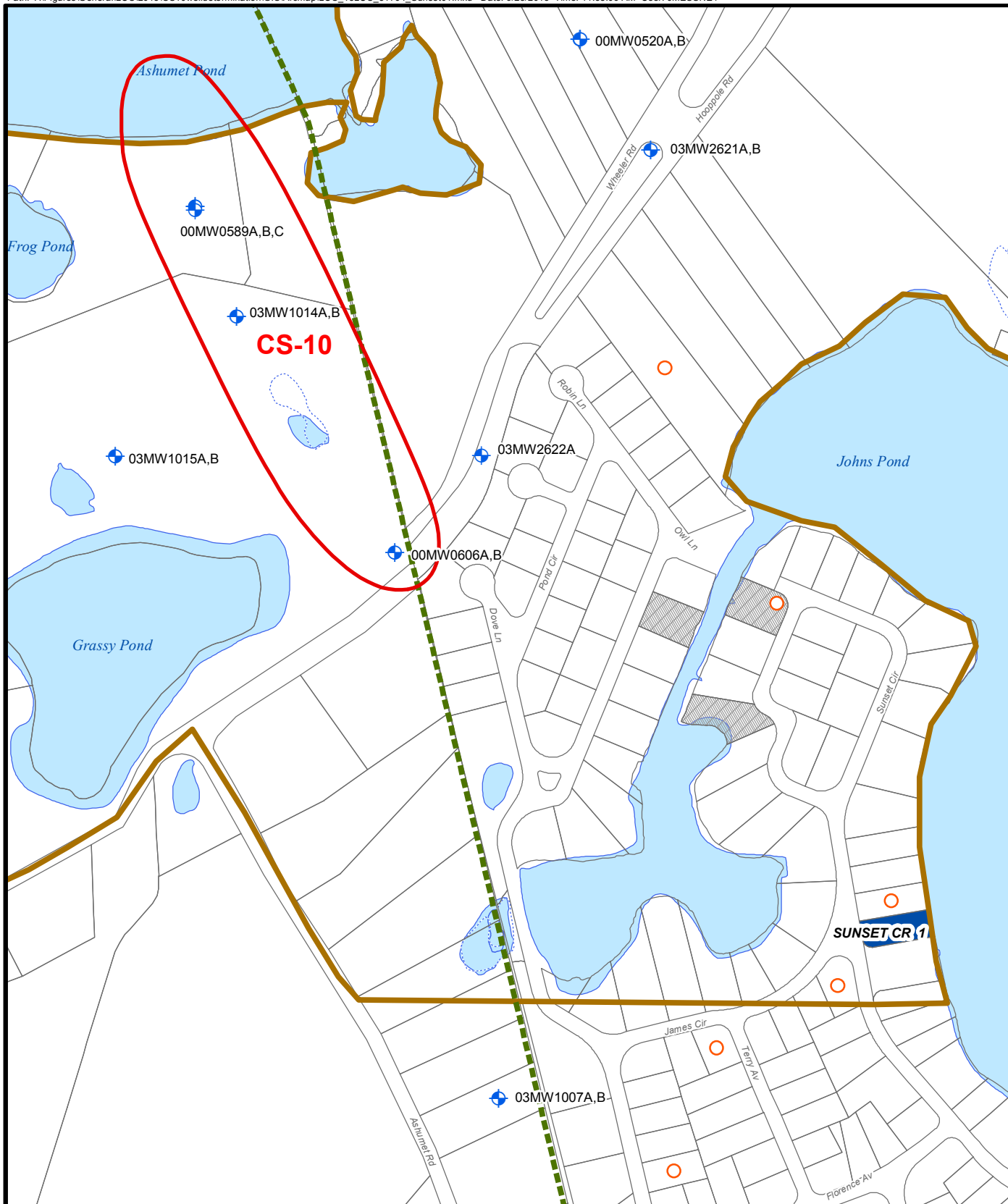
//SIGNED//

DOUGLAS C. KARSON, GS-11, DAF

Community Involvement Lead, Joint Base Cape Cod Air Force Civil Engineer Center DSN 557-4678, x2; Comm (508) 968-4678, x2

Cell: (508) 566-6628

douglas.karson@us.af.mil



Legend

- Plume Boundary
- LUC Boundary
- - - Town Boundary
- Parcel of Interest
- Other Parcel



Private Well Sampled in 2012



Monitoring Well



Private Well (Historic Sampling)

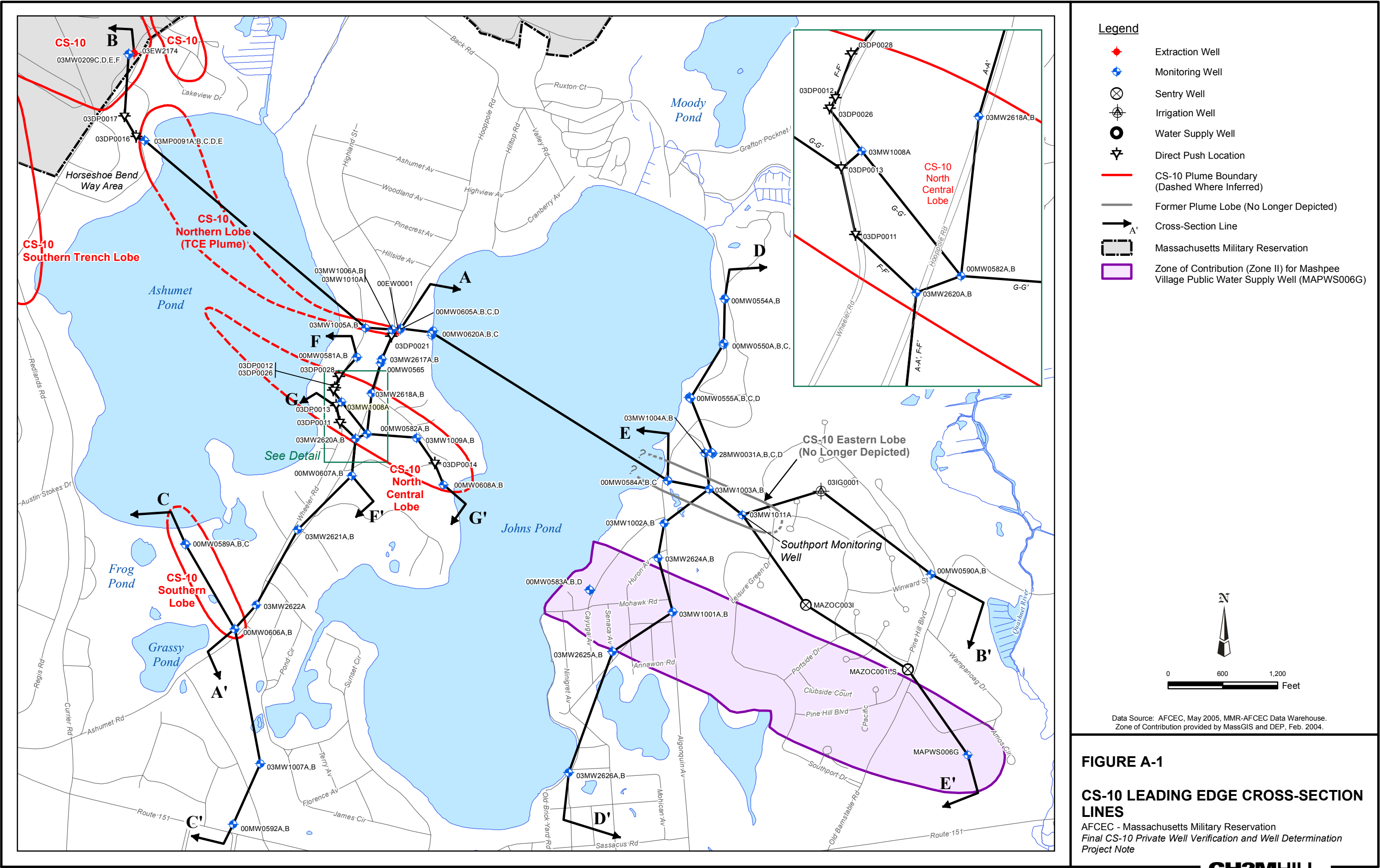
Data Source: AFCEC, September 2015

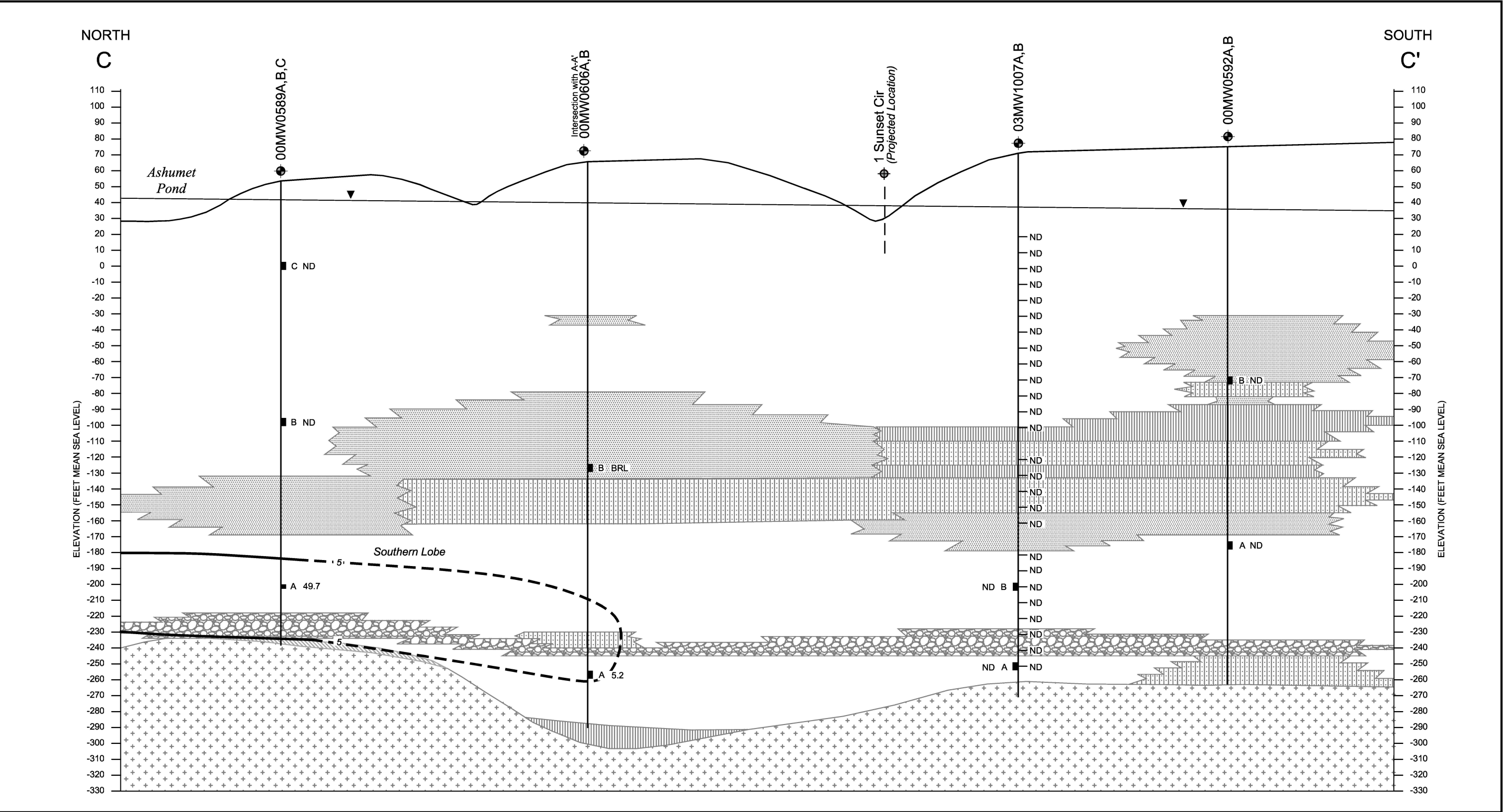


0 180 360
Feet

LOCATION: 1 SUNSET CR

AFCEC - Joint Base Cape Cod
CS-10 2015 Land Use Control





Legend

- Monitoring Well
- Well Screen ID
- Water Table
- Nondetect
- Isoconcentration Contour (Dashed Where Inferred) (MCL = 5.0 µg/L)
- Private Well (Unknown Depth)
- TCE Screening Data (µg/L)
- TCE Concentrations, Latest Available Data (µg/L)

- Silt
- Clay
- Silty Sand
- Fine Sand
- Gravelly Sand
- Bedrock

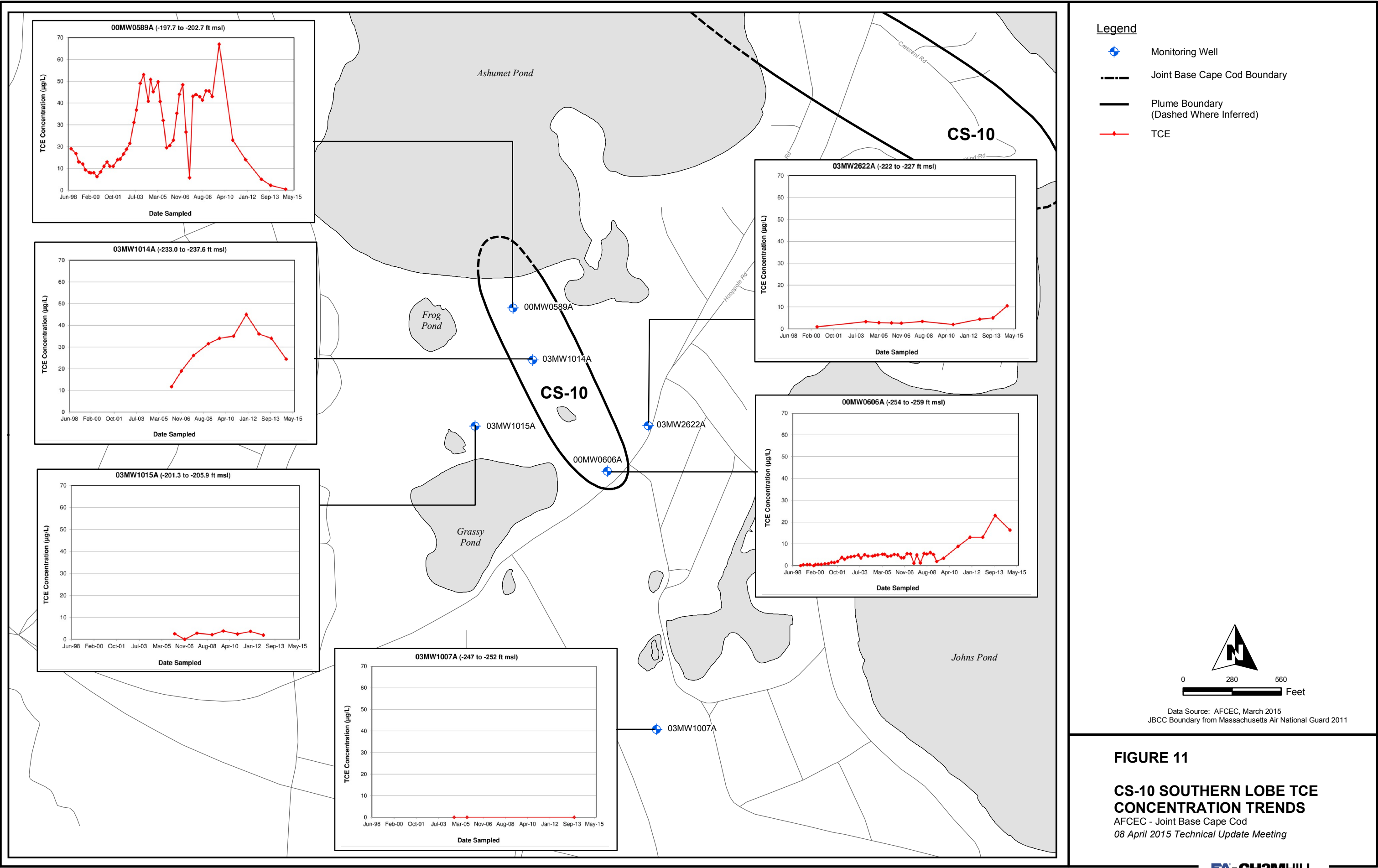
Note: The white background consists of poorly sorted fine to coarse grained sands.



FIGURE 3-4

CS-10 LEADING EDGE CROSS-SECTION C-C'

AFCEE-Massachusetts Military Reservation
Final CS-10 Leading Edge Technical Memorandum (Modified With Private Well Location)



Summary of PCE and TCE Results
CS-10 Southern Lobe Area

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
00MW0589A	WA	CVOL	TETRACHLOROETHENE (PCE)	253.5	7/1/1997	ND	0.41	1	µg/L
00MW0589A	WG	CVOL	TETRACHLOROETHENE (PCE)	253.8	8/13/1997	ND	0.41	1	µg/L
00MW0589A	WG	CVOL	TETRACHLOROETHENE (PCE)	253.8	8/24/1998	ND	0.22	1	µg/L
00MW0589A	WG	CVOL	TETRACHLOROETHENE (PCE)	253.8	1/6/1999	ND	0.22	1	µg/L
00MW0589A	WG	CVOL	TETRACHLOROETHENE (PCE)	253.8	3/19/1999	ND	0.1	1	µg/L
00MW0589A	WG	CVOL	TETRACHLOROETHENE (PCE)	253.8	3/29/1999	ND	0.1	1	µg/L
00MW0589A	WG	CVOL	TETRACHLOROETHENE (PCE)	253.8	7/14/1999	ND	0.1	1	µg/L
00MW0589A	WG	CVOL	TETRACHLOROETHENE (PCE)	253.8	9/23/1999	ND	0.1	1	µg/L
00MW0589A	WG	CVOL	TETRACHLOROETHENE (PCE)	253.8	1/7/2000	ND	0.1	1	µg/L
00MW0589A	WG	CVOL	TETRACHLOROETHENE (PCE)	253.8	2/21/2000	ND	0.1	1	µg/L
00MW0589A	WG	CVOL	TETRACHLOROETHENE (PCE)	253.8	5/11/2000	ND	0.11	1	µg/L
00MW0589A	WG	CVOL	TETRACHLOROETHENE (PCE)	253.8	8/8/2000	ND	0.11	1	µg/L
00MW0589A	WG	CVOL	TETRACHLOROETHENE (PCE)	253.8	11/14/2000	ND	0.11	1	µg/L
00MW0589A	WG	CVOL	TETRACHLOROETHENE (PCE)	253.8	2/19/2001	BRL	0.11	1	µg/L
00MW0589A	WG	CVOL	TETRACHLOROETHENE (PCE)	253.8	5/14/2001	BRL	0.11	1	µg/L
00MW0589A	WG	CVOL	TETRACHLOROETHENE (PCE)	253.8	7/31/2001	BRL	0.11	1	µg/L
00MW0589A	WG	CVOL	TETRACHLOROETHENE (PCE)	253.8	11/2/2001	ND	0.13	1	µg/L
00MW0589A	WG	SW8260	TETRACHLOROETHENE (PCE)	253.8	2/28/2002	BRL	0.146	1	µg/L
00MW0589A	WG	SW8260	TETRACHLOROETHENE (PCE)	253.8	5/14/2002	BRL	0.146	1	µg/L
00MW0589A	WG	SW8260	TETRACHLOROETHENE (PCE)	253.8	8/15/2002	BRL	0.146	1	µg/L
00MW0589A	WG	SW8260	TETRACHLOROETHENE (PCE)	253.8	11/4/2002	BRL	0.146	1	µg/L
00MW0589A	WG	SW8260	TETRACHLOROETHENE (PCE)	253.8	2/5/2003	BRL	0.146	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	5/27/2003	1.4	0.137	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	8/5/2003	2.08	0.137	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	11/17/2003	3.5	0.421	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	2/19/2004	5 J	0.421	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	6/28/2004	5.9	0.08	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	8/30/2004	7.4	0.18	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	11/12/2004	8.4	0.18	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	3/28/2005	11	0.14	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	5/23/2005	10.6	0.18	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	8/15/2005	9.2	0.27	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	11/16/2005	5	0.27	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	2/15/2006	4.6	0.27	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	5/24/2006	7.1	0.2	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	8/29/2006	8.3	0.15	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	11/6/2006	11.1	0.15	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	2/6/2007	15.9	0.18	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	5/9/2007	7.7	0.18	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	8/13/2007	1.6	0.18	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	11/15/2007	11.7	0.18	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	2/7/2008	12.5	0.18	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	5/22/2008	14.3	0.18	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	8/5/2008	14.3	0.18	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	11/10/2008	16.2	0.18	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	2/5/2009	17.5	0.18	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	5/4/2009	15.6	0.18	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	11/12/2009	26	0.18	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	11/22/2010	9.6	0.19	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	11/14/2011	8.2	0.19	1	µg/L
00MW0589A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.8	1/23/2013	2.5	0.19	1	µg/L
00MW0589A	WG	SW8260C	TETRACHLOROETHENE (PCE)	253.8	10/9/2013	1.3	0.18	1	µg/L
00MW0589A	WG	SW8260C	TETRACHLOROETHENE (PCE)	253.8	11/25/2014	BRL	0.29	1	µg/L
00MW0589A	WA	CVOL	TRICHLOROETHENE (TCE)	253.5	7/1/1997	18	0.62	1	µg/L

Summary of PCE and TCE Results
CS-10 Southern Lobe Area

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
00MW0589A	WG	CVOL	TRICHLOROETHENE (TCE)	253.8	8/13/1997	19	0.62	1	µg/L
00MW0589A	WG	CVOL	TRICHLOROETHENE (TCE)	253.8	8/24/1998	19	0.35	1	µg/L
00MW0589A	WG	CVOL	TRICHLOROETHENE (TCE)	253.8	1/6/1999	16.8	0.35	1	µg/L
00MW0589A	WG	CVOL	TRICHLOROETHENE (TCE)	253.8	3/19/1999	13	0.12	1	µg/L
00MW0589A	WG	CVOL	TRICHLOROETHENE (TCE)	253.8	3/29/1999	13 J	0.12	1	µg/L
00MW0589A	WG	CVOL	TRICHLOROETHENE (TCE)	253.8	7/14/1999	12	0.12	1	µg/L
00MW0589A	WG	CVOL	TRICHLOROETHENE (TCE)	253.8	9/23/1999	9.3	0.12	1	µg/L
00MW0589A	WG	CVOL	TRICHLOROETHENE (TCE)	253.8	1/7/2000	8.1	0.12	1	µg/L
00MW0589A	WG	CVOL	TRICHLOROETHENE (TCE)	253.8	2/21/2000	7.9	0.12	1	µg/L
00MW0589A	WG	CVOL	TRICHLOROETHENE (TCE)	253.8	5/11/2000	8	0.09	1	µg/L
00MW0589A	WG	CVOL	TRICHLOROETHENE (TCE)	253.8	8/8/2000	6.2	0.09	1	µg/L
00MW0589A	WG	CVOL	TRICHLOROETHENE (TCE)	253.8	11/14/2000	8.4	0.09	1	µg/L
00MW0589A	WG	CVOL	TRICHLOROETHENE (TCE)	253.8	2/19/2001	11	0.09	1	µg/L
00MW0589A	WG	CVOL	TRICHLOROETHENE (TCE)	253.8	5/14/2001	13	0.09	1	µg/L
00MW0589A	WG	CVOL	TRICHLOROETHENE (TCE)	253.8	7/31/2001	11	0.09	1	µg/L
00MW0589A	WG	CVOL	TRICHLOROETHENE (TCE)	253.8	11/2/2001	11	0.15	1	µg/L
00MW0589A	WG	SW8260	TRICHLOROETHENE (TCE)	253.8	2/28/2002	14	0.138	1	µg/L
00MW0589A	WG	SW8260	TRICHLOROETHENE (TCE)	253.8	5/14/2002	14.3	0.138	1	µg/L
00MW0589A	WG	SW8260	TRICHLOROETHENE (TCE)	253.8	8/15/2002	16.6	0.138	1	µg/L
00MW0589A	WG	SW8260	TRICHLOROETHENE (TCE)	253.8	11/4/2002	18.8	0.138	1	µg/L
00MW0589A	WG	SW8260	TRICHLOROETHENE (TCE)	253.8	2/5/2003	21.5	0.138	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	5/27/2003	31.1	0.203	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	8/5/2003	36.8	0.203	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	11/17/2003	49	0.241	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	2/19/2004	53	0.482	2	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	6/28/2004	40.8	0.08	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	8/30/2004	50.8	0.11	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	11/12/2004	45.2	0.11	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	3/28/2005	49.7	0.1	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	5/23/2005	40.7	0.11	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	8/15/2005	32	0.27	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	11/16/2005	19.5	0.27	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	2/15/2006	20.5	0.21	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	5/24/2006	23	0.21	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	8/29/2006	35.3	0.15	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	11/6/2006	44	0.15	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	2/6/2007	48.4	0.15	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	5/9/2007	26.7	0.15	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	8/13/2007	5.7	0.15	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	11/15/2007	43.1	0.15	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	2/7/2008	43.9	0.15	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	5/22/2008	42.9	0.15	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	8/5/2008	41.3	0.15	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	11/10/2008	45.6	0.15	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	2/5/2009	45.5	0.15	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	5/4/2009	43	0.15	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	11/12/2009	67	0.17	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	11/22/2010	23	0.2	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	11/14/2011	14	0.2	1	µg/L
00MW0589A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.8	1/23/2013	5	0.2	1	µg/L
00MW0589A	WG	SW8260C	TRICHLOROETHENE (TCE)	253.8	10/9/2013	2.2	0.17	1	µg/L
00MW0589A	WG	SW8260C	TRICHLOROETHENE (TCE)	253.8	11/25/2014	BRL	0.4	1	µg/L
00MW0589B	WG	CVOL	TETRACHLOROETHENE (PCE)	151.55	8/13/1997	ND	0.41	1	µg/L
00MW0589B	WG	CVOL	TETRACHLOROETHENE (PCE)	151.55	1/6/1999	ND	0.22	1	µg/L

Summary of PCE and TCE Results
CS-10 Southern Lobe Area

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
00MW0589B	WG	CVOL	TETRACHLOROETHENE (PCE)	151.55	3/19/1999	ND	0.1	1	µg/L
00MW0589B	WG	CVOL	TETRACHLOROETHENE (PCE)	151.55	3/29/1999	ND	0.1	1	µg/L
00MW0589B	WG	CVOL	TETRACHLOROETHENE (PCE)	151.55	7/14/1999	ND	0.1	1	µg/L
00MW0589B	WG	CVOL	TETRACHLOROETHENE (PCE)	151.55	9/23/1999	ND	0.1	1	µg/L
00MW0589B	WG	CVOL	TETRACHLOROETHENE (PCE)	151.55	1/7/2000	ND	0.1	1	µg/L
00MW0589B	WG	CVOL	TETRACHLOROETHENE (PCE)	151.55	2/21/2000	ND	0.1	1	µg/L
00MW0589B	WG	CVOL	TETRACHLOROETHENE (PCE)	151.55	5/11/2000	ND	0.11	1	µg/L
00MW0589B	WG	CVOL	TETRACHLOROETHENE (PCE)	151.55	8/8/2000	ND	0.11	1	µg/L
00MW0589B	WG	CVOL	TETRACHLOROETHENE (PCE)	151.55	11/14/2000	ND	0.11	1	µg/L
00MW0589B	WG	CVOL	TETRACHLOROETHENE (PCE)	151.55	2/19/2001	ND	0.11	1	µg/L
00MW0589B	WG	CVOL	TETRACHLOROETHENE (PCE)	151.55	5/14/2001	ND	0.11	1	µg/L
00MW0589B	WG	CVOL	TETRACHLOROETHENE (PCE)	151.55	7/31/2001	ND	0.11	1	µg/L
00MW0589B	WG	CVOL	TETRACHLOROETHENE (PCE)	151.55	11/2/2001	ND	0.13	1	µg/L
00MW0589B	WG	SW8260	TETRACHLOROETHENE (PCE)	151.55	2/28/2002	ND	0.146	1	µg/L
00MW0589B	WG	SW8260	TETRACHLOROETHENE (PCE)	151.55	5/14/2002	ND	0.146	1	µg/L
00MW0589B	WG	SW8260	TETRACHLOROETHENE (PCE)	151.55	8/15/2002	ND	0.146	1	µg/L
00MW0589B	WG	SW8260	TETRACHLOROETHENE (PCE)	151.55	11/4/2002	ND	0.146	1	µg/L
00MW0589B	WG	SW8260	TETRACHLOROETHENE (PCE)	151.55	2/5/2003	ND	0.146	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	5/27/2003	ND	0.137	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	8/5/2003	ND	0.137	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	11/17/2003	ND	0.421	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	2/19/2004	ND	0.421	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	6/28/2004	ND	0.08	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	8/30/2004	ND	0.18	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	11/12/2004	ND	0.18	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	3/28/2005	ND	0.14	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	5/23/2005	ND	0.18	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	8/15/2005	ND	0.27	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	11/16/2005	ND	0.27	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	2/15/2006	ND	0.27	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	5/24/2006	ND	0.2	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	8/29/2006	ND	0.15	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	11/6/2006	ND	0.15	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	2/6/2007	ND	0.18	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	5/9/2007	ND	0.18	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	8/13/2007	ND	0.18	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	11/5/2007	ND	0.18	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	2/7/2008	ND	0.18	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	5/22/2008	ND	0.18	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	8/5/2008	ND	0.18	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	11/10/2008	ND	0.18	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	2/5/2009	ND	0.18	1	µg/L
00MW0589B	WG	SW8260B	TETRACHLOROETHENE (PCE)	151.55	5/4/2009	ND	0.18	1	µg/L
00MW0589B	WG	CVOL	TRICHLOROETHENE (TCE)	151.55	8/13/1997	ND	0.62	1	µg/L
00MW0589B	WG	CVOL	TRICHLOROETHENE (TCE)	151.55	1/6/1999	ND	0.35	1	µg/L
00MW0589B	WG	CVOL	TRICHLOROETHENE (TCE)	151.55	3/19/1999	ND	0.12	1	µg/L
00MW0589B	WG	CVOL	TRICHLOROETHENE (TCE)	151.55	3/29/1999	ND	0.12	1	µg/L
00MW0589B	WG	CVOL	TRICHLOROETHENE (TCE)	151.55	7/14/1999	ND	0.12	1	µg/L
00MW0589B	WG	CVOL	TRICHLOROETHENE (TCE)	151.55	9/23/1999	ND	0.12	1	µg/L
00MW0589B	WG	CVOL	TRICHLOROETHENE (TCE)	151.55	1/7/2000	ND	0.12	1	µg/L
00MW0589B	WG	CVOL	TRICHLOROETHENE (TCE)	151.55	2/21/2000	ND	0.12	1	µg/L
00MW0589B	WG	CVOL	TRICHLOROETHENE (TCE)	151.55	5/11/2000	ND	0.09	1	µg/L
00MW0589B	WG	CVOL	TRICHLOROETHENE (TCE)	151.55	8/8/2000	ND	0.09	1	µg/L
00MW0589B	WG	CVOL	TRICHLOROETHENE (TCE)	151.55	11/14/2000	ND	0.09	1	µg/L

Summary of PCE and TCE Results
CS-10 Southern Lobe Area

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
00MW0589B	WG	CVOL	TRICHLOROETHENE (TCE)	151.55	2/19/2001	ND	0.09	1	µg/L
00MW0589B	WG	CVOL	TRICHLOROETHENE (TCE)	151.55	5/14/2001	ND	0.09	1	µg/L
00MW0589B	WG	CVOL	TRICHLOROETHENE (TCE)	151.55	7/31/2001	BRL	0.09	1	µg/L
00MW0589B	WG	CVOL	TRICHLOROETHENE (TCE)	151.55	11/2/2001	ND	0.15	1	µg/L
00MW0589B	WG	SW8260	TRICHLOROETHENE (TCE)	151.55	2/28/2002	ND	0.138	1	µg/L
00MW0589B	WG	SW8260	TRICHLOROETHENE (TCE)	151.55	5/14/2002	ND	0.138	1	µg/L
00MW0589B	WG	SW8260	TRICHLOROETHENE (TCE)	151.55	8/15/2002	ND	0.138	1	µg/L
00MW0589B	WG	SW8260	TRICHLOROETHENE (TCE)	151.55	11/4/2002	ND	0.138	1	µg/L
00MW0589B	WG	SW8260	TRICHLOROETHENE (TCE)	151.55	2/5/2003	ND	0.138	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	5/27/2003	ND	0.203	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	8/5/2003	ND	0.203	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	11/17/2003	ND	0.241	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	2/19/2004	ND	0.241	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	6/28/2004	ND	0.08	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	8/30/2004	ND	0.11	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	11/12/2004	ND	0.11	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	3/28/2005	ND	0.1	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	5/23/2005	ND	0.11	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	8/15/2005	ND	0.27	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	11/16/2005	ND	0.27	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	2/15/2006	ND	0.21	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	5/24/2006	ND	0.21	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	8/29/2006	ND	0.15	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	11/6/2006	ND	0.15	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	2/6/2007	ND	0.15	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	5/9/2007	ND	0.15	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	8/13/2007	ND	0.15	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	11/5/2007	ND	0.15	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	2/7/2008	ND	0.15	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	5/22/2008	ND	0.15	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	8/5/2008	ND	0.15	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	11/10/2008	ND	0.15	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	2/5/2009	ND	0.15	1	µg/L
00MW0589B	WG	SW8260B	TRICHLOROETHENE (TCE)	151.55	5/4/2009	ND	0.15	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	42.5	10/29/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	52.5	10/29/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	62.5	10/29/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	72.5	10/29/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	82.5	10/29/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	92.5	10/29/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	102.5	10/29/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	112.5	10/29/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	122.5	10/29/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	132.5	10/29/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	142.5	10/30/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	152.5	10/30/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	162.5	10/30/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	172.5	10/30/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	182.5	10/30/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	192.5	10/30/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	202.5	10/30/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	212.5	10/30/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	222.5	11/2/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	232.5	11/2/1998	ND	0.154	1	µg/L

Summary of PCE and TCE Results
CS-10 Southern Lobe Area

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	242.5	11/2/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	252.5	11/3/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	262.5	11/3/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	272.5	11/3/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	282.5	11/4/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	292.5	11/4/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	312.5	11/4/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	322.5	11/5/1998	ND	0.154	1	µg/L
00MW0606A	WA	SW8260	TETRACHLOROETHENE (PCE)	342.5	11/6/1998	ND	0.154	1	µg/L
00MW0606A	WG	CVOL	TETRACHLOROETHENE (PCE)	322.5	1/11/1999	ND	0.22	1	µg/L
00MW0606A	WG	CVOL	TETRACHLOROETHENE (PCE)	322.5	3/23/1999	ND	0.1	1	µg/L
00MW0606A	WG	CVOL	TETRACHLOROETHENE (PCE)	322.5	3/29/1999	ND	0.1	1	µg/L
00MW0606A	WG	CVOL	TETRACHLOROETHENE (PCE)	322.5	7/13/1999	ND	0.1	1	µg/L
00MW0606A	WG	CVOL	TETRACHLOROETHENE (PCE)	322.5	9/23/1999	ND	0.1	1	µg/L
00MW0606A	WG	CVOL	TETRACHLOROETHENE (PCE)	322.5	1/7/2000	ND	0.1	1	µg/L
00MW0606A	WG	CVOL	TETRACHLOROETHENE (PCE)	322.5	2/23/2000	ND	0.1	1	µg/L
00MW0606A	WG	CVOL	TETRACHLOROETHENE (PCE)	322.5	5/11/2000	ND	0.11	1	µg/L
00MW0606A	WG	CVOL	TETRACHLOROETHENE (PCE)	322.5	8/8/2000	ND	0.11	1	µg/L
00MW0606A	WG	CVOL	TETRACHLOROETHENE (PCE)	322.5	11/14/2000	ND	0.11	1	µg/L
00MW0606A	WG	CVOL	TETRACHLOROETHENE (PCE)	322.5	2/19/2001	ND	0.11	1	µg/L
00MW0606A	WG	CVOL	TETRACHLOROETHENE (PCE)	322.5	5/14/2001	ND	0.11	1	µg/L
00MW0606A	WG	CVOL	TETRACHLOROETHENE (PCE)	322.5	7/31/2001	ND	0.11	1	µg/L
00MW0606A	WG	CVOL	TETRACHLOROETHENE (PCE)	322.5	11/1/2001	ND	0.19	1.7	µg/L
00MW0606A	WG	SW8260	TETRACHLOROETHENE (PCE)	322.5	2/27/2002	ND	0.146	1	µg/L
00MW0606A	WG	SW8260	TETRACHLOROETHENE (PCE)	322.5	5/14/2002	ND	0.146	1	µg/L
00MW0606A	WG	SW8260	TETRACHLOROETHENE (PCE)	322.5	8/6/2002	ND	0.146	1	µg/L
00MW0606A	WG	SW8260	TETRACHLOROETHENE (PCE)	322.5	11/1/2002	ND	0.146	1	µg/L
00MW0606A	WG	SW8260	TETRACHLOROETHENE (PCE)	322.5	2/5/2003	ND	0.146	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	5/27/2003	ND	0.137	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	8/7/2003	ND	0.137	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	11/17/2003	ND	0.421	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	2/20/2004	ND	0.421	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	6/28/2004	ND	0.08	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	8/30/2004	ND	0.18	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	11/18/2004	ND	0.08	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	3/28/2005	ND	0.14	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	5/23/2005	ND	0.18	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	8/15/2005	ND	0.27	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	11/16/2005	ND	0.27	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	2/15/2006	ND	0.27	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	5/24/2006	ND	0.2	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	8/29/2006	ND	0.15	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	11/6/2006	ND	0.15	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	2/6/2007	ND	0.18	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	5/9/2007	ND	0.18	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	8/13/2007	ND	0.18	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	11/5/2007	ND	0.18	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	2/7/2008	ND	0.18	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	5/21/2008	ND	0.18	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	8/5/2008	ND	0.18	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	11/10/2008	ND	0.18	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	2/5/2009	ND	0.18	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	5/4/2009	ND	0.18	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	11/12/2009	ND	0.18	1	µg/L

Summary of PCE and TCE Results
CS-10 Southern Lobe Area

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	12/16/2010	BRL	0.19	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	11/14/2011	BRL	0.19	1	µg/L
00MW0606A	WG	SW8260B	TETRACHLOROETHENE (PCE)	322.5	10/31/2012	1.1	0.19	1	µg/L
00MW0606A	WG	SW8260C	TETRACHLOROETHENE (PCE)	322.5	10/9/2013	3.5	0.18	1	µg/L
00MW0606A	WG	SW8260C	TETRACHLOROETHENE (PCE)	322.5	11/25/2014	3.1	0.5	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	42.5	10/29/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	52.5	10/29/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	62.5	10/29/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	72.5	10/29/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	82.5	10/29/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	92.5	10/29/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	102.5	10/29/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	112.5	10/29/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	122.5	10/29/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	132.5	10/29/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	142.5	10/30/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	152.5	10/30/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	162.5	10/30/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	172.5	10/30/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	182.5	10/30/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	192.5	10/30/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	202.5	10/30/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	212.5	10/30/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	222.5	11/2/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	232.5	11/2/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	242.5	11/2/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	252.5	11/3/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	262.5	11/3/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	272.5	11/3/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	282.5	11/4/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	292.5	11/4/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	312.5	11/4/1998	ND	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	322.5	11/5/1998	BRL	0.318	1	µg/L
00MW0606A	WA	SW8260	TRICHLOROETHENE (TCE)	342.5	11/6/1998	ND	0.318	1	µg/L
00MW0606A	WG	CVOL	TRICHLOROETHENE (TCE)	322.5	1/11/1999	ND	0.35	1	µg/L
00MW0606A	WG	CVOL	TRICHLOROETHENE (TCE)	322.5	3/23/1999	BRL	0.12	1	µg/L
00MW0606A	WG	CVOL	TRICHLOROETHENE (TCE)	322.5	3/29/1999	BRL	0.12	1	µg/L
00MW0606A	WG	CVOL	TRICHLOROETHENE (TCE)	322.5	7/13/1999	BRL	0.12	1	µg/L
00MW0606A	WG	CVOL	TRICHLOROETHENE (TCE)	322.5	9/23/1999	BRL	0.12	1	µg/L
00MW0606A	WG	CVOL	TRICHLOROETHENE (TCE)	322.5	1/7/2000	ND	0.12	1	µg/L
00MW0606A	WG	CVOL	TRICHLOROETHENE (TCE)	322.5	2/23/2000	BRL	0.12	1	µg/L
00MW0606A	WG	CVOL	TRICHLOROETHENE (TCE)	322.5	5/11/2000	BRL	0.09	1	µg/L
00MW0606A	WG	CVOL	TRICHLOROETHENE (TCE)	322.5	8/8/2000	BRL	0.09	1	µg/L
00MW0606A	WG	CVOL	TRICHLOROETHENE (TCE)	322.5	11/14/2000	BRL	0.09	1	µg/L
00MW0606A	WG	CVOL	TRICHLOROETHENE (TCE)	322.5	2/19/2001	BRL	0.09	1	µg/L
00MW0606A	WG	CVOL	TRICHLOROETHENE (TCE)	322.5	5/14/2001	1.5	0.09	1	µg/L
00MW0606A	WG	CVOL	TRICHLOROETHENE (TCE)	322.5	7/31/2001	1.4	0.09	1	µg/L
00MW0606A	WG	CVOL	TRICHLOROETHENE (TCE)	322.5	11/1/2001	1.9	0.15	1	µg/L
00MW0606A	WG	SW8260	TRICHLOROETHENE (TCE)	322.5	2/27/2002	3.76	0.138	1	µg/L
00MW0606A	WG	SW8260	TRICHLOROETHENE (TCE)	322.5	5/14/2002	2.89	0.138	1	µg/L
00MW0606A	WG	SW8260	TRICHLOROETHENE (TCE)	322.5	8/6/2002	3.78	0.138	1	µg/L
00MW0606A	WG	SW8260	TRICHLOROETHENE (TCE)	322.5	11/1/2002	4.02	0.138	1	µg/L
00MW0606A	WG	SW8260	TRICHLOROETHENE (TCE)	322.5	2/5/2003	4.32	0.138	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	5/27/2003	4.85	0.203	1	µg/L

Summary of PCE and TCE Results
CS-10 Southern Lobe Area

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	8/7/2003	3.51	0.203	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	11/17/2003	5	0.241	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	2/20/2004	4.4	0.241	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	6/28/2004	4.4	0.08	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	8/30/2004	4.7	0.11	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	11/18/2004	4.9	0.08	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	3/28/2005	5.2	0.1	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	5/23/2005	5.2	0.11	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	8/15/2005	4.2	0.27	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	11/16/2005	4.5	0.27	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	2/15/2006	5.1	0.21	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	5/24/2006	4.9	0.21	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	8/29/2006	3.6	0.15	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	11/6/2006	3.6	0.15	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	2/6/2007	5.5	0.15	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	5/9/2007	5.4	0.15	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	8/13/2007	1.1	0.15	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	11/5/2007	4.9	0.15	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	2/7/2008	1.2	0.15	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	5/21/2008	5.6	0.15	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	8/5/2008	5.3	0.15	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	11/10/2008	6	0.15	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	2/5/2009	5.1	0.15	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	5/4/2009	1.9	0.15	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	11/12/2009	3.4	0.17	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	12/16/2010	8.8	0.2	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	11/14/2011	13	0.2	1	µg/L
00MW0606A	WG	SW8260B	TRICHLOROETHENE (TCE)	322.5	10/31/2012	13	0.2	1	µg/L
00MW0606A	WG	SW8260C	TRICHLOROETHENE (TCE)	322.5	10/9/2013	23	0.17	1	µg/L
00MW0606A	WG	SW8260C	TRICHLOROETHENE (TCE)	322.5	11/25/2014	16.3	0.5	1	µg/L
00MW0606B	WG	CVOL	TETRACHLOROETHENE (PCE)	192.5	1/11/1999	ND	0.22	1	µg/L
00MW0606B	WG	CVOL	TETRACHLOROETHENE (PCE)	192.5	3/19/1999	ND	0.1	1	µg/L
00MW0606B	WG	CVOL	TETRACHLOROETHENE (PCE)	192.5	3/29/1999	ND	0.1	1	µg/L
00MW0606B	WG	CVOL	TETRACHLOROETHENE (PCE)	192.5	7/13/1999	ND	0.1	1	µg/L
00MW0606B	WG	CVOL	TETRACHLOROETHENE (PCE)	192.5	9/23/1999	ND	0.1	1	µg/L
00MW0606B	WG	CVOL	TETRACHLOROETHENE (PCE)	192.5	1/7/2000	ND	0.1	1	µg/L
00MW0606B	WG	CVOL	TETRACHLOROETHENE (PCE)	192.5	2/23/2000	ND	0.1	1	µg/L
00MW0606B	WG	CVOL	TETRACHLOROETHENE (PCE)	192.5	5/11/2000	ND	0.11	1	µg/L
00MW0606B	WG	CVOL	TETRACHLOROETHENE (PCE)	192.5	8/8/2000	ND	0.11	1	µg/L
00MW0606B	WG	CVOL	TETRACHLOROETHENE (PCE)	192.5	11/14/2000	ND	0.11	1	µg/L
00MW0606B	WG	CVOL	TETRACHLOROETHENE (PCE)	192.5	2/19/2001	ND	0.11	1	µg/L
00MW0606B	WG	CVOL	TETRACHLOROETHENE (PCE)	192.5	5/14/2001	ND	0.11	1	µg/L
00MW0606B	WG	CVOL	TETRACHLOROETHENE (PCE)	192.5	7/31/2001	ND	0.11	1	µg/L
00MW0606B	WG	CVOL	TETRACHLOROETHENE (PCE)	192.5	11/1/2001	ND	0.13	1	µg/L
00MW0606B	WG	SW8260	TETRACHLOROETHENE (PCE)	192.5	2/27/2002	ND	0.146	1	µg/L
00MW0606B	WG	SW8260	TETRACHLOROETHENE (PCE)	192.5	5/14/2002	ND	0.146	1	µg/L
00MW0606B	WG	SW8260	TETRACHLOROETHENE (PCE)	192.5	8/6/2002	ND	0.146	1	µg/L
00MW0606B	WG	SW8260	TETRACHLOROETHENE (PCE)	192.5	11/1/2002	ND	0.146	1	µg/L
00MW0606B	WG	SW8260	TETRACHLOROETHENE (PCE)	192.5	2/5/2003	ND	0.146	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	5/27/2003	ND	0.137	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	8/7/2003	ND	0.137	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	11/17/2003	ND	0.421	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	2/20/2004	ND	0.421	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	6/28/2004	ND	0.08	1	µg/L

Summary of PCE and TCE Results
CS-10 Southern Lobe Area

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	8/30/2004	ND	0.18	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	11/18/2004	ND	0.08	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	3/28/2005	ND	0.14	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	5/23/2005	ND	0.18	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	8/15/2005	ND	0.27	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	11/16/2005	ND	0.27	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	2/15/2006	ND	0.27	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	5/24/2006	ND	0.2	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	8/29/2006	ND	0.15	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	11/6/2006	ND	0.15	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	2/6/2007	ND	0.18	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	5/9/2007	ND	0.18	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	8/13/2007	ND	0.18	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	11/5/2007	ND	0.18	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	2/7/2008	ND	0.18	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	5/21/2008	ND	0.18	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	8/5/2008	ND	0.18	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	11/10/2008	ND	0.18	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	2/5/2009	ND	0.18	1	µg/L
00MW0606B	WG	SW8260B	TETRACHLOROETHENE (PCE)	192.5	5/4/2009	ND	0.18	1	µg/L
00MW0606B	WG	CVOL	TRICHLOROETHENE (TCE)	192.5	1/11/1999	ND	0.35	1	µg/L
00MW0606B	WG	CVOL	TRICHLOROETHENE (TCE)	192.5	3/19/1999	ND	0.12	1	µg/L
00MW0606B	WG	CVOL	TRICHLOROETHENE (TCE)	192.5	3/29/1999	ND	0.12	1	µg/L
00MW0606B	WG	CVOL	TRICHLOROETHENE (TCE)	192.5	7/13/1999	ND	0.12	1	µg/L
00MW0606B	WG	CVOL	TRICHLOROETHENE (TCE)	192.5	9/23/1999	ND	0.12	1	µg/L
00MW0606B	WG	CVOL	TRICHLOROETHENE (TCE)	192.5	1/7/2000	ND	0.12	1	µg/L
00MW0606B	WG	CVOL	TRICHLOROETHENE (TCE)	192.5	2/23/2000	ND	0.12	1	µg/L
00MW0606B	WG	CVOL	TRICHLOROETHENE (TCE)	192.5	5/11/2000	ND	0.09	1	µg/L
00MW0606B	WG	CVOL	TRICHLOROETHENE (TCE)	192.5	8/8/2000	ND	0.09	1	µg/L
00MW0606B	WG	CVOL	TRICHLOROETHENE (TCE)	192.5	11/14/2000	ND	0.09	1	µg/L
00MW0606B	WG	CVOL	TRICHLOROETHENE (TCE)	192.5	2/19/2001	ND	0.09	1	µg/L
00MW0606B	WG	CVOL	TRICHLOROETHENE (TCE)	192.5	5/14/2001	ND	0.09	1	µg/L
00MW0606B	WG	CVOL	TRICHLOROETHENE (TCE)	192.5	7/31/2001	ND	0.09	1	µg/L
00MW0606B	WG	CVOL	TRICHLOROETHENE (TCE)	192.5	11/1/2001	ND	0.15	1	µg/L
00MW0606B	WG	SW8260	TRICHLOROETHENE (TCE)	192.5	2/27/2002	ND	0.138	1	µg/L
00MW0606B	WG	SW8260	TRICHLOROETHENE (TCE)	192.5	5/14/2002	ND	0.138	1	µg/L
00MW0606B	WG	SW8260	TRICHLOROETHENE (TCE)	192.5	8/6/2002	ND	0.138	1	µg/L
00MW0606B	WG	SW8260	TRICHLOROETHENE (TCE)	192.5	11/1/2002	ND	0.138	1	µg/L
00MW0606B	WG	SW8260	TRICHLOROETHENE (TCE)	192.5	2/5/2003	ND	0.138	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	5/27/2003	ND	0.203	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	8/7/2003	ND	0.203	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	11/17/2003	ND	0.241	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	2/20/2004	ND	0.241	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	6/28/2004	ND	0.08	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	8/30/2004	ND	0.11	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	11/18/2004	ND	0.08	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	3/28/2005	ND	0.1	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	5/23/2005	ND	0.11	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	8/15/2005	ND	0.27	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	11/16/2005	ND	0.27	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	2/15/2006	ND	0.21	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	5/24/2006	ND	0.21	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	8/29/2006	ND	0.15	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	11/6/2006	ND	0.15	1	µg/L

Summary of PCE and TCE Results
CS-10 Southern Lobe Area

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	2/6/2007	ND	0.15	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	5/9/2007	ND	0.15	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	8/13/2007	ND	0.15	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	11/5/2007	ND	0.15	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	2/7/2008	ND	0.15	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	5/21/2008	ND	0.15	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	8/5/2008	ND	0.15	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	11/10/2008	ND	0.15	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	2/5/2009	ND	0.15	1	µg/L
00MW0606B	WG	SW8260B	TRICHLOROETHENE (TCE)	192.5	5/4/2009	ND	0.15	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	32.5	11/16/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	42.5	11/16/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	52.5	11/16/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	62.5	11/16/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	72.5	11/16/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	82.5	11/17/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	92.5	11/17/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	102.5	11/17/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	112.5	11/17/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	122.5	11/17/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	132.5	11/17/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	142.5	11/17/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	152.5	11/17/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	162.5	11/18/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	172.5	11/18/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	182.5	11/21/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	192.5	11/21/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	202.5	11/22/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	212.5	11/22/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	222.5	11/22/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	232.5	11/22/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	242.5	11/23/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	252.5	11/23/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	262.5	11/29/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	272.5	11/29/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	282.5	11/29/2005	BRL	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	292.5	11/29/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TETRACHLOROETHENE (PCE)	302.5	11/30/2005	ND	0.27	1	µg/L
03MW1014A	WG	SW8260B	TETRACHLOROETHENE (PCE)	292.35	3/6/2006	ND	0.27	1	µg/L
03MW1014A	WG	SW8260B	TETRACHLOROETHENE (PCE)	292.35	12/5/2006	BRL	0.15	1	µg/L
03MW1014A	WG	SW8260B	TETRACHLOROETHENE (PCE)	292.35	11/8/2007	BRL	0.18	1	µg/L
03MW1014A	WG	SW8260B	TETRACHLOROETHENE (PCE)	292.35	12/24/2008	2.5	0.18	1	µg/L
03MW1014A	WG	SW8260B	TETRACHLOROETHENE (PCE)	292.35	10/29/2009	6.2	0.18	1	µg/L
03MW1014A	WG	SW8260B	TETRACHLOROETHENE (PCE)	292.35	11/22/2010	8.7	0.19	1	µg/L
03MW1014A	WG	SW8260B	TETRACHLOROETHENE (PCE)	292.35	11/14/2011	16	0.19	1	µg/L
03MW1014A	WG	SW8260B	TETRACHLOROETHENE (PCE)	292.35	10/31/2012	15	0.19	1	µg/L
03MW1014A	WG	SW8260C	TETRACHLOROETHENE (PCE)	292.35	10/9/2013	18	0.18	1	µg/L
03MW1014A	WG	SW8260C	TETRACHLOROETHENE (PCE)	292.35	11/25/2014	17.9	0.5	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	32.5	11/16/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	42.5	11/16/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	52.5	11/16/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	62.5	11/16/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	72.5	11/16/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	82.5	11/17/2005	ND	0.27	1	µg/L

Summary of PCE and TCE Results
CS-10 Southern Lobe Area

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	92.5	11/17/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	102.5	11/17/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	112.5	11/17/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	122.5	11/17/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	132.5	11/17/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	142.5	11/17/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	152.5	11/17/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	162.5	11/18/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	172.5	11/18/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	182.5	11/21/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	192.5	11/21/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	202.5	11/22/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	212.5	11/22/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	222.5	11/22/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	232.5	11/22/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	242.5	11/23/2005	ND	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	252.5	11/23/2005	BRL	0.26	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	262.5	11/29/2005	2	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	272.5	11/29/2005	2.3	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	282.5	11/29/2005	6.1	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	292.5	11/29/2005	11.6	0.27	1	µg/L
03MW1014A	WA	SW8260B	TRICHLOROETHENE (TCE)	302.5	11/30/2005	BRL	0.27	1	µg/L
03MW1014A	WG	SW8260B	TRICHLOROETHENE (TCE)	292.35	3/6/2006	11.7	0.21	1	µg/L
03MW1014A	WG	SW8260B	TRICHLOROETHENE (TCE)	292.35	12/5/2006	18.9 J	0.15	1	µg/L
03MW1014A	WG	SW8260B	TRICHLOROETHENE (TCE)	292.35	11/8/2007	26.1	0.15	1	µg/L
03MW1014A	WG	SW8260B	TRICHLOROETHENE (TCE)	292.35	12/24/2008	31.5	0.15	1	µg/L
03MW1014A	WG	SW8260B	TRICHLOROETHENE (TCE)	292.35	10/29/2009	34	0.17	1	µg/L
03MW1014A	WG	SW8260B	TRICHLOROETHENE (TCE)	292.35	11/22/2010	35	0.2	1	µg/L
03MW1014A	WG	SW8260B	TRICHLOROETHENE (TCE)	292.35	11/14/2011	45	0.2	1	µg/L
03MW1014A	WG	SW8260B	TRICHLOROETHENE (TCE)	292.35	10/31/2012	36	0.2	1	µg/L
03MW1014A	WG	SW8260C	TRICHLOROETHENE (TCE)	292.35	10/9/2013	34	0.17	1	µg/L
03MW1014A	WG	SW8260C	TRICHLOROETHENE (TCE)	292.35	11/25/2014	24.4	0.5	1	µg/L
03MW1014B	WG	SW8260B	TETRACHLOROETHENE (PCE)	261.42	3/6/2006	ND	0.27	1	µg/L
03MW1014B	WG	SW8260B	TRICHLOROETHENE (TCE)	261.42	3/6/2006	BRL	0.21	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	32.5	10/17/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	42.5	10/17/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	52.5	10/17/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	62.5	10/17/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	72.5	10/17/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	82.5	10/18/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	92.5	10/18/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	102.5	10/18/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	112.5	10/18/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	122.5	10/18/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	132.5	10/18/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	142.5	10/18/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	152.5	10/18/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	162.5	10/18/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	172.5	10/18/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	182.5	10/19/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	192.5	10/19/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	202.5	10/19/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	212.5	10/19/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	222.5	10/19/2005	ND	0.27	1	µg/L

Summary of PCE and TCE Results
CS-10 Southern Lobe Area

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	232.5	10/20/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	242.5	10/20/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	252.5	10/20/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	262.5	10/20/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	272.5	10/20/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TETRACHLOROETHENE (PCE)	282.5	10/21/2005	ND	0.27	1	µg/L
03MW1015A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.01	3/7/2006	ND	0.27	1	µg/L
03MW1015A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.01	12/5/2006	ND	0.15	1	µg/L
03MW1015A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.01	11/8/2007	ND	0.18	1	µg/L
03MW1015A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.01	12/24/2008	ND	0.18	1	µg/L
03MW1015A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.01	10/29/2009	ND	0.18	1	µg/L
03MW1015A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.01	11/22/2010	ND	0.19	1	µg/L
03MW1015A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.01	11/14/2011	BRL	0.19	1	µg/L
03MW1015A	WG	SW8260B	TETRACHLOROETHENE (PCE)	253.01	10/31/2012	ND	0.19	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	32.5	10/17/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	42.5	10/17/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	52.5	10/17/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	62.5	10/17/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	72.5	10/17/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	82.5	10/18/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	92.5	10/18/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	102.5	10/18/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	112.5	10/18/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	122.5	10/18/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	132.5	10/18/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	142.5	10/18/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	152.5	10/18/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	162.5	10/18/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	172.5	10/18/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	182.5	10/19/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	192.5	10/19/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	202.5	10/19/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	212.5	10/19/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	222.5	10/19/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	232.5	10/20/2005	ND	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	242.5	10/20/2005	1.2	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	252.5	10/20/2005	2.2	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	262.5	10/20/2005	BRL	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	272.5	10/20/2005	BRL	0.27	1	µg/L
03MW1015A	WA	SW8260B	TRICHLOROETHENE (TCE)	282.5	10/21/2005	ND	0.27	1	µg/L
03MW1015A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.01	3/7/2006	2.5	0.21	1	µg/L
03MW1015A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.01	12/5/2006	ND	0.15	1	µg/L
03MW1015A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.01	11/8/2007	2.8	0.15	1	µg/L
03MW1015A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.01	12/24/2008	2.1	0.15	1	µg/L
03MW1015A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.01	10/29/2009	3.8	0.17	1	µg/L
03MW1015A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.01	11/22/2010	2.4	0.2	1	µg/L
03MW1015A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.01	11/14/2011	3.6	0.2	1	µg/L
03MW1015A	WG	SW8260B	TRICHLOROETHENE (TCE)	253.01	10/31/2012	1.9	0.2	1	µg/L
03MW1015B	WG	SW8260B	TETRACHLOROETHENE (PCE)	212.97	3/7/2006	ND	0.27	1	µg/L
03MW1015B	WG	SW8260B	TRICHLOROETHENE (TCE)	212.97	3/7/2006	ND	0.21	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	52.5	7/11/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	62.5	7/11/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	72.5	7/11/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	82.5	7/11/2000	ND	0.195	1	µg/L

Summary of PCE and TCE Results
CS-10 Southern Lobe Area

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	92.5	7/12/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	102.5	7/12/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	112.5	7/12/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	122.5	7/12/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	132.5	7/12/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	142.5	7/12/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	152.5	7/12/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	162.5	7/12/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	172.5	7/13/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	182.5	7/13/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	192.5	7/13/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	202.5	7/13/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	212.5	7/13/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	222.5	7/14/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	232.5	7/14/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	242.5	7/14/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	252.5	7/15/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	262.5	7/15/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	272.5	7/15/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	280.5	7/17/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	292.5	7/17/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	302.5	7/17/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	312.5	7/18/2000	ND	0.195	1	µg/L
03MW2622A	WA	SW8260	TETRACHLOROETHENE (PCE)	322.5	7/18/2000	ND	0.195	1	µg/L
03MW2622A	WG	CVOL	TETRACHLOROETHENE (PCE)	300.95	7/26/2000	ND	0.11	1	µg/L
03MW2622A	WG	SW8260B	TETRACHLOROETHENE (PCE)	300.95	3/29/2004	ND	0.06	1	µg/L
03MW2622A	WG	SW8260B	TETRACHLOROETHENE (PCE)	300.95	3/23/2005	ND	0.14	1	µg/L
03MW2622A	WG	SW8260B	TETRACHLOROETHENE (PCE)	300.95	3/8/2006	ND	0.27	1	µg/L
03MW2622A	WG	SW8260B	TETRACHLOROETHENE (PCE)	300.95	11/30/2006	ND	0.15	1	µg/L
03MW2622A	WG	SW8260B	TETRACHLOROETHENE (PCE)	300.95	7/2/2008	ND	0.18	1	µg/L
03MW2622A	WG	SW8260B	TETRACHLOROETHENE (PCE)	300.95	10/29/2010	ND	0.19	1	µg/L
03MW2622A	WG	SW8260B	TETRACHLOROETHENE (PCE)	300.95	10/31/2012	BRL	0.19	1	µg/L
03MW2622A	WG	SW8260C	TETRACHLOROETHENE (PCE)	300.95	10/28/2013	BRL	0.18	1	µg/L
03MW2622A	WG	SW8260C	TETRACHLOROETHENE (PCE)	300.95	11/25/2014	4	0.5	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	52.5	7/11/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	62.5	7/11/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	72.5	7/11/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	82.5	7/11/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	92.5	7/12/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	102.5	7/12/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	112.5	7/12/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	122.5	7/12/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	132.5	7/12/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	142.5	7/12/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	152.5	7/12/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	162.5	7/12/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	172.5	7/13/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	182.5	7/13/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	192.5	7/13/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	202.5	7/13/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	212.5	7/13/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	222.5	7/14/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	232.5	7/14/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	242.5	7/14/2000	ND	0.205	1	µg/L

Summary of PCE and TCE Results
CS-10 Southern Lobe Area

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	252.5	7/15/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	262.5	7/15/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	272.5	7/15/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	280.5	7/17/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	292.5	7/17/2000	ND	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	302.5	7/17/2000	BRL	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	312.5	7/18/2000	BRL	0.205	1	µg/L
03MW2622A	WA	SW8260	TRICHLOROETHENE (TCE)	322.5	7/18/2000	ND	0.205	1	µg/L
03MW2622A	WG	CVOL	TRICHLOROETHENE (TCE)	300.95	7/26/2000	BRL	0.09	1	µg/L
03MW2622A	WG	SW8260B	TRICHLOROETHENE (TCE)	300.95	3/29/2004	3.3	0.05	1	µg/L
03MW2622A	WG	SW8260B	TRICHLOROETHENE (TCE)	300.95	3/23/2005	2.8	0.1	1	µg/L
03MW2622A	WG	SW8260B	TRICHLOROETHENE (TCE)	300.95	3/8/2006	2.7	0.21	1	µg/L
03MW2622A	WG	SW8260B	TRICHLOROETHENE (TCE)	300.95	11/30/2006	2.6	0.15	1	µg/L
03MW2622A	WG	SW8260B	TRICHLOROETHENE (TCE)	300.95	7/2/2008	3.4	0.15	1	µg/L
03MW2622A	WG	SW8260B	TRICHLOROETHENE (TCE)	300.95	10/29/2010	2	0.2	1	µg/L
03MW2622A	WG	SW8260B	TRICHLOROETHENE (TCE)	300.95	10/31/2012	4.4	0.2	1	µg/L
03MW2622A	WG	SW8260C	TRICHLOROETHENE (TCE)	300.95	10/28/2013	5	0.17	1	µg/L
03MW2622A	WG	SW8260C	TRICHLOROETHENE (TCE)	300.95	11/25/2014	10.5	0.5	1	µg/L

Data Source: AFCEC, November 2015

Key:

BRL = below reporting limit

DL = detection limit

J = estimated value

ND = non detect

RL = reporting limit

WA = borehole water (vertical profiling)

WG = groundwater

µg/L = micrograms per liter

WELL DETERMINATION

ADDRESS: 360 Nathan Ellis Highway, Falmouth MA

APEMS ID: 39561

WELL STATUS: ACTIVE

WELL USE: Irrigation/outdoor use

SUMMARY: According to the property owner response, which is included in the parcel summary report (attached), there is a private well located on this property that is used for outdoor irrigation purposes. This property is connected to the Falmouth municipal water supply. This residence receives a water bill from the Town of Falmouth. The total depth of this well is unknown. Depth to water in this area is approximately 65 ft bgs (39 ft msl).

DATA REVIEW:

- ☒ SPEIM monitoring data are available in the vicinity of this well [see attached map, cross section I-I' and table]
 - 69MW1514A,B (-181 ft msl and -59 ft msl, respectively)
 - 82MW00019A,B (-210 ft msl and -58 ft msl, respectively)
 - 82MW0017B (-93 ft msl)
- ☒ SPEIM monitoring data indicate the CS-21 plume is being captured by extraction well 82EW0001, which began operation in 2006 and is located approximately 1,000 feet hydraulically crossgradient of 360 Nathan Ellis Highway (Map attached). The top of the CS-21 plume near 360 Nathan Ellis Highway is approximately 150 feet below the water table (i.e., at approximately -110 ft msl ; as defined by NDs at 82MW0019B). TCE concentrations in this portion of the plume are decreasing (69MW1514B, -59 ft msl).
- ☒ A sample was collected from this well in May 2013 and submitted for VOC analysis. No TCE was detected (Laboratory Report attached). This well was also sampled 29 times between 1997 and 1999 (table attached). TCE was detected at concentrations below the laboratory reporting limit (BRL) of 0.5 µg/L in three samples collected between December 1997 and January 1998. TCE was not detected in any other samples collected from this well.

DETERMINATION: No TCE was detected in a sample collected from the private irrigation well at 360 Nathan Ellis Highway in May 2013. Therefore, there is no current risk of exposure to the CS-21 plume at this time. The top of the CS-21 plume near 360 Nathan Ellis Highway is approximately 150 feet below the water table. The depth of the private well on this property is not known, but it is likely to be screened shallower in the aquifer than the CS-21 plume and it is unlikely that intermittent operation of this well will result in TCE concentrations above the MCL. This determination is supported by current and historic sampling of the private well at 360 Nathan Ellis Highway.

PATH FORWARD: No further evaluation or sampling is required.

SAMPLING NEEDED: ☐Yes ☒No

RE-EVALUATE IN NEXT 5-YEAR REVIEW: ☒Yes ☐No



AFCEC MMR Land Use Controls Parcel Summary

Report Produced: 7/10/2013

Name: WREDE J SCOTT, TRACEY J

Plume: CS21

Telephone No. 508-563-7967

Mailing Address

Town Numbers

AFCEE Plume: CS21

Map: 06 **Section:** 02 **Parcel:** 002 **Lot:** 001

Mailing PO:

Mailing Street: PO BOX 903

Mailing City: NORTH FALMOUTH

Mailing State: MA

Mailing ZIP: 02556-0903

Residential Well Notes: 4-13-2013. Per owner's call, the well is used for irrigation purposes and has been for 11 years. Previously listed as non-functional. Is willing to have it tested.

Irrigation Well Notes:

Parcel Address

Town Water Notes: Existing Town of Falmouth water account (May 2007)

APEMS ID: 39561

Parcel Street: 360 NATHAN S ELLIS HWY

Parcel City: Falmouth

Parcel State:

Parcel ZIP:

Other Notes:

☐ Checked if the parcel respond to the state's 5-Star survey.

☐ Checked if AFCEE has been in contact with the parcel and no contact is needed.

Initial Mailing Sent? ☒

Date Sent: 6/1/2009

Date Returned: 6/22/2009

Second Mailing Sent? ☐

Date Sent:

Date Returned:

Third Mailing Sent? ☐

Date Sent:

Date Returned:

Contacted by Phone? ☐

Date Contacted:

Contact Note:

Contacted by Email? ☐

Email Date:

Date Returned::

Contacted In-Person? ☐

Date Contacted:

Field Visit Performed? ☐

Field Visit Date:

Field Visit Note:

Other Contact Notes: Any

Wells associated with this parcel:

LocID

Functional? ☒

Depth 0

Decomissioned? ☐

Well Deemed Safe? ☐

Non-Functional? ☐

Pump Rate 0

Decomission Offer Made? ☐

Date:

Other Status?

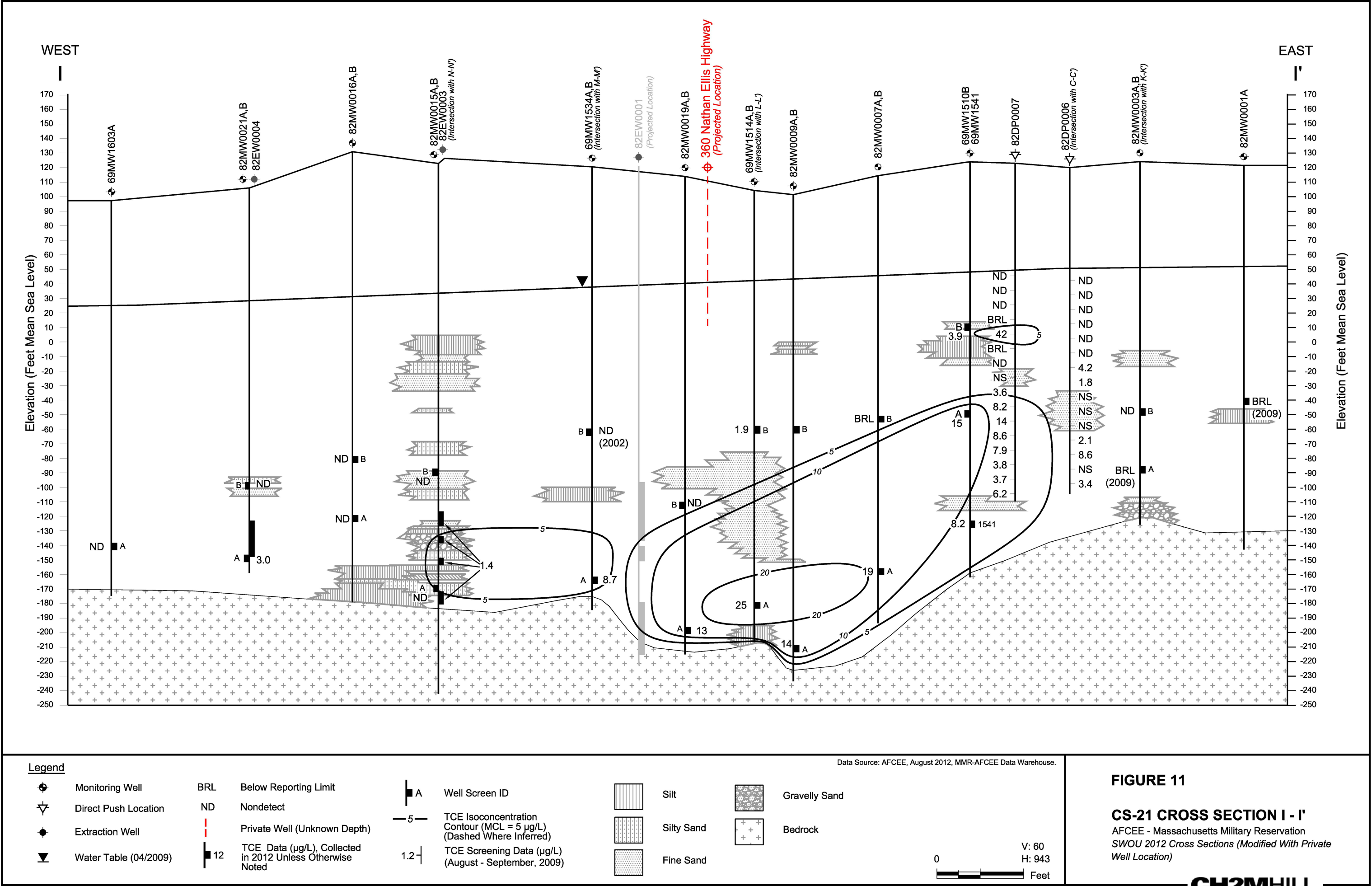
Decomission Offer Received? ☐

Originating Source:

 Plume Boundary
 LUC Area
 Parcel of Interest *
 Other Parcel
 Monitoring Well
 Extraction Well

LOCATION: 360 NATHAN ELLIS HWY

AFCEC - Massachusetts Military Reservation
CS-21 Land Use Control



Summary of Groundwater Monitoring Results for TCE
CS-21 Area

Location	Matrix	Test	Analyte	Depth (ft bgs)	Date	Result	DL	RL	Units
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	72.5	3/16/1998	ND	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	83.5	3/16/1998	ND	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	93.5	3/16/1998	ND	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	103.5	3/16/1998	ND	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	113.5	3/16/1998	BRL	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	125.5	3/16/1998	5.31	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	133.5	3/16/1998	7.72	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	145	3/17/1998	6.51	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	155	3/17/1998	4.35	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	165	3/17/1998	16.5	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	175	3/17/1998	7.75	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	185	3/17/1998	8.19	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	195	3/17/1998	10.6	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	205	3/17/1998	7.55	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	215	3/18/1998	1.58	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	225	3/18/1998	6.55	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	235	3/18/1998	4.25	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	243	3/18/1998	7.78	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	255	3/19/1998	6.51	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	264	3/19/1998	3.08	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	274	3/19/1998	28	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	285	3/19/1998	28.5	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	294	3/19/1998	11.3	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	304.5	3/20/1998	11	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	309	3/20/1998	10.3	0.318	1	µg/L
69MW1514A	WG	CVOL	TRICHLOROETHENE (TCE)	285.6	4/29/1998	47	0.32	2	µg/L
69MW1514A	WG	CVOL	TRICHLOROETHENE (TCE)	285.6	9/11/2000	40	0.18	2	µg/L
69MW1514A	WG	SW8260	TRICHLOROETHENE (TCE)	285.6	6/10/2002	37.1	0.138	1	µg/L
69MW1514A	WG	SW8260B	TRICHLOROETHENE (TCE)	285.6	6/8/2006	27.6	0.21	1	µg/L
69MW1514A	WG	SW8260B	TRICHLOROETHENE (TCE)	285.6	3/12/2007	21.6	0.15	1	µg/L
69MW1514A	WG	SW8260B	TRICHLOROETHENE (TCE)	285.6	3/26/2008	19.6	0.15	1	µg/L
69MW1514A	WG	SW8260B	TRICHLOROETHENE (TCE)	285.6	5/5/2009	11.7	0.15	1	µg/L
69MW1514A	WG	SW8260B	TRICHLOROETHENE (TCE)	285.6	3/29/2010	15	0.17	1	µg/L
69MW1514A	WG	SW8260B	TRICHLOROETHENE (TCE)	285.6	4/1/2011	24	0.2	1	µg/L
69MW1514A	WG	SW8260B	TRICHLOROETHENE (TCE)	285.6	2/24/2012	25	0.2	1	µg/L
69MW1514A	WG	SW8260B	TRICHLOROETHENE (TCE)	285.6	3/13/2013	23	0.2	1	µg/L
69MW1514B	WG	CVOL	TRICHLOROETHENE (TCE)	164.75	4/29/1998	9.7	0.16	1	µg/L
69MW1514B	WG	CVOL	TRICHLOROETHENE (TCE)	164.75	9/11/2000	6.4	0.09	1	µg/L
69MW1514B	WG	SW8260	TRICHLOROETHENE (TCE)	164.75	6/10/2002	5.32	0.138	1	µg/L
69MW1514B	WG	SW8260B	TRICHLOROETHENE (TCE)	164.75	6/8/2006	12.6	0.21	1	µg/L
69MW1514B	WG	SW8260B	TRICHLOROETHENE (TCE)	164.75	3/12/2007	36.7	0.15	1	µg/L
69MW1514B	WG	SW8260B	TRICHLOROETHENE (TCE)	164.75	4/9/2008	29.7	0.15	1	µg/L
69MW1514B	WG	SW8260B	TRICHLOROETHENE (TCE)	164.75	5/5/2009	19.7	0.15	1	µg/L
69MW1514B	WG	SW8260B	TRICHLOROETHENE (TCE)	164.75	3/29/2010	7.2	0.17	1	µg/L
69MW1514B	WG	SW8260B	TRICHLOROETHENE (TCE)	164.75	4/8/2011	5.4	0.2	1	µg/L
69MW1514B	WG	SW8260B	TRICHLOROETHENE (TCE)	164.75	4/20/2012	1.9	0.2	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	112.5	8/6/2002	ND	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	122.5	8/7/2002	ND	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	132.5	8/7/2002	ND	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	142.5	8/7/2002	1.99	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	152.5	8/7/2002	2.12	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	162.5	8/7/2002	BRL	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	172.5	8/7/2002	ND	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	182.5	8/8/2002	BRL	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	192.5	8/8/2002	ND	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	202.5	8/8/2002	1.7	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	212.5	8/8/2002	16.1	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	222.5	8/9/2002	15.5	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	232.5	8/9/2002	18.4	0.138	1	µg/L

Private Well Sampling Results
360 Nathan Ellis Highway

Location	Date	Test	Analyte	Result	DL	RL	Units
RS0360NAEL	12/2/1997	E524.2	TRICHLOROETHENE (TCE)	ND	0.39	0.5	µg/L
RS0360NAEL	12/23/1997	E524.2	TRICHLOROETHENE (TCE)	BRL	0.16	0.5	µg/L
RS0360NAEL	12/30/1997	E524.2	TRICHLOROETHENE (TCE)	BRL	0.16	0.5	µg/L
RS0360NAEL	1/12/1998	E524.2	TRICHLOROETHENE (TCE)	BRL	0.16	0.5	µg/L
RS0360NAEL	2/10/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.16	0.5	µg/L
RS0360NAEL	2/23/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.16	0.5	µg/L
RS0360NAEL	3/10/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.16	0.5	µg/L
RS0360NAEL	3/24/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.16	0.5	µg/L
RS0360NAEL	4/7/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.16	0.5	µg/L
RS0360NAEL	4/21/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.16	0.5	µg/L
RS0360NAEL	5/5/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.16	0.5	µg/L
RS0360NAEL	6/3/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.075	0.5	µg/L
RS0360NAEL	6/16/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.075	0.5	µg/L
RS0360NAEL	6/30/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.075	0.5	µg/L
RS0360NAEL	8/11/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.075	0.5	µg/L
RS0360NAEL	8/25/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.075	0.5	µg/L
RS0360NAEL	9/22/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	10/6/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	10/19/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	11/16/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	12/1/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	12/16/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	12/29/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	1/12/1999	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	2/9/1999	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	2/23/1999	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	3/9/1999	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	3/23/1999	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	4/6/1999	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L

Data Source: AFCEC-MMR Data Warehouse, July 2013

Key:

BRL = below reporting limit

DL = detection limit

ND = non detect

RL = reporting limit

µg/L = micrograms per liter

Summary of Groundwater Monitoring Results for TCE

CS-21 Area

Location	Matrix	Test	Analyte	Depth (ft bgs)	Date	Result	DL	RL	Units
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	242.5	8/9/2002	16	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	252.5	8/12/2002	17	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	262.5	8/13/2002	19.1	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	272.5	8/13/2002	1.72	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	302.5	8/13/2002	16.8	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	312.5	8/14/2002	4.01	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	322.5	8/14/2002	12.4	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	332.5	8/14/2002	38.2	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	342.5	8/15/2002	8.76	0.138	1	µg/L
82MW0017A	WG	SW8260B	TRICHLOROETHENE (TCE)	319.6	6/15/2006	24.4	0.15	1	µg/L
82MW0017A	WG	SW8260B	TRICHLOROETHENE (TCE)	319.6	4/29/2009	12.7	0.15	1	µg/L
82MW0017A	WG	SW8260B	TRICHLOROETHENE (TCE)	319.6	4/16/2012	14	0.2	1	µg/L
82MW0017B	WG	SW8260B	TRICHLOROETHENE (TCE)	216.55	6/15/2006	16.3	0.15	1	µg/L
82MW0017B	WG	SW8260B	TRICHLOROETHENE (TCE)	216.55	4/29/2009	ND	0.15	1	µg/L
82MW0017B	WG	SW8260B	TRICHLOROETHENE (TCE)	216.55	4/16/2012	ND	0.2	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	122.5	9/6/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	132.5	9/6/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	142.5	9/6/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	152.5	9/6/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	162.5	9/6/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	172.5	9/7/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	182.5	9/7/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	192.5	9/7/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	202.5	9/7/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	212.5	9/7/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	232.5	9/7/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	252.5	9/9/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	272.5	9/9/2002	1.9	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	292.5	9/9/2002	26.6	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	312.5	9/10/2002	8.64	0.138	1	µg/L
82MW0019A	WG	SW8260B	TRICHLOROETHENE (TCE)	312.5	8/8/2006	13.2	0.15	1	µg/L
82MW0019A	WG	SW8260B	TRICHLOROETHENE (TCE)	312.5	5/12/2009	22.9	0.15	1	µg/L
82MW0019A	WG	SW8260B	TRICHLOROETHENE (TCE)	312.5	3/6/2012	13	0.2	1	µg/L
82MW0019B	WG	SW8260B	TRICHLOROETHENE (TCE)	226.42	8/8/2006	ND	0.15	1	µg/L
82MW0019B	WG	SW8260B	TRICHLOROETHENE (TCE)	226.42	5/12/2009	ND	0.15	1	µg/L
82MW0019B	WG	SW8260B	TRICHLOROETHENE (TCE)	226.42	3/6/2012	ND	0.2	1	µg/L

Data Source: AFCEC-MMR Data Warehouse, July 2013

Key:

BRL = below reporting limit

DL = detection limit

ft bgs = feet below ground surface

ND = non detect

µg/L = micrograms per liter

RL = reporting limit

WG = groundwater sample

WA = groundwater vertical profiling sample

Mr. Doug Scott
CH2M Hill
1748 West Truck Road/Otis ANG Base
Buzzards Bay MA 02542

June 6, 2013

SAMPLE DATA

CLIENT SAMPLE ID
Project Name: MMR 2013/05 LUC CS-10, CS-21, AV
Project Number: 437075.05.07.18
Field Sample ID: CHPR0360NA-O0513

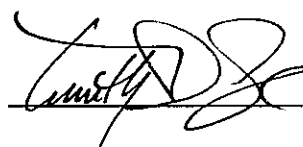
Lab Sample ID: 75664-3
Matrix: Aqueous
Percent Solid: N/A
Dilution Factor: 1
Collection Date: 05/30/13
Lab Receipt Date: 05/31/13
Analysis Date: 06/05/13

ANALYTICAL RESULTS VOLATILE ORGANICS							
COMPOUND	Detection Limit µg/L	Quantitation Limit µg/L	Result µg/L	COMPOUND	Detection Limit µg/L	Quantitation Limit µg/L	Result µg/L
1,1,1-Trichloroethane	0.18	1.0	U	Toluene	0.20	1.0	U
1,1-Dichloroethane	0.20	1.0	U	trans-1,2-Dichloroethene	0.20	1.0	U
1,2,4-Trichlorobenzene	0.21	1.0	U	trans-1,3-Dichloropropene	0.10	1.0	U
1,2-Dibromo-3-chloropropane	0.50	1.0	U	Trichloroethene	0.20	1.0	U
1,2-Dichlorobenzene	0.16	1.0	U	1,1,2,2-Tetrachloroethane	0.13	1.0	U
1,3-Dichlorobenzene	0.20	1.0	U	1,1,2-Trichloroethane	0.11	1.0	U
1,4-Dichlorobenzene	0.19	1.0	U	1,1-Dichloroethene	0.13	1.0	U
Benzene	0.20	1.0	U	1,2-Dibromoethane	0.15	1.0	U
Bromochloromethane	0.20	1.0	U	1,2-Dichloroethane	0.50	1.0	U
Chlorobenzene	0.17	1.0	U	1,2-Dichloropropane	0.50	1.0	U
Chloroform	0.20	1.0	0.75 J	Bromodichloromethane	0.15	1.0	U
cis-1,2-Dichloroethene	0.20	1.0	U	Bromoform	0.12	1.0	U
cis-1,3-Dichloropropene	0.10	1.0	U	Bromomethane	0.50	1.0	U
Ethylbenzene	0.20	1.0	U	Carbon Tetrachloride	0.20	1.0	U
Methylene Chloride	1.0	2.0	U	Chloroethane	0.50	1.0	U
o-Xylene	0.20	1.0	U	Chloromethane	0.20	1.0	U
m,p-Xylene	0.40	1.0	U	Dibromochloromethane	0.15	1.0	U
Styrene	0.20	1.0	U	Methyl-tert-butyl ether (MTBE)	0.20	1.0	U
Tetrachloroethene	0.19	1.0	U	Vinyl chloride	0.20	1.0	U
Surrogate Standard Recovery							
Bromofluorobenzene	99%	d4-1,2-Dichloroethane		101%	d8-Toluene		101%
U=Undetected J=Estimated E=Exceeds Calibration Range B=Detected in Blank							

METHODOLOGY: Sample analysis was conducted according to: Test Methods for Evaluating Solid Waste, SW-846 Method 8260B.

COMMENTS:

Authorized signature





DEPARTMENT OF THE AIR FORCE
AIR FORCE CIVIL ENGINEER CENTER
INSTALLATION RESTORATION PROGRAM
OTIS AIR NATIONAL GUARD BASE, MA 02542-1320

24 October 2017

Installation Restoration Program
AFCEC/JBCC
322 East Inner Road
Otis ANG Base, MA 02542-1320

Ron Klattenberg
135 Regis Road
Falmouth, MA 02536

RE: 135 Regis Road
Falmouth, MA

Dear Mr. Klattenberg:

The Installation Restoration Program (IRP) sampled your residential private irrigation well on 09 March 2017. This well was reportedly restarted in 2016 as a source for non-potable water that will be used primarily for outdoor irrigation purposes. The depth of your well is unknown.

Your well was identified for sampling because your property is located near the Ashumet Valley groundwater plume, which is defined by the presence of two volatile organic compounds (VOCs), trichloroethene (TCE) and tetrachloroethene (PCE), at concentrations greater than drinking water standards. 1,4-Dioxane and per- and polyfluoroalkyl substances (PFAS) are emerging contaminants that have recently been identified within the Ashumet Valley plume at concentrations greater than drinking water standards/Health Advisory (HA) Values. In addition, PFAS have been detected in surface water of Ashumet Pond. Water from Ashumet Pond recharges the shallow aquifer to the south and east of the pond. Groundwater in the aquifer to the southeast of Ashumet pond is a potential source of water to your private well.

The sample collected from your well on 09 March 2017 was submitted for analysis for VOCs, 1,4-dioxane and PFAS. A certified laboratory used U.S. Environmental Protection Agency (EPA) approved methods for analyzing your water samples. A summary of analytical results for the 09 March 2017 sample collected from your well is provided in the attached table. Although your well at 135 Regis Road is not used as a source of drinking water, the analytical results were compared to available drinking water standards or health advisories, which are assumed to be sufficiently protective for water used for non-consumptive exposure scenarios.

No VOCs were detected. 1,4-Dioxane was detected, but at a low estimated concentration that is less than the laboratory reporting limit of 0.15 micrograms per liter ($\mu\text{g/L}$) and well below the Massachusetts state standard of 0.3 $\mu\text{g/L}$ for 1,4-dioxane in a drinking water source. Several PFAS were detected. The EPA has established HA values for two of the PFAS, perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA), in drinking water. In situations where both PFOS and PFOA are present in drinking water, it is recommended that the concentrations of these two compounds be added together and the sum compared to the 0.07 $\mu\text{g/L}$ HA. Note that there are no Federal or State standards or HAs for the other PFAS.

PFOS was detected at a concentration that is greater than the HA value of 0.07 µg/L for this compound in drinking water. PFOA was also detected, but at a concentration that is less than the HA. Several other PFAS were detected. Currently there are no HA values for these other compounds. The concentrations of PFAS detected in the groundwater sample from your irrigation well are similar to those reported in surface water at Ashumet Pond. According to the 2017 *Recreational Use of Water Bodies on or Near Joint Base Cape Cod Community Fact Sheet* (attached), the Massachusetts Department of Public Health (MassDPH) has determined that occasional exposure to PFOS and PFOA from recreational use (i.e., non-consumptive use) is not expected to result in any adverse health effects. More information about PFAS and 1,4-dioxane can be found online at <https://www.epa.gov/ground-water-and-drinking-water/drinking-water-health-advisories-pfoa-and-pfos> and https://www.epa.gov/sites/production/files/2014-03/documents/ffrro_factsheet_contaminant_14-dioxane_january2014_final.pdf.

Please note, because the concentration of PFOS in the sample obtained from your private irrigation well was greater the drinking water standard it is recommended that this well **not** be used as a source of drinking water.

For more information or to request a copy of your laboratory summary report please call/email Doug Karson, Community Involvement Lead at (508) 968-4678 x 2 or douglas.karson@us.af.mil. You may also contact Ellie Donovan, Regional Planner, Massachusetts Department of Environmental Protection, at (508) 946-2866; ellie.donovan@state.ma.us.

Sincerely

ROSE H. FORBES, P.E.
Remediation Program Manager

Attachments:

Summary Table – 135 Regis Road

MassDPH Community Fact Sheet - Recreational Use of Waterbodies On or Near Joint Base Cape Cod

- c. David Carignan, Falmouth BOH
- Robert Lim/Kate Melanson, EPA
- Len Pinaud/Ellie Donovan, MassDEP
- Jan Sullivan/Marc Nascarella, MassDPH
- Doug Karson, AFCEC

Summary of Analytical Results
135 Regis Road

Location	Date	Test	Analyte	Result	DL	RL
				all units = µg/L		
Per- and polyfluoroalkyl substances (PFAS)						
RS0135REGS	3/9/2017	LC0012	PFOS	0.19	0.0012	0.01
RS0135REGS	3/9/2017	LC0012	PFOA	0.054	0.0008	0.01
RS0135REGS	3/9/2017	LC0012	PFBS	0.01 J	0.0012	0.01
RS0135REGS	3/9/2017	LC0012	PFHpA	0.019	0.0012	0.01
RS0135REGS	3/9/2017	LC0012	PFHxS	0.032	0.0012	0.01
RS0135REGS	3/9/2017	LC0012	PFNA	0.0073 J	0.0005	0.01
1,4-Dioxane						
RS0135REGS	3/9/2017	BNASIM	1,4-DIOXANE	0.022 J	0.016	0.15
Volatile Organic Compounds (VOCs)						
RS0135REGS	3/9/2017	SW8260B	1,1,1-TRICHLOROETHANE	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	1,1,2,2-TETRACHLOROETHANE	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	1,1,2-TRICHLOROETHANE	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	1,1-DICHLOROETHANE	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	1,1-DICHLOROETHENE	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	1,2,4-TRICHLOROBENZENE	ND	1	2
RS0135REGS	3/9/2017	SW8260B	1,2-DIBROMO-3-CHLOROPROPANE	ND	2	5
RS0135REGS	3/9/2017	SW8260B	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	1	2
RS0135REGS	3/9/2017	SW8260B	1,2-DICHLOROBENZENE	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	1,2-DICHLOROETHANE	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	1,2-DICHLOROPROPANE	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	1,3-DICHLOROBENZENE	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	1,4-DICHLOROBENZENE	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	BENZENE	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	BROMOCHLOROMETHANE	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	BROMODICHLOROMETHANE	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	BROMOFORM	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	BROMOMETHANE	ND	1	2
RS0135REGS	3/9/2017	SW8260B	CARBON TETRACHLORIDE	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	CHLOROBENZENE	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	CHLOROETHANE	ND	1	2
RS0135REGS	3/9/2017	SW8260B	CHLOROFORM	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	CHLOROMETHANE	ND	1	2
RS0135REGS	3/9/2017	SW8260B	cis-1,2-DICHLOROETHENE	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	cis-1,3-DICHLOROPROPENE	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	DIBROMOCHLOROMETHANE	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	ETHYLBENZENE	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	M,P-XYLENE (SUM OF ISOMERS)	ND	1	2
RS0135REGS	3/9/2017	SW8260B	METHYLENE CHLORIDE	ND	4	5
RS0135REGS	3/9/2017	SW8260B	O-XYLENE (1,2-DIMETHYLBENZENE)	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	STYRENE	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	tert-BUTYL METHYL ETHER	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	TETRACHLOROETHENE (PCE)	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	TOLUENE	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	trans-1,2-DICHLOROETHENE	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	trans-1,3-DICHLOROPROPENE	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	TRICHLOROETHENE (TCE)	ND	0.5	1
RS0135REGS	3/9/2017	SW8260B	VINYL CHLORIDE	ND	0.5	1

Data Source: AFCEC, October 2017

Bold indicates an exceedance of a drinking water standard or Health Advisory value.

Key:

DL = detection limit

J = estimated concentration

ND = not detected

µg/L = micrograms per liter

RL = laboratory reporting limit

Per- and Polyfluoroalkyl Substances

PFBS = Perfluorobutane Sulfonic Acid

PFHpA = Perfluoroheptanoic Acid

PFHxS = Perfluorohexane Sulfonic Acid

PFNA = Perfluorononanoic Acid

PFOA = Perfluorooctanoic Acid

PFOS = Perfluorooctane Sulfonic Acid

Recreational Use of Waterbodies On or Near Joint Base Cape Cod (JBCC) (Formerly the Massachusetts Military Reservation)

Community Fact Sheet Summer 2017

This community fact sheet addresses environmental health concerns related to recreational use of selected Upper Cape Cod waterbodies and the results of recent chemical testing. **Based on the available data, water bodies tested near JBCC are safe for swimming, wading, boating, and catch-and-release fishing.** The Massachusetts Department of Public Health (MDPH) has posted fish consumption advisories due to raised mercury levels in many waterbodies across Massachusetts, including several ponds near JBCC.

This fact sheet does not describe the sampling of microbes such as cyanobacteria (algae) and fecal indicator bacteria that is performed at many of the waterbodies during the summer months. For specific information about microbial water quality measurements, contact your local health department or visit:

www.mass.gov/dph/beaches

CAN I SAFELY SWIM, WADE, OR BOAT IN THE SURFACE WATER BODIES AT OR NEAR JBCC?

Yes, based on the currently available chemical data, all of the surface water bodies (including lakes, ponds, and rivers) shown in Table 1 are safe swimming, wading and boating. Table 1 summarizes available data for the 31 surface water bodies on or near JBCC that have been routinely sampled and analyzed for environmental chemicals.

Low levels of chemicals associated with JBCC were sometimes detected in the ponds or rivers. None of the chemical detections appear to be a health concern for these activities.



CAN I SAFELY FISH IN WATERS AT OR NEAR JBCC?

Catch-and-release fishing is safe for all water bodies near JBCC. Catch and release fishing means fish are caught for fun and are released back into the water body unharmed. However, mercury has been detected in fish throughout the commonwealth at levels that may be unsafe to eat.

Johns, Ashumet, Snake, Mashpee-Wakeby, and Peters ponds each have a public health fish consumption advisory. Table 1 has more information about the fish advisories for the ponds near JBCC. Mercury levels in the fish in these ponds are not believed to be related to JBCC.

In addition, many Bullhead Catfish in Johns and Ashumet ponds have papillomas (wart-like growths). Although papillomas may not look appealing, there are no known health concerns from eating fish with papillomas.

WHAT IS THE MDPH STATEWIDE FISH CONSUMPTION ADVISORY FOR MERCURY?

The MDPH issued a statewide advisory recommending that until more information is available on mercury levels in fish in a specific local waterbody, certain people should not eat fish caught from that waterbody.

Women who are pregnant, women of childbearing age who may become pregnant, nursing mothers, and children under 12 years old should not eat fish that were caught from a local waterbody that hasn't been tested by MDPH. The general advisory also includes several marine fish species. However, please be aware that this advisory does not apply to fish stocked in freshwater lakes and ponds. MDPH has issued other important recommendations for eating locally caught fish.

For more information on mercury and fish consumption advisories, call the MDPH Environmental Toxicology program at 617-624-5757 or visit http://webapps.ehs.state.ma.us/dph_fishadvisory/default.aspx

WHERE DOES MERCURY COME FROM? AND HOW CAN THE PONDS BE SAFE TO SWIM IN BUT CONTAIN FISH THAT ARE NOT SAFE TO EAT?

Mercury enters the environment naturally when rocks are worn down, as well as through industrial burning and power generation. The mercury travels through the air and settles onto waterbodies. Fish ingest the mercury that's in the water and sediment, which then builds up inside them over time.

While there is a warning about eating fish, there is no known health concern related to activities such as swimming, boating, or catch-and-release fishing in these ponds. This is because the health advisories are based on chemical levels in the fish. Some chemicals build up in fish's fat and muscle which can accumulate to levels that are sometimes much greater than the surrounding waters. Only eating the fish will expose someone to these chemicals. Swimming, boating, and touching fish are not likely to expose individuals to high levels of mercury or other chemicals.

IN THE PAST, ETHYLENE DIBROMIDE (EDB) WAS DETECTED IN THE GROUNDWATER BELOW SNAKE POND AND IN THE COONAMESSETT RIVER SURFACE WATER. SNAKE POND SURFACE WATER HAS ALSO BEEN TESTED FOR EXPLOSIVES AND PERCHLORATE. ARE THERE POSSIBLE HEALTH IMPACTS RELATED TO RECREATIONAL USE OF EITHER SNAKE POND OR THE COONAMESSETT RIVER?

Adverse health effects are not expected from recreational use of either Snake Pond or the Coonamessett River. EDB was found in the groundwater below Snake Pond in 2001 and in surface water of the Coonamessett River in 1996. Testing for EDB has been routinely conducted for the surface waters of Snake Pond at the public beach and Camp Good News areas as well as multiple locations on the Coonamessett River. EDB has not been detected at all in either waterbody since 2010. Additionally, Royal Demolition Explosives (RDX) has not been detected at all and perchlorate has not been detected above the Massachusetts Drinking Water Standard in Snake Pond since 2010.



SHOULD I BE CONCERNED ABOUT TRICHLOROETHYLENE (TCE) AND TETRACHLOROETHYLENE (PCE) FROM GROUNDWATER PLUMES ASSOCIATED WITH JBCC?

Physical contact with the ponds, river, and bogs near the groundwater plumes is not likely to present a health hazard. The surface waters of Ashumet Pond, Johns Pond, Deep Pond, Backus River, Red Brook Harbor, and Squeteague Harbor have been regularly checked for these chemicals since the early 2000's. TCE and/or PCE have not been detected above the drinking water standard since 2009 or earlier. Using any of these waterbodies for recreational or cranberry growing is not expected to have any effects on your health.

SHOULD I BE CONCERNED ABOUT EMERGING CONTAMINANTS LIKE PERFLUOROOCTANOIC ACID (PFOA) AND PERFLUOROOCTANE SULFONATE (PFOS) OR 1,4-DIOXANE THAT HAVE BEEN DETECTED IN THESE WATERBODIES?

Both of these emerging contaminants have not been detected at levels in area waterbodies that present a health risk to people that are using them for recreation.

PFOA and PFOS are chemicals that are part of a larger group of chemicals referred to as per- and polyfluoroalkyl substances (PFAS). They have been used to make carpets, clothing, fabrics for furniture, paper packaging for food, and other materials (e.g., cookware) that are resistant to water, grease or stains. They are also used in firefighting foam and in a number of industrial processes. Because these chemicals have been used in a range of consumer products, most people have been exposed to them.

In May 2016 the United States Environmental Protection Agency (EPA) issued health-based guidance (known as a drinking water health advisory) determining a level that is safe and protective against adverse health effects for individuals drinking water over an entire lifetime.

PFOS and PFOA detected in the surface water of the Backus River in 2016 are below the drinking water health advisory. Johns and Ashumet Ponds were sampled in 2016 and both had levels of PFOS that were greater than the drinking water health advisory. The Backus River, Johns Pond, and Ashumet Pond are waterbodies that are only used for recreation or for cranberry bog irrigation, and are not a source of drinking water. Occasional exposure to PFOA and PFOS from swimming, boating, or fishing in these waterbodies is not expected to result in any adverse health effects.

1,4-Dioxane is an industrial chemical in solvents, paints and waxes which was detected at low levels in the Backus River, Pond 14, Coonamessett River and Johns Pond. All of these detections are below the Massachusetts Department of Environmental Protection (MassDEP) drinking water regulation. Health risks from recreational activity in these waterbodies are not expected.

For more information, visit the Agency for Toxic Substances and Disease Registry's (ATSDR) websites on PFOA and PFOS http://www.atsdr.cdc.gov/pfc/docs/pfas_fact_sheet.pdf and 1,4-Dioxane <https://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=954&tid=199>

ENVIRONMENTAL TOXICOLOGY PROGRAM

BUREAU OF ENVIRONMENTAL HEALTH

Massachusetts Department of Public Health

250 Washington Street, 7th Floor, Boston, MA 02108

Phone: 617-624-5757 | Fax: 617-624-5777 | TTY: 617-624-5286

http://www.mass.gov/dph/environmental_health



June 2017

SOURCES OF ADDITIONAL INFORMATION

Air Force Civil Engineer Center

Douglas Karson
(508) 968-4678, x2
douglas.karson@us.af.mil

MADEP Community Involvement

Ellie Donovan
(508) 946-2866
ellie.donovan@state.ma.us

Environmental Protection Agency

Kate Melanson
(617) 918-1491
Melanson.kate@epa.gov

Impact Area Groundwater Study Program

Pam Richardson
(508) 968-5630
pamela.j.richardson.nfg@mail.mil

Agency for Toxic Substances and Disease Registry

Tarah S.Somers
(617) 918-1495
tvs4@cdc.gov

LOCAL BOARDS OF HEALTH

Town of Bourne Board of Health

Terri Guarino
(508-759-0600, x1513
TGuarino@townofbourne.com

Town of Falmouth Board of Health

David Carignan
(508) 495-7485
health@falmouthmass.us

Town of Mashpee Board of Health

Glen Harrington
(508) 539-1426
gharrington@mashpeeema.gov

Town of Sandwich Board of Health

David Mason
(508) 888-4200
dmason@townofsandwich.net

Barnstable County Dept. of Health and the Environment

George Heufelder
(508) 375-6616
gheufelder@barnstablecounty.org

**Table 1:
Recreational Waterbodies on or Near JBCC* With Available Chemical Sampling Data**

Town	Water Body	SAFE FOR			
		Swimming	Wading	Fish Consumption	Boating
Barnstable	Shubael Pond	yes	yes	no data	yes
Bourne	Cuff Pond	yes	yes	no data	yes
	Long Pond	yes	yes	no data	yes
	Flax Pond	yes	yes	no data	yes
	Red Brook Pond	yes	yes	no data	yes
	Red Brook Harbor	yes	yes	no data	yes
	Squeteague Harbor	yes	yes	no data	yes
	Wilson Bog Pond	yes	yes	no data	yes
Falmouth	Backus River (Bogs)	yes	yes	no data	yes
	Coonamessett Pond	yes	yes	no data	yes
	Coonamessett River (Bogs)	yes	yes	no data	yes
	Crooked Pond	yes	yes	no data	yes
	Deep Pond/Lily Pond	yes	yes	no data	yes
	Flax Pond	yes	yes	no data	yes
	Fresh Pond	yes	yes	no data	yes
	Grews Pond	yes	yes	no data	yes
	Jenkins Pond	yes	yes	no data	yes
	Mares Pond	yes	yes	no data	yes
	Round Pond	yes	yes	no data	yes
	Pond 14	yes	yes	no data	yes
	Collins Bog	yes	yes	no data	yes
	Bournes Pond River (Bogs)	yes	yes	no data	yes
Mashpee	Mashpee-Wakeby Pond	yes	yes	NO ¹	yes
	Ashumet Pond	yes	yes	NO ²	yes
	Johns Pond	yes	yes	NO ³	yes
	Moody Pond	yes	yes	no data	yes
	Quashnet River (Bogs)	yes	yes	no data	yes
	Santuit Pond	yes	yes	no data	yes
Sandwich	Pimlico Pond	yes	yes	no data	yes
	Triangle Pond	yes	yes	no data	yes
	Peters Pond	yes	yes	NO ¹	yes
	Weeks Pond	yes	yes	no data	yes
	Snake Pond	yes	yes	NO ³	yes

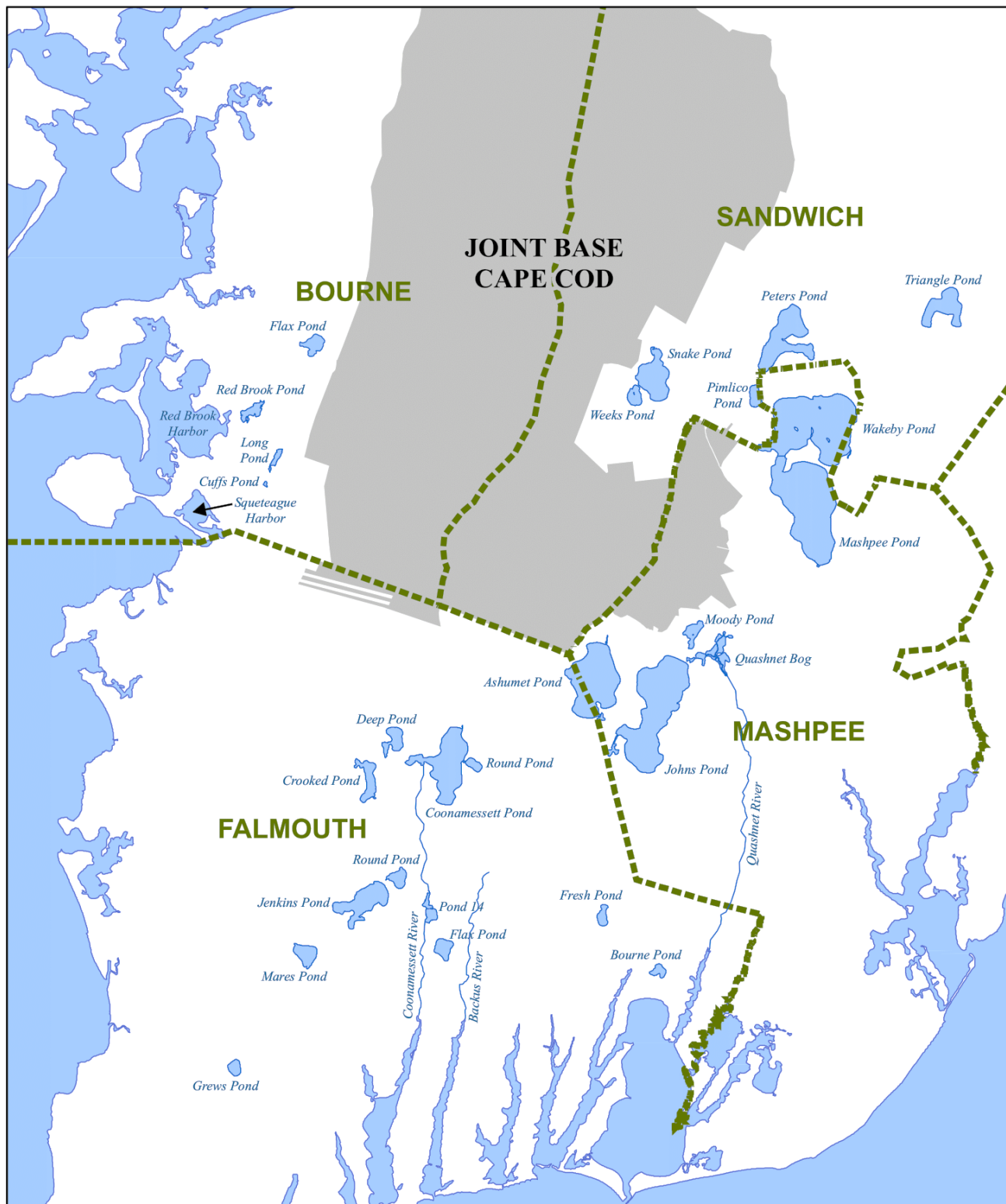
*Fish consumption recommendations are based on available data for mercury concentrations in fish tissue, which are not expected to be related to activities at Joint Base Cape Cod.

¹ **Mashpee-Wakeby Pond and Peters Pond:** Children younger than 12 years, pregnant women, nursing mothers, and women who may become pregnant should not eat any smallmouth bass from this pond. The general public should limit consumption of smallmouth bass from this pond to two meals per month.

² **Ashumet Pond:** Children younger than 12 years, pregnant women, nursing mothers, and women who may become pregnant should not eat any largemouth bass from this pond. The general public should limit consumption of largemouth bass from this pond to two meals per month.

³ **Johns and Snake Ponds:** Children younger than 12 years, pregnant women, nursing mothers, and women who may become pregnant should not eat any fish from these ponds. The general public should not eat any smallmouth bass from these ponds, and limit consumption of all other fish from these ponds to two meals per month.

Figure 1.
Recreational Water Bodies on or Near Joint Base Cape Cod with Available Chemical Data.



Legend

- Joint Base Cape Cod
- Lakes, Ponds, and Bogs
- Town Boundary

0 0.5 1 2 3 Miles



WELL DETERMINATION

ADDRESS: 539 Currier Road, Falmouth MA

APEMS ID: 39899

WELL STATUS: ACTIVE

WELL USE: Outdoor uses

SUMMARY: According to the property owner response (attached), this residence is connected to the Falmouth municipal water supply. This residence receives a water bill from the Town of Falmouth. However, there is a private well located on this property that is used for outdoor purposes. The total depth of this well is unknown. Depth to water in this area is approximately 12 ft bgs (+45 ft msl). This property is located along the southern border of the Ashumet Valley LTM area, approximately 580 feet north and outside of the Ashumet Valley Plume boundary.

DATA REVIEW:

- ☒ SPEIM monitoring data are available in the vicinity of this well [see attached map and cross sections].
 - 03MW1059A,B,C [vertical profiling and monitoring data; tables attached]
 - 30MW0583A,B,C,D,E [monitoring data; table attached]
 - Water table elevation is approximately 45 ft msl.
- ☒ Groundwater vertical profiling for PCE and TCE was conducted in 2009 at a boring located approximately 400 feet upgradient of this property (03MW1059A). PCE and TCE were not detected at concentrations greater than the Maximum Contaminant Level (MCL) of 5 micrograms per liter ($\mu\text{g/L}$) for each compound (see attached table). At the time of vertical profiling, a maximum TCE concentration of 2.6 $\mu\text{g/L}$ was detected at a depth of 167 ft bgs (-111 ft msl) and PCE was detected at concentrations below the laboratory reporting limit (BRL) of 1 $\mu\text{g/L}$. Sampling of the monitoring wells at this location since 2009 indicates that concentrations of TCE and PCE have decreased to ND (see attached table). Groundwater sampling at monitoring well cluster 30MW0583A,B,C,D,E, which is located on 539 Currier Rd, indicate that no TCE or PCE was detected at the shallowest (D and E) screens (-9 and +37 ft msl, respectively) when these wells were last sampled in 1997 and 1999. A maximum TCE concentration of 83 $\mu\text{g/L}$ was reported at the B screen in 1997 (mid-screen elevation of -40 ft msl). However, TCE concentrations at this monitoring well had declined to less than 1 $\mu\text{g/L}$ (BRL) by 2004.
- ☒ Sample results are available for this private well (attached). A sample from this well was collected and submitted for VOC analysis by EPA Method 8260B and total manganese analysis by SW-846 6010B on 28 May 2013. Additionally, samples were collected from private wells at nearby properties (AFCEE Parcel IDs 39677, 39772, 39700, 39910, 39902; see location map) in 2012 and submitted for VOC and manganese analysis.
 - No PCE or TCE was reported in the sample collected from 539 Currier Road in 2013 or five nearby private wells that were sampled in 2012. TCE was detected at one location, AFCEE Parcel ID 39902, at a concentration that is less than the laboratory reporting limit of 1 $\mu\text{g/L}$ (BRL).
 - No Mn was detected in the sample collected from this private well in May 2013.

WELL DETERMINATION

DETERMINATION: Based on the May 2013 sampling results there is no current risk of exposure to Ashumet Valley plume COC concentrations above applicable standards. This property is located approximately 580 feet north and upgradient of the Ashumet Valley VOC plume boundary; the top of which is at a depth of ~150 ft bgs [-100 ft msl]. The depth of the private well at 539 Currier Road is unknown, but is likely to be shallower in the aquifer than the top of the Ashumet Valley plume. PCE and TCE concentrations at nearby monitoring wells are currently either non-detect or below the laboratory reporting limit of 1 µg/L (BRL) for each of these compounds and concentrations, when present, are expected to continue to decrease. This private well is located approximately 700 feet downgradient of CS-10 southern trench extraction well, 03EW2112, which was installed in 2009 to intercept the CS-10 southern trench lobe. Impacts to this property from the CS-10 southern trench lobe are not anticipated. No Mn was detected in a sample collected from this private well in May 2013. Therefore, intermittent pumping of this well for outdoor irrigation purposes is unlikely to draw in groundwater with PCE and TCE concentrations greater than the MCL or result in an unacceptable exposure risk to total Mn.

PATH FORWARD: No further sampling needed.

SAMPLING NEEDED: ☐Yes ☒No

RE-EVALUATE IN NEXT 5-YEAR REVIEW: ☒Yes ☐No



Installation Restoration Program



Air Force Center for
Engineering and the Environment

Private Well Verification Form

Please respond by February 3, 2012

1) Is your home connected to Municipal water? ☒ Yes ☐ No ☐ Don't know

2) Is there a water well(s) located on your property? ☒ Yes ☐ No ☐ Don't know

If YES, how many wells are located on your property? 1

If NO, survey complete, please skip to 10) and return form.

RECEIVED

JAN 16 2012

3) Is the well water used for?

➤ Drinking (indoors) ☐ Yes ☒ No

➤ Other indoor uses (cooking, bathing, clothes washing) ☐ Yes ☒ No

➤ Outdoor uses (gardening, car washing, filling pools) ☐ Yes ☒ No

➤ Other (specify) Run for 1 Hour / Yearly

➤ Is the well disconnected ☐ Yes ☒ No ☐ Don't know

4) Would you allow the Air Force to test your well water if necessary? ☒ Yes ☐ No

➤ (At no cost to you)

5) Has your well ever been tested? ☐ Yes (elaborate on back of this page) ☐ No ☒ Don't know

6) Do you know the depth of your private well? ☐ Yes, the depth is ☒ No

7) Do you know any other construction details of the well? (Company that installed it, date of installation, and exact location on your property?) ☐ Yes ☒ No

➤ (If yes, please provide additional details on the back of this page.)

8) If there is a concern about the safety of your well water, would you allow the Air Force to decommission your well at no cost to you? ☐ Yes ☐ No

➤ (Involves disconnecting piping and filling in the well casing, at no cost to you)

9) Would you like to keep your well for future use? ☒ Yes ☐ No

10) Contact information.

Name: Ted Handy

Street address: 539 Currier Rd.

Mailing address if different: P.O. Box 931 West Falm Mass 02571

Email: _____

Phone number (day): 508-795-7381

Phone number (night): 508-563-9297

Cell phone number: _____

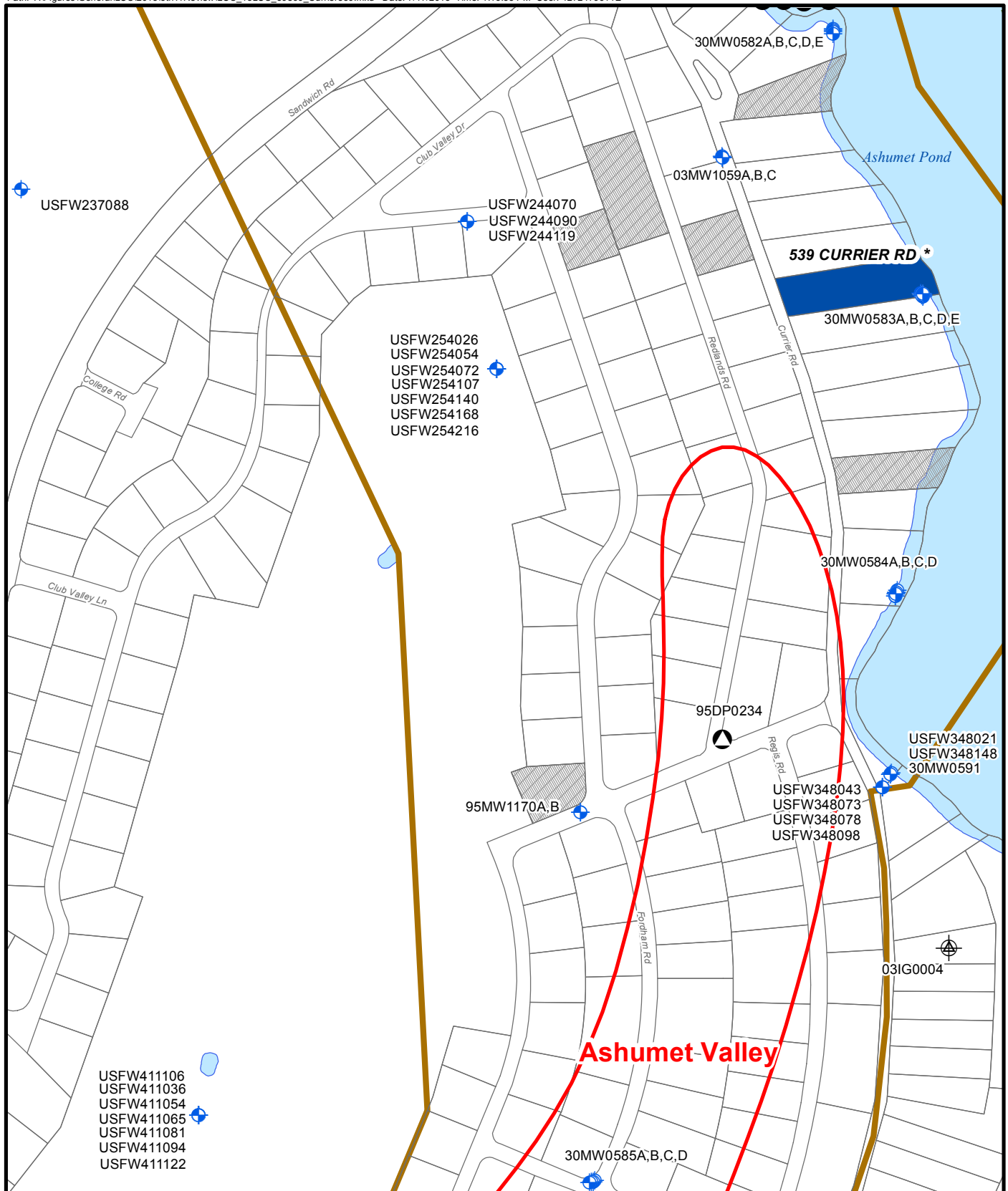
Best time to contact you: 5-6 pm

Homeowner signature: Ted Handy

Date: 1/11/12

Additional Information

There are test wells just east
of my neighbors property that I
believe gov installed about
10 years ago, along the shore
of Ashumet Pond

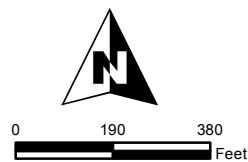


Data Source: AFCEC, MMR-AFCEC Data Warehouse

Legend

- | | |
|---|---|
| — Plume Boundary | + Monitoring Well |
| — LUC Boundary | ● Direct Push/Borehole |
| ■ Parcel of Interest * | + Irrigation Well |
| ■ Private Well Sampled in 2012 | |
| ■ Other Parcel | |

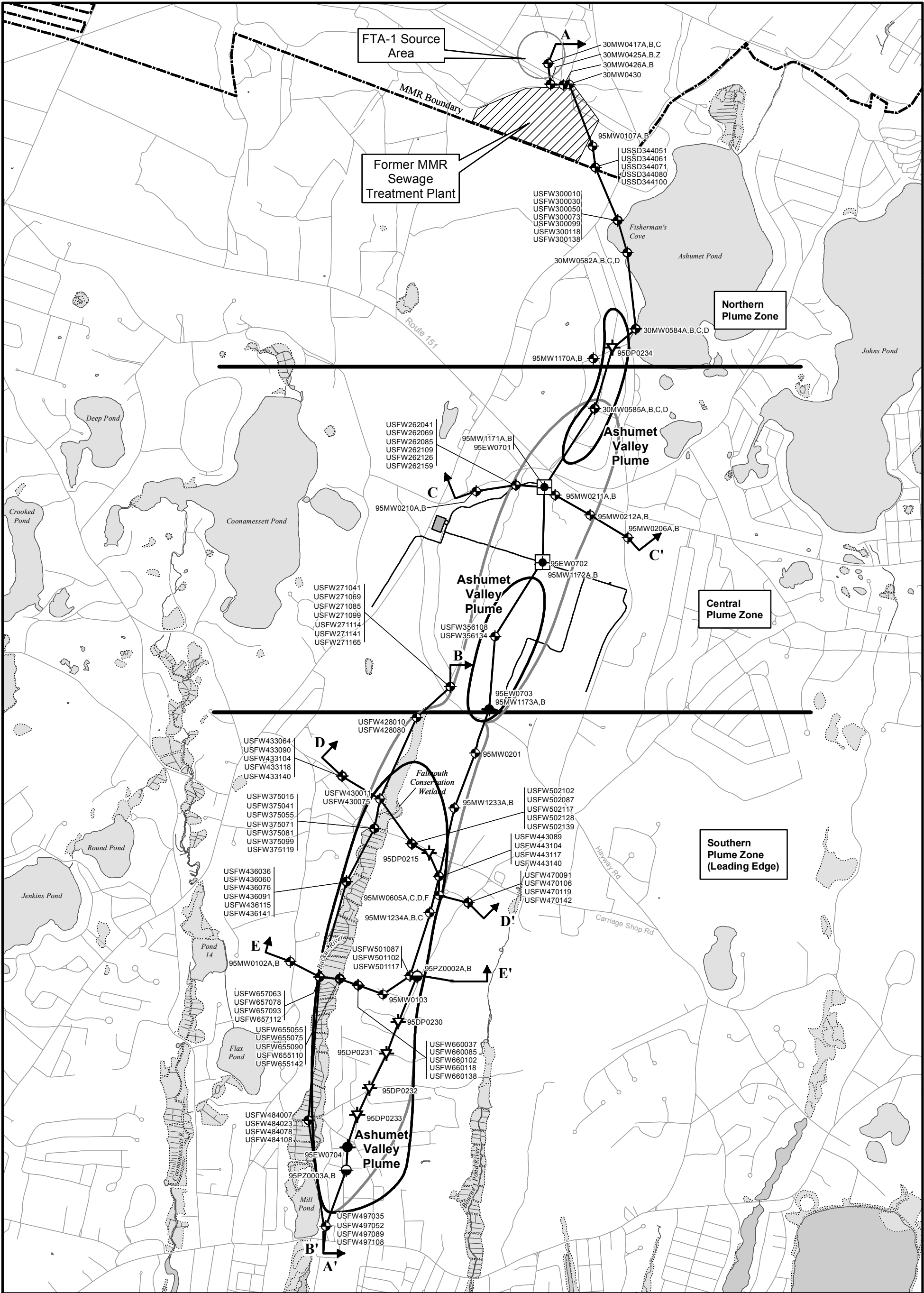
* Note: Private Well Sampled in 2013



LOCATION: 539 CURRIER RD

AFCEC - Massachusetts Military Reservation
Ashumet Valley Land Use Control

CH2MHILL



Data Source: AFCEE, January 2012, AFCEE - MMR Data Warehouse

Legend

- Massachusetts Military Reservation Boundary
- ETI System Pipeline and Treatment Plant
- 2007 Plume Boundary
- 2011 Plume Boundary
- Bog/Wetland

A — A'

- Extraction Well (On)
- Extraction Well (Off)
- Monitoring Well
- Piezometer
- Vertical Profiling Location (Direct Push)



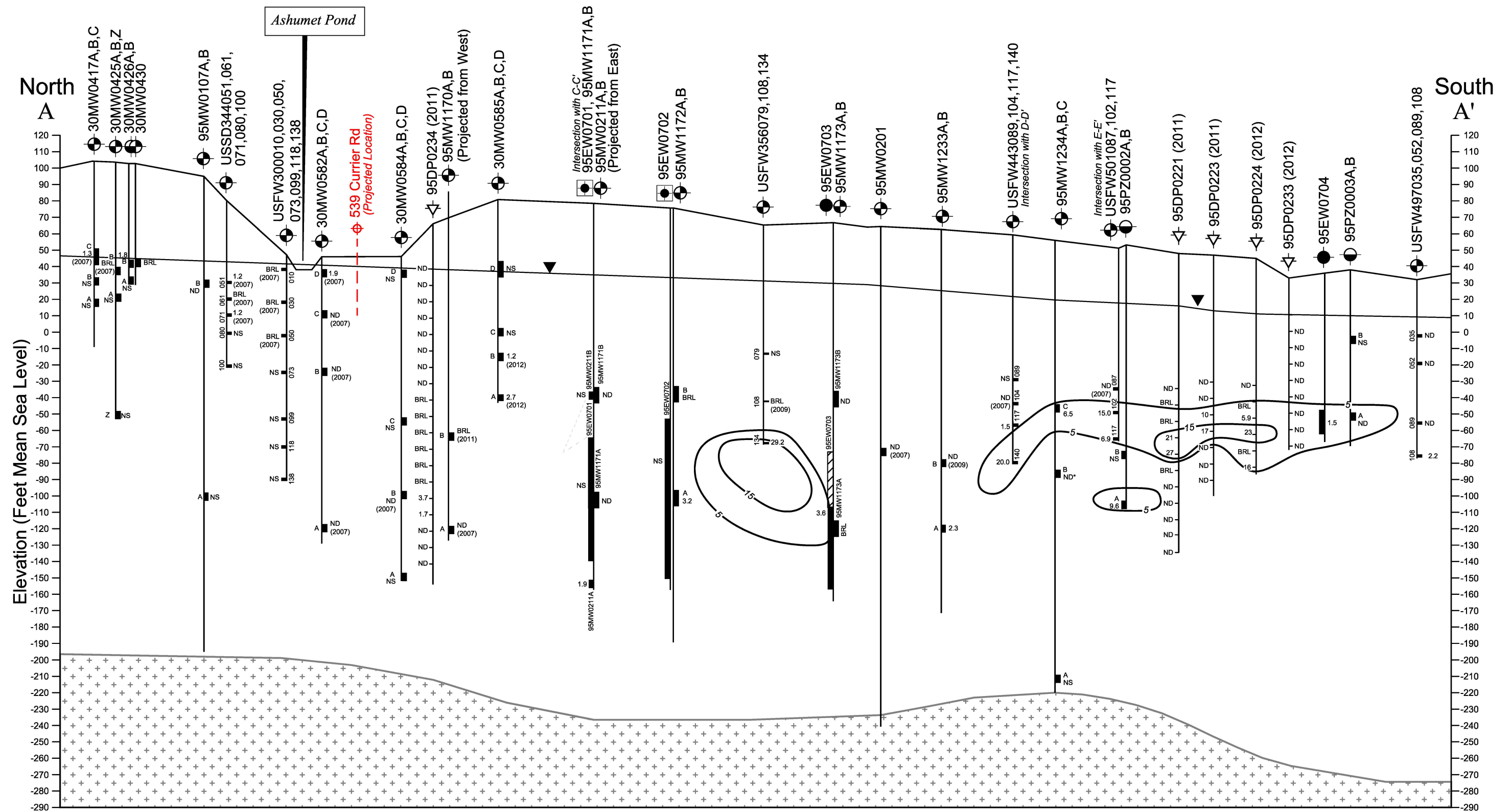
0 950 1,900 Feet

FIGURE 3

ASHUMET VALLEY PLUME AND
LOCATION OF CROSS-SECTION LINES

AFCEE - Massachusetts Military Reservation
26 January 2012 Technical Update Meeting

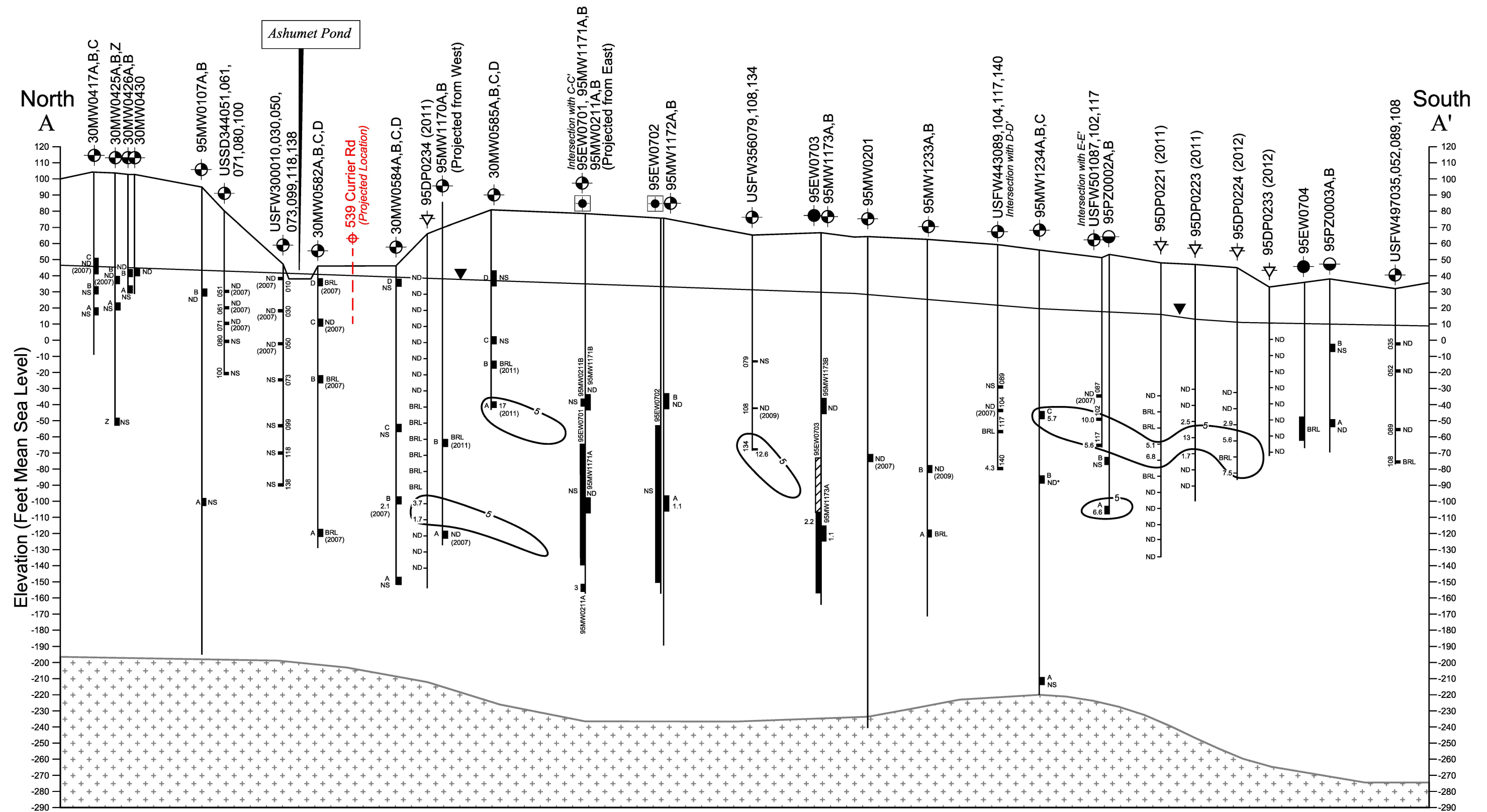
CH2MHILL



Legend

- CH2MHILL®—**





Legend

- | | | | |
|---|-----------------------|---|-----------------------|
|  | Monitoring Well |  | Piezometer |
|  | Extraction Well (On) |  | Water Table |
|  | Extraction Well (Off) | NS | Not Sampled |
|  | Direct Push Location | ND | Nondetect |
| | | BRL | Below Reporting Limit |

-

- ND
ND
- Streamwater Vertical
Profile Results (µg/L)
(December 2011/January 2012)
-  Packered Well Screen
-  Bedrock

Groundwater Vertical
Profile Results (µg/L)
(December 2011/January 2012)

Packered Well Screen

Bedrock

Source: AFCEE, January 2012, MMR-AFCEE Data Warehouse.

Note: Data Presented Includes Most Recent Monitoring Results Through December 2010 (Triennial Wells) or August 2011 (Annual Wells) (Unless Otherwise Noted)

* One-time Sampling of 95MW1234B Conducted in October 2011

FIGURE 5

**ASHUMET VALLEY TCE
CROSS-SECTION A-A'**

AFCEE - Massachusetts Military Reservation
26 January 2012 Technical Update Meeting (Modified
With Private Well Location)

—CH2MHILL®—

0 V: 60
H: 1335 Feet

Technical Update Meeting - 09 December 2009
Borehole Preliminary Groundwater Screening Results
Boring 03MW1059A (Downgradient of 03EW2112 - Currier Road)

Sample Interval	Date Sampled	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	TCE (µg/L) MCL = 5 µg/L	PCE (µg/L) MCL = 5 µg/L
A	10/12/09	25	30	27.5	28.5	ND	ND
B	10/13/09	35	40	37.5	18.5	ND	ND
C	10/13/09	45	50	47.5	8.5	ND	ND
D	10/13/09	55	60	57.5	-1.5	ND	ND
E	10/14/09	65	70	67.5	-11.5	ND	ND
F	10/14/09	75	80	77.5	-21.5	ND	ND
G	10/14/09	85	90	87.5	-31.5	ND	ND
H	10/14/09	95	100	97.5	-41.5	ND	ND
I	10/14/09	105	110	107.5	-51.5	BRL	ND
J	10/15/09	115	120	117.5	-61.5	BRL	ND
K	10/15/09	125	130	127.5	-71.5	BRL	ND
L	10/15/09	135	140	137.5	-81.5	ND	ND
M	10/15/09	145	150	147.5	-91.5	BRL	BRL
N	10/16/09	155	160	157.5	-101.5	2.2	BRL
O	10/16/09	165	170	167.5	-111.5	2.6	BRL
P	10/16/09	175	180	177.5	-121.5	BRL	ND
Q	10/16/09	185	190	187.5	-131.5	ND	ND
R	10/19/09	195	200	197.5	-141.5	ND	ND
S	10/19/09	205	210	207.5	-151.5	BRL	ND
T	10/19/09	215	220	217.5	-161.5	ND	ND
U	10/19/09	225	230	227.5	-171.5	ND	ND
V	10/20/09	235	240	237.5	-181.5	ND	ND
W	10/20/09	245	250	247.5	-191.5	ND	ND
X	10/20/09	255	260	257.5	-201.5	NS	NS

Data Source: AFCEE, October 2009, Analytics

Key:

BOS = bottom of sample

BRL = below reporting limit

ft bgs = feet below ground surface

ft msl = feet mean sea level

MCL = Maximum Contaminant Level

ND = not detected

NS = not sampled

PCE = tetrachloroethene

TCE = trichloroethene

TOS = top of sample

µg/L = micrograms per liter

Notes:

Ground surface elevation is approximately 56 ft msl.

03EW2112 screened from 148 to 208 ft bgs (-89.6 to -149.6 ft msl).

Bottom of boring was at 261 ft bgs (-205 ft msl).

Monitoring wells were installed from 205-210 ft bgs (03MW1059A), 165-170 ft bgs (03MW1059B), and 115-120 ft bgs (03MW1059C).

**Summary of Groundwater Monitoring Results for PCE and TCE
03MW1059A,B,C**

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
03MW1059A	WG	SW8260B	TETRACHLOROETHENE (PCE)	207.3	5/3/2010	ND	0.07	1	µg/L
03MW1059A	WG	SW8260B	TETRACHLOROETHENE (PCE)	207.3	2/16/2011	ND	0.19	1	µg/L
03MW1059A	WG	SW8260B	TETRACHLOROETHENE (PCE)	207.3	11/17/2011	ND	0.19	1	µg/L
03MW1059A	WG	SW8260B	TRICHLOROETHENE (TCE)	207.3	5/3/2010	ND	0.14	1	µg/L
03MW1059A	WG	SW8260B	TRICHLOROETHENE (TCE)	207.3	2/16/2011	ND	0.2	1	µg/L
03MW1059A	WG	SW8260B	TRICHLOROETHENE (TCE)	207.3	11/17/2011	ND	0.2	1	µg/L
03MW1059B	WG	SW8260B	TETRACHLOROETHENE (PCE)	167.35	5/3/2010	BRL	0.07	1	µg/L
03MW1059B	WG	SW8260B	TETRACHLOROETHENE (PCE)	167.35	2/16/2011	ND	0.19	1	µg/L
03MW1059B	WG	SW8260B	TETRACHLOROETHENE (PCE)	167.35	11/17/2011	ND	0.19	1	µg/L
03MW1059B	WG	SW8260B	TRICHLOROETHENE (TCE)	167.35	5/3/2010	1.7	0.14	1	µg/L
03MW1059B	WG	SW8260B	TRICHLOROETHENE (TCE)	167.35	2/16/2011	BRL	0.2	1	µg/L
03MW1059B	WG	SW8260B	TRICHLOROETHENE (TCE)	167.35	11/17/2011	ND	0.2	1	µg/L
03MW1059C	WG	SW8260B	TETRACHLOROETHENE (PCE)	117.4	5/3/2010	ND	0.07	1	µg/L
03MW1059C	WG	SW8260B	TETRACHLOROETHENE (PCE)	117.4	2/16/2011	ND	0.19	1	µg/L
03MW1059C	WG	SW8260B	TETRACHLOROETHENE (PCE)	117.4	11/17/2011	ND	0.19	1	µg/L
03MW1059C	WG	SW8260B	TRICHLOROETHENE (TCE)	117.4	5/3/2010	BRL	0.14	1	µg/L
03MW1059C	WG	SW8260B	TRICHLOROETHENE (TCE)	117.4	2/16/2011	ND	0.2	1	µg/L
03MW1059C	WG	SW8260B	TRICHLOROETHENE (TCE)	117.4	11/17/2011	ND	0.2	1	µg/L

Data Source: AFCEE-MMR Data Warehouse, May 2012

Key:

BRL = below laboratory reporting limit µg/L = micrograms per liter
DL = detection limit RL = laboratory reporting limit
ND = non detect WG = groundwater sample

Summary of Groundwater Monitoring Results for PCE and TCE
30MW0583A,B,C,D,E

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	8/12/1997	ND	0.41	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	7/12/1999	ND	0.22	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	9/27/1999	ND	0.1	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	1/26/2000	ND	0.1	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	3/27/2000	ND	0.11	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	6/28/2000	ND	0.11	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	9/27/2000	ND	0.11	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	12/21/2000	ND	0.11	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	4/3/2001	ND	0.11	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	5/29/2001	ND	0.11	1	µg/L
30MW0583A	WG	SW8260	TETRACHLOROETHENE (PCE)	170.5	9/11/2001	ND	0.161	1	µg/L
30MW0583A	WG	SW8260	TETRACHLOROETHENE (PCE)	170.5	4/5/2002	ND	0.146	1	µg/L
30MW0583A	WG	SW8260	TETRACHLOROETHENE (PCE)	170.5	10/29/2002	ND	0.146	1	µg/L
30MW0583A	WG	SW8260B	TETRACHLOROETHENE (PCE)	170.5	4/14/2003	BRL	0.137	1	µg/L
30MW0583A	WG	SW8260B	TETRACHLOROETHENE (PCE)	170.5	10/24/2003	ND	0.421	1	µg/L
30MW0583A	WG	SW8260B	TETRACHLOROETHENE (PCE)	170.5	5/13/2004	ND	1	1	µg/L
30MW0583A	WG	SW8260B	TETRACHLOROETHENE (PCE)	170.5	11/10/2004	BRL	0.18	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	8/12/1997	ND	0.62	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	7/12/1999	2.65	0.35	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	9/27/1999	1.7	0.12	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	1/26/2000	2	0.12	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	3/27/2000	1.8	0.09	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	6/28/2000	1.9	0.09	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	9/27/2000	2.2	0.09	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	12/21/2000	2.1	0.09	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	4/3/2001	2.4	0.09	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	5/29/2001	2.3	0.09	1	µg/L
30MW0583A	WG	SW8260	TRICHLOROETHENE (TCE)	170.5	9/11/2001	2.3	0.2	1	µg/L
30MW0583A	WG	SW8260	TRICHLOROETHENE (TCE)	170.5	4/5/2002	2.51	0.138	1	µg/L
30MW0583A	WG	SW8260	TRICHLOROETHENE (TCE)	170.5	10/29/2002	2.1	0.138	1	µg/L
30MW0583A	WG	SW8260B	TRICHLOROETHENE (TCE)	170.5	4/14/2003	2.28	0.203	1	µg/L
30MW0583A	WG	SW8260B	TRICHLOROETHENE (TCE)	170.5	10/24/2003	3	0.241	1	µg/L
30MW0583A	WG	SW8260B	TRICHLOROETHENE (TCE)	170.5	5/13/2004	1.8	0.14	1	µg/L
30MW0583A	WG	SW8260B	TRICHLOROETHENE (TCE)	170.5	11/10/2004	2.5	0.11	1	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	8/12/1997	ND	0.41	5	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	7/12/1999	1.3	0.22	1	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	9/27/1999	ND	1	10	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	1/26/2000	ND	0.2	2	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	3/27/2000	ND	0.11	1	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	6/28/2000	ND	0.22	2	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	9/27/2000	ND	0.44	4	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	12/21/2000	ND	0.55	5	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	4/3/2001	BRL	0.44	4	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	5/29/2001	BRL	0.44	4	µg/L
30MW0583B	WG	SW8260	TETRACHLOROETHENE (PCE)	135.5	9/12/2001	BRL	0.161	1	µg/L
30MW0583B	WG	SW8260	TETRACHLOROETHENE (PCE)	135.5	4/5/2002	1.51	0.146	1	µg/L
30MW0583B	WG	SW8260	TETRACHLOROETHENE (PCE)	135.5	10/29/2002	1.6	0.146	1	µg/L
30MW0583B	WG	SW8260B	TETRACHLOROETHENE (PCE)	135.5	4/14/2003	1.48	0.137	1	µg/L
30MW0583B	WG	SW8260B	TETRACHLOROETHENE (PCE)	135.5	10/24/2003	BRL	0.421	1	µg/L
30MW0583B	WG	SW8260B	TETRACHLOROETHENE (PCE)	135.5	5/13/2004	1.3	0.16	1	µg/L
30MW0583B	WG	SW8260B	TETRACHLOROETHENE (PCE)	135.5	11/10/2004	1.1	0.18	1	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	8/12/1997	83	0.62	5	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	7/12/1999	18.4	0.35	1	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	9/27/1999	BRL	1.2	10	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	1/26/2000	1.9	0.24	2	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	3/27/2000	ND	0.09	1	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	6/28/2000	ND	0.18	2	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	9/27/2000	3.9	0.36	4	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	12/21/2000	10	0.45	5	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	4/3/2001	BRL	0.36	4	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	5/29/2001	BRL	0.36	4	µg/L

Summary of Groundwater Monitoring Results for PCE and TCE
30MW0583A,B,C,D,E

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
30MW0583B	WG	SW8260	TRICHLOROETHENE (TCE)	135.5	9/12/2001	2.73	0.2	1	µg/L
30MW0583B	WG	SW8260	TRICHLOROETHENE (TCE)	135.5	4/5/2002	BRL	0.138	1	µg/L
30MW0583B	WG	SW8260	TRICHLOROETHENE (TCE)	135.5	10/29/2002	BRL	0.138	1	µg/L
30MW0583B	WG	SW8260B	TRICHLOROETHENE (TCE)	135.5	4/14/2003	BRL	0.203	1	µg/L
30MW0583B	WG	SW8260B	TRICHLOROETHENE (TCE)	135.5	10/24/2003	1.7	0.241	1	µg/L
30MW0583B	WG	SW8260B	TRICHLOROETHENE (TCE)	135.5	5/13/2004	BRL	0.14	1	µg/L
30MW0583B	WG	SW8260B	TRICHLOROETHENE (TCE)	135.5	11/10/2004	BRL	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	8/12/1997	6.6	0.41	2	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	7/12/1999	ND	0.22	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	9/27/1999	ND	0.1	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	1/26/2000	ND	0.1	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	3/27/2000	ND	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	6/28/2000	ND	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	9/27/2000	ND	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	12/21/2000	ND	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	4/3/2001	BRL	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	5/29/2001	BRL	0.22	2	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	10/1/2001	BRL	0.26	2	µg/L
30MW0583C	WG	SW8260	TETRACHLOROETHENE (PCE)	86.5	4/5/2002	BRL	0.146	1	µg/L
30MW0583C	WG	SW8260	TETRACHLOROETHENE (PCE)	86.5	10/29/2002	1.05	0.146	1	µg/L
30MW0583C	WG	SW8260B	TETRACHLOROETHENE (PCE)	86.5	4/14/2003	2.53	0.137	1	µg/L
30MW0583C	WG	SW8260B	TETRACHLOROETHENE (PCE)	86.5	10/24/2003	BRL	0.421	1	µg/L
30MW0583C	WG	SW8260B	TETRACHLOROETHENE (PCE)	86.5	5/13/2004	1.3	0.16	1	µg/L
30MW0583C	WG	SW8260B	TETRACHLOROETHENE (PCE)	86.5	11/10/2004	BRL	0.18	1	µg/L
30MW0583C	WG	SW8260B	TETRACHLOROETHENE (PCE)	86.5	11/10/2004	BRL	0.18	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	8/12/1997	11	0.62	2	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	7/12/1999	ND	0.35	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	9/27/1999	ND	0.12	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	1/26/2000	ND	0.12	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	3/27/2000	ND	0.09	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	6/28/2000	ND	0.09	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	9/27/2000	ND	0.09	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	12/21/2000	ND	0.09	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	4/3/2001	BRL	0.09	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	5/29/2001	BRL	0.18	2	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	10/1/2001	ND	0.3	2	µg/L
30MW0583C	WG	SW8260	TRICHLOROETHENE (TCE)	86.5	4/5/2002	BRL	0.138	1	µg/L
30MW0583C	WG	SW8260	TRICHLOROETHENE (TCE)	86.5	10/29/2002	BRL	0.138	1	µg/L
30MW0583C	WG	SW8260B	TRICHLOROETHENE (TCE)	86.5	4/14/2003	BRL	0.203	1	µg/L
30MW0583C	WG	SW8260B	TRICHLOROETHENE (TCE)	86.5	10/24/2003	BRL	0.24	1	µg/L
30MW0583C	WG	SW8260B	TRICHLOROETHENE (TCE)	86.5	5/13/2004	BRL	0.14	1	µg/L
30MW0583C	WG	SW8260B	TRICHLOROETHENE (TCE)	86.5	11/10/2004	ND	0.11	1	µg/L
30MW0583C	WG	SW8260B	TRICHLOROETHENE (TCE)	86.5	11/10/2004	ND	0.11	1	µg/L
30MW0583D	WG	CVOL	TETRACHLOROETHENE (PCE)	55.5	8/13/1997	ND	0.41	1	µg/L
30MW0583D	WG	CVOL	TETRACHLOROETHENE (PCE)	55.5	7/12/1999	ND	0.22	1	µg/L
30MW0583D	WG	CVOL	TRICHLOROETHENE (TCE)	55.5	8/13/1997	ND	0.62	1	µg/L
30MW0583D	WG	CVOL	TRICHLOROETHENE (TCE)	55.5	7/12/1999	ND	0.35	1	µg/L
30MW0583E	WG	CVOL	TETRACHLOROETHENE (PCE)	10.5	8/13/1997	ND	0.41	1	µg/L
30MW0583E	WG	CVOL	TETRACHLOROETHENE (PCE)	10.5	7/12/1999	ND	0.22	1	µg/L
30MW0583E	WG	CVOL	TRICHLOROETHENE (TCE)	10.5	8/13/1997	ND	0.62	1	µg/L
30MW0583E	WG	CVOL	TRICHLOROETHENE (TCE)	10.5	7/12/1999	ND	0.35	1	µg/L

Data Source: AFCEE-MMR Data Warehouse, May 2012

Key:

BRL = below laboratory reporting limit µg/L = micrograms per liter
DL = detection limit RL = laboratory reporting limit
ND = non detect WG = groundwater sample

**Summary of Groundwater Monitoring Results for Manganese
RS0539CURR**

Location	Matrix	Test	Analyte	Date	Result	DL	RL	Units
RS0539CURR	WG	SW6010B	MANGANESE	5/28/2013	ND	2.8	15	µg/L

Data Source: AFCEC-MMR Data Warehouse, July 2013

Key:

DL = detection limit

ND = non detect

RL = reporting limit

WG = groundwater

µg/L = micrograms per liter

Mr. Doug Scott
CH2M Hill
1748 West Truck Road/Otis ANG Base
Buzzards Bay MA 02542

May 31, 2013

SAMPLE DATA

CLIENT SAMPLE ID

Project Name: MMR 2013/06 LUC CS-10, CS-21, AV

Project Number: 437075.05.07.18

Field Sample ID: CHPE0539CU-O0513

Lab Sample ID: 75634-1

Matrix: Aqueous

Percent Solid: N/A

Dilution Factor: 1

Collection Date: 05/28/13

Lab Receipt Date: 05/30/13

Analysis Date: 05/30/13

ANALYTICAL RESULTS VOLATILE ORGANICS							
COMPOUND	Detection Limit µg/L	Quantitation Limit µg/L	Result µg/L	COMPOUND	Detection Limit µg/L	Quantitation Limit µg/L	Result µg/L
1,1,1-Trichloroethane	0.18	1.0	U	Toluene	0.20	1.0	U
1,1-Dichloroethane	0.20	1.0	U	trans-1,2-Dichloroethene	0.20	1.0	U
1,2,4-Trichlorobenzene	0.21	1.0	U	trans-1,3-Dichloropropene	0.10	1.0	U
1,2-Dibromo-3-chloropropane	0.50	1.0	U	Trichloroethene	0.20	1.0	U
1,2-Dichlorobenzene	0.16	1.0	U	1,1,2,2-Tetrachloroethane	0.13	1.0	U
1,3-Dichlorobenzene	0.20	1.0	U	1,1,2-Trichloroethane	0.11	1.0	U
1,4-Dichlorobenzene	0.19	1.0	U	1,1-Dichloroethene	0.13	1.0	U
Benzene	0.20	1.0	U	1,2-Dibromoethane	0.15	1.0	U
Bromochloromethane	0.20	1.0	U	1,2-Dichloroethane	0.50	1.0	U
Chlorobenzene	0.17	1.0	U	1,2-Dichloropropane	0.50	1.0	U
Chloroform	0.20	1.0	U	Bromodichloromethane	0.15	1.0	U
cis-1,2-Dichloroethene	0.20	1.0	U	Bromoform	0.12	1.0	U
cis-1,3-Dichloropropene	0.10	1.0	U	Bromomethane	0.50	1.0	U
Ethylbenzene	0.20	1.0	U	Carbon Tetrachloride	0.20	1.0	U
Methylene Chloride	1.0	2.0	U	Chloroethane	0.50	1.0	U
o-Xylene	0.20	1.0	U	Chloromethane	0.20	1.0	U
m,p-Xylene	0.40	1.0	U	Dibromochloromethane	0.15	1.0	U
Styrene	0.20	1.0	U	Methyl-tert-butyl ether (MTBE)	0.20	1.0	U
Tetrachloroethene	0.19	1.0	U	Vinyl chloride	0.20	1.0	U
Surrogate Standard Recovery							
Bromofluorobenzene	101%	d4-1,2-Dichloroethane		105%	d8-Toluene		99%
U=Undetected J=Estimated E=Exceeds Calibration Range B=Detected in Blank							

METHODOLOGY: Sample analysis was conducted according to: Test Methods for Evaluating Solid Waste, SW-846 Method 8260B.

COMMENTS:

WELL DETERMINATION

ADDRESS: 533 Currier Road, Falmouth MA

APEMS ID: 39900

WELL STATUS: ACTIVE

WELL USE: Outdoor uses

SUMMARY: According to the property owner response (attached), this residence is connected to the Falmouth municipal water supply. This residence receives a water bill from the Town of Falmouth. However, there is a private well located on this property that is used for outdoor purposes. The total depth of this well is unknown. Depth to water in this area is approximately 12 ft bgs (+45 ft msl). This property is located along the southern border of the Ashumet Valley LTM area, approximately 580 feet north and outside of the Ashumet Valley Plume boundary.

DATA REVIEW:

- ☒ SPEIM monitoring data are available in the vicinity of this well [see attached map and cross sections].
 - 03MW1059A,B,C [vertical profiling and monitoring data; tables attached]
 - 30MW0583A,B,C,D,E [monitoring data; table attached]
 - Water table elevation is approximately 45 ft msl.
- ☒ Groundwater vertical profiling for PCE and TCE was conducted in 2009 at a boring located approximately 420 feet upgradient of this property (03MW1059A). PCE and TCE were not detected at concentrations greater than the Maximum Contaminant Level (MCL) of 5 micrograms per liter ($\mu\text{g/L}$) for each compound (see attached table). At the time of vertical profiling, a maximum TCE concentration of 2.6 $\mu\text{g/L}$ was detected at a depth of 167 ft bgs (-111 ft msl) and PCE was detected at concentrations below the laboratory reporting limit (BRL) of 1 $\mu\text{g/L}$. Sampling of the monitoring wells at this location since 2009 indicates concentrations of TCE and PCE have decreased to ND (see attached table). Groundwater sampling at monitoring well cluster 30MW0583A,B,C,D,E, which is located on 533 Currier Rd, indicates that no TCE or PCE was detected at the shallowest (D and E) screens (-9 and +37 ft msl, respectively) when these wells were last sampled in 1997 and 1999. A maximum TCE concentration of 83 $\mu\text{g/L}$ was reported at the B screen in 1997 (mid-screen elevation of -40 ft msl). However, TCE concentrations at this monitoring well had declined to less than 1 $\mu\text{g/L}$ (BRL) by 2004.
- ☒ Sample results are available for this private well (attached). A sample from this well was collected and submitted for VOC analysis by EPA Method 8260B and total manganese analysis by SW-846 6010B on 30 May 2013. Additionally, samples were collected from private wells at nearby properties (AFCEE Parcel IDs 39677, 39772, 39700, 39910, 39902; see location map) in 2012 and submitted for VOC and manganese analysis.
 - No PCE or TCE was reported in the sample collected from 533 Currier Road in 2013 or five nearby private wells that were sampled in 2012. TCE was detected at one location, AFCEE Parcel ID 39902, at a concentration that is less than the laboratory reporting limit of 1 $\mu\text{g/L}$ (BRL).
 - No Mn was detected in the sample collected from this private well.

WELL DETERMINATION

DETERMINATION: Based on the May 2013 sampling results there is no current risk of exposure to Ashumet Valley plume COC concentrations above applicable standards. This property is located approximately 580 feet north and upgradient of the Ashumet Valley VOC plume boundary; the top of which is at a depth of ~150 ft bgs [-100 ft msl]. The depth of the private well at 533 Currier Road is unknown, but is likely to be shallower in the aquifer than the top of the Ashumet Valley plume. PCE and TCE concentrations at nearby monitoring wells are currently either non-detect or below the laboratory reporting limit of 1 µg/L (BRL) for each of these compounds and concentrations, when present, are expected to continue to decrease. This private well is located approximately 720 feet downgradient of CS-10 southern trench extraction well, 03EW2112, which was installed in 2009 to intercept the CS-10 southern trench lobe. Impacts to this property from the CS-10 southern trench lobe are not anticipated. No Mn was detected in the sample collected from this well in May 2013. Therefore, intermittent pumping of this well for outdoor irrigation purposes is unlikely to draw in groundwater with PCE and TCE concentrations greater than the MCL or result in an unacceptable exposure risk to total Mn.

PATH FORWARD: No further sampling needed.

SAMPLING NEEDED: ☐Yes ☒No

RE-EVALUATE IN NEXT 5-YEAR REVIEW: ☒Yes ☐No



AFCEC MMR Land Use Controls Parcel Summary

Report Produced: 7/9/2013

Name: Westcott, David

Plume: Ashumet Valley

Telephone No.

Mailing Address

Town Numbers

AFCEE Plume: Ashumet Valley

Map: 09 *Section:* 01 *Parcel:* 007 *Lot:* 006

Mailing PO:

Mailing Street: 533 CURRIER RD

Residential Well Notes: 02-02-2013: Well has been reactivated per email response. Used for outdoor watering.

Mailing City: EAST FALMOUTH

Mailing State: MA

Irrigation Well Notes:

Mailing ZIP: 02536

Parcel Address

Town Water Notes:

APEMS ID: 39900

Parcel Street: 533 CURRIER RD

Other Notes:

Parcel City: Falmouth

Parcel State:

Parcel ZIP:

☐ Checked if the parcel respond to the state's 5-Star survey.

☐ Checked if AFCEE has been in contact with the parcel and no contact is needed.

Initial Mailing Sent? ☐

Date Sent:

Date Returned: 1/18/2012

Second Mailing Sent? ☐

Date Sent:

Date Returned:

Third Mailing Sent? ☐

Date Sent:

Date Returned:

Contacted by Phone? ☐

Date Contacted:

Contact Note:

Contacted by Email? ☐

Email Date:

Date Returned::

Contacted In-Person? ☒

Date Contacted: 2/22/2012

Field Visit Performed? ☒

Field Visit Date: 2/22/2012

Field Visit Note: Well exists but is non-functional per owner during field visit.

Other Contact Notes: Changed owner per well verification form and Town of Falmouth Assessor records.

Wells associated with this parcel:

LocID

Functional? ☒

Depth 0

Decomissioned? ☐

Well Deemed Safe? ☐

Non-Functional? ☐

Pump Rate 0

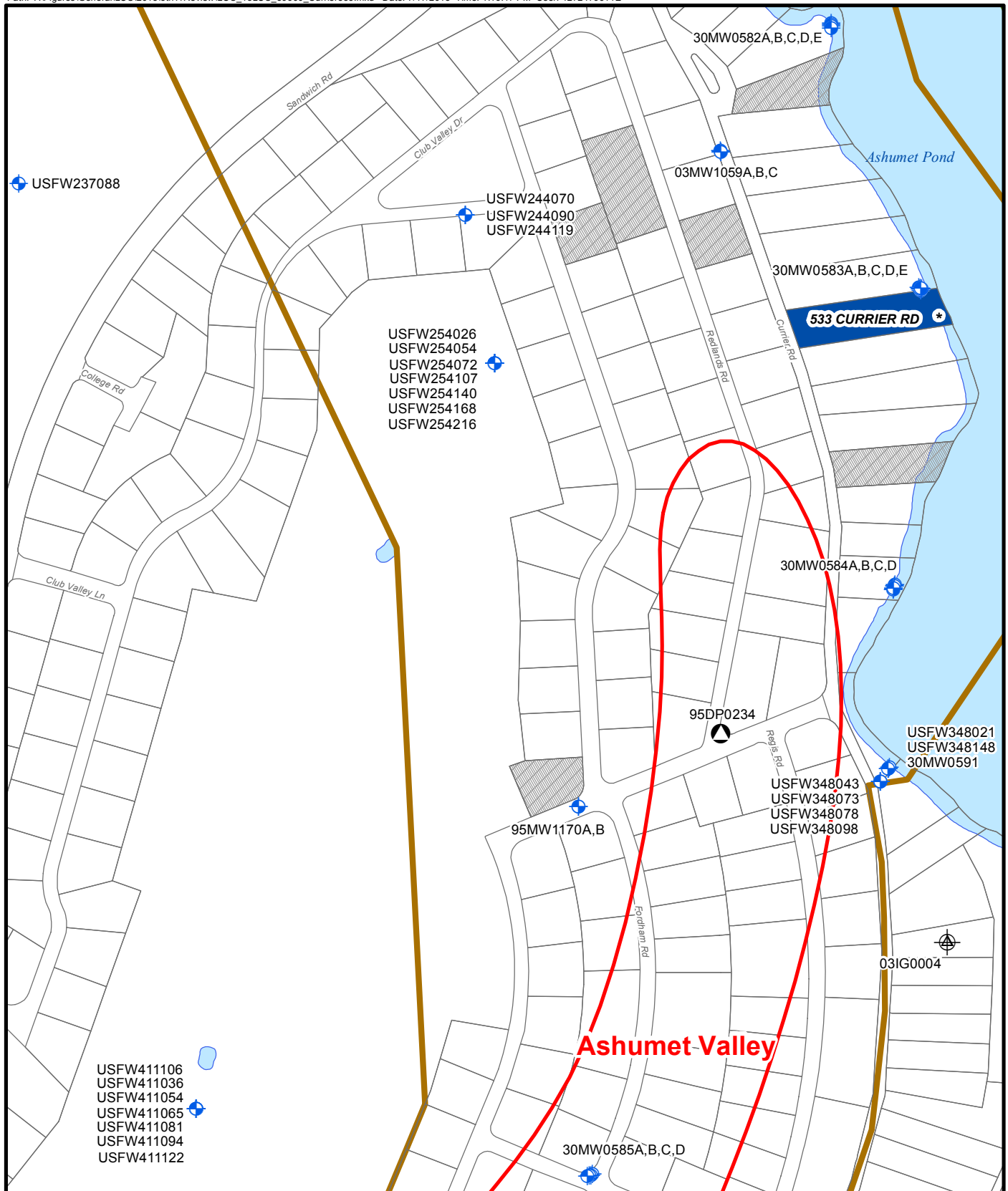
Decomission Offer Made? ☐

Date:

Other Status?

Decomission Offer Received? ☐

Originating Source:

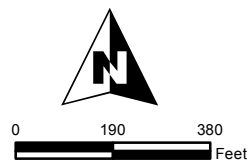


Data Source: AFCEC, MMR-AFCEC Data Warehouse

Legend

- Plume Boundary
- LUC Boundary
- Parcel of Interest *
- Private Well Sampled in 2012
- Other Parcel
- + Monitoring Well
- Direct Push/Borehole
- ⊕ Irrigation Well

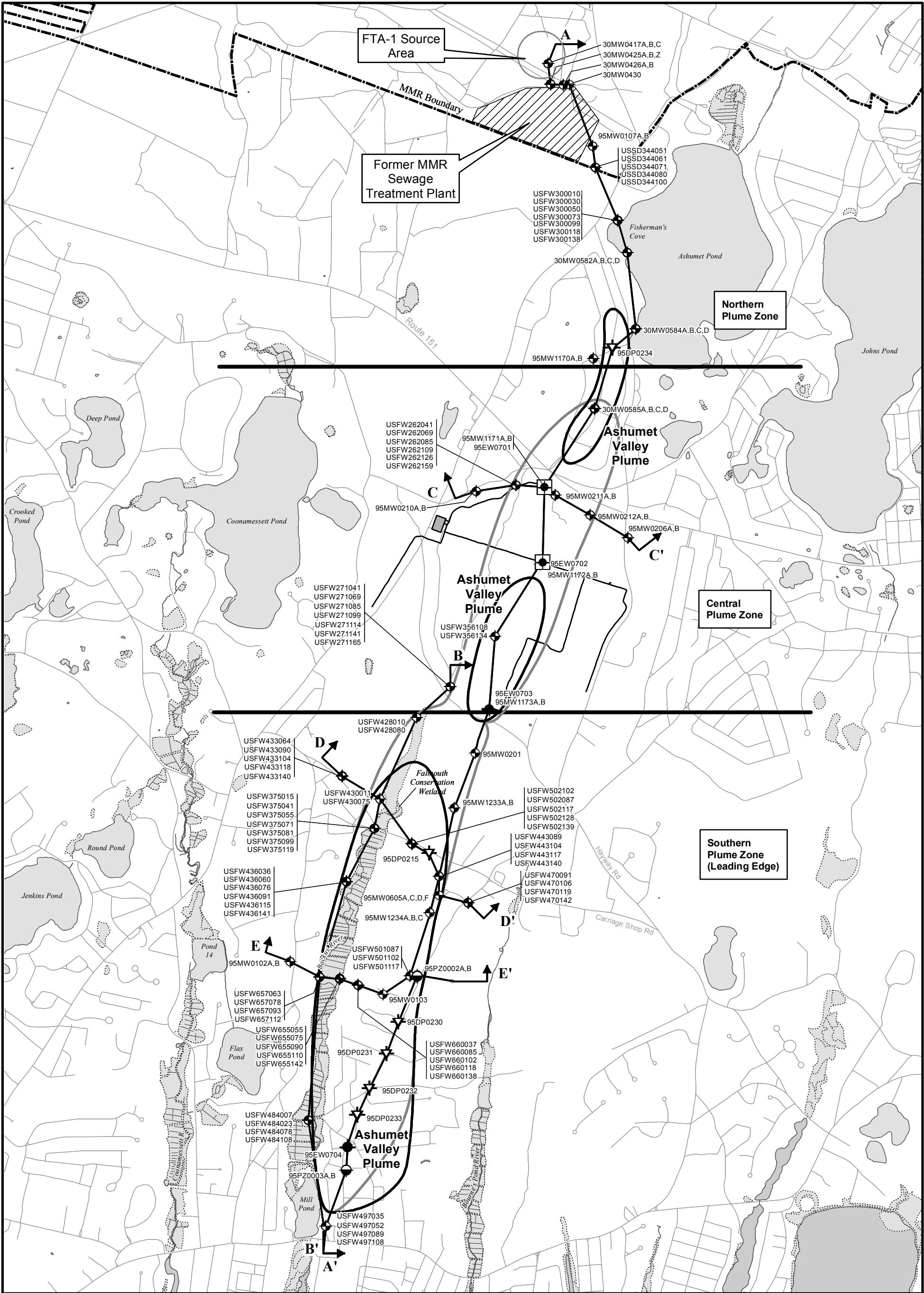
* Note: Private Well Sampled in 2013



LOCATION: 533 CURRIER RD

AFCEC - Massachusetts Military Reservation
Ashumet Valley Land Use Control

CH2MHILL.



Data Source: AFCEE, January 2012, AFCEE - MMR Data Warehouse

Legend

- Massachusetts Military Reservation Boundary
- ETI System Pipeline and Treatment Plant
- 2007 Plume Boundary
- 2011 Plume Boundary
- Bog/Wetland

A — A'

- Location of Cross-section
- Extraction Well (On)
- Extraction Well (Off)
- Monitoring Well
- Piezometer
- Vertical Profiling Location (Direct Push)



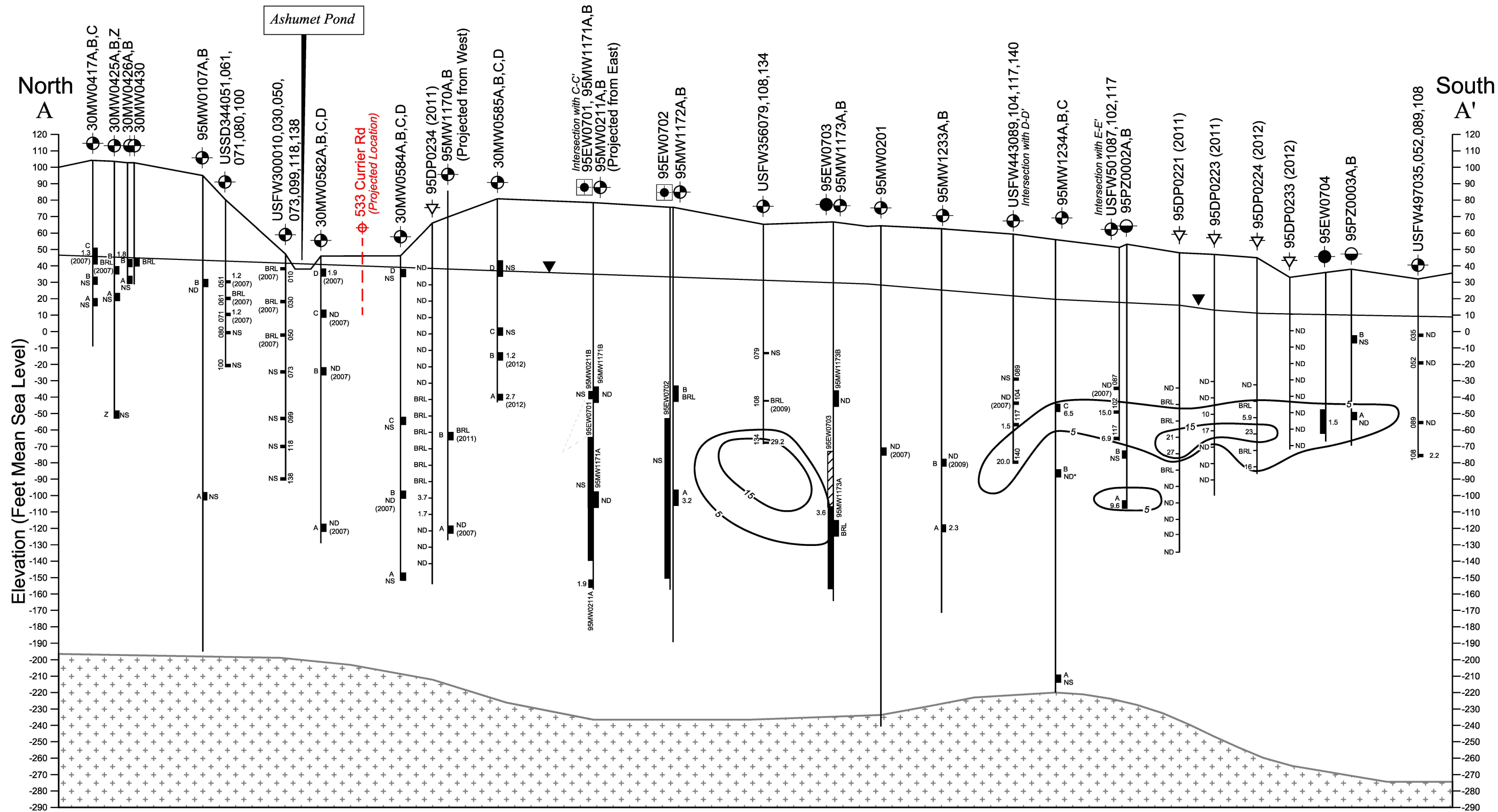
0 950 1,900 Feet

FIGURE 3

ASHUMET VALLEY PLUME AND
LOCATION OF CROSS-SECTION LINES

AFCEE - Massachusetts Military Reservation
26 January 2012 Technical Update Meeting

CH2MHILL



Legend

- Monitoring Well
- Extraction Well (On)
- Extraction Well (Off)
- Direct Push Location

- Piezometer
- Water Table
- NS Not Sampled
- ND Nondetect
- BRL Below Reporting Limit

- Private Well (Unknown Depth)
- 2011 PCE Isoconcentration Contour (Dashed Where Inferred)
- PCE Results (µg/L)
- Well Screen ID

- ND
- ND
- 15
- 119

- Groundwater Vertical Profile Results (µg/L) (December 2011/January 2012)
- Packer Well Screen
- Bedrock

Note: Data Presented Includes Most Recent Monitoring Results Through December 2010 (Triennial Wells) or August 2011 (Annual Wells) (Unless Otherwise Noted)

* One-time Sampling of 95MW1234B Conducted in October 2011

Source: AFCEE, January 2012, MMR-AFCEE Data Warehouse.



FIGURE 4

ASHUMET VALLEY PCE CROSS-SECTION A-A'

AFCEE - Massachusetts Military Reservation
26 January 2012 Technical Update Meeting (Modified With Private Well Location)

CH2MHILL

Technical Update Meeting - 09 December 2009
Borehole Preliminary Groundwater Screening Results
Boring 03MW1059A (Downgradient of 03EW2112 - Currier Road)

Sample Interval	Date Sampled	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	TCE (µg/L) MCL = 5 µg/L	PCE (µg/L) MCL = 5 µg/L
A	10/12/09	25	30	27.5	28.5	ND	ND
B	10/13/09	35	40	37.5	18.5	ND	ND
C	10/13/09	45	50	47.5	8.5	ND	ND
D	10/13/09	55	60	57.5	-1.5	ND	ND
E	10/14/09	65	70	67.5	-11.5	ND	ND
F	10/14/09	75	80	77.5	-21.5	ND	ND
G	10/14/09	85	90	87.5	-31.5	ND	ND
H	10/14/09	95	100	97.5	-41.5	ND	ND
I	10/14/09	105	110	107.5	-51.5	BRL	ND
J	10/15/09	115	120	117.5	-61.5	BRL	ND
K	10/15/09	125	130	127.5	-71.5	BRL	ND
L	10/15/09	135	140	137.5	-81.5	ND	ND
M	10/15/09	145	150	147.5	-91.5	BRL	BRL
N	10/16/09	155	160	157.5	-101.5	2.2	BRL
O	10/16/09	165	170	167.5	-111.5	2.6	BRL
P	10/16/09	175	180	177.5	-121.5	BRL	ND
Q	10/16/09	185	190	187.5	-131.5	ND	ND
R	10/19/09	195	200	197.5	-141.5	ND	ND
S	10/19/09	205	210	207.5	-151.5	BRL	ND
T	10/19/09	215	220	217.5	-161.5	ND	ND
U	10/19/09	225	230	227.5	-171.5	ND	ND
V	10/20/09	235	240	237.5	-181.5	ND	ND
W	10/20/09	245	250	247.5	-191.5	ND	ND
X	10/20/09	255	260	257.5	-201.5	NS	NS

Data Source: AFCEE, October 2009, Analytics

Key:

BOS = bottom of sample

BRL = below reporting limit

ft bgs = feet below ground surface

ft msl = feet mean sea level

MCL = Maximum Contaminant Level

ND = not detected

NS = not sampled

PCE = tetrachloroethene

TCE = trichloroethene

TOS = top of sample

µg/L = micrograms per liter

Notes:

Ground surface elevation is approximately 56 ft msl.

03EW2112 screened from 148 to 208 ft bgs (-89.6 to -149.6 ft msl).

Bottom of boring was at 261 ft bgs (-205 ft msl).

Monitoring wells were installed from 205-210 ft bgs (03MW1059A), 165-170 ft bgs (03MW1059B), and 115-120 ft bgs (03MW1059C).

**Summary of Groundwater Monitoring Results for PCE and TCE
03MW1059A,B,C**

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
03MW1059A	WG	SW8260B	TETRACHLOROETHENE (PCE)	207.3	5/3/2010	ND	0.07	1	µg/L
03MW1059A	WG	SW8260B	TETRACHLOROETHENE (PCE)	207.3	2/16/2011	ND	0.19	1	µg/L
03MW1059A	WG	SW8260B	TETRACHLOROETHENE (PCE)	207.3	11/17/2011	ND	0.19	1	µg/L
03MW1059A	WG	SW8260B	TRICHLOROETHENE (TCE)	207.3	5/3/2010	ND	0.14	1	µg/L
03MW1059A	WG	SW8260B	TRICHLOROETHENE (TCE)	207.3	2/16/2011	ND	0.2	1	µg/L
03MW1059A	WG	SW8260B	TRICHLOROETHENE (TCE)	207.3	11/17/2011	ND	0.2	1	µg/L
03MW1059B	WG	SW8260B	TETRACHLOROETHENE (PCE)	167.35	5/3/2010	BRL	0.07	1	µg/L
03MW1059B	WG	SW8260B	TETRACHLOROETHENE (PCE)	167.35	2/16/2011	ND	0.19	1	µg/L
03MW1059B	WG	SW8260B	TETRACHLOROETHENE (PCE)	167.35	11/17/2011	ND	0.19	1	µg/L
03MW1059B	WG	SW8260B	TRICHLOROETHENE (TCE)	167.35	5/3/2010	1.7	0.14	1	µg/L
03MW1059B	WG	SW8260B	TRICHLOROETHENE (TCE)	167.35	2/16/2011	BRL	0.2	1	µg/L
03MW1059B	WG	SW8260B	TRICHLOROETHENE (TCE)	167.35	11/17/2011	ND	0.2	1	µg/L
03MW1059C	WG	SW8260B	TETRACHLOROETHENE (PCE)	117.4	5/3/2010	ND	0.07	1	µg/L
03MW1059C	WG	SW8260B	TETRACHLOROETHENE (PCE)	117.4	2/16/2011	ND	0.19	1	µg/L
03MW1059C	WG	SW8260B	TETRACHLOROETHENE (PCE)	117.4	11/17/2011	ND	0.19	1	µg/L
03MW1059C	WG	SW8260B	TRICHLOROETHENE (TCE)	117.4	5/3/2010	BRL	0.14	1	µg/L
03MW1059C	WG	SW8260B	TRICHLOROETHENE (TCE)	117.4	2/16/2011	ND	0.2	1	µg/L
03MW1059C	WG	SW8260B	TRICHLOROETHENE (TCE)	117.4	11/17/2011	ND	0.2	1	µg/L

Data Source: AFCEE-MMR Data Warehouse, May 2012

Key:

BRL = below laboratory reporting limit µg/L = micrograms per liter
DL = detection limit RL = laboratory reporting limit
ND = non detect WG = groundwater sample

Summary of Groundwater Monitoring Results for PCE and TCE
30MW0583A,B,C,D,E

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	8/12/1997	ND	0.41	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	7/12/1999	ND	0.22	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	9/27/1999	ND	0.1	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	1/26/2000	ND	0.1	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	3/27/2000	ND	0.11	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	6/28/2000	ND	0.11	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	9/27/2000	ND	0.11	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	12/21/2000	ND	0.11	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	4/3/2001	ND	0.11	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	5/29/2001	ND	0.11	1	µg/L
30MW0583A	WG	SW8260	TETRACHLOROETHENE (PCE)	170.5	9/11/2001	ND	0.161	1	µg/L
30MW0583A	WG	SW8260	TETRACHLOROETHENE (PCE)	170.5	4/5/2002	ND	0.146	1	µg/L
30MW0583A	WG	SW8260	TETRACHLOROETHENE (PCE)	170.5	10/29/2002	ND	0.146	1	µg/L
30MW0583A	WG	SW8260B	TETRACHLOROETHENE (PCE)	170.5	4/14/2003	BRL	0.137	1	µg/L
30MW0583A	WG	SW8260B	TETRACHLOROETHENE (PCE)	170.5	10/24/2003	ND	0.421	1	µg/L
30MW0583A	WG	SW8260B	TETRACHLOROETHENE (PCE)	170.5	5/13/2004	ND	1	1	µg/L
30MW0583A	WG	SW8260B	TETRACHLOROETHENE (PCE)	170.5	11/10/2004	BRL	0.18	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	8/12/1997	ND	0.62	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	7/12/1999	2.65	0.35	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	9/27/1999	1.7	0.12	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	1/26/2000	2	0.12	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	3/27/2000	1.8	0.09	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	6/28/2000	1.9	0.09	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	9/27/2000	2.2	0.09	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	12/21/2000	2.1	0.09	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	4/3/2001	2.4	0.09	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	5/29/2001	2.3	0.09	1	µg/L
30MW0583A	WG	SW8260	TRICHLOROETHENE (TCE)	170.5	9/11/2001	2.3	0.2	1	µg/L
30MW0583A	WG	SW8260	TRICHLOROETHENE (TCE)	170.5	4/5/2002	2.51	0.138	1	µg/L
30MW0583A	WG	SW8260	TRICHLOROETHENE (TCE)	170.5	10/29/2002	2.1	0.138	1	µg/L
30MW0583A	WG	SW8260B	TRICHLOROETHENE (TCE)	170.5	4/14/2003	2.28	0.203	1	µg/L
30MW0583A	WG	SW8260B	TRICHLOROETHENE (TCE)	170.5	10/24/2003	3	0.241	1	µg/L
30MW0583A	WG	SW8260B	TRICHLOROETHENE (TCE)	170.5	5/13/2004	1.8	0.14	1	µg/L
30MW0583A	WG	SW8260B	TRICHLOROETHENE (TCE)	170.5	11/10/2004	2.5	0.11	1	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	8/12/1997	ND	0.41	5	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	7/12/1999	1.3	0.22	1	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	9/27/1999	ND	1	10	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	1/26/2000	ND	0.2	2	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	3/27/2000	ND	0.11	1	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	6/28/2000	ND	0.22	2	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	9/27/2000	ND	0.44	4	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	12/21/2000	ND	0.55	5	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	4/3/2001	BRL	0.44	4	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	5/29/2001	BRL	0.44	4	µg/L
30MW0583B	WG	SW8260	TETRACHLOROETHENE (PCE)	135.5	9/12/2001	BRL	0.161	1	µg/L
30MW0583B	WG	SW8260	TETRACHLOROETHENE (PCE)	135.5	4/5/2002	1.51	0.146	1	µg/L
30MW0583B	WG	SW8260	TETRACHLOROETHENE (PCE)	135.5	10/29/2002	1.6	0.146	1	µg/L
30MW0583B	WG	SW8260B	TETRACHLOROETHENE (PCE)	135.5	4/14/2003	1.48	0.137	1	µg/L
30MW0583B	WG	SW8260B	TETRACHLOROETHENE (PCE)	135.5	10/24/2003	BRL	0.421	1	µg/L
30MW0583B	WG	SW8260B	TETRACHLOROETHENE (PCE)	135.5	5/13/2004	1.3	0.16	1	µg/L
30MW0583B	WG	SW8260B	TETRACHLOROETHENE (PCE)	135.5	11/10/2004	1.1	0.18	1	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	8/12/1997	83	0.62	5	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	7/12/1999	18.4	0.35	1	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	9/27/1999	BRL	1.2	10	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	1/26/2000	1.9	0.24	2	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	3/27/2000	ND	0.09	1	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	6/28/2000	ND	0.18	2	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	9/27/2000	3.9	0.36	4	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	12/21/2000	10	0.45	5	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	4/3/2001	BRL	0.36	4	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	5/29/2001	BRL	0.36	4	µg/L

Summary of Groundwater Monitoring Results for PCE and TCE
30MW0583A,B,C,D,E

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
30MW0583B	WG	SW8260	TRICHLOROETHENE (TCE)	135.5	9/12/2001	2.73	0.2	1	µg/L
30MW0583B	WG	SW8260	TRICHLOROETHENE (TCE)	135.5	4/5/2002	BRL	0.138	1	µg/L
30MW0583B	WG	SW8260	TRICHLOROETHENE (TCE)	135.5	10/29/2002	BRL	0.138	1	µg/L
30MW0583B	WG	SW8260B	TRICHLOROETHENE (TCE)	135.5	4/14/2003	BRL	0.203	1	µg/L
30MW0583B	WG	SW8260B	TRICHLOROETHENE (TCE)	135.5	10/24/2003	1.7	0.241	1	µg/L
30MW0583B	WG	SW8260B	TRICHLOROETHENE (TCE)	135.5	5/13/2004	BRL	0.14	1	µg/L
30MW0583B	WG	SW8260B	TRICHLOROETHENE (TCE)	135.5	11/10/2004	BRL	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	8/12/1997	6.6	0.41	2	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	7/12/1999	ND	0.22	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	9/27/1999	ND	0.1	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	1/26/2000	ND	0.1	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	3/27/2000	ND	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	6/28/2000	ND	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	9/27/2000	ND	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	12/21/2000	ND	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	4/3/2001	BRL	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	5/29/2001	BRL	0.22	2	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	10/1/2001	BRL	0.26	2	µg/L
30MW0583C	WG	SW8260	TETRACHLOROETHENE (PCE)	86.5	4/5/2002	BRL	0.146	1	µg/L
30MW0583C	WG	SW8260	TETRACHLOROETHENE (PCE)	86.5	10/29/2002	1.05	0.146	1	µg/L
30MW0583C	WG	SW8260B	TETRACHLOROETHENE (PCE)	86.5	4/14/2003	2.53	0.137	1	µg/L
30MW0583C	WG	SW8260B	TETRACHLOROETHENE (PCE)	86.5	10/24/2003	BRL	0.421	1	µg/L
30MW0583C	WG	SW8260B	TETRACHLOROETHENE (PCE)	86.5	5/13/2004	1.3	0.16	1	µg/L
30MW0583C	WG	SW8260B	TETRACHLOROETHENE (PCE)	86.5	11/10/2004	BRL	0.18	1	µg/L
30MW0583C	WG	SW8260B	TETRACHLOROETHENE (PCE)	86.5	11/10/2004	BRL	0.18	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	8/12/1997	11	0.62	2	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	7/12/1999	ND	0.35	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	9/27/1999	ND	0.12	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	1/26/2000	ND	0.12	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	3/27/2000	ND	0.09	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	6/28/2000	ND	0.09	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	9/27/2000	ND	0.09	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	12/21/2000	ND	0.09	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	4/3/2001	BRL	0.09	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	5/29/2001	BRL	0.18	2	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	10/1/2001	ND	0.3	2	µg/L
30MW0583C	WG	SW8260	TRICHLOROETHENE (TCE)	86.5	4/5/2002	BRL	0.138	1	µg/L
30MW0583C	WG	SW8260	TRICHLOROETHENE (TCE)	86.5	10/29/2002	BRL	0.138	1	µg/L
30MW0583C	WG	SW8260B	TRICHLOROETHENE (TCE)	86.5	4/14/2003	BRL	0.203	1	µg/L
30MW0583C	WG	SW8260B	TRICHLOROETHENE (TCE)	86.5	10/24/2003	BRL	0.24	1	µg/L
30MW0583C	WG	SW8260B	TRICHLOROETHENE (TCE)	86.5	5/13/2004	BRL	0.14	1	µg/L
30MW0583C	WG	SW8260B	TRICHLOROETHENE (TCE)	86.5	11/10/2004	ND	0.11	1	µg/L
30MW0583C	WG	SW8260B	TRICHLOROETHENE (TCE)	86.5	11/10/2004	ND	0.11	1	µg/L
30MW0583D	WG	CVOL	TETRACHLOROETHENE (PCE)	55.5	8/13/1997	ND	0.41	1	µg/L
30MW0583D	WG	CVOL	TETRACHLOROETHENE (PCE)	55.5	7/12/1999	ND	0.22	1	µg/L
30MW0583D	WG	CVOL	TRICHLOROETHENE (TCE)	55.5	8/13/1997	ND	0.62	1	µg/L
30MW0583D	WG	CVOL	TRICHLOROETHENE (TCE)	55.5	7/12/1999	ND	0.35	1	µg/L
30MW0583E	WG	CVOL	TETRACHLOROETHENE (PCE)	10.5	8/13/1997	ND	0.41	1	µg/L
30MW0583E	WG	CVOL	TETRACHLOROETHENE (PCE)	10.5	7/12/1999	ND	0.22	1	µg/L
30MW0583E	WG	CVOL	TRICHLOROETHENE (TCE)	10.5	8/13/1997	ND	0.62	1	µg/L
30MW0583E	WG	CVOL	TRICHLOROETHENE (TCE)	10.5	7/12/1999	ND	0.35	1	µg/L

Data Source: AFCEE-MMR Data Warehouse, May 2012

Key:

BRL = below laboratory reporting limit µg/L = micrograms per liter
DL = detection limit RL = laboratory reporting limit
ND = non detect WG = groundwater sample

Mr. Doug Scott
CH2M Hill
1748 West Truck Road/Otis ANG Base
Buzzards Bay MA 02542

June 6, 2013

SAMPLE DATA

CLIENT SAMPLE ID

Project Name: MMR 2013/05 LUC CS-10, CS-21, AV

Project Number: 437075.05.07.18

Field Sample ID: CHPE0533CU-O0513

Lab Sample ID: 75664-1
Matrix: Aqueous
Percent Solid: N/A
Dilution Factor: 1
Collection Date: 05/30/13
Lab Receipt Date: 05/31/13
Analysis Date: 06/05/13

ANALYTICAL RESULTS VOLATILE ORGANICS

COMPOUND	Detection Limit µg/L	Quantitation Limit µg/L	Result µg/L	COMPOUND	Detection Limit µg/L	Quantitation Limit µg/L	Result µg/L
1,1,1-Trichloroethane	0.18	1.0	U	Toluene	0.20	1.0	U
1,1-Dichloroethane	0.20	1.0	U	trans-1,2-Dichloroethene	0.20	1.0	U
1,2,4-Trichlorobenzene	0.21	1.0	U	trans-1,3-Dichloropropene	0.10	1.0	U
1,2-Dibromo-3-chloropropane	0.50	1.0	U	Trichloroethene	0.20	1.0	U
1,2-Dichlorobenzene	0.16	1.0	U	1,1,2,2-Tetrachloroethane	0.13	1.0	U
1,3-Dichlorobenzene	0.20	1.0	U	1,1,2-Trichloroethane	0.11	1.0	U
1,4-Dichlorobenzene	0.19	1.0	U	1,1-Dichloroethene	0.13	1.0	U
Benzene	0.20	1.0	U	1,2-Dibromoethane	0.15	1.0	U
Bromochloromethane	0.20	1.0	U	1,2-Dichloroethane	0.50	1.0	U
Chlorobenzene	0.17	1.0	U	1,2-Dichloropropane	0.50	1.0	U
Chloroform	0.20	1.0	U	Bromodichloromethane	0.15	1.0	U
cis-1,2-Dichloroethene	0.20	1.0	U	Bromoform	0.12	1.0	U
cis-1,3-Dichloropropene	0.10	1.0	U	Bromomethane	0.50	1.0	U
Ethylbenzene	0.20	1.0	U	Carbon Tetrachloride	0.20	1.0	U
Methylene Chloride	1.0	2.0	U	Chloroethane	0.50	1.0	U
o-Xylene	0.20	1.0	U	Chloromethane	0.20	1.0	U
m,p-Xylene	0.40	1.0	U	Dibromochloromethane	0.15	1.0	U
Styrene	0.20	1.0	U	Methyl-tert-butyl ether (MTBE)	0.20	1.0	U
Tetrachloroethene	0.19	1.0	U	Vinyl chloride	0.20	1.0	U
Surrogate Standard Recovery							
Bromofluorobenzene	100%			d4-1,2-Dichloroethane	102%		
				d8-Toluene	101%		
U=Undetected J=Estimated E=Exceeds Calibration Range B=Detected in Blank							

METHODOLOGY: Sample analysis was conducted according to: Test Methods for Evaluating Solid Waste, SW-846 Method 8260B.

COMMENTS:

Authorized signature

**Summary of Groundwater Monitoring Results for Manganese
RS0533CURR**

Location	Matrix	Test	Analyte	Date	Result	DL	RL	Units
RS0533CURR	WG	SW6010B	MANGANESE	5/30/2013	ND	2.8	15	µg/L

Data Source: AFCEC-MMR Data Warehouse, July 2013

Key:

DL = detection limit

ND = non detect

RL = reporting limit

WG = groundwater

µg/L = micrograms per liter

WELL DETERMINATION

ADDRESS: 74 Round Pond Drive, Falmouth MA

APEMS ID: 43579

WELL STATUS: ACTIVE

WELL USE: Irrigation/outdoor use

SUMMARY: According to the property owner response, which is provided in the parcel summary report (attached), this residence is connected to the Falmouth municipal water supply. This residence receives a water bill from the Town of Falmouth. However, there is one private well located on this property that was restarted in 2013 and is used for outdoor purposes. The depth of this private well is unknown.

DATA REVIEW:

- ☒ SPEIM monitoring data are available in the vicinity of this well [see attached map].
 - 69DP0124 [vertical profile data]
 - 69DP0135 [vertical profile data]
 - 69DP0146 [vertical profile data]
 - 69MW0032B [vertical profile and monitoring data], [Figure 9 attached]
 - 69MW0028A/69DP0141 (Vertical profile and monitoring data)
 - Water table is approximately 23 ft bgs (i.e., 19 ft msl).
- ☒ Groundwater vertical profiling was completed at several locations in the vicinity of 74 Round Pond Drive (69DP0124, 69DP0135, 69DP0146, 69MW0032B, and 69MW0028A). 74 Round Pond Drive is located approximately 180 feet to the west and outside of the FS-28 plume. The results of groundwater vertical profiling (table attached) indicate that the top of the FS-28 plume near Round Pond Drive is at approximately -70 ft msl (93 feet below the water table). Groundwater monitoring wells are in place to monitor the location of the plume.
- ☒ Sampling results are available for this private well. A groundwater sample was collected from this private well in July 2013. No EDB was detected (laboratory report attached). This well was also sampled ten times between 1997 and 2001. No EDB was detected (table attached).

DETERMINATION: This property is located approximately 180 feet west of the FS-28 leading edge portion of the plume. The depth of this private well is not known, however no EDB has been detected in groundwater samples collected from this private well. Due to the relative distance of this well from the FS-28 plume intermittent use of this well for outdoor use is not expected to draw in groundwater with EDB concentrations greater than the MMCL.

PATH FORWARD: No further evaluation or sampling is required.

SAMPLING NEEDED: ☐ Yes ☒ No

RE-EVALUATE IN NEXT 5-YEAR REVIEW: ☒ Yes ☐ No



AFCEC MMR Land Use Controls Parcel Summary

Report Produced: 9/20/2013

Name: SAVAGE DAVID L

Plume: FS28

Telephone No.

Mailing Address

Town Numbers

AFCEE Plume: FS28

Map: 21 **Section:** 04 **Parcel:** 003 **Lot:** 95R

Mailing PO:

Mailing Street: 74 ROUND POND DR

Mailing City: EAST FALMOUTH

Mailing State: MA

Mailing ZIP: 02536-4737

Residential Well Notes: The property owner indicated in 2013 that this well has been restarted for intermittent outdoor use.

Irrigation Well Notes: Well has been reactivated per owner's email response. Owner states it is used only for outdoor irrigation purposes. This is a change from prior survey response. Private well sampled by AFCEC for EDB analysis on 08 July 2013.

Parcel Address

APEMS ID: 43579

Parcel Street: 74 ROUND POND DR

Parcel City: Falmouth

Parcel State:

Parcel ZIP:

Town Water Notes: Existing Town of Falmouth water account (May 2007)

Other Notes:

☐ Checked if the parcel respond to the state's 5-Star survey.

☐ Checked if AFCEE has been in contact with the parcel and no contact is needed.

Initial Mailing Sent? ☒

Date Sent: 4/27/2009

Date Returned: 5/6/2009

Second Mailing Sent? ☐

Date Sent:

Date Returned:

Third Mailing Sent? ☐

Date Sent:

Date Returned:

Contacted by Phone? ☐

Date Contacted:

Contact Note:

Contacted by Email? ☐

Email Date:

Date Returned::

Contacted In-Person? ☐

Date Contacted:

Field Visit Performed? ☐

Field Visit Date:

Field Visit Note:

Other Contact Notes:

Wells associated with this parcel:

LocID

Functional? ☒

Depth 0

Decomissioned? ☐

Well Deemed Safe? ☐

Non-Functional? ☐

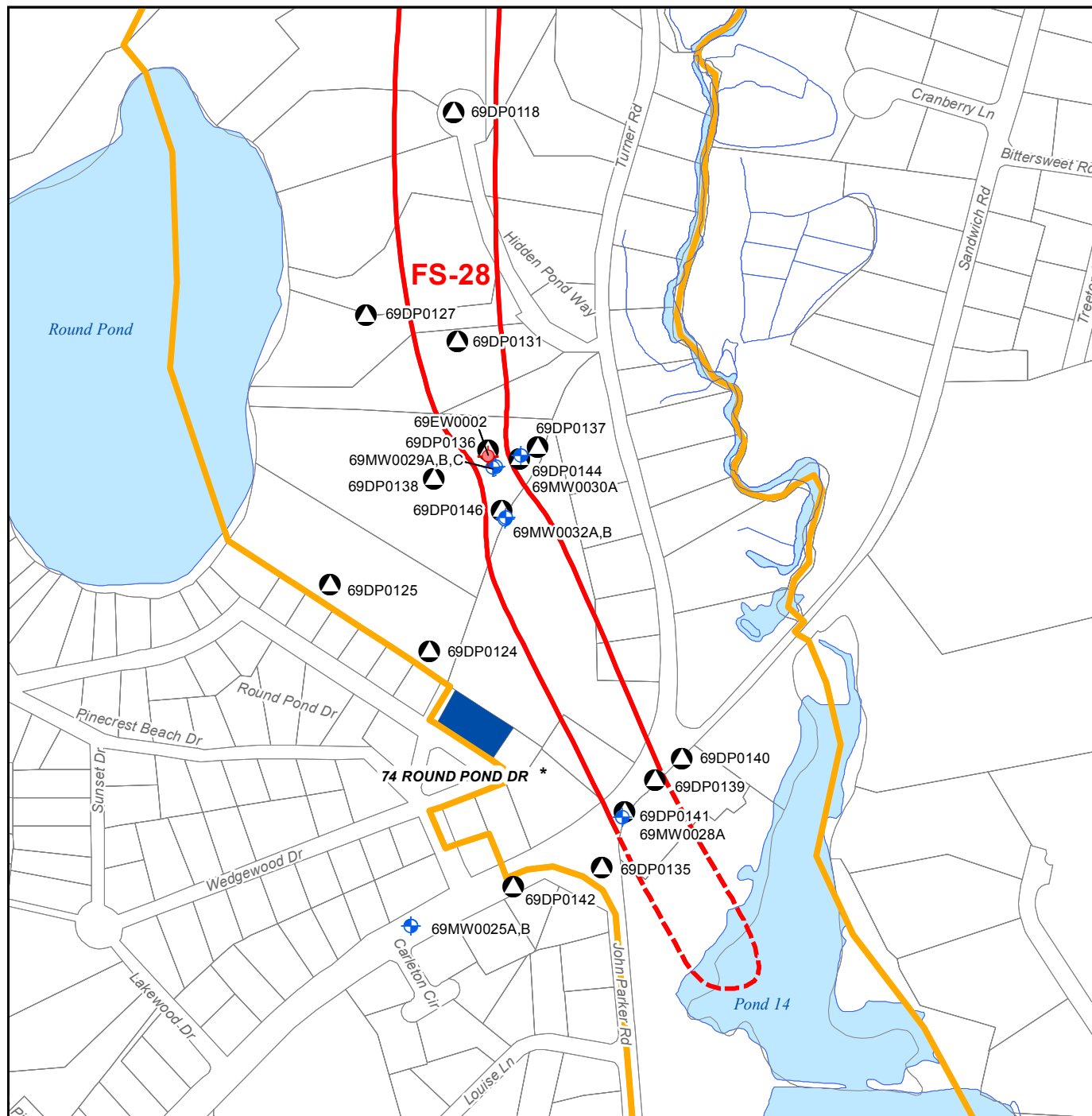
Pump Rate 0

Decomission Offer Made? ☐

Date:

Other Status?

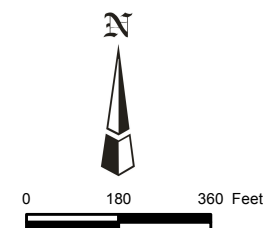
Decomission Offer Received? ☐



Legend

- Plume Boundary
- LUC Area
- Parcel of Interest *
- Other Parcel
- + Monitoring Well
- + Extraction Well
- + Borehole

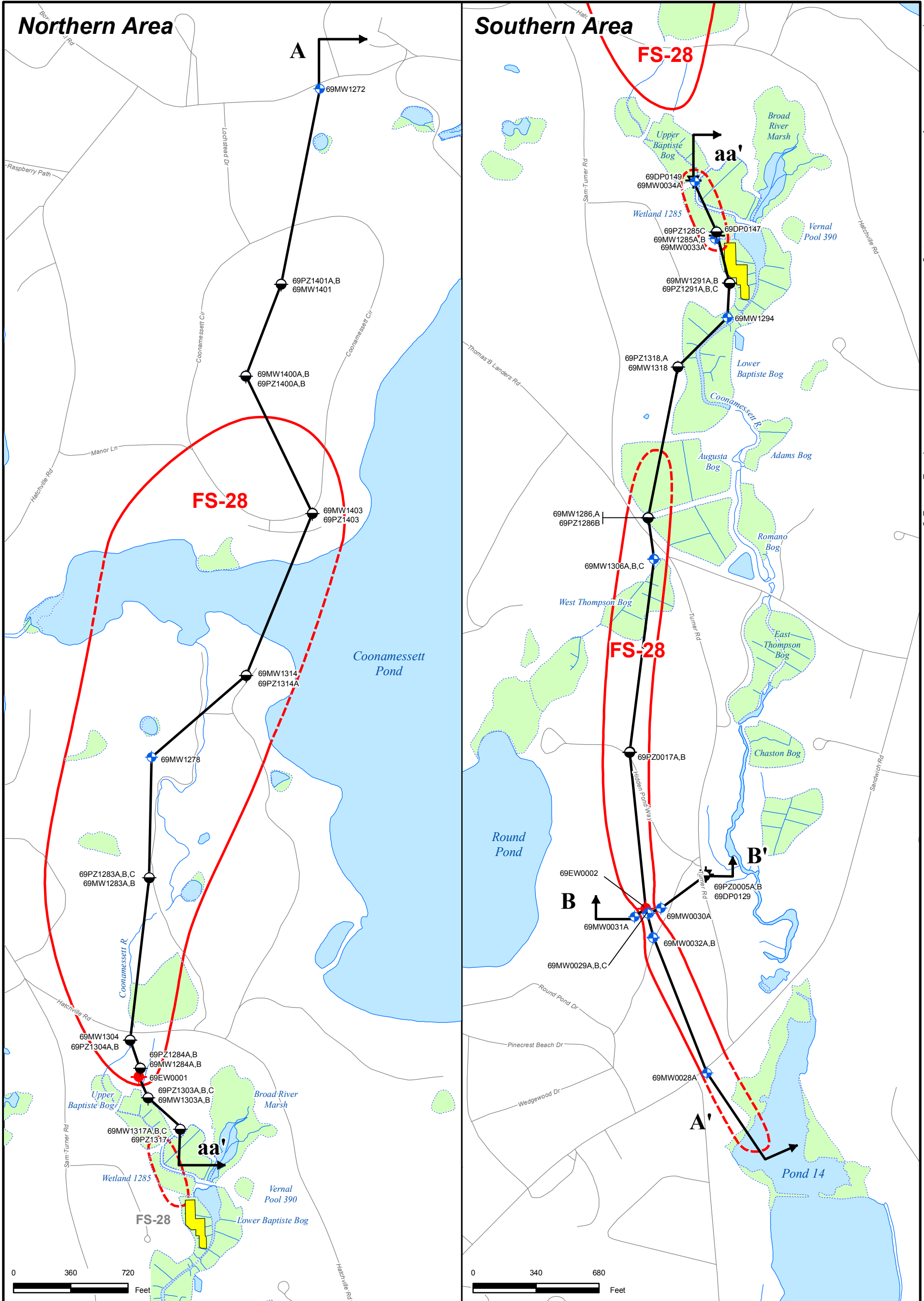
* Note: Private Well Sampled in 2013



Data Source: AFCEC, MMR-AFCEC Data Warehouse

LOCATION: 74 ROUND POND DR

AFCEC - Massachusetts Military Reservation
FS-28 Land Use Control



Data Source: AFCEE, March 2010, MMR-AFCEE Data Warehouse

Legend

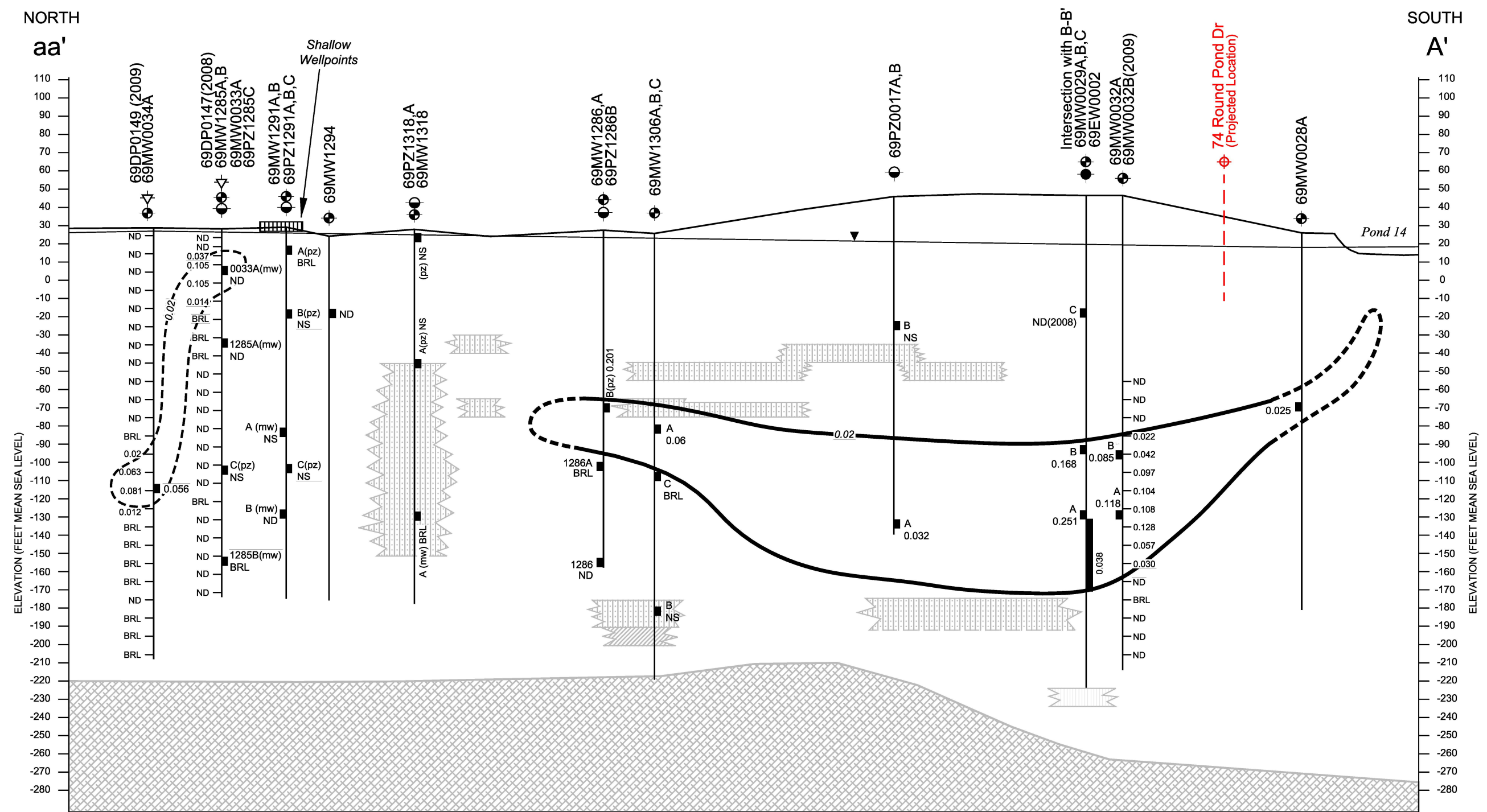
- Direct Push Location
- Extraction Well
- Monitoring Well
- Piezometer
- Shallow Wellpoints
- Transect
- FS-28 2009 EDB Plume Boundary (Dashed Where Inferred)
- Bog/Wetland

FIGURE A-1

FS-28 PLUME AND LOCATION OF CROSS-SECTION LINES

AFCEE - Massachusetts Military Reservation
Fuel Spill-28 and Southwest Plumes 2011 Private Well Verification and Well Determination Project Note

CH2MHILL



Data Source: AFCEE, September 2009, MMR AFCEE Data Warehouse

NOTE: Lithology at direct push locations is inferred from purge water observations. Date of borehole screening data is noted on figure.



FIGURE 9

FS-28 CROSS-SECTION aa'-A'

AFCEE-Massachusetts Military Reservation

Conceptual Site Model (Modified With Private Well Location)

Summary of Groundwater Monitoring Results
FS-28 Area

Location	Date	Matrix	Sample Elevation (ft msl)	Analytical Method	EDB Result	DL	RL	Units
69DP0124	9/1/2005	WA	10.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/1/2005	WA	0.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/1/2005	WA	-9.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/6/2005	WA	-19.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/6/2005	WA	-29.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/6/2005	WA	-39.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/6/2005	WA	-49.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/6/2005	WA	-59.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/6/2005	WA	-69.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/6/2005	WA	-79.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/7/2005	WA	-89.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/7/2005	WA	-99.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/7/2005	WA	-109.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/8/2005	WA	-119.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/8/2005	WA	-129.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/24/2006	WA	12.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/24/2006	WA	2.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/24/2006	WA	-7.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/24/2006	WA	-17.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/24/2006	WA	-27.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/24/2006	WA	-37.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/30/2006	WA	-47.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/30/2006	WA	-57.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/30/2006	WA	-67.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/30/2006	WA	-77.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/30/2006	WA	-87.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/30/2006	WA	-97.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/30/2006	WA	-107.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/30/2006	WA	-117.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/31/2006	WA	-127.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/31/2006	WA	-137.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/31/2006	WA	-147.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/31/2006	WA	-157.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/31/2006	WA	-167.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	6/1/2006	WA	-177.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	6/1/2006	WA	-187.5	E504.1	ND	0.002	0.01	µg/L
69DP0141	3/15/2007	WA	8.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/15/2007	WA	-1.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/15/2007	WA	-11.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/19/2007	WA	-21.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/19/2007	WA	-31.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/19/2007	WA	-41.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/19/2007	WA	-51.5	E504.1	BRL	0.003	0.01	µg/L
69DP0141	3/19/2007	WA	-61.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/19/2007	WA	-71.5	E504.1	0.093	0.003	0.01	µg/L
69DP0141	3/19/2007	WA	-81.5	E504.1	0.035	0.003	0.01	µg/L
69DP0141	3/19/2007	WA	-91.5	E504.1	0.011	0.003	0.01	µg/L
69DP0141	3/21/2007	WA	-101.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/21/2007	WA	-111.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/21/2007	WA	-121.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/22/2007	WA	-131.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/22/2007	WA	-141.5	E504.1	ND	0.003	0.01	µg/L

Summary of Groundwater Monitoring Results
FS-28 Area

Location	Date	Matrix	Sample Elevation (ft msl)	Analytical Method	EDB Result	DL	RL	Units
69DP0141	3/22/2007	WA	-151.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/22/2007	WA	-161.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/23/2007	WA	-171.5	E504.1	ND	0.003	0.01	µg/L
69DP0146	9/6/2007	WA	13.5	E504.1	ND	0.002	0.01	µg/L
69DP0146	9/6/2007	WA	3.5	E504.1	ND	0.002	0.01	µg/L
69DP0146	9/6/2007	WA	-6.5	E504.1	ND	0.002	0.01	µg/L
69DP0146	9/6/2007	WA	-16.5	E504.1	ND	0.002	0.01	µg/L
69DP0146	9/6/2007	WA	-26.5	E504.1	ND	0.002	0.01	µg/L
69DP0146	9/6/2007	WA	-36.5	E504.1	ND	0.002	0.01	µg/L
69DP0146	9/6/2007	WA	-46.5	E504.1	ND	0.002	0.01	µg/L
69DP0146	9/7/2007	WA	-56.5	E504.1	ND	0.002	0.01	µg/L
69DP0146	9/7/2007	WA	-66.5	E504.1	ND	0.002	0.01	µg/L
69DP0146	9/7/2007	WA	-76.5	E504.1	ND	0.002	0.01	µg/L
69DP0146	9/7/2007	WA	-86.5	E504.1	BRL	0.002	0.01	µg/L
69DP0146	9/7/2007	WA	-96.5	E504.1	0.084	0.002	0.01	µg/L
69DP0146	9/7/2007	WA	-106.5	E504.1	0.124	0.002	0.01	µg/L
69DP0146	9/7/2007	WA	-116.5	E504.1	0.386	0.002	0.01	µg/L
69DP0146	9/7/2007	WA	-126.5	E504.1	0.334	0.002	0.01	µg/L
69DP0146	9/10/2007	WA	-136.5	E504.1	0.316	0.002	0.01	µg/L
69DP0146	9/10/2007	WA	-146.5	E504.1	0.332	0.002	0.01	µg/L
69DP0146	9/10/2007	WA	-156.5	E504.1	0.18	0.002	0.01	µg/L
69DP0146	9/10/2007	WA	-166.5	E504.1	0.144	0.002	0.01	µg/L
69DP0146	9/10/2007	WA	-176.5	E504.1	0.092	0.002	0.01	µg/L
69DP0146	9/10/2007	WA	-186.5	E504.1	0.012	0.002	0.01	µg/L
69DP0146	9/11/2007	WA	-196.5	E504.1	ND	0.002	0.01	µg/L
69DP0146	9/11/2007	WA	-206.5	E504.1	ND	0.002	0.01	µg/L
69MW0028A	10/30/2007	WG	-69.83	E504.1	0.03	0.002	0.01	µg/L
69MW0028A	8/26/2008	WG	-69.83	E504.1	0.015	0.002	0.01	µg/L
69MW0028A	4/8/2009	WG	-69.83	E504.1	0.025	0.002	0.01	µg/L
69MW0028A	2/2/2010	WG	-69.83	E504.1	0.103	0.003	0.01	µg/L
69MW0028A	2/18/2011	WG	-69.83	E504.1	0.011	0.005	0.01	µg/L
69MW0028A	2/15/2012	WG	-69.83	E504.1	ND	0.005	0.01	µg/L
69MW0028A	1/30/2013	WG	-69.83	E504.1	ND	0.005	0.01	µg/L
69MW0032A	10/30/2007	WG	-129.16	E504.1	0.404	0.004	0.02	µg/L
69MW0032A	8/26/2008	WG	-129.16	E504.1	0.046	0.002	0.01	µg/L
69MW0032A	4/7/2009	WG	-129.16	E504.1	0.118	0.002	0.01	µg/L
69MW0032A	8/18/2009	WG	-129.16	E504.1	0.056	0.003	0.01	µg/L
69MW0032A	1/13/2010	WG	-129.16	E504.1	0.059	0.003	0.01	µg/L
69MW0032A	5/27/2010	WG	-129.16	E504.1	ND	0.005	0.01	µg/L
69MW0032A	7/12/2010	WG	-129.16	E504.1	ND	0.005	0.01	µg/L
69MW0032A	2/18/2011	WG	-129.16	E504.1	ND	0.005	0.01	µg/L
69MW0032A	8/15/2011	WG	-129.16	E504.1	ND	0.005	0.01	µg/L
69MW0032A	2/15/2012	WG	-129.16	E504.1	ND	0.005	0.01	µg/L
69MW0032A	1/30/2013	WG	-129.16	E504.1	BRL	0.005	0.01	µg/L
69MW0032A	5/30/2013	WG	-129.16	E504.1	0.016	0.005	0.01	µg/L
69MW0032B	4/14/2009	WA	-56.59	E504.1	ND	0.002	0.01	µg/L
69MW0032B	4/14/2009	WA	-66.59	E504.1	ND	0.002	0.01	µg/L
69MW0032B	4/14/2009	WA	-76.59	E504.1	ND	0.002	0.01	µg/L
69MW0032B	4/14/2009	WA	-86.59	E504.1	0.022	0.002	0.01	µg/L
69MW0032B	4/14/2009	WA	-96.59	E504.1	0.042	0.002	0.01	µg/L
69MW0032B	4/14/2009	WA	-106.59	E504.1	0.097	0.002	0.01	µg/L
69MW0032B	4/15/2009	WA	-116.59	E504.1	0.104	0.002	0.01	µg/L

Summary of Groundwater Monitoring Results

FS-28 Area

Location	Date	Matrix	Sample Elevation (ft msl)	Analytical Method	EDB Result	DL	RL	Units
69MW0032B	4/15/2009	WA	-126.59	E504.1	0.108	0.002	0.01	µg/L
69MW0032B	4/15/2009	WA	-136.59	E504.1	0.128	0.002	0.01	µg/L
69MW0032B	4/16/2009	WA	-146.59	E504.1	0.057	0.002	0.01	µg/L
69MW0032B	4/16/2009	WA	-156.59	E504.1	0.03	0.002	0.01	µg/L
69MW0032B	4/17/2009	WA	-166.59	E504.1	ND	0.002	0.01	µg/L
69MW0032B	4/17/2009	WA	-176.59	E504.1	BRL	0.002	0.01	µg/L
69MW0032B	4/17/2009	WA	-186.59	E504.1	ND	0.002	0.01	µg/L
69MW0032B	4/20/2009	WA	-196.59	E504.1	ND	0.002	0.01	µg/L
69MW0032B	4/20/2009	WA	-206.59	E504.1	ND	0.002	0.01	µg/L
69MW0032B	6/8/2009	WG	-96.47	E504.1	0.085	0.003	0.01	µg/L
69MW0032B	8/18/2009	WG	-96.47	E504.1	0.123	0.003	0.01	µg/L
69MW0032B	1/13/2010	WG	-96.47	E504.1	0.033	0.003	0.01	µg/L
69MW0032B	5/6/2010	WG	-96.47	E504.1	ND	0.005	0.01	µg/L
69MW0032B	7/12/2010	WG	-96.47	E504.1	ND	0.005	0.01	µg/L
69MW0032B	2/18/2011	WG	-96.47	E504.1	ND	0.005	0.01	µg/L
69MW0032B	8/15/2011	WG	-96.47	E504.1	ND	0.005	0.01	µg/L
69MW0032B	2/15/2012	WG	-96.47	E504.1	ND	0.005	0.01	µg/L
69MW0032B	1/30/2013	WG	-96.47	E504.1	0.155	0.005	0.01	µg/L
69MW0032B	5/30/2013	WG	-96.47	E504.1	0.224	0.005	0.01	µg/L

Data Source: AFCEC-MMR Data Warehouse, July 2013

Key:

BRL = below reporting limit

DL = detection limit

ft msl = feet mean sea level

ND = non detect

µg/L = micrograms per liter

RL = reporting limit

WG = groundwater sample

WA = groundwater vertical profiling sample

Project Name: 07 LUC FS-28/CFIG**Lab Number:** L1312714**Project Number:** 437075.05.07.18**Report Date:** 07/10/13**SAMPLE RESULTS**

Lab ID: L1312714-01
 Client ID: CHPL00074RO-O0713
 Sample Location: MMR 2013
 Matrix: Water
 Analytical Method: 14,504.1
 Analytical Date: 07/10/13 01:03
 Analyst: SR

Date Collected: 07/08/13 10:15
 Date Received: 07/09/13
 Field Prep: Not Specified
 Extraction Date: 07/09/13 18:50

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Microextractables by GC - Westborough Lab						
1,2-Dibromoethane	ND		ug/l	0.010	0.003	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria	Column
1,1,1,2-Tetrachloroethane	109		80-120	A

Private Well Sampling Results
74 Round Pond Drive

Location	Date	Test	Analyte	Result	DL	RL	Units
RS0074ROPO	4/17/1997	E504	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.0044	0.02	µg/L
RS0074ROPO	9/17/1997	E504	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.006	0.01	µg/L
RS0074ROPO	6/22/1998	E504	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.0047	0.01	µg/L
RS0074ROPO	9/22/1998	E504	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.0047	0.01	µg/L
RS0074ROPO	5/7/1999	E504	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.0027	0.01	µg/L
RS0074ROPO	10/6/1999	E504	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.0027	0.01	µg/L
RS0074ROPO	5/18/2000	E504	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.0051	0.01	µg/L
RS0074ROPO	8/29/2000	E504	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.0051	0.01	µg/L
RS0074ROPO	6/4/2001	E504	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L
RS0074ROPO	9/27/2001	E504	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.0039	0.01	µg/L

Data Source: AFCEC-MMR Data Warehouse, July 2013

Key:

DL = detection limit

ND = non detect

RL = reporting limit

µg/L = micrograms per liter

APPENDIX D



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

Charles D. Baker
Governor

Karyn E. Polito
Lieutenant Governor

Matthew A. Beaton
Secretary

Martin Suuberg
Commissioner

August 20, 2018

Ms. Rose H. Forbes, P.E.
Remediation Program Manager
HQ AFCEC/JBCC
322 East Inner Road
Otis ANG Base, Massachusetts 02542

RE: **BOURNE**
Release Tracking Number: 4-0000037
Joint Base Cape Cod
Draft 5th Five Year Review 2012-2017,
Joint Base Cape Cod (JBCC) Superfund
Site Otis Air National Guard Base, MA;
Concurrence

Dear Ms. Forbes:

The Massachusetts Department of Environmental Protection (MassDEP) has reviewed the document entitled **"Memorandum of Resolution for the Draft 5th Five Year Review, 2012-2017 Joint Base Cape Cod (JBCC) Superfund Site Otis Air National Guard Base, MA"** (the MOR) dated August 8, 2018. The MOR has been generated by the Air Force Civil Engineer Center (AFCEC) to address additional comments received to the Responses to Comments on the Draft Five Year Review from MassDEP dated 6 August 2018 and discussed during a resolution meeting with MassDEP and EPA on 7 August 2018.

MassDEP concurs with the MOR.

Please incorporate this letter into the Administrative Record for the AFCEC Installation Restoration Program Five Year Review Program at JBCC. If you have any questions regarding this letter, please contact Ellie Donovan at (508) 946-2866.

Sincerely,

Leonard J. Pinaud, Chief,
Federal Site Management
Bureau of Waste Site Cleanup

P/ed

Ec: Upper Cape Boards of Selectmen
Upper Cape Boards of Health

This information is available in alternate format. Contact Michelle Waters-Ekanem, Director of Diversity/Civil Rights at 617-292-5751.

TTY# MassRelay Service 1-800-439-2370

MassDEP Website: www.mass.gov/dep

Printed on Recycled Paper

JBCC Cleanup Team
MassDEP Southeast Regional Office



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Region 1

5 Post Office Square, Suite 100
BOSTON, MA 02109

July 31, 2018

Rose H. Forbes, P.E.
Remediation Program Manager
HQ AFCEC/JBCC
322 East Inner Road
Otis ANG Base, MA 02542-5028

Re: *Draft 5th Five Year Review, 2012-2017, Joint Base Cape Cod (JBCC) Superfund Site Otis Air National Guard Base*

Dear Ms. Forbes:

EPA has completed its review of the response to comments letter dated July 26, 2018 on the *Draft 5th Five Year Review, 2012-2017, Joint Base Cape Cod (JBCC) Superfund Site Otis Air National Guard Base* dated June 2018.

EPA finds the responses to be acceptable and approves finalization of the document. We look forward to working with your office in implementing the recommendations and request submission of the final document at the earliest convenience.

Please contact me at (617) 918-1392 should you have any questions.

Sincerely,

A handwritten signature in black ink, appearing to read "Robert Lim", is written over a horizontal line.

Robert Lim, Remedial Project Manager
Federal Facilities Superfund Section

cc: Anni Loughlin/EPA
Len Pinaud/MassDEP

APPENDIX E

Risk Based Concentration Summary
Final 5th Five-Year Review, 2012-2017

Site	Chemical	Limit Type	Old Limit (ug/L)	New Limit (ug/L)	References
Ashumet Valley	Mn	HA	300	300	Verified with 2018 EPA drinking water standards
CS-19	RDX	RBL	0.6	0.7	Tapwater SSL from 11-2017 RSLs
FS-1	EDB	RBC	6.5	328	Recalculated with new slope factors from IRIS (11/2017)
FS-13	TMB	RBC	19	1,2,4-TMB (56 ug/); 1,35-TMB (60 ug/L)	EPA issued noncancer child resident tap water RSLs for for 1,2,4-TMB and 1,3,5-TMB since the last five year review (EPA 2016).
FTA-2	TMB	RBC	19	1,2,4-TMB (56 ug/); 1,35-TMB (60 ug/L)	EPA issued noncancer child resident tap water RSLs for for 1,2,4-TMB and 1,3,5-TMB since the last five year review (EPA 2016).
PFSA	TMB	RBC	19	1,2,4-TMB (56 ug/); 1,35-TMB (60 ug/L)	EPA issued noncancer child resident tap water RSLs for for 1,2,4-TMB and 1,3,5-TMB since the last five year review (EPA 2016).

Key:

CS = Chemical Spill

EDB = ethylene dibromide

EPA = Environmental Protection Agency

FS = Fuel Spill; Feasibility Study

FTA = fire training area

PFSA = Petroleum Fuel Storage Area

Mn = manganese

RDX = Royal Demolition Explosive or hexahydro-1,3,5-trinitro-1,3,5-triazine

RBC = risk based concentration

Rfd = reference dose

TMB = trimethylbenzene

ug/L = micrograms per liter

EPA (March) 2018. 2018 Edition of the Drinking Water Standards and Health Advisories Tables

EPA (November 2017). Regional Screening Level (RSL) Resident Tapwater Table (TR=1E-06, HQ=1)

EPA (September) 2016. Toxicological Review of Trimethylbenzenes: Executive Summary