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Massachusetts Military Reservation

PLUME RESPONSE PROGRAM

Final Record of Decision for the Fuel Spill-28 and Fuel Spill-29 Plumes

October 2000

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ACRONYMS AND ABBREVIATIONS

AFCEE	Air Force Center for Environmental Excellence
AOC	area of concern
APCC	Association for the Preservation of Cape Cod
ARAR	applicable or relevant and appropriate requirement
CCl_4	carbon tetrachloride
CDI	chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Identification System
CFR	Code of Federal Regulations
CMR	Code of Massachusetts Regulations
COC	contaminant of concern
COPC	contaminant of potential concern
CS-#	chemical spill, as in CS-4
CT	central tendency
CWMA	Francis A. Crane Wildlife Management Area
CWSW	Coonamessett Water Supply Well
DA	dermally absorbed
DEP	Massachusetts Department of Environmental Protection
DOD	U.S. Department of Defense
EDB	ethylene dibromide, 1,2-dibromoethane
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ETR	extraction, treatment, and reinjection

EW	extraction well
FFA	federal facility agreement
FS-#	fuel spill, as in FS-13
ft	feet
HEAST	health effects assessment summary table
HI	hazard index
HQ	hazard quotient
IRIS	Integrated Risk Information System
IROD	Final Record of Decision for Interim Action
IRP	Installation Restoration Program
JPAT	Joint Process Action Team
K	hydraulic conductivity
kg	kilogram
LF-#	landfill, as in Landfill-1
MCL	maximum contaminant level
mg	milligram
MMCL	Massachusetts maximum contaminant level
MMR	Massachusetts Military Reservation
msl	mean sea level
NCP	National Oil and Hazardous Substances Contingency Plan
NGB	National Guard Bureau
NPL	National Priorities List
O&M	operations and maintenance
PVC	polyvinyl chloride
RAGS	Risk Assessment Guidance for Superfund

RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI	remedial investigation
RME	reasonable maximum exposure
ROD	record of decision
SARA	Superfund Amendment and Reauthorization Act
SDI	subchronic daily intake
SF	slope factor
SWOU	Southwest Operable Unit
TIC	total installed cost
USCG	U.S. Coast Guard
UCL	upper confidence level
VOC	volatile organic compound
µg/L	micrograms per liter

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1.0 DECLARATION

1.1 SITE NAME AND LOCATION

The Massachusetts Military Reservation (MMR) on Cape Cod Massachusetts lies within the boundaries of the towns of Bourne, Mashpee, and Sandwich, and abuts the town of Falmouth. This site is listed on the National Priority List as Otis Air National Guard/Camp Edwards in Falmouth, Massachusetts. This Record of Decision (ROD) addresses the Fuel Spill-28 (FS-28) and Fuel Spill-29 (FS-29) plumes that lie within the Southwest Operable Unit (SWOU). The Comprehensive Environmental Response, Compensation and Liability Identification System (CERCLIS) number for the site is MA2570024487.

1.2 STATEMENT OF BASIS AND PURPOSE

This ROD presents the selected remedies for the SWOU FS-28 and FS-29 plumes at MMR. These remedies were chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendment and Reauthorization Act (SARA), and to the extent practicable, the National Oil and Hazardous Substances Contingency Plan (NCP). This decision is based on the administrative record for this site.

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

1.3 ASSESSMENT OF THE SITE

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

1.4 SIGNIFICANT CHANGES SINCE ISSUANCE OF THE PROPOSED PLAN

The *Proposed Plan for the FS-28 and FS-29 Plumes in the Southwest Operable Unit* was released for public comment in February 2000. The Proposed Plan identified Alternative 7 as AFCEE's preferred alternative for the FS-28 plume. In addition to continued operation of the existing treatment system, this alternative included the design and construction of an additional groundwater extraction, treatment, and discharge system in the middle of the FS-28 plume to reduce aquifer restoration time, provided that such construction was implementable and publicly acceptable. AFCEE's preferred alternative for the FS-29 plume was Alternative 7 and included the design and construction of a groundwater extraction, treatment, and reinjection (ETR) system to capture the central portion of the FS-29 plume.

AFCEE, EPA, and DEP reviewed all written and verbal comments submitted during the public comment period. After consideration of these comments, AFCEE and EPA, in consultation with DEP, agreed that different alternatives (which were presented and evaluated in the feasibility study) should be selected in lieu of those in the Proposed Plan. For the FS-28 plume, the selected remedy is Alternative 3 rather than the proposed Alternative 7. Alternative 3 does not include the design and construction of an additional groundwater extraction, treatment, and discharge system in the middle of the FS-28 plume to reduce aquifer restoration time. The selected remedy for the FS-28 plume includes optimization of the existing treatment system to ensure that cleanup goals are achieved. For the FS-29 plume, the selected remedy is also Alternative 3 rather than the proposed Alternative 7. Alternative 3 for the FS-29 plume includes the design and construction of a groundwater ETR system to capture the entire plume, not just the central portion of the plume as had been proposed under Alternative 7.

1.4.1 Rationale for the Change from Alternative 7 to Alternative 3 for the FS-28 Plume

Numerous factors were considered in changing the preferred alternative for the FS-28 plume. Most of the public input received during the public comment period indicated a preference for Alternative 3. Alternative 3 would not involve any potential ecological

harm to the Souza Conservation Area and its natural resources. Alternative 3 would also not have the potential to disturb the delicate hydrologic balance in the upper Coonamessett River and adjacent wetland areas, which would have been a potential problem posed by in-plume pumping included in Alternative 7. The public expressed concerns about the potential impact of Alternative 7 on the nearby Coonamessett Water Supply Well. Since Alternative 3 would not involve pumping any additional wells in the body of the plume, potential impacts to this water supply well would not be an issue. Numerous people voiced strong opposition to any alternative that would require extraction wells or treatment systems on residential property. Alternative 3 would not require additional access to private land. Such access would be required to implement Alternative 7.

While Alternative 7 would restore the aquifer in the shortest time frame of all the alternatives considered (nine years as opposed to 18 years for Alternative 3), Alternative 3 nevertheless provides the best balance of trade-offs among the nine criteria established under the National Contingency Plan (40 CFR 300). It is highly protective and effective in the long-term since it will capture over 99 percent of the plume and achieve aquifer restoration within a reasonable time frame without the potential for adverse ecological and hydrological impacts posed by Alternative 7. Moreover, Alternative 3 is both implementable and publicly acceptable.

1.4.2 Rationale for the Change from Alternative 7 to Alternative 3 for the FS-29 Plume

The preferred alternative for the FS-29 plume was also changed in response to public input. Opposition was expressed to AFCEE's preferred alternative (Alternative 7) since it would fail to capture the distal portion of the plume, thus failing to meet AFCEE's stated goal of 100 percent plume capture. Alternative 3 provides for more timely, overall aquifer restoration than Alternative 7 (8 versus 10 years), and does so at little additional cost ($11 million versus $10 million).

Alternative 7 was designed to provide expedited aquifer restoration in the central portion of the plume, which is in close proximity to a potential water supply well site near Ballymeade Estates. However, since the entire FS-29 plume is located within a potential water supply area and the town of Falmouth has limited locations that can be developed to meet its future water supply needs, Alternative 3 is being selected since it restores the entire plume in the shortest time frame.

Finally, AFCEE, EPA, and DEP believe that Alternative 3 provides the best balance of trade-offs among the nine criteria established under the National Contingency Plan. It is highly protective and effective in the long-term since it achieves aquifer restoration within the shortest time frame. Moreover, it is implementable and publicly acceptable.

1.5 DESCRIPTION OF SELECTED REMEDIES

The selected remedies for the FS-28 and FS-29 plumes include the following major components:

FS-28: Continue operation of the extraction, treatment, and discharge system currently in place at the leading edge of the plume to capture ethylene dibromide (EDB) in groundwater before it discharges to surface water in the Coonamessett River and neighboring cranberry bogs. Optimize the system, as necessary, to ensure that cleanup goals are achieved. Continue to maintain the wellhead protection system for the Coonamessett Water Supply Well, maintain the systems the Air Force Center for Environmental Excellence (AFCEE) has installed to separate the bogs affected by EDB-contaminated surface water from the river, and supply uncontaminated water to the agricultural users on the Coonamessett River. Conduct a comprehensive long-term monitoring program for the following purposes: to evaluate treatment system performance, to track the location of contaminant concentrations, to ensure that the system causes no adverse impacts to ecologically sensitive areas, to confirm that there are no detectable concentrations of EDB in the river, and to ensure that the river is not adversely impacted by the discharge of treated water.

FS-29: Conduct additional site characterization and modeling to better understand plume dimensions and hydraulic conditions. Design and construct a groundwater ETR system within the leading portion of the plume to capture EDB and carbon tetrachloride (CCl_4) in groundwater. Conduct long-term monitoring to demonstrate that the selected remedy is effective and protective of human health and the environment.

If, as a result of additional site characterization and modeling, the proposed groundwater ETR system for the FS-29 plume is determined not to be appropriate, the selected remedy will be reviewed. Alternate remedies would then be evaluated to determine which remedy provides the best balance of trade-offs among the nine CERCLA criteria. A new remedy would then be selected by AFCEE and the EPA, with state concurrence and public input.

For both plumes: Institutional controls will be put in place to reduce the risk of current and future exposure to contaminated groundwater in the FS-28 and FS-29 plumes until cleanup levels are attained in the plumes. The Commonwealth of Massachusetts will be responsible for enforcing institutional controls on public water supplies and within the Crane Wildlife Management Area.

The Town of Falmouth will be responsible for implementing and enforcing institutional controls on private wells within the town. The Town of Falmouth Board of Health approved a series of water well regulations at its September 13, 1999 meeting. These regulations require a permit from the Board of Health for the installation and use of all wells, including drinking water wells, irrigation wells, and monitoring wells within the town of Falmouth. Along with other requirements, this regulation states that "A Drinking Water Well must [be] tested for ... volatile organic compounds and found to be within potable water limits as defined in 310 CMR 22.000 Drinking Water Regulations and must not exceed the Commonwealth of Massachusetts' Maximum Contaminant Levels." AFCEE will coordinate with the Falmouth Board of Health periodically (but not less than annually) to ensure the town knows of any changes to the plume configurations and contaminant concentrations.

In addition, if the Board of Health allows the installation of a well above a plume, within 500 feet crossgradient of a plume, or 1500 feet downgradient of a plume, AFCEE would sample this well regularly. Furthermore, AFCEE will regularly sample private wells installed prior to the promulgation of the Board of Health regulations that are over a plume, within 500 feet crossgradient of a plume, or 1,500 feet downgradient of a plume for which public water connections have not been provided. The frequency of residential well sampling will be determined in consultation among AFCEE, health authorities, and the regulatory agencies.

Five-year reviews will be conducted to ensure that the remedies continue to be protective of human health and the environment. The next five-year review is scheduled to occur in 2002.

The selected remedies are one aspect of the overall cleanup strategy for MMR. The overall MMR environmental cleanup program goal for groundwater is 100 percent capture of all plumes above maximum contaminant levels or other risk-based levels and the treatment of contaminants and the cleanup of plumes to background levels if technically and economically feasible. The following three-step process for attaining cleanup goals has been agreed to solely for groundwater cleanup at MMR due to unique circumstances presented by the location of the FS-28 and FS-29 plumes within the sole-source aquifer on Upper Cape Cod. The following steps will be taken for active treatment of the FS-28 and FS-29 plumes:

1. Remediate the aquifer to federal and state drinking water standards or other risk-based cleanup levels.

2. When maximum contaminant levels (MCLs) or Massachusetts maximum contaminant levels (MMCLs) are achieved and before the system is shut off, perform a risk assessment to determine if unacceptable ecological and/or human health risks are present; continue system operation and/or pursue additional measures as required to achieve acceptable risks.

3. Once acceptable risks have been achieved, evaluate the technical and economic feasibility of additional remediation to approach or achieve background concentrations.

There are no ecological receptors identified for the FS-29 plume. The FS-28 plume flows underneath Coonamessett Pond and discharges to the Coonamessett River and surrounding bogs. Potential ecological risks within these water bodies were attributable to metals rather than plume contaminants. Because the metal concentrations present in Coonamessett Pond and Coonamessett River surface water and sediment are generally equivalent to background metals concentrations, remedial action decisions are not driven by the results of the ecological risk assessment, but only by human health risks. Some portions of area groundwater also contain concentrations of metals which could theoretically pose a low-level threat to human health; however, these metals are not mobile. The mobile contamination dissolved in the FS-28 (EDB) and FS-29 (EDB and carbon tetrachloride) plumes poses the principal threat to human health.

1.6 STATUTORY DETERMINATIONS

The selected remedies are protective of human health and the environment, comply with federal and Commonwealth of Massachusetts requirements that are applicable or relevant and appropriate to the remedial action, are cost-effective, and use permanent solutions and alternative treatment technologies to the maximum extent practicable. For the contamination present in the FS-28 and FS-29 plumes, these remedies also satisfy the statutory preference for treatment as a principal element of the remedies (i.e., reduce the toxicity, mobility, or volume of contaminants comprising principal threats through treatment). Because the remedies for both plumes will result in hazardous substances remaining onsite above levels that allow for unlimited use and unrestricted exposure, five-year reviews will be conducted to ensure that the remedies continue to be protective of human health and the environment.

1.7 ROD DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary (Section 2.0) of this record of decision. Additional information can be found in the administrative record for this site.

- Contaminants of concern (COCs) and their respective concentrations (Table 2-1).

- Baseline cancer risks and noncancer hazards attributable to the COCs (Tables 2-7, 2-8).
- Cleanup levels established for COCs and the basis for the levels (Table 2-19).
- Current and future land and groundwater use assumptions used in the baseline risk assessment and ROD (Section 2.6).
- Land and groundwater use that will be available as a result of the selected remedies (Section 2.11.3).
- Estimated capital, operations and maintenance (O&M, and total present worth costs (Table 2-18); discount rate (Section 2.10.1.2); and the number of years that the cost estimates of the remedies are projected (Table 2-20).
- Decisive factors that led to selecting the remedies (Section 2.11).

1.8 AUTHORIZING SIGNATURES

The foregoing represents the decision for remedial action at the FS-28 and FS-29 plumes by AFCEE and the EPA with the concurrence of the DEP.

Concur and recommend for immediate implementation.

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE

By: _____ Date: 16 OCT 2000

Gary M. Erickson, PE
Director

U.S. ENVIRONMENTAL PROTECTION AGENCY

By: _____ Date: 10/23/00

Patricia L. Meaney
Director, Office of Site Remediation and Restoration

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2.0 DECISION SUMMARY

This section describes the setting, potential risks, and remedial action objectives, and evaluates remedial alternatives for the FS-28 and FS-29 groundwater plumes.

2.1 SITE NAME, LOCATION, AND BRIEF DESCRIPTION

MMR, listed on the National Priorities List (NPL) as Otis Air National Guard/Camp Edwards, lies within the towns of Bourne, Mashpee, and Sandwich and abuts the town of Falmouth, Massachusetts (Figure 2-1). The CERCLIS number for the site is MA2570024487. In accordance with Executive Order 12580, DOD is the lead agency for remedial actions at MMR. EPA and DEP are the support agencies for this action. MMR was formally added to the NPL in 1989. The FFA for the site was signed in 1991. In 1995, the FFA was amended to add the U.S. Air Force as the lead agent for the cleanup at MMR. The FFA, as amended, requires the U.S. Air Force to implement CERCLA requirements at MMR.

MMR occupies approximately 22,000 acres on Cape Cod and provides facilities for several operating command units: the Air National Guard, the Army National Guard, the Air Force, the U.S. Coast Guard (USCG), and the Veterans Administration. Past military training and maneuvers, military aircraft operations, and maintenance and support activities have resulted in releases of hazardous materials at MMR.

MMR has a year-round population of approximately 2000, which increases significantly during the summer months when military training activities increase the population by several thousand. Property use in towns surrounding MMR is primarily residential and light industrial.

MMR is located on two distinct sedimentary units that were deposited by a lobe of the Laurentian ice sheet. The majority of MMR lies on a broad, flat, gently southward-sloping glacial outwash plain known as the Mashpee Pitted Plain (Figure 2-2). The Mashpee Pitted Plain consists of stratified outwash sand underlain by either silty

glaciolacustrine sediment, gravel, or basal till. The topography of the Mashpee Pitted Plain gradually slopes from 70 feet above mean sea level (msl) in the south to 140 feet msl in the north and is pocked with numerous kettle ponds. Moraines bound MMR to the west and north. The Buzzards Bay Moraine consists of a north-south ridge of bouldery till overlying reworked drift deposits. The surface of the Buzzards Bay Moraine is hummocky with a complex topography that can vary from approximately 80 to 220 feet msl. There are generally few ponds located within the Buzzards Bay Moraine.

The single groundwater flow system that underlies western Cape Cod, including MMR, is known as the Sagamore Lens. This sole-source aquifer is primarily unconfined and recharged by infiltration of precipitation. Groundwater flow is generally radial from the recharge area toward the ocean, which forms the lateral boundary of the aquifer on three sides; the Bass River in Yarmouth forms the eastern boundary of the Sagamore Lens. Flow direction within the aquifer is generally horizontal with stronger vertical gradients near surface water bodies. Ponds are generally an expression of the water table and are hydraulically connected with the aquifer. Water table elevations fluctuate from one to four feet per year.

2.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES

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

The site history is defined by a series of complex interactions between various federal agencies and the Commonwealth of Massachusetts. These interactions are described in the MMR Strategic Plan (AFCEE 1997). Activities resulting in CERCLA actions are summarized below.

In 1982, the DOD initiated the Installation Restoration Program (IRP) at the Otis Air National Guard Base area of the MMR. The National Guard Bureau (NGB) was responsible for implementing the IRP at MMR. In 1986, the IRP was expanded to include all potential hazardous waste sites at MMR. The IRP investigatory process continued with review and interaction from the DEP. In 1989, MMR was formally added to the NPL. An FFA among the National Guard Bureau, the EPA, and the USCG was signed in 1991. The FFA provides a framework for EPA oversight and enforcement of the MMR investigations and cleanup activities and identifies a schedule for cleanup activities. A Community Relations plan is included as an attachment to the FFA. In 1996, the EPA Region I Administrator requested that DOD provide a new management structure for the MMR IRP. In response to that request, the U.S. Air Force assumed the lead role in the execution of the IRP and assigned AFCEE to manage the program (Amendment 1 to the FFA). Under Amendment 2, additional enforceable milestones and the Plume Response Decision Criteria and Schedule were added to the FFA. More recently, the USCG has been removed from its status as a party to the FFA (Amendment 3 to the FFA). Amendment 4 added Section 7003 of the Resource Conservation and Recovery Act (RCRA) to the FFA in order to address contamination caused solely by petroleum releases that fall within the scope of the CERCLA "petroleum exclusion" described in the last sentence of CERCLA Section 101(14). The EDB contamination being addressed under this ROD is believed to have originated from petroleum releases at MMR and is therefore within the scope of contaminants covered by Amendment 4 to the FFA.

A wide variety of investigations, removal actions, and remedial actions have been and are currently being conducted at MMR. A summary of past investigations and actions is presented in the MMR Strategic Plan (AFCEE 1997). Appendix III, Timetables 2 and 3 of the FFA, presents the schedules for current and planned activities at MMR.

In 1997, AFCEE proposed that the area between the Landfill-1 (LF-1) and Chemical Spill-10 (CS-10) plumes be investigated as a comprehensive groundwater operable unit known as the SWOU (Figure 2-3). This approach allowed AFCEE to simultaneously

address groundwater contamination associated with known source areas and groundwater contamination in the area that had not been linked to any specific source. The LF-1 source and LF-1 and CS-10 plumes have been specifically excluded from the SWOU because they are addressed by other investigations and remedial actions. The *Final SWOU Remedial Investigation* (AFCEE 1999b) contains a detailed description of the contamination present. The SWOU has subsequently been divided into two parts: one consisting of the CS-4, CS-20, CS-21, and FS-13 plumes, and another consisting of the FS-28 and FS-29 plumes. A previous ROD which addressed the CS-4, CS-20, CS-21, and FS-13 plumes (AFCEE 2000b) was issued by AFCEE in February 2000. The *Final FS-28 and FS-29 Groundwater Feasibility Study* (AFCEE 2000d) presented and evaluated remedial alternatives for the FS-28 and FS-29 plumes. This ROD presents the selected remedies for these two plumes.

2.3 COMMUNITY PARTICIPATION

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

In addition, several citizen teams advise the IRP and the regulators about the program. They include the Senior Management Board and the Joint Process Action Team (JPAT). The JPAT is made up of the Plume Containment Team, the Long-Range Water Supply Team, and the Public Information Team. All these teams are made up of citizen volunteers and government representatives working together to resolve problems and complete the cleanup. All citizen team meetings are open to the public. Certain teams are decision-making teams. They include the Executive Review Group, the Management Review Group, and the Remedial Project Managers. A technical advisory team called the

Technical Review and Evaluation Team advises the decision-making teams. Assumptions about reasonably anticipated future land use and potential beneficial uses of groundwater and surface water are regularly discussed by these teams.

The public has been kept up to date on the progress of the SWOU through the various public and citizen team meetings described above. The remedial investigation (RI) (AFCEE 1999b) describes the extent of contamination across the entire SWOU and was made available to the public in May 1999. The *Final FS-28 and FS-29 Groundwater Feasibility Study* (AFCEE 2000d) and the proposed plan for the FS-28 and FS-29 plumes (AFCEE 2000c) were made available to the public in January and February 2000, respectively. These documents can be found in the Administrative Record file maintained at the MMR IRP office, the Falmouth, Bourne, Mashpee, and Sandwich public libraries, and at the USCG library located on MMR. The proposed plan is also on the MMR website. The notice of availability of the proposed plan was published on 28 January 2000 in the Falmouth Enterprise, the Bourne Enterprise, the Mashpee Enterprise, and the Sandwich Enterprise and on 29 January 2000 in the Cape Cod Times. A public comment period was planned for 11 February through 11 March 2000, but was subsequently extended through 25 April in response to public input. A public meeting was held on 10 February 2000 to present the proposed plan to a broad community audience. At this meeting, representatives from AFCEE presented the proposed remedies and answered questions from the audience. On 2 March 2000, a public hearing was held to receive formal public comment which is included in the official record. The remedial alternatives for FS-28 were also presented and discussed at the 12 April 2000 JPAT meeting. AFCEE's response to all oral and written comments received during the comment period are included in the Responsiveness Summary, which is Section 3.0 of this ROD.

2.4 SCOPE AND ROLE OF OPERABLE UNIT

Numerous source control actions have been undertaken as part of MMR's strategy to promptly remove sources of continuing groundwater contamination. The overall MMR

environmental cleanup program goal for groundwater is 100 percent capture of all plumes above maximum contaminant levels or other risk-based levels and treatment of contaminants and cleanup of plume to background levels if technically and economically feasible. The program's principles include pursuing remedial action strategies that are cost-effective while being fully protective of human health and the environment.

Past groundwater remedial actions that support this strategy are documented in:

- *Record of Decision for Interim Remedial Action*: *West Truck Road Motor Pool (AOC CS-4) Groundwater Operable Unit* (HAZWRAP 1992).
- *Final Record of Decision for Interim Action: Containment of Seven Groundwater Plumes* (IROD)(ANG 1995).[1]

Concurrent and future groundwater remedial actions that will support this strategy are documented in:

- *Record of Decision Area of Contamination FS-1, Final* (AFCEE 2000a)
- *Final Record of Decision for the CS-4, CS-20, CS-21, and FS-13 Plumes* (AFCEE 2000b)
- Individual final RODs for the seven groundwater plumes that were part of the 1995 IROD.

This ROD addresses the cost-effective remedial action strategies that are fully protective of human health and the environment for the FS-28 and FS-29 plumes. Active remedial actions along with institutional controls were chosen for both fuel spill plumes.

2.5 SITE CHARACTERISTICS

The conceptual models for groundwater contamination associated with the FS-28 and FS-29 plumes are presented in Figures 2-4 and 2-5. Generally, contamination released at a

[1] This document covers the following plumes: LF-1, SD-5, Western Aquafarm, Eastern Briarwood, FS-12, CS-10, and Ashumet Valley. Although this document has been finalized, it is an interim ROD, and final RODs will eventually be issued which present the final remedies selected for each of these seven plumes.

source area enters the aquifer through infiltration of precipitation. As precipitation passes through the vadose zone at a source area, contaminants bound in the soil matrix are dissolved and carried down to the water table. The contaminated water then enters the aquifer and migrates downgradient to form a plume. As the plume migrates further downgradient, clean precipitation accumulates at the water table above the plume, forming a wedge of clean water over the plume. This wedge of clean water forces the plume deeper into the aquifer with increasing distance from the source area. Contaminants in inactive sources are eventually removed, either through natural processes, such as dissolution and biodegradation, or by remedial action. These processes cause the plumes to detach from source areas as clean water begins to flush through the aquifer in the source area.

This section presents a brief overview of the SWOU setting; more detail is available in the SWOU RI (AFCEE 1999b). The site characteristics described were used to develop the SWOU human health conceptual exposure model, which is the framework for the human health and ecological risk assessments.

2.5.1 SWOU Setting

The SWOU study area was conceived as the area between the LF-1 and CS-10 plumes on upper Cape Cod, Massachusetts, and is described in detail in the SWOU RI. The northern part of the SWOU consists of open mowed grasslands and lawns broken by small areas of pitch pines and various oak species. South of MMR, the SWOU encompasses portions of the Francis A. Crane Wildlife Management Area (CWMA), which consists of 1721 acres of low rolling hills and flat areas. The CWMA supports four general habitat types: (1) pitch pine-mixed oak forest with an understory of huckleberry and blueberry, (2) open pitch pine forest with scrub oak understory, (3) disturbed grassland, and (4) game bird management plots of nonnative grasses and other herbaceous plants. The northern portion of CWMA also supports a small scrub-shrub wetland. South of Route 151, the SWOU study area becomes residential.

There are two potentially significant ponds in the vicinity of the FS-28 plume: Coonamessett Pond and Deep Pond (Figure 2-6). Coonamessett Pond is a 158-acre freshwater kettle hole pond located north of Hatchville Road. The average depth of water is 19 feet with a maximum depth of 34 feet. Deep Pond has a surface area of approximately 27 acres and a maximum depth of 28 feet. The southwestern arm of Deep Pond is less than 5 feet deep and is sometimes mapped as a marsh.

The Coonamessett River flows from the western arm of Coonamessett Pond through a flow control structure and eventually discharges to the Atlantic Ocean at Great Pond, approximately 3.5 miles downstream. The river flows over a gentle gradient in a southerly direction through approximately 60 acres of commercial cranberry bogs, of which about 20 acres are in the SWOU study area. The river provides a source of floodwater for the active cranberry bogs. There is a ponded wetland area in the upper area of the commercial cranberry bogs called Broad River (Figure 2-6). Broad River originates in this area as a result of upwelling groundwater and is a tributary to the Coonamessett River.

A golf course lies on the eastern side of Coonamessett Pond. A residential community is located to the northwest of the pond; the Souza Memorial Conservation Area is located to the southwest of the pond. The presence of single-family residences increases south of the conservation area, in proximity to the active cranberry bogs along the Coonamessett River. Recreational walkers, joggers, bird watchers, and fishermen use the perimeter roads and dikes surrounding the cranberry bogs and reservoir ponds.

Other than perched, manmade ponds, there are no ponds in the vicinity of the FS-29 plume.

The land above and around the FS-28 and FS-29 plumes does not contain known or likely habitat for rare wetland wildlife species. The site is not identified as a high priority site for rare species or as an exemplary natural community. No state-listed rare plants or

animals were observed at the project site during the field surveys.[2] Watch list species recorded in the various field surveys include great blue heron, spotted sandpiper, and osprey. The aquatic wetlands and terrestrial systems provide important wildlife and wetland benefits.

The FS-28 plume lies within the Mashpee Pitted Plain (Figure 2-2). The terrain north of Route 151 in CWMA is nearly level, with an approximate surface elevation of 100 feet msl. The geology of this area may be summarized as predominantly poorly graded sands with many discontinuous silty-sand layers down to approximately -70 feet msl. From -70 feet msl to -125 feet msl lies a more continuous silt layer sandwiched between discontinuous silty-sands. A basal silt layer up to 25 feet thick overlies bedrock, which dips from approximately -160 feet msl in the north to -190 feet msl near Route 151.

Further to the south, the FS-28 plume flows under Coonamessett Pond, which is the main topographic feature in this area. More localized topographic elevation changes that vary between approximately 30 and 80 feet msl occur in this area. The geology from the surface to approximately -110 feet msl consists primarily of poorly graded sands and silty-sands with occasional thin silt lenses. Below -140 feet msl, additional discontinuous silt, gravel, silty-sand, and sandy-clay layers are located above poorly graded sands that overlie 1 to 11 feet of basal till. Bedrock was encountered between approximately -200 feet msl in the north and -240 feet msl in the south.

Surface water bodies, such as Coonamessett Pond, are generally in hydraulic connection with the aquifer. Typically, localized upward vertical gradients may be present on the upgradient portions of surface water bodies (i.e., where groundwater discharges to the surface) and localized downward vertical gradients may be present on the downgradient portion of surface water bodies (i.e., where surface water recharges the aquifer).

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[2] Sandplain gerardia, a plant species listed under the Natural Heritage Endangered Species Program, is being raised in a select portion of CWMA.

The trailing edge of the FS-29 plume also lies within the Mashpee Pitted Plain, but the majority of the plume lies beneath the Buzzards Bay Moraine, which runs generally from north to south. Bedrock in this area is generally 200 to 250 feet below ground surface. Beneath the Buzzards Bay Moraine, the groundwater surface lies as much as 100 feet below the land surface. Locally, silty or clayey zones within the outwash sand cause the aquifer to be semiconfined. A detailed description of the aquifer, including description of such properties as hydraulic gradient, hydraulic conductivity, transmissivity, specific yield, horizontal to vertical conductivity ratio (anisotropy), and groundwater flow velocity is presented in the SWOU RI.

Groundwater modeling is a vital tool to the decision-making process at MMR. Two groundwater models were used in the SWOU RI and the feasibility study for the FS-28 and FS-29 plumes. A regional model has been developed and refined over the past several years. The 1999 regional model was used as the basis for the SWOU Zoom Model. The localized SWOU Zoom Model, a detailed section of the 1999 regional model, was used to estimate the efficacy of the remedial actions being considered.

Vertical discretization in the SWOU Zoom Model is the same as in the 1999 regional model; however, the lateral discretization is more refined to allow for detailed analysis of remedial alternatives. The boundary conditions in the SWOU Zoom Model are inherited from the 1999 regional model. Both models were developed using MODFLOW-SURFACT for flow. Particle tracking was performed in both models to estimate contaminant movement in the plumes. The groundwater models are described in detail in the *Final SWOU Feasibility Study* (AFCEE 1999a) and the *Final FS-28 and FS-29 Groundwater Feasibility Study* (AFCEE 2000d).

2.5.2 Source Investigation

Neither the FS-28 plume nor the FS-29 plume can be attributed to specific known source areas on the base. Site records were reviewed to identify possible sources of FS-28 and FS-29 groundwater contamination. The records investigation is described in detail in the SWOU RI. The investigation consisted primarily of a search of the MMR Administrative

Record for information on 30 sites that have a past history of contamination or were potential sources of contamination. Separate decision documents or RODs, as appropriate, will be prepared for the source areas in the SWOU that have not been addressed to date.

2.5.3 Sampling Strategy

The sampling strategy for the SWOU investigations conducted from 1997 to 1998 included geologic and hydrogeologic characterization, groundwater sampling and analysis, and surface water sampling and analysis. Several tasks were performed to improve the understanding of the SWOU study area geology and hydrology, including drilling, borewater sampling, borehole geophysical surveying, slug tests, and hydrologic data collection. Elements of the field investigation are summarized as follows:

- The FS-28 remedial investigation was conducted between January and May 1997. A total of 35 monitoring wells were installed at 27 drilling locations. In addition, 10 geologic borings were installed. To support the SWOU RI, an additional 59 monitoring wells were installed at 43 drilling locations located throughout the SWOU area between January and July 1998. Six geologic borings were included in the SWOU RI field program. Borings were advanced using rigs that allowed collection of depth-specific groundwater samples. Geologic borings were drilled with a sonic rig that produced a continuous soil core into bedrock. Geologic boring and monitoring well locations are shown in Figure 2-7.

- Borehole geophysical logging was conducted in completed monitoring wells at 63 locations during the SWOU RI (April to May 1998).[3] All wells were logged using both natural gamma radiation and gamma-gamma (density) techniques.

- Falling head (injection) and rising head (withdrawal) slug tests were conducted in 53 wells throughout the SWOU area during the SWOU RI. The slug test data were used to calculate a localized, horizontal hydraulic conductivity (K) for the screened zone at each monitoring well location.

- In May 1998, a synoptic water level study was conducted for the entire MMR, including the FS-28 and FS-29 plume areas. Over 750 groundwater elevations were

[3] Data collection activities conducted under the SWOU RI included activities specific to the FS-28 and FS-29 plumes, activities directed at characterizing other plumes within the SWOU, and activities aimed at characterizing the operable unit as a whole.

measured in monitoring wells and piezometers, 21 pond elevations were measured, and 21 discharge measurements were made at seven rivers.

The groundwater, surface water, and sediment sampling program was performed to better define the nature and extent of the groundwater contaminant plumes in the SWOU study area and support the human health and ecological risk assessments. Sampling activities are described below.

- Several hundred borewater samples were analyzed for select target volatile organic compounds (VOCs) and EDB. These samples were used to define the horizontal and vertical extent of the plumes.
- A total of 162 wells were sampled during the SWOU RI field investigation in 1998. These 162 wells included the 59 monitoring wells installed during the SWOU drilling program and 103 existing wells. Of the 103 existing wells, 25 were installed during the FS-28 RI in 1997 and had not yet been sampled. A total of 51 wells were sampled for the FS-28 RI between December 26, 1996 and December 9, 1997. Locations of existing wells (before 1998) sampled for the SWOU RI and for the FS-28 RI are shown in Figure 2-8.
- During the SWOU RI, 10 surface water and sediment samples were collected from each of the following locations: Coonamessett River, Coonamessett Pond, Broad River and Deep Pond and analyzed for the full analytical suite. In addition, 37 surface water samples were collected from Coonamessett Pond and analyzed for VOCs and EDB only. (Details of the analyses conducted and results were presented in AFCEE 1999b.)
- The SWOU RI also included groundwater data collected after June 1, 1996 under other programs, such as the inorganics investigation and the CS-4 treatment system evaluation (see AFCEE 1998a for a complete listing).

At the completion of the SWOU RI, the leading edge of the FS-29 plume remained undefined. Since that time, three monitoring wells have been installed to define the leading edge of the FS-29 plume. Sampling has been conducted within the FS-28 and FS-29 plumes since the completion of the SWOU RI (results are presented in AFCEE 2000d). All samples collected were analyzed for EDB; some samples collected from the FS-29 plume area were also analyzed for VOCs. Groundwater analytical results indicate that EDB concentrations within the portion of the FS-28 plume which lies north of Coonamessett Pond are continuing to decrease as clean water flushes through the aquifer. This sampling also indicates that the FS-29 plume does not appear to be expanding and

provides an initial indication that FS-29 plume contaminant concentrations may be decreasing.

2.5.4 Contamination Summary

Neither the FS-28 plume nor the FS-29 plume can be attributed to specific known source areas on the base. Given the detached nature of the plumes, the sources may never be discovered because all the contaminants may have already left the soil at the source areas and entered the groundwater. Before installation of the shallow well-point extraction system for the FS-28 plume (which began operation in April 1999), the plume discharged to the Coonamessett River and surrounding bogs. This plume appears to be separated from Coonamessett Pond by a layer of clean water. However, because of the proximity of the FS-28 plume to Coonamessett Pond and the Coonamessett River (Figure 2-6), these surface water bodies were included in the risk assessments. The FS-29 plume does not discharge to any surface water body.

Contaminants of concern for each plume are presented in Table 2-1. Table 2-2 presents plume-specific contaminant mass and volume. A brief summary of the extent of contamination and the potential for human exposure to each plume is presented below.

Table 2-1
Summary of FS-28 and FS-29 Groundwater Contaminants of Concern

Contaminant of Concern	MCL (µg/L)	MMCL (µg/L)	Plume Specific Maximum Concentrations (µg/L)		Characteristics
			FS-28	FS-29	
Carbon Tetrachloride (CCl_4)	5	5	-	9.5	B2-carcinogen, mobile, does not undergo rapid aerobic degradation or hydrolysis
Ethylene Dibromide (EDB)	0.05	0.02	18	0.071*	B2-carcinogen, mobile, does not undergo aerobic biodegradation, degrades slowly by hydrolysis

µg/L = micrograms per liter MCL = maximum contaminant level MMCL = Massachusetts maximum contaminant level
B2 – Probable human carcinogen with sufficient evidence in animals and inadequate or no evidence in humans
* The data presented represents the highest concentrations detected in a monitoring well sample. A bore water sample collected from 69MW1536 contained 0.108 µg/L of EDB.

Table 2-2
Estimated Contaminant Mass and Volume of Contaminated Groundwater

Plume	Contaminant	Contaminant Mass (kilograms)	Volume of Contaminated Groundwater (million ft^3)	Volume of Contaminated Groundwater (billion gallons)
FS-28	EDB	11.7	580	4.4
FS-29	EDB*	0.160	160	1.2

ft^3 = cubic feet EDB = ethylene dibromide
*Because of its limited extent, carbon tetrachloride, a contaminant of concern for the FS-29 plume, has not been included in this table.

FS-28 Plume: EDB is the primary contaminant of concern in the FS-28 plume. The plume extends from the Crane Wildlife Management Area, under the western portion of Coonamessett Pond, and terminates in the cranberry bogs surrounding the Coonamessett River. (Figure 2-9 is an aerial photograph of the FS-28 plume area.)

The groundwater with the highest concentration of EDB within the plume is being captured by an extraction and treatment system—referred to as the EW-1 (for extraction well-1 or 69EW0001) system—that has been operational since October 1997. This system was installed as part of a time-critical removal action to capture most of the plume mass at Hatchville Road and to minimize upwelling into the Coonamessett River system. Subsequently, in April 1999, AFCEE implemented a non-time-critical removal action which added additional extraction capacity to the system in the form of shallow well points (Figure 2-10) to eliminate the discharge of EDB to the Coonamessett River and neighboring cranberry bogs. Since May 1999, EDB has not been detected in the Coonamessett River.[4] It is believed that the effectiveness of the time-critical and non-time-critical removal actions implemented by AFCEE is responsible for preventing detectable concentrations of EDB in the Coonamessett River. Additional actions taken by AFCEE in response to the FS-28 plume include the construction and operation of a

[4] A May 2000 sample collected at 69SW2018 contained 0.068 µg/L of EDB. This sample was collected from a ditch which drains water from the E3 cranberry bog into the Coonamessett River. Subsequent sampling and analysis confirmed the presence of EDB in the ditch. Flows from this ditch and the associated culvert are significantly less than the flow in the Coonamessett River at that point and EDB has not been detected in the river water. The planned response to this contamination is presented in Section 2.11.1.

wellhead treatment system for the town of Falmouth's Coonamessett Water Supply Well (CWSW) and the construction of berms and sheet piles to separate the river from neighboring cranberry bogs.

The highest concentration of EDB ever measured in the FS-28 plume—18 micrograms per liter (µg/L)—(Table 2-1) was detected in 1997 in a monitoring well located south of Hatchville Road, near the area in which extraction well 69EW0001 was constructed. Concentrations decrease significantly to the north. The maximum concentration just north of Hatchville Road was 14 µg/L; the maximum concentration just south of the western arm of Coonamessett Pond was 4.9 µg/L. Between the western arm of Coonamessett Pond and Route 151, concentrations continue to decrease to the north. The highest concentration of EDB detected just north of the western arm of Coonamessett Pond was 3.1 µg/L, and the highest concentration detected between Route 151 and Boxberry Hill Road was 0.025 µg/L.

Just south of the western arm of Coonamessett Pond, the FS-28 plume lies from -85 to -220 feet msl, and stays relatively deep until it passes under Hatchville Road. In the area between Coonamessett Pond and Route 151, EDB has been detected generally between the elevations of -30 and -190 feet msl. The plume appears to be separated from Coonamessett Pond by a layer of clean water. None of the 45 water samples or 10 sediment samples collected from Coonamessett Pond during the RI contained detectable concentrations of EDB. North of Route 151, the FS-28 plume becomes laterally and vertically discontinuous at various elevations ranging from -20 to -220 feet msl. The trailing edge of the FS-28 plume is difficult to define because the concentrations are generally close to the EDB detection limit of 0.004 µg/L. The northern-most detection of EDB associated with the FS-28 plume is located approximately 1000 feet south of the MMR boundary.

FS-29 Plume: The FS-29 plume is over 9000 feet long, extending from the Crane Wildlife Management Area across Route 151. The maximum width of the plume, just south of Route 151, is approximately 1300 feet. EDB and carbon tetrachloride ($CC1_4$)

generally appear together in this plume, although not in every sample. The plume is comprised of two lobes, the shallower one occurring from approximately -30 to -100 feet msl, with an average thickness of 30 feet, and the deeper one occurring from approximately -120 to -220 feet msl, with a thickness ranging from 30 to 50 feet.

The plume is defined by the presence of EDB and/or CCl_4 at concentrations above MCLs/MMCLs, although the upgradient portion of the plume appears to intersect the CS-21 plume. The maximum EDB concentration detected in a borewater sample was 0.108 µg/L; the maximum EDB concentration detected in a monitoring well sample was 0.071 µg/L (Table 2-1). The maximum CCl_4 concentration detected was 9.5 µg/L.

2.6 CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

This section discusses the current and reasonably anticipated future land uses and current and potential beneficial groundwater uses in the vicinity of the FS-28 and FS-29 plumes, and presents the basis for future groundwater use assumptions.

2.6.1 Land Use

Both the FS-28 and the FS-29 plumes lie within the town of Falmouth. The land above these two plumes is used for wildlife management, residential housing, conservation land, and, to a more limited extent, agriculture.

Figure 2-9 is an aerial photo displaying land use in the vicinity of the FS-28 plume. The upgradient portion of the FS-28 plume, north of Route 151, lies beneath the Crane Wildlife Management Area (CWMA). These state-owned lands are protected from development. Just south of Route 151, the plume passes beneath an area of undeveloped land. Further south, the plume lies under a residential neighborhood, with a small area of undeveloped land to the west of this neighborhood. South of Coonamessett Pond the axis of the plume lies beneath the Souza Conservation Area. The conservation area is protected from development. The town of Falmouth's CWSW lies above the plume, within the conservation area. The plume also extends to the east (under private homes)

and west (under farm land) of the conservation area. Further south the plume crosses under Hatchville Road. The land above the plume in this area is occupied by both private homes and cranberry bogs. These cranberry bogs include several acres owned by the Town of Falmouth. The FS-28 treatment system, including EW-1 and the shallow well-point extraction system, is located on this and other surrounding town-owned land.

Figure 2-11 displays land use in the vicinity of the FS-29 plume. The upgradient portion of this plume also lies beneath the CWMA. The central portion of the FS-29 plume lies beneath generally undeveloped, privately-owned land. Much of this land has been proposed for development as a golf course (CLSV Associates Limited Partnership 1998). The distal portion of the plume lies beneath a residential neighborhood.

It is anticipated that currently undeveloped land in the vicinity of these plumes will undergo residential development over time. The current use of the CWMA is not expected to change significantly in the near future.

2.6.2 Water Resource Use

The aquifer throughout Upper Cape Cod, referred to as the Sagamore Lens, is generally highly transmissive and is a potentially productive aquifer. Because the Sagamore Lens is designated as a sole-source aquifer, all future groundwater use, regardless of location, is considered residential from a regulatory perspective.

Current groundwater uses in the town of Falmouth include residential, agricultural, and commercial. All residences potentially impacted by the FS-28 or FS-29 plumes are connected to public water supplies. Some residences also have private wells for nonpotable purposes. Agricultural uses include those associated with cranberry bogs and small farms in the area. Surface water bodies, which are generally fed by groundwater, provide recreational opportunities, including wading, swimming, and fishing.

There are no current uses of groundwater beneath the CWMA. The CWMA is protected from development and any future municipal water supply well drilling would require approval from the Massachusetts Legislature.

In 1996, as a precaution, the Air Force installed a carbon adsorption system at the CWSW to provide wellhead protection from the potential impacts of the FS-28 plume. The well is screened approximately 100 feet above the plume, and plume contaminants have never been detected in the well's influent. The influent to the adsorption system and three sentinel wells upgradient of the water supply well are monitored for the presence of EDB on a monthly basis.[5] Following installation of this system, area residents were connected to town water to prevent exposure to EDB. Water mains measuring 16,700 feet were installed to connect 125 private residences and one business to the Falmouth public water supply system (AFCEE 1998a). All of the homes in the vicinity of the FS28 plume are connected to public water supplies.

The upgradient portion of the FS-29 plume lies beneath the CWMA, and the distal portion of the plume lies largely under a residential neighborhood. As detailed above, institutional controls prevent exposure to the groundwater beneath the CWMA. The homes above the plume are all connected to municipal water supplies. Water mains are in place and as additional homes are constructed in this area, they will be connected to municipal water supplies.

AFCEE has developed a working relationship with the water commissioners of the town of Falmouth to ensure that future development of the groundwater resource is coordinated with planned and ongoing remediation at MMR. Drinking water for the town of Falmouth

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5 Monitoring results from the sentinel wells can be summarized as follows. 69MW1279A is screened just below the depth of the CWSW and has consistently had no detectable concentrations of EDB. 69MW1279B is screened approximately 47 feet deeper than the CWSW and has consistently had no detectable concentrations of EDB. 69MW1279C is screened approximately 87 feet deeper than the CWSW and has had EDB detected at concentrations ranging from below the detection limit to approximately 0.015 µg/L, three quarters of the MMCL.

remains in short supply, and the town is in the process of considering additional drinking water supply well sites.

2.7 SUMMARY OF SITE RISKS

The baseline risk assessment estimates the risks posed by the plumes if no action were taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed in the remedial action. The baseline risk assessment shows that FS-28 and FS-29 plume contaminants, if not addressed by implementing the response action selected in this ROD, may present a current or potential threat to public health, welfare, or the environment.

This section of the ROD summarizes how the results of the baseline risk assessment for the SWOU apply to the FS-28 and FS-29 plumes. The baseline human health and ecological risk assessments conducted for the SWOU RI evaluated the potential impacts to human health and wildlife from exposure to contaminated groundwater, and to surface water and sediment from Deep Pond, Coonamessett Pond, and Coonamessett River (Figures 2-12 and 2-13). Human health impacts were evaluated for both average exposure and reasonable maximum exposure scenarios. Cancer risks (the increase in the probability that an individual will develop cancer over the course of his or her lifetime) and noncancer hazards were quantified. Ecological impacts were evaluated for both aquatic and semiaquatic organisms and populations. Terrestrial organisms were not included in the analysis because the SWOU RI was a groundwater investigation.

As described below, the entire SWOU (including the FS-28 and FS-29 plume areas) was divided into four areas for purposes of conducting the risk assessment (Figure 2-14). Therefore, a plume-by-plume risk assessment is not presented. Instead, plume-specific risks were extracted from the area-based risk assessment. Each section below includes a description of the area-based risk assessment approach and how the results relate to the FS-28 and FS-29 plumes.

2.7.1 Summary of Human Health Risk Assessment

This section summarizes the risk to human health attributable to FS-28 and FS-29 plume contaminants of concern. For risk assessment purposes, the SWOU was originally divided into four areas based on plume constituents, land use, and human and ecological receptor groups (Figure 2-14). Thus, the risk assessment included the FS-28 and FS-29 plumes, as well as areas not impacted by these plumes. The current and potential exposure pathways associated with the SWOU are summarized according to groundwater area in the human health exposure model (Figure 2-12). The FS-28 and FS-29 plumes lie entirely within Areas 2 and 4. Table 2-3 summarizes the characteristics of Areas 2 and 4 and current and future human health exposure pathways. To maintain consistency with the SWOU RI and feasibility study risk assessment methods, the area-based discussions include contaminant information from the entire SWOU area. Tables included in Appendix A are taken directly from the RI risk assessment and therefore also contain information pertaining to the CS-4, CS-20, CS-21, and FS-13 plumes.[6] Explanations are provided below to describe how FS-28 and FS-29 plume-specific risk assessment information was derived.

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6 The *Final Record of Decision* for the *CS-4, CS-20, CS-21,* and *FS-13 Plumes* presented risks for the entire SWOU area outside the FS-28 and FS-29 plumes. Thus, the risks potentially posed by groundwater within the SWOU, but outside any of the defined plumes, were accounted for in that document.

Table 2-3
Summary of Risk Areas

Area Characteristics	Current Exposure Pathway/Receptors	Future Exposure Pathway/Receptors	SWOU Plumes
Area 2 • Crane Wildlife Management Area (CMWA) • No surface water bodies	• No current receptors	• Off-site residential	• CS-4* • CS-20* • CS-21* • FS-28 • FS-29
Area 4 • Mainly SWOU south of Route 151 • Residents supplied by both public and private water • Surface water bodies include Coonamessett Pond, Deep Pond, and Coonamessett River	• Residential • Recreational swimmers • Recreational waders • Recreational fishers • Cranberry workers	• Off-site residential • Recreational swimmers** • Recreational waders** • Recreational fishers** • Cranberry workers**	• CS-21 * • FS-28 • FS-29

Note: The phrase recreational fishers refers to people who eat fish from the referenced surface water bodies.
*Although not part of this ROD, the CS-4, CS-20, and CS-21 plumes were included In SWOU risk assessment calculations.
**The FS-29 plume is not discharging to surface waters. Deep Pond was Included because it is downgradlent of the CS-20 plume. For Coonamessett Pond and the Coonamessett River, potential risks to recreational swimmers, recreational waders, recreational fishers, and cranberry workers were considered for the FS-28 plume.

2.7.1.1 Identification of Contaminants of Concern

Based on the risk assessment presented in the SWOU RI (AFCEE 1999b), the groundwater contaminants of concern are EDB for the FS-28 plume and EDB and CCl_4 for the FS-29 plume. In building the database for the baseline risk assessment, only qualified data from level C and level D data packages were used. Field screening data and groundwater samples collected from irrigation wells were not included.

Analytical results for each chemical constituent were compared to background reference concentrations, applicable or relevant and appropriate requirements (ARARs), and toxicological screening values to determine contaminants of potential concern (COPCs). Chemicals with two or more detections and a detection frequency of greater than 5 percent were carried through as COPCs if they did not have background reference concentrations, potential ARARs, or toxicological screening values. Only the higher of the dissolved and total concentrations for inorganics were carried through the risk assessment.

For COPCs retained through the screening process, a representative exposure point concentration (EPC) was computed. For groundwater, the concentrations for the reasonable maximum exposure (RME) and central tendency (CT) condition are the maximum and average concentrations, respectively. For surface water and sediment, the concentrations for both the RME and CT concentrations are the 95 percent upper confidence level (UCL) unless the UCL exceeds the maximum concentration. If this is the case, then the RME EPC is the maximum concentration. The 95 percent UCL is calculated using the arithmetic mean of the concentrations, with or without log transformation depending on the underlying normal or log normal distribution of the data.

The SWOU area conceptual model indicates that the only existing pathway for MMR-related contaminants to reach surface water is through the emergence of contaminated groundwater into risk Area 4. The only MMR-related COPC that is elevated and mobile in Area 4 is EDB (from the FS-28 plume).

Contaminants for which a reasonable maximum exposure would result in an excess lifetime cancer risk greater than one in a million or a hazard index greater than one were determined for each risk area. In the baseline risk assessment, all detected compounds were initially considered for use in the quantification of risk. However, certain contaminants were eliminated from consideration as contaminants of concern for these plumes if they met any of the following criteria:

- Contaminant is present at similar concentrations in background samples.
- Contaminant is a nutrient (e.g., magnesium, calcium, or potassium).
- Contaminant is present at a similar concentrations in lab blanks, equipment blanks, or is otherwise attributable to sampling or analytical equipment contamination.
- The maximum contaminant concentration detected did not exceed the appropriate risk-based reference concentration.
- Contaminant was not detected in the plumes of concern.
- The detection frequency is below criteria for retention as a contaminant of potential concern.

- Contaminant has a sporadic distribution and is not present in multiple samples from a similar area, so no contiguous area of groundwater contamination can be defined.

To make the transition from the RI's risk area approach to a plume-by-plume approach, each contaminant of potential concern from the risk areas surrounding the FS-28 and FS-29 plumes was screened according to spatial distribution and the COPC's measured concentrations within the plumes. The results of this screening are presented in Table 2-4. Based on this analysis, only CCl_4 and EDB were retained as contaminants of concern for these two plumes.

Table 2-4
Screening of FS-28 and FS-29 Contaminants of Potential Concern

Contaminant of Potential Concern	10^{-6} REC (µg/L)	HI = 1 HEC (µg/L)	Max. detect (µg/L)*	COC? (Y / N)	Reason for selection or rejection.
Arsenic	**0.057**	**11**	**11**	N	The highest detections (11.1 µg/L at 38MW0009, 7.5 µg/L at 32MW1307, and 4.6 µg/L at 69MW1519) were more than a mile away from any other detections. The remaining 6 samples had concentrations less than EPA threshold for remedial action (10^{-4}) REC of 5.7 µg/L. Distributions are irregular, and not particular to any VOC or EDB plume. There may be a weak relationship between detections ranging from 2.2 to 4.2 µg/L at 69MW1417, 69MW1420, and 69MW1512. There also may be a weak relationship between detections ranging from 2.2 to 3 at 03MW0038, 69MW1515, and 69MW1528. All other samples were nondetects. Generally, arsenic is not attributable to MMR. Reporting limit for arsenic is 5 µg/L, below which results are estimated.
Barium		**2500**	252	N	Maximum detection is less than HEC.
BEHP	**2.3**	274	2100	N	Contaminant is artifact of sampling equipment and possibly laboratory contamination.
Cadmium		**18**	5.2	N	Maximum detection is less than HEC.
CCl_4	**0.24**	4.6	32	Y	Carbon tetrachloride is a COC in the FS-29 plume. The highest concentration of CCl4 in the FS-29 plume is 9.5 µg/L.
Chloroform	**0.28**	0.90	7.6	N	Contaminant is not attributable to MMR. Chloroform is primarily due to the infiltration of chlorinated water.
Chromium		**77**	151	N	Only two samples (151 µg/L from 69MW1290B and 83 µg/L from 69MW1283B) exceeded HEC. Distribution appears random and not particular to an VOC or EDB plume(s). Chromium is generally not attributable to MMR.
EDB	**0.00095**	0.60	18	Y	EDB is a COC in the FS-28 and FS-29 plumes. The highest concentration in the FS-28 plume is 18 µg/L, and the highest concentration of EDB in the FS-29 plume is 0.071 µg/L.
Manganese		**840**	1820	N	Only four wells contained manganese concentrations above the HEC. The distribution of manganese in the SWOU appears random and is considered not to be attributable to MMR.
Nickel		**733**	110	N	Maximum detection is less than HEC.
1,1,2,2-TCA	**0.088**		22	N	Contaminant is not found in either the FS-28 or FS-29 plumes. Its distribution is limited to the CS-4 plume.
PCE	**0.11**	242	140	N	PCE is a risk-driver in the FS-28 and FS-29 plumes. The highest concentration in the FS-28 plume is 2.4 µg/L, and the highest concentration of PCE in the FS-29 plume is 0.47J (estimated) µg/L. However, because PCE concentrations in these plumes are less than the MCLs, and the water containing the low levels of PCE is contaminated b higher levels of EDB, CCl_4, or both, PCE is not considered a COC for these plumes.
TCE	**2.45**		710	N	TCE is not a COC in the FS-28 or FS-29 plumes because the concentrations in the FS-28 and FS-29 plumes were less than the REC.
Thallium		**2.9**	9.7	N	Distribution of thallium within SWOU is random and not particular to any VOC or EDB plume(s). Generally, thallium is not attributable to MMR.

1,1,2,2-TCA = 1,1,2,2-tetrachloroethane
BEHP = bis (2-ethylhexyl) phthalate
CCl_4 = carbon tetrachloride
COC = contaminant of concern
EDB = ethylene dibromide
HEC = hazard equivalent concentration
HI = hazard index
PCE = tetrachloroethene
REC = risk equivalent concentration
TCE = trichloroethene
VOC = volatile organic compound
µg/L = micrograms per liter
Bold = the lower of the pair of equivalent concentrations (RECs and HECs).

* = The concentrations shown are the highest detections In the SWOU groundwater, which may be higher than the highest concentrations within the FS-28 and FS-29 plumes.

2.7.1.2 Exposure Assessment

Current and future pathways were determined using the area-based risk assessment methods and are presented in Table 2-3. Details on the routes of exposure for each receptor are provided below. Appendix A contains EPA risk assessment guidance Part D (RAGS D)(EPA 1998b). Table 1 of Appendix A lists all exposure pathways considered including those not quantitatively addressed. Specific exposure factors are included in RAGS, Tables 4-2 through 4-14 and 4-16 presented in Appendix A.

Primary routes of exposure for each medium are presented in the risk assessment conceptual exposure model (see Figure 2-12). For residential exposure to groundwater, the exposure duration for the child (6 years) was added to the exposure duration for the adult (9 or 24 years) to comprise a lifetime (adult) RME exposure duration term of 30 years. The lifetime CT exposure duration was 9 years.

Current and future land use was taken into consideration in the risk assessment. For example, since the FS-28 plume is upwelling into the cranberry bogs surrounding the Coonamessett River, the risk to adult waders, child waders, cranberry workers, and humans ingesting fish caught in the river were evaluated based on contaminant concentrations in the surface water and sediment. Land use was also considered for exposure to groundwater. For example, since there are no current residents in the CWMA, which overlies the trailing edges of both the FS-28 and FS-29 plumes, the groundwater contamination in that area does not pose a current risk. Similarly, in the residential neighborhoods located south of the CWMA, residents in homes that overlie both plumes are not currently threatened because they are connected to the municipal water supply. However, because the future land use for the areas surrounding these plumes is uncertain, the risk assessment conclusions focus on future groundwater use scenarios, which conservatively assume that the residents would be exposed to the highest detected concentrations of all contaminants of concern over the course of their lifetime.

Off-site residents are considered probable current and future human receptors for groundwater because groundwater is used as a water source for both municipal water supplies and private residences. In addition, these residents are considered potential receptors as recreational swimmers, waders, and fish consumers for surface water, sediment, and edible biota in contact with surface water because contaminants from the deep groundwater could be released to surface water. Off-site cranberry bog workers are considered potential current and future human receptors for contamination in surface water and sediment. Surface water exposure scenarios were included because the FS-28 plume was known to discharge into the Coonamessett River and surrounding cranberry bogs.

Several exposure pathways have been eliminated (Appendix A, Table 1) based on the likely absence of SWOU-related contamination in the exposure media and the site conceptual model. Soil exposure pathways were not considered because the SWOU investigation was a groundwater RI and feasibility study. Areas of known or suspected soil contamination on MMR are being addressed separately. The site conceptual model states that the only MMR-related contamination in the SWOU comes from the migration of contaminants from the military base in deep groundwater and the discharge of that water to surface water in the Coonamessett River system.

2.7.1.3 Toxicity Assessment

Toxicity values are obtained from EPA's most current versions of the Integrated Risk Information System (IRIS) (EPA 1998a) or the Health Effects Assessment Summary Table (BEAST) (EPA 1997), which are databases containing toxicity values for use in quantitative risk assessment. The potential for the COPCs to produce adverse effects in humans was evaluated in the SWOU risk assessment. Cancer oral, dermal, and inhalation slope factors and unit risks are listed in RAGS Part D Tables 6.1 and 6.2. Noncancer oral, dermal, and inhalation reference doses, reference concentrations, and affected target organs for each COPC are presented in RAGS Part D Tables 5.1 and 5.2. These tables are contained in Appendix A.

There are two SWOU groundwater COCs included in this ROD: EDB and CCl_4. The cancer toxicity data used in the human health risk assessment for these COCs are summarized in Table 2-5 below:

Table 2-5
Cancer Toxicity Data

COC	Slope Factors $(mg/kg/day)^{-1}$			Weight of Evidence Class	Source
	Oral	Dermal	Inhalation		
EDB	8.5 X 10	8.5 X 10	7.7×10^{-1}	B2	IRIS 6/2/98
CCl_4	1.3×10^{-1}	1.3×10^{-1}	5.3×10^{-2}	B2	IRIS 6/2/98

$(mg/kg/day)^{-1}$ = 1/(milligrams per kilogram per day)
IRIS - Integrated Risk Information System (EPA 1998a)
B2 - Probable human carcinogen with sufficient evidence in animals and inadequate or no evidence in humans

The dermal slope factors were derived from the oral slope factors by multiplying by an adjustment factor of one. The inhalation slope factors were derived from unit risk concentrations by dividing by inhalation rate (20 cubic meters per day) and multiplying by body weight (70 kilograms).

The noncancer toxicity data used in the human health baseline risk assessment for these COCs are summarized in Table 2-6 below:

Table 2-6
Noncancer Toxicity Data

COC	Reference Doses (mg/kg/day)			Target Organs		Source
	Oral	Dermal	Inhalation	Oral/Dermal	Inhalation	
EDB	NA	NA	6×10^{-5}	NA	Sperm	HEAST
CCl_4	7×10^{-4}	7×10^{-4}	6×10^{-4}	Liver	Liver	IRIS 6/2/98

mg/kg/day = milligrams per kilogram per day
NA - not available IRIS - Integrated Risk Information System (EPA 1998a)
HEAST = Health Effects Assessment Summary Table (EPA 1997)

The dermal reference doses were derived from the oral reference doses by multiplying by an adjustment factor of one. The inhalation reference doses were derived from reference concentrations by multiplying by inhalation rate (20 cubic meters per day) and dividing by body weight (70 kilograms).

2.7.1.4 Risk Characterization

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

Risk = (CDI or SDI or DA) x SF

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

CDI = chronic daily intake averaged over 70 years (mg/kg-day)

SDI = subchronic daily intake averaged over 70 years (mg/kg-day)

DA = dermally absorbed dose averaged over 70 years (mg/kg-day)

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

These risks are probabilities that usually are expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure theoretically has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an "excess lifetime cancer risk" because it would be in addition to the risk of cancer an individual faces from other causes such as smoking or exposure to too much sun. The chance of an individual developing cancer from all other causes has been estimated to be as high as one in three. EPA's generally acceptable risk range for site-related exposures is 10^{-4} to 10^{-6}. Under the Massachusetts Contingency Plan (310 Code of Massachusetts Regulations [CMR] 40), sites where the risk is less than 10^{-5} are considered to have attained a level of no significant risk.

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

Noncancer HQ = (CDI or DA) / (Rl) or Subchronic RfD)

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

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

RM = reference dose (mg/kg-day)

CDI, DA, and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short-term). An HQ less than 1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic noncarcinogenic effects from that chemical are unlikely.

The hazard index (HI) is calculated by adding the HQs for all COCs that affect the same target organ (e.g., liver) within a medium or across all media to which a given individual may reasonably be exposed. An HI less than 1 indicates that, based on all of the different contaminants and exposure routes, toxic non-carcinogenic effects are unlikely. An HI greater than 1 indicates that site-related exposures may present a hazard to human health.

To make the transition from the area-based approach to a plume-by-plume approach, COC-specific contributions to the total (RME) risk for future residents were calculated and are presented in Table 2-7 and Table 2-8. Based on the above conclusions from the SWOU RI risk assessment, the residential scenario (residential exposure to contaminated groundwater) drives risk for the contaminants (primarily EDB and CCl_4) contained in the FS-29 plume. Both residential exposure and exposure through the Coonamessett River drive the risks caused by the contaminants in the FS-28 plume.

The baseline cancer risk calculations in the SWOU RI indicated that, unless remedial action is undertaken, future residential exposure to contaminated groundwater in risk Areas 2 and 4 may present an excess lifetime cancer risk greater than the acceptable state threshold of 1×10^{-5} and the acceptable federal range of 1×10^{-4} to 1×10^{-6}.

Table 2-7
Plume-Specific Carcinogenic Risk Values
Based on Reasonable Maximum Exposure for Future Residents

Contaminant of Concern*	FS-28					FS-29				
	Maximum Concentration (µg/L)	Dermal Risk	Ingestion Risk	Inhalation Risk	Total Plume Risk	Maximum Concentration (µg/L)	Dermal Risk	Ingestion Risk	Inhalation Risk	Total Plume Risk
EDB	18	8.6×10^{-4}	1.8×10^{-2}	6.1×10^{-4}	1.9×10^{-2}	0.071	3.4×10^{-6}	7.1×10^{-5}	2.4×10^{-6}	7.7×10^{-5}
CCl_4	ND				NA	9.5	3.3×10^{-6}	1.4×10^{-5}	2.2×10^{-5}	4.0×10^{-5}
Total Plume Risk					**1.9×10^{-2}**					**1.2×10^{-4}**

NA – not applicable ND – nondetect µg/L – micrograms per liter
*Risks derived from contaminants other than the contaminants of concern did not contribute significantly to total plume risk.

Table 2-8
Plume-Specific Noncarcinogenic Hazard Indices
Based on Reasonable Maximum Exposure for Future Residents

Contaminant of Concern*	Primary Target Organ	FS-28					FS-29				
		Maximum Concentration (µg/L)	Dermal Hazard	Ingestion Hazard	Inhalation Hazard	Total Plume HI	Maximum Concentration (µg/L)	Dermal Hazard	Ingestion Hazard	Inhalation Hazard	Total Plume HI
EDB	Sperm	18	NA	NA	3.1×10^{1}	3.1×10^{1}	0.071	NA	NA	1.2×10^{-1}	1.2×10^{-1}
CCl_4	Liver	ND	ND	ND	ND	NA	9.5	8.5×10^{-2}	3.7×10^{-1}	3.1×10^{0}	3.1×10^{0}
Total Plume Risk						**3.1×10^{1}**					**2.2×10^{0}**

NA – not applicable HI – hazard Index ND – nondetect µg/L – micrograms per liter
*Risks derived from contaminants other than the contaminants of concern did not contribute significantly to total plume risk.

The cancer risks for adult and child swimmers and fish consumers exposed to Coonamessett Pond were all less than the regulatory criteria. However, cranberry workers (with the reasonable maximum exposure) who are exposed to the Coonamessett River may have cancer risks within the EPA risk management criteria range (1×10^{-6} to 1×10^{-4}) and less than the DEP criteria (1×10^{-5}). The primary contributor to this risk is EDB in river water (Table 2-9). Adult and child waders in the Coonamessett River may have cancer risks within the EPA risk management criteria range but slightly higher than the DEP criteria. This risk is primarily due to EDB in river water and arsenic in sediment. The Coonamessett River fish consumer (with the reasonable maximum exposure) may have cancer risks higher than both regulatory criteria primarily due to EDB and arsenic in the river water.[7]

2.7.1.5 Uncertainty Analysis

There are uncertainties involved in the process of quantifying risk for human receptors and they tend to make the baseline risk assessment very conservative. There are many conservative factors built into the human health risk assessment. The exposure scenarios and health-protective exposure factors used generally overestimate rather than underestimate exposure. For each risk area (plume), the assessment assumed that an individual receptor would be exposed to all contaminants at their respective maximum concentrations detected within the given area. In the RME groundwater assumptions, the maximum concentrations of contaminants detected in groundwater (for a given area or plume) were conservatively assumed to be present in all groundwater throughout the risk area for the entire 30-year period. (This assumption disregards the actual distribution of contaminants within the plume, contaminant degradation, and plume movement.) It is assumed that human exposure remains constant over the lifetime of an individual. In

[7] The baseline risk assessment was based on data collected in 1998. Since May 1999, time-critical and non-time-critical removal actions implemented by AFCEE have significantly reduced EDB discharging to the Coonamessett River and surrounding bogs. EDB has not been detected in the Coonamessett River since shortly after the shallow well-point extraction system began operation in April 1999.

fact, lifestyle changes and movement of individuals in and out of the potentially exposed community also affect exposure duration. Chronic reference concentrations and doses were used for all exposure scenarios even though some exposure pathways were 6.6 years or less. Slope factors developed by the EPA are generally conservative and represent the upper bound limit of the probability of a cancer response. Also, it is possible for carcinogenic risk to be reported for chemicals that may not induce cancer.

Table 2-9
FS-28 Cancer Risks from Exposure to the Coonamessett River and Bogs

	Cancer Risks (Reasonable Maximum Exposure) Child Wader in Coonamessett River and Bogs			
	Ingestion	**Inhalation (vapor)**	**Dermal**	**Total Risk**
EDB in surface water	5.05×10^{-6}	0	2.98×10^{-6}	8.03×10^{-6}
Arsenic in sediment	3.21×10^{-5}	NA	1.64×10^{-6}	4.84×10^{-6}
All media				1.29×10^{-5}

	Cancer Risks (Reasonable Maximum Exposure) Adult Wader in Coonamessett River and Bogs			
	Ingestion	**Inhalation (vapor)**	**Dermal**	**Total Risk**
EDB in surface water	4.33×10^{-6}	0	4.96×10^{-6}	9.29×10^{-6}
Arsenic in sediment	1.37×10^{-6}	NA	3.81×10^{-7}	1.76×10^{-6}
All media				1.10×10^{-5}

	Cancer Risks (Reasonable Maximum Exposure) Cranberry Worker in Coonamessett River and Bogs			
	Ingestion	**Inhalation (vapor)**	**Dermal**	**Total Risk**
EDB in surface water	5.2×10^{-7}	0	2.4×10^{-6}	2.56×10^{-6}
All media				

Table 2-9
FS-28 Cancer Risks from Exposure to the Coonamessett River and Bogs

	Cancer Risks (Reasonable Maximum Exposure) Eater of Fish from Coonamessett River and Bogs			
	Ingestion	**Inhalation (vapor)**	**Dermal**	**Total Risk**
EDB in surface water	9.47×10^{-5}	NA	NA	9.47×10^{-5}
Arsenic in surface water	5.04×10^{-5}	NA	NA	5.04×10^{-5}
All media				1.45×10^{-4}

Other factors introduce uncertainty in the risk assessment which may cause the risk assessment to be overly conservative, but which could also potentially cause the risk assessment to be less protective than the results indicate. Reference concentrations and doses developed by the EPA are generally considered to have uncertainty spanning an order of magnitude or more. There are numerous uncertainties concerning the adjustment of oral reference doses and slope factors to dermal reference doses and slope factors based on intestinal absorption. Regarding the consumer of fish caught in the Coonamessett River, there is some uncertainty associated with the estimated factor representing the bioaccumulation of EDB in fish tissue. Finally, carcinogenic risks and noncancer hazards for different contaminants were totaled; this ignores the possible synergistic or antagonistic effects between different contaminants.

Based on the above considerations, it is believed that the conclusions of the baseline risk assessment are very conservative.

2.7.2 Summary of Ecological Risk Assessment

The ecological risk assessment presented in Section 6.2 of the SWOU RI consists of a screening level and a baseline risk analysis conducted for surface water and sediment in the Coonamessett River and Coonamessett Pond, which lie in the vicinity of the FS-28 plume. The ecological risk assessment is a qualitative and/or quantitative evaluation of the potential impacts that SWOU groundwater contaminants may have on wildlife species. The ecological risk assessment evaluated potential impacts to representative

aquatic (alewife and tidewater mucket) and semi-aquatic organisms (osprey, black-crowned night heron, raccoon, and the eastern box turtle) that would use the Coonamessett River or Coonamessett Pond for habitat or for gathering food. Terrestrial organisms were not included in the assessment because the SWOU RI focused on groundwater and surface water bodies that are potentially affected by contaminated groundwater.

Two different risk characterization approaches were used. For protection of populations of organisms that do not have special status and are mobile enough to forage over wide areas of habitat (black-crowned night heron and raccoon), an average exposure scenario was used. An extreme exposure scenario was used for protection of individuals of species of special concern (alewife, osprey, and eastern box turtle) and nonmobile benthic invertebrates (tidewater mucket).

The risk analysis indicates that there could be ecologically significant adverse effects for individual alewife and eastern box turtle in the Coonamessett River and for individual alewife, mucket, osprey, and heron in the pond. These risks are primarily due to cobalt and mercury in the pond environments and arsenic, cadmium, mercury, iron, zinc, lead, pyrene, and fluoranthene in the river environment. However, when background levels of metals were eliminated, there were no significant adverse effects on SWOU ecological receptors. Therefore, since MMR-related organic contaminants did not drive the ecological risk and the risk was primarily attributable to non-MMR-related metals in emerging groundwater, surface water, and sediment, it was concluded in the SWOU RI that remedial action would be driven by human health risk and not ecological risk. Thus, actions contained in the selected remedies only address ecological risks incidental to their goal of addressing human health risks.

2.8 REMEDIAL ACTION OBJECTIVES

Based on the risk calculations described in Section 2.7, contamination within the FS-28 and FS-29 plumes, if not addressed by implementing response actions such as the ones

selected in this ROD, may present a current or potential threat to public health, welfare, or the environment. AFCEE, EPA, and DEP developed the remedial action objectives presented in this section for the FS-28 and FS-29 plumes. The remedial action objectives aim to reduce risk by preventing or reducing exposure and by restoring the aquifer.

2.8.1 FS-28 Plume Remedial Action Objectives

The remedial action objectives for the FS-28 plume are the following:

- Prevent or reduce residential exposure to EDB exceeding 0.02 µg/L in groundwater.
- Restore the aquifer to its beneficial uses within a reasonable time.
- Prevent worker contact and child and adult wader contact with Coonamessett River water containing unacceptable concentrations of EDB.
- Prevent or reduce ingestion of fish exposed to Coonamessett River water containing unacceptable concentrations of EDB.

2.8.2 FS-28 Actions Taken to Date

Several actions have already been taken in response to the FS-28 plume. These include:

- Connections to municipal water supplies have been provided for all private well users above and in the immediate vicinity of the plume.
- A granular activated carbon system has been installed at the CWSW to protect this public water supply.
- An extraction well (EW-1) and treatment system have been constructed and operated to remove the highest concentrations of EDB from the plume.
- The treatment system has been modified to add extraction from shallow well-points in order to prevent contaminated water from entering the Coonamessett River.
- Systems have been put into place to provide agricultural users with clean water.
- Berms and sheet piles have been installed to separate the Coonamessett River from the surrounding cranberry bogs.

These actions should be considered in relation to the remedial action objectives. The municipal water supply hookups and the treatment system for the CWSW prevent residential exposure to plume contaminants. Operating in concert, EW-1 and the shallow

well-points capture plume contaminants before they discharge to the river in detectable concentrations. Since May 1999, no EDB has been detected in the Coonamessett River.[8] This directly addresses the remedial action objectives, which call for prevention of worker and wader contact to unacceptable concentrations of EDB in the river and prevention or reduction of the ingestion of fish exposed to unacceptable concentrations of EDB. Additional alternatives were considered in the *Final FS-28 and FS-29 Groundwater Feasibility Study* (AFCEE 2000d) that provide more expedited aquifer restoration.

2.8.3 FS-29 Plume Remedial Action Objectives

The remedial action objectives for the FS-29 plume are the following:

- Prevent or reduce residential exposure to EDB exceeding 0.02 µg/L and CCl_4 exceeding 5 µg/L in groundwater.
- Restore the aquifer to its beneficial uses within a reasonable time.

2.8.4 Steps to Achieving Remedial Action Objectives

MMR groundwater plumes, including the FS-28 and FS-29 plumes, are located within the Cape Cod sole-source aquifer. Therefore, AFCEE has agreed that for all active remedies selected, it will undertake a three-step process in achieving remedial action objectives. For active remedies for FS-28 and FS-29, this three-step process, which was outlined in the Proposed Plan dated February 2000 (AFCEE 2000c), will be implemented in the following manner:

1. **Remediate the aquifer to federal and state drinking water standards.** Restoration time frames and remedial costs estimated in this ROD were developed based on the expected time to attain federal and state drinking water standards

[8] A May 2000 sample collected at 69SW2018 contained 0.068 µg/L of EDB. This sample was collected from a ditch which drains water from the E3 cranberry bog into the Coonamessett River. Flows from this ditch and the associated culvert are orders of magnitude less than the flow in the Coonamessett River at that point. The planned response to this contamination is presented in Section 2.11.1.

(MCLs and MMCLs). During the period that remedial systems are in operation, AFCEE will monitor the plumes in accordance with the approved system performance monitoring plan. The plumes will be considered to have reached MCLs and MMCLs when there have been no detections exceeding those levels over a time period agreed to by AFCEE and EPA in consultation with DEP.

2. **When MCLs and MMCLs are achieved and before the system is shut off, perform a risk assessment to determine if unacceptable ecological and/or human health risks are present; continue system operation and/or pursue additional measures as required to achieve acceptable risks.** AFCEE shall conduct a risk assessment once MCLs and MMCLs have been achieved (as defined in step 1, above) to determine whether the contaminants of concern remaining in the aquifer continue to pose unacceptable ecological and/or human health risks. This risk determination shall be made jointly between AFCEE and EPA in consultation with DEP and may result in aquifer cleanup that is more protective than the NCP point of departure risk level of 10^{-6} (40 CFR Part 300.430(e)(2)), if justified, based on the following site-specific factors: "cumulative effects of multiple contaminants, the potential for exposure from other pathways of exposure at the site, population sensitivities, potential impacts on environmental receptors, and cross-media impacts" (NCP Preamble, page 8717).

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

   A. Technological - Not feasible if

      i. The existing technologies or modifications cannot remediate to a level of no significant risk, or to levels which approach or achieve background; or

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

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

   B. Economic - The benefits of implementing a remedy and reducing the concentrations of contaminants in the environment to levels which approach or achieve background justifies related cost unless:

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

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

AFCEE and EPA, with input from DEP, have also agreed that if the implementation of steps two and/or three above leads to a mutual decision to undertake additional cleanup and such decision results in a "significant" or "fundamental" change to the remedial approach, cleanup levels, and/or costs documented in this final ROD, AFCEE will execute an Explanation of Significant Differences (with public comment) or ROD Amendment, as appropriate. Whether any such additional cleanup actions result in a significant or fundamental change to this final ROD shall be determined jointly by AFCEE and EPA, in consultation with DEP, in accordance with the criteria set forth in EPA's *A Guide to Preparing Superfund Proposed Plans, Records of Decision, And Other Remedy Selection Decision Documents,* OSWER 9200.1-23P (1999). In this manner, such changes will be subject to regulatory review and stakeholder involvement through issuance of a new proposed plan and/or a public comment period. If a dispute arises regarding any of the determinations to be jointly reached under the three-step process outlined above, such dispute shall be resolved under the dispute resolution procedures of the MMR FFA. This three-step process has been agreed to solely for groundwater cleanup at MMR due to unique circumstances presented by the location of the MMR plumes within the sole-source aquifer on Upper Cape Cod.

2.9 DESCRIPTION OF ALTERNATIVES

The *Final FS-28 and FS-29 Groundwater Feasibility Study* (AFCEE 2000d) reviewed a wide range of technologies for remediating the FS-28 and FS-29 plumes. Technologies were screened on the basis of effectiveness, implementability and cost. Acceptable technologies were developed into remedial alternatives, which were in turn screened. Alternatives judged to be acceptable at this stage received detailed development and analysis in the feasibility study and are presented below. The numbering convention used during the alternative screening process has been retained, and thus, the numbering of the alternatives presented is not sequential.

Section 2.9.1 describes institutional controls that would be a component of any remedial alternative. Sections 2.9.2 and 2.9.3 describe remedial alternatives for the FS-28 and FS-29 plumes, respectively.

2.9.1 Institutional Controls

Several institutional controls protect area residents from exposure to FS-28 and FS-29 plume contaminants. The safety of all public water supplies within Massachusetts is currently regulated by the Commonwealth. Additionally, the drilling of a new drinking water supply well within the CWMA would require the approval of the Massachusetts Legislature. In addition to the steps AFCEE has already taken to connect potentially affected residents to the municipal water supply, the town of Falmouth has also adopted bylaws to protect residents from exposure to contaminated groundwater. Thus, the institutional controls presently in place adequately prevent residential exposure in all Falmouth households surrounding the FS-28 and FS-29 plumes.

At its September 13, 1999 meeting, the Falmouth Board of Health adopted water well regulations to minimize the risk of exposure to groundwater contamination. The Town of Falmouth will be responsible for implementing and enforcing these institutional controls on private wells within the town. These regulations require a permit from the Board of Health for the installation and use of all wells, including drinking water wells, irrigation wells, and monitoring wells. Along with other requirements, this regulation states that "A Drinking Water Well must [be] tested for... volatile organic compounds and found to be within potable water limits as defined in 310 CMR 22.000 Drinking Water Regulations and must not exceed the Commonwealth of Massachusetts' maximum contaminant levels." AFCEE will coordinate with the Falmouth Board of Health periodically (but not less than annually) to ensure the town knows of any changes to plume configurations or contaminant concentrations.

If the Board of Health allows the installation of a well above a plume, within 500 feet crossgradient of a plume, or 1500 feet downgradient of a plume, AFCEE will sample this

well regularly. Furthermore, AFCEE will regularly sample private wells installed prior to the promulgation of the Board of Health regulations that are over a plume, within 500 feet crossgradient of a plume, or 1500 feet downgradient of a plume for which public water connections have not been provided. The frequency of residential well sampling will be determined in consultation with AFCEE, health authorities, and the regulatory agencies.

2.9.2 Alternatives for the FS-28 Plume

The FS-28 and FS-29 Groundwater Feasibility Study evaluated the following seven remedial alternatives for the FS-28 plume. Alternatives in italic type were screened out on the basis of effectiveness, implementability, and cost, as described in further detail in the *Final FS-28 and FS-29 Groundwater Feasibility Study* (AFCEE 2000d).

1. No remedial action with long-term monitoring.
2. *Continued operation of EW-1 and the CWSW wellhead protection system only.*
3. Continued treatment system operations (EW-1, the CWSW wellhead protection system, and the shallow well-point extraction system).
4. *Continued remedial operations with the addition of a new ETR system north of Coonamessett Pond to reduce aquifer restoration time and prevent plume migration under the pond.*
5. *Continued remedial operations with the addition of a new ETR system north of the western arm of Coonamessett Pond to reduce aquifer restoration time.*
6. Continued remedial operations with the addition of a new ETR system in the area of Coonamessett Circle to reduce aquifer restoration time and prevent contaminants in the northwestern portion of the plume from migrating under the pond.
7. Continued remedial operations with the addition of a new extraction, treatment, and discharge system in the Souza Conservation Area (immediately south of the western arm of Coonamessett Pond) to reduce aquifer restoration time.

The four alternatives which passed the screening phase received additional analysis and are summarized below.

2.9.2.1 Alternative 1: No Remedial Action with Long-Term Monitoring

- No active treatment would be conducted. Natural processes, primarily dispersion and abiotic degradation, would continue to influence the FS-28 plume, as described in the *Final FS-28 and FS-29 Groundwater Feasibility Study* (AFCEE 2000d) and the SWOU RI (AFCEE 1999b).
- No steps would be taken to contain plume contaminants.
- No institutional controls are included in this alternative.[9]
- No operations and maintenance activities are included in this alternative. Operation of the existing FS-28 treatment system and the CWSW wellhead protection system would cease.
- Groundwater monitoring would be required as long as COC concentrations remain above the standards presented in the remedial action objectives. A thorough site review would be conducted every five years until contaminant concentrations are below cleanup levels.

2.9.2.2 Alternative 3: Continued Treatment System Operations

- This alternative includes continued operation of the existing FS-28 treatment system, including the 204 shallow well-point extraction system, and the CWSW wellhead treatment system. Extracted water would be treated with granular activated carbon. Contaminants would be destroyed during carbon reactivation.
- Treated water could be used, if necessary to avoid the use of potentially contaminated river water, for cranberry operations in the upper bogs. Berms and vinyl sheet piles would separate some cranberry bogs from the river.
- Institutional controls, as discussed in Section 2.9.1, are included in this alternative.
- Operations and maintenance would continue until the three-step process outlined in Section 2.8.4 has been satisfied.
- This alternative includes monitoring of the plume and performance monitoring of the treatment systems. Ecological sampling would also be conducted as part of this alternative. The focus of ecological sampling is to measure the impact that treatment systems (not the plume) have on the environment. A thorough site review would be conducted every five years until cleanup levels are met.

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[9] In accordance with CERCLA, for no action alternatives, it is assumed that existing institutional controls will be ineffective.

2.9.2.3 Alternative 6: Continued Remedial Operations with Capture North of the Western Arm of Coonamessett Pond

- This alternative includes continued operation of the existing FS-28 treatment system, including the 204 shallow well-point extraction system, and the CWSW wellhead treatment system. Extracted groundwater would be treated with granular activated carbon. Plume contaminants would be destroyed during reactivation of the carbon.

- Additional drilling and sampling would be required to design the new ETR system. New extraction wells would be drilled within the body of the plume to provide additional capture and to reduce aquifer restoration time. Water would be extracted from wells located in the center of the plume and the treated water would be discharged to the aquifer through reinjection wells. Modeling indicates that most of the northern portion of the FS-28 plume could be captured by extracting and treating 600 gallons per minute.

- Institutional controls, as discussed in Section 2.9.1, are included in this alternative.

- Operations and maintenance would continue until the three-step process outlined in Section 2.8.4 has been satisfied.

- This alternative includes monitoring of the plume and performance monitoring of the treatment systems. Ecological sampling would also be conducted as part of this alternative. The focus of ecological sampling is to measure the impact that treatment systems (not the plume) have on the environment. A thorough site review would be conducted every five years until contaminant cleanup levels are met.

2.9.2.4 Alternative 7: Continued Remedial Operations with Additional Extraction and Treatment in the Souza Conservation Area

- This alternative includes continued operation of the existing FS-28 treatment system, including the 204 shallow well-point extraction system, and the CWSW wellhead treatment system. Extracted groundwater would be treated with granular activated carbon. Plume contaminants would be destroyed during reactivation of the carbon.

- Additional drilling and sampling would be required to design the new ETR system. New extraction wells would be drilled just south of the western arm of Coonamessett Pond (near the CWSW) in the Souza Conservation Area to provide additional capture and to reduce aquifer restoration time. Water would be extracted from approximately three wells, treated, and discharged to Coonamessett Pond, the Coonamessett River, or both surface water bodies. Modeling indicates that the plume could be effectively cut off at the extraction location by extracting and treating 600 gallons per minute.

- Institutional controls, as discussed in Section 2.9.1, are included in this alternative.

- Operations and maintenance would continue until the three-step process outlined in Section 2.8.4 has been satisfied.

- This alternative includes monitoring of the plume and performance monitoring of the

treatment systems. Ecological sampling would also be conducted as part of this alternative. The focus of ecological sampling is to measure the impact that treatment systems (not the plume) have on the environment. A thorough site review would be conducted every five years until contaminant cleanup levels are met.

2.9.2.5 Common Elements and Distinguishing Features of FS-28 Plume Alternatives

Alternative 1 does not actively treat the FS-28 plume since the existing treatment systems (the FS-28 treatment system, including the shallow well-point extraction system, and the CWSW) would not be operated under this alternative. The existing residential connections to the public water supply would remain in place, and the berms and sheet piles in the bogs would remain in place although they would not be maintained. The monitoring program would be similar to the existing program, but without the FS-28 treatment system operating, the results would be expected to be different. Alternatives 3, 6, and 7 would actively extract and treat plume contamination.

Each of the active alternatives would eventually capture the same mass of EDB, approximately 99.7 percent of the EDB in the FS-28 plume. The distinguishing factor is how long it would take for the entire plume to reach the cleanup levels. Alternative 3 would capture approximately 99.7 percent of the EDB in the FS-28 plume within approximately 18 years by taking advantage of the naturally converging flow field to allow the plume to continue to flow into the capture systems AFCEE has already put in place in the downgradient portion of the plume. Alternatives 6 and 7 would speed aquifer restoration by continuing the existing treatment operations at the southern portion of the plume while also extracting and treating the contamination in the northern portion of the plume. The construction and operation of the northern components proposed in Alternatives 6 and 7 could pose unacceptable ecological impacts. Gaining access to the land overlying the northern part of the plume would pose an implementation challenge.

Alternatives 3, 6, and 7 would have to comply with the Massachusetts Endangered Species Act. As described in the Final FS-28 and FS-29 Groundwater Feasibility Study (AFCEE 2000d), the activities proposed under Alternatives 3, 6, and 7 would also have to

comply with various provisions of RCRA and the Massachusetts Hazardous Waste Management Regulations. Table 2-10 summarizes the cost estimates prepared for each of the alternatives.

Alternative 1 could be implemented immediately. Alternatives 6 and 7 would require additional site characterization and modeling to support system design. The systems proposed under Alternatives 6 and 7 may not become operational until 2-3 years after the ROD is finalized. Alternative 3 is essentially in place. However, since the existing extraction, treatment, and discharge system components that are part of Alternatives 3, 6, and 7 were installed as somewhat temporary systems under time-critical and non-time-critical removal actions, these system components will require modification to make them part of a more permanent remedial system.[10]

Table 2-10
Costs Associated with FS-28 Plume Remedial Alternatives

Alternative	Total Installed Costs*	Annual Costs*	Number of Years to Reach MCLs	Total Present Worth Costs*
1	$270,000**	$340,000	18	$3,400,000
3	$0	$680,000	18	$7,100,000
6	$8,800,000	$1,000,000	11	$15,000,000
7	$5,700,000	$970,000	9	$12,000,000

MCL = maximum contaminant level
Future costs returned to present worth based on a discount rate of 7 percent.
* Costs presented above do not include the costs previously incurred for design and construction of the EW-1 treatment system ($670,000) or the CWSW wellhead treatment system ($470,000). The shallow well-point system and berm construction costs ($2,650,000) are also not included.
** Alternative 1 total installed costs are estimated based on sampling and analysis costs to establish baseline environmental conditions.

2.9.2.6 Expected Outcomes of FS-28 Alternatives

Alternative 1 would allow EDB in the FS-28 plume to discharge to the Coonamessett River and surrounding bogs, and the EDB concentrations in groundwater would remain

[10] Such modification is not included in the cost estimates presented in Table 2-9 and elsewhere in this document.

above the drinking water standard for approximately 18 years. Alternatives 3, 6, and 7 would prevent the discharge of EDB to the surface, provide clean water for agricultural purposes along the Coonamessett River, and prevent human exposure to the FS-28 plume. Since all residences overlying the plume are connected to the municipal water supply, and institutional controls are in place to prevent human exposure to the plume, no immediate reduction of human health risks would be realized by implementing Alternative 6 or 7 rather than Alternative 3.

Alternative 3 would actively remove EDB contamination from the groundwater system until cleanup standards are met in approximately 18 years. Alternatives 6 and 7 would build on Alternative 3 by reducing the time for the entire plume to reach cleanup standards from 18 years to 11 years or 9 years, respectively. Once contaminant concentrations have been reduced to drinking water standards, groundwater in the current area of the FS-28 plume can be used without restriction. Due to the unique nature of the sole-source aquifer on Upper Cape Cod, under Alternatives 3, 6, and 7, the actions described in steps 2 and 3 of Section 2.8.4 would be undertaken once contaminant concentrations were reduced to drinking water standards.

2.9.3 Alternatives for the FS-29 Plume

Seven remedial alternatives for the FS-29 plume were developed and evaluated in the *Final FS-28 and FS-29 Groundwater Feasibility Study* (AFCEE 2000d). Alternatives in italic type were screened out on the basis of effectiveness, implementability and cost.

1. No remedial action with long-term monitoring.
2. Use institutional and engineering controls to prevent future residential exposure to FS-29 plume contaminants.
3. Construct a groundwater ETR system using granular activated carbon treatment to capture the plume.
4. *Construct a groundwater ETR system using granular activated carbon treatment for mass removal within the plume.*
5. *Use recirculating wells to remove plume contaminants.*
6. *Use extraction wells with mobile carbon treatment systems as defined in Section*

3.2.4.5 of the FS-28 and FS-29 Groundwater Feasibility Study to capture the central portion of the plume.

7. Construct a groundwater ETR system to capture the central portion of the plume

The four alternatives which passed the screening phase received additional analysis and are summarized below.

2.9.3.1 Alternative 1: No Remedial Action with Long-Term Monitoring

- The planned CS-21 plume ETR system will capture approximately 23 percent of the mass of the FS-29 plume (AFCEE 2000d). No additional actions would be undertaken to remove, destroy, or immobilize contamination or to prevent exposure to the FS-29 plume.
- The available site information indicates that the plume extent is not expanding and will not migrate past Route 28. Natural processes, primarily advection, sorption, desorption, dispersion, and possibly hydrolysis, will continue to cause contaminant concentrations to decrease. Long-term monitoring would be conducted to ensure that the plume is not migrating.
- No institutional controls or engineering controls are included in this alternative.[11]
- No operations and maintenance activities are included in this alternative.
- Groundwater monitoring would be required as long as COC concentrations remain above the standards presented in the remedial action objectives. A thorough site review would be conducted every five years until contaminant concentrations are below cleanup levels.

2.9.3.2 Alternative 2: Institutional and Engineering Controls

- The planned CS-21 plume ETR system will capture approximately 23 percent of the mass of the FS-29 plume. No additional actions would be undertaken to remove, destroy, or immobilize contamination or to prevent exposure to the FS-29 plume.
- The available site information indicates that the plume extent is not expanding and will not migrate past Route 28. Natural processes, primarily advection, sorption, desorption, dispersion, and possibly hydrolysis, will continue to cause contaminant concentrations to decrease. Long-term monitoring would be conducted to ensure that the plume is not migrating.

[11] In accordance with CERCLA, for no action alternatives, it is assumed that existing institutional controls will be ineffective.

- Institutional controls, as discussed in Section 2.9.1, are included in this alternative.
- Wellhead protection treatment systems (an engineering control) could be used to protect municipal supply wells, if such wells were permitted near the plume.
- Groundwater monitoring would be required as long as COC concentrations remain above the standards presented in the remedial action objectives. A thorough site review would be conducted every five years until contaminant concentrations are below cleanup levels.

2.9.3.3 Alternative 3: Extraction, Treatment, and Reinjection for Plume Capture

- Under this alternative, an ETR system would be constructed to capture and treat plume contaminants. Extracted water would be treated with granular activated carbon. Contaminants would be destroyed during carbon reactivation.
- Water would be extracted through approximately two extraction wells and discharged to the aquifer in infiltration galleries. Groundwater modeling indicates that capture can be accomplished by pumping and treating approximately 600 gallons per minute. The upgradient portion of the plume would be captured by the planned CS-21 treatment system.
- Institutional controls, as discussed in Section 2.9.1, are included in this alternative.
- Operations and maintenance would continue until the three-step process outlined in Section 2.8.4 has been satisfied.
- Additional drilling and sampling and groundwater modeling would be required to improve the understanding of the plume extent in support of system design. Also included in this alternative are long-term monitoring of the plume, performance monitoring and evaluation of the treatment systems, and ecological sampling to monitor the impacts of the treatment systems on the environment. A thorough site review would be conducted every five years until cleanup levels are met.

2.9.3.4 Alternative 7: Extraction, Treatment, and Reinjection to Capture the Central Portion of the FS-29 Plume

- Under this alternative, an ETR system would be constructed to capture and treat the central portion of the FS-29 plume. Extracted water would be treated with granular activated carbon. Contaminants would be destroyed during carbon reactivation.
- Water would be extracted through approximately two extraction wells and discharged to the aquifer in infiltration galleries. Groundwater modeling indicates that capture can be accomplished by pumping and treating approximately 600 gallons per minute. The upgradient portion of the plume would be captured by the planned CS-21 treatment system.

- Institutional controls, as discussed in Section 2.9.1, are included in this alternative.
- Operations and maintenance would continue until the three-step process outlined in Section 2.8.4 has been satisfied.
- Additional drilling and sampling and groundwater modeling would be required to improve the understanding of the plume extent in support of system design. Also included in this alternative are long-term monitoring of the plume, performance monitoring and evaluation of the treatment systems, and ecological sampling to monitor the impacts of the treatment systems on the environment. A thorough site review would be conducted every five years until contaminant cleanup levels were met.

2.9.3.5 Common Elements and Distinguishing Features of FS-29 Plume Alternatives

Alternatives 1 and 2 include no actions to speed the remediation of the FS-29 plume. Under both Alternatives 1 and 2, natural processes would degrade the contamination within the plume within approximately 13 to 17 years, and the contaminant concentrations within the plume would be monitored until the cleanup standards are met. Currently all residences over the FS-29 plume are connected to the municipal water supply. However, Alternative 2 would provide additional protection of human health by using institutional and engineering controls to prevent any future human exposure to the FS-29 plume. All alternatives (1, 2, 3, and 7) include the capture of approximately 23 percent of the plume mass by the planned treatment system for the CS-21 plume.

Alternatives 3 or 7 would actively remove plume contaminants from the groundwater. As conceptually designed, they are similar in that they both would extract approximately 600 gallons per minute, and both would use approximately 2 extraction wells located along the plume axis and would probably use infiltration to return the treated water to the aquifer.

Alternatives 3 and 7 are distinguished by the manner in which the leading edge of the plume would reach cleanup standards. Under Alternative 3, the entire plume, including the thinner leading edge would be captured by the extraction system. Alternative 7, on the other hand, would extract groundwater from the central portion of the plume where

the EDB concentrations are highest, and rely on natural processes to dilute (and possibly degrade) the forward portion of the plume to concentrations below cleanup standards. Under Alternative 3, the cleanup levels would be met in approximately 8 years. Under Alternative 7, the cleanup levels in the central and forward portions of the plume would be met within approximately 6 years and 10 years, respectively.

Alternatives 3 and 7 would have to comply with the Massachusetts Endangered Species Act. As described in the *Final FS-28 and FS-29 Groundwater Feasibility Study* (AFCEE 2000d), the activities proposed under Alternatives 3 and 7 would also have to comply with various provisions of RCRA and the Massachusetts Hazardous Waste Management Regulations. Table 2-11 presents cost estimates for each of the alternatives.

Table 2-11
Costs Associated with FS-29 Plume Remedial Alternatives

Alternative	Total Installed Cost	Annual Costs	Number of Years to Reach MCLs	Total Present Worth Cost
1	$0	$100,000	13 to 17	$970,000
2	$0	$270,000	13 to 17	$3,100,00
3	$6,600,000	$740,000	8	$11,000,000
7	$6,000,000	$740,000	10	$10,000,000

MCL = maximum contaminant level
Note: Future costs returned to present worth based on a discount rate of 7 percent.

Alternative 1 or 2 could be implemented immediately. Alternatives 3 and 7 would require additional site characterization and modeling to support system design. The systems proposed under Alternatives 3 and 7 may not become operational for approximately 2 years after this ROD is finalized.

2.9.3.6 Expected Outcomes of FS-29 Alternatives

For every alternative (1, 2, 3, and 7), it is assumed that the FS-29 plume is not expanding and will not migrate past Route 28, and that approximately 23 percent of the plume mass will be captured and treated by the planned CS-21 plume system. Under Alternatives 1 and 2, plume contaminants would be reduced to concentrations below drinking water standards in approximately 13 to 17 years. Alternatives 3 and 7 would actively remove

groundwater contamination and speed aquifer restoration. The plume contaminants would be reduced to concentrations below drinking water standards in 8 and 10 years for Alternatives 3 and 7, respectively. Once contaminant concentrations have been reduced to drinking water standards, groundwater in the current area of the FS-29 plume can be used without restriction. Due to the unique nature of the sole-source aquifer on Upper Cape Cod, under Alternatives 3 and 7, the actions described in steps 2 and 3 of Section 2.8.4 would be undertaken once contaminant concentrations were reduced to drinking water standards.

2.10 SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

This section summarizes the comparative analysis of alternatives presented in the *Final FS-28 and FS-29 Groundwater Feasibility Study* (AFCEE 2000d).

2.10.1 Criteria For Detailed Analysis of Alternatives

The NCP (40 CFR, Part 300) presents nine criteria for analyzing the acceptability of a given alternative. These nine criteria are categorized as threshold criteria, primary balancing criteria, and modifying criteria.

2.10.1.1 Threshold Criteria

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

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

Compliance with ARARs: Each alternative was assessed to determine whether it complies with applicable or relevant and appropriate requirements under federal and state laws. Section 121(d) of CERCLA requires that remedial actions at CERCLA sites attain legally applicable or relevant and appropriate federal and state requirements, standards, criteria, and limitations, unless such ARARs are waived under CERCLA Section 121(d)(4). Appendix A of the *Final FS-28 and FS-29 Groundwater Feasibility Study* (AFCEE 2000d) outlines ARARs for all FS-28 and FS-29 plume remedial alternatives that received detailed analysis. Appendix B of this document outlines ARARs for the selected remedy for each plume.

Chemical-specific standards and guidance values in accordance with the ARARs are presented in Table 2-12.

Table 2-12
Chemical-Specific Standards and Guidance Values

Contaminant	Federal SDWA MCL[1]	Massachusetts Drinking Water MMCL[2]	Contaminant of Concern for Plumes
CCl_4	5	5	FS-29
EDB	0.05	0.02	FS-28 and FS-29

All values in micrograms per liter

1. Environmental Protection Agency Safe Drinking Wafer Act (SDWA) National Primary Drinking Water Regulations per 40 CFR 141 (available on line at http://www.epa.gov).
2. Massachusetts Drinking water standards, Spring 1998, published by the Massachusetts Department of Environmental Protection, Office of Research and Standards, May 1998.

As discussed in the RI (AFCEE 1999b), the FS-28 and FS-29 plumes have been defined according to contaminant concentrations above the MCL or MMCL. Once captured, at a minimum, groundwater will be treated to comply with the most stringent among the following standards: MCL, MMCL, and Massachusetts Groundwater Quality Standards (314 CMR 6.00). Cleanup and treatment system aquifer discharge (effluent) standards are presented in Table 2-13.

Table 2-13
Capture and Aquifer Discharge Standards

Contaminant	Maximum Detected Concentration[1]	Cleanup Level[2]	10^{-6} Risk-based Aquifer Discharge Standard[3]	Regulatory Aquifer Discharge Standard[4]	Combined Aquifer Discharge Standard[5]
CCl_4	9.5	5	0.24	5	0.24
EDB	18	0.02	0.00095	0.02	0.00095

All values in micrograms per liter

1. Maximum detected in the FS-28 or FS-29 plumes.
2. The cleanup level is MCL or MMCL, whichever is more stringent. See Section 2.8.4 for a discussion of steps to be taken to achieve remedial action objectives.
3. 10^{-6} risk-based discharge standards are based on dermal, Ingestion and Inhalation cancer risk, using the exposure factors published In the *Final SWOU Remedial Investigation* (AFCEE 1999b). See Table 2-4.
4. Regulatory aquifer discharge standard is the most stringent of the MCL, MMCL, and Massachusetts Groundwater Quality Standards (314 CMR 6.00). Refer to the text for a further discussion of discharge standards.
5. The combined aquifer discharge standard is the lower of the risk-based and regulatory discharge standards. The aquifer discharge standards apply to treatment system effluent being discharged to the aquifer.

AFCEE remains committed to the goal of only discharging treated water that contains nondetectable levels of contaminants of concern when the treatment technologies employed are capable of meeting this goal.

2.10.1.2 Primary Balancing Criteria

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

Long-Term Effectiveness and Permanence: Each alternative is assessed for its long-term effectiveness and the permanence of the solution. This criterion assesses the destruction or removal of contaminants, the magnitude of residual risks remaining at the conclusion of remedial activities, and the adequacy and reliability of controls to be used to manage residual risk. Under this criterion, the following subcriteria will be addressed (for MMR contamination only):

- 100 percent capture of plume contaminants
- treatment of captured groundwater to background concentrations
- human health and ecological impacts from any uncaptured portion of the plume

- potential water supply impacts
- socioeconomic impacts.

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

Short-Term Effectiveness: This criterion addresses the effects of the alternative during construction and operational phases until remedial objectives are met. Each alternative is evaluated with respect to its (potentially negative) effects on community health, worker safety, and environmental quality during the course of remedial actions. This criterion also addresses the time required by each alternative until remedial objectives are achieved.

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

For remedial alternatives that involve the pumping of groundwater, the impacts of groundwater table mounding and drawdown on area water bodies and vernal pools are a concern. The locations of surface water bodies near the FS-28 and FS-29 plumes are shown in Figure 2-6.

Cost: Cost estimates include both total installed costs (TICs) and O&M costs. TICs include costs for equipment, materials, construction related labor, land, site development, utility connections, engineering support, and sampling and analysis in support of system design and start-up. O&M costs include operating labor, maintenance and repair materials and labor, energy, process chemicals, disposal of treatment residues, operational sampling and analysis, data management, and administration. O&M costs are included in life cycle costs using present worth analysis. This analysis discounts the costs back to present value at an annual rate of 7 percent. It has also been assumed that costs are incurred at the beginning of each year and that the expected useful project life is 30 years, unless modeling predicts that a treatment system can be turned off sooner.

Cost estimates are prepared using data available from the RI and are intended to provide an accuracy of between +50 percent and -30 percent. The cost estimates provided are preliminary. More detailed and accurate cost estimates will be developed as the CERCLA process progresses. Cost estimates included in this document are intended for comparative purposes only.

2.10.1.3 Modifying Criteria

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

State Acceptance: State acceptance evaluates the technical and administrative issues and concerns of the state, specifically the Massachusetts DEP.

Community Acceptance: Community acceptance evaluates the issues and concerns that the public may have regarding each of the alternatives. A summary of the public comments received during the public comment period on the FS-28 and FS-29 proposed plan, along with AFCEE's responses, are provided in Section 3.0, Responsiveness Summary, of this ROD.

2.10.2 Comparison of FS-28 Plume Alternatives

The following four alternatives received detailed description and evaluation for the FS-28 Plume:

- Alternative 1: No Remedial Action with Long-Term Monitoring
- Alternative 3: Continued Treatment System Operations
- Alternative 6: Continued Remedial Operations with Capture North of the Western Arm of Coonamessett Pond
- Alternative 7: Continued Remedial Operations with Additional Extraction and Treatment in the Souza Conservation Area

Overall Protection of Human Health and the Environment. Alternative 1 fails to protect human health and the environment by allowing unacceptable levels of EDB to enter the Coonamessett River. Alternatives 3, 6, and 7 are protective of human health by preventing human contact with contaminated groundwater. A potential risk also exists from wading in or eating fish from the Coonamessett River. This risk is addressed by Alternatives 3, 6, and 7 which provide plume capture that will minimize short-term risks, long-term risks, and environmental exposure to EDB. Alternatives 6 and 7 also include actions that will speed aquifer restoration thereby reducing potential risk over time.

Compliance with ARARs. Alternatives 3, 6, and 7 comply with ARARs. These three alternatives will reduce the levels of EDB in groundwater and surface water to below statutory limits over different time frames (Table 2-14). The restoration time flames for the FS-28 plume are estimates of time needed to reduce EDB concentrations below the MMCL and are based on groundwater flow rates rather than solute transport modeling.

Table 2-14
Comparison of FS-28 Alternatives Approximate Cleanup Times

	Alternative 1: No Remedial Action with Long-Term Monitoring	Alternative 3: Continued Treatment System Operations	Alternative 6: Continued Remedial Operations with Capture North of the Western Arm of Coonamessett Pond	Alternative 7: Continued Remedial Operations with Additional Extraction and Treatment in the Souza Conservation Area
EDB (groundwater)	0.02 µg/L MMCL will be met in 18 years	0.02 µg/L MMCL will be met in 18 years	0.02 µg/L MMCL will be met in 11 years	0.02 µg/L MMCL will be met in 9 years

Note: Under all active treatment alternatives, the three-step process presented in Section 2.8.4 will be followed.

In addition to state and federal drinking water standards (MMCLs and MCLs), key ARARs include: the Clean Water Act, the Resource Conservation and Recovery Act, the Massachusetts Endangered Species Act, and Massachusetts hazardous waste management regulations. The proximity of the FS-28 treatment system to the Coonamessett River and the discharge of treated water to that river also triggers National Pollutant Discharge Elimination System standards, Massachusetts Surface Water Quality Standards, the Rivers and Harbors Act of 1899, the Fish and Wildlife Coordination Act, and Massachusetts wetlands regulations. Appendix B, Tables 1 through 3 provides a complete list of ARARs and a description of the selected remedy's ability to comply with chemical-, location- and action-specific ARARs, respectively.

Alternative 1 does not comply with ARARs. Because Alternative 1 fails to comply with threshold criteria, it will not be considered further.

Long-Term Effectiveness and Permanence. Alternatives 3, 6, and 7 provide long-term effectiveness and are reliable. All of these alternatives will remove approximately the same mass of contamination (approximately 99.7 percent of the FS-28 plume mass) from the aquifer and treat captured groundwater so that no detectable EDB would be released into the aquifer or the receiving surface water bodies. When combined with natural processes, these alternatives will reduce contaminant concentrations in the aquifer to background levels. No unacceptable human health or ecological impacts from uncaptured EDB are anticipated. Alternatives 6 and 7 speed the removal of contaminants from the aquifer. Once removed, recurrence of the contamination is not possible.

Alternatives 3, 6, and 7 all protect the CWSW with wellhead treatment. The accelerated treatment offered in Alternatives 6 and 7 could reduce the amount of time that the CWSW wellhead protection system would be required. Alternative 7 includes deep groundwater extraction near the shallow water supply well, which would tend to draw plume contaminants away from the CWSW well screen. However, the additional extraction would also depress the elevation of the water table, adding to the existing drawdown effects of the supply well operation.

The accelerated cleanup of the plume under Alternatives 6 and 7 would reduce the operational life of treatment systems operating in the southern portion of the plume.

Reduction of Toxicity, Mobility, or Volume Through Treatment. Alternatives 3, 6, and 7 reduce contaminant mobility, toxicity, and volume through treatment and satisfy the regulatory preference for treatment. The highly mobile nature of EDB ensures that significant residuals will not remain after treatment.

All three of these alternatives allow a small amount of contamination that is currently downgradient of the shallow well-point extraction system (and north of Thomas B. Landers Road) to remain uncaptured. However, it is believed that EDB concentrations will be non-detectable in the Coonamessett River because the small volume of contaminated water will discharge to the river over a relatively long period of time resulting in dilution of the EDB to concentrations below the detection limit.

Short-Term Effectiveness. Alternatives 3, 6, and 7 can be implemented in a manner that will be protective of both the community and site workers. Remedial action objectives would be met in approximately 18 years under Alternative 3. Alternatives 6 and 7 would restore the aquifer in approximately 11 years and 9 years, respectively. The shallow well-point extraction system carne on-line in April 1999, and none of the 27 monthly monitored surface water locations in the Coonamessett River have shown detectable EDB since May 1999, suggesting that Alternative 3 is effective at capturing the plume before it discharges to the river and surrounding bogs.

During active treatment, Alternative 6 could have a negative impact on the quality of life and property values on the northwest side of Coonamessett Pond. Similarly, the construction and operation of a remediation system within the conservation area would have a negative impact on the quality of life for area residents who use the area for recreation.

No significant adverse ecological impacts from the existing systems (Alternative 3) have been documented. Alternative 6 carries the potential for ecological impacts that may exceed ecological design targets (AFCEE 1998b), and extensive wellfield design efforts would need to address potential problems with groundwater drawdown and mounding and the relatively high flux of treated water through Coonamessett Pond.

Alternative 7 would have significant environmental impacts. To the extent possible, these impacts would be mitigated through system design. The Souza Conservation Area is a wooded tract located just south of the western arm of Coonamessett Pond. The construction of access roads and clearing of vegetation for the installation of monitoring and extraction wells, extraction and discharge pipelines, and the treatment facility would adversely affect the ecosystem. The Coonamessett River exits Coonamessett Pond in this area, and because the upper 300 yards of the river is a man-made ditch excavated in 1906 to connect the existing river with the pond (Belding 1912), the hydraulic balance between groundwater and surface water in this area is extremely sensitive. Monitoring data collected since 1997 in this area indicate that this upper reach of the river is a losing stream; where the river crosses Hatchville Road, flow is equal to or less than that exiting the pond. These data also suggest that the river becomes dry when groundwater elevations are low or when the pond elevation is low, and that the river is impacted by the removal of shallow groundwater from the CWSW. The additional removal of 600 gallons per minute from the groundwater and discharge to the pond or river, as proposed in Alternative 7, will significantly affect the upper reach of the Coonamessett River. Section 5.2.4 of the *Final FS-28 and FS-29 Groundwater Feasibility Study* (AFCEE 2000d) provides a detailed discussion of the potential adverse ecological impacts associated with Alternative 7.

Implementability. Alternatives 3, 6, and 7 rely on proven technologies at MMR. Alternative 3 is the most implementable because construction aspects of Alternative 3 have already been implemented. Because the FS-28 plume is composed of fuel components (which are excluded from the definition of hazardous substances under CERCLA section 101(14)), remediation will not qualify for CERCLA's exemption from permitting. All necessary permits needed for implementation of Alternative 3 have already been obtained.

Implementation of Alternatives 6 and 7 would be likely to face significant administrative obstacles. Obtaining the required access permission to implement these alternatives may be a major obstacle. The area in which additional treatment facilities would be located under Alternative 6 is a private, gated community where area residents have specifically requested that there be no remedial construction. The construction area for Alternative 7 is on public land intended for recreation, which may make obtaining the necessary property access difficult there as well. If implementation of Alternatives 6 and 7 is delayed, the benefits presented by these alternatives in terms of reduced time until aquifer restoration is achieved would be reduced.

Cost. The estimated present worth cost for Alternative 3 is $7.1 million, and the present worth costs for Alternatives 6 and 7 are approximately $15 million and $12 million, respectively. These costs do not include the costs previously incurred for design and construction of the FS-28 treatment system, including the shallow well-point extraction system, berms, and sheet piles, and the CWSW well-head treatment system.

State Acceptance. The Massachusetts DEP has expressed its support for Alternatives 3 and 7.

Community Acceptance. Numerous comments were received on the proposed plan concerning the alternatives that were evaluated for the FS-28 plume. Most of the comments made by the public expressed strong opposition to Alternative 6 because of the disruption this alternative would cause the Lochstead Estates community. While some

comments noted preference for the more aggressive cleanup offered by Alternatives 6 and 7, more comments supported Alternative 3. The principal reasons the public gave for opposing Alternative 7 included the potential ecological impacts to the Souza Conservation Area and the Coonamessett River and opposition to granting property access to implement the alternative. Other comments expressed the opinion that the benefits of expedited cleanup do not outweigh the impacts caused by system construction and operation and that additional groundwater extraction could potentially impact the CWSW. While there was not unanimous support for any one alternative, Alternative 3 appears to have the greatest degree of community acceptance.

2.10.3 Comparison of FS-29 Plume Alternatives

The following four alternatives received detailed description and evaluation for the FS-29 plume:

- Alternative 1: No Remedial Action with Long-Term Monitoring
- Alternative 2: Institutional and Engineering Controls
- Alternative 3: Extraction, Treatment, and Reinjection for Plume Capture
- Alternative 7: Extraction, Treatment, and Reinjection to Capture the Central Portion of the FS-29 Plume.

Overall Protection of Human Health and the Environment. Alternatives 2, 3 and 7 adequately protect human health and the environment. Alternative 1 fails to adequately meet the standards set forth in this criterion since contaminants would continue to migrate and no controls would be in place to restrict future access to contaminated groundwater. Under Alternative 2, while there are no current completed pathways to expose human beings or wildlife to contaminants of concern from this plume, institutional and engineering controls would provide additional protection by restricting installation of future private and municipal wells above and in close proximity to the plume. The extraction, treatment, and reinjection of contaminated groundwater offered with Alternative 3 or 7 would reduce the mass of contaminants present and the volume of contaminated groundwater and reduce potential risk over time.

Compliance with ARARs. Alternatives 1, 2, 3, and 7 comply with ARARs. Table 2-15 presents the estimated time required to meet drinking water standards in the aquifer.

Table 2-15
Comparison of FS-29 Alternatives
Approximate Cleanup Times

Contaminant	Alternative 1: No Remedial Action with Long-Term Monitoring	Alternative 2: Institutional and Engineering Controls	Alterative 3: Extraction, Treatment and Reinjection for Plume Capture**	Alternative 7: Extraction, Treatment and Reinjection to Capture the Central Portion of the FS-29 Plume***
EDB	0.02 µg/L MMCL will be met in 13-17 years*	0.02 µg/L MMCL will be met in 13-17 years*	0.02 µg/L MMC will be met in 8 years	0.02 µg/L MMCL will be met in 10 years
CCl_4	5 µg/L MCL will be met in 10 years	5 µg/L MCL will be met in 10 years	5 µg/L MCL will be met in 5 years	5 µg/L MCL will be met in 10 years

* These times are from the date of data acquisition.
** Advective flow modeling indicates that 28 years would be required for Alternative 3 to restore the aquifer, but this ignores hydrolysis and dispersion.
*** Under Alternative 7, contaminant concentrations in the central portion of the plume would be below MCLs and MMCLs in less than approximately eight years.

In addition to state and federal drinking water standards (MMCLs and MCLs), key ARARs include: the Massachusetts Endangered Species Act, Massachusetts Hazardous Waste Management Regulations, and the Resource Conservation and Recovery Act. The discharge of treated water to the aquifer also triggers Massachusetts Groundwater Quality Standards, the federal Underground Injection Control Program, and Massachusetts Underground Water Source Protection standards. Appendix B, Tables 4 through 6, provides a complete list of ARARs and a description of the selected remedy's ability to comply with chemical-, location- and action-specific ARARs, respectively.

Because Alternative 1 fails to comply with threshold criteria, it will not be considered further.

Long-Term Effectiveness and Permanence. Under Alternative 2, natural processes are expected to reduce contaminant concentrations within the current plume to background

levels; however, this will require more time than the active alternatives (3 and 7) which capture and treat contamination. Since residents overlying and downgradient of the FS-29 plume are connected to municipal water supplies, no impacts to existing private wells are anticipated under any of these alternatives. There are currently no known municipal water supply wells above or downgradient of the plume, but if one were developed in the future, it would be protected by the engineering controls offered in Alternative 2. Alternatives 2, 3, and 7 include institutional controls as described in Section 2.9.1.

With all FS-29 alternatives, approximately 23 percent of the plume mass would be captured and treated by the planned CS-21 system. Contaminants captured by either the CS-21 system or the system proposed in Alternatives 3 and 7 would be removed to background levels. Of the active alternatives, Alternative 3 is currently projected to remove more mass than Alternative 7 because Alternative 7 would rely on natural processes to reduce contaminants in the distal portion of the plume to concentrations below drinking water standards and Alternative 3 would capture the entire plume by axial extraction at the downgradient extent of the plume. However, due to the limited extent of the available data, there is considerable uncertainty regarding the actual percentages of mass capture that could be achieved by any of the alternatives. More accurate mass capture rates will be established during the pre-design investigation work prior to the design of the system.

Reduction of Toxicity, Mobility, or Volume Through Treatment. Alternative 2 would not treat, remove, or immobilize contamination other than that incidentally captured by the planned CS-21 treatment system. Because Alternative 3 is currently projected to capture the entire plume and Alternative 7 would not, Alternative 3 meets this criteria more effectively than Alternative 7. Under Alternatives 3 and 7, an ETR system designed to treat the FS-29 plume would be required to extract approximately 0.160 kilograms of EDB from 1.2 billion gallons of contaminated water.

Short-Term Effectiveness. Alternative 2 has greater short-term effectiveness than Alternatives 3 and 7, which are essentially equal. Under Alternative 2, no extensive intrusive activities would be required, the alternative would have no negative impacts on the community, worker safety, or environmental quality, and drinking water standards would be met within 13 to 17 years. Alternatives 3 and 7 would involve construction impacts on site workers, the community and the environment, but the alternative would be implemented in a manner that would minimize these impacts to the extent possible. No unacceptable levels of drawdown or mounding are anticipated which would affect the ecology in surface water systems or wetlands. For Alternatives 3 and 7, cleanup objectives would be met in 8 and 10 years, respectively.

Negative socioeconomic impacts may result from construction activities required to implement the active alternatives (3 and 7). However, the magnitude of these impacts may be comparable to the negative socioeconomic impacts caused by the plume itself.

Implementability. Alternative 2 is more implementable than Alternatives 3 and 7, which are essentially equal. Although there are no significant technical difficulties associated with the implementation of Alternative 2, there are other challenges for this alternative. In order to demonstrate the effectiveness of naturally occurring processes at diluting the plume to background levels of plume contaminants, AFCEE would have to conduct extensive monitoring in and around the plume. With such a heterogeneous aquifer and plume, and such low concentrations of EDB, it will be almost impossible to establish which of the several natural processes is controlling the disappearance of contamination with time.

Access to monitoring wells within the CWMA during hunting seasons and on the private properties within the Ballymeade development may limit the implementability of Alternative 2, but will more significantly affect Alternatives 3 and 7. The FS-29 plume underlies a part of Ballymeade where a new golf course is planned. In addition, AFCEE anticipates that the managers of the CWMA may not welcome a treatment building on

their property because hunting is forbidden within a 500-foot radius of a permanent structure. AFCEE is working with the Massachusetts Division of Fisheries and Wildlife and representatives from Ballymeade Estates to ensure that access issues are addressed early. Finally, the highly variable topography of the Buzzards Bay Moraine, which includes the Ballymeade and FS-29 areas, limits the possible locations for the pipelines and treatment plant which are included in Alternatives 3 and 7.

Cost. The estimated present worth costs for Alternative 2 is $3.1 million, and the present worth costs for Alternatives 3 and 7 are $11 million and $10 million, respectively.

State Acceptance. The Massachusetts DEP has expressed its support for Alternatives 3 and 7.

Community Acceptance. The Association for the Preservation of Cape Cod (APCC) and the Joint Process Action Team (JPAT) favor Alternative 3 because it calls for a more aggressive cleanup. Town of Falmouth representatives and a resident of Ballymeade Estates supported Alternative 2 on the basis that speeding aquifer restoration by three to seven years would not justify the costs of the more aggressive alternatives. Alternative 3 appears to be the only alternative that meets the environmental cleanup program goal of 100 percent capture of all plumes above maximum contaminant levels or other risk-based levels and treatment of contaminants and cleanup of the plume to background levels if technically and economically feasible. Representatives of the town of Falmouth and Ballymeade Estates supported Alternative 2 on the basis that speeding aquifer restoration by three to seven years would not justify the costs of the more aggressive alternatives. Some public comments indicated that the data available on the FS-29 plume was not sufficient to fully evaluate the given alternatives, and also that monitoring at this point would still allow for revisiting the decision in the future if there were problems. The community also noted that any remediation involving additional site characterization, construction activities, or physical alteration within the golf course or subdivision could be very disruptive and have significant adverse impacts on this community, and that

proposed activities should be coordinated with Ballymeade Estates to minimize such adverse impacts.

2.11 SELECTED REMEDIES

The selected remedies are a comprehensive response to the FS-28 and FS-29 plumes (Figure 2-15).

Alternative 3 is the selected remedy for the FS-28 plume. The selected remedy will take advantage of the naturally converging flow field surrounding the FS-28 plume to capture over 99 percent of the plume mass using the extraction, treatment, and discharge systems AFCEE has already implemented under interim actions. Together with institutional controls, maintenance of the wellhead treatment system for the CWSW, and the maintenance of the systems that ensure a safe water supply for agricultural users of water in the Coonamessett River valley, the remedy provides a comprehensive approach for the protection of human health and the environment. If these remedial systems were not operating, the plume would discharge to the Coonamessett River and surrounding bogs and pose unacceptable health risks to human and ecological receptors.

Alternative 3 is the selected remedy for the FS-29 plume. The proposed actions will capture the FS-29 plume through axial extraction at the distal portion of the plume preventing any potential discharge to surface water bodies or human exposure to contaminated groundwater through private or municipal wells. The selected remedy will remediate the FS-29 plume before it can spread further and before remediation becomes more difficult. The current understanding of the FS-29 plume is based on a relatively limited data set. Therefore, the remedy also includes significant additional site characterization and modeling to better understand the effectiveness of the selected remedy. If the additional data collection and modeling indicates that the selected remedy (Alternative 3) is not appropriate, new alternatives may be reviewed, with public involvement, to identify an alternate remedy that provides the best balance of trade-offs among the nine CERCLA criteria.

Institutional controls as discussed in Section 2.9.1 are included in the selected remedy for both plumes.

Table 2-16 summarizes the estimated costs for the selected remedies. Individual components of the selected remedies are discussed in Sections 2.11.1 and 2.11.2.

Table 2-16
Summary of Selected Remedies

Plume	Alternative Number	Alternative Description	Present Worth Cost
FS-28	3	Continued Treatment System Operations	$7,100,000
FS-29	3	Extraction, Treatment and Reinjection for Plume Capture	$11,000,000

2.11.1 Selected Remedy for the FS-28 Plume

The selected remedy for the FS-28 plume is Alternative 3. This remedy includes the continued operation of the FS-28 treatment system, including the shallow well-points, and continued operation of the CWSW wellhead treatment system. Also included is continued maintenance of the earthen berms and vinyl sheet piles installed to separate the Coonamessett River from the surrounding cranberry bogs. Because several components of the selected remedy were installed as part of interim actions, the selected remedy may involve more engineering and construction work to upgrade the existing systems (particularly the treatment buildings and pipelines) to more permanent systems. Institutional controls and long-term monitoring of the treatment systems and the plume itself are also included in the selected remedy.

Water in the Coonamessett River and surrounding bogs is routinely monitored to evaluate surface water quality in the area of the cranberry crop, to appraise the performance of the existing treatment system, and to assess any ecological impacts that the treatment system may be having. Routine analysis of a surface water sample collected in a ditch next to the E3 Upper Baptiste Bog on 18 May 2000 indicated the presence of EDB (location 69SW2018, concentration 0.068 µg/L). Samples collected at this location in previous

months did not contain detectable concentrations of EDB, but subsequent sampling and analysis confirmed the presence of EDB in the surface water. The Upper Baptiste Bog is located downgradient from the deep extraction well (EW-1) and upgradient from the shallow well-point extraction system. Water from the ditch discharges to the Coonamessett River. However, because of the relatively low concentration of EDB present in the ditch, the low flow rate of water discharging from the ditch, and the much higher flow rate within the Coonamessett River, no EDB has been detected in the river.

Because upwelling of EDB in this area was not occurring when alternatives for the FS-28 plume were evaluated during the *Final FS-28 and FS-29 Groundwater Feasibility Study* (AFCEE 2000d), this upwelling was not considered in the development of these alternatives. AFCEE, EPA, and DEP have agreed to the following steps to address the contamination: During the fall of 2000, after the cranberry crop from adjacent bogs is harvested, the FS-28 treatment system will be shut down to allow for hydraulic testing and additional monitoring. Data collected will be used to infer the three-dimensional capture zone for the system. While the system is off-line, samples will be collected from some of the shallow well-points and analyzed for the presence of EDB to better determine the areas of upwelling. The capture zone information and the analytical data will be used to optimize flow rates for the shallow well-points and the deep extraction well and, if appropriate, to justify an increase in the capacity of the treatment system. If optimization of the selected remedy is not sufficient to prevent continued releases of EDB to surface water and more substantial changes to the remedy are required (for example, installation of additional deep extraction wells), such changes would be accomplished through an Explanation of Significant Differences or ROD amendment after full consultation with the public.

The performance monitoring data collected since the start-up of the shallow well-point extraction system indicate that the FS-28 treatment system is effective at preventing most of the plume from discharging to surface waters. Ethylene dibromide is the only contaminant of concern for the FS-28 plume, and the hydrologic data indicate that within 18 years the EDB concentrations within the plume will be below the cleanup level of 0.02

µg/L, and that the river will continue to contain non-detectable levels of EDB. A small dilute portion of the plume (less than 0.3 percent of the total plume mass) will remain uncaptured by the proposed remedy. This portion of the plume lies downgradient of the existing treatment system and north of Thomas B. Landers Road. It is migrating in the subsurface downgradient of the current extraction system and is expected to discharge farther downstream, but is expected to be undetectable when it does reach the river.

The extraction system is comprised of one deep extraction well (69EW0001) screened from 160 to 220 feet below the ground surface and a shallow well-point extraction system. The shallow well-point extraction system uses a vacuum extraction system to extract water from up to 204 well-points. Each well-point is constructed of 2-inch diameter steel pipe installed to a depth of 13 feet below ground surface with a 2.3-foot or 3.0-foot screen. The well-points are connected using a polyvinyl chloride (PVC) header system. Water from the deep well and the shallow well-point extraction system are combined in the treatment plant.

The treatment system is comprised of two 20,000-pound granular activated carbon vessels operating in series and has the capacity of treating 750 gallons per minute. (As the system is currently being operated, 400 gallons per minute are being extracted from the deep extraction well and 350 gallons per minute are being extracted from the shallow well-points.) Treatment system influent concentrations of EDB have dropped from almost 5 µg/L when the system first became operational in October 1997 to approximately 0.5 µg/L in the spring of 2000. Since EDB concentrations in the plume decrease with upgradient distance from the extraction system, the influent concentrations will continue to decrease with time.

Under normal operation, treated water is discharged to surface water. Treated water flows through the effluent pipeline to a vertical riser called a bubbler, constructed of 18-inch corrugated metal pipe. The bubbler is designed to increase the levels of dissolved oxygen in the treated water. Water cascades out of the bubbler into the Coonamessett

River. To ensure that clean water will be available for cranberry bog flooding, the discharge system was designed to allow treated water to be discharged at six alternate locations. Remote discharge is available through bubblers located in the Adams bog, Augusta bog, Augusta bog reservoir, Quanamet bog, Chaston bog, and the east Thompson bog. At the primary discharge location, treated water can also be directed to flow through the spray irrigation system for the adjacent cranberry bog.

Several institutional controls protect area residents from exposure to the FS-28 plume. The safety of all public water supplies within Massachusetts is currently regulated by the Commonwealth. In addition to the steps AFCEE has already taken to connect potentially affected residents to the municipal water supply, the Town of Falmouth has also adopted bylaws (described in Section 2.9.1) to protect residents from exposure to contaminated groundwater. If the Falmouth Board of Health allows the installation of a well above the FS-28 plume, within 500 feet crossgradient of the plume, or 1500 feet downgradient of the plume, AFCEE will sample this well regularly. Furthermore, AFCEE will regularly sample private wells installed prior to the promulgation of the Board of Health regulations that are over the FS-28 plume, within 500 feet crossgradient of the plume, or 1500 feet downgradient of the plume for which public water connections have not been provided. The frequency of residential well sampling will be determined in consultation with AFCEE, health authorities, and the regulatory agencies. AFCEE will coordinate with the Falmouth Board of Health periodically (but not less than annually) to ensure the town knows of any changes to plume configurations or contaminant concentrations. Thus, the institutional controls presently in place adequately prevent residential exposure in all households surrounding the FS-28 plume.

Long-term monitoring of the site will continue to assess: (1) potential risks to the CWSW, (2) the migration of the small uncaptured portion of the plume, (3) the performance of the treatment system, (4) the quality of irrigation water and surface water near the plume, and (5) potential ecological impacts due to the operation of the treatment system. The monitoring program for FS-28 has been modified several times during the

past four years and is expected to continue evolving as more is learned about the system performance. Monthly influent, intermediate (between the carbon beds), and effluent sampling for EDB analysis will still be required. Every five years a thorough site review will be conducted until contaminant concentrations are below regulatory standards. Operations, maintenance, monitoring, and reporting will continue until the three-step process outlined in Section 2.8.4 has been satisfied.

Table 2-17 summarizes the estimated costs for the selected remedy for the FS-28 plume. The following key assumptions were made in developing this estimate:

- The costs previously incurred for design and construction of the EW-1 treatment system ($670,000), the CWSW wellhead treatment system ($470,000), and the shallow well-point extraction system and associated berms ($2,650,000) are not included.
- Operations and maintenance will take place over a period of 18 years. No major upgrade of existing treatment system components will be required during that time.
- The existing treatment system will capture all FS-28 plume contaminants located farther upgradient.
- Capture of FS-28 plume contaminants downgradient of the shallow well-points (an estimated 0.3 percent of plume mass) and north of Thomas B. Landers Road is not included.

Table 2-17
Estimated Costs for the Selected Remedy for the FS-28 Plume

Description	Subtotal	Total
Project Integration		**$36,960**
Independent Planning/Reporting Oversight	$36,960	
Operations and Maintenance		**$4,479,683**
ETR Continued Operations and Maintenance	$3,836,907	
Monitoring Well Maintenance	$23,136	
Maintenance and Monitoring Integration	$619,640	
Monitoring		**$2,470,831**
Well Sampling, Years 1 to 18	$352,068	
Surface Water Sampling, Years 1 to 18	$606,563	
Sample Analysis, Years 1 to 18	$858,694	

Table 2-17
Estimated Costs for the Selected Remedy
for the FS-28 Plume

Description	Subtotal	Total
Treatment System Performance Sampling and Analysis	$111,455	
CERCLA 5-Year Reporting	$70,219	
Sampling and Operations Management Report	$471,832	
Contract Management		**$86,080**
Procurement	$14,080	
Project Management	$72,000	
Total	**$7,073,553**	**$7,073,554**

Note: Operations and maintenance costs are reported as present worth estimates given a 7 percent discount rate. Cost estimates are within a +50 to -30 percent accuracy expectation.

Annual operations and maintenance costs of approximately $680,000 will accrue for approximately the next 18 years. The present value of the life cycle costs for this action is approximately $7,100,000.

2.11.2 Selected Remedy for the FS-29 Plume

The selected remedy for the FS-29 plume is Alternative 3. This remedy includes design, construction, and operation of an extraction, treatment, and infiltration system to hydraulically capture and treat plume contaminants. The available data in and around the FS-29 plume is limited. Therefore, to support remedial design and to better understand the site physical and chemical characteristics, additional sampling and analysis will be conducted. This remedy also includes institutional controls, long-term monitoring of the plume, performance monitoring and evaluation of the treatment system, and ecological sampling to monitor the impacts of the system on the environment.

The selected remedy will remove, treat, and replace approximately 600 gallons per minute of groundwater. Contaminated groundwater will be removed through approximately two extraction wells located along the plume axis in the downgradient (western) portion of the plume, and treated water would be discharged to an infiltration

gallery. Groundwater modeling indicates that the most upgradient portion of the FS-29 plume will be captured and treated by the system planned for the CS-21 plume.

The location of both extraction wells and the infiltration gallery will fall within the Ballymeade residential housing development, The nearest potentially acceptable location for a treatment plant would be east of Route 28 and west of the nearby residential area. This would require approximately 4000 feet of extraction well pipeline and approximately 4200 feet of reinjection well piping. An estimated 500-foot long access road would be required.

The expected influent concentrations for the FS-29 system (Table 2-18) were based on samples taken in the vicinity of the proposed extraction well locations. The high iron and manganese present in these locations suggest that pretreatment may be necessary upstream of the carbon filters. The need for pretreatment will be reviewed during the design phase. If the pretreatment requirement is still questionable at that point, the system will be constructed without pretreatment. A pretreatment system would be installed at a later date, only if it proves to be an operational necessity or if it appears to reduce life cycle costs.

Table 2-18
FS-29 Plume Selected Remedy Expected Treatment System Influent

Constituent	Maximum Influent Concentration (µg/L)	Long-Term Influent Concentration (µg/L)
CCl_4	3	0.26
EDB	0.031	0.003
Trichloroethene (TCE)	2	0.18
Total Iron	941	470
Total Manganese	415	200

Long-term influent concentration is weighted average over the first five years of operation, based on data presented in the *Final FS-28 and FS 29 Groundwater Feasibility Study*, Appendix B. Weighted average EDB influent concentration over the anticipated life of the remedial action would be approximately 0.007 µg/L.

As part of the detailed design of this extraction, treatment, and infiltration system, additional data will be needed. In comparison to the other MMR plumes, little is known about the FS-29 plume since it was the last plume discovered during the SWOU RI. The

pre-design FS-29 field investigation will be conducted to better understand aquifer properties in and around the plume and to better define the distribution of EDB and CCl_4 within the plume. After the pre-design investigation, groundwater modeling will be conducted to confirm that extraction, treatment, and infiltration for plume capture is still considered effective as a plume remedy. If the additional site characterization and modeling indicate that the selected remedy (Alternative 3) is not appropriate, AFCEE and EPA will review and select, with DEP concurrence and public involvement, an alternate remedy that provides that best balance of trade-offs among the nine CERCLA criteria.[12] Because of the close hydraulic and physical connection between the CS-21 and FS-29 plumes, the final design of remedial systems for both plumes should be completed at the same time. For this reason, the pre-design field investigation for the FS-29 plume will begin concurrently with the pre-design field investigations for the CS-4, CS-20, and CS-21 plumes.

Once the system is designed, a sampling and analysis plan, a performance monitoring evaluation plan, and an ecological sampling plan will be prepared. The long-term monitoring program will consist of sampling and analysis at monitoring wells within the body of the plume, downgradient of the plume and to either side of the plume. Operational monitoring will require monthly sampling of influent, effluent, and water collected between carbon vessels. Additionally, samples will be collected from each extraction well approximately twice each year. All samples will be analyzed for EDB and VOCs. As long as plume contaminants remain above statutory standards, a thorough site review will be conducted every five years.

Several institutional controls protect area residents from exposure to the FS-29 plume. The safety of all public water supplies within Massachusetts is currently regulated by the Commonwealth. Although all of the residences overlying or close to the FS-29 plume

[12]The alternate remedy would have to comply with the threshold criteria and provide the best balance of trade-offs among the remaining seven CERCLA criteria.

are connected to the municipal water supply, additional protection is provided by the bylaws adopted by the town of Falmouth (described in Section 2.9.1) that protect residents from exposure to contaminated groundwater. If the Falmouth Board of Health allows the installation of a well above the FS-29 plume, within 500 feet crossgradient of the plume, or 1500 feet downgradient of the plume, AFCEE will sample this well regularly. Furthermore, AFCEE will regularly sample private wells installed prior to the promulgation of the Board of Health regulations that are over the FS-29 plume, within 500 feet crossgradient of the plume, or 1500 feet downgradient of the plume for which public water connections have not been provided. The frequency of residential well sampling will be determined in consultation with AFCEE, health authorities, and the regulatory agencies. AFCEE will coordinate with the Falmouth Board of Health periodically (but not less than annually) to ensure the town knows of any changes to plume configurations or contaminant concentrations. Thus, the institutional controls presently in place adequately prevent residential exposure in all households surrounding the FS-29 plume.

Table 2-19 presents estimated costs for the selected remedy for the FS-29 plume. The following key assumptions were made during the development of this cost estimate:

- The FS-29 plume can be hydraulically captured with a flow rate of approximately 600 gallons per minute.
- Two extraction wells will be required.
- Approximately 4000 feet of extraction pipeline and 4200 feet of reinjection pipeline will be required.
- The treatment train will include both greensand filtration and carbon adsorption.
- An infiltration gallery capable of discharging approximately 600 gallons per minute will be needed.
- The treatment system will remain operational for a period of approximately eight years.

This cost estimate also assumed that a separate treatment system would be constructed for the FS-29 plume. The close proximity of the CS-21 plume and potential difficulties

in gaining property access for treatment plants may make it desirable to treat water from the CS-21 and FS-29 plumes at a single treatment plant. Based on initial assumptions concerning treatment plant locations, this would result in higher capital costs due to longer piping but may make property access easier to obtain. Operations and maintenance costs are expected to be similar regardless of whether separate or combined treatment plants are used.

Table 2-19
Estimated Costs for the Selected Remedy for the FS-29 Plume

Description	Subtotal	Total
Plans And Design		**$92,764**
Project Execution Plan	$45,062	
Design Report	$47,702	
Project Integration		**$100,517**
Independent Planning/Report Oversight	$15,400	
Independent Fieldwork Oversight	$16,170	
Construction Oversight	$17,600	
Operations Oversight	$46,200	
Vehicle	$ 5,147	
Mobilization		**$197,763**
Sampling and Analysis Plan	$29,966	
Establish Contractor Facility	$34,400	
Equipment/Material Transport and Storage	$111,690	
Access to Drilling (approximately 1800 linear yards)	$9,760	
Orientation and Training	$1,711	
Personal Protective Equipment	$10,236	
Baseline Environmental Sampling		**$1,081,674**
Data Gap Boring and Monitoring Well Installation	$920,550	
Groundwater Sampling	$19,140	
Samples Analysis	$93,065	
Interim Sampling Report	$12,154	
Baseline Report	$36,765	
Treatment System Construction		**$2,932,640**
Granular Activated Carbon/Greensand/Sedimentation Modular Unit	$2,833,710	
Instrumentation	$98,930	
Well Construction		**$1,544,050**
Extraction Wells	$467,050	
Infiltration Gallery	$100,000	
Piping from Wells and to Gallery	$977,000	
ETR Operation and Verification		**$336,865**
Treatment Unit Operation	$199,675	
Baseline Operation for Modular System	$27,500	
Performance Monitoring, Years 1 to 8	$61,624	
Operations Verification Report	$48,066	

Table 2-19
Estimated Costs for the Selected Remedy for the FS-29 Plume

Description	Subtotal	Total
Operations And Maintenance		**$3,958,695**
Treatment System Operations and Maintenance	$2,446,740	
Monitoring Well Maintenance	$ 5,792	
Monitoring Well Installation	$83,292	
Monitoring Well Closing	$20,691	
Maintenance and Monitoring Integration	$1,402,180	
Monitoring		**$302,607**
Well Sampling, Years 1 and 2	$14,193	
Well Sampling, Years 3 to 8	$10,929	
Samples Analysis, Years 1 and 2	$22,040	
Samples Analysis, Years 3 to 8	$49,148	
Interim Sampling Report	$32,317	
Annual Sampling and Analysis Report	$125,585	
CERCLA 5-Year Reporting	$48,395	
Contract Management		**$547,250**
Procurement	$176,000	
Project Management	$371,250	
Total	**$11,094,823**	**$11,094,825**

Note: Operations and maintenance costs are reported as present worth estimates given a 7 percent discount rate. Cost estimates are based on treatment volumes calculated from flow modeling and will be refined as the remedy is designed.
Cost estimates are within +50 to -30 percent accuracy expectation.

The total installed cost of this alternative is approximately $6,600,000. Annual operations and maintenance costs are estimated at approximately $740,000 for the next eight years. The present value of life cycle costs is approximately $11,000,000.

2.11.3 Expected Outcomes of the Selected Remedies

The treatment systems included in the selected remedies will be designed to clean up the FS-28 and FS-29 plumes so that contaminant concentrations are below drinking water standards. The selected remedies for both plumes incorporate granular activated carbon adsorption, which has been documented to meet the goal of only discharging treated water that contains nondetectable levels of contaminants of concern. Before shutdown, risk assessments will be performed to evaluate residual risks. If residual risks are unacceptable, the remedial system will continue operation or other actions will be taken to reduce risk. Once residual risks are acceptable, the technical and economic feasibility

of continuing remediation to approach or achieve background concentrations will be evaluated. Cleanup levels for these plumes are presented in Table 2-20.

Table 2-20
Cleanup Levels for Contaminants of Concern for the FS-28 and FS-29 Plumes

COC	Cleanup Levels [µg/L]	Basis for Cleanup Levels
EDB	0.02	MMCL
CCl_4	5	MCL

Table 2-21 presents estimated times to reach drinking water standards in the aquifer.

Table 2-21
Estimated Times to Reach Drinking Water Standards in the Aquifer

Plume	Expected Outcome
FS-28	Drinking water standards will be met in 18 years.
FS-29	Drinking water standards will be met in 8 years.

Once cleanup levels have been obtained and a risk assessment indicates that residual risks are acceptable, area groundwater will be available for use without restriction.

In addition to preventing residential exposure to plume contaminants and restoring the aquifer, the selected remedies will provide a number of socioeconomic benefits. Remediation will provide peace of mind for local residents. Restoration of the aquifer may increase the value of local property holdings. This in turn will increase tax revenues for local communities. A restored aquifer will help the area to remain a major tourist destination. Finally, the selected remedies will provide jobs for people who will live and spend money in the surrounding community.

2.12 STATUTORY DETERMINATIONS

Under CERCLA Section 121, selected remedies must be protective of human health and the environment, comply with ARARs (unless a waiver is justified), be cost-effective, and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a

preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element. The following sections discuss how the selected remedies meet these statutory requirements.

2.12.1 Protection of Human Health and the Environment

The selected remedies will protect human health and the environment through extraction, treatment, and reinjection of contaminated groundwater. By pumping and treating contaminated groundwater, the selected remedies will prevent mobile groundwater contaminants from migrating to groundwater users and will reduce contaminant concentrations to federal and Commonwealth of Massachusetts drinking water standards. Monitoring and institutional controls will prevent residential exposure to the uncaptured portion of the FS-28 plume which lies downgradient of the existing treatment system and north of Thomas B. Landers Road. There are no short-term threats associated with the selected remedies that cannot be readily controlled. In addition, no adverse cross-media impacts are expected from the selected remedies.

2.12.2 Compliance with Applicable or Relevant and Appropriate Requirements

The selected remedies of extraction, treatment and reinjection for the FS-28 and FS-29 plumes comply with all ARARs. Chemical-, location-, and action-specific ARARs for the selected remedies are presented in Appendix B.

2.12.3 Cost-Effectiveness

AFCEE evaluated the cost-effectiveness of the remedies for the FS-28 and FS-29 plumes. In making this determination, the following definition was used: “A remedy shall be cost-effective if its costs are proportional to its overall effectiveness.” (40 CFR 300.430(f)(l)(ii)(D)). Overall effectiveness was determined by evaluating the following criteria: long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness. Overall effectiveness was then compared to cost to determine cost-effectiveness.

In AFCEE's judgment, the selected remedy for FS-28 is cost-effective. The overall effectiveness of the selected remedy was determined to be proportional to its costs and hence to represent a reasonable value for the money to be spent.

The cost-effectiveness of the FS-29 remedy was evaluated based on the data currently available for the FS-29 plume and the following considerations: (1) The proposed system would be capable of capturing and treating plume contaminants. (2) Contaminant concentrations in extracted groundwater could be reduced below regulatory limits. (3) The selected remedy appears to be capable of restoring approximately 1.2 billion gallons of contaminated groundwater in a potential water supply area within approximately eight years after the treatment system begins operating. (4) Despite this significant reduction in the volume of contaminated groundwater, the projected reduction in contaminant mass, and thus toxicity, appears to be limited because the contaminant mass within the plume is so low and the contamination is so dispersed.

When overall effectiveness is compared to the estimated system life cycle cost, it is possible that the selected remedy will not be cost-effective as envisioned by the National Contingency Plan (40 CFR 300). The cost of $11,000,000 to remove the currently estimated 0.16 kilograms of EDB from this sole source aquifer may be viewed as a considerable amount to spend. However, the selected remedy includes additional data collection activities which will enable the parties to better evaluate the selected remedy based on this criterion. These activities will improve the density of data available within and surrounding the plume and improve our understanding of how the plume is changing over time. The data currently available suggest that contaminant concentrations are decreasing due to natural processes and that the plume is not expanding or migrating. Data collected during the pre-design investigation may reveal substantially higher contaminant concentrations or indicate that the plume is migrating over time. These results would increase the cost-effectiveness of the selected remedy for the FS-29 plume.

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

AFCEE has determined that the selected remedies represent the maximum extent to which permanent solutions and treatment technologies can be used in a practicable manner for these groundwater plumes. Of those alternatives that are protective of human health and the environment and comply with ARARs, AFCEE has determined that the selected remedies provide the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element and considering state and community acceptance.

The selected remedies treat the principal threats at the site by achieving significant reductions in EDB and CCl_4 in groundwater. The selected remedies satisfy the criteria for long-term effectiveness by removing contaminants of concern from the groundwater and destroying them during carbon regeneration. The hydraulic control provided by extraction and reinjection of groundwater will prevent further migration of mobile contaminants. The selected remedies do not present short-term risks significantly different from other treatment alternatives. There are no special implementability issues that make the selected remedies unacceptable.

2.12.5 Preference for Treatment as a Principal Element

The selected remedies extract and treat the contamination present in the FS-28 and FS-29 plumes. By treating the mobile contamination with activated carbon, the selected remedies address the principal threats posed by the groundwater contamination through treatment technologies. By using treatment as a significant portion of the remedies, the statutory preference for remedies that employ treatment as a principal element is satisfied.

2.12.6 Five-Year Review Requirements

Because these remedies will result in hazardous substances remaining on site above levels that allow for unlimited use and unrestricted exposure, a review will be conducted

within five years after initiation of remedial action to ensure that they continue to provide adequate protection of human health and the environment.

2.13 DOCUMENTATION OF SIGNIFICANT CHANGES

The *Proposed Plan for the FS-28 and FS-29 Plumes in the Southwest Operable Unit* was released for public comment in February 2000. The Proposed Plan identified the following alternatives as AFCEE's preferred alternatives:

- **FS-28 Plume: Alternative 7:** Continue operation of the extraction, treatment and discharge system currently in place at the leading edge of the plume. Continue to maintain the wellhead protection system for the Coonamessett Water Supply Well, maintain the systems AFCEE has installed to separate the bogs affected by EDB-contaminated surface water from the river, and continue to supply uncontaminated water to the agricultural users on the Coonamessett River. If implementable and publicly acceptable, design and construct an additional groundwater extraction, treatment, and discharge system in the middle of the plume to reduce aquifer restoration time.

- **FS-29 Plume: Alternative 7:** Conduct additional site characterization and modeling to better understand plume dimensions and hydraulic conditions. Design and construct a groundwater extraction, treatment, and infiltration system to capture the central portion of the plume. If, as a result of additional site characterization and modeling, the proposed groundwater extraction, treatment, and infiltration system is not appropriate, an alternate remedy will be proposed and selected following public input. Conduct long-term monitoring to demonstrate that the contaminants in the uncaptured forward portion of the plume are being reduced by natural processes and that the plume is not expanding or migrating.

- **For both plumes:** Use institutional controls to reduce the risk of future exposure to contaminated groundwater until cleanup standards are attained. Conduct five-year reviews to ensure that the remedies continue to provide adequate protection of human health and the environment.

AFCEE, EPA, and DEP reviewed all written and verbal comments submitted during the public comment period. After consideration of these comments, AFCEE, EPA, and DEP agreed that different alternatives (which were presented and evaluated in the feasibility study) should be selected in lieu of those put forward as preferred in the Proposed Plan. For the FS-28 plume, the selected remedy is Alternative 3 rather than the proposed

Alternative 7, and for the FS-29 plume, the selected remedy is also Alternative 3 rather than the proposed Alternative 7.

2.13.1 Rationale for the Change from Alternative 7 to Alternative 3 for the FS-28 Plume

- The change is responsive to most of the public input received during the public comment period.

- Alternative 3 would not involve any potential ecological harm to the Souza Conservation Area and its natural resources, a concern expressed in a number of comments including those received from the MMR Natural Resource Trustee Council and the Falmouth Conservation Commission, the entity charged with administering the area in which Alternative 7 would have been constructed.

- Moreover, Alternative 3 would not potentially disturb the delicate hydrologic balance in the upper Coonamessett River or adjacent wetland areas, which would have been a potential problem posed by the in-plume pumping under Alternative 7, particularly under drought conditions.

- Concerns were also voiced by the Falmouth Senior Management Board (SMB) Selectmen and a Sierra Club representative about the potential impact of Alternative 7 on the nearby CWSW. Since Alternative 3 would not involve pumping any additional wells in the body of the plume, potential impacts to this water supply well would not be an issue.

- Alternative 3 was supported by a majority of JPAT members.

- Most of the comments voiced strong opposition to any alternative which would require the location of extraction wells or treatment systems on residential property. Alternative 3 will not require additional access to private land. Such access would be required to implement Alternative 7.

- While Alternative 7 would restore the aquifer in the shortest time frame of all the alternatives considered (nine years as opposed to 18 years for Alternative 3), Alternative 3 nevertheless provides the best balance of trade-offs among the nine criteria established under the National Contingency Plan (40 CFR 300). It is highly protective and effective in the long-term since it will capture 99.7 percent of the plume and achieves aquifer restoration within a reasonable time frame without the potential for adverse ecological and hydrological impacts posed by Alternative 7. Moreover, Alternative 3 is both implementable and publicly acceptable.

2.13.2 Optimization of the Existing FS-28 Treatment System

Because upwelling of EDB in the Upper Baptiste Bog was not occurring when alternatives for the FS-28 plume were evaluated during the *Final FS-28 and FS-29*

Groundwater Feasibility Study (AFCEE 2000d), this upwelling was not considered in the development of these alternatives. AFCEE, EPA, and DEP have agreed to the following steps to address the contamination: During the fall of 2000, after the cranberry crop from adjacent bogs is harvested, the FS-28 treatment system will be shut down to allow for hydraulic testing and additional monitoring. Data collected will be used to infer the three-dimensional capture zone for the system. While the system is off-line, samples will be collected from a percentage of the shallow well-points and analyzed for the presence of EDB to better determine the areas of upwelling. The capture zone information and the analytical data will be used to optimize flow rates for the shallow well-points and the deep extraction well and, if appropriate, to justify an increase in the capacity of the treatment system. If that optimization of the selected remedy is not sufficient to prevent continued releases of EDB to surface water and more substantial changes to the remedy are required (for example, installation of additional deep extraction wells), such changes would be accomplished through an Explanation of Significant Differences or ROD amendment after full consultation with the public.

2.13.3 Rationale for Change from Alternative 7 to Alternative 3 for the FS-29 Plume

- While public input on the FS-29 alternatives was limited to only six comments, the JPAT and a member of the Association for the Preservation of Cape Cod both expressed support for Alternative 3.

- Moreover, the JPAT unanimously expressed opposition to Alternative 7 since it does not meet AFCEE's stated goal of 100 percent plume capture in an expedited time frame.

- JPAT members noted that in addition to capturing the distal portion of the plume, Alternative 3 also provides for more timely overall aquifer restoration than Alternative 7 (8 versus 10 years) and does so at little additional cost ($11 vs. $10 million).

- Alternative 7 was designed to provide expedited aquifer restoration in the central portion of the plume, which is in close proximity to a proposed water supply well site near Ballymeade Estates. However, since the entire FS-29 plume is located within a potential water supply area and the town of Falmouth has limited locations that can be successfully developed to meet its future water supply needs, Alternative 3 is now being selected since it restores the entire plume in the shortest time frame.

- Alternative 3 is currently expected to present fewer access concerns. Under Alternative 7, the conceptual locations for extraction wells are expected to be in an undisturbed natural area; whereas, under Alternative 3, the likely locations for extraction wells are in an area already developed by Ballymeade Estates. Moreover, in public comments Ballymeade Estates has indicated a willingness to work with the Installation Restoration Program should a system be constructed within its boundaries.

- Finally, AFCEE, EPA, and DEP believe that Alternative 3 provides the best balance of trade-offs among the nine criteria established under the National Contingency Plan (40 CFR 300). It is highly protective and effective in the long-term since it will capture almost the entire plume and achieve aquifer restoration within the shortest time frame. Moreover, it is implementable and publicly acceptable.

3.0 RESPONSIVENESS SUMMARY

SEPTEMBER 2000

RESPONSIVENESS SUMMARY for the Fuel Spill-28 and Fuel Spill-29 Plumes

INTRODUCTION

The purpose of this Responsiveness Summary is to provide written responses to the comments received during the Fuel Spill-28 and Spill-29 (FS-28 and FS-29) Proposed Plan public comment period.

COMMENTS ON THE PROPOSED PLAN FOR FS-28

Comment: Support Alternative #3.

Comments received in support of Alternative #3 were:

- *Deborah McIntosh, East Falmouth resident:* Prefers Alternative #3 for FS-28.
- *Joint Process Action Team discussion:* Seven members voted in favor of Alternative #3 at the March 15, 2000 meeting of the Joint Process Action Team.
- *Joint Process Action Team discussion:* The Natural Resource Trustee Council ought to account for the natural resource damages that will persist with Alternative #3 due to the longer restoration time for this alternative as compared to Alternative #7.
- *Tom Cambareri, JPAT member, Joint Process Action Team discussion:* Alternative #3 could be used as a fallback, but there are some damages in there [Alternative #3], and aquifer restoration is not happening quickly enough.

Response: Considering the potential for adverse ecological impacts associated with Alternative #7 and the limited implementability of Alternative #6, the general consensus is that Alternative #3 provides the best balance of the criteria.
Regarding the potential resource damages, AFCEE will provide the information needed by the Natural Resource Trustee Council to determine the injury to the resource and its associated damages. The comment regarding the speed of aquifer restoration is one of the concerns taken under advisement.

Comment: Support Alternative #3 over Alternative #7, but oppose Alternative #6.

- *Naomi Litvin, representing Lochstead Association:* We oppose any alternative that calls for extraction wells or any other treatment system within the borders of the Lochstead community. No alternative is superior to #3 in terms of effectiveness, risk reduction, and protection of public health. The only possible benefit derived from a different alternative is reducing the time for aquifer restoration. The

possibility of speeding the process is no reason for choosing an alternative that would expose Lochstead residents to the disruption, ecological disruption, and risks of construction and maintenance of wells that pump contaminants to the surface. We do favor Alternative #3 over Alternative #7; however, under no circumstances should Alternative #6 be chosen. Alternative #6 would harm our community, compromise the local ecology, more than double the remediation costs, and result in loss of property values.

- *Gene Kanter, East Falmouth resident:* If there was any plan to bring this hazardous material from below the ground up to the surface, I can only foresee somewhere in the distant future, once this is done, a problem with the pipes, leaks and hazardous material now on the surface. Alternative #3 is the way to go.
- *David Swartz, East Falmouth resident:* I am asking you for your consideration to allow me to have as much of a lifespan as I can have without these chemicals that will be or have the possibility of being part of the atmosphere.

Response: Alternative #7 recognized the concerns of the Lochstead community and avoids construction there. However, Alternative #7 carried the potential for adverse ecological impacts, and although the overall plume restoration time would be improved by Alternative #7, it will not capture more contaminant mass than Alternative #3. Considering the potential for adverse ecological impacts associated with Alternative #7 and the Lochstead community's opposition to Alternative #6, the general consensus is that Alternative #3 provides the best balance of the criteria.

Comment: Support Alternative #3, but oppose Alternative #7.

- *David Potter, chairman, representing the Falmouth Conservation Commission:* The Falmouth Conservation Commission does not support the planned expansion of the pumping effort at the cost of several millions of dollars (our tax dollars), and the certain negative impact on the Souza Conservation Area in exchange for the possibility of speeding up the EDB cleanup by 7-9 years. The Commission finds the current extraction system is working well and sees no overriding public benefit in speeding up the project at such a cost both environmentally and financially.
- *Ronald Smolowitz, owner of Coonamessett Farm, East Falmouth resident:* I would strongly recommend Alternative #3. My biggest concern is the damage that is going to be done to the conservation land to the east of my farm from Alternative #7. Already there is damage from the military coming in there and sinking wells, laying roads, and dear-cutting trees out of the way. Your proposal, which is incomplete, doesn't show the final construction that will be necessary for this alternative to take place. So, this will be a major construction project that will ruin that conservation area in perpetuity.

Response: These are valid concerns. The phrase "within a reasonable time frame" qualifying the remedial action objective of "aquifer restoration to beneficial uses," is highly subjective.

If an 18-year cleanup is considered reasonable, Alternative #3 most efficiently meets the remedial action objectives and avoids the concerns raised in the comment. Considering the relatively short operational time frame for the northern components of Alternatives #6 or #7, the general consensus is that the potential for damages would outweigh the benefit.

Comment: Support Alternative #3, but oppose Alternatives #6 and #7.

- *Charles Innis, Jr., East Falmouth resident:* The present treatment system is obviously working well and, given the allotted time, will complete the job. I am convinced that any additional withdrawals from the water table will have adverse effects on the river and Coonamessett Pond. I also do not want to see the Souza Conservation Area decimated any more than it has been already by trucks and equipment. I am also concerned about noise (pre- and post-construction).
- *Virginia Valiela, Falmouth Selectmen, representing the Town of Falmouth:* I

want to strongly support Alternative #3, and I want to oppose Alternatives #6 and #7. Alternative #3 captures 99.7% of the plume, and Alternative #7 does no better. Alternative #7 has significant environmental impacts, and for the price of speed, we will be significantly altering a really beautiful section of conservation land in Falmouth. I don't think it should be altered any further. With Alternative #7, we would be extracting almost 900,000 gallons a day, and with the Coonamessett Water Supply Well close by, I don't think this is very wise. I thought they [the JPAT] gave a very thorough analysis of Alternative #7 and looking at the whole picture, recommended Alternative #3. I concur.

- *David Dow, representing Sierra Club:* We favor Alternative #3 with the following exception: we are not supportive of AFCEE's use of berms to separate the cranberry bogs from the river and feel that these areas should be returned to natural wetlands, or utilize dry harvesting processes. The current berm system tends to channelize the water flow, which alters a natural hydrology of the river and releases herbicides and pesticides back into the river after their applications to the bogs, which is not good for the ecology. Given the strong community opposition in the Lochstead community to Alternative #6, this option is a non-starter.
- *David Dow, representing Sierra Club:* Alternative #7 has many problems, such as potential disruption of the hydrologic balance in Coonamessett Pond/River, changes in the Coonamessett River's physical, biological, and chemical characteristics, and potential interactions between the Coonamessett Water Supply Well (CWSW) and the proposed extraction, treatment and reinjection (ETR) system. We also believe the Souza Conservation Area is a pristine region, which should not be disrupted.
- *David Dow, representing Sierra Club:* We favor continued operation of the current ETR system at the point where the plume discharges into the Coonamessett River. This component of Alternative #3 resulted in no detectable ethylene dibromide (EDB) detections in the Coonamessett River since May 1999, which we find encouraging.
- *Susan Walker, representing the Association for the Preservation of Cape Cod:* We are concerned that Alternative #6 is unacceptable because of the residential feeling about the plan. We also find Alternative #7 unacceptable because of what it would do to the Souza Conservation Area and because of the impacts to the Coonamessett River. For that reason, we support Alternative #3, but we find the amount of time for Alternative #3 to be unacceptable at 18 years. We are hoping that AFCEE will come up with another alternative that everyone would find acceptable and that would be faster than the 18 years.

Response: AFCEE concurs with the noted potential problems with Alternative #7 and recognizes the local opposition to Alternative #6. These are valid concerns. The operational time frame for either of the proposed northern components of Alternatives #6 or #7 would be relatively short considering the additional time required to design and build the systems. Considering the local opposition to Alternative #6 and the potential for adverse ecological impacts or interference with the Coonamessett Water Supply Well, the general consensus is that the potential for damages would outweigh the benefit. The general consensus is that Alternative #3 provides the best balance of the criteria.

Regarding the comment concerning the use of berms to separate the cranberry bogs from the river, AFCEE does not oversee the agriculture or land use of the bogs surrounding the Coonamessett River. The town-owned bogs are leased to grower/operators and managed by the Falmouth Cranberry Bog Committee and the Falmouth Conservation Commission. Use of this land is under their authority. There are also some privately owned bogs. AFCEE's involvement in the bogs stems from its commitment to provide clean water for agricultural uses.

The comment regarding the speed of aquifer restoration is one of the concerns taken under advisement.

Comment: Support Alternative #6.

- *Richard Hugus, Joint Process Action Team member:* Since Alternative #3 is already in place, my preference is for Alternative #6. However, this alternative may have changed in order to gain acceptance with residents near Coonamessett Pond. Access concerns regarding Alternative #6 need to be further explored and better understood. Alternative #6 should be reconsidered, seeking to avoid impacts to public lands while also addressing and mitigating concerns of private property owners north and west of Coonamessett Pond.

Response: Alternative #6 did not change in order to gain acceptance with residents near Coonamessett Pond. Of the three alternatives (4, 5, and 6) considered for the FS-28 plume north of the western arm of Coonamessett Pond (the Lochstead Estates properties), Alternative #6 was the most efficient and least disruptive, with extraction wells located in existing roadways.

During the extended public comment period, a hybrid alternative for the northern part of the FS -28 plume was considered based on comments from a community advisory group. This hybrid alternative involved extraction from the west side of Lochstead Estates and also from the western shore of Coonamessett Pond, east of the Souza Conservation Area. After much consideration, AFCEE concluded that such hybrid alternatives offered no improvement over Alternatives #6 and #7 because (1) they were ineffective at reducing the overall restoration time frame because they could not effectively "cut off" the northern part of the plume; (2) they did not improve (and could have worsened) potential drawdown impacts to the upper reaches of the Coonamessett River; (3) they would have required construction of two modular treatment facilities (each treating about 600 gpm), meaning increased costs for construction, operations, and maintenance; and (4) due to the strong opposition to any construction within Lochstead Estates, such hybrids are not implementable.

Comment: Support Alternative #7.

- *Minos Gordy, Centerville resident:* Insofar as the Souza Conservation Area is concerned, I believe that accelerated treatment is worthwhile. Objections due to surface effects could be ameliorated by selective irrigation of sensitive areas. Preventing a dry Coonamessett River would probably be unfeasible, but pools could be conserved that offer a refuge to wildlife until the project's end, at which time things would be returned to the natural state.

Response: AFCEE's initial preference for Alternative #7 was based on the assumption that damages to the river system and site vegetation would be minimized to the extent possible. If Alternative #7 were implemented, AFCEE would strive to return the site to its natural state. However, AFCEE recognizes that some damages (e.g., the removal of large trees) are virtually irreversible. Considering the relatively short operational time for this northern component of Alternative #7, the general consensus is that the damages outweigh the benefit.

Comment: Support Alternative #7 but oppose Alternative #6.

- *Naomi Litvin, representing the Lochstead Association:* Support AFCEE's preferred choice (Alternative #7) and register opposition to any alternative (Alternative #6) that involves the location of extraction wells of any kind or hazardous substances treatment capability within the Lochstead community. The environmental and human costs of Alternative #6 outweigh the negligible benefits.

Response: Alternative #7 recognized the concerns of the Lochstead community. Alternative #7 carried the potential for adverse ecological impacts, and although the overall plume restoration time would be improved by Alternative #7, it would not capture more contaminant mass than Alternative #3. Considering the potential for adverse ecological impacts associated with Alternative #7 and Lochstead's opposition to Alternative #6, the general consensus is that

Alternative #3 provides the best balance of the criteria.

Comment: Oppose Alternative #6.

- *Joint Process Action Team discussion:* Neighborhood organizations oppose treatment systems within the borders of Lochstead, as they believe property values and ecosystems would be adversely affected.
- *Naomi Litvin, representing the Lochstead Association:* We oppose any alternative that calls for extraction wells or any other treatment system within the borders of Lochstead. Under no circumstances should Alternative #6 be chosen. The potential loss of property value would be devastating and life-altering for many of our residents, most of whom are beyond their income producing years.
- *Paula J. Canosa, East Falmouth resident:* How can putting wells in Lochstead solve the plume problem without causing future damage to an already safe, stable ecosystem and water supply?

Response: Considering Lochstead's opposition to Alternative #6 and the potential for adverse ecological impacts associated with Alternative #7, the general consensus is that Alternative #3 provides the best balance of the criteria. See response to previous comment.

Comment: Oppose Alternative #7.

- *Joint Process Action Team discussion:* Neighborhood groups and government organizations were opposed to Alternative #7 because of significant natural resource damages, such as: disruption to the residents, potential to adversely affect the Coonamessett Water Supply Well, possible localized drawdown of water table, wetlands and habitat effects, and private property access concerns. The increased cleanup time was also recognized.
- *Donna Dupee Jewett, Falmouth resident:* We would like to encourage and congratulate you on your project of remediation of the contaminated groundwater. We feel strongly that there should be no access to our land or clearing of brush along the Coonamessett River conservation land and our property (Attamannsit). Placing a well close to the pond would require an access road crossing most of the "back lot". Continued monitoring of the well would basically make the lot unusable for any other purposes. Continued use of the site would also be a source of continued interruption for the residents.
- *Joint Process Action Team discussion:* A number of JPAT members are opposed to Alternative #7.
- *Joint Process Action Team discussion:* The Coonamessett Public Water Supply Well (CWSW) could be adversely affected by Alternative #7, which could disrupt a significant supply of water for the Town of Falmouth.
- *Bruce Leighton & Dale Young, representing the National Resource Trustee Council:* Based on our limited review of the available information, the NRTC believes that Alternative #7 raises serious natural resource concerns. The implementation of Alternative #7 will result in significant and unacceptable injury to natural resources. The NRTC recognizes the benefits of Alternative #7 in achieving an expedited restoration of groundwater in an estimated nine years; however, the resulting impacts to other natural resources are significant, and the NRTC cannot endorse the implementation of Alternative #7. Impacts include:
  - Construction of Alternative #7 would result in significant disturbance of a large portion of the Souza Conservation Area. Clearing and brush removal, earthwork and grading, installation of access roads, and installation of extraction and discharge piping would all adversely affect this resource.
  - Operation of Alternative #7 would likely result in localized drawdown and periodic flux of the water table, adversely affecting surface water resources south of Coonamessett Pond. Specifically, the upper reaches of the Coonamessett River,

Coonamessett Pond, and several wetland areas fringing the Coonamessett Pond and River would be adversely affected. The potential discharge of 600 gallons per minute of water to the Coonamessett River during periods of high water (March-May) could erode the river banks.

— Once the operation of Alternative #7 is terminated in an estimated nine years, certain aquatic biota that adapt to the changing surface water conditions created by the treated water surface discharge could be potentially adversely affected.

The NRTC recommends that AFCEE reconsider other remedial alternatives, such as Alternative #6 and Alternative #3 that pose fewer potential adverse natural resource impacts. In comparison to Alternative #7, the NRTC does recognize that Alternative #3 would take longer (18 years) to restore the groundwater resource and that Alternative #6 would take slightly longer (11 years) but raise property access concerns.

Response: Alternative #7 was initially proposed because, as conceptually designed, it would be effective at reducing the overall cleanup time by using a fence of wells aligned perpendicular to groundwater flow to hydraulically contain the plume. If property access restrictions prevent installation of wells in this fence-type pattern, or only part of the fence can be constructed, the alternative loses effectiveness and will not achieve the goal of mid-plume cut-off.

Considering the potential for adverse ecological impacts associated with Alternative #7 and the local opposition to Alternative #6, the general consensus is that Alternative #3 provides the best balance of the criteria.

Comment: Consideration of a "hybrid alternative".

- *Joel Feigenbaum, Joint Process Action Team member:* A hybrid alternative should be considered that seeks to avoid placing the full burden of cleanup on one particular area or another or which avoids any expedited mass capture. Two or more southern wells ought to be considered that are placed away from the Coonamesett Pond shoreline and would minimize the impacts to the Souza Conservation Area. These wells should use reinjection rather than surface discharge. This should be considered along with the placement of an extraction well north of Coonamessett Pond on the western edge of Lochstead together with an extraction well south of Coonamessett Pond to the east of the Souza Conservation Area. A hybrid option of Alternative #6 and Alternative #7 is an option for expedited cleanup besides the dead-end scenarios offered by AFCEE. The details await modeling and cost analysis.
- *Naomi Litvin, representing the Lochstead Association:* The extension of the public comment period to research a combined remedy (Alternatives #6 and #7) is indeed another "alternative" and was never explained in the comment period or the published proposed plan. We respectfully submit that this is highly irregular and deviant from the normal protocol for proposed plans. How can one comment on an alternative that was neither discussed nor published for public review? Lochstead objects to any new alternative that involves the installation of even one extraction well in the Lochstead community.
- *Naomi Litvin, representing the Lochstead Association:* The March 15, 2000 JPAT discussion of the hybrid shows that such a concept is ill-advised.
- *Naomi Litvin, representing the Lochstead Association:* A hybrid between Alternative #6 and #7 would damage two areas instead of just one as proposed in either Alternatives #6 and #7.
- *Naomi Litvin, representing the Lochstead Association:* Rather than "spread the pain around" as a JPAT member suggests, this hybrid would harm the residents of Lochstead two-

fold, if not three-fold: (1) just like any other Falmouth resident, they [the residents of Lochstead] will suffer damage to the Souza Conservation Area; (2) unlike other citizens, the damage will be more immediate to Lochstead residents because the Souza Conservation Area is directly adjacent to the community; and (3) for many other reasons (see previous comments), Lochstead residents will suffer directly from the disruption to the neighborhood, both short- and long-term, from the installation of extraction wells and piping.

- *Naomi Litvin, representing the Lochstead Association:* We support AFCEE's position on Alternative #7, but would prefer the selection of Alternative #3, since it is ultimately as effective as Alternative #7 and will not negatively impact the environment. There is no threat from the FS-28 plume that requires the fastest remedy available. A slower, less environmentally damaging remedy is more appropriate.

Response: During the extended public comment period, AFCEE considered and discussed in JPAT meetings the feasibility of a hybrid alternative for the northern part of the FS-28 plume. This hybrid theoretically involved extraction from the west side of Lochstead Estates and also from the western shore of Coonamessett Pond east of the Souza Conservation Area. After much consideration, AFCEE concluded that such hybrid alternatives offered no improvement over Alternatives #6 and #7 because (1) the hybrid alternative was ineffective at reducing the overall restoration time frame because it could not effectively cut off the northern part of the plume; (2) the hybrid alternative did not improve (and could have worsened) potential drawdown impacts to the upper reaches of the Coonamessett River; (3) the hybrid alternative would have required construction of two modular treatment facilities (each treating roughly 600 gpm), meaning increased costs for construction, operations, and maintenance; and (4) due to the strong opposition to any construction within Lochstead Estates, such hybrids are not implementable. Considering the relatively short operational time for these northern components of Alternatives #6 or #7 or even a hybrid alternative, the general consensus is that the potential for damages would outweigh the benefit.

Comment: Technical questions/ comments offered.

- *Joint Process Action Team discussion:* The JPAT is extremely concerned about the numerous impacts that the preferred alternative (#7) poses to the Souza Conservation Area just below Coonamessett Pond. Construction of a system will disturb a pristine, sensitive natural environment. JPAT concerns are:
  - The siting of wells and treatment plants will forever alter the natural landscape in the area.
  - Surface discharges into the Coonamessett River will alter this natural system.
  - Adverse impacts to pH, temperature, oxygen content, and other parameters caused by treated water could harm aquatic ecosystems.
  - Expected shutdowns in the treatment system due to electrical outages, storms, and/or mechanical failures could disrupt these systems and cause damage to fisheries and other natural systems.
  - The introduction of man-made systems that alter natural ecosystems almost always leads to unforeseen and adverse impacts to the environment.
  - The leading edge of the FS-28 plume is not and will not be contained under any proposed remedy. This sliver of EDB could later emerge in surface waters and pose risks to human health and the environment.
  - The objective in any plume cleanup alternative should be 100 percent plume capture in an expedited time frame.
  - Some JPAT members are concerned about property access for Alternatives #6 and #7.
  - Some JPAT members are

concerned that Alternative #3 avoids any mass capture, a significant remedial objective of the program.

Other technical questions/comments offered:

- *Joel Feigenbaum, Joint Process Action Team member:* I am really not certain that a single southern extraction well will eventually capture every last bit of EDB, with absolutely no surface upwelling or other releases into the environment.
- *Joel Feigenbaum, Joint Process Action Team member:* Expedited cleanup is also an insurance against the possibility that the status quo (Alternative #3) will not be as perfect as AFCEE claims.
- *Joel Feigenbaum, Joint Process Action Team member:* Modular treatment ought to be considered to avoid the impacts of a full-scale treatment plant and the difficulty of piping extracted water from dispersed wells. Also, modular treatment in this instance is required rather than the giant "factories" that Jacobs loves to build.
- *Richard Hugus, Joint Process Action Team member*: I would like to take the entire northern body of the FS-28 plume as if there were no restrictions on land or access and figure where the best locations are for extraction wells to both reduce the mass of contaminants in the plume and to expedite plume cleanup over time.
- *Richard Hugus, Joint Process Action Team member:* None of the alternatives listed seem satisfactory.
- *Bruce Leighton & Dale Young, representing the National Resource Trustee Council:* If AFCEE, after due consideration of comments opposing Alternative #7, still proceeds with that particular alternative, the Natural Resources Trustee Council (NRTC) does recommend several mitigation measures which might help reduce environmental impacts.
  - Careful monitoring of treated water discharge for hydrological and biological parameters to ensure adequate protection of aquatic and fisheries habitat.
  - The upper reaches of the Coonamessett River should be stabilized and measures taken to prevent erosion due to increased water flow from this alternative's surface water discharge.
  - AFCEE should consider discharge to a created wetland within the Souza Conservation Area to offset the impacts of surface water discharges. The created wetland could function to regulate flows and stabilize water quality prior to entering the pond or river. An additional benefit of this type of wetland system is the natural buffer the wetland would provide to the Coonamessett Pond and River system. In addition, this wetland could partially mitigate for the loss of wetland associated with construction actions:
  - The IRP should carefully evaluate the impacts of a potential power failure on natural resources, particularly on aquatic resources in the upper reaches of the Coonamessett River that will become dependent on surface water discharges if Alternative #7 is installed. If a potential power failure would result in adverse impacts, then appropriate contingency measures, such as a back-up power source for the treatment system, should be put in place.
  - The NRTC recognizes that such mitigation of injury may be beyond the scope and funding authority of the IRP.
  - The NRTC also requests consultation on such measures prior to any construction activities should Alternative #7 be chosen.
  - The NRTC notes that even if mitigation measures are taken, the adverse impacts of Alternative #7 to the natural resources may not be sufficiently mitigated.
  - AFCEE should continue to

monitor the Coonamessett river system downgradient of the existing EW-1 and shallow surface water extraction wells for biological parameters such as pH, temperature, and dissolved oxygen. In particular, surface water temperatures should be closely monitored because there appears to be a localized increase in surface water temperatures above ecological thresholds in winter months.

Response: The JPAT has raised many valid concerns regarding the potential for adverse environmental impacts caused by Alternative #7. For clarification, AFCEE's cleanup goals for FS-28 are still 100 percent plume capture within a reasonable time frame, and all three alternatives for FS-28 (3, 6, and 7) presented in the Proposed Plan capture the same mass. Another point to clarify is that the 600- to 700-gpm treatment plants AFCEE has installed recently are referred to as modular treatment plants. The Ashumet Valley treatment system is comprised of two Mod 1 facilities; the LF-1 treatment system is one Mod 1 facility; and the CS-10 In-Plume and Southern/Southwest system is comprised of four Mod 1 facilities. Each Mod 1 facility contains two 20,000-pound carbon vessels along with pumps and tanks to backwash the carbon vessels. In the SWOU feasibility studies, AFCEE considered smaller mobile carbon treatment units as an alternative to the more permanent modular treatment systems. In AFCEE's analysis, there were limited applications for mobile carbon treatment for the FS-28 and FS-29 plumes.

Alternative #7 would pose significant environmental impacts to the Souza Conservation Area. These impacts would include construction impacts, such as tree cutting and road construction, and changes to the groundwater flow regime, which would impact the Coonamessett River and Coonamessett Pond. If Alternative #7 were to be implemented, steps would be taken to minimize these impacts to the extent possible. However, Coonamessett River would be dependent on the treatment system for a continuous supply of clean water and could be adversely impacted by a mechanical failure, such as an extended power outage.

EDB within the leading edge of the FS-28 plume represents less than 0.3 percent of the entire plume mass. AFCEE is monitoring the downgradient migration of the leading edge with quarterly sampling of monitoring wells screened within and around this detached lobe. As the plume moves further south, it becomes very narrow and thin, and rises very slowly (about 4 to 5 feet for every 100 feet in the downgradient direction). All indications are that the leading edge contamination will eventually discharge to the Coonamessett River well south of Thomas B. Landers Road. When and if it does, the EDB concentrations are expected to be non-detectable in the river because (1) EDB concentrations in the leading edge are low, (2) EDB concentrations will decrease over time as the plume moves downgradient, and (3) contaminated water discharging to the river will mix with great quantities of clean water.

AFCEE will provide the information needed by the Natural Resource Trustee Council to determine the injury to the resources associated with Alternative #3. AFCEE's long-term monitoring program for the FS-28 system south of Hatchville Road includes monitoring the Coonamessett River system downgradient of the existing EW-1 and shallow surface water extraction wells for biological parameters, including pH, temperature, and dissolved oxygen.

See final response on page 4 for additional remarks.

Comment: Support Alternative #2, but oppose Alternative #7.

- *James Burns, Falmouth resident:* There is insufficient justification to commit funds to Alternative #7. Alternative #2 is sufficient for the following reasons: the impact of the CS-21 treatment will reduce mass by another 23 percent, no access, no health hazards exist, and computer modeling of Alternative #7 must come with the "probability of success" that the aquifer will be restored in 10 years. The difference in the 10-year plan and 13-17 years for Alternative #2 is not significant considering the "probability of success" issue.

Response: AFCEE will be collecting additional data on the FS-29 plume during the next year. After we evaluate these data, it may become apparent that we need to change the remedy for this plume. If necessary, AFCEE, EPA, and DEP will review and select, with public involvement, an alternate remedy that provides the best balance of trade-offs among the nine CERCLA criteria.

Comment: Support Alternative #3.

- *Susan Walker representing the Association for the Preservation of Cape Cod (APCC):* The Association for the Preservation of Cape Cod (APCC) supports Alternative #3.

Response: Based in part on community input, including APCC's support of Alternative #3, Alternative #3 was chosen as the selected remedy.

Comment: Support Alternative #3, but oppose Alternative #7.

- *Joint Process Action Team discussion:* The JPAT recommends Alternative #3 because it best meets the goal of 100 percent plume capture and best minimizes risks to human health and the environment. Alternative #7 does not meet the program goal of 100 percent plume capture in the expedited time frame. Alternative #7 also allows a portion of the EDB plume to remain. The JPAT is concerned that this portion could migrate further downgradient and pose potential impacts to ground and surface waters. The cost difference between Alternative #7 and Alternative #3 is not substantial, and thus, should not be a decisive factor in this remedial decision. The JPAT also agrees that further plume characterization is needed.

Response: Alternative #3 is the selected remedy for the FS-29 plume. Although limited, the available data indicate that the EDB concentrations in the leading edge of the plume are not high enough to move very far. That is, the natural processes (e.g., dispersion) that cause the edges of plumes to become diluted to concentrations below MCLs will exceed the natural processes (e.g., advection) that cause plumes to move forward. AFCEE initially preferred Alternative #7 because it would aggressively clean up the most contaminated part of the plume rather than waiting for this portion to migrate toward the further downgradient wells proposed in Alternative #3. AFCEE agrees that further plume characterization is needed and will be conducting further investigative activities in the FS-29 plume during the next year.

Comment: Technical questions/comments offered.

- *David Dow, representing the Sierra Club:* Due to the limited knowledge as to whether the plume is actually in equilibrium and potential property access issues at Ballymeade, we [Sierra Club] cannot come to any consensus on a preferred option.
- *Virginia Valiela, selectwoman from Falmouth, MA:* I believe that they [AFCEE] should really continue to monitor, but that there should be no active system constructed there. Again, that's a 600-gallon per minute system. It is an extremely dilute plume and it's actually in two pieces with clean water in between. A system of monitoring would allow us to revisit the issue if there should be further problems.
- *Holmes and McGrath, representing*

Ballymeade Estates: A portion of the FS-29 plume is located directly beneath the residents and community of Ballymeade. Any remediation involving additional site characterization, construction activities, or physical alteration within the golf course or subdivision could be very disruptive and have significant adverse impacts on this community. Any such work should be carefully coordinated with the developer and owners' association of Ballymeade Estates to minimize adverse impacts of any proposed construction. Ballymeade Estates requests that any such construction plans be subject to a special hearing, that Ballymeade Estates be given timely notice of such meeting or hearing, and that the developers and owners' association be included in the coordination and implementation of any proposed construction activities within their boundaries.

Response: Because the information available on the FS-29 plume is limited, all of the alternatives for this plume include additional site characterization. AFCEE, EPA and DEP are taking into consideration the fact that we will learn more about the plume, and as we learn more, the decision on the type of remedy may change. If the additional data suggest that the decision on the type of remedy might change to one that provides a better balance of trade-offs among the nine CERCLA criteria, this change will be made with public input.

AFCEE agrees with and appreciates the cooperation the Ballymeade Development Corporation has given the Installation Restoration Program in the past, and looks forward to working closely with the developer and the owners' association in the future. All future work in Ballymeade will be closely coordinated with the affected parties.

OERR\NTSD Pilot Project: Managed Virtual Private Network for Superfund On-Scene Coordinators

I. Background

EPA has an interest in evaluating the capability of Virtual Private Networks (VPN) to satisfy a variety of requirements for secure data communications. One such requirement is for EPA employees to have access, while traveling, at home, or at a temporary duty station, to the computing resources to which they ordinarily can reach from the desktops in their EPA offices.

EPA's National Technology Services Division is currently working in collaboration with the Office of Solid Waste and Emergency Response (OSWER)/Office of Emergency and Remedial Response (OERR)/Information Management Center (IMC) on a Managed VPN pilot project. The end users in this project are the approximately 200 Superfund On-Scene Coordinators (OSCs) throughout the nation. These EPA personnel manage EPA's activities at the location of Superfund sites wherever they may occur in the United States. The OSCs require 24x7x365 access to EPA email, local area network, and Intranet resources, and to the Internet, from wherever they may be at any given time–their homes, hotel rooms, rented office space, temporary offices (for example, trailers) set up at or near the actual Superfund site, or elsewhere. NTSD and OERR/IMC have acquired the VPN service and plan to conduct the pilot through the end of FY2002.

II. Proposed Solution for Remote Access via VPN

NTSD and OERR/IMC have entered into a Working Capital Fund service agreement for the infrastructure component of this project whereby OERR/IMC would fund the Managed VPN pilot project and NTSD would implement and manage it. NTSD has engaged its primary IT infrastructure planning support contractor, SRA International, Inc., to acquire a Managed VPN service for this project, to serve as project coordinator, and to assist in the evaluation of the technology. SRA selected AT&T as its Managed VPN provider. NTSD, SRA, AT&T, and the telecommunications and security groups of NTSD's infrastructure operations support contractor, Lockheed Martin, have collaborated closely in the implementation planning for the project. In addition, OERR/IMC is providing supplemental funding to pay for high-speed internet access where AT&T high-speed access is not available.

Once connected to the EPA infrastructure via the VPN, the OSC users will have access to the following resources:

- Lotus Notes email
- Novell NetWare file and print servers
- EPA Intranet resources to which OSCs ordinarily have access from their office desktops, including the "EPA@Work" intranet web site, regional intranet web sites, and various centralized and distributed application servers
- The Internet

Each OSC will be set up with an AT&T dial-up account, enabling dial access to any of AT&T's over 2000 points of presence. In addition, DSL service (arranged for, if not actually

provided by, AT&T) will be provided to OSCs' temporary duty stations and homes where it is available. Where AT&T DSL service is not available, OSC's will be able to use locally available high-speed internet connections at EPA's expense.

An EPA Federal "Customer Point of Contact" (CPOC), a Superfund representative, will be responsible for maintaining the list of approved OSC users and will serve as the approving official for the OSCs high-speed internet connection bills.. John Gilbert of OERR's Emergency Response Team is serving as the CPOC and approving official on this project.

IV. Time Frame

The pilot will extend through September 2002. The work may be continued based on the results of EPA's evaluation of the project.

V. References

The following are available from Jody Zeugner, NTSD Senior Telecommunications Program Manager and sponsor of this project (919-541-2606; zeugner.jody@epa.gov):

- Statement of Work, Contract 68-W-99-038, Task 008-020-003, "Managed Virtual Private Network Pilot Project Support"

- Memorandum of Understanding (draft) between Office of Emergency and Remedial Response/ Information Management Center and Office of Technology Operations and Planning/National Technology Services Division

The following are available from Michael Kittrell, SRA Project Manager (919-474-4312; Michael_ Kittrell@sra.com):

- Managed VPN Pilot Project Plan

- Statement of Requirement/Solicitation used by SRA in selection of managed service provider

- AT&T proposal for Managed VPN service

- AT&T "Managed VPN Tunneling Services - IPSec Nortel Option" Customer Point of Contact (CPOC) Guide

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FIGURES

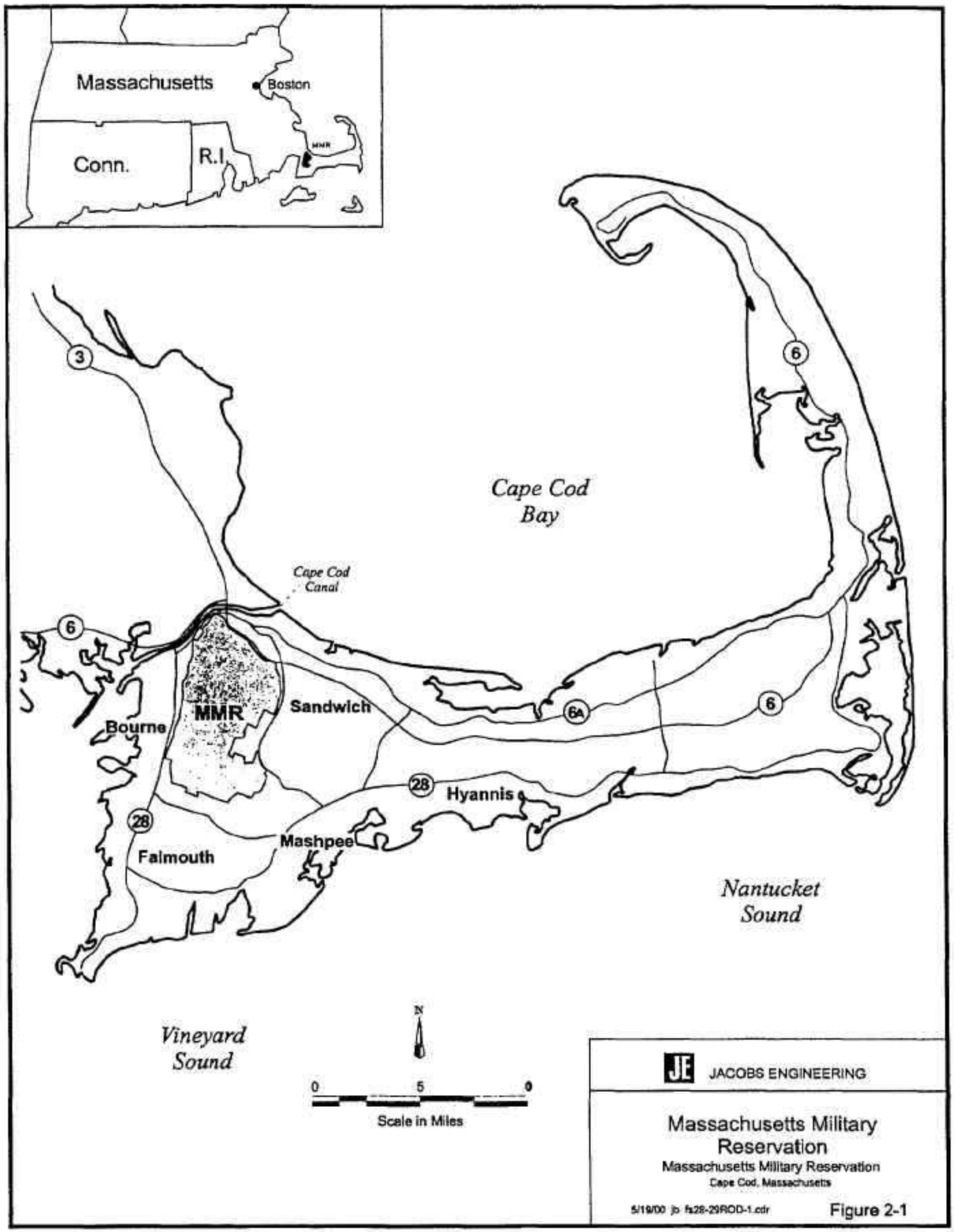
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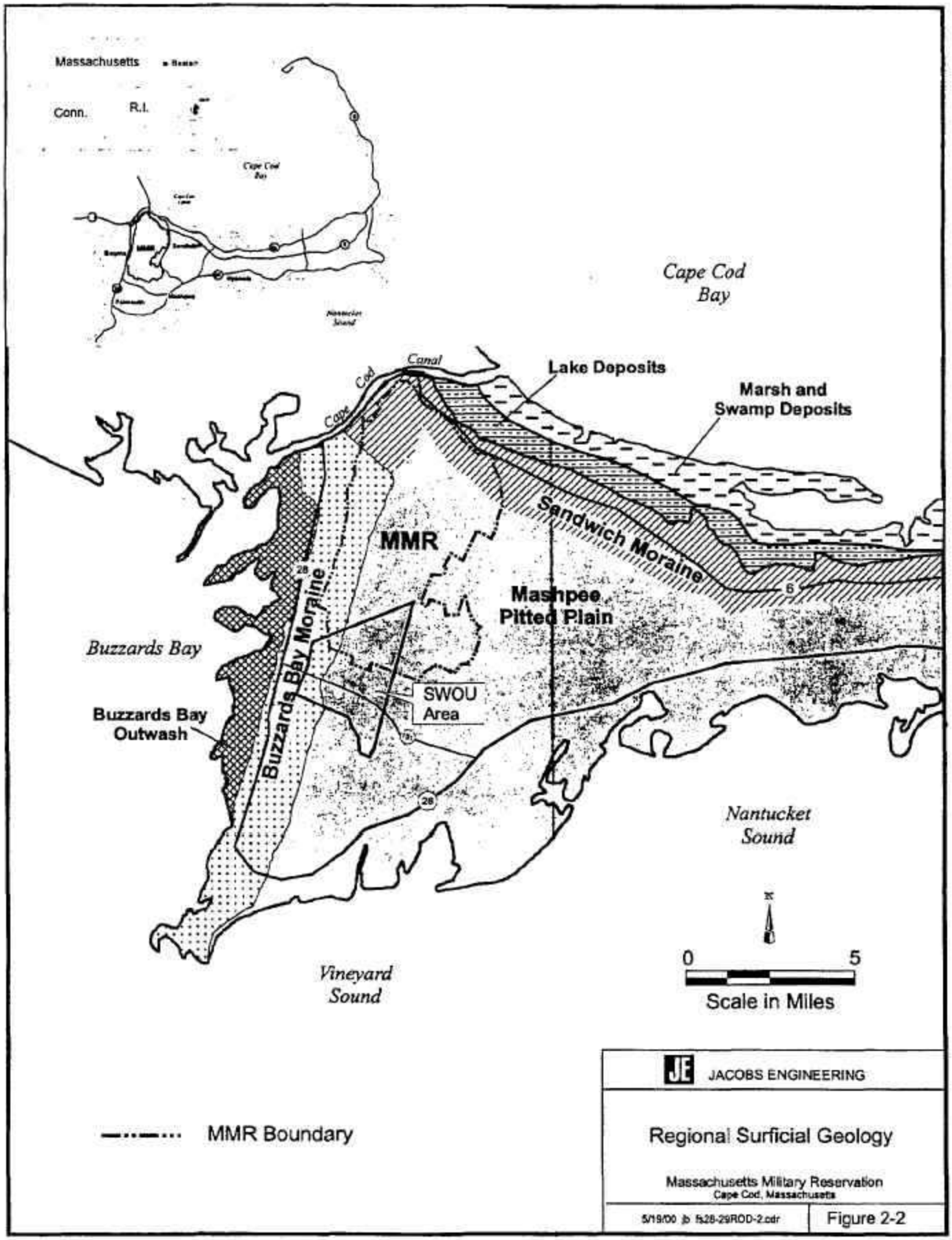
Figure 2-1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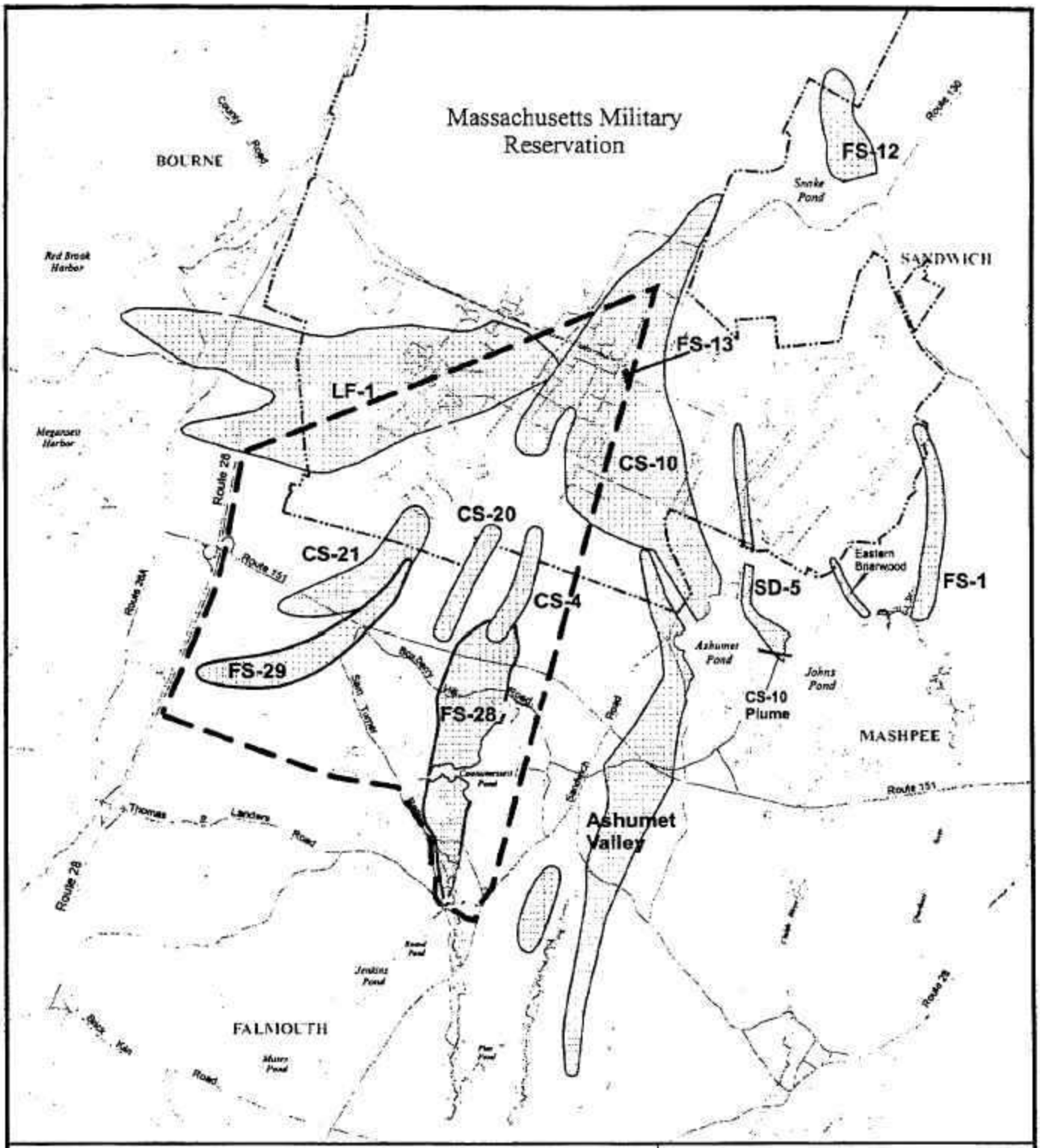
Buzzards Bay
Buzzards Bay Outwash
SWOU Area
Nantucket Sound
Vineyard Sound
0
5
Scale in Miles
MMR Boundary
JACOBS ENGINEERING
Regional Surficial Geology
Massachusetts Military Reservation
Cape Cod, Massachusetts
5/19/00 jb fs28-29ROD-2.cdr
Figure 2-2



Legend

Plume Contour (based on applicable MCL exceedance)

MMR Boundary

Pond

SWOU Boundary

Bog

N

0 3000

Scale in Feet

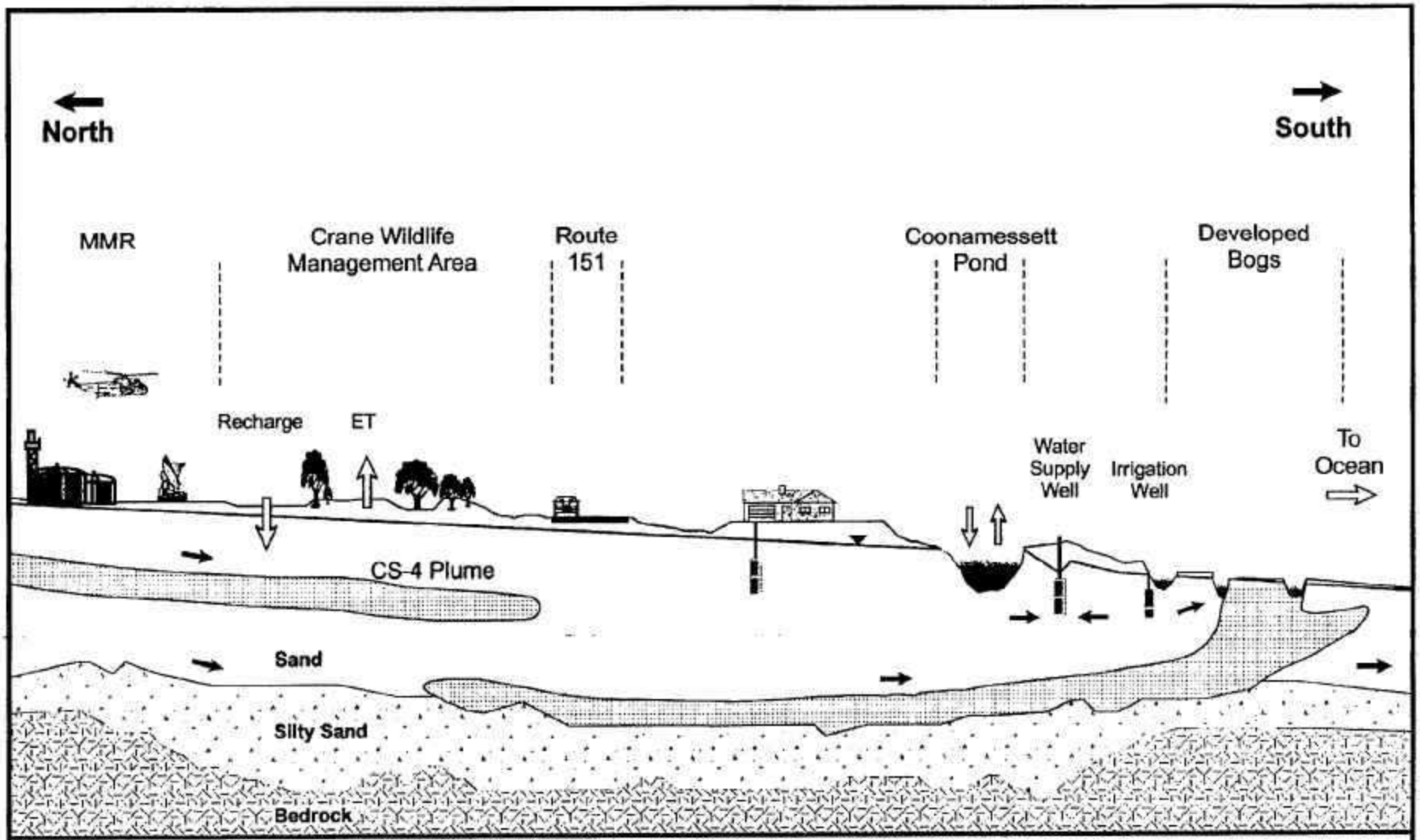
JACOBS ENGINEERING

SWOU Study Area

Massachusetts Military Reservation
Cape Cod, Massachusetts

5/19/00 jb fs28-29RCD-3.cdr

Figure 2-3



Legend

- Recharge
- ET= Evaporation/Transpiration
- Groundwater Flow
- Plume

Conceptual drawing not to scale.

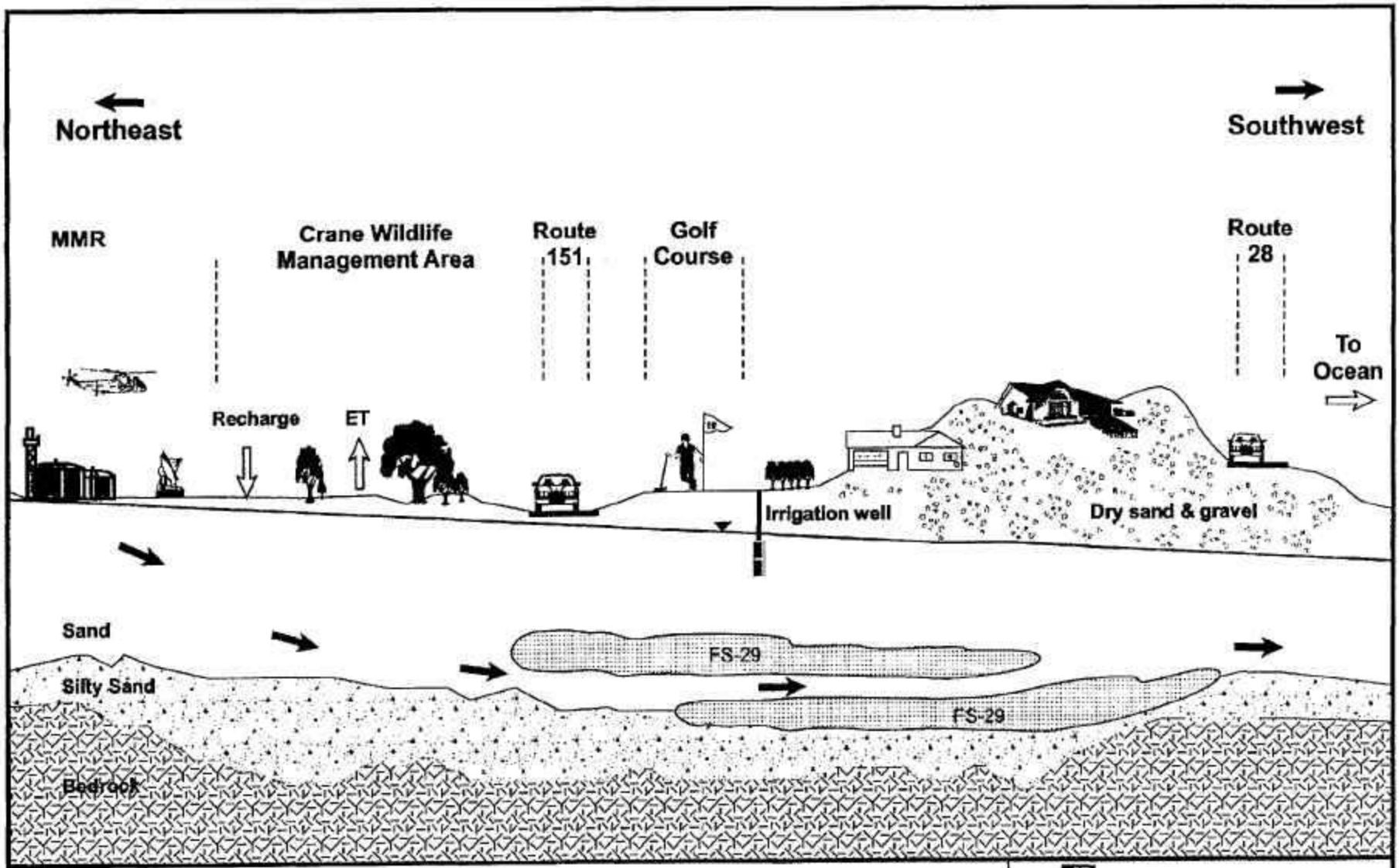
JACOBS ENGINEERING

FS-28 Plume Conceptual Model

Massachusetts Military Reservation
Cape Cod, Massachusetts

5/18/00 jp fs28-29ROD-5.cdr

Figure 2-4



Legend

Recharge

ET= Evaporation/Transpiration

Plume

Groundwater Flow

Conceptual drawing not to scale.

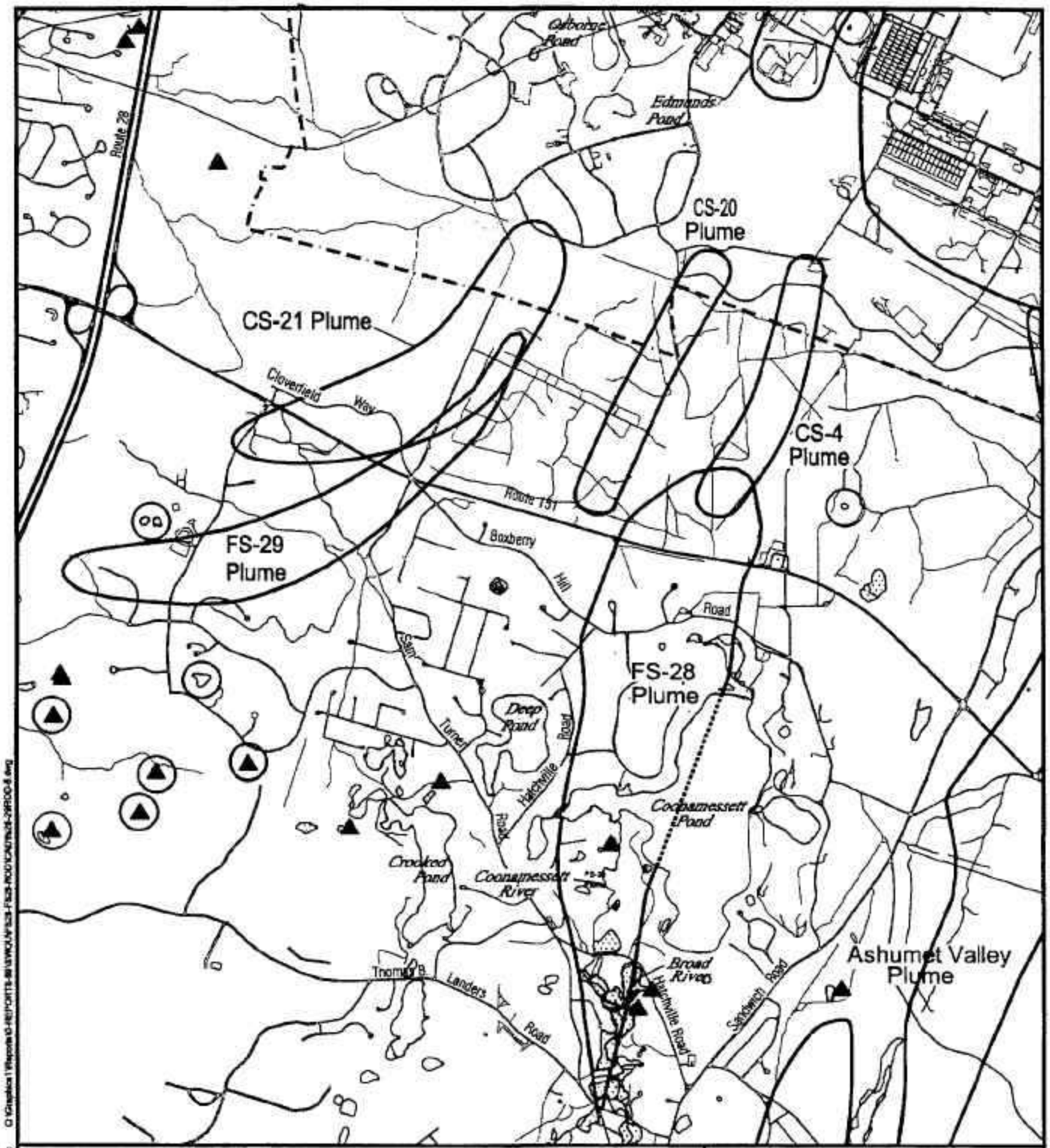
JACOBS ENGINEERING

FS-29 Plume Conceptual Model

Massachusetts Military Reservation
Cape Cod, Massachusetts

5/18/00 jb fs28-29ROD-4.cdr

Figure 2-5



Legend

MMR Boundary

Wetland or Vernal Pool

Perched Pond, Wetland, or Vernal Pool

Bog or Other Wetland

0 1500

Scale in Feet

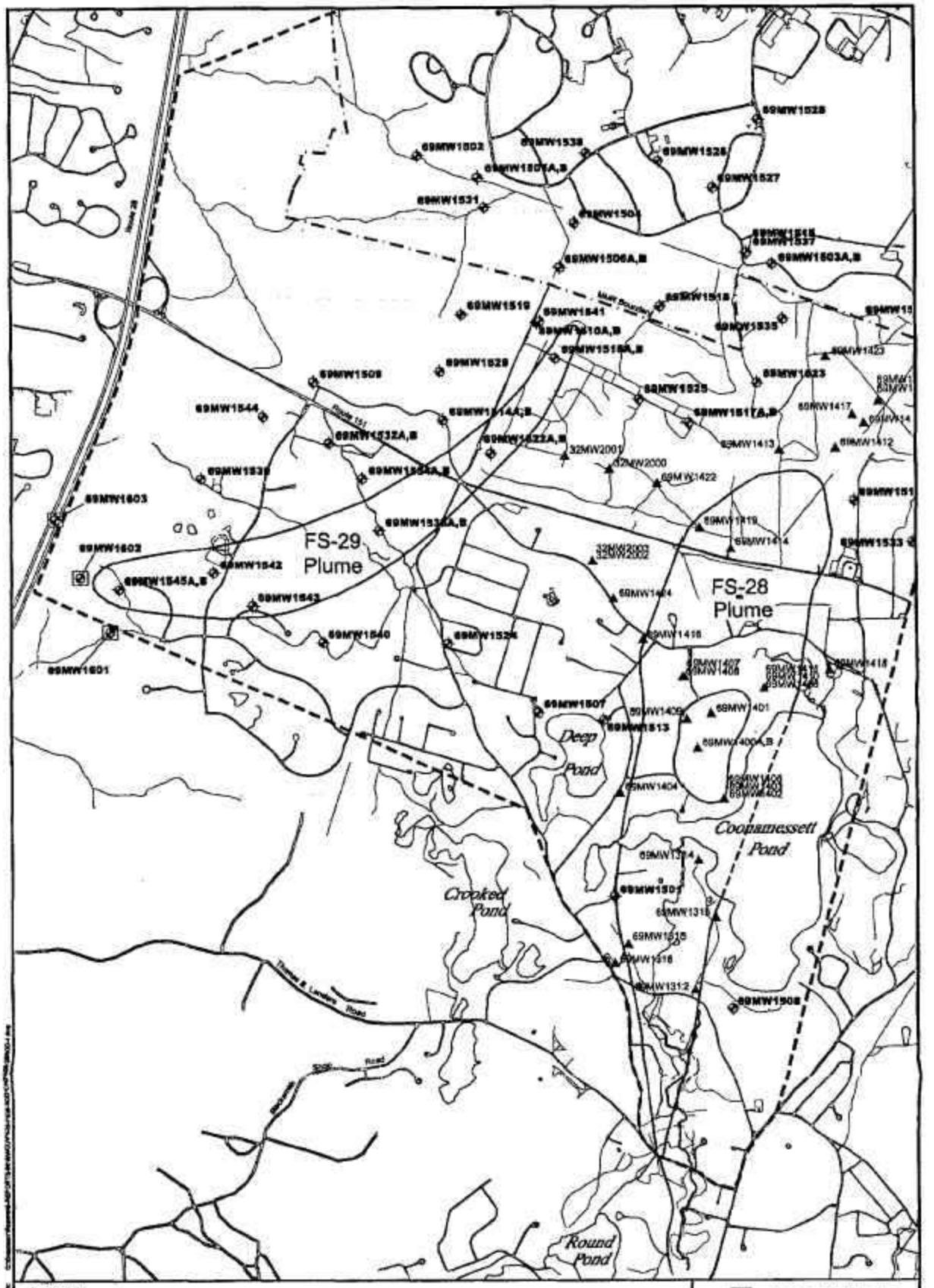
JACOBS ENGINEERING

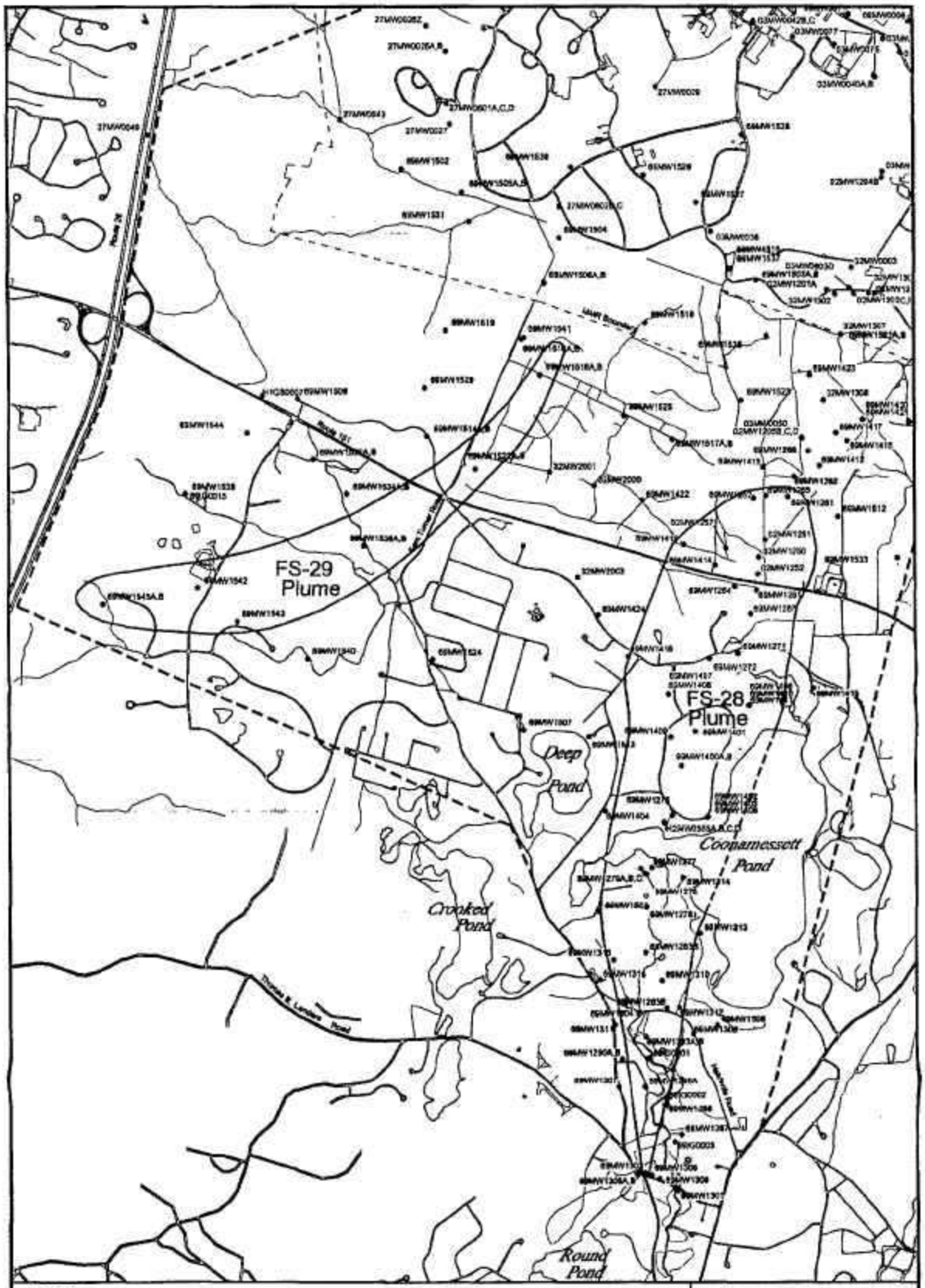
Surface Water Bodies Near the FS-28 and FS-29 Plumes

Massachusetts Military Reservation
Cape Cod, Massachusetts

5/21/00 jb fs28-29ROD-6.dwg

Figure 2-6


FS-29
Plume
FS-28
Plume
Deep
Pond
Coonamessett
Pond
Crooked
Pond
Round
Pond
Route 151
Thomas B. Landers Road
Main Roadway
69MW1528
69MW1538
69MW1526
69MW1527
69MW1531
69MW1506A,B
69MW1503A,B
69MW1519
69MW1541
69MW1518
69MW1535
69MW1509
69MW1529
69MW1525
69MW1544
69MW1517A,B
69MW1423
69MW1417
69MW1413
69MW1412
32MW2001
32MW2000
69MW1422
69MW1419
69MW1414
69MW1603
69MW1602
69MW1542
69MW1545A,B
69MW1543
69MW1540
69MW1601
69MW1507
69MW1513
69MW1404
69MW1401
69MW1400A,B
69MW1501
69MW1508
Legend
Monitoring Wells Installed During SWOU RI
Monitoring Wells Installed Spring 1999
Monitoring Wells first sampled during SWOU RI
SWOU Study Area
MMR Boundary
0
1250
Scale in Feet
JACOBS ENGINEERING
Recently Installed Monitoring Wells
Massachusetts Military Reservation
Cape Cod, Massachusetts
Figure 2-7



Legend

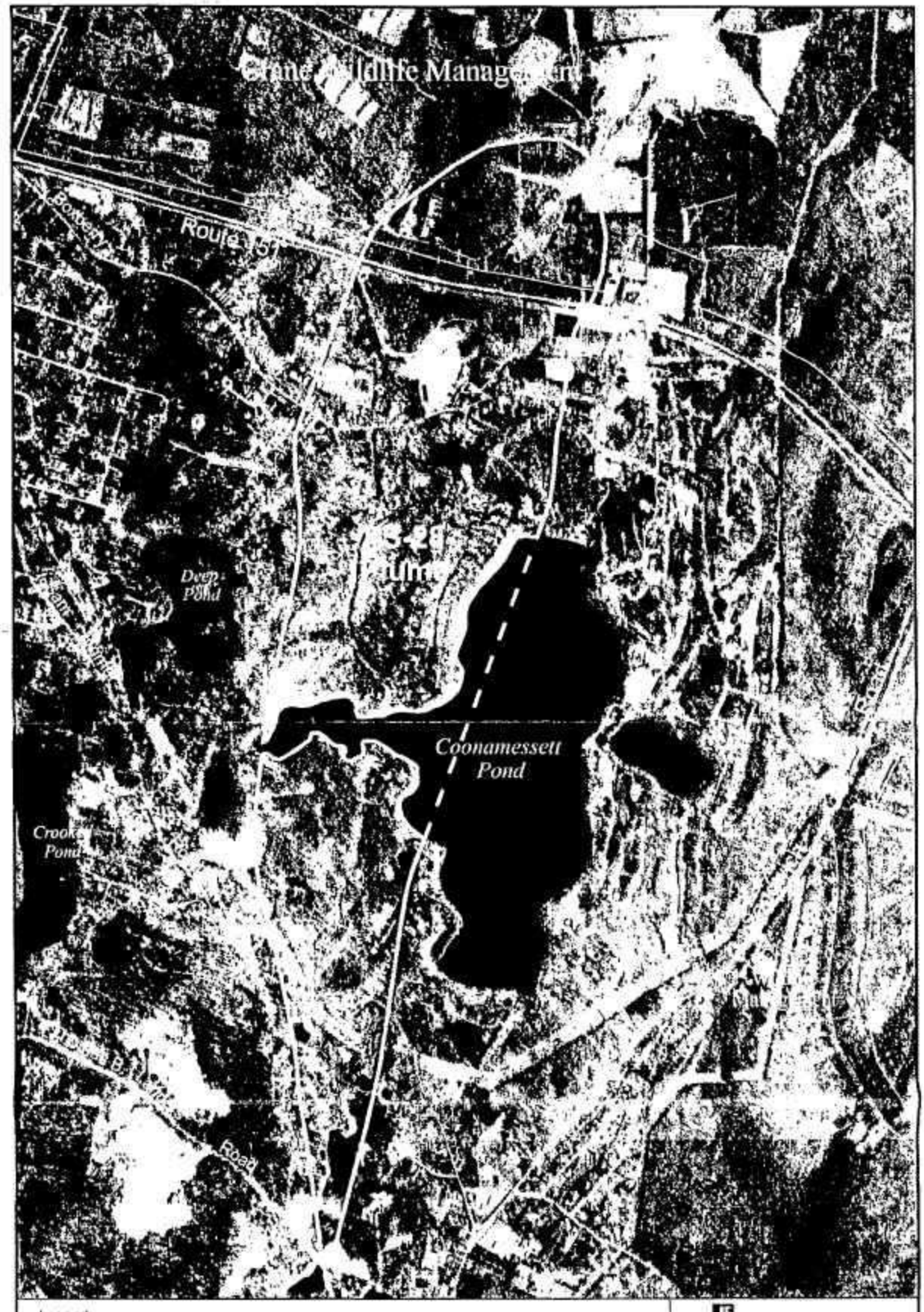
- Monitoring Wells
- MMR Boundary
- SWOU Study Area Boundary

0 1250
Scale in Feet

JACOBS ENGINEERING

Monitoring Wells
Sampled for SWOU
Remedial Investigation
Massachusetts Military Reservation
Cape Cod, Massachusetts

Figure 2-8



Legend

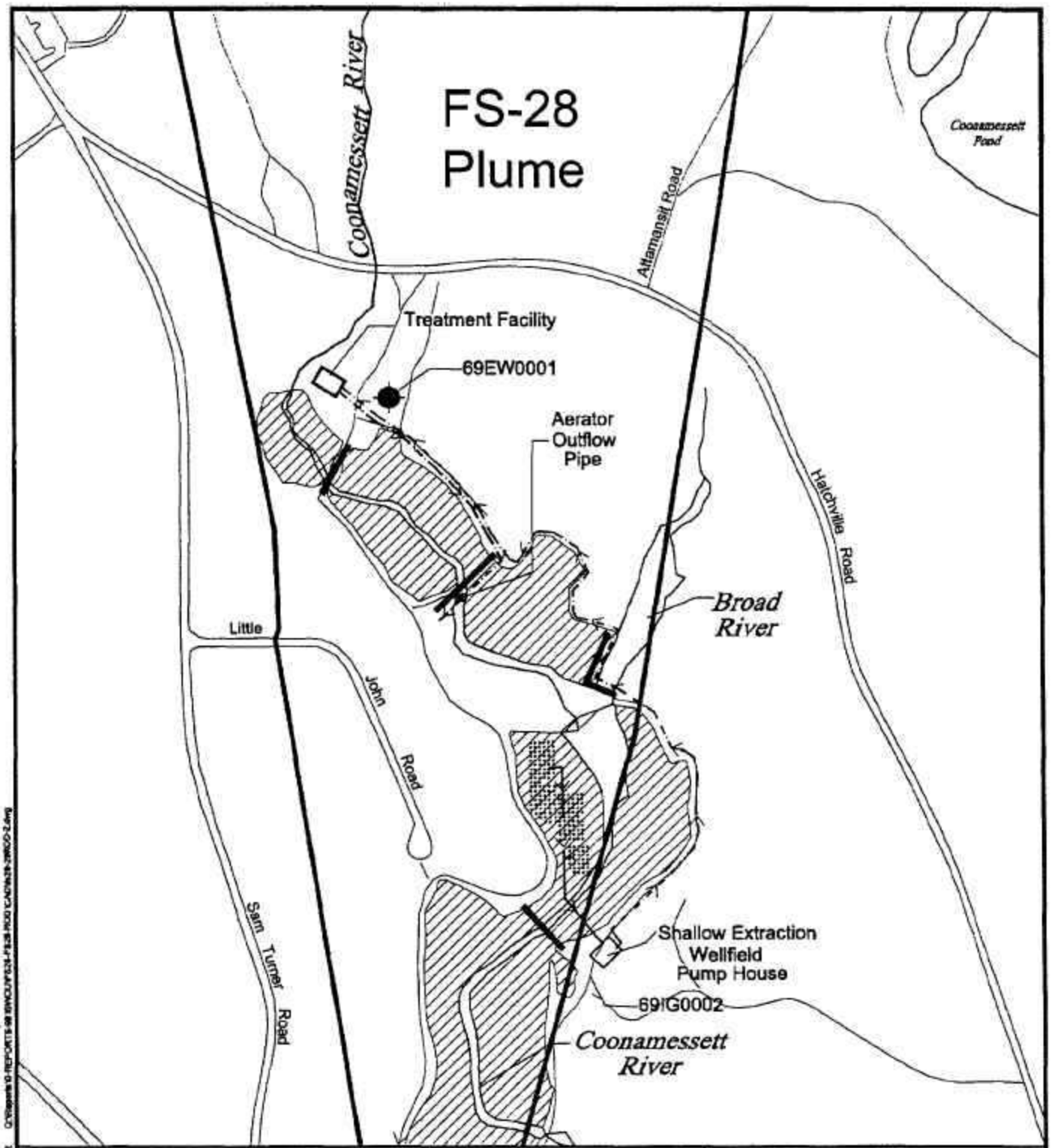
1994 Aerial Photo

JACOBS ENGINEERING

FS-28 Plume Area
Aerial Photograph

Massachusetts Military Reservation

Figure 2-9



Legend

- Well Points
- Extraction Well
- Berm
- Bogs
- Pipeline
- Plume Contour

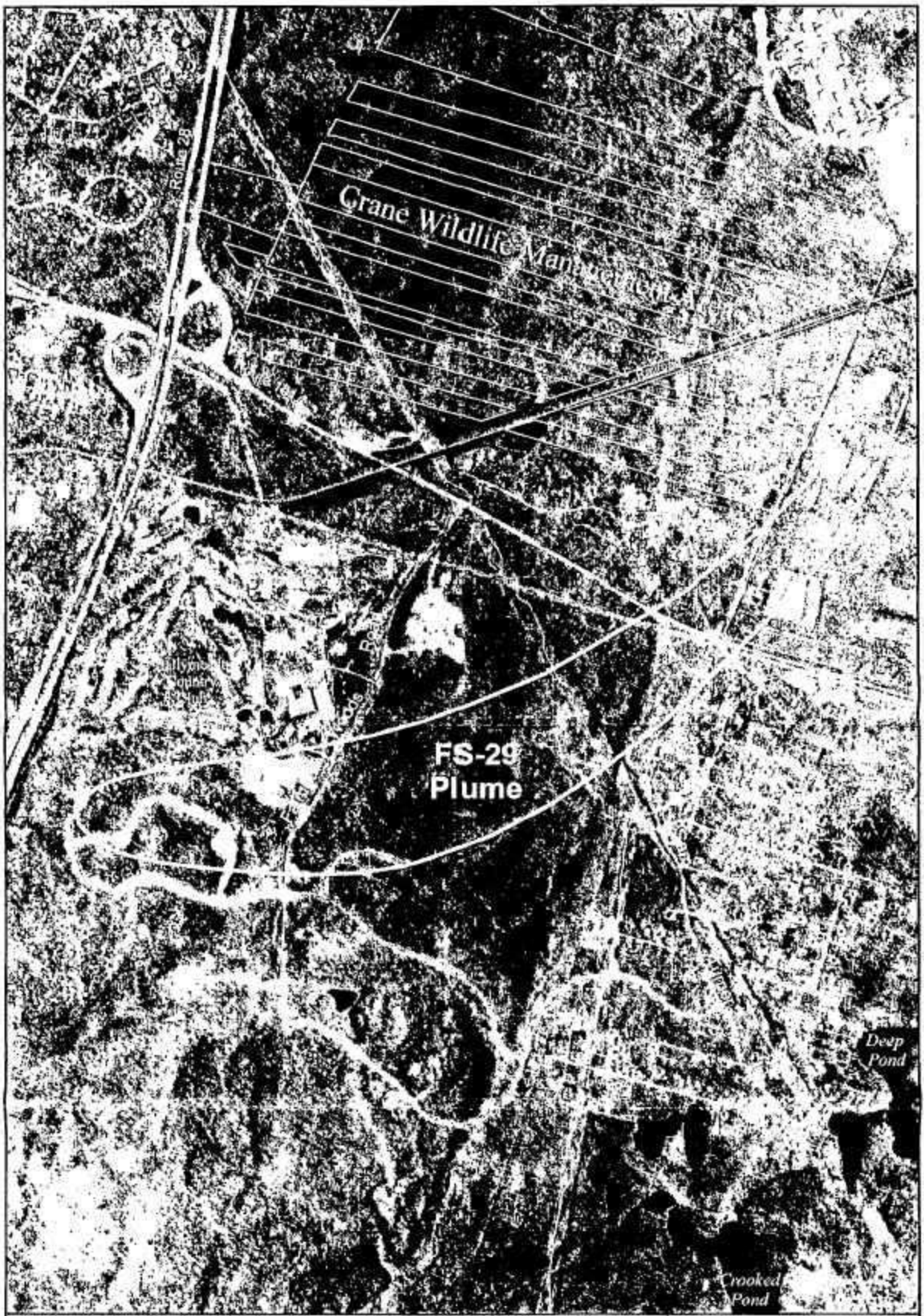
0 300
Scale in Feet

JACOBS ENGINEERING

FS-28
Extraction, Treatment, and
Discharge System
Massachusetts Military Reservation
Cape Cod, Massachusetts

05/19/00 JB fs28-29ROD-2.dwg

Figure 2-10

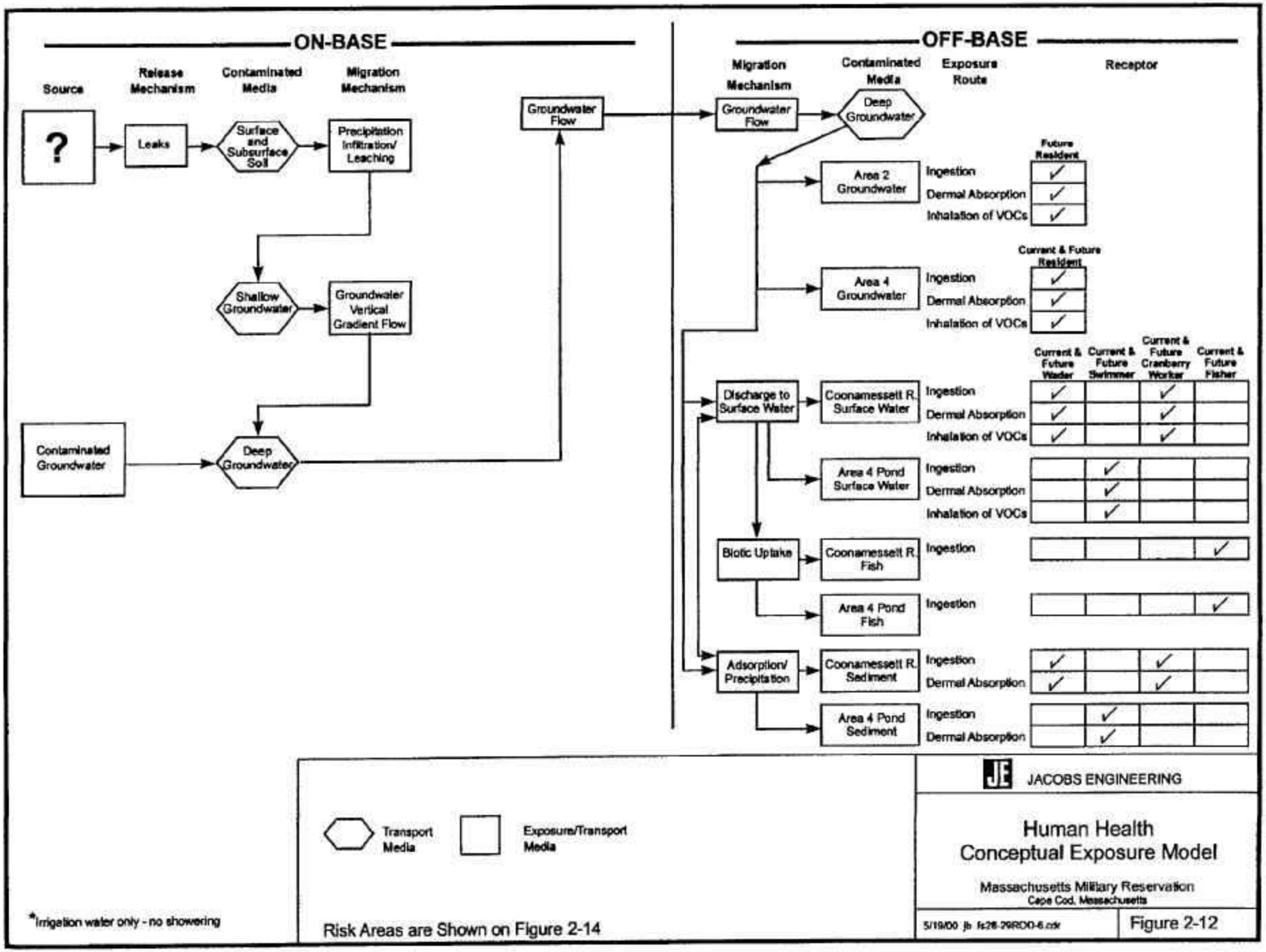


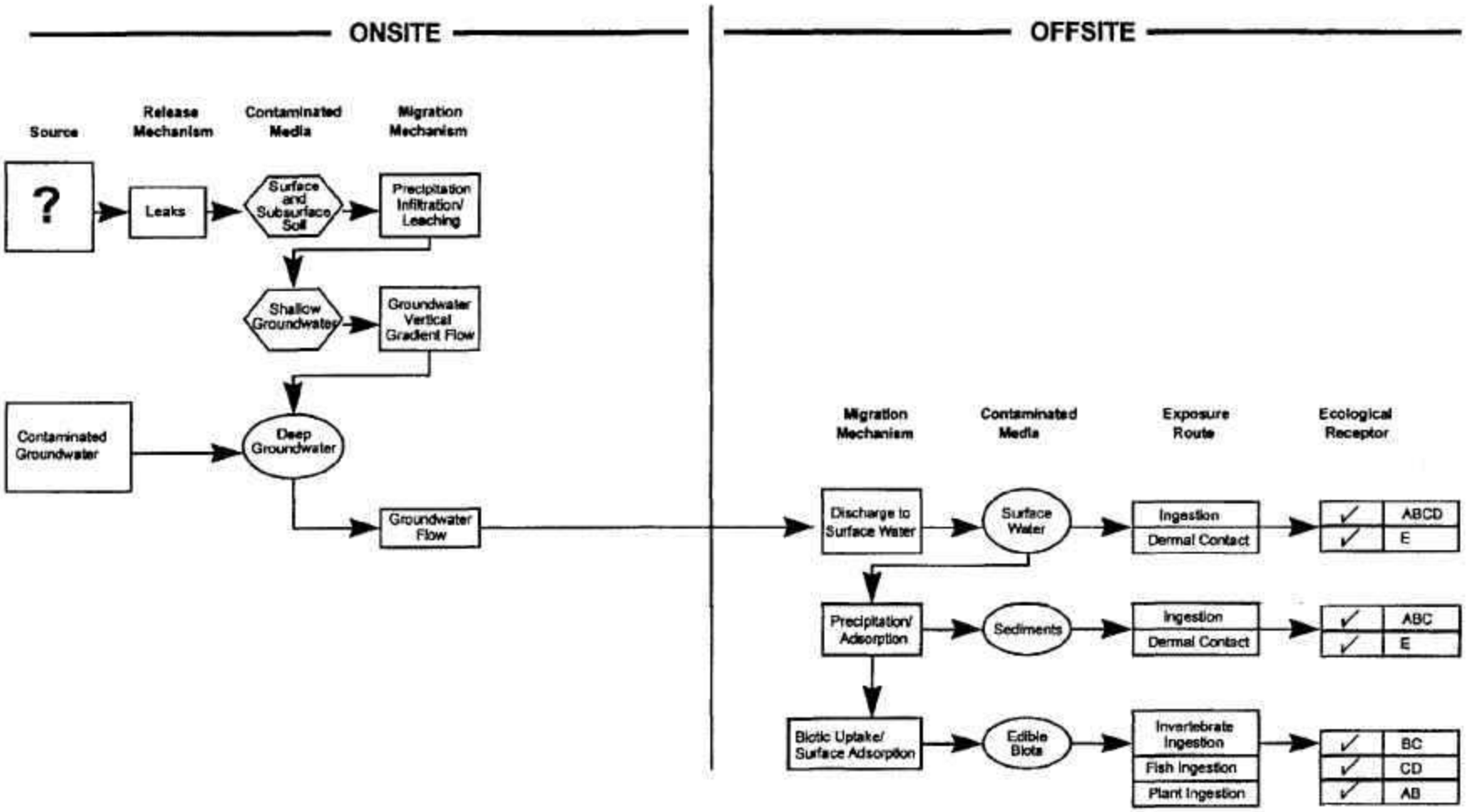
Legend
1994 Aerial Photo

JACOBS ENGINEERING

FS-29 Plume Area
Aerial Photograph

Figure 2-11


ON-BASE
Source
Release Mechanism
Contaminated Media
Migration Mechanism
?
Leaks
Surface and Subsurface Soil
Precipitation Infiltration/ Leaching
Shallow Groundwater
Groundwater Vertical Gradient Flow
Contaminated Groundwater
Deep Groundwater
Groundwater Flow
OFF-BASE
Migration Mechanism
Contaminated Media
Exposure Route
Receptor
Groundwater Flow
Deep Groundwater
Area 2 Groundwater
Future Resident
Ingestion
Dermal Absorption
Inhalation of VOCs
Area 4 Groundwater
Current & Future Resident
Ingestion
Dermal Absorption
Inhalation of VOCs
Current & Future Wader
Current & Future Swimmer
Current & Future Cranberry Worker
Current & Future Fisher
Discharge to Surface Water
Coonamessett R. Surface Water
Ingestion
Dermal Absorption
Inhalation of VOCs
Area 4 Pond Surface Water
Ingestion
Dermal Absorption
Inhalation of VOCs
Biotic Uptake
Coonamessett R. Fish
Ingestion
Area 4 Pond Fish
Ingestion
Adsorption/ Precipitation
Coonamessett R. Sediment
Ingestion
Dermal Absorption
Area 4 Pond Sediment
Ingestion
Dermal Absorption
Transport Media
Exposure/Transport Media
*Irrigation water only - no showering
Risk Areas are Shown on Figure 2-14
JACOBS ENGINEERING
Human Health Conceptual Exposure Model
Massachusetts Military Reservation
Cape Cod, Massachusetts
5/19/00 jb fs28-29RDD-6.cdr
Figure 2-12



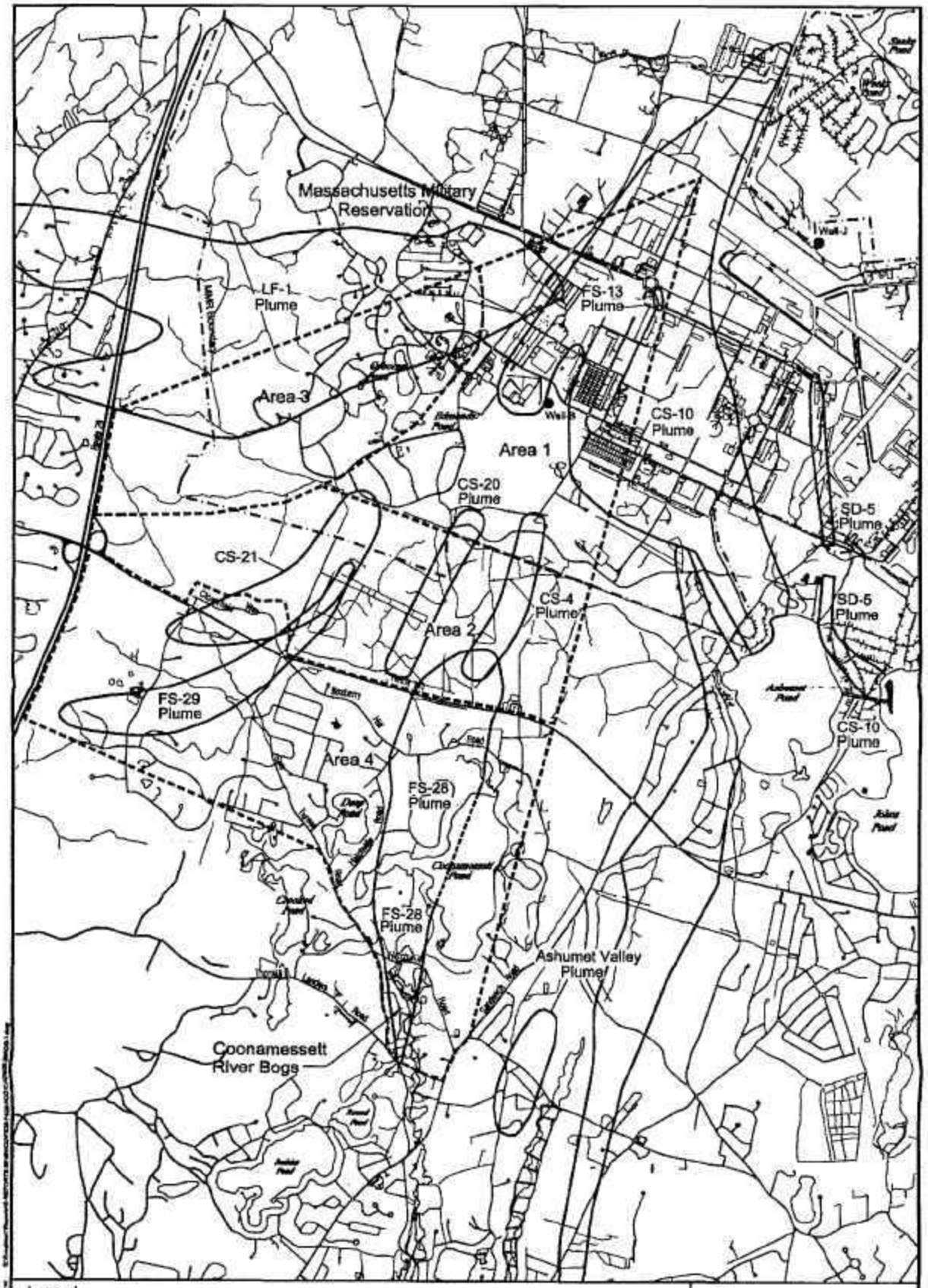
JACOBS ENGINEERING

Ecological Conceptual Exposure Model

Massachusetts Military Reservation
Cape Cod, Massachusetts

5/19/00 jb fs28-29ROD-7.cdr

Figure 2-13



Legend

— · —	MMR Boundary	Well-J	MMR Base Water Supply Well
~	Plume Contour	Well-B	Irrigation Well
	Bog		
— — —	Area Boundary		

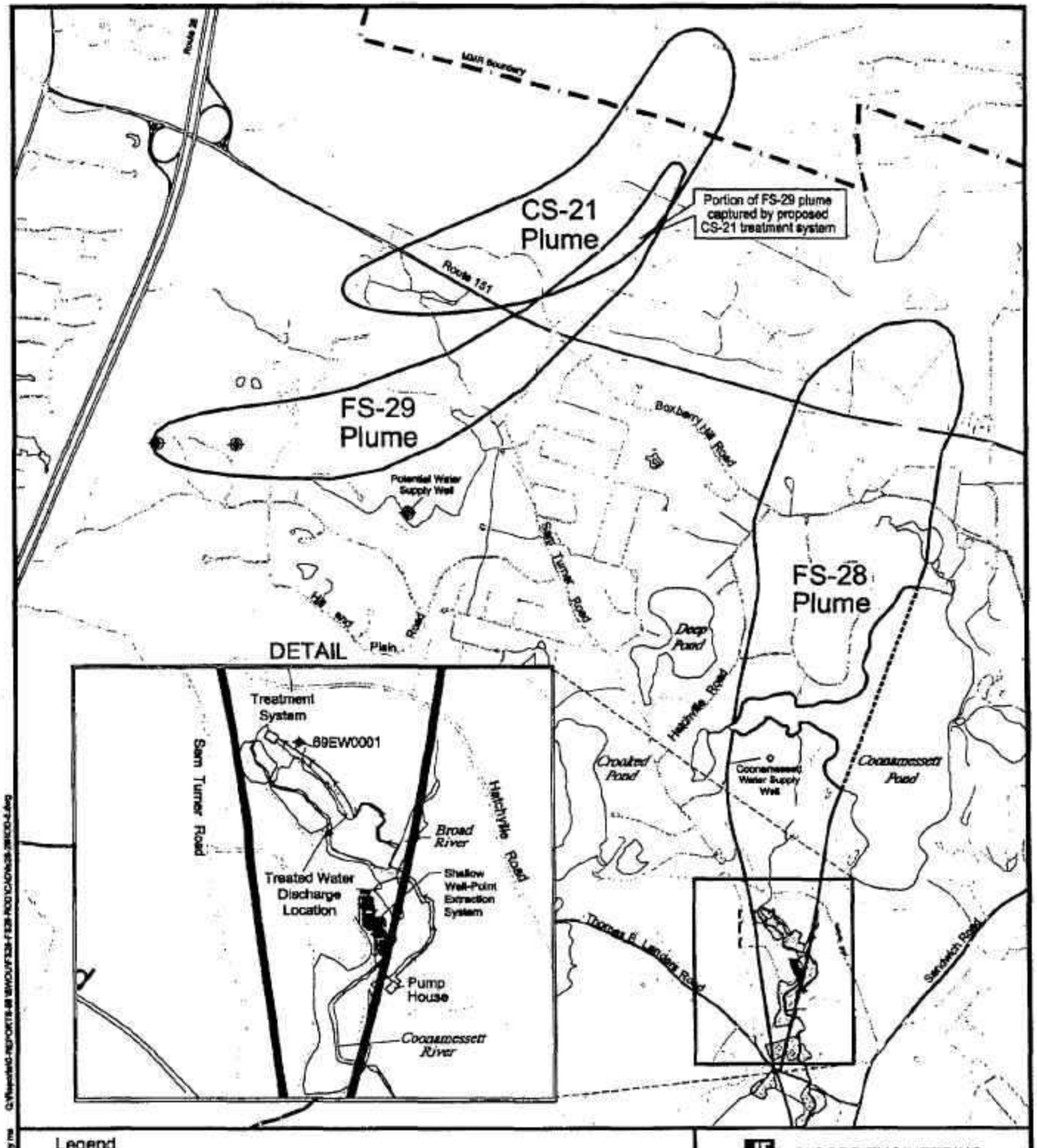
0 2500
Scale in Feet

JACOBS ENGINEERING

SWOU Groundwater Risk Areas

Massachusetts Military Reservation
Cape Cod, Massachusetts

Figure 2-14



Legend

- Plume Contour
- Pipeline
- Existing Extraction Well
- Proposed Extraction Well
- Potential Water Supply Well
- Coonamessett Water Supply Well
- Bog

N

0 1500

Scale in Feet

JACOBS ENGINEERING

Conceptual Design of the Selected Remedies

Massachusetts Military Reservation
Cape Cod, Massachusetts

5/21/00 jb fs28-29ROD-5.dwg

Figure 2-15

APPENDIX A

Selected Risk Assessment Tables from the SWOU RI

PREFACE A-1

Table Number	Title	Matrix, Media, Receptors
1	Selection of Exposure Pathways	All
2.2	Occurrence, Distribution and Selection of Chemicals of Potential Concern	Sediment, River (Area 4)
2.3	Occurrence, Distribution and Selection of Chemicals of Potential Concern	Surface Water, River (Area 4)
2.4	Occurrence, Distribution and Selection of Chemicals of Potential Concern	Sediment, Pond (Area 4)
2.5	Occurrence, Distribution and Selection of Chemicals of Potential Concern	Surface Water, Pond (Area 4)
2.6	Occurrence, Distribution and Selection of Chemicals of Potential Concern	Groundwater, Area 4
2.8	Occurrence, Distribution and Selection of Chemicals of Potential Concern	Groundwater, Area 2
4.2	Values used for Daily Sediment Intake Calculations	Coonamessett River Sediment Cranberry Worker
4.3	Values Used for Surface Water Daily Intake Calculations	Coonamessett River Surface Water Cranberry Worker
4.4	Values Used for Daily Sediment Intake Calculations	Coonamessett River Sediment Adult Recreational Wader
4.5	Values Used for Surface Water Daily Intake Calculations	Coonamessett River Surface Water Adult Wader
4.6	Values Used for Fish Tissue Daily Intake Calculations	Coonamessett River Surface Water (modeled to fish), Adult Fisher
4.7	Values Used for Daily Sediment Intake Calculations	Coonamessett River Sediment Child Wader
4.8	Values Used for Surface Water Daily Intake Calculations	Coonamessett River Surface Water Child Wader

4.9	Values Used for Daily Sediment Intake Calculations	Deep and Coonamessett Pond Sediment Adult Swimmer
4.10	Values Used for Surface Water Daily Intake Calculations	Deep and Coonamessett Pond Surface Water Adult Swimmer
4.11	Values Used for Fish Tissue Daily Intake Calculations	Deep and Coonamessett Pond Surface Water (modeled to fish) Adult Fisher
4.12	Values Used for Daily Sediment Intake Calculations	Deep and Coonamessett Pond Sediment Child Swimmer
4.13	Values Used for Surface Water Daily Intake Calculations	Deep and Coonamessett Pond Surface Water Child Swimmer
4.14	Values Used for Groundwater Daily Intake Calculations	Area 4 Groundwater and Vapor Resident Adult
4.16	Values Used for Groundwater Daily Intake Calculations	Area 2 Groundwater and Vapor Resident Adult
5.1	Non-Cancer Toxicity Data – Oral/Dermal	All
5.2	Non-Cancer Toxicity Data – Inhalation	All
6.1	Cancer Toxicity Data – Oral/Dermal	All
6.2	Cancer Toxicity Data – Inhalation	All
7.20	Calculation of Non-Cancer Hazards, Reasonable Maximum Exposure	Groundwater, Area 4 Resident Adult
7.20 CT	Calculation of Non-Cancer Hazards, Central Tendency Exposure	Groundwater, Area 4 Resident Adult
7.21	Calculation of Non-Cancer Hazards, Reasonable Maximum Exposure	Groundwater, Vapor, Area 4 Resident Adult
7.21 CT	Calculation of Non-Cancer Hazards, Central Tendency Exposure	Groundwater, Vapor, Area 4 Resident Adult

7.24	Calculation of Non-Cancer Hazards, Reasonable Maximum Exposure	Groundwater, Area 2 Resident Adult
7.24 CT	Calculation of Non-Cancer Hazards, Central Tendency Exposure	Groundwater, Area 2 Resident Adult
7.25	Calculation of Non-Cancer Hazards, Reasonable Maximum Exposure	Groundwater, Vapor, Area 2 Resident Adult
7.25 CT	Calculation of Non-Cancer Hazards, Central Tendency Exposure	Groundwater, Vapor, Area 2 Resident Adult
10.2 CT	Risk Assessment Summary, Central Tendency Exposure	Current/Future Adult Cranberry Worker
10.2 RME	Risk Assessment Summary, Reasonable Maximum Exposure	Current/Future Adult Cranberry Worker
10.3 CT	Risk Assessment Summary, Central Tendency Exposure	Current/Future Adult Wader (River)
10.3 RME	Risk Assessment Summary, Reasonable Maximum Exposure	Current/Future Adult Wader (River)
10.4 CT	Risk Assessment Summary, Central Tendency Exposure	Current/Future Adult Fisher (River)
10.4 RME	Risk Assessment Summary, Reasonable Maximum Exposure	Current/Future Adult Fisher (River)
10.5 CT	Risk Assessment Summary, Central Tendency Exposure	Current/Future Child Wader (River)
10.5 RME	Risk Assessment Summary, Reasonable Maximum Exposure	Current/Future Child Wader (River)
10.6 CT	Risk Assessment Summary, Central Tendency Exposure	Current/Future Adult Swimmer (Pond)
10.6 RME	Risk Assessment Summary, Reasonable Maximum Exposure	Current/Future Adult Swimmer (Pond)
10.7 CT	Risk Assessment Summary, Central Tendency Exposure	Current/Future Child Swimmer (Pond)
10.7 RME	Risk Assessment Summary, Reasonable Maximum Exposure	Current/Future Child Swimmer (Pond)
10.8 CT	Risk Assessment Summary, Central Tendency Exposure	Current/Future Adult Fisher (Pond)
10.8 RME	Risk Assessment Summary,	Current/Future Adult Fisher (Pond)

	Reasonable Maximum Exposure	
10.9 CT	Risk Assessment Summary, Central Tendency Exposure	Current/Future Adult Resident (Area 4)
10.9 RME	Risk Assessment Summary, Reasonable Maximum Exposure	Current/Future Adult Resident (Area 4)
10.11 CT	Risk Assessment Summary, Central Tendency Exposure	Future Adult Resident (Area 2)
10.11 RME	Risk Assessment Summary, Reasonable Maximum Exposure	Future Adult Resident (Area 2)

PREFACE

This appendix includes selected tables from the human health baseline risk assessment conducted during the Southwest Operable Unit (SWOU) Remedial Investigation (RI). The complete series of human health risk assessment tables can be found in Appendix O of the *Final Southwest Operable Unit Remedial Investigation* (Volume V).[1] The risks to a future resident from exposure to groundwater in the SWOU were evaluated using an area-based approach during the RI because the SWOU investigation was designed to characterize the entire study area as an operable unit rather than using a plume-specific approach. However, since it was not practical to evaluate the whole study area with one data set, the SWOU was divided into four separate risk areas, based primarily on land use and secondarily on groundwater flow direction and known contamination. The tables presented in this appendix show the risk calculations for these four separate risk areas.

After the RI was completed, the *Final FS-28 and FS-29 Groundwater Feasibility Study*[2] approached the development of remedial alternatives on a plume-specific basis. Based on a careful review of the contaminant distribution throughout the entire SWOU, it was determined that all of the groundwater contamination that the RI concluded would cause unacceptable risk was either not attributable to MMAR, was contained within the LF-1 or CS-10 plumes, or was contained within the CS-4, CS-20, CS-21, FS-13, FS-28, and FS-29 plumes. At that point, contaminants of concern (COCs) were established for each plume, and the cancer risks and noncancer hazards for each COC in each plume were calculated. When the decision was made to split apart the SWOU from one area containing six plumes into two groups of plumes, it became even more appropriate to look at risks on a plume-by-plume basis.

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[1] Air Force Center for Environmental Excellence. 199b (May). *Final Southwest Operable Unit Remedial Investigation*. AFC-J23-35Q86101-M14-0006. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR Installation Restoration Program, Otis Air National Guard Base, MA.

[2] Air Force Center for Environmental Excellence. 2000d (January). *Final FS-28 and FS-20 Groundwater Feasibility Study*. AFC-J23-35Q86101-M16-0011. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR Installation Restoration Program, Otis Air National Guard Base, MA.

Section 2.7 of this Record of Decision summarizes the human health and ecological risk assessments conducted during the RI. The main document includes tables showing human health risks on a plume-specific basis, and also explains further how the transition was made from an area-based approach to risk to a plume-specific approach to risk. The following human health risk tables from the area-based risk assessment are included to support the risk assessment summary presented in Section 2.7.

TABLE 1
SELECTION OF EXPOSURE PATHWAYS
MASSACHUSETTS MILITARY RESERVATION
SOUTHWEST OPERABLE UNIT

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/ Future	Soil	Soil	Entire SWOU	Resident/ Worker	Adult/Child	Ingestion	On/Off-Site	None	No known remaining soil contamination
						Dermal	On/Off-Site	None	No known remaining soil contamination
		Dust	*	*	*	Inhalation	On/Off-Site	None	No known remaining soil contamination
Current	Groundwater	Groundwater	Well B	Other Worker*	Adult	Dermal	On-Base	Quant	Workers irrigate golf courses with Well B groundwater
		Vapor	*	*	*	Inhalation	On-Base	Quant	Workers irrigate golf course with Well B groundwater
Current/ Future	Sediment	Sediment	Coonamessett River	Farmer*	Adult	Ingestion	Off-Site	Quant	Cranberry workers work in Coonamessett River
						Dermal	Off-Site	Quant	Cranberry workers work in Coonamessett River
	Surface Water	Surface Water	*	*	*	Ingestion	Off-Site	Quant	Cranberry workers work in Coonamessett River
						Dermal	Off-Site	Quant	Cranberry workers work in Coonamessett River
		Vapor	*	*	*	Inhalation	Off-Site	Quant	Cranberry workers work in Coonamessett River
Current/ Future	Sediment	Sediment	*	Other Recreational Person[c]	*	Ingestion	Off-Site	Quant	SWOU adult residents use river for wading
						Dermal	Off-Site	Quant	SWOU adult residents use river for wading
	Surface Water	Surface Water	*	*	*	Ingestion	Off-Site	Quant	SWOU adult residents use river for wading
						Dermal	Off-Site	Quant	SWOU adult residents use river for wading
		Vapor	*	*	*	Inhalation	Off-Site	Quant	SWOU adult residents use river for wading
		Fish Tissue	*	Fisher	*	Ingestion	Off-Site	Quant	SWOU adult residents eat fish from river
Current/ Future	Sediment	Sediment	*	Other Recreational Person[c]	Child	Ingestion	Off-Site	Quant	SWOU child residents use river for wading
						Dermal	Off-Site	Quant	SWOU child residents use river for wading
	Surface Water	Surface Water	*	*	*	Ingestion	Off-Site	Quant	SWOU child residents use river for wading
						Dermal	Off-Site	Quant	SWOU child residents use river for wading
		Vapor	*	*	*	Inhalation	Off-Site	Quant	SWOU child residents use river for wading
Current/ Future	Sediment	Sediment	Osborne & Edwards Ponds	Swimmer	Adult/Child	Ingestion	Off-Site	None	Ponds not hydraulically connected to plumes
					*	Dermal	Off-Site	None	Ponds not hydraulically connected to plumes
	Surface Water	Surface Water	*	*	*	Ingestion	Off-Site	None	Ponds not hydraulically connected to plumes
					*	Dermal	Off-Site	None	Ponds not hydraulically connected to plumes
		Vapor	*	*	*	Inhalation	Off-Site	None	Ponds not hydraulically connected to plumes
		Fish Tissue	*	Fisher	*	Ingestion	Off-Site	None	Ponds not hydraulically connected to plumes
Current/ Future	Sediment	Sediment	Deep Pond & Coonamessett Pond	Swimmer	Adult	Ingestion	Off-Site	Quant	SWOU adult residents use ponds for swimming
					*	Dermal	Off-Site	Quant	SWOU adult residents use ponds for swimming
	Surface Water	Surface Water	*	*	*	Ingestion	Off-Site	Quant	SWOU adult residents use ponds for swimming
					*	Dermal	Off-Site	Quant	SWOU adult residents use ponds for swimming
		Vapor	*	*	*	Inhalation	Off-Site	Quant	SWOU adult residents use ponds for swimming
		Fish Tissue	*	Fisher	*	Ingestion	Off-Site	Quant	SWOU adult residents eat fish from ponds
Current/ Future	Sediment	Sediment	*	Swimmer	Child	Ingestion	Off-Site	Quant	SWOU child residents use ponds for swimming
				*	*	Dermal	Off-Site	Quant	SWOU child residents use ponds for swimming
	Surface Water	Surface Water	*	*	*	Ingestion	Off-Site	Quant	SWOU child residents use ponds for swimming
				*	*	Dermal	Off-Site	Quant	SWOU child residents use ponds for swimming
		Vapor	*	*	*	Inhalation	Off-Site	Quant	SWOU child residents use ponds for swimming
Current/ Future	Groundwater	Groundwater	Area 4 Residence	Resident	Adult	Ingestion	Off-Site	Quant	Current and future residents may use groundwater
						Dermal	Off-Site	Quant	Current and future residents may use groundwater
		Vapor	*	*	*	Inhalation	Off-Site	Quant	Current and future residents may use groundwater

TABLE 1
SELECTION OF EXPOSURE PATHWAYS
MASSACHUSETTS MILITARY RESERVATION
SOUTHWEST OPERABLE UNIT

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Groundwater	Groundwater	Area 3 Residence	Resident	Adult/child	Ingestion	Off-Site	None	No Area 3 residences currently use groundwater
						Dermal	Off-Site	None	No Area 3 residences currently use groundwater
		Vapor	*	*	*	Inhalation	Off-Site	None	No Area 3 residences currently use groundwater
Future	Groundwater	Groundwater	Area 3 Residence	Resident	Adult	Ingestion	Off-Site	Quant	Future Residents may use groundwater
						Dermal	Off-Site	Quant	Future Residents may use groundwater
		Vapor	*	*	*	Inhalation	Off-Site	Quant	Future Residents may use groundwater
Current	Groundwater	Groundwater	Area 2 Residence	Resident	Adult/child	Ingestion	Off-Site	None	No Area 2 residences currently use groundwater
						Dermal	Off-Site	None	No Area 2 residences currently use groundwater
		Vapor	*	*	*	Inhalation	Off-Site	None	No Area 2 residences currently use groundwater
Future	Groundwater	Groundwater	Area 2 Residence	Resident	*	Ingestion	Off-Site	Quant	Future Residents may use groundwater
						Dermal	Off-Site	Quant	Future Residents may use groundwater
		Vapor	*	*	*	Inhalation	Off-Site	Quant	Future Residents may use groundwater
Current	Groundwater	Groundwater	Area 1 Residence	Resident	Adult/child	Ingestion	Off-Site	None	There are no residences on industrial part of Base
						Dermal	Off-Site	None	There are no residences on industrial part of Base
		Vapor	*	*	*	Inhalation	Off-Site	None	There are no residences on industrial part of Base
Future	Groundwater	Groundwater	Area 1 Residence	Resident	Adult	Ingestion	Off-Site	Quant	Future Residents may use groundwater
						Dermal	Off-Site	Quant	Future Residents may use groundwater
		Vapor	*	*	*	Inhalation	Off-Site	Quant	Future Residents may use groundwater

Table 2.2
Occurrence, Distribution and Selection of Chemicals of Potential Concern
MMR RI SWOU

Scenario Timeframe: CURRENT
Medium: SEDIMENT
Exposure Medium: SEDIMENT
Exposure Point: RIVER

Cas Number	Chemical	Minimum Detected Concentration	Minimum Qualifier	Maximum Detected Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency #Detect of #Result	Range of Detection Limits	Concentration Used for Screening (Maximum)	Background Value	Screening Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Yes or No)	Rationale for COPC Yes Flag (Most Restrictive)
106-93-4	1,2-DIBROMOMETHANE (EDB)	0.02	J	0.036	J	UG/KG	69SW1265	2 of 23	0.0130 To 0.0370	0.036		1.00E+03 C			Yes$	
106-44-5	4-METHYLPHENOL (P-CREOSOL)	50.5	J	127	J	UG/KG	69SW0014	2 of 24	185.0000 To 596.0000	127		3.85E+07 N			No	
67-64-1	ACETONE	17.7		215		UG/KG	69SW0102	4 of 23	8.2400 To 23.0000	216		7.30E+08 N			No	
7429-90-5T	ALUMINUM (TOTAL)	572		5750		MG/KG	69SW0901	30 of 30	2.1200 To 6.5000	5750	42566.3	7.30E+06 N			No*	
7440-38-2T	ARSENIC (TOTAL)	0.803	J	49.3		MG/KG	69SW0902	13 of 30	0.2600 To 5.2200	49.3	13.7	2.19E+03 C			Yes	Bkgd
7440-39-3T	BARIUM (TOTAL)	2.6		170		MG/KG	69SW0902	30 of 30	0.0320 To 0.0990	170	76.9	5.11E+05 N			Yes	Bkgd
205-99-2	BENZO(B)FLUORANTHENE	138	J	594		UG/KG	69SW0105	2 of 24	127.0000 To 412.0000	594		1.17E+05 C			No	
7440-41-7T	BERYLLIUM (TOTAL)	0.0572	J	2.28		MG/KG	69SW0901	29 of 30	0.0320 To 0.0990	2.28	1.13	1.96E+01 N			Yes	Bkgd
7440-43-9T	CADMIUM (TOTAL)	0.0796	J	3.09	J	MG/KG	69SW0902	10 of 30	0.0650 To 0.1960	3.09	2.08	3.85E+03 N			Yes	Bkgd
7440-70-2T	CALCIUM (TOTAL)	57.1	J	3260	J	MG/KG	69SW0907	30 of 30	1.2300 To 3.7700	3280	2930				No*	
7440-47-3T	CHROMIUM (TOTAL)	1.14	J	8.39	J	MG/KG	69SW0907	29 of 30	0.0860 To 0.8490	8.39	57.3	3.65E+04 N			No	
7440-48-4T	COBALT (TOTAL)	0.102	J	6.06	J	MG/KG	69SW0902	26 of 30	0.0810 To 0.2480	6.06	11.25	N			No*	
7440-50-8T	COPPER (TOTAL)	0.962	J	19.5		MG/KG	69SW0102	25 of 30	0.1140 To 1.0000	19.5	81.2	N			No	
206-44-0	FLUORANTHENE	180	J	1200		UG/KG	69SW0105	2 of 24	118.0000 To 381.0000	1200		2.92E+06 N			No	
7439-89-6T	IRON (TOTAL)	1460		104000		MG/KG	69SW0902	30 of 30	2.7500 To 8.3900	104000	26572.8	N			No*	
7439-92-1T	LEAD (TOTAL)	1.45		47.6		MG/KG	69SW0901	29 of 30	0.1950 To 1.1100	47.6	259.4				No	
7439-95-4T	MAGNESIUM (TOTAL)	138	J	1050	J	MG/KG	69SW0907	30 of 30	1.2300 To 3.7700	1050	5417				No*	
7439-96-5T	MANGANESE (TOTAL)	7.2		92.4		MG/KG	69SW0901	30 of 30	0.0610 To 0.2480	92.4	233.9	3.65E+04 N			No	
7439-97-6T	MERCURY (TOTAL)	0.0528		0.2		MG/KG	69SW0903	5 of 30	0.0100 To 0.1500	0.2		2.19E+03			No	
7440-02-0T	NICKEL (TOTAL)	0.135	J	5.16	J	MG/KG	69SW0907	22 of 30	0.0970 To 1.1300	5.16	38.2	1.46E+05 N			No	
7440-09-7T	POTASSIUM (TOTAL)	102	J	419	J	MG/KG	69SW0024	27 of 30	1.2000 To 134.0000	419	3250				No*	
129-00-0	PYRENE	151	J	758		UG/KG	69SW0105	2 of 24	144.0000 To 466.0000	758		2.19E+06 N			No	
7782-49-2T	SELENIUM (TOTAL)	0.363	J	15.8		MG/KG	69SW0902	13 of 30	0.2920 To 0.8930	15.8	4.4	3.65E+04 N			Yes	Bkgd
7440-21-3T	SILICON (TOTAL)	151		4250		MG/KG	69SW0901	28 of 28	0.8570 To 2.7700	4250	11716.7				No*	
7440-23-5T	SODIUM (TOTAL)	32.3	J	2050		MG/KG	69SW0901	20 of 30	28.80000 To 87.8000	2050	790				No*	
108-88-3	TOLUENE	6.19	J	267		UG/KG	69SW0102	3 of 24	2.3700 To 11.4000	267		1.46E+09 N			No	
7440-62-2T	VANADIUM (TOTAL)	2.5	J	82.1		MG/KG	69SW0901	30 of 30	0.0970 To 2.1000	82.1	150.5	5.11E+04 N			No	
7440-86-6T	ZINC (TOTAL)	2.17	J	51.2	J	MG/KG	69SW0907	29 of 30	0.0970 To 3.3600	51.2	220.4	2.19E+06 N			No	

Notes:
The data sources are SEE database Jacobs and Stone & Webster tables.
Only the latest results, with the most complete analyte lists, were used if more than one sample available.
Only normal, validated, non-rejected results for samples collected after 06/01/96 are used.
Only analytes with 2 or more detections and greater than 5% detection frequency are shown.
The analyte concentration used for screening is the maximum detected result.
ARAR is unavailable
Screening toxicity is either Tier 1 Human Health HEC (if available) or EPA Region 3 risk-based residential soil standard.
COPC flag is Yes if screening result exceeds any of the background, screening toxicity, or ARAR concentrations.
COPC flag is Yes if there is no background, screening toxicity, or ARAR value to compare to.
Rationale for COPC Yes flag gives the most restrictive of the comparison values.
* indicates that common cations (Al, Ca, Fe, Mg, K, Na, Sl) are presented for informational purposes and are not considered to be COPCs.
C indicates a carcinogen as reported on EPA Region 3 RBC Table.
N indicates a non-carcinogen as reported on EPA Region 3 RBC Table.
# indicates Bis(2-ethylhexyl)phthalate is not a COPC because it is a common lab and sampling equipment contaminant.
% indicates Lead is a COPC but is treated separately by the IEUBK Model and reported in a separate set of tables referenced in the SWOU RI BRA.
Data qualifier J indicates an estimated value.
$ indicates EDB is a COPC for informational purposes only.

Table 2.3
Occurrence, Distribution and Selection of Chemicals of Potential Concern
MMR RI SWOU

Scenario Timeframe: CURRENT
Medium: SURFACE WATER
Exposure Medium: SURFACE WATER
Exposure Point: RIVER

Cas Number	Chemical	Minimum Detected Concentration	Minimum Qualifier	Maximum Detected Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency #Detect of #Result	Range of Detection Limits	Concentration Used for Screening (Maximum)	Background Value	Screening Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Yes or No)	Rationale for COPC Yes Flag (Most Restrictive)
106-93-4	1,2-DIBROMOMETHANE (EDB)	0.007	J	0.73		UG/L	69SW0016	16 of 30	0.0024 To 0.2800	0.73		5.41E-03 C			Yes	Tox
7429-90-5T	ALUMINUM (TOTAL)	214		299		UG/L	69SW0105	2 of 30	16.0000 To 184.0000	299	68.5	1.72E+04 N	87	AWQC	No*	
7440-38-2	ARSENIC	1.56	J	1.93	J	UG/L	69SW0901	2 of 30	1.3000 To 1.5000	1.93		1.85E-01 C	190	AWQC	Yes	Tox
7440-38-2T	ARSENIC (TOTAL)	1.36	J	2.2	J	UG/L	69SW0105	3 of 30	1.3000 To 1.5000	2.2	2.7	1.85E-01 C	190	AWQC	Yes	Tox
7440-39-3	BARIUM	2.36	J	9.05	J	UG/L	69SW0010	30 of 30	0.2000 To 0.2000	9.05	11.2	3.00E+03 N			No	
7440-39-3T	BARIUM (TOTAL)	3.41	J	17.9	J	UG/L	69SW0022	30 of 30	0.2000 To 0.2000	17.9	11.4	3.00E+03 N			Yes	Bkgd
117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	43.2		76.6	J	UG/L	69SW0014	3 of 28	4.9000 To 19.3000	76.6		1.33E+01 C			No#	
7440-70-2	CALCIUM	1850		3120		UG/L	69SW0907	30 of 30	7.6000 To 7.6000	3120	3550				No*	
7440-70-2T	CALCIUM (TOTAL)	1670		3330	J	UG/L	69SW0011	30 of 30	7.6000 To 7.6000	3330	3450				No*	
7440-47-3T	CHROMIUM (TOTAL)	0.47	J	1.15	J	UG/L	69SW0044	2 of 30	0.4000 To 0.4000	1.15	0.71	4.32E+00 N	117.32	AWQC	Yes	Bkgd
7440-47-3	CHROMIUM, TOTAL	0.41	J	0.46	J	UG/L	69SW0102	2 of 30	0.4000 To 0.4000	0.46	0.8	4.32E+00 N	117.32	AWQC	No	
7439-89-6	IRON	151		967		UG/L	69SW0103	18 of 30	16.9000 To 214.0000	967	89.4	1.10E+04 N	1000	AWQC	No*	
7439-89-6T	IRON (TOTAL)	158		2840		UG/L	69SW0105	24 of 30	16.9000 To 81.3000	2840	525	1.10E+04 N	1000	AWQC	No*	
7439-92-1	LEAD	1.12	J	2.46		UG/L	69SW0007	2 of 30	1.1000 To 1.6300	2.46	2.5		1.32	AWQC	Yes%	ARAR
7439-92-1T	LEAD (TOTAL)	1.56	J	6.46		UG/L	69SW0011	3 of 30	1.1000 To 2.4700	6.46	1.9		1.32	AWQC	Yes%	ARAR
7439-95-4	MAGNESIUM	1070		1710		UG/L	69SW0014	30 of 30	7.6000 To 7.6000	1710	1940				No*	
7439-95-4T	MAGNESIUM (TOTAL)	1070		1700	J	UG/L	69SW0011	30 of 30	7.6000 To 7.6000	1700	2066.5				No*	
7439-96-5	MANGANESE	5.41	J	22.5		UG/L	69SW0105	25 of 30	0.5000 To 6.3100	22.5	176	2.47E+03 N			Yes	Tox
7439-96-5T	MANGANESE (TOTAL)	5.45	J	26.2		UG/L	69SW0106	25 of 30	0.5000 To 6.5700	26.2	165	2.47E-03 N			Yes	Tox
78-93-3	METHYL ETHYL KETONE (2-BUTANONE)	7.72	J	31.2	J	UG/L	69SW0010	3 of 3	1.7400 To 1.7400	31.2		8.11E+04 N			No	
106-10-1	METHYL ISOBUTYL KETONE (4-METHYL-2-	9.13		10.9		UG/L	69SW0044	2 of 30	1.4200 To 1.4200	10.9		2.90E+03 N			No	
7440-09-7	POTASSIUM	694	J	1030		UG/L	69SW0022	30 of 30	7.4000 To 7.4000	1030	1390				No*	
7440-09-7T	POTASSIUM (TOTAL)	711	J	1040		UG/L	69SW0037	30 of 30	7.4000 To 7.4000	1040	1410				No*	
7440-21-3	SILICON	1030		4960		UG/L	69SW0016	30 of 30	7.2000 To 7.2000	4960	2280				No*	
7440-21-3T	SILICON (TOTAL)	1130		5170		UG/L	69SW0016	30 of 30	7.2000 To 7.2000	5170	1950				No*	
7440-23-5	SODIUM	5900		7650		UG/L	69SW0909	30 of 30	51.9000 To 177.0000	7650	13500				No*	
7440-23-5T	SODIUM (TOTAL)	6070		7770		UG/L	69SW0909	30 of 30	51.9000 To 177.0000	7770	13200				No*	
7440-86-6	ZINC	7.06	J	91.8		UG/L	69SW0103	15 of 30	0.8000 To 12.8000	91.8	12.7	5.38E+01 N	58.91	AWQC	Yes	Bkgd
7440-86-6T	ZINC (TOTAL)	6.45	J	24		UG/L	69SW0037	7 of 30	0.8000 To 11.7000	24	9	5.38E+01 N	58.91	AWQC	Yes	Bkgd

Notes:
The data sources are SEE database Jacobs and Stone & Webster tables.
Only the latest results, with the most complete analyte lists, were used if more than one sample available.
Only normal, validated, non-rejected results for samples collected after 06/01/96 are used.
Only analytes with 2 or more detections and greater than 5% detection frequency are shown.
The analyte concentration used for screening is the maximum detected result.
ARAR is AWQC value
Screening toxicity is either Tier 1 Human Health HEC (if available) or EPA Region 3 risk-based tap water standard
COPC flag is Yes if screening result exceeds any of the background, screening toxicity, or ARAR concentrations.
COPC flag is Yes if there is no background, screening toxicity, or ARAR value to compare to.
Rationale for COPC Yes flag gives the most restrictive of the comparison values.
* Indicates that common cations (Al, Ca, Fe, Mg, K, Na, Sl) are presented for informational purposes and are not considered to be COPCs.
C indicates a carcinogen as reported on EPA Region 3 RBC Table.
N indicates a non-carcinogen as reported on EPA Region 3 RBC Table.
# indicates Bis(2-ethylhexyl)phthalate is not a COPC because it is a common lab and sampling equipment contaminant.
% indicates Lead is a COPC but is treated separately by the IEUBK Model and reported in a separate set of tables referenced in the SWOU RI BRA.
Data qualifier J indicates an estimated value.

Table 2.4
Occurrence, Distribution and Selection of Chemicals of Potential Concern
MMR RI SWOU

Scenario Timeframe: CURRENT
Medium: SEDIMENT
Exposure Medium: SEDIMENT
Exposure Point: POND

Cas Number	Chemical	Minimum Detected Concentration	Minimum Qualifier	Maximum Detected Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency #Detect of #Result	Range of Detection Limits	Concentration Used for Screening (Maximum)	Background Value	Screening Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Yes or No)	Rationale for COPC Yes Flag (Most Restrictive)
67-64-1	ACETONE	24.4		76.7		UG/KG	69SW0743	2 of 13	8.0500 To 25.8000	76.7		7.30E+06 N			No	
7429-90-5T	ALUMINUM (TOTAL)	298		15300		MG/KG	69SW0611	20 of 20	2.3100 To 6.2300	15300	42566.3	7.30E+06 N			No*	
7440-38-2T	ARSENIC (TOTAL)	0.704	J	7.63		MG/KG	69SW0611	8 of 20	0.2860 To 1.2100	7.63	13.7	2.19E+03 C			No	
7440-39-3T	BARIUM (TOTAL)	2.49	J	122		MG/KG	69SW0615	20 of 20	0.0180 To 0.0430	122	76.9	5.11E+05 N			Yes	Bkgd
7440-41-7T	BERYLLIUM (TOTAL)	0.558	J	1.53		MG/KG	69SW0611	7 of 20	0.0380 To 0.6390	1.53	1.13	1.96E+01 N			Yes	Bkgd
7440-43-9T	CADMIUM (TOTAL)	0.0485	J	1.4		MG/KG	69SW0742	10 of 20	0.0480 To 0.1390	1.4	2.06	3.65E+03 N			No	
7440-70-2T	CALCIUM (TOTAL)	77.6	J	2950		MG/KG	69SW0615	20 of 20	1.3800 To 6.9800	2950	2930				No*	
7440-47-3T	CHROMIUM (TOTAL)	0.32	J	17.2		MG/KG	69SW0611	20 of 20	0.0710 To 0.3050	17.2	57.3	3.65E+04 N			No	
7440-48-4T	COBALT (TOTAL)	0.233	J	4.09	J	MG/KG	69SW0806	8 of 20	0.0970 To 1.5700	4.09	11.25	N			No*	
7440-50-8T	COPPER (TOTAL)	0.458	J	17		MG/KG	69SW0611	11 of 20	0.1250 To 0.8030	17	61.2	N			No	
206-44-0	FLUORANTHENE	55.2	J	375	J	UG/KG	69SW0511	5 of 16	119.0000 To 864.0000	375		2.92E+06 N			No	
7439-89-6T	IRON (TOTAL)	497		11000		MG/KG	69SW0511	20 of 20	2.8900 To 7.3800	11000	26572.8	N			No*	
7439-92-1T	LEAD (TOTAL)	1.88		106		MG/KG	69SW0611	20 of 20	0.1620 To 0.5230	106	259.4				No	
7439-95-4T	MAGNESIUM (TOTAL)	71.2	J	1910		MG/KG	69SW0606	20 of 20	2.0400 To 11.5000	1910	5417				No*	
7439-96-5T	MANGANESE (TOTAL)	4.04		74.8		MG/KG	69SW0606	20 of 20	0.0640 To 0.2180	74.6	233.9	3.65E+04 N			No	
7439-97-6T	MERCURY (TOTAL)	0.0734	J	0.442	J	MG/KG	69SW0744	7 of 20	0.0380 To 0.3790	0.442		2.19E+03 N			No	
7440-02-0T	NICKEL (TOTAL)	0.776	J	9.56		MG/KG	69SW0611	9 of 20	0.1070 To 3.4900	9.56	38.2	1.48E+05 N			No	
7440-09-7T	POTASSIUM (TOTAL)	86.2	J	731	J	MG/KG	69SW0606	16 of 20	1.4500 To 114.0000	731	3250				No*	
129-00-0	PYRENE	68.2	J	287	J	UG/KG	69SW0744	5 of 17	145.0000 To 1170.000	287		2.19E+06 N			No	
7782-49-2T	SELENIUM (TOTAL)	0.349	J	3.15		MG/KG	69SW0611	12 of 20	0.2750 To 0.7840	3.15	4.4	3.65E+04 N			No	
7440-21-3T	SILICON (TOTAL)	96.8	J	612		MG/KG	69SW0615	19 of 20	1.2900 To 8.1900	612	11716.7				No*	
7440-22-4T	SILVER (TOTAL)	0.136	J	0.156	J	MG/KG	69SW0611	2 of 10	0.0530 To 0.2610	0.156	1	3.68E+04 N			No	
7440-23-5T	SODIUM (TOTAL)	56	J	509	J	MG/KG	69SW0742	12 of 20	9.7900 To 77.9000	509	790				No*	
7440-62-2T	VANADIUM (TOTAL)	1.54	J	41.6		MG/KG	69SW0611	18 of 20	0.0600 To 1.6500	41.6	150.5	5.11E+04 N			No	
7440-86-6T	ZINC (TOTAL)	2.81	J	106		MG/KG	69SW0611	20 of 20	0.1070 To 0.6540	106	220.4	2.19E+06 N			No	

Notes:
The data sources are SEE database Jacobs and Stone & Webster tables.
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Only normal, validated, non-rejected results for samples collected after 06/01/96 are used.
Only analytes with 2 or more detections and greater than 5% detection frequency are shown.
The analyte concentration used for screening is the maximum detected result.
ARAR is unavailable
Screening toxicity is either Tier 1 Human Health HEC (if available) or EPA Region 3 risk-based residential soil standard.
COPC flag is Yes if screening result exceeds any of the background, screening toxicity, or ARAR concentrations.
COPC flag is Yes if there is no background, screening toxicity, or ARAR value to compare to.
Rationale for COPC Yes flag gives the most restrictive of the comparison values.
* Indicates that common cations (Al, Ca, Fe, Mg, K, Na, Sl) are presented for informational purposes and are not considered to be COPCs.
C indicates a carcinogen as reported on EPA Region 3 RBC Table.
N indicates a non-carcinogen as reported on EPA Region 3 RBC Table.
# indicates Bis(2-ethylhexyl)phthalate is not a COPC because it is a common lab and sampling equipment contaminant.
% indicates Lead is a COPC but is treated separately by the IEUBK Model and reported in a separate set of tables referenced in the SWOU RI BRA.
Data qualifier J indicates an estimated value.
$ indicates EDB is a COPC for informational purposes only.

Table 2.5
Occurrence, Distribution and Selection of Chemicals of Potential Concern
MMR RI SWOU

Scenario Timeframe: CURRENT
Medium: SURFACE WATER
Exposure Medium: SURFACE WATER
Exposure Point: POND

Cas Number	Chemical	Minimum Detected Concentration	Minimum Qualifier	Maximum Detected Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency #Detect of #Result	Range of Detection Limits	Concentration Used for Screening (Maximum)	Background Value	Screening Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Yes or No)	Rationale for COPC Yes Flag (Most Restrictive)
67-64-1	ACETONE	5.57	J	18.5	J	UG/L	69SW0702	2 of 2	2.8200 To 2.8200	18.8		3.20E+04 N			No	
7440-39-3	BARIUM	9.68	J	13	J	UG/L	69SW0611	20 of 20	0.1000 To 0.2000	13	11.2	3.00E+03 N			Yes	Bkgd
7440-39-3T	BARIUM (TOTAL)	10.6	J	13.2	J	UG/L	69SW0615	20 of 20	0.1000 To 0.2000	13.2	11.4	3.00E+03 N			Yes	Bkgd
117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	6.36		49.5		UG/L	69SW0743	7 of 20	4.9500 To 10.0000	49.5		1.33E+01 C			No#	
7440-70-2	CALCIUM	2000		3940		UG/L	69SW0737	20 of 20	7.6000 To 20.6000	3940	3550				No*	
7440-70-2T	CALCIUM (TOTAL)	1820		4060		UG/L	69SW0738	20 of 20	7.8000 To 20.6000	4060	3450				No*	
7440-48-4	COBALT	1.11	J	4.07	J	UG/L	69SW0743	4 of 20	0.5000 To 0.6000	4.07		2.20E+03 N			No*	
7439-89-6	IRON	17.9	J	34.4	J	UG/L	69SW0614	2 of 20	18.8000 To 208.0000	34.4	89.4	1.10E+04 N	1000	AWQC	No*	
7439-89-6T	IRON (TOTAL)	17.6	J	27.4	J	UG/L	69SW0614	4 of 20	18.8000 To 122.0000	27.4	525	1.10E+04 N	1000	AWQC	No*	
7439-92-1	LEAD	1.16	J	1.54	J	UG/L	69SW0743	3 of 20	0.9000 To 1.5000	1.54	2.5		1.32	AWQC	Yes%	Arar
7439-95-4	MAGNESIUM	1240		1800		UG/L	69SW0737	20 of 20	7.6000 To 12.6000	1800	1940				No*	
7439-95-4T	MAGNESIUM (TOTAL)	1210		1850		UG/L	69SW0738	20 of 20	7.6000 To 12.6000	1850	2066.5				No*	
7439-96-5	MANGANESE	9.99	J	15.2		UG/L	69SW0743	2 of 20	0.4000 To 8.0400	15.2	176	2.47E-03 N			Yes	Tox
7440-09-7	POTASSIUM	926		1250		UG/L	69SW0614	20 of 20	7.4000 To 106.0000	1250	1390				No*	
7440-09-7T	POTASSIUM (TOTAL)	953		1260		UG/L	69SW0615	20 of 20	7.4000 To 106.0000	1260	1410				No*	
7440-21-3	SILICON	586		1140		UG/L	69SW0742	20 of 20	7.2000 To 14.2000	1140	2260				No*	
7440-21-3T	SILICON (TOTAL)	575		1780		UG/L	69SW0742	20 of 20	7.2000 To 14.2000	1780	1950				No*	
7440-23-5	SODIUM	6090		7250		UG/L	69SW0609	20 of 20	177.0000 To 295.0000	7250	13500				No*	
7440-23-5T	SODIUM (TOTAL)	6250		7030		UG/L	69SW0606	20 of 20	177.0000 To 295.0000	7030	13200				No*	

Notes:
The data sources are SEE database Jacobs and Stone & Webster tables.
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Only normal, validated, non-rejected results for samples collected after 06/01/96 are used.
Only analytes with 2 or more detections and greater than 5% detection frequency are shown.
The analyte concentration used for screening is the maximum detected result.
ARAR is AWQC value
Screening toxicity is either Tier 1 Human Health HEC (if available) or EPA Region 3 risk-based tap water standard.
COPC flag is Yes if screening result exceeds any of the background, screening toxicity, or ARAR concentrations.
COPC flag is Yes if there is no background, screening toxicity, or ARAR value to compare to.
Rationale for COPC Yes flag gives the most restrictive of the comparison values.
* Indicates that common cations (Al, Ca, Fe, Mg, K, Na, Sl) are presented for informational purposes and are not considered to be COPCs.
C indicates a carcinogen as reported on EPA Region 3 RBC Table.
N indicates a non-carcinogen as reported on EPA Region 3 RBC Table.
# indicates Bis(2-ethylhexyl)phthalate is not a COPC because it is a common lab and sampling equipment contaminant.
% indicates Lead is a COPC but is treated separately by the IEUBK Model and reported in a separate set of tables referenced in the SWOU RI BRA.
Data qualifier J indicates an estimated value.

Table 2.6
Occurrence, Distribution and Selection of Chemicals of Potential Concern
MMR RI SWOU

Scenario Timeframe: CURRENT
Medium: GROUNDWATER
Exposure Medium: GROUNDWATER
Exposure Point: AREA 4

Cas Number	Chemical	Minimum Detected Concentration	Minimum Qualifier	Maximum Detected Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency #Detect of #Result	Range of Detection Limits	Concentration Used for Screening (Maximum)	Background Value	Screening Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Yes or No)	Rationale for COPC Yes Flag (Most Restrictive)
106-93-4	1,2-DIBROMOETHANE (EDB)	0.0085	J	18	J	UG/L	69MW1304	43 of 114	0.0035 To 0.0800	18		7.50E-04 C	0.02	MMCL	Yes	Tox
7429-90-5	ALUMINUM	15.5	J	811		UG/L	H2MW0555D	20 of 85	11.1000 To 137.0000	811	811	3.70E+04 N			No*	
7429-90-5T	ALUMINUM (TOTAL)	12	J	2530		UG/L	69MW1290B	32 of 83	11.1000 To 134.0000	2530	2215.4	3.70E+04 N			No*	
7440-39-3	BARIUM	2		252		UG/L	89MW1283B	78 of 85	0.2000 To 36.0000	252	58.5	2.60E+03 N	2000	SDWA, MMCL	Yes	Bkgd
7440-39-3T	BARIUM (TOTAL)	0.89	J	40		UG/L	89MW1290B	78 of 83	0.2000 To 27.1000	40	63	2.60E+03 N	2000	SDWA, MMCL	No	
117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	1.3	J	25		UG/L	69MW1291A	4 of 77	0.80000 To 4.5400	25		C	6	SDWA, MMCL	Yes	Arar
7440-42-8	BORON	4.4	J	43.7	J	UG/L	69MW1288	4 of 5	2.2000 To 35.7000	43.7					Yes	No Comp
7440-42-8T	BORON (TOTAL)	51.5	J	53	J	UG/L	69MW1288	2 of 5	2.2000 To 21.4000	53					Yes	No Comp
7440-43-9T	CADMIUM (TOTAL)	0.21	J	5.2		UG/L	69MW1400A	5 of 83	0.2000 To 4.3000	5.2		1.80E+01 N	5	SDWA, MMCL	Yes	Arar
7440-70-2	CALCIUM	1280		20300		UG/L	69MW1514A	85 of 85	5.3000 To 103.0000	20300	9294.4				No*	
7440-70-2T	CALCIUM (TOTAL)	1300		20300		UG/L	69MW1514A	83 of 83	5.3000 To 103.0000	20300	10233.1				No*	
56-23-5	CARBON TETRACHLORIDE	0.25	J	9.5		UG/L	69MW1543	10 of 113	0.0500 To 0.8000	9.5		1.60E-01 C	5	SDWA, MMCL	Yes	Tox
67-66-3	CHLOROFORM	0.25	J	1.5		UG/L	69MW1408	15 of 113	0.0900 To 2.4000	1.5		1.50E-01 C	5	MMCL	Yes	Tox
7440-47-3T	CHROMIUM (TOTAL)	0.46	J	151		UG/L	69MW1290B	30 of 83	0.4000 To 6.1000	151	7	N	100	SDWA, MMCL	Yes	Bkgd
7440-47-3	CHROMIUM, TOTAL	0.62	J	83		UG/L	69MW1263B	9 of 85	0.4000 To 6.1000	83	2.2	N	100	SDWA, MMCL	Yes	Bkgd
7440-48-4	COBALT	0.71	J	9.9		UG/L	69MW1403	50 of 85	0.4000 To 8.3000	9.9	5.2	2.20E+03 N			No*	
7440-48-4T	COBALT (TOTAL)	0.61	J	9.6		UG/L	69MW1514A	53 of 83	0.4000 To 6.7000	9.6	9.1	2.20E+03 N			No*	
7440-50-8	COPPER	1.1	J	17.8		UG/L	69MW1405	36 of 84	0.6000 To 4.8000	17.8	20.5	1.50E+03 N	1300	SDWA, MMCL	No	
7440-50-8T	COPPER (TOTAL)	1	J	35.2	J	UG/L	69MW1293A	28 of 83	0.6000 To 4.4000	35.2	5.8	N	1300	SDWA, MMCL	Yes	Bkgd
7439-89-6	IRON	15.4	J	4040		UG/L	69MW1307	39 of 85	9.6000 To 150.0000	4040	10100	1.10E+04 N			No*	
7439-89-6T	IRON (TOTAL)	24.7	J	4620		UG/L	69MW1307	63 of 84	7.3000 To 128.0000	4620	14860.5	1.10E+04 N			No*	
7439-92-1	LEAD	1.1	J	37.9		UG/L	69MW1302	15 of 85	0.9000 To 6.7000	37.9	37.9		15	SDWA, MMCL	Yes%	Arar
7439-92-1T	LEAD (TOTAL)	1.4	J	39.2		UG/L	69MW1300B	13 of 83	0.9000 To 6.9000	39.2	14.5		15	SDWA, MMCL	Yes%	Bkgd
7439-95-4	MAGNESIUM	887		9100		UG/L	69MW1514A	85 of 85	8.8000 To 1010.000	9100	3859.6				No*	
7439-95-4T	MAGNESIUM (TOTAL)	881		9380		UG/L	69MW1514A	83 of 83	8.8000 To 44.1000	9380	3984.5				No*	
7439-96-5	MANAGANESE	3.5	J	848		UG/L	69MW1532A	85 of 85	0.2000 To 5.3000	848	1898.6	7.30E+02 N			Yes	Tox
7439-96-5T	MANAGANESE (TOTAL)	3.6	J	887		UG/L	69MW1532A	83 of 84	0.2000 To 6.0000	887	1891	7.30E+02 N			Yes	Tox
7439-97-6	MERCURY	0.032	J	0.76		UG/L	69MW1305	11 of 85	0.0300 To 0.2000	0.76	0.26		2	SDWA, MMCL	Yes	Bkgd
7440-02-0	NICKEL	1.1	J	5.3	J	UG/L	69MW1290B	33 of 85	1.0000 To 10.2000	5.3	13.8	7.30E+02 N	100	MMCL	No	
7440-02-0T	NICKEL (TOTAL)	1.3	J	110		UG/L	69MW1290B	30 of 83	1.0000 To 10.2000	110	5.2	7.30E+02 N	100	MMCL	Yes	Bkgd
7440-09-7	POTASSIUM	601	J	3220		UG/L	69MW1544	50 of 85	29.5000 To 5260.000	3220	4116.6				No*	
7440-09-7T	POTASSIUM (TOTAL)	616	J	3920		UG/L	69MW1544	40 of 83	29.5000 To 4860.000	3920	2607.9				No*	
7440-21-3	SILICON	2600		8940		UG/L	69MW1311	53 of 53	5.1000 To 46.9000	8940	10093.2				No*	
7440-21-3T	SILICON (TOTAL)	394		11700		UG/L	69MW1544	51 of 51	3.9000 To 45.9000	11700	10543.9				No*	
7440-23-5	SODIUM	5260		26300		UG/L	69MW1539	85 of 85	17.3000 To 975.0000	26300	26300		20000	MMCL	No*	
7440-23-5T	SODIUM (TOTAL)	1580	J	25400		UG/L	69MW1290B	83 of 83	17.3000 To 975.0000	25400	25100		20000	MMCL	No*	
127-18-4	TETRACHLOROETHYLENE(PCE)	0.17	J	2.4		UG/L	69MW1267	7 of 113	0.1000 To 0.9000	2.4		1.10E+00 C	5	SDWA, MMCL	Yes	Tox
7440-28-0T	THALLIUM (TOTAL)	3.2	J	8.1	J	UG/L	69MW1307	7 of 83	2.0000 To 6.0000	8.1	8.1	2.60E+00 N	2	SDWA, MMCL	Yes	Arar
108-88-3	TOLUENE	0.061	J	15		UG/L	69MW1298B	17 of 113	0.0700 To 1.0000	15		7.50E+02 N	1000	SDWA, MMCL	No	
79-01-6	TRICHLOROETHYLENE (TCE)	0.095	J	66		UG/L	69MW1532A	18 of 113	0.0700 To 0.8000	66		1.60E+00 C	5	SDWA, MMCL	Yes	Tox
7440-62-2T	VANADIUM (TOTAL)	0.78	J	3	J	UG/L	69MW1290B	9 of 83	0.6000 To 3.2000	3	2.2	2.60E+02 N			Yes	Bkgd
7440-66-6	ZINC	4	J	280		UG/L	69MW1314	54 of 86	0.3000 To 21.4000	260	50.5	1.10E+04 N			Yes	Bkgd
7440-66-6T	ZINC (TOTAL)	5.1		245		UG/L	69MW1506	47 of 84	0.3000 To 55.9000	245	76.5	1.10E+04 N			Yes	Bkgd

Notes:

Table 2.6
Occurrence, Distribution and Selection of Chemicals of Potential Concern
MMR RI SWOU

The data sources are SEE database Jacobs and Stone & Webster tables.
Only the latest results, with the most complete analyte lists, were used if more than one sample available.
Only normal, validated, non-rejected results for samples collected after 06/01/96 are used.
Only analytes with 2 or more detections and greater than 5% detection frequency are shown.
The analyte concentration used for screening is the maximum detected result.
ARAR is AWQC value
Screening toxicity is either Tier 1 Human Health HEC (if available) or EPA Region 3 risk-based tap water standard.
COPC flag is Yes if screening result exceeds any of the background, screening toxicity, or ARAR concentrations.
COPC flag is Yes if there is no background, screening toxicity, or ARAR value to compare to.
Rationale for COPC Yes flag gives the most restrictive of the comparison values.
* Indicates that common cations (Al, Ca, Fe, Mg, K, Na, Sl) are presented for informational purposes and are not considered to be COPCs.
C indicates a carcinogen as reported on EPA Region 3 RBC Table.
N indicates a non-carcinogen as reported on EPA Region 3 RBC Table.
# indicates Bis(2-ethylhexyl)phthalate is not a COPC because it is a common lab and sampling equipment contaminant.
% indicates Lead is a COPC but is treated separately by the IEUBK Model and reported in a separate set of tables referenced in the SWOU RI BRA.
Data qualifier J indicates an estimated value.

Table 2.8
Occurrence, Distribution and Selection of Chemicals of Potential Concern
MMR RI SWOU

Scenario Timeframe: CURRENT
Medium: GROUNDWATER
Exposure Medium: GROUNDWATER
Exposure Point: AREA 2

Cas Number	Chemical	Minimum Detected Concentration	Minimum Qualifier	Maximum Detected Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency #Detect of #Result	Range of Detection Limits	Concentration Used for Screening (Maximum)	Background Value	Screening Toxicity Value		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Yes or No)	Rationale for COPC Yes Flag (Most Restrictive)
79-34-5	1,1,2,2-TETRACHLOROETHANE	1.1		22		UG/L	69MW1262	17 of 67	0.1000 To 1.5000	22		5.30E-02	C			Yes	Tox
106-93-4	1,2-DIBROMOETHANE (EDB)	0.011	J	0.063		UG/L	69MW1520	23 of 67	0.0035 To 0.0060	0.063		7.50E-04	C	0.02	MMCL	Yes	Tox
7429-90-5	ALUMINUM	20.4	J	134		UG/L	69MW1510B	18 of 47	15.6000 To 132.0000	134	811	3.70E+04	N			No*	
7429-90-5T	ALUMINUM (TOTAL)	23	J	1100		UG/L	USFW241096	34 of 47	13.6000 To 114.0000	1100	2215.4	3.70E+04	N			No*	
7440-36-2	ARSENIC	2.2	J	4.6	J	UG/L	69MW1519	4 of 47	1.0000 To 3.4000	4.6	5.4	4.50E-02	C	50	SDWA, MMCL	Yes	Tox
7440-39-3	BARIUM	2.2	J	17.9	J	UG/L	69MW15226	44 of 47	0.2000 To 2.5000	17.9	58.5	2.60E+03	N	2000	SDWA, MMCL	No	
7440-39-3T	BARIUM (TOTAL)	2.4	J	19.3	J	UG/L	69MW15226	46 of 47	0.2000 To 2.4000	19.3	63	2.60E+03	N	2000	SDWA, MMCL	No	
117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	1.1	J	2100	J	UG/L	69MW1420	7 of 36	0.8000 To 3.0000	2100			C	6	SDWA, MMCL	Yes	Arar
7440-42-8	BORON	88.7	J	169	J	UG/L	69MW1262	3 of 3	10.6000 To 10.8000	169						Yes	No Comp
7440-42-8T	BORON (TOTAL)	22.9	J	107	J	UG/L	69MW1262	3 of 3	10.6000 To 10.8000	107						Yes	No Comp
7440-70-2	CALCIUM	954		32900		UG/L	69MW1522A	47 of 47	5.3000 To 68.6000	32900	9294.4					No*	
7440-70-2T	CALCIUM (TOTAL)	167	J	31200		UG/L	69MW1522A	47 of 47	5.3000 To 68.6000	31200	10233.1					No*	
56-23-5	CARBON TETRACHLORIDE	0.56	J	5	J	UG/L	69MW1522A	4 of 67	0.0500 To 1.6000	5		1.60E-01	C	5	SDWA, MMCL	Yes	Tox
57-66-3	CHLOROFORM	0.3	J	0.9		UG/L	02PZ0021C	7 of 67	0.0700 To 1.5000	0.9		1.50E-01	C	5	MMCL	Yes	Tox
7440-47-3T	CHROMIUM (TOTAL)	0.79	J	15.3	J	UG/L	02MW0002D	23 of 47	0.4000 To 2.9000	15.3	7		N	100	SDWA, MMCL	Yes	Bkgd
7440-47-3	CHROMIUM, TOTAL	1	J	3.9	J	UG/L	02MW0002D	9 of 47	0.4000 To 1.5000	3.9	2.2		N	100	SDWA, MMCL	Yes	Bkgd
156-59-2	CIS-1,2-DICHLOROETHYLENE	0.2	J	2.7		UG/L	69MW1262	5 of 66	0.600 To 1.4000	2.7		6.10E+01	N	70	SDWA, MMCL	No	
7440-48-4	COBALT	0.65	J	17.2		UG/L	69MW1522B	32 of 47	0.6000 To 2.6000	17.2	5.2	2.20E+03	N			No*	
7440-48-4T	COBALT (TOTAL)	0.83	J	16.8		UG/L	69MW1522B	33 of 47	0.6000 To 2.6000	16.8	9.1	2.20E+03	N			No*	
7440-50-8	COPPER	0.8	J	33.3		UG/L	69MW1512	17 of 47	0.8000 To 6.3000	33.3	20.5	1.50E+03	N	1300	SDWA, MMCL	Yes	Bkgd
7440-50-8T	COPPER (TOTAL)	0.69	J	65.4		UG/L	69MW1262	18 of 47	0.8000 To 5.7000	85.4	5.8		N	1300	SDWA, MMCL	Yes	Bkgd
7439-89-6	IRON	13.4	J	5440		UG/L	69MW1512	18 of 47	5.3000 to 105.0000	5440	10100	1.10E+04	N			No*	
7439-89-6T	IRON (TOTAL)	7	J	7230		UG/L	69MW1512	34 of 47	5.3000 To 138.0000	7230	14860.5	1.10E+04	N			No*	
7439-92-1T	LEAD (TOTAL)	1.1	J	6.9		UG/L	02PZ0011C	3 of 47	0.9000 To 3.8000	6.9	14.5			15	SDWA, MMCL	No	
7439-95-4	MAGNESIUM	707		13200		UG/L	69MW1522A	47 of 47	17.7000 To 59.1000	13200	3659.8					No*	
7439-95-4T	MAGNESIUM (TOTAL)	17.7	J	13100		UG/L	69MW1510A	47 of 47	17.7000 To 59.1000	13100	3984.5					No*	
7439-96-5	MANGANESE	1.6	J	1820		UG/L	69MW1522B	46 of 47	0.3000 To 1.3000	1820	1896.6	7.30E+02	N			Yes	Tox
7439-96-5T	MANGANESE (TOTAL)	1.6	J	1770		UG/L	69MW1522B	47 of 47	0.3000 To 1.3000	1770	1891	7.30E+02	N			Yes	Tox
7439-97-6	MERCURY	0.031	J	0.6		UG/L	USFW228040	5 of 47	0.300 To 0.2000	0.6	0.28			2	SDWA, MMCL	Yes	Bkgd
7440-02-0	NICKEL	1.2	J	13.6	J	UG/L	69MW1530	22 of 47	1.0000 To 5.2000	13.8	13.8	7.30+02	N	100	MMCL	No	
7440-02-0T	NICKEL (TOTAL)	1.3	J	13.2	J	UG/L	02MW0002D	23 of 47	1.0000 To 5.4000	13.2	5.2	7.30+02	N	100	MMCL	Yes	Bkgd
7440-09-7	POTASSIUM	542	J	4420		UG/L	69MW1530	37 of 47	33.7000 To 2720.000	4420	4116.6					No*	
7440-09-7T	POTASSIUM (TOTAL)	559	J	3680		UG/L	69MW1533	35 of 47	33.7000 To 3800.000	3680	2607.9					No*	
7440-21-3	SILICON	2360		10300		UG/L	03MW0050	47 of 47	5.1000 To 35.3000	10300	10093.2					No*	
7440-21-3T	SILICON (TOTAL)	2430		10100	J	UG/L	03MW0050	46 of 47	3.9000 To 176.0000	10100	10543.9					No*	
7440-23-5	SODIUM	4340		20500		UG/L	69MW1510A	47 of 47	17.3000 To 37.8000	20500	26300			20000	MMCL	No*	
7440-23-5T	SODIUM (TOTAL)	153	J	23000		UG/L	69MW1510A	47 of 47	17.3000 to 37.8000	23000	25100			20000	MMCL	No*	
127-18-4	TETRACHLOROETHYLENE (PCE)	0.47	J	71		UG/L	69MW1517A	26 of 67	0.0500 To 1.0000	71		1.10E+00	C	5	SDWA, MMCL	Yes	Tox
7440-28-0T	THALLIUM (TOTAL)	3.3	J	9.7	J	UG/L	69MW1518	5 of 47	1.0000 To 5.0000	9.7	8.1	2.60E+00	N	2	SDWA, MMCL	Yes	Arar
79-01-6	TRICHLOROETHYLENE (TCE)	0.49	J	86		UG/L	69MW1504	37 of 67	0.0700 To 1.6000	65		1.60E+00	C	5	SDWA, MMCL	Yes	Tox
7440-62-2T	VANADIUM (TOTAL)	1	J	1.9	J	UG/L	69MW1535	5 of 47	0.7000 To 4.4000	1.9	2.2	2.60E+02	N			No	
7440-66-6	ZINC	4.8	J	137		UG/L	69MW1511A	29 of 47	0.5000 To 20.8000	137	50.5	1.10E+04	N			Yes	Bkgd
7440-66-6T	ZINC (TOTAL)	5.7		141		UG/L	69MW1511A	31 of 47	0.5000 To 20.4000	141	78.5	1.10E+04	N			Yes	Bkgd

Notes:

Table 2.8
Occurrence, Distribution and Selection of Chemicals of Potential Concern
MMR RI SWOU

The data sources are SEE database Jacobs and Stone Webster tables.
Only the latest results, with the most complete analyte lists, were used if more than one sample available.
Only normal, validated, non-rejected results for samples collected after 06/01/96 are used.
Only analytes with 2 or more detections and greater than 5% detection frequency are shown.
The analyte concentration used for screening is the maximum detected result.
ARAR is smaller of Safe Drinking Water Act (SWDA) MCLs and Massachusetts Drinking Water MCLs (MMCL)
Screening toxicity value is EPA Region 3 risk-based tap water standard.
COPC flag is Yes if screening result exceeds any of the background, screening toxicity, or ARAR concentrations.
COPC flag is Yes if there is no background, screening toxicity, or ARAR value to compare to.
Rationale for COPC Yes flag gives the most restrictive of the comparison values.
* indicates that common cations (Al, Ca, Co, Fe, Mg, K, Na, Si) are presented for informational purposes and are not considered to be COPCs.
C indicates a carcinogen as reported on EPA Region 3 RBC Table.
N indicates a non-carcinogen as reported on EPA Region 3 RBC Table.
# indicates Bis(2-ethylhexyl)phthalate is not a COPC because it is a common lab and sampling equipment contaminant.
% indicates Lead is a COPC but is treated separately by the IEUBK Model and reported in a separate set of tables referenced in the SWOU RI BRA.
Data qualifier J indicates an estimated value.

TABLE 4.2
VALUES USED FOR DAILY SEDIMENT INTAKE CALCULATIONS
MMR SOUTHWEST OPERABLE UNIT

Scenario Timeframe: Current and Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Coonamessett River Sediment
Receptor Population: Cranberry Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Cs	Chemical Concentration in Sediment	mg/kg	max or 95% UCL of mean (See Table 3.2)	Site-specific	mean or 95% UCL of mean (See Table 3.2)	Site-specific	Chronic Daily Intake (CDI) (mg/kg-day)=
	FI	Fraction Ingested	dimensionless	1		1		Cs x IRs x CF1 x FI x EF x ED x 1/BW x 1/ATn,c
	IRs	Ingestion Rate of Sediment	mg/day	200	Lim, 1996	100	Lim, 1996	
	EF	Exposure Frequency	days/year	12	Site-specific	8	Site-specific	
	ED	Exposure Duration	years	25	EPA, 1991a	6.6	EPA, 1997c	
	CF1	Conversion Factor 1	kg/mg	1.00E-06	–	1.00E-06	–	
	BW	Body Weight	kg/mg	70	EPA, 1989a	70	EPA, 1989a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	9,125	EPA, 1989a	2,409	EPA, 1991a	
Dermal	Cs	Chemical Concentration in Sediment	mg/kg	max or 95% UCL of mean (See Table 3.2)	Site-specific	mean or 95% UCL of mean (See Table 3.2)	Site-specific	Dermally Absorbed Dose (DAD)(mg/kg-day)=
	DA_{event}	Absorbed dose per event	mg/cm^2-event	calculated	–	calculated	–	
	Saw	Skin Surface Area, working & wading	cm^2	6,600	EPA, 1997a	5,700	EPA, 1997a	DA_{event} x ED x EF x SAw x 1/BW x 1/ATn,c
	CF1	Conversion Factor 1	kg/mg	1.00E-06		1.00E-06		
	AF	Sediment to skin adherence factor	mg/cm^2-event	0.14	Lim, 1998	0.14	Lim, 1998	Where DAevent = Cs x AF x ABS x CF1
	ABS	Absorption Factor	dimensionless	chemical-specific	–	chemical-specific	–	
	EF	Exposure Frequency	events/year	12	Site-specific	8	Site-specific	
	ED	Exposure Duration	years	25	EPA, 1991a	6.6	EPA, 1997c	
	BW	Body Weight	kg	70	EPA, 1989a	70	EPA, 1989a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	9,125	EPA, 1991a	2,409	EPA, 1997c	

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TABLE 4.3
VALUES USED FOR SURFACE WATER DAILY INTAKE CALCULATIONS
MMR SOUTHWEST OPERABLE UNIT

Scenario Timeframe: Current and Future
Medium: Surface Water
Exposure Medium: Surface Water & Vapor
Exposure Point: Coonamessett River Surface Water
Exposure Point Concentration Current Coonamessett River Surface Water
Receptor Population: Cranberry Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Csw	Chemical Concentration in Surface Water	mg/L	max or 95% UCL of mean (See Table 3.3)	Site-specific	mean or 95% UCL of mean (see Table 3.3)	Site-specific	Chronic Daily Intake (CDI) (mg/kg-day)=
	IRsw	Ingestion Rate, surface water	L/day	0.05	Lim, 1996	0.05	Lim, 1996	Csw x IRsw x EF x ED x 1/BW x 1/ATn,c
	EF	Exposure Frequency	days/year	12	Site-specific	8	Site-specific	
	ED	Exposure Duration	years	25	EPA, 1991a	6.6	EPA, 1997c	
	BW	Body Weight	kg	70	EPA, 1989a	70	EPA, 1989a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	9,125	EPA, 1991a	2,409	EPA, 1991a	
Dermal	Csw	Chemical Concentration in Surface Water	mg/cm^3	max or 95% UCL of mean (See Table 3.1)	Site-specific	mean or 95% UCL of mean (See Table 3.1)	Site-specific	Dermally Absorbed Dose (DAD)(mg/kg-day)=
	DA_{event}	Absorbed dose per event	mg/cm^2-event	calculated	–	calculated	–	
	Ab	Skin Surface Area, wading	cm^2	6,600	EPA, 1997a	5,700	EPA, 1997a	DA_{event} x EV x ED x EF x Ab x 1/BW x 1/ATn,c
	Kp	Dermal Permeability Constant	cm/hour	chemical-specific	–	chemical-specific	–	
	t_{event}	Exposure Duration	hr	8	Site-specific	8	Site-specific	
	t^a	Time to reach steady-status	hr	chemical-specific	–	chemical-specific	–	
	t	Lag time	hr	chemical-specific	–	chemical-specific	–	
	EV	Event Frequency	event/day	1		1		
	ED	Exposure Duration	years	25	EPA, 1991a	6.6	EPA, 1997c	
	EF	Exposure Frequency	day/year	12	Site-specific	8	Site-specific	
	B	Permeability ratio (skin layers)	dimensionless	chemical-specific	–	chemical-specific	–	
	BW	Body Weight	kg	70	EPA, 1989a	70	EPA, 1989a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	9,125	EPA, 1991a	2,409	EPA, 1997c	
Inhalation	Csw	Chemical Concentration in Surface Water	mg/L	max or 95% UCL of mean (See Table 3.3)	Site-specific	mean or 95% UCL of mean (see Table 3.3)	Site-Specific	Chronic Daily Intake (CDI) (mg/kg-day)=
	IRh	Inhalation Rate, hourly	m^3/hr	3.3	EPA, 1997a	1.3	EPA, 1997a	Csw x IRh x VF x ET x EF x ED x 1/BW x 1/ATn,c
	VF	Volatilization Factor	L/m^3	0.2	EPA, 1991b	0.2	Appendix R4	
	ET	Exposure Time	hr/day	8	Site-specific	8	Site-Specific	
	EF	Exposure Frequency	day/year	12	Site-specific	8	Site-specific	
	ED	Exposure Duration	years	25	EPA, 1991a	6.6	EPA, 1997c	
	BW	Body Weight	kg	70	EPA, 1989a	70	EPA, 1989a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	9,125	EPA, 1991a	2,409	EPA, 1997c	

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TABLE 4.4
VALUES USED FOR DAILY SEDIMENT INTAKE CALCULATIONS
MMR SOUTHWEST OPERABLE UNIT

Scenario Timeframe: Current and Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Coonamessett River Sediment
Receptor Population: Recreational Wader
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Cs	Chemical Concentration in Sediment	mg/kg	max or 95% UCL of mean (See Table 3.2)	Site-specific	mean or 95% UCL of mean (See Table 3.2)	Site-specific	Chronic Daily Intake (CDI) (mg/kg-day)=
	FI	Fraction Ingested	dimensionless	1		1		Cs x IRs x CF1 x FI x EF x ED x 1/BW x 1/ATn,c
	IRs	Ingestion Rate of Sediment	mg/day	100	EPA, 1991a	50	EPA, 1997a	
	EF	Exposure Frequency	days/year	104	Lim, 1998	52	Lim, 1998	
	ED	Exposure Duration	years	24	EPA, 1989a	9	EPA, 1989a	
	CF1	Conversion Factor 1	kg/mg	1.00E-06	–	1.00E-06	–	
	BW	Body Weight	kg	70	EPA, 1989a	70	EPA, 1989a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	8,760	EPA, 1989a	3,285	EPA, 1989a	
Dermal	Cs	Chemical Concentration in Sediment	mg/kg	max or 95% UCL of mean (See Table 3.2)	Site-specific	mean or 95% UCL of mean (See Table 3.2)	Site-specific	Chronic Daily Intake (CDI)(mg/kg-day)=
	DA_{event}	Absorbed dose per event	mg/cm^2-event	calculated	–	calculated	–	
	Saw	Skin Surface Area, working & wading	cm^2	6,600	EPA, 1997a	5,700	EPA, 1997a	DA_{event} x ED x EF x SAw x 1/BW x 1/ATn,c
	CF1	Conversion Factor 1	kg/mg	1.00E-06		1.00E-06		
	AF	Sediment to skin adherence factor	mg/cm^2-event	0.14	Lim, 1998	0.14	Lim, 1998	Where DAevent = Cs x AF x ABS x CF1
	ABS	Absorption Factor	dimensionless	chemical-specific	–	chemical-specific	–	
	EF	Exposure Frequency	events/year	104	Lim, 1998	52	Lim, 1998	
	ED	Exposure Duration	years	24	EPA, 1989a	9	EPA, 1989a	
	BW	Body Weight	kg	70	EPA, 1989a	70	EPA, 1989a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	8,760	EPA, 1989a	3,285	EPA, 1989a	

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TABLE 4.5
VALUES USED FOR SURFACE WATER DAILY INTAKE CALCULATIONS
MMR SOUTHWEST OPERABLE UNIT

Scenario Timeframe: Current and Future
Medium: Surface Water
Exposure Medium: Surface Water & Vapor
Exposure Point: Coonamessett River Surface Water
Receptor Population: Adult Wader
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Csw	Chemical Concentration in Surface Water	mg/L	max or 95% UCL of mean (See Table 3.3)	Site-specific	mean or 95% UCL of mean (see Table 3.3)	Site-specific	Chronic Daily Intake (CDI) (mg/kg-day)=
	IRsw	Ingestion Rate, surface water	L/day	0.05	Levinson, 1996	0.05	Levinson, 1996	Csw x IRsw x EF x ED x 1/BW x 1/ATn,c
	EF	Exposure Frequency	days/year	104	Lim, 1996	52	Lim, 1996	
	ED	Exposure Duration	years	24	EPA, 1989a	6	EPA, 1989a	
	BW	Body Weight	kg	70	EPA, 1989a	70	EPA, 1989a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	8,760	EPA, 1989a	3,265	EPA, 1989a	
Dermal	Csw	Chemical Concentration in Surface Water	mg/cm^3	max or 95% UCL of mean (See Table 3.3)	Site-specific	mean or 95% UCL of mean (See Table 3.3)	Site-specific	Dermally Absorbed Dose (DAD)(mg/kg-day)=
	DA_{event}	Absorbed dose per event	mg/cm^2-event	calculated	–	calculated	–	
	Ab	Skin Surface Area, wading	cm^2	6,600	EPA, 1997a	5,700	EPA, 1997a	DA_{event} x EV x ED x EF x Ab x 1/BW x 1/ATn,c
	Kp	Dermal Permeability Constant	cm/hour	chemical-specific	–	chemical-specific	–	
	t_{event}	Exposure Duration	hr	1	ASG, 1994	1	ASG, 1994	
	t^a	Time to reach steady-status	hr	chemical-specific	–	chemical-specific	–	
	t	Lag time	hr	chemical-specific	–	chemical-specific	–	
	EV	Event Frequency	event/day	1		1		
	ED	Exposure Duration	years	24	EPA, 1989a	9	EPA, 1989a	
	EF	Exposure Frequency	day/year	104	Lim, 1996	52	Lim, 1996	
	B	Permeability ratio (skin layers)	dimensionless	chemical-specific	–	chemical-specific	–	
	BW	Body Weight	kg	70	EPA, 1989a	70	EPA, 1989a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	8,760	EPA, 1989a	3,285	EPA, 1989a	
Inhalation	Csw	Chemical Concentration in Surface Water	mg/L	max or 95% UCL of mean (See Table 3.3)	Site-specific	mean or 95% UCL of mean (see Table 3.3)	Site-Specific	Chronic Daily Intake (CDI) (mg/kg-day)= Csw x IRh x VF x ET x EF x ED x 1/BW x 1/ATn,c
	IRh	Inhalation Rate, hourly	m^3/hr	1.5	EPA, 1997a	1	EPA, 1997a	
	VF	Volatilization Factor	L/m^3	0.2	EPA, 1991b	0.2	Appendix R4	
	ET	Exposure Time	hr/day	1	ASG, 1994	1	ASG, 994	
	EF	Exposure Frequency	days/year	104	Lim, 1996	52	Lim, 1996	
	ED	Exposure Duration	years	24	EPA, 1989a	9	EPA, 1989a	
	BW	Body Weight	kg	70	EPA, 1989a	70	EPA, 1989a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	8,760	EPA, 1989a	3,285	EPA, 1989a	

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TABLE 4.6
VALUES USED FOR FISH TISSUE DAILY INTAKE CALCULATIONS
MMR SOUTHWEST OPERABLE UNIT

Scenario Timeframe: Current and Future
Medium: Surface Water
Exposure Medium: Fish Tissue
Exposure Point: Coonamessett River Surface Water (modeled to fish)
Exposure Point Concentration Current Coonamessett River Surface Water
Receptor Population: Fisher
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Csw	Chemical Concentration in Surface Water	mg/L	max or 95% UCL of mean (See Table 3.3)	Site-specific	mean or 95% UCL of mean (See Table 3.3)	Site-specific	Chronic Daily Intake (CDI) (mg/kg-day)= Csw x BAF x IRf x FI x CF3 x EF x ED x 1/BW x 1/ATn,c
	BAF	Bioaccumulation Factor	L/kg	chemical-specific		chemical-specific		
	IRf	Ingestion Rate, Fish	g/day	26	EPA, 1997b	6.4	EPA, 1997b	
	FI	Fraction Ingested	dimensionless	1	Assumption	1	Assumption	
	EF	Exposure Frequency	days/year	350	Assumption	350	Assumption	
	ED	Exposure Duration	years	30	EPA, 1989a	9	EPA, 1989a	
	BW	Body Weight	kg	70	EPA, 1989a	70	EPA, 1989a	
	CF3	Conversion Factor 3	kg/mg	0.001	–	0.001	–	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	10,950	EPA, 1989a	3,285	EPA, 1989a	

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TABLE 4.7
VALUES FOR DAILY SEDIMENT INTAKE CALCULATIONS
MMR SOUTHWEST OPERABLE UNIT

Scenario Timeframe: Current and Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Coonamessett River Sediment
Receptor Population: Child Wader
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Cs	Chemical Concentration in Sediment	mg/kg	max or 95% UCL of mean (See Table 3.2)	Site-specific	mean or 95% UCL of mean (see Table 3.2)	Site-specific	Chronic Daily Intake (CDI) (mg/kg-day)=
	FI	Fraction Ingested	dimensionless	1		1		
	IRs	Ingestion Rate of sediment	mg/day	200	EPA, 1991a	100	EPA, 1997a	Cs x IRs x CF1 x EF x ED x 1/BW x 1/ATn,c
	EF	Exposure Frequency	days/year	104	Lim, 1996	52	Lim, 1996	
	ED	Exposure Duration	years	5	EPA, 1989a	6	EPA, 1989a	
	CF1	Conversion Factor 1	kg/mg	1.00E-06	--	1.00E-06	--	
	BW	Body Weight	kg	15	EPA, 1991a	15	EPA, 1991a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	2,190	EPA, 1991a	2,190	EPA, 1991a	
Dermal	Cs	Chemical Concentration in Sediment	mg/kg	max or 95% UCL of mean (See Table 3.2)	Site-specific	mean or 95% UCL of mean (See Table 3.2)	Site-specific	Chronic Daily Intake (CDI) (mg/kg-day)=
	DA_{event}	Absorbed dose per event	mg/cm^2-event	calculated	--	calculated	--	
	Saw	Skin, Surface Area, working & wading	cm^3	3,400	EPA, 1997a	2,900	EPA, 1997a	DA_{event} x ED x EF x SAw x 1/BW x 1/ATn,c
	CF1	Conversion Factor 1	kg/mg	1.00E-06		1.00E-06		
	AF	Sediment to skin adherence factor	mg/cm^2-event	1	Levinson, 1998	0.3	Levinson, 1996	Where DA_{event} = Cs x AF x ABS x CF1
	ABS	Absorption Factor	dimensionless	chemical-specific	--	chemical-specific	--	
	EF	Exposure Frequency	events/years	104	Lim, 1989a	52	Lim, 1996	
	ED	Exposure Duration	years	6	EPA, 1989a	6	EPA, 1989a	
	BW	Body Weight	kg	15	EPA, 1991a	15	EPA, 1991a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	2,190	EPA, 1991a	2,190	EPA, 1991a	

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TABLE 4.8
VALUES USED FOR SURFACE WATER DAILY INTAKE CALCULATIONS
MMR SOUTHWEST OPERABLE UNIT

Scenario Timeframe: Current and Future
Medium: Surface Water
Exposure Medium: Surface Water & Vapor
Exposure Point: Coonamessett River Surface Water
Receptor Population: Child Wader
Receptor Age: 1-6 years

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Csw	Chemical Concentration in Surface Water	mg/L	max or 95% UCL of mean (See Table 3.3)	Site-specific	mean or 95% UCL of mean (see Table 3.3)	Site-specific	Chronic Daily Intake (CDI) (mg/kg-day)=
	IRsw	Ingestion Rate, surface water	L/day	0.05	Levinson, 1996	0.05	Levinson, 1996	Csw x IRsw x EF x ED x 1/BW x 1/ATn,c
	EF	Exposure Frequency	days/year	104	Lim, 1996	52	Lim, 1996	
	ED	Exposure Duration	years	6	EPA, 1991a	6	EPA, 1991a	
	BW	Body Weight	kg	15	EPA, 1991a	15	EPA, 1991a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	2,190	EPA, 1991a	2,190	EPA, 1991a	
Dermal	Csw	Chemical Concentration in Surface Water	mg/cm^3	max or 95% UCL of mean (See Table 3.3)	Site-specific	mean or 95% UCL of mean (See Table 3.3)	Site-specific	Dermally Absorbed Dose (DAD)(mg/kg-day)=
	DA_{event}	Absorbed dose per event	mg/cm^2-event	calculated	–	calculated	–	
	Saw	Skin Surface Area, wading	cm^3	3,400	EPA, 1997a	2,900	EPA, 1997a	DA_{event} x EV x ED x EF x SAw x 1/BW x 1/ATn,c
	Kp	Dermal Permeability Constant	cm/hour	chemical-specific	–	chemical-specific	–	
	t_{event}	Exposure Duration	hr	1	ASG, 1994	1	ASG, 1994	
	t^a	Time to reach steady-status	hr	chemical-specific	–	chemical-specific	–	
	t	Lag time	hr	chemical-specific	–	chemical-specific	–	
	EV	Event Frequency	event/day	1		1		
	ED	Exposure Duration	years	6	EPA, 1991a	6	EPA, 1991a	
	EF	Exposure Frequency	day/year	104	Lim, 1996	52	Lim, 1996	
	B	Permeability ratio (skin layers)	dimensionless	chemical-specific	–	chemical-specific	–	
	BW	Body Weight	kg	15	EPA, 1991a	15	EPA, 1991a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	2,190	EPA, 1991a	2,190	EPA, 1991a	
Inhalation	Csw	Chemical Concentration in Surface Water	mg/L	max or 95% UCL of mean (See Table 3.3)	Site-specific	mean or 95% UCL of mean (see Table 3.3)	Site-specific	Chronic Daily Intake (CDI) (mg/kg-day)= Csw x IRh x VF x ET x EF x ED x 1/BW x 1/ATn,c
	IRh	Inhalation Rate, hourly	m^3/hr	1.2	EPA, 1997a	1	EPA, 1997a	
	VF	Volatilization Factor	L/m^3	0.2	EPA, 1991b	0.2	Appendix R4	
	ET	Exposure Time	hr/day	1	Site-specific	1	Site-specific	
	EF	Exposure Frequency	days/year	104	Lim, 1996	52	Lim, 1996	
	ED	Exposure Duration	years	6	EPA, 1991a	6	EPA, 1991a	
	BW	Body Weight	kg	15	EPA, 1991a	15	EPA, 1991a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	2,190	EPA, 1991a	2,190	EPA, 1991a	

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TABLE 4.9
VALUES USED FOR DAILY SEDIMENT INTAKE CALCULATIONS
MMR SOUTHWEST OPERABLE UNIT

Scenario Timeframe: Current and Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Deep and Coonamessett Pond Sediment
Receptor Population: Adult Swimmer
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Cs	Chemical Concentration in Sediment	mg/kg	maximum (See Table 3.4)	Site-specific	mean (See Table 3.4)	Site-specific	Chronic Daily Intake (CDI) (mg/kg-day)=
	IRS	Ingestion Rate of Sediment	mg/day	100	EPA, 1991a	50	EPA, 1997a	Cs x IRS x CF1 x FI x EF x ED x 1/BW x 1/ATn,c
	EF	Exposure Frequency	days/year	60	Lim, 1998	24	Lim, 1998	
	ED	Exposure Duration	years	24	EPA, 1989a	9	EPA, 1989a	
	CF1	Conversion Factor 1	kg/mg	1.00E-06	–	1.00E-06	–	
	BW	Body Weight	kg	70	EPA, 1989a	70	EPA, 1989a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	8,760	EPA, 1989a	3,285	EPA, 1989a	
Dermal	Cs	Chemical Concentration in Sediment	mg/kg	maximum (See Table 3.4)	Site-specific	mean (See Table 3.4)	Site-specific	Chronic Daily Intake (CDI)(mg/kg-day)=
	DA_{event}	Absorbed dose per event	mg/cm^2-event	calculated	–	calculated	–	
	Saw	Skin Surface Area, working & wading	cm^2	6,600	EPA, 1997a	5,700	EPA, 1997a	DA_{event} x ED x EF x SAw x 1/BW x 1/ATn,c
	CF1	Conversion Factor 1	kg/mg	1.00E-06		1.00E-06		
	AF	Sediment to skin adherence factor	mg/cm^2-event	0.14	Lim, 1998	0.14	Lim, 1998	Where DAevent = Cs x AF x ABS x CF1
	ABS	Absorption Factor	dimensionless	chemical-specific	–	chemical-specific	–	
	EF	Exposure Frequency	events/year	60	Lim, 1998	24	Lim, 1998	
	ED	Exposure Duration	years	24	EPA, 1989a	9	EPA, 1989a	
	BW	Body Weight	kg	70	EPA, 1989a	70	EPA, 1989a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	8,760	EPA, 1989a	3,285	EPA, 1989a	

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TABLE 4.10
VALUES USED FOR SURFACE WATER DAILY INTAKE CALCULATIONS
MMR SOUTHWEST OPERABLE UNIT

Scenario Timeframe: Current and Future
Medium: Surface Water
Exposure Medium: Surface Water & Vapor
Exposure Point: Deep and Coonamessett Pond Surface Water
Exposure Point Concentration: Current Deep and Coonamessett Pond Surface Water
Receptor Population: Adult Swimmer
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Csw	Chemical Concentration in Surface Water	mg/L	max or 95% UCL of mean (See Table 3.5)	Site-specific	mean or 95% UCL of mean (See Table 3.5)	Site-specific	Chronic Daily Intake (CDI) (mg/kg-day) =
	IRsw	Ingestion Rate, surface water	L/hour	0.05	EPA, 1989a	0.05	EPA, 1989a	Csw x IRsw x ET x EF x ED x 1/BW x 1/ATn,c
	ET	Exposure Time	hr/day	2.6	Lim, 1996	2.6	Lim, 1998	
	EF	Exposure Frequency	days/year	60	Lim, 1996	24	Lim, 1996	
	ED	Exposure Duration	years	24	EPA, 1989a	9	EPA, 1989a	
	BW	Body Weight	kg	70	EPA, 1989a	70	EPA, 1989a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	8,760	EPA, 1989a	3,285	EPA, 1989a	
Dermal	Csw	Chemical Concentration in Surface Water	mg/cm^3	max or 95% UCL of mean (See Table 3.5)	Site-specific	mean or 95% UCL of mean (See Table 3.5)	Site-specific	Dermally Absorbed Dose (DAD)(mg/kg-day) =
	DA_{event}	Absorbed dose per event	mg/cm^2-event	calculated	--	calculated	--	
	Ab	Skin Surface Area, bathing & swimming	cm^2	22,000	EPA, 1997a	18,000	EPA, 1997a	DA_{event} x EV x ED x EF x Ab x 1/BW x 1/ATn,c
	Kp	Dermal Permeability Constant	cm/hour	chemical-specific	--	chemical-specific	--	
	t_{event}	Exposure Duration	hr	2.6	Lim, 1996	2.6	Lim, 1998	
	t*	Time to reach steady-state	hr	chemical-specific	--	chemical-specific	--	
	t	Lag time	hr	chemical-specific	--	chemical-specific	--	
	EV	Event frequency	event/day	1		1		
	ED	Exposure Duration	years	24	EPA, 1989a	9	EPA, 1989a	
	EF	Exposure Frequency	day/year	60	Lim, 1996	24	Lim, 1998	
	B	Permeability ratio (skin layers)	dimensionless	chemical-specific	--	chemical-specific	--	
	BW	Body Weight	kg	70	EPA, 1989a	70	EPA, 1989a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	8,760	EPA, 1989a	3,285	EPA, 1989a	
Inhalation	Csw	Chemical Concentration in Surface Water	mg/L	max or 95% UCL of mean (See Table 3.5)	Site-specific	max or 95% UCL of mean (See Table 3.5)	Site-specific	Chronic Daily Intake (CDI) (mg/kg-day) = Csw x IRh x VF x ET x EF x ED x 1/BW x 1/ATn,c
	IRh	Inhalation Rate, hourly	m^3/hr	1.6	EPA, 1997a	1	EPA, 1997a	
	VF	Volatilization Factor	L/m^3	0.2	EPA, 1991b	0.2	Appendix R4	
	ET	Exposure Time	hr/day	2.6	Lim, 1996	2.6	Lim, 1996	
	EF	Exposure Frequency	days/year	80	Lim, 1996	24	Lim, 1996	
	ED	Exposure Duration	years	24	EPA, 1989a	9	EPA, 1989a	
	BW	Body Weight	kg	70	EPA, 1989a	70	EPA, 1989a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	8,760	EPA, 1989a	3,285	EPA, 1989a	

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TABLE 4.11
VALUES USED FOR FISH TISSUE DAILY INTAKE CALCULATIONS
MMR SOUTHWEST OPERABLE UNIT

Scenario Timeframe: Current
Medium: Surface Water
Exposure Medium: Fish Tissue
Exposure Point: Deep and Connamessett Pond Surface Water (modeled to fish)
Receptor Population: Fisher
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Csw	Chemical Concentration in Surface Water	mg/L	max or 95% UCL of mean (See Table 3.5)	Site specific	mean or 95% UCL of mean (See Table 3.5)	Site-specific	Chronic Daily Intake (CDI) (mg/kg-day) = Csw x BAF x IRf x FI x CF3 x EF x ED 1/BW x 1/ATn,c
	BAF	Bioaccumulation Factor	L/kg	chemical-specific		chemical-specific		
	IRf	Ingestion Rate, Fish	g/day	26	EPA, 1997b	6.4	EPA, 1997b	
	FI	Fraction Ingested	dimensionless	1	Assumption	1	Assumption	
	EF	Exposure Frequency	day/year	350	Assumption	350	Assumption	
	ED	Exposure Duration	years	30	EPA, 1989a	9	EPA, 1989a	
	BW	Body Weight	kg	70	EPA, 1989a	70	EPA, 1989a	
	CF3	Conversion Factor -3	kg/g	0.001		0.001		
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	10,950	EPA, 1989a	3,285	EPA, 1989a	

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TABLE 4.12
VALUES USED FOR DAILY SEDIMENTS INTAKE CALCULATIONS
MMR SOUTHWEST OPERABLE UNIT

Scenario Timeframe: Current and Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Deep and Coonamessett Pond Sediment
Receptor Population: Child Swimmer
Receptor Age: Child (1-6 years)

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Cs	Chemical Concentration in Sediment	mg/kg	maximum (See Table 3.4)	Site specific	mean (See Table 3.4)	Site-specific	Chronic Daily Intake (CDI) (mg/kg-day) =
	IRs	Ingestion Rate of Sediment	mg/day	200	EPA, 1991a	100	EPA, 1997a	Cs x IRs x CF1 x FI x EF x ED x 1/BW x 1/ATn,c
	EF	Exposure Frequency	days/year	60	Lim, 1996	24	Lim, 1998	
	ED	Exposure Duration	years	8	EPA, 1991a	6	EPA, 1991a	
	CF1	Conversion Factor 1	kg/mg	1.00E-06	--	1.00E-06	–	
	BW	Body Weight	kg	15	EPA, 1991a	15	EPA, 1991a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	2,190	EPA, 1991a	2,190	EPA, 1991a	
Dermal	Cs	Chemical Concentration in Sediment	mg/kg	maximum (See Table 3.4)	Site-specific	mean (See Table 3.4)	Site-specific	Chronic Daily Intake (CDI) (mg/kg-day) =
	DA_{event}	Absorbed dose per event	mg/cm^2-event	calculated	--	calculated	--	
	Saw	Skin Surface Area, working & wading	cm^2	3,400	EPA, 1997a	2,900	EPA, 1997a	DA_{event} x ED x EF x SAw x 1/BW x 1/ATn,c
	CF1	Conversion Factor 1	kg/mg	1.00E-08		1.00E-06		
	AF	Sediment to skin adherence factor	mg/cm^2-event	1	Levinson, 1998	0.3	Levinson, 1998	Where DAevent = Cs x AF x ABS x CF1
	ABS	Absorption Factor	dimensionless	chemical-specific	--	chemical-specific	--	
	EF	Exposure Frequency	events/year	60	Lim, 1996	24	Lim, 1998	
	ED	Exposure Duration	years	8	EPA, 1991a	6	EPA,1991a	
	BW	Body Weight	kg	15	EPA, 1991a	15	EPA, 1991a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	2,190	EPA, 1991	2,190	EPA, 1991a	

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TABLE 4.13
VALUES USED FOR SURFACE WATER DAILY INTAKE CALCULATIONS
MMR SOUTHWEST OPERABLE UNIT

Scenario Timeframe: Current and Future
Medium: Surface Water
Exposure Medium: Surface Water & Vapor
Exposure Point: Deep and Coonamessett Pond Surface Water
Exposure Point Concentration: Current Deep and Coonamessett Pond Surface Water
Receptor Population: Child Swimmer
Receptor Age: 1-6 years

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Csw	Chemical Concentration in Surface Water	mg/L	max or 95% UCL of mean (See Table 3.5)	Site specific	mean or 95% UCL of mean (See Table 3.5)	Site-specific	Chronic Daily Intake (CDI) (mg/kg-day) =
	IRsw	Ingestion Rate, surface water	L/hour	0.05	EPA, 1989a	0.05	EPA, 1989a	Csw x IRsw x ET x EF x ED x 1/BW x 1/ATn,c
	ET	Exposure Time	hr/day	2.8	Lim, 1996	2.6	Lim, 1996	
	EF	Exposure Frequency	days/year	60	Lim, 1996	24	Lim, 1996	
	ED	Exposure Duration	years	6	EPA, 1991a	8	EPA, 1991a	
	BW	Body Weight	kg	15	EPA, 1991a	15	EPA, 1991a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	2,190	EPA, 1991a	2,190	EPA, 1991a	
Dermal	Csw	Chemical Concentration in Surface Water	mg/cm^3	max or 95% UCL of mean (See Table 3.5)	Site-specific	mean or 95% UCL of mean (See Table 3.5)	Site-specific	Dermally Absorbed Dose (DAD)(mg/kg-day) =
	DA_{event}	Absorbed dose per event	mg/cm^2-event	calculated	--	calculated	--	
	Ab	Skin Surface Area, bathing & swimming	cm^2	7,500	EPA, 1997a	8,500	EPA, 1997a	DA_{event} x EV x ED x EF x Ab x 1/BW x 1/ATn,c
	Kp	Dermal Permeability Constant	cm/hour	chemical-specific	--	chemical-specific	--	
	t_{event}	Exposure Duration	hr	2.6	Lim, 1996	2.6	Lim, 1998	
	t*	Time to reach steady-state	hr	chemical-specific	--	chemical-specific	--	
	t	Lag time	hr	chemical-specific	--	chemical-specific	--	
	EV	Event frequency	event/day	1		1		
	ED	Exposure Duration	years	5	EPA, 1991a	6	EPA, 1991a	
	EF	Exposure Frequency	day/year	60	Lim, 1996	24	Lim, 1998	
	B	Permeability ratio (skin layers)	dimensionless	chemical-specific	--	chemical-specific	--	
	BW	Body Weight	kg	15	EPA, 1991a	15	EPA, 1991a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	2,190	EPA, 1991a	2,190	EPA, 1991a	
Inhalation	Csw	Chemical Concentration in Surface Water	mg/L	max or 95% UCL of mean (See Table 3.5)	Site-specific	max or 95% UCL of mean (See Table 3.5)	Site-specific	Chronic Daily Intake (CDI) (mg/kg-day) = Csw x IRh x VF x ET x EF x ED x 1/BW x 1/ATn,c
	IRh	Inhalation Rate, hourly	m^3/hr	1.2	EPA, 1997a	1	EPA, 1997a	
	VF	Volatilization Factor	L/m^3	0.2	EPA, 1991b	0.2	Appendix R4	
	ET	Exposure Time	hr/day	2.6	Lim, 1996	0.6	Lim, 1996	
	EF	Exposure Frequency	days/year	60	Lim, 1996	24	Lim, 1996	
	ED	Exposure Duration	years	6	EPA, 1991a	6	EPA, 1991a	
	BW	Body Weight	kg	70	EPA, 1991a	15	EPA, 1991a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	2,190	EPA, 1991a	2,190	EPA, 1991a	

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TABLE 4.14
VALUES USED FOR GROUNDWATER DAILY INTAKE CALCULATIONS
MMR SOUTHWEST OPERABLE UNIT

Scenario Timeframe: Current and Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Area 4 Groundwater & Vapor
Receptor Population: Residential Adult
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Cgw	Chemical Concentration in Ground Water	mg/L	Max Concentration (See Table 3.6)	Site specific	Mean Concentration (See Table 3.6)	Site-specific	Chronic Daily Intake (CDI) (mg/kg-day) =
	IRgw	Ingestion Rate Ground water	L/day	2	EPA, 1989a	1.4	EPA, 1989a	Cgw x IRgw x EF x ED x 1/BW x 1/ATn,c
	EF	Exposure Frequency	days/year	350	EPA, 1991a	350	EPA, 1991a	
	ED	Exposure Duration	years	30	EPA, 1989a	9	EPA, 1989a	
	BW	Body Weight	kg	70	EPA, 1989a	70	EPA, 1989a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	10,950	EPA, 1989a	3,285	EPA, 1989a	
Dermal	Cgw	Chemical Concentration in Ground Water	mg/cm^3	Max Concentration (See Table 3.6)	Site-specific	Mean Concentration (See Table 3.6)	Site-specific	Dermally Absorbed Dose (DAD)(mg/kg-day) =
	DA_{event}	Absorbed dose per event	mg/cm^2-event	calculated	--	calculated	--	
	Ab	Skin Surface Area, bathing & swimming	cm^2	22,000	EPA, 1997a	18,000	EPA, 1997a	DA_{event} x EV x ED x EF x Ab x 1/BW x 1/ATn,c
	Kp	Dermal Permeability Constant	cm/hour	chemical-specific	--	chemical-specific	--	
	t_{event}	Exposure Duration	hr	0.25	EPA, 1997a	0.17	EPA, 1997a	
	t*	Time to reach steady-state	hr	chemical-specific	--	chemical-specific	--	
	t	Lag time	hr	chemical-specific	--	chemical-specific	--	
	EV	Event frequency	event/day	1		1		
	ED	Exposure Duration	years	30	EPA, 1989a	9	EPA, 1989a	
	EF	Exposure Frequency	day/year	350	EPA, 1989a	350	EPA, 1989a	
	B	Permeability ratio (skin layers)	dimensionless	chemical-specific	--	chemical-specific	--	
	BW	Body Weight	kg	70	EPA, 1989a	70	EPA, 1989a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	10,950	EPA, 1989a	3,285	EPA, 1989a	
Inhalation	Cgw	Chemical Concentration in Ground Water	mg/L	Max Concentration (See Table 3.6)	Site-specific	Mean Concentration (See Table 3.6)	Site-specific	Chronic Daily Intake (CDI) (mg/kg-day) = Cgw x IRd x VF x EF x ED x 1/BW x 1/ATn,c
	IRd	Inhalation Rate, daily	m^3/day	15	EPA, 1991b	15	EPA, 1991b	
	VF	Volatilization Factor	L/m^3	0.5	EPA, 1991b	0.5	EPA, 1991b	
	ET	Exposure Time	hr/day	24	EPA, 1991b	24	EPA, 1991b	
	EF	Exposure Frequency	days/year	350	EPA, 1991a	350	EPA, 1991a	
	ED	Exposure Duration	years	30	EPA, 1989a	9	EPA, 1989a	
	BW	Body Weight	kg	70	EPA, 1989a	70	EPA, 1989a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	10,950	EPA, 1989a	3,285	EPA, 1989a	

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TABLE 4.16
VALUES USED FOR GROUNDWATER DAILY INTAKE CALCULATIONS
MMR SOUTHWEST OPERABLE UNIT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Area 2 Groundwater & Vapor
Exposure Point Concentration: Current Area 2 groundwater
Receptor Population: Residential Adult
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Cgw	Chemical Concentration in Ground Water	mg/L	Max Concentration (See Table 3.8)	Site specific	Mean Concentration (See Table 3.8)	Site-specific	Chronic Daily Intake (CDI) (mg/kg-day) =
	IRgw	Ingestion Rate Ground water	L/day	2	EPA, 1989a	1.4	EPA, 1989a	Cgw x IRgw x EF x ED x 1/BW x 1/ATn,c
	EF	Exposure Frequency	days/year	350	EPA, 1991a	350	EPA, 1991a	
	ED	Exposure Duration	years	30	EPA, 1989a	9	EPA, 1989a	
	BW	Body Weight	kg	70	EPA, 1989a	70	EPA, 1989a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	10,950	EPA, 1989a	3,285	EPA, 1989a	
Dermal	Cgw	Chemical Concentration in Ground Water	mg/cm^3	Max Concentration (See Table 3.8)	Site-specific	Mean Concentration (See Table 3.8)	Site-specific	Dermally Absorbed Dose (DAD)(mg/kg-day) =
	DA_{event}	Absorbed dose per event	mg/cm^2-event	calculated	--	calculated	--	
	Ab	Skin Surface Area, bathing & swimming	cm^2	22,000	EPA, 1997a	18,000	EPA, 1997a	DA_{event} x EV x ED x EF x Ab x 1/BW x 1/ATn,c
	Kp	Dermal Permeability Constant	cm/hour	chemical-specific	--	chemical-specific	--	
	t_{event}	Exposure Duration	hr	0.25	EPA, 1997a	0.17	EPA, 1997a	
	t*	Time to reach steady-state	hr	chemical-specific	--	chemical-specific	–	
	t	Lag time	hr	chemical-specific	--	chemical-specific	--	
	EV	Event frequency	event/day	1		1		
	ED	Exposure Duration	years	30	EPA, 1989a	9	EPA, 1989a	
	EF	Exposure Frequency	day/year	350	EPA, 1989a	350	EPA, 1989a	
	B	Permeability ratio (skin layers)	dimensionless	chemical-specific	--	chemical-specific	--	
	BW	Body Weight	kg	70	EPA, 1989a	70	EPA, 1989a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	10,950	EPA, 1989a	3,285	EPA, 1989a	
Inhalation	Cgw	Chemical Concentration in Ground Water	mg/L	Max Concentration (See Table 3.8)	Site-specific	Mean Concentration (See Table 3.8)	Site-specific	Chronic Daily Intake (CDI) (mg/kg-day) = Cgw x IRd x VF x EF x ED x 1/BW x 1/ATn,c
	IRd	Inhalation Rate, daily	m^3/day	15	EPA, 1991b	15	EPA, 1991b	
	VF	Volatilization Factor	L/m^3	0.5	EPA, 1991b	0.5	EPA, 1991b	
	ET	Exposure Time	hr/day	24	EPA, 1991b	24	EPA, 1991b	
	EF	Exposure Frequency	days/year	350	EPA, 1991a	350	EPA, 1991a	
	ED	Exposure Duration	years	30	EPA, 1989a	9	EPA, 1989a	
	BW	Body Weight	kg	70	EPA, 1989a	70	EPA, 1989a	
	ATc	Averaging Time (Cancer)	days	25,550	EPA, 1989a	25,550	EPA, 1989a	
	ATn	Averaging Time (Non-cancer)	days	10,950	EPA, 1989a	3,285	EPA, 1989a	

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TABLE 5.1
NON-CANCER TOXICITY DATA – ORAL/DERMAL
MASSACHUSETTS MILITARY RESERVATION, SOUTHWEST OPERATIONAL UNIT

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Oral to Dermal Adjustment Factor (1)	Source of Oral to Dermal Adjustment Factor (1)	Adjusted Dermal RfD (2)	Units	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (3) (MM/DD/YY)
Inorganics											
Arsenic	Chronic	3.0E-04	mg/kg-day	1	EPA, 1997d	3E-04	mg/kg-day	Skin	3.E+00	IRIS	6/8/98
Barium	Chronic	7.0E-02	mg/kg-day	0.07	EPA, 1997d	5E-03	mg/kg-day	Cardiovascular	3.E+00	IRIS	8/10/98
Beryllium	Chronic	2.0E-03	mg/kg-day	0.007	EPA, 1997d	1E-05	mg/kg-day	Intestines	3.E+00	IRIS	6/8/98
Boron	Chronic	9.0E-02	mg/kg-day	1	[b]	9E-02	mg/kg-day		1.E+02	IRIS	2/8/99
Cadmium	Chronic (water)	5.0E-04	mg/kg-day	0.05	EPA, 1997d	3E-05	mg/kg-day	Kidney	1.E+01	IRIS	6/8/98
Chromium, Total [c]	Chronic	3.0E-03	mg/kg-day	0.013	ATSDR, 1993 (Chromium)	4E-05	mg/kg-day	Not Reported	5.E+02	IRIS	6/8/98
Copper	Chronic	4.0E-02	mg/kg-day	1	EPA, 1997d	4E-02	N/A	Gastrointestinal	N/A	HEAST	7/31/97
Lead	No Data	N/A	N/A	N/A	N/A	N/A	N/A	n/a	N/A	N/A	N/A
Manganese	Chronic	1.4E-01	mg/kg-day	0.06	EPA, 1997d	8E-03	mg/kg-day	CNS	1E+00	IRIS	2/7/99
Mercury (inorganic) (HgCl2)	Chronic	3.0E-04	mg/kg-day	0.07	EPA, 1997d	2E-05	mg/kg-day	Autoimmune	1E+03	IRIS	8/7/98
Nickel	Chronic	2.0E-02	mg/kg-day	0.04	EPA, 1997d	8E-04	mg/kg-day	Major Organs	3E+02	IRIS	8/7/98
Selenium	Chronic	5.0E-03	mg/kg-day	1	[a]	5E-03	mg/kg-day		3E+00	IRIS	2/8/99
Thallium	Chronic	8.0E-05	mg/kg-day	1	[a]	8E-05	mg/kg-day	Blood	3.E+03	IRIS	6/8/98
Vanadium	Chronic	9.0E-03	mg/kg-day	0.026	ATSDR,1992 (Vanadium)	2E-04	mg/kg-day	Not Reported	1.E+02	IRIS	2/8/99
Zinc	Chronic	3.0E-01	mg/kg-day	1	[a]	3E-01	mg/kg-day	Blood	3.E+00	IRIS	2/8/99
Organics											
1,1,2,2-Tetrachloroethane	No Data	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,1-Dichloroethene	Chronic	9E-03	mg/kg-day	1	EPA, 1997d	9E-03	mg/kg-day		1E+03	IRIS	2/8/99
1,2,4-Trimethylbenzene	No Data	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,2-Dibromoethane (EDB)	No Data	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,2-Dichloroethane	No Data	N/A	N/A	N/A	N/A	N/A	N/A				
1,3,5-Trimethylbenzene (Mesitylene)	No Data	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2-Methylnaphthalene	No Data	N/A	N/A	N/A	N/A	N/A	N/A				
bis(2-Ethylhexyl)phthalate	Chronic	2.0E-02	mg/kg-day	1	EPA, 1997d	2E-02	mg/kg-day	Liver	1.E+03	IRIS	6/2/98
Carbon tetrachloride	Chronic	7.0E-04	mg/kg-day	1	[b]	7E-04	mg/kg-day	Liver	1.E+03	IRIS	6/2/98
Chloroform	Chronic	1.0E-02	mg/kg-day	1	EPA, 1997d	1E-02	mg/kg-day	Liver	1.E+03	IRIS	6/2/98
n-Propylbenzene (isocumene)	No Data	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Naphthalene	Chronic	2.0E-02	mg/kg-day	1	[b]	2E-02	mg/kg-day	N/A	1.E+03	IRIS	2/2/99
N-Butlybenzene	No Data	N/A	N/A	N/A	N/A	N/A	N/A				
Tetrachloroethylene (PCE)	Chronic	1.0E-02	mg/kg-day	1	EPA, 1997d	1E-02	mg/kg-day	Liver	1.E+03	IRIS	6/2/98
Trichloroethylene (TCE)	No Data	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

N/A = Not Applicable

(1) Based on absorption effciency as per RAGS, PART A (USEPA, 1989).

(2) Adjusted Dermal RfD = Oral RfD x Oral to Dermal Adjustment Factor.

(3) For IRIS values, the date IRIS was search is provided.
For HEAST values, the date of the HEAST publication used is given.
For NCEA values, the date of the article provided by NCEA is given.

[a] Draft Risk Assessment Guidance for Superfund, Supplemental Dermal Guidance (Draft, 12/97)

[b] No data available this organic compound. Assumed 100%.

[c] Toxicity data for Cr^6+ reported.

TABLE 5.2
NON-CANCER TOXICITY DATA – INHALATION
MASSACHUSETTS MILITARY RESERVATION, SOUTHWEST OPERATIONAL UNIT

Chemical of Potential Concern	Chronic/ Subchronic	Value Inhalation RfC	Units	Adjustment Inhalation RfD (1)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfC:RfD: Target Organ	Dates (2) (MM/DD/YY)
Organics									
1,1,2,2-Tetrachloroethane	No Data	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,1-Dichloroethene	No Data	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,2,4-Trimethylbenzene	Chronic	6.0E-03	mg/m3	2E-03	mg/kg-day	N/A	N/A	NCEA (prov.)	12/18/98
1,2-Dibromoethane (EDB)	Chronic	2.0E-04	mg/m3	6E-05	mg/kg-day	Sperm	1E+03	HEAST	7/31/97
1,2-Dichloroethane	No Data	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene (Mesitylene)	Chronic	6.0E-03	mg/m3	2E-03	mg/kg-day	N/A	N/A	NCEA (prov.)	12/18/98
Carbon tetrachloride				6E-04	mg/kg-day	Liver	1.E+02	NCEA	8/25/93
Chloroform	Chronic	3.0E-04	mg/m3	9E-05	mg/kg-day	Nasal tissue	1.E+03	NCEA	12/1/97
N-Butlybenzene	No Data	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tetrachloroethylene (PCE)	No Data	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Trichloroethylene (TCE)	No Data	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

N/A = Not Applicable

(1) Adjusted Dermal RfD (mg/kg/day) = Inhalation RfC (mg/m3) x [Inhalation Rate (20 m3/day) / Body Weight (70 kg)]. In some cases only the RfD is available.

(2) For IRIS values, the date IRIS was search is provided.
For HEAST values, the date of the HEAST publication used is given.
For NCEA values, the date of the article provided by NCEA is given.

[a] Toxicity data for Cr^6+ reported.

TABLE 6.1
CANCER TOXICITY DATA – ORAL/DERMAL
MASSACHUSETTS MILITARY RESERVATION, SOUTHWEST OPERATIONAL UNIT

Chemical of Potential Concern	Oral Cancer Slope Factor	Oral to Dermal Adjustment Factor	Source of Oral to Dermal Adjustment Factor	Adjusted Dermal Cancer Slope Factor (1)	Units	Weight of Evidence/ Cancer Guideline Description	Sources	Date (MM/DD/YY)
Inorganics								
Arsenic	1.5E+00	1	EPA, 1997d	2E+00	(mg/kg/day)-1	A	IRIS	6/8/98
Organics								
1,1,2,2-Tetrachloroethane	2.0E-01	1	EPA, 1997d	2E-01	(mg/kg/day)-1	C	IRIS	8/7/98
1,1-Dichloroethene	6.0E-01	1	EPA, 1997d	6E-01	(mg/kg/day)-1	C	IRIS	2/5/99
1,2-Dibromoethane (EDB)*	8.5E+01	1	EPA, 1997d	9E+01	(mg/kg/day)-1	B2	IRIS	6/2/98
1,2-Dichloroethane	9.1E-02	1	EPA, 1997d	9E-02	(mg/kg/day)-1	B2	IRIS	2/5/99
bis(2-Ethylhexyl)phthalate	1.4E-02	1	EPA, 1997d	1E-02	(mg/kg/day)-1	B2	IRIS	6/2/98
Carbon tetrachloride	1.3E-01	1	[b]	1E-01	(mg/kg/day)-1	B2	IRIS	6/2/98
Chloroform	6.1E-03	1	EPA, 1997d	6E-03	(mg/kg/day)-1	B2	IRIS	6/2/98
Tetrachloroethylene (PCE)	5.2E-02	1	EPA, 1997d	5E-02	(mg/kg/day)-1	C-B2	NCEA	12/31/97
Trichloroethylene (TCE)	1.1E-02	1	EPA, 1997d	1E-02	(mg/kg/day)-1	C-B2	NCEA	12/31/97

IRIS = Integrated Risk Information System
HEAST = Health Effects Assessment Summary Tables

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

(1) Adjusted Dermal Cancer Slope Factor = Oral Cancer Slope Factor/ Oral to Dermal Adjustment Factor.
(2) For IRIS values, the date IRIS was searched is provided.
For HEAST values, the date of the HEAST publication used is given.
For NCEA values, the date of the article provided by NCEA is given.

[a] Absorption assumed to be 5% in absence of chemical specific information (U.S. EPA, 1989)
[b] No data available. Assumed 100%.
[c] Toxicity data for Cr^6+ reported.
* Cancer slope factor only defined for concentrations up to 4 ug/l

TABLE 6.2
CANCER TOXICITY DATA – INHALATION
MASSACHUSETTS MILITARY RESERVATION, SOUTHWEST OPERATIONAL UNIT

Chemical of Potential Concern	Unit Risk	Units	Adjustment (2)	Inhalation Cancer Slope Factor	Units	Weight of Evidence Cancer Guideline Description	Source	Date (1) (MM/DD/YY)
Organics								
1,1,2,2-Tetrachloroethane	5.8E-05	(ug/m^3)^-1	3500	2.0E-01	(mg/kg/day)-1	C	IRIS	2/5/99
1,1-Dichloroethene	5.0E-05	(ug/m^3)^-1	3500	1.8E-01	(mg/kg/day)-1	C	IRIS	2/5/99
1,2-Dibromoethane (EDB)*	2.2E-04	(ug/m^3)^-1	3500	7.7E-01	(mg/kg/day)-1	B2	IRIS	6/2/98
1,2-Dichloroethane	2.6E-05	(ug/m^3)^-1	3500	9.1E-02	(mg/kg/day)-1	B2	IRIS	2/5/99
Carbon tetrachloride	1.5E-05	(ug/m^3)^-1	3500	5.3E-02	(mg/kg/day)-1	B2	HEAST	7/31/97
Chloroform	2.3E-05	(ug/m^3)^-1	3500	8.1E-02	(mg/kg/day)-1	B2	IRIS	6/2/98
Tetrachloroethylene (PCE)	5.5E-05	(ug/m^3)^-1	3500	1.9E-01	(mg/kg/day)-1	C-B2	DEP	1/19/98
Trichloroethylene (TCE)	1.7E-06	(ug/m^3)^-1	3500	6.0E-03	(mg/kg/day)-1	C-B2	NCEA	4/10/92

IRIS = Integrated Risk Information System
HEAST = Health Effects Assessment Summary Tables
DEP = Massachusetts Department of Environmental Protection

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

(1) For IRIS values, the date IRIS was searched is provided.
For HEAST values, the date of the HEAST publication used is given.
For NCEA values, the date of the article provided by NCEA is given.

(2) Adjustment factor applied to unit risk to calculate inhalation slope factor = 70 kg x (1/20 m3/day) x 1000 ug/mg

* Cancer slope factor only defined for concentrations up to 4 ug/l

Table 7.20
Calculation of Non-Cancer Hazards, Reasonable Maximum Exposure
MMR RI SWOU

Scenario Timeframe: CURRENT OR FUTURE
Medium: GROUNDWATER
Exposure Medium: GROUNDWATER
Exposure Point: AREA 4
Receptor Population: RESIDENT
Receptor Age: ADULT

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal	1,2-DIBROMOETHANE (EDB)	18	UG/L	1.80E+01	UG/L	M	2.35E-05	mg/kg-day	NA	NA	NA	NA	NA
Dermal	BARIUM	252	UG/L	2.52E+02	UG/L	M	1.90E-05	mg/kg-day	4.90E-03	mg/kg-day	NA	NA	3.87E-03
Dermal	BIS(2-ETHYLHEXYL) PHTHALATE	25	UG/L	2.50E+01	UG/L	M	1.14E-03	mg/kg-day	2.00E-02	mg/kg-day	NA	NA	5.71E-02
Dermal	BORON (TOTAL)	53	UG/L	5.30E+01	UG/L	M	3.99E-06	mg/kg-day	9.00E-02	mg/kg-day	NA	NA	4.44E-05
Dermal	CADMIUM (TOTAL)	5.2	UG/L	5.20E+00	UG/L	M	3.92E-07	mg/kg-day	2.50E-05	mg/kg-day	NA	NA	1.57E-02
Dermal	CARBON TETRACHLORIDE	9.5	UG/L	9.50E+00	UG/L	M	5.94E-05	mg/kg-day	7.00E-04	mg/kg-day	NA	NA	8.48E-02
Dermal	CHLOROFORM	1.5	UG/L	1.50E+00	UG/L	M	3.10E-06	mg/kg-day	1.00E-02	mg/kg-day	NA	NA	3.10E-04
Dermal	CHROMIUM (T0TAL)	151	UG/L	1.51E+02	UG/L	M	2.28E-05	mg/kg-day	3.90E-05	mg/kg-day	NA	NA	5.83E-01
Dermal	COPPER (TOTAL)	35.2	UG/L	3.52E+01	UG/L	M	2.65E-06	mg/kg-day	4.00E-02	mg/kg-day	NA	NA	6.63E-05
Dermal	MANGANESE (TOTAL)	887	UG/L	8.87E+02	UG/L	M	6.68E-05	mg/kg-day	8.40E-03	mg/kg-day	NA	NA	7.96E-03
Dermal	MERCURY	0.78	UG/L	7.80E-01	UG/L	M	5.88E-08	mg/kg-day	2.10E-05	mg/kg-day	NA	NA	2.80E-03
Dermal	NICKEL (TOTAL)	110	UG/L	1.10E+02	UG/L	M	8.29E-07	mg/kg-day	8.08E-04	mg/kg-day	NA	NA	1.03E-03
Dermal	TETRACHLOROETHYLENE(PCE)	2.4	UG/L	2.40E+00	UG/L	M	3.35E-05	mg/kg-day	1.00E-02	mg/kg-day	NA	NA	3.35E-03
Dermal	THALLIUM (TOTAL)	8.1	UG/L	8.10E+00	UG/L	M	6.10E-07	mg/kg-day	8.00E-05	mg/kg-day	NA	NA	7.63E-03
Dermal	TRICHLOROETHYLENE (TCE)	66	UG/L	6.60E+01	UG/L	M	2.53E-04	mg/kg-day	NA	NA	NA	NA	NA
Dermal	VANADIUM (TOTAL)	3	UG/L	3.00E+00	UG/L	M	2.26E-07	mg/kg-day	2.30E-04	mg/kg-day	NA	NA	9.83E-04
Dermal	ZINC	280	UG/L	2.80E+02	UG/L	M	1.27E-05	mg/kg-day	3.00E-01	mg/kg-day	NA	NA	4.22E-05
Dermal	TOTAL												7.69E-01
Ingestion	1,2-DIBROMOETHANE (EDB)	18	UG/L	1.80E+01	UG/L	M	4.93E-04	mg/kg-day	NA	NA	NA	NA	NA
Ingestion	BARIUM	252	UG/L	2.52E+02	UG/L	M	6.90E-03	mg/kg-day	7.00E-02	mg/kg-day	NA	NA	9.86E-02
Ingestion	BIS(2-ETHYLHEXYL)PHTHALATE	25	UG/L	2.50E+01	UG/L	M	6.85E-04	mg/kg-day	2.00E-02	mg/kg-day	NA	NA	3.42E-02
Ingestion	BORON (TOTAL)	53	UG/L	5.30E+01	UG/L	M	1.45E-03	mg/kg-day	9.00E-02	mg/kg-day	NA	NA	1.61E-02
Ingestion	CADMIUM (TOTAL)	5.2	UG/L	5.20E+00	UG/L	M	1.42E-04	mg/kg-day	5.00E-04	mg/kg-day	NA	NA	2.85E-01
Ingestion	CARBON TETRACHLORIDE	9.5	UG/L	9.50E+00	UG/L	M	2.60E-04	mg/kg-day	7.00E-04	mg/kg-day	NA	NA	3.72E-01
Ingestion	CHLOROFORM	1.5	UG/L	1.50E+00	UG/L	M	4.11E-05	mg/kg-day	1.00E-02	mg/kg-day	NA	NA	4.11E-03
Ingestion	CHROMIUM (TOTAL)	151	UG/L	1.51E+02	UG/L	M	4.14E-03	mg/kg-day	3.00E-03	mg/kg-day	NA	NA	1.38E+00
Ingestion	COPPER (TOTAL)	35.2	UG/L	3.52E+01	UG/L	M	9.64E-04	mg/kg-day	4.00E-02	mg/kg-day	NA	NA	2.41E-02
Ingestion	MANGANESE (TOTAL)	887	UG/L	8.87E+02	UG/L	M	2.43E-02	mg/kg-day	1.40E-01	mg/kg-day	NA	NA	1.74E-01
Ingestion	MERCURY	0.78	UG/L	7.80E-01	UG/L	M	2.14E-05	mg/kg-day	3.00E-04	mg/kg-day	NA	NA	7.12E-02
Ingestion	NICKEL (TOTAL)	110	UG/L	1.10E+02	UG/L	M	3.01E-03	mg/kg-day	2.02E-02	mg/kg-day	NA	NA	1.49E-01
Ingestion	TETRACHLOROETHYLENE(PCE)	2.4	UG/L	2.40E+00	UG/L	M	6.58E-05	mg/kg-day	1.00E-02	mg/kg-day	NA	NA	6.58E-03
Ingestion	THALLIUM (TOTAL)	8.1	UG/L	8.10E+00	UG/L	M	2.22E-04	mg/kg-day	6.00E-05	mg/kg-day	NA	NA	2.77E+00
Ingestion	TRICHLOROETHYLENE (TCE)	66	UG/L	6.60E+01	UG/L	M	1.81E-03	mg/kg-day	NA	NA	NA	NA	NA
Ingestion	VANADIUM (TOTAL)	3	UG/L	3.00E+00	UG/L	M	8.22E-05	mg/kg-day	9.00E-03	mg/kg-day	NA	NA	9.13E-03
Ingestion	ZINC	280	UG/L	2.80E+02	UG/L	M	7.67E-03	mg/kg-day	3.00E-01	mg/kg-day	NA	NA	2.56E-02
Ingestion	TOTAL												5.42E+00
	TOTAL HAZARD INDEX												6.19E+00

Notes:
EPC Selected for Risk Calculation: (M) Medium Specific.
Route EPC Value = Medium EPC Value.

Table 7.20CT
Calculation of Non-Cancer Hazards, Central Tendency Exposure
MMR RI SWOU

Scenario Timeframe: CURRENT OR FUTURE
Medium: GROUNDWATER
Exposure Medium: GROUNDWATER
Exposure Point: AREA 4
Receptor Population: RESIDENT
Receptor Age: ADULT

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal	1,2-DIBROMOETHANE (EDB)	0.56477	UG/L	5.65E-01	UG/L	M	4.99E-07	mg/kg-day	NA	NA	NA	NA	NA
Dermal	BARIUM	9.73294	UG/L	9.73E+00	UG/L	M	4.08E-07	mg/kg-day	4.90E-03	mg/kg-day	NA	NA	8.33E-05
Dermal	BIS(2-ETHYLHEXYL) PHTHALATE	0.96753	UG/L	9.68E-01	UG/L	M	2.98E-05	mg/kg-day	2.00E-02	mg/kg-day	NA	NA	1.49E-03
Dermal	BORON (TOTAL)	26.51	UG/L	2.65+01	UG/L	M	1.11E-06	mg/kg-day	9.00E-02	mg/kg-day	NA	NA	1.23E-05
Dermal	CADMIUM (TOTAL)	0.30627	UG/L	3.06-01	UG/L	M	1.28E-08	mg/kg-day	2.50E-05	mg/kg-day	NA	NA	5.14E-04
Dermal	CARBON TETRACHLORIDE	0.39584	UG/L	3.96E-01	UG/L	M	1.67E-06	mg/kg-day	7.00E-04	mg/kg-day	NA	NA	2.38E-03
Dermal	CHLOROFORM	0.24642	UG/L	2.46E-01	UG/L	M	3.43E-07	mg/kg-day	1.00E-02	mg/kg-day	NA	NA	3.43E-05
Dermal	CHROMIUM (T0TAL)	3.03687	UG/L	3.04E+00	UG/L	M	2.55E-07	mg/kg-day	3.90E-05	mg/kg-day	NA	NA	6.53E-03
Dermal	COPPER (TOTAL)	2.29398	UG/L	2.29E+00	UG/L	M	9.62E-08	mg/kg-day	4.00E-02	mg/kg-day	NA	NA	2.40E-06
Dermal	MANGANESE (TOTAL)	135.02262	UG/L	1.35E+02	UG/L	M	5.66E-06	mg/kg-day	8.40E-03	mg/kg-day	NA	NA	6.74E-04
Dermal	MERCURY	0.07649	UG/L	7.65E-02	UG/L	M	3.20E-09	mg/kg-day	2.10E-05	mg/kg-day	NA	NA	1.53E-04
Dermal	NICKEL (TOTAL)	3.13012	UG/L	3.13E+00	UG/L	M	1.31E-08	mg/kg-day	8.08E-04	mg/kg-day	NA	NA	1.62E-05
Dermal	TETRACHLOROETHYLENE(PCE)	0.18854	UG/L	1.89E-01	UG/L	M	1.77E-06	mg/kg-day	1.00E-02	mg/kg-day	NA	NA	1.77E-04
Dermal	THALLIUM (TOTAL)	1.8494	UG/L	1.85E+00	UG/L	M	7.75E-08	mg/kg-day	8.00E-05	mg/kg-day	NA	NA	9.69E-04
Dermal	TRICHLOROETHYLENE (TCE)	1.31465	UG/L	1.31E+00	UG/L	M	3.40E-06	mg/kg-day	NA	NA	NA	NA	NA
Dermal	VANADIUM (TOTAL)	0.57892	UG/L	5.79E-01	UG/L	M	2.43E-08	mg/kg-day	2.30E-04	mg/kg-day	NA	NA	1.06E-04
Dermal	ZINC	20.225	UG/L	2.02E+01	UG/L	M	5.09E-07	mg/kg-day	3.00E-01	mg/kg-day	NA	NA	1.70E-06
Dermal	TOTAL												1.31E-02
Ingestion	1,2-DIBROMOETHANE (EDB)	0.56477	UG/L	5.65E-01	UG/L	M	1.08E-05	mg/kg-day	NA	NA	NA	NA	NA
Ingestion	BARIUM	9.73294	UG/L	9.73E+00	UG/L	M	1.87E-04	mg/kg-day	7.00E-02	mg/kg-day	NA	NA	2.67E-03
Ingestion	BIS(2-ETHYLHEXYL)PHTHALATE	0.96753	UG/L	9.68E-01	UG/L	M	1.86E-05	mg/kg-day	2.00E-02	mg/kg-day	NA	NA	9.28E-04
Ingestion	BORON (TOTAL)	26.51	UG/L	2.65E+01	UG/L	M	5.08E-04	mg/kg-day	9.00E-02	mg/kg-day	NA	NA	5.65E-03
Ingestion	CADMIUM (TOTAL)	0.30627	UG/L	3.06E-01	UG/L	M	5.87E-06	mg/kg-day	5.00E-04	mg/kg-day	NA	NA	1.17E-02
Ingestion	CARBON TETRACHLORIDE	0.39584	UG/L	3.96E-01	UG/L	M	7.59E-06	mg/kg-day	7.00E-04	mg/kg-day	NA	NA	1.08E-02
Ingestion	CHLOROFORM	0.24642	UG/L	2.46E-01	UG/L	M	4.73E-06	mg/kg-day	1.00E-02	mg/kg-day	NA	NA	4.73E-04
Ingestion	CHROMIUM (TOTAL)	3.03687	UG/L	3.04E+00	UG/L	M	5.82E-05	mg/kg-day	3.00E-03	mg/kg-day	NA	NA	1.94E-02
Ingestion	COPPER (TOTAL)	2.29398	UG/L	2.29E+00	UG/L	M	4.40E-05	mg/kg-day	4.00E-02	mg/kg-day	NA	NA	1.10E-03
Ingestion	MANGANESE (TOTAL)	135.02262	UG/L	1.35E+02	UG/L	M	2.59E-03	mg/kg-day	1.40E-01	mg/kg-day	NA	NA	1.85E-02
Ingestion	MERCURY	0.07649	UG/L	7.65E-02	UG/L	M	1.47E-06	mg/kg-day	3.00E-04	mg/kg-day	NA	NA	4.89E-03
Ingestion	NICKEL (TOTAL)	3.13012	UG/L	3.13E+00	UG/L	M	6.00E-05	mg/kg-day	2.02E-02	mg/kg-day	NA	NA	2.97E-03
Ingestion	TETRACHLOROETHYLENE(PCE)	0.18854	UG/L	1.89E-01	UG/L	M	3.62E-06	mg/kg-day	1.00E-02	mg/kg-day	NA	NA	3.62E-04
Ingestion	THALLIUM (TOTAL)	1.8494	UG/L	1.85E+00	UG/L	M	3.55E-05	mg/kg-day	8.00E-05	mg/kg-day	NA	NA	4.43E-01
Ingestion	TRICHLOROETHYLENE (TCE)	1.31465	UG/L	1.31E+00	UG/L	M	2.52E-05	mg/kg-day	NA	NA	NA	NA	NA
Ingestion	VANADIUM (TOTAL)	0.57892	UG/L	5.79E-01	UG/L	M	1.11E-05	mg/kg-day	9.00E-03	mg/kg-day	NA	NA	1.23E-03
Ingestion	ZINC	20.225	UG/L	2.02E+01	UG/L	M	3.88E-04	mg/kg-day	3.00E-01	mg/kg-day	NA	NA	1.29E-03
Ingestion	TOTAL												5.25E-01
	TOTAL HAZARD INDEX												5.39E-01

Notes:
EPC Selected for Risk Calculation: (M) Medium Specific.
Route EPC Value = Medium EPC Value.

Table 7.21
Calculation of Non-Cancer Hazards, Reasonable Maximum Exposure
MMR RI SWOU

Scenario Timeframe: CURRENT OR FUTURE
Medium: GROUNDWATER
Exposure Medium: VAPOR
Exposure Point: AREA 4
Receptor Population: RESIDENT
Receptor Age: ADULT

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Inhalation	1,2-DIBROMOETHANE (EDB)	18	UG/L	9.00E-03	MG/M3	R	1.85E-03	mg/kg-day	5.70E-05	mg/kg-day	0.0002	mg/m3	3.24E+01
Inhalation	CARBON TETRACHLORIDE	9.5	UG/L	4.75E-03	MG/M3	R	9.76E-04	mg/kg-day	5.71E-04	mg/kg-day	0.06	mg/m3	1.71E+00
Inhalation	CHLOROFORM	1.5	UG/L	7.50E-04	MG/M3	R	1.54E-04	mg/kg-day	8.60E-05	mg/kg-day	0.0003	mg/m3	1.79E+00
Inhalation	TETRACHLOROETHYLENE(PCE)	2.4	UG/L	1.20E-03	MG/M3	R	2.47E-04	mg/kg-day	NA	NA	NA	NA	NA
Inhalation	TRICHLOROETHYLENE (TCE)	66	UG/L	3.30E-02	MG/M3	R	6.78E-03	mg/kg-day	NA	NA	NA	NA	NA
Inhalation	TOTAL												3.59E+01
	TOTAL HAZARD INDEX												3.59E+01

Notes:
EPC Selected for Risk Calculation: (R) Route Specific.
Route EPC Value = Medium EPC Value * Volatilization Factor.

Table 7.21CT
Calculation of Non-Cancer Hazards, Central Tendency Exposure
MMR RI SWOU

Scenario Timeframe: CURRENT OR FUTURE
Medium: GROUNDWATER
Exposure Medium: VAPOR
Exposure Point: AREA 4
Receptor Population: RESIDENT
Receptor Age: ADULT

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Inhalation	1,2-DIBROMOETHANE (EDB)	0.56477	UG/L	2.82E-04	MG/M3	R	5.80E-05	mg/kg-day	5.70E-05	mg/kg-day	0.0002	mg/m3	1.02E+00
Inhalation	CARBON TETRACHLORIDE	0.39584	UG/L	1.98E-04	MG/M3	R	4.07E-05	mg/kg-day	5.71E-04	mg/kg-day	0.06	mg/m3	7.12E-02
Inhalation	CHLOROFORM	0.24642	UG/L	1.23E-04	MG/M3	R	2.53E-05	mg/kg-day	8.60E-05	mg/kg-day	0.0003	mg/m3	2.94E-01
Inhalation	TETRACHLOROETHYLENE(PCE)	0.18854	UG/L	9.43E-05	MG/M3	R	1.94E-05	mg/kg-day	NA	NA	NA	NA	NA
Inhalation	TRICHLOROETHYLENE (TCE)	1.31465	UG/L	6.57E-04	MG/M3	R	1.35E-04	mg/kg-day	NA	NA	NA	NA	NA
Inhalation	TOTAL												1.38E+00
	TOTAL HAZARD INDEX												1.38E+00

Notes:
EPC Selected for Risk Calculation: (R) Route Specific.
Route EPC Value = Medium EPC Value * Volatilization Factor.

Table 7.24
Calculation of Non-Cancer Hazards, Reasonable Maximum Exposure
MMR RI SWOU

Scenario Timeframe: FUTURE
Medium: GROUNDWATER
Exposure Medium: GROUNDWATER
Exposure Point: AREA 2
Receptor Population: RESIDENT
Receptor Age: ADULT

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal	1,1,2,2-TETRACHLOROETHANE	22	UG/L	2.20E+01	UG/L	M	6.36E-05	mg/kg-day	NA	NA	NA	NA	NA
Dermal	1,2-DIBROMOETHANE (EDB)	0.063	UG/L	6.30E-02	UG/L	M	8.24E-08	mg/kg-day	NA	NA	NA	NA	NA
Dermal	ARSENIC	4.6	UG/L	4.60E+00	UG/L	M	3.47E-07	mg/kg-day	3.00E-04	mg/kg-day	NA	NA	1.16E-03
Dermal	BIS(2-ETHYLHEXYL)PHTHALATE	2100	UG/L	2.10E+03	UG/L	M	9.59E-02	mg/kg-day	2.00E-02	mg/kg-day	NA	NA	4.79E+00
Dermal	BORON	169	UG/L	1.69E+02	UG/L	M	1.27E-05	mg/kg-day	9.00E-02	mg/kg-day	NA	NA	1.41E-04
Dermal	CARBON TETRACHLORIDE	5	UG/L	5.00E+00	UG/L	M	3.13E-05	mg/kg-day	7.00E-04	mg/kg-day	NA	NA	4.46E-02
Dermal	CHLOROFORM	0.9	UG/L	9.00E-01	UG/L	M	1.86E-06	mg/kg-day	1.00E-02	mg/kg-day	NA	NA	1.86E-04
Dermal	CHROMIUM (TOTAL)	15.3	UG/L	1.53E+01	UG/L	M	2.31E-06	mg/kg-day	3.90E-05	mg/kg-day	NA	NA	5.91E-02
Dermal	COPPER (TOTAL)	65.4	UG/L	6.54E+01	UG/L	M	4.93E-06	mg/kg-day	4.00E-02	mg/kg-day	NA	NA	1.23E-04
Dermal	MANGANESE	1820	UG/L	1.82E+03	UG/L	M	1.37E-04	mg/kg-day	8.40E-03	mg/kg-day	NA	NA	1.63E-02
Dermal	MERCURY	0.6	UG/L	6.00E-01	UG/L	M	4.52E-08	mg/kg-day	2.10E-05	mg/kg-day	NA	NA	2.15E-03
Dermal	NICKEL (TOTAL)	13.2	UG/L	1.32E+01	UG/L	M	9.95E-08	mg/kg-day	8.06E-04	mg/kg-day	NA	NA	1.23E-04
Dermal	TETRACHLOROETHYLENE(PCE)	71	UG/L	7.10E+01	UG/L	M	9.90E-04	mg/kg-day	1.00E-02	mg/kg-day	NA	NA	9.90E-02
Dermal	THALLIUM (TOTAL)	9.7	UG/L	9.70E+00	UG/L	M	7.31E-07	mg/kg-day	8.00E-05	mg/kg-day	NA	NA	9.14E-03
Dermal	TRICHLOROETHYLENE (TCE)	66	UG/L	6.60E+01	UG/L	M	2.53E-04	mg/kg-day	NA	NA	NA	NA	NA
Dermal	ZINC (TOTAL)	141	UG/L	1.41E+02	UG/L	M	6.37E-06	mg/kg-day	3.00E-01	mg/kg-day	NA	NA	2.12E-05
Dermal	TOTAL												5.03E+00
Ingestion	1,1,2,2-TETRACHLOROETHANE	22	UG/L	2.20E+01	UG/L	M	6.03E-04	mg/kg-day	NA	NA	NA	NA	NA
Ingestion	1,2-DIBROMOETHANE (EDB)	0.063	UG/L	6.30E-02	UG/L	M	1.73E-06	mg/kg-day	NA	NA	NA	NA	NA
Ingestion	ARSENIC	4.6	UG/L	4.60E+00	UG/L	M	1.26E-04	mg/kg-day	3.00E-04	mg/kg-day	NA	NA	4.20E-01
Ingestion	BIS(2-ETHYLHEXYL)PHTHALATE	2100	UG/L	2.10E+03	UG/L	M	5.75E-02	mg/kg-day	2.00E-02	mg/kg-day	NA	NA	2.88E+00
Ingestion	BORON	169	UG/L	1.69E+02	UG/L	M	4.63E-03	mg/kg-day	9.00E-02	mg/kg-day	NA	NA	5.14E-02
Ingestion	CARBON TETRACHLORIDE	5	UG/L	5.00E+00	UG/L	M	1.37E-04	mg/kg-day	7.00E-04	mg/kg-day	NA	NA	1.96E-01
Ingestion	CHLOROFORM	0.9	UG/L	9.00E-01	UG/L	M	2.47E-05	mg/kg-day	1.00E-02	mg/kg-day	NA	NA	2.47E-03
Ingestion	CHROMIUM (TOTAL)	15.3	UG/L	1.53E+01	UG/L	M	4.19E-04	mg/kg-day	3.00E-03	mg/kg-day	NA	NA	1.40E-01
Ingestion	COPPER (TOTAL)	65.4	UG/L	6.54E+01	UG/L	M	1.79E-03	mg/kg-day	4.00E-02	mg/kg-day	NA	NA	4.48E-02
Ingestion	MANGANESE	1820	UG/L	1.82E+03	UG/L	M	4.99E-02	mg/kg-day	1.40E-01	mg/kg-day	NA	NA	3.56E-01
Ingestion	MERCURY	0.6	UG/L	6.00E-01	UG/L	M	1.64E-05	mg/kg-day	3.00E-04	mg/kg-day	NA	NA	5.48E-02
Ingestion	NICKEL (TOTAL)	13.2	UG/L	1.32E+01	UG/L	M	3.62E-04	mg/kg-day	2.02E-02	mg/kg-day	NA	NA	1.79E-02
Ingestion	TETRACHLOROETHYLENE(PCE)	71	UG/L	7.10E+01	UG/L	M	1.95E-03	mg/kg-day	1.00E-02	mg/kg-day	NA	NA	1.95E-01
Ingestion	THALLIUM (TOTAL)	9.7	UG/L	9.70E+00	UG/L	M	2.66E-04	mg/kg-day	8.00E-05	mg/kg-day	NA	NA	3.32E+00
Ingestion	TRICHLOROETHYLENE (TCE)	66	UG/L	6.60E+01	UG/L	M	1.81E-03	mg/kg-day	NA	NA	NA	NA	NA
Ingestion	ZINC (TOTAL)	141	UG/L	1.41E+02	UG/L	M	3.86E-03	mg/kg-day	3.00E-01	mg/kg-day	NA	NA	1.29E-02
Ingestion	TOTAL												7.69E+00
	TOTAL HAZARD INDEX												1.27E+01

Notes:
EPC Selected for Risk Calculation: (M) Medium Specific.
Route EPC Value = Medium EPC Value.

Table 7.24CT
Calculation of Non-Cancer Hazards, Central Tendency Exposure
MMR RI SWOU

Scenario Timeframe: FUTURE
Medium: GROUNDWATER
Exposure Medium: GROUNDWATER
Exposure Point: AREA 2
Receptor Population: RESIDENT
Receptor Age: ADULT

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal	1,1,2,2-TETRACHLOROETHANE	2.06187	UG/L	2.06E+00	UG/L	M	4.02E-06	mg/kg-day	NA	NA	NA	NA	NA
Dermal	1,2-DIBROMOETHANE (EDB)	0.00902	UG/L	9.02E-03	UG/L	M	8.00E-09	mg/kg-day	NA	NA	NA	NA	NA
Dermal	ARSENIC	1.21595	UG/L	1.22E+00	UG/L	M	5.10E-08	mg/kg-day	3.00E-04	mg/kg-day	NA	NA	1.70E-04
Dermal	BIS(2-ETHYLHEXYL)PHTHALATE	59.34444	UG/L	5.93E+01	UG/L	M	1.83E-03	mg/kg-day	2.00E-02	mg/kg-day	NA	NA	9.14E-02
Dermal	BORON	122.56667	UG/L	1.23E+02	UG/L	M	5.14E-06	mg/kg-day	9.00E-02	mg/kg-day	NA	NA	5.71E-05
Dermal	CARBON TETRACHLORIDE	0.29721	UG/L	2.97E-01	UG/L	M	1.25E-06	mg/kg-day	7.00E-04	mg/kg-day	NA	NA	1.79E-03
Dermal	CHLOROFORM	0.22224	UG/L	2.22E-01	UG/L	M	3.10E-07	mg/kg-day	1.00E-02	mg/kg-day	NA	NA	3.10E-05
Dermal	CHROMIUM (TOTAL)	1.68179	UG/L	1.68E+00	UG/L	M	1.41E-07	mg/kg-day	3.90E-05	mg/kg-day	NA	NA	3.62E-03
Dermal	COPPER (TOTAL)	3.13064	UG/L	3.13E+00	UG/L	M	1.31E-07	mg/kg-day	4.00E-02	mg/kg-day	NA	NA	3.28E-06
Dermal	MANGANESE	227.70568	UG/L	2.28E+02	UG/L	M	9.54E-06	mg/kg-day	8.40E-03	mg/kg-day	NA	NA	1.14E-03
Dermal	MERCURY	0.05333	UG/L	5.33E-02	UG/L	M	2.20E-09	mg/kg-day	2.10E-05	mg/kg-day	NA	NA	1.06E-04
Dermal	NICKEL (TOTAL)	2.97766	UG/L	2.98E+00	UG/L	M	1.25E-08	mg/kg-day	8.08E-04	mg/kg-day	NA	NA	1.54E-05
Dermal	TETRACHLOROETHYLENE(PCE)	6.4504	UG/L	6.45E+00	UG/L	M	6.07E-05	mg/kg-day	1.00E-02	mg/kg-day	NA	NA	6.07E-03
Dermal	THALLIUM (TOTAL)	1.81809	UG/L	1.82E+00	UG/L	M	7.62E-08	mg/kg-day	8.00E-05	mg/kg-day	NA	NA	9.53E-04
Dermal	TRICHLOROETHYLENE (TCE)	5.68396	UG/L	5.68E+00	UG/L	M	1.47E-05	mg/kg-day	NA	NA	NA	NA	NA
Dermal	ZINC (TOTAL)	22.54043	UG/L	2.25E+01	UG/L	M	5.67E-07	mg/kg-day	3.00E-01	mg/kg-day	NA	NA	1.89E-06
Dermal	TOTAL												1.05E-01
Ingestion	1,1,2,2-TETRACHLOROETHANE	2.06187	UG/L	2.06E+00	UG/L	M	3.95E-05	mg/kg-day	NA	NA	NA	NA	NA
Ingestion	1,2-DIBROMOETHANE (EDB)	0.00902	UG/L	9.02E-03	UG/L	M	1.73E-07	mg/kg-day	NA	NA	NA	NA	NA
Ingestion	ARSENIC	1.21596	UG/L	1.22E+00	UG/L	M	2.33E-05	mg/kg-day	3.00E-04	mg/kg-day	NA	NA	7.77E-02
Ingestion	BIS(2-ETHYLHEXYL)PHTHALATE	59.34444	UG/L	5.93E+01	UG/L	M	1.14E-03	mg/kg-day	2.00E-02	mg/kg-day	NA	NA	5.69E-02
Ingestion	BORON	122.56667	UG/L	1.23E+02	UG/L	M	2.35E-03	mg/kg-day	9.00E-02	mg/kg-day	NA	NA	2.61E-02
Ingestion	CARBON TETRACHLORIDE	0.29721	UG/L	2.97E-01	UG/L	M	5.70E-06	mg/kg-day	7.00E-04	mg/kg-day	NA	NA	8.14E-03
Ingestion	CHLOROFORM	0.22224	UG/L	2.22E-01	UG/L	M	4.26E-06	mg/kg-day	1.00E-02	mg/kg-day	NA	NA	4.26E-04
Ingestion	CHROMIUM (TOTAL)	1.68179	UG/L	1.68E+00	UG/L	M	3.23E-05	mg/kg-day	3.00E-03	mg/kg-day	NA	NA	1.08E-02
Ingestion	COPPER (TOTAL)	3.13064	UG/L	3.13E+00	UG/L	M	6.00E-05	mg/kg-day	4.00E-02	mg/kg-day	NA	NA	1.50E-03
Ingestion	MANGANESE	227.70568	UG/L	2.28E+02	UG/L	M	4.37E-03	mg/kg-day	1.40E-01	mg/kg-day	NA	NA	3.12E-02
Ingestion	MERCURY	0.05333	UG/L	5.33E-02	UG/L	M	1.02E-06	mg/kg-day	3.00E-04	mg/kg-day	NA	NA	3.41E-03
Ingestion	NICKEL (TOTAL)	2.97766	UG/L	2.98E+00	UG/L	M	5.71E-05	mg/kg-day	2.02E-02	mg/kg-day	NA	NA	2.83E-03
Ingestion	TETRACHLOROETHYLENE(PCE)	6.4504	UG/L	6.45E+00	UG/L	M	1.24E-04	mg/kg-day	1.00E-02	mg/kg-day	NA	NA	1.24E-02
Ingestion	THALLIUM (TOTAL)	1.81809	UG/L	1.82E+00	UG/L	M	3.49E-05	mg/kg-day	8.00E-05	mg/kg-day	NA	NA	4.36E-01
Ingestion	TRICHLOROETHYLENE (TCE)	5.68396	UG/L	5.68E+00	UG/L	M	1.09E-04	mg/kg-day	NA	NA	NA	NA	NA
Ingestion	ZINC (TOTAL)	22.54043	UG/L	2.25E+01	UG/L	M	4.32E-04	mg/kg-day	3.00E-01	mg/kg-day	NA	NA	1.44E-03
Ingestion	TOTAL												6.69E-03
	TOTAL HAZARD INDEX												7.74E-01

Notes:
EPC Selected for Risk Calculation: (M) Medium Specific.
Route EPC Value = Medium EPC Value.

Table 7.25
Calculation of Non-Cancer Hazards, Reasonable Maximum Exposure
MMR RI SWOU

Scenario Timeframe: FUTURE
Medium: GROUNDWATER
Exposure Medium: VAPOR
Exposure Point: AREA 2
Receptor Population: RESIDENT
Receptor Age: ADULT

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Inhalation	1,1,2,2-TETRACHLOROETHANE	22	UG/L	1.10E-02	MG/M3	R	2.26E-03	mg/kg-day	NA	NA	NA	NA	NA
Inhalation	1,2-DIBROMOETHANE (EDB)	0.063	UG/L	3.15E-05	MG/M3	R	6.47E-06	mg/kg-day	5.70E-05	mg/kg-day	0.0002	mg/m3	1.14E-01
Inhalation	CARBON TETRACHLORIDE	5	UG/L	2.50E-03	MG/M3	R	5.14E-04	mg/kg-day	5.71E-04	mg/kg-day	0.06	mg/m3	9.00E-01
Inhalation	CHLOROFORM	0.9	UG/L	4.50E-04	MG/M3	R	9.25E-05	mg/kg-day	8.60E-05	mg/kg-day	0.0003	mg/m3	1.08E+00
Inhalation	TETRACHLOROETHYLENE(PCE)	71	UG/L	3.55E-02	MG/M3	R	7.29E-03	mg/kg-day	NA	NA	NA	NA	NA
Inhalation	TRICHLOROETHYLENE (TCE)	66	UG/L	3.30E-02	MG/M3	R	6.78E-03	mg/kg-day	NA	NA	NA	NA	NA
Inhalation	TOTAL												2.09E+00
	TOTAL HAZARD INDEX												2.09E+00

Notes:
EPC Selected for Risk Calculation: (R) Route Specific.
Route EPC Value = Medium EPC Value * Volatilization Factor.

Table 7.25CT
Calculation of Non-Cancer Hazards, Central Tendency Exposure
MMR RI SWOU

Scenario Timeframe: FUTURE
Medium: GROUNDWATER
Exposure Medium: VAPOR
Exposure Point: AREA 2
Receptor Population: RESIDENT
Receptor Age: ADULT

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Inhalation	1,1,2,2-TETRACHLOROETHANE	2.06187	UG/L	1.03E-03	MG/M3	R	2.12E-04	mg/kg-day	NA	NA	NA	NA	NA
Inhalation	1,2-DIBROMOETHANE (EDB)	0.00902	UG/L	4.51E-06	MG/M3	R	9.27E-07	mg/kg-day	5.70E-05	mg/kg-day	0.0002	mg/m3	1.63E-02
Inhalation	CARBON TETRACHLORIDE	0.29721	UG/L	1.49E-04	MG/M3	R	3.05E-05	mg/kg-day	5.71E-04	mg/kg-day	0.06	mg/m3	5.35E-02
Inhalation	CHLOROFORM	0.22224	UG/L	1.11E-04	MG/M3	R	2.28E-05	mg/kg-day	8.60E-05	mg/kg-day	0.0003	mg/m3	2.65E-01
Inhalation	TETRACHLOROETHYLENE(PCE)	6.4504	UG/L	3.23E-03	MG/M3	R	6.63E-04	mg/kg-day	NA	NA	NA	NA	NA
Inhalation	TRICHLOROETHYLENE (TCE)	5.68396	UG/L	2.84E-03	MG/M3	R	5.84E-04	mg/kg-day	NA	NA	NA	NA	NA
Inhalation	TOTAL												3.35E-01
	TOTAL HAZARD INDEX												3.35E-01

Notes:
EPC Selected for Risk Calculation: (R) Route Specific.
Route EPC Value = Medium EPC Value * Volatilization Factor.

TABLE 10.2 CT
RISK ASSESSMENT SUMMARY
CENTRAL TENDENCY EXPOSURE
MMR RI SWOU

Scenario Timeframe:	CURRENT OR FUTURE
Receptor Population:	CRANBERRY WORKER
Receptor Age:	ADULT

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
SEDIMENT	SEDIMENT	RIVER											
			TOTAL	0.00E+00	NA	0.00E+00	0.00E+00	TOTAL		0.00E+00	NA	0.00E+00	0.00E+00
SURFACE WATER	SURFACE WATER	RIVER											
			TOTAL	0.00E+00	NA	0.00E+00	0.00E+00	TOTAL		0.00E+00	NA	0.00E+00	0.00E+00
	VAPOR	RIVER - VAPOR											
			TOTAL	NA	0.00E+00	NA	0.00E+00	TOTAL		NA	0.00E+00	NA	0.00E+00

Total Risk Across Sediment	0.00E+00
Total Risk Across Surface Water	0.00E+00
Total Risk Across All Media and All Exposure Routes	0.00E+00
Total hazard Index Across All Media and All Exposure Routes	0.00E+00

TABLE 10.2 RME
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
MMR RI SWOU

Scenario Timeframe:	CURRENT OR FUTURE
Receptor Population:	CRANBERRY WORKER
Receptor Age:	ADULT

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
SEDIMENT	SEDIMENT	RIVER											
			TOTAL	0.00E+00	NA	0.00E+00	0.00E+00	TOTAL		0.00E+00	NA	0.00E+00	0.00E+00
SURFACE WATER	SURFACE WATER	RIVER	1,2_DIBROMOETHANE(EDB)	5.20E-07	NA	2.04E-06	2.56E-06						
			TOTAL	5.20E-07	NA	2.04E-06	2.56E-06	TOTAL		0.00E+00	NA	0.00E+00	0.00E+00
	VAPOR	RIVER - VAPOR											
			TOTAL	NA	0.00E+00	NA	0.00E+00	TOTAL		NA	0.00+00	NA	0.00E+00

Total Risk Across Sediment	0.00E+00
Total Risk Across Surface Water	2.56E-08
Total Risk Across All Media and All Exposure Routes	2.56E-08
Total hazard Index Across All Media and All Exposure Routes	0.00E+00

TABLE 10.3 CT
RISK ASSESSMENT SUMMARY
CENTRAL TENDENCY EXPOSURE
MMR RI SWOU

Scenario Timeframe:
CURRENT OR FUTURE
Receptor Population: WADER
Receptor Age: ADULT

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
SEDIMENT	SEDIMENT	RIVER											
			TOTAL	0.00E+00	NA	0.00E+00	0.00E+00	TOTAL		0.00E+00	NA	0.00E+00	0.00E+00
SURFACE WATER	SURFACE WATER	RIVER											
			TOTAL	0.00E+00	NA	0.00E+00	0.00E+00	TOTAL		0.00E+00	NA	0.00E+00	0.00E+00
	VAPOR	RIVER - VAPOR											
			TOTAL	NA	0.00E+00	NA	0.00E+00	TOTAL		NA	0.00E+00	NA	0.00E+00

Total Risk Across Sediment	0.00E+00
Total Risk Across Surface Water	0.00E+00
Total Risk Across All Media and All Exposure Routes	0.00E+00
Total Hazard Index Across All Media and All Exposure Routes	0.00E+00

TABLE 10.3 RME
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
MMR RI SWOU

Scenario Timeframe: CURRENT OR FUTURE
Receptor Population: WADER
Receptor Age: ADULT

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
SEDIMENT	SEDIMENT	RIVER	ARSENIC (TOTAL)	1.37E-06	NA	3.81E-07	1.76E-06						
			TOTAL	1.37E-06	NA	3.81E-07	1.76E-06	TOTAL		0.00E+00	NA	0.00E+00	0.00E+00
SURFACE WATER	SURFACE WATER	RIVER	1,2_DIBROMOETHANE (EDB)	4.33E-06	NA	4.96E-06	9.29E-06						
			TOTAL	4.33E-06	NA	4.96E-06	9.29E-06	TOTAL		0.00E+00	NA	0.00E+00	0.00E+00
	VAPOR	RIVER - VAPOR											
			TOTAL	NA	0.00E+00	NA	0.00E+00	TOTAL		NA	0.00E+00	NA	0.00E+00

Total Risk Across Sediment	1.76E-06
Total Risk Across Surface Water	9.29E-06
Total Risk Across All Media and All Exposure Routes	1.10E-06
Total Hazard Index Across All Media and All Exposure Routes	0.00E+00

TABLE 10.4 CT
RISK ASSESSMENT SUMMARY
CENTRAL TENDENCY EXPOSURE
MMR RI SWOU

Scenario Timeframe:
CURRENT OR FUTURE
Receptor Population: FISHER
Receptor Age: ADULT

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
SURFACE WATER	FISH	RIVER	ARSENIC (TOTAL)	1.45E-06	NA	NA	1.45E-06						
			TOTAL	1.45E-06	NA	NA	1.45E-06	TOTAL		0.00E+00	NA	NA	0.00E+00
						Total Risk Across Surface Water	1.45E-06					Total Hazard Index Across All Media and All Exposure Routes	0.00E+00
						Total Risk Across All Media and All Exposure Routes	1.45E-06						

TABLE 10.4 RME
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
MMR RI SWOU

Scenario Timeframe:
CURRENT OR FUTURE
Receptor Population: FISHER
Receptor Age: ADULT

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
SURFACE WATER	FISH	RIVER	1,2_DIBROMOETHANE (EDB)	9.47E-05	NA	NA	9.47E-05	ARSENIC (TOTAL)	Skin	1.15E-01	NA	NA	1.15E-01
			ARSENIC (TOTAL)	5.04E-05	NA	NA	5.04E-05						
			TOTAL	1.45E-04	NA	NA	1.45E-04	TOTAL		1.15E-01	NA	NA	1.15E-01
						Total Risk Across Surface Water	1.45E-04					Total Hazard Index Across All Media and All Exposure Routes	1.15E-01
						Total Risk Across All Media and All Exposure Routes	1.45E-04						

Total Skin HI = 1.15E-01

TABLE 10.5 CT
RISK ASSESSMENT SUMMARY
CENTRAL TENDENCY EXPOSURE
MMR RI SWOU

Scenario Timeframe:
CURRENT OR FUTURE
Receptor Population: WADER
Receptor Age: CHILD

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
SEDIMENT	SEDIMENT	RIVER	ARSENIC (TOTAL)	8.02E-07	NA	2.09E-07	1.01E-06						
			TOTAL	8.02E-07	NA	2.09E-07	1.01E-06	TOTAL		0.00E+00	NA	0.00E+00	0.00E+00
SURFACE WATER	SURFACE WATER	RIVER											
			TOTAL	0.00E+00	NA	0.00E+00	0.00E+00	TOTAL		0.00E+00	NA	0.00E+00	0.00E+00
	VAPOR	RIVER - VAPOR											
			TOTAL	NA	0.00E+00	NA	0.00E+00	TOTAL		NA	0.00E+00	NA	0.00E+00
						Total Risk Across Sediment	1.01E-06					Total Hazard Index Across All Media and All Exposure Routes	0.00E+00
						Total Risk Across Surface Water	0.00E+00						
						Total Risk Across All Media and All Exposure Routes	1.01E-06						

TABLE 10.5 RME
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
MMR RI SWOU

Scenario Timeframe:
CURRENT OR FUTURE
Receptor Population: WADER
Receptor Age: CHILD

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
SEDIMENT	SEDIMENT	RIVER	ARSENIC (TOTAL)	3.21E-06	NA	1.64E-06	4.54E-06	ARSENIC (TOTAL)	Skin	8.31E-02	NA	4.24E-02	1.26E-01
								BERYLLIUM (TOTAL)	Intestines	4.33E-02	NA	1.05E-01	1.10E-01
								CADMIUM (TOTAL)	Kidney	2.35E-02	NA	7.98E-02	1.03E-01
			TOTAL	3.21E-06	NA	1.64E-06	4.64E-06	TOTAL		1.11E-01	NA	2.27E-01	3.38E-01
SURFACE WATER	SURFACE WATER	RIVER	1,2_DIBROMOETHANE (EDB)	5.05E-06	NA	2.98E-06	8.03E-06						
			TOTAL	5.05E-06	NA	2.98E-06	8.03E-06	TOTAL		0.00E+00	NA	0.00E+00	0.00E+00
	VAPOR	RIVER - VAPOR											
			TOTAL	NA	0.00E+00	NA	0.00E+00	TOTAL		NA	0.00E+00	NA	0.00E+00

Total Risk Across Sediment	4.64E-06
Total Risk Across Surface Water	8.03E-06
Total Risk Across All Media and All Exposure Routes	1.29E-05

Total Hazard Index Across All Media and All Exposure Routes	3.36E-01
Total Skin HI =	1.26E-01
Total Kidney =	1.03E-01
Total Intestines =	1.10E-01

TABLE 10.6 CT
RISK ASSESSMENT SUMMARY
CENTRAL TENDENCY EXPOSURE
MMR RI SWOU

Scenario Timeframe:
CURRENT OR FUTURE
Receptor Population: SWIMMER
Receptor Age: ADULT

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
SEDIMENT	SEDIMENT	POND											
			TOTAL	0.00E+00	NA	0.00E+00	0.00E+00	TOTAL		0.00E+00	NA	0.00E+00	0.00E+00
SURFACE WATER	SURFACE WATER	POND											
			TOTAL	0.00E+00	NA	0.00E+00	0.00E+00	TOTAL		0.00E+00	NA	0.00E+00	0.00E+00
	VAPOR	POND - VAPOR											
			TOTAL	NA	0.00E+00	NA	0.00E+00	TOTAL		NA	0.00E+00	NA	0.00E+00

Total Risk Across Sediment	0.00E+00
Total Risk Across Surface Water	0.00E+00
Total Risk Across All Media and All Exposure Routes	0.00E+00
Total Hazard Index Across All Media and All Exposure Routes	0.00E+00

TABLE 10.6 RME
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
MMR RI SWOU

Scenario Timeframe:
CURRENT OR FUTURE
Receptor Population: SWIMMER
Receptor Age: ADULT

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
SEDIMENT	SEDIMENT	POND											
			TOTAL	0.00E+00	NA	0.00E+00	0.00E+00	TOTAL		0.00E+00	NA	0.00E+00	0.00E+00
SURFACE WATER	SURFACE WATER	POND											
			TOTAL	0.00E+00	NA	0.00E+00	0.00E+00	TOTAL		0.00E+00	NA	0.00E+00	0.00E+00
	VAPOR	POND - VAPOR											
			TOTAL	NA	0.00E+00	NA	0.00E+00	TOTAL		NA	0.00E+00	NA	0.00E+00

Total Risk Across Sediment	0.00E+00
Total Risk Across Surface Water	0.00E+00
Total Risk Across All Media and All Exposure Routes	0.00E+00
Total Hazard Index Across All Media and All Exposure Routes	0.00E+00

TABLE 10.7 CT
RISK ASSESSMENT SUMMARY
CENTRAL TENDENCY EXPOSURE
MMR RI SWOU

Scenario Timeframe:
CURRENT OR FUTURE
Receptor Population: SWIMMER
Receptor Age: CHILD

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
SEDIMENT	SEDIMENT	POND											
			TOTAL	0.00E+00	NA	0.00E+00	0.00E+00	TOTAL		0.00E+00	NA	0.00E+00	0.00E+00
SURFACE WATER	SURFACE WATER	POND											
			TOTAL	0.00E+00	NA	0.00E+00	0.00E+00	TOTAL		0.00E+00	NA	0.00E+00	0.00E+00
	VAPOR	POND - VAPOR											
			TOTAL	NA	0.00E+00	NA	0.00E+00	TOTAL		NA	0.00E+00	NA	0.00E+00

Total Risk Across Sediment	0.00E+00
Total Risk Across Surface Water	0.00E+00
Total Risk Across All Media and All Exposure Routes	0.00E+00
Total Hazard Index Across All Media and All Exposure Routes	0.00E+00

TABLE 10.7 RME
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
MMR RI SWOU

Scenario Timeframe:
CURRENT OR FUTURE
Receptor Population: SWIMMER
Receptor Age: CHILD

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
SEDIMENT	SEDIMENT	POND											
			TOTAL	0.00E+00	NA	0.00E+00	0.00E+00	TOTAL		0.00E+00	NA	0.00E+00	0.00E+00
SURFACE WATER	SURFACE WATER	POND											
			TOTAL	0.00E+00	NA	0.00E+00	0.00E+00	TOTAL		0.00E+00	NA	0.00E+00	0.00E+00
	VAPOR	POND - VAPOR											
			TOTAL	NA	0.00E+00	NA	0.00E+00	TOTAL		NA	0.00E+00	NA	0.00E+00

Total Risk Across Sediment	0.00E+00
Total Risk Across Surface Water	0.00E+00
Total Risk Across All Media and All Exposure Routes	0.00E+00
Total Hazard Index Across All Media and All Exposure Routes	0.00E+00

TABLE 10.8 CT
RISK ASSESSMENT SUMMARY
CENTRAL TENDENCY EXPOSURE
MMR RI SWOU

Scenario Timeframe: CURRENT OR FUTURE
Receptor Population: FISHER
Receptor Age: ADULT

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
SURFACE WATER	FISH	POND											
			Total	0.00E+00	NA	N/A	0.00E+00	TOTAL		0.00E+00	NA	NA	0.00E+00
						Total Risk Across Sediment	0.00E+00					Total Hazard Index Across All Media and All Exposure Routes	0.00E+00
						Total Risk Across All Media and All Exposure Routes	0.00E+00						

TABLE 10.8 RME
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
MMR RI SWOU

Scenario Timeframe:	CURRENT OR FUTURE
Receptor Population:	FISHER
Receptor Age:	ADULT

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
SURFACE WATER	FISH	POND											
			TOTAL	0.00E+00	N/A	NA	0.00E+00	TOTAL		0.00E+00	NA	NA	0.00E+00
						Total Risk Across Sediment	0.00E+00					Total Hazard Index Across All Media and All Exposure Routes	0.00E+00
						Total Risk Across All Media and All Exposure Routes	0.00E+00						

TABLE 10.9 CT
RISK ASSESSMENT SUMMARY
CENTRAL TENDENCY EXPOSURE
MMR RI SWOU

Scenario Timeframe:	CURRENT OR FUTURE
Receptor Population:	AREA 4 RESIDENT
Receptor Age:	ADULT

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
GROUNDWATER	GROUNDWATER	AREA 4 - TAP WATER	1,2-DIBROMOETHANE (EDB)	1.18E-04	NA	5.45E-06	1.24E-04	THALLIUM (TOTAL)	Blood	4.43E-01	NA	9.69E-04	4.44E-01
			TOTAL	1.18E-04	NA	5.45E-06	1.24E-04	TOTAL		4.43E-01	NA	9.69E-04	4.44E-01
	VAPOR	AREA 4 - VAPOR	1,2-DIBROMOETHANE (EDB)	NA	5.74E-06	NA	5.74E-06	1,2-DIBROMOETHANE (EDB) CHLOROFORM	Sperm Nassal Tissue	NA NA	1.02E+00 2.94E-01	NA NA	1.02E+00 2.94E-01
			TOTAL	NA	5.74E.06	NA	5.74E.-06	TOTAL		NA	1.31E+00	NA	1.31E+00
						Total Risk Across Sediment	1.30E-04					Total Hazard Index Across All Media and All Exposure Routes	1.76E+00
						Total Risk Across All Media and All Exposure Routes	1.30E-04						

Total Blood HI =	4.44E-01
Total Sperm HI =	1.02E+00
Total Nassal Tissue HI =	2.94E-01

TABLE 10.9 RME
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
MMR RI SWOU

Scenario Timeframe:	CURRENT OR FUTURE
Receptor Population:	AREA 4 RESIDENT
Receptor Age:	ADULT

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
GROUNDWATER	GROUNDWATER	AREA 4 - TAP WATER	1,2-DIBROMOETHANE (EDB)	1.80E-02	NA	8.58E-04	1.88E-02	BARIUM	Cardiovascular	9.86E-02	NA	3.87E-03	1.03E-01
			BIS(2-ETHYLHEXYL) PHTHALATE	4.11E-06	NA	6.85E-06	1.10E-06	CADMIUM (TOTAL)	Kidney	2.85E-01	NA	1.57E-02	3.01E-01
			CARBON TETRACHLORIDE	1.45E-05	NA	3.31E-06	1.78E-06	CARBON TETRACHLORIDE	Liver	3.72E-01	NA	8.48E-02	4.57E-01
			TETRACHLOROETHYLENE (PCE)	1.47E-06	NA	7.45E-07	2.21E-06	CHROMIUM (TOTAL)	NA	1.38E+00	NA	5.83E-01	1.96E+00
			TRICHLOROETHYLENE (TCE)	8.52E-06	NA	1.19E-06	9.72E-06	MANGANESE (TOTAL)	CNS	1.74E-01	NA	7.96E-03	1.82E-01
								NICKEL (TOTAL)	Major Organs	1.49E-01	NA	1.03E-03	1.50E-01
								THALLIUM (TOTAL)	Blood	2.77E+00	NA	7.63E-03	2.78E+00
			TOTAL	1.80E+00	NA	8.70E-04	1.89E-02	TOTAL		5.23E+00	NA	7.04E-01	5.94E+00
	VAPOR	AREA 4 - VAPOR	1,2-DIBROMOETHANE (EDB)	NA	6.10E-04	NA	6.10E-04	1,2-DIBROMOETHANE (EDB)	Sperm	NA	3.24E+01	NA	3.24E+01
			CARBON TETRACHLORIDE	NA	2.22E-05	NA	2.22E-05	CARBON TETRACHLORIDE	Liver	NA	1.71E+00	NA	1.71E+00
			CHLOROFORM	NA	5.35E-06	NA	5.35E-06	CHLOROFORM	Nassal Tissue	NA	1.79E+00	NA	1.79E+00
			TETRACHLOROETHYLENE (PCE)	NA	2.04E-05	NA	2.04E-06						
			TRICHLOROETHYLENE (TCE)	NA	1.74E-05	NA	1.74E-05						
			TOTAL	NA	6.76E-04	NA	6.76E-04	TOTAL		NA	3.59E+01	NA	3.59E+01
						Total Risk Across Groundwater	1.95E-02					Total Hazard Index Across All Media and All Exposure Routes	4.19E+01
						Total Risk Across All Media and All Exposure Routes	1.95E-02						

Total Cardiovascular HI =	1.03E-01
Total Kidney HI =	3.01E-01
Total CNS HI =	1.82E-01
Total Liver HI =	2.17E+00
Total Major Organs HI =	1.50E-01
Total Blood HI =	2.76E+00
Total Sperm HI =	3.24E+01
Total Nassal Tissue HI =	1.79E+00

Notes:
* Indicates that EDB risk is based on a concentration in water that exceeds the linear portion of the dose/response estimate.

TABLE 10.11 CT
RISK ASSESSMENT SUMMARY
CENTRAL TENDENCY EXPOSURE
MMR RI SWOU

Scenario Timeframe:	FUTURE
Receptor Population:	AREA 2 RESIDENT
Receptor Age:	ADULT

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
GROUNDWATER	GROUNDWATER	AREA 2 - TAP WATER	1,1,2,2-TETRACHLOROETHANE	1.02E-06	NA	1.03E-07	1.12E-06	BIS(2-ETHYLHEXYL) PHTHALATE	Liver	5.89E-02	NA	9.14E-02	1.48E-01
			1,2-DIBROMOETHANE (EDB)	1.89E-06	NA	8.70-08	1.96E-06	THALLIUM (TOTAL)	Blood	4.36E-01	NA	9.53E-04	4.37E-01
			ARSENIC	4.50E-06	NA	9.80E-09	4.51E-06						
			BIS(2-ETHYLHEXYL) PHTHALATE	2.06E-06	NA	3.29E-06	5.34E-06						
			TETRACHLOROETHYLENE(PCE)	8.27E-07	NA	4.06E-07	1.23E-06						
			TOTAL	1.03E-05	NA	3.90E-06	1.42E-05	TOTAL		4.93E-01	NA	9.24E-02	5.85E-01
	VAPOR	AREA 2 - VAPOR	1,1,2,2-TETRACHLOROETHANE	NA	5.45E-06	NA	5.45E-05	CHLOROFORM	Nasal Tissue	NA	2.65E-01	NA	2.65E-01
			TETRACHLOROETHYLENE(PCE)	NA	1.64E-05	NA	1.64E-05						
			TOTAL	NA	2.16E-05	NA	2.10E.-05	TOTAL		NA	2.65E+01	NA	2.65E-01
						Total Risk Across Groundwater	3.60E-05					Total Hazard Index Across All Media and All Exposure Routes	8.51E-01
						Total Risk Across All Media and All Exposure Routes	3.49E-04						

Total Skin HI =	1.48E-01
Total Liver HI =	4.37E-01
Total CNS HI =	2.65E-01

TABLE 10.11 RME
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
MMR RI SWOU

Scenario Timeframe:	FUTURE
Receptor Population:	AREA 2 RESIDENT
Receptor Age:	ADULT

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
GROUNDWATER	GROUNDWATER	AREA 2 - TAP WATER	1,1,2,2-TETRACHLOROETHANE	5.17E-05	NA	5.45E-06	5.71E-05	ARSENIC	Skin	4.20E-01	NA	1.16E-03	4.21E-01
			1,2-DIBROMOETHANE (EDB)	6.29E-05	NA	3.00E-06	6.59E-05	BIS(2-ETHYLHEXYL) PHTHALATE	Liver	2.88E+00	NA	4.79E+00	7.67E+00
			ARSENIC	8.10E-05	NA	2.23E-07	8.12E-05	CARBON TETRACHLORIDE	Liver	1.96E-01	NA	4.46E-02	2.40E-01
			BIS(2-ETHYLHEXYL) PHTHALATE	3.45E-04	NA	5.75E-04	9.20E-04	CHROMIUM (TOTAL)	NA	1.40E-01	NA	5.91E-02	1.99E-01
			CARBON TETRACHLORIDE	7.63E-06	NA	1.74E-06	9.37E-06	MANGANESE (TOTAL)	CNS	3.56E-01	NA	1.63E-02	3.72E-01
			TETRACHLOROETHYLENE(PCE)	4.34E-05	NA	2.21E-06	6.54E-05	TETRACHLOROETHYLENE(PCE)	Liver	1.95E-01	NA	9.90E-02	2.94E-01
			TRICHLOROETHYLENE (TCE)	8.52E-06	NA	1.19E-06	9.72E-06	THALLIUM (TOTAL)	Blood	3.32E+00	NA	9.14E+03	3.23E+00
			TOTAL	6.00E-04	NA	6.09E-04	1.21E-03	TOTAL		7.50E+00	NA	5.02E+00	1.25E+01
	VAPOR	AREA 2 - VAPOR	1,1,2,2-TETRACHLOROETHANE	NA	1.94E-04	NA	1.94E-04	1,2-DIBROMOETHANE (EDB)	Sperm	NA	1.14E-01	NA	1.14E-01
			1,2-DIBROMOETHANE (EDB)	NA	2.14E-06	NA	2.14E-06	CARBON TETRACHLORIDE	Liver	NA	9.00E-01	NA	9.00E-01
			CARBON TETRACHLORIDE	NA	1.17E-05	NA	1.17E-05	CHLOROFORM	Nassal Tissue	NA	1.08E+00	NA	1.08E+00
			CHLOROFORM	NA	3.21E-06	NA	3.21E-06						
			TETRACHLOROETHYLENE(PCE)	NA	6.03E-04	NA	6.03E-04						
			TRICHLOROETHYLENE (TCE)	NA	1.74E-05	NA	1.74E-05						
			TOTAL	NA	8.32E-04	NA	8.32E-04	TOTAL		NA	2.09E+00	NA	2.09E+00

Total Risk Across Groundwater	2.04E-03
Total Risk Across All Media and All Exposure Routes	2.04E-03
Total Hazard Index Across All Media and All Exposure Routes	1.46E-01

Total Skin HI =	4.21E-01
Total Liver HI =	9.10E+00
Total CNS HI =	3.72E-01
Total Blood HI =	3.33E+00
Total Sperm HI =	1.14E-01
Total Nassal Tissue HI =	1.08E+00

APPENDIX B

Applicable or Relevant and Appropriate Requirements (ARARs)

APPENDIX B
Table 1
FS-28 Plume Chemical-Specific ARARs

Requirement	Status	Requirement Synopsis	Action to Be Taken to Attain Requirement
Federal Regulations and Guidance			
SDWA - MCLs (40 CFR 141.61-141.63)	Relevant and Appropriate	The purpose of the SDWA is to protect United States drinking water resources. MCLs have been promulgated for organic and inorganic contaminants. These levels regulate the concentration of contaminants in public drinking water supplies, but may also be considered relevant and appropriate for groundwater aquifers used for drinking water.	MCLs will be used as cleanup goals and met for all contaminants of concern throughout the plume.
State Regulations			
Massachusetts Drinking Water Standards (310 CMR 22.00)	Relevant and Appropriate	Massachusetts Drinking Water Standards establish MMCLs for public drinking water systems. When state MCLs are more stringent than federal levels, the state levels must be attained. The state MCL for EDB is 0.02 micrograms per liter, which is more stringent than the federal MCL of 0.05 micrograms per liter.	Area residents have previously been connected to public drinking water supplies. The CWSW well head treatment system will help ensure that public water supplies will not be exposed to plume contaminants. For the treatment system, MMCLs are relevant and appropriate. The treatment system was designed to treat extracted groundwater to concentrations less than MMCL prior to discharge into the aquifer. MMCLs, where more stringent than MCLs, will be used as cleanup goals and will be met for all contaminants of concern throughout the plume. MMCLs will be attained in approximately 18 years.

APPENDIX B
Table 1
FS-28 Plume Chemical-Specific ARARs

Requirement	Status	Requirement Synopsis	Action to Be Taken to Attain Requirement
Massachusetts Surface Water Quality Standards (314 CMR 4.00)	Relevant and Appropriate	These regulations limit or prohibit discharges of pollutants to surface waters to assure that surface water quality standards of the receiving waters are protected and maintained or attained. Discharges may be limited or prohibited to protect existing uses and not interfere with the attainment of designated uses in downstream and adjacent segments.	Discharge of treated water into the Connamessett River will comply with these requirements for a Class B river.

APPENDIX B
Table 2
FS-28 Plume Location-Specific ARARs

Requirement	Status	Requirement Synopsis	Action to Be Taken to Attain Requirement
Federal Regulations and Guidance			
Rivers and Harbors Act of 1899 (33 USC 403; 33 CFR Parts 320-323)	Applicable	Section 10 of the Rivers and Harbors Act of 1899 requires authorization from the Secretary of the Army, acting through the Army Corps of Engineers, for the construction of any structure in or over any "navigable water of the U.S." It also requires such authorization for the excavation from or deposition of material in such waters, or any obstruction or alteration in such waters.	All actions within navigable waters will be coordinated with the Army Corps of Engineers.
Protection of Wetlands - Executive Order 11990 (40 CFR 6, Appendix A)	Applicable	Appendix A of 40 CFR 6 sets forth policy for carrying out provisions of the Protection of Wetlands Executive Order. Under this order, federal agencies are required to minimize the degradation, loss, or destruction of wetlands, and to preserve the natural and beneficial values of wetlands. Appendix A requires that no remedial alternatives adversely affect a wetland if another practicable alternative is available. If no alternative is available, effects from implementing the chosen alternative must be mitigated.	Remedial actions within a cranberry bog or other wetland will be done in a manner to minimize impacts. Altered areas will be repaired or restored.
Fish and Wildlife Coordination Act (16 USC 661 et seq., 40 CFR 6.302)	Applicable	This act requires that any federal agency proposing to modify a body of water must consult with the U.S. Fish and Wildlife Service, National Marine Fisheries Services, and related state agencies to develop measures to prevent, mitigate or compensate for project-related losses to fish and wildlife. Such action should be viewed in the context of obtaining maximum overall project benefits such as cleaning up the site. The requirements to comply with this Act are contained in EPA's NPDES permit regulations (40 CFR 122.49)	Actions will be taken to develop measures to prevent, mitigate, or compensate for project-related impacts to fish and wildlife. Relevant agencies will be contacted to help analyze the impact on fish and wildlife from operating the treatment system and discharging treated water to the Coonamesset River.

APPENDIX B
Table 2
FS-28 Plume Location-Specific ARARs

Requirement	Status	Requirement Synopsis	Action to Be Taken to Attain Requirement
CWA Section 404, 40 CFR Part 230, 33 CFR Parts 320-323	Applicable	No activity that adversely affects a wetland shall be permitted if a practicable alternative with less effects is available. If no practicable alternative exists, impacts must be mitigated.	The treatment system is being operated so as to minimize impacts to wetlands. All impacts will be mitigated.
Floodplain Management, Executive Order 11988 (40 CFR Part 6, Appendix A)	Applicable	Requires federal agencies to minimize potential harm to or within floodplains and avoid floodplain development wherever there is a practicable alternative.	Proposed activities do not harm the floodplain. Treatment facilities are located outside the 100-year floodplain.
State Regulations			
Massachusetts Wetlands Regulations (310 CMR 10.00)	Applicable	These regulations protect inland and coastal wetlands, as well as a 100-foot buffer zone, from activities that may alter the resource area. Some wetlands receive additional protection as wildlife habitat. Status of wildlife habitat is determined by the presence of particular plant communities or hydrologic characteristics. The regulations specifically prohibit the loss of over 5,000 square feet of bordering vegetated wetlands. The loss may be permitted with replication of the lost area within two growing season.	All activities within wetlands areas and buffer zones will be conducted to meet all requirements.

APPENDIX B
Table 2
FS-28 Plume Location-Specific ARARs

Requirement	Status	Requirement Synopsis	Action to Be Taken to Attain Requirement
Massachusetts Endangered Species Act (321 CMR 8.00)	Applicable	The Commonwealth of Massachusetts has authority to research, list, and protect any species deemed endangered, threatened, or of other special concern. These species are listed as either endangered, threatened, or species of special concern in the regulations. The Massachusetts lists may differ from the federal lists of endangered species. Actions must be conducted in a manner that minimizes the effect on Massachusetts-listed endangered species and species listed by the Massachusetts Natural Heritage Program.	Several state-listed species have been identified in the vicinity of MMR. Areas in which work is to be conducted are being evaluated for the presence of habitat for endangered or threatened species. Activities will be designed to meet the requirements of these regulations.

APPENDIX B
Table 3
FS-29 Plume Action-Specific ARARs

Requirement	Status	Requirement Synopsis	Action to Be Taken to Attain Requirement
Federal Regulations and Guidance			
National Pollutant Discharge Elimination System (NPDES) (40 CFR 122-125 and 131)	Applicable	Establishes discharge limitations, monitoring requirements and best management practices for any direct discharge from a point source into surface water.	Discharges of treated water from the treatment system into the Coonamessett River or cranberry bogs will meet these standards.
RCRA - Identification and listing of Hazardous Wastes; Toxicity Characteristics (40 CFR Part 261.24)	Relevant and Appropriate	These requirements identify the maximum concentrations of contaminants for which the waste would be a RCRA-characteristic hazardous waste for toxicity. The analytical test given in Appendix II is referred to as the TCLP.	Drill cuttings, spent activated carbon, and sludge sent offsite for disposal (not including regeneration) will be analyzed according to the TCLP. If TCLP results exceed the standards in 261.24, the material will be disposed of off-site in a RCRA-permitted treatment, storage, and disposal facility.
RCRA Subtitle C, 40 CFR Part 264 - Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities.	Relevant and Appropriate	These standards, which regulate the operation of facilities that treat, store, or dispose of hazardous waste, take effect through authorized state RCRA programs cited below (Massachusetts Hazardous Waste Management Regulations).	See MA hazardous waste regulations cited below.

APPENDIX B
Table 3
FS-29 Plume Action-Specific ARARs

Requirement	Status	Requirement Synopsis	Action to Be Taken to Attain Requirement
RCRA Air Emission Standards for Process Vents (40 CFR 264, Subpart AA)	Relevant and Appropriate	These regulations established requirements for controlling emissions from process vents associated with treatment processes that manage hazardous wastes with organic concentrations of 10 ppm or more.	If thresholds are met, emissions from process vents will be controlled in accordance with these requirements.
Standards for Control of Emissions of VOCs, RCRA (40 CFR 264, Subpart BB)	Relevant and Appropriate	Contains air pollutant emissions standards for equipment leaks at hazardous waste TSD facilities. Contains design specifications and requirements for monitoring for leak detection. It is applicable to equipment that contains hazardous wastes with organic concentrations of at least 10 % by weight.	If treatment involves groundwater with organic concentrations of at least 10% by weight, equipment will meet design specifications and will be monitored for leaks.
State Regulations			
Massachusetts Department of Public Health Food Tolerance Action Levels (105 CMR 515.00)	To Be Considered	Establishes food tolerance action levels for EDB.	The FS-28 treatment system (including the well-point extraction system) will minimize the possibility that concentrations of EDB exceeding food tolerance action levels are present in the cranberry crop. Cranberries will be sampled and analyzed as an additional measure of the performance of the alternative.
Massachusetts Air Pollution Control Regulations (310 CMR 7.00)	Applicable	These regulations set emission limits necessary to attain ambient air quality standards.	Operation of the treatment systems will be conducted to meet standards for volatile organic compounds (310 CMR 7.18).

APPENDIX B
Table 3
FS-29 Plume Action-Specific ARARs

Requirement	Status	Requirement Synopsis	Action to Be Taken to Attain Requirement
Massachusetts HWMR - Requirements for Generators (310 CMR 30.300-30.371)	Relevant and Appropriate	This requirement sets standards for generators of hazardous waste that address (1) accumulating waste, (2) preparing hazardous waste for shipment, and (3) preparing the uniform hazardous waste manifest. Massachusetts specifies requirements for very small quantity generators, as well as small and large quantity generators.	If RCRA-characteristic hazardous wastes are generated, the material will be managed in accordance with these requirements.

APPENDIX B
Table 4
FS-29 Plume Chemical-Specific ARARs

Requirement	Status	Requirement Synopsis	Action to Be Taken to Attain Requirement
Federal Regulations and Guidance			
SDWA - MCLs (40 CFR 141.61-141.63)	Relevant and Appropriate	The purpose of the SDWA is to protect United States drinking water resources. MCLs have been promulgated for organic and inorganic contaminants. These levels regulate the concentration of contaminants in public drinking supplies, but may also be considered relevant and appropriate for groundwater aquifers used for drinking water. The MCL (federal) for carbon tetrachloride is 5.0 micrograms per liter.	MCLs will be used as a cleanup goal and concentrations for all contaminants of concern will be reduced below MCLs throughout the plume. The treatment system will be designed to treat extracted water to concentrations less than MCLs prior to discharge into the aquifer. In the aquifer, this alternative will attain the MCL for carbon tetrachloride in approximately 5 years.
State Regulations			
Massachusetts Drinking Water Standards (310 CMR 22.00)	Relevant and Appropriate	Massachusetts Drinking Water Standards establish MMCLs for public drinking water systems. When state MCL levels are more stringent than federal levels, the state levels must be attained. The MMCL for EDB, which is 0.02 micrograms per liter, is more stringent than the federal MCL of 0.05 micrograms per liter.	The MMCL for EDB will be used as a cleanup goal and will be met throughout the plume. The treatment system will be designed to treat extracted groundwater to concentrations less than MMCLs prior to discharge into the aquifer, the MMCL for EDB will be attained in approximately 8 years.
Massachusetts Groundwater Quality Standards (314 CMR 6.00)	Relevant and Appropriate	These standards limit the concentration of certain materials allowed in classified Massachusetts waters. The groundwater beneath MMR has been classified as a Class I water (fresh groundwater found in the saturated zone of unconsolidated deposits) and is designated as a source of potable water supply.	The system will be designed and operated to treat groundwater to obtain groundwater quality standards prior to discharge.

Requirement	Status	Requirement Synopsis	Action to Be Taken to Attain Requirement
State Regulations			

APPENDIX B
Table 5
FS-29 Plume Location-Specific ARARs

Requirement	Status	Requirement Synopsis	Action to Be Taken to Attain Requirement
Massachusetts Endangered Species Act (321 CMR 8.00)	Applicable	The Commonwealth of Massachusetts has authority to research, list, and protect any species deemed endangered, threatened, or of other special concern. These species are listed as either endangered, threatened, or species of special concern in the regulations. The Massachusetts lists may differ from the federal lists of endangered species. Actions must be conducted in a manner that minimizes the effect on Massachusetts-listed endangered species and species listed by the Massachusetts Natural Heritage Program.	Several state-listed species have been identified in the vicinity of MMR. Areas where work is to be conducted will be evaluated for the presence of habitat for endangered or threatened species. Activities will be designed to meet the requirements of these regulations.

APPENDIX B Table 6
FS-29 Plume Action-Specific ARARs

Requirement	Status	Requirement Synopsis	Action to Be Taken to Attain Requirement
Federal Regulations and Guidance			
RCRA - Identification and Listing of Hazardous Wastes; Toxicity Characteristics (40 CFR 261.24)	Relevant and Appropriate	These requirements identify the maximum concentrations of contaminants for which the waste would be a RCRA-characteristic hazardous waste for toxicity. The analytical test given in Appendix II is referred to as the TCLP.	Drill cuttings, spent activated carbon, and sludge sent offsite for disposal (not including regeneration) will be analyzed according to the TCLP. If TCLP results exceed the standards in 261.24, the material will be disposed of off-site in a RCRA-permitted treatment, storage, and disposal facility.
RCRA Subtitle C, 40 CFR Part 264 - Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities.	Relevant and Appropriate	These standards, which regulate the operation of facilities that treat, store, or dispose of hazardous waste, take effect through authorized state RCRA programs cited below (Massachusetts Hazardous Waste Management Regulations).	See MA hazardous waste regulations cited below.
RCRA Air Emission Standards for Process Vents (40 CFR, Subpart AA)	Relevant and Appropriate	These regulations establish requirements for controlling emissions from process vents associated with treatment processes that manage hazardous wastes with organic concentrations of 10 ppm or more.	If thresholds are exceeded, emissions from process vents will be controlled in accordance with these requirements.
Standards for Control of Emissions of VOCs, RCRA (40 CFR 264, Subpart BB)	Relevant and Appropriate	Contains air pollutant emissions standards for equipment leaks at hazardous waste TSD facilities. Contains design specifications and requirements for monitoring for leaks. It is applicable to equipment that contains hazardous wastes with organic concentrations of at least 10% by weight.	If treatment involves groundwater with organic concentrations of at least 10% by weight, equipment will meet design specifications and will be monitored for leaks.

APPENDIX B Table 6
FS-29 Plume Action-Specific ARARs

Requirement	Status	Requirement Synopsis	Action to Be Taken to Attain Requirement
Underground Injection Control Program, 40 CFR 144, 146, 147, 1000	Applicable	These regulations outline minimum program and performance standards for underground injection wells and prohibit any injection that may cause a violation of any primary drinking water regulation in the aquifer. Infiltration galleries fall within the broad definition of Class V wells.	Extracted groundwater will be treated to levels at or below federal and state drinking water standards to ensure that discharges to infiltration galleries will not cause any violation of drinking water standards in the receiving aquifer.
State Regulations			
Massachusetts Air Pollution Control Regulations (310 CMR 7.00)	Applicable	These regulations set emission limits necessary to attain ambient air quality standards.	Remedial actions (e.g., well drilling and the installation of piping) will be conducted to meet the standards for visible emissions (310 CMR 7.06); dust, odor, construction, and demolition (310 CMR 7.09); noise (310 CMR 7.10); and volatile organic compounds (310 CMR 7.18). If limits are exceeded, emissions will be managed through engineering controls.
Massachusetts HWMR - Requirements for Generators (310 CMR 30.300-30.371)	Relevant and Appropriate	This requirement sets standards for generators of hazardous waste that address (1) accumulating waste, (2) preparing hazardous waste for shipment, and (3) preparing the uniform hazardous waste manifest. Massachusetts specifies requirements for very small quantity generators, as well as small and large quantity generators.	If RCRA-characteristic hazardous wastes are generated, the material will be managed in accordance with these requirements.
Massachusetts Hazardous Waste Management Regulations - Location Standards for Facilities (310 CMR 30.700 - 30.707)	Relevant and Appropriate	There shall be a minimum of 300 feet from the active portion of the facility property line.	A waiver may be requested for exemption form the distance requirement from the treatment facility to the property line.

APPENDIX B Table 6
FS-29 Plume Action-Specific ARARs

Requirement	Status	Requirement Synopsis	Action to Be Taken to Attain Requirement
Massachusetts Underground Water Source Protection, 310 CMR 27.00	Applicable	Under these regulations, “no underground injection shall be allowed where a Class V well causes or allows movement of fluid containing any pollutant into underground sources of drinking water and the presence of such pollutant causes or is likely to cause a violation of any Massachusetts Drinking Water Regulation ... or ... adversely affects or is likely to adversely affect the health of persons.” Class V wells are defined to include “recharge wells used to replenish the water in an aquifer.”	Extracted groundwater will be treated to levels at or below federal and state drinking water standards to ensure that discharges to infiltration galleries will not cause any violation of drinking water standards in the receiving aquifer.

APPENDIX C

Massachusetts Department of Environmental Protection Concurrence Letter

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

COPY

ARGEO PAUL CELLUCCI
Governor

JANE SWIFT
Lieutenant Governor

BOB DURAND
Secretary

LAUREN A. LISS
Commissioner

OCT 2000
RECEIVED

October 20, 2000

Gary M. Erickson, P.E., Director
HQ AFCEE/CC
3207 North Road
Brooks Air Force Base
San Antonio, TX 78235

RE: BOURNE--BWSC-4-0037
Massachusetts Military Reservation
Final Record of Decision for the Fuel Spill-28 and Fuel Spill-29 Plumes, Concurrence

Patricia L. Meaney, Director
Office of Site Remediation
U.S. EPA Region I
JFK Federal Building
Boston, MA 02203

Dear Mr. Erickson and Ms. Meaney:

The Department of Environmental Protection (the "Department") has reviewed the **"FINAL RECORD OF DECISION FOR THE FUEL SPILL-28 AND FUEL SPILL-29 PLUMES"** at the Massachusetts Military Reservation ("MMR") dated September 2000 and prepared by Jacobs Engineering Group Inc. for the Air Force Center for Environmental Excellence (AFCEE).

The Record of Decision (ROD) describes remedial actions to address groundwater contamination associated with the following plumes:

- Fuel Spill No. 28 (FS-28).
- Fuel Spill No. 29 (FS-29).

Both of these plumes are located in the Southwest Operable Unit (SWOU) study area. The SWOU is described as the area between the LF-1, CS-10 and Ashumet Valley plumes emanating from the MMR, and includes the southwest portion of the MMR, the western portion of the Francis A. Crane Wildlife Management Area and residential neighborhoods in Falmouth. The FS-28 and FS-29 plumes extend south and west of the MMR boundary. AFCEE plans to conduct the following remedial actions:

- FS-28: Continued operation of existing leading edge extraction, treatment with granular-activated carbon and discharge system (ETD) consisting of a shallow extraction wellfield

system and deep extraction well 69EW0001 for plume capture, and maintenance of existing wellhead protection system for the Coonamessett Water Supply Well; and

- FS-29: Extraction, Treatment and Infiltration (ETI) for plume capture. Additional site characterization and modeling will be performed to support the design of the FS-29 ETI system. If, as a result of additional site characterization and modeling, the proposed ETI system is determined not to be appropriate, the selected remedy will be reviewed. Alternate remedies would then be evaluated to determine which remedy provides the best balance of trade-offs among the nine CERCLA criteria. A new remedy would then be selected by AFCEE and the EPA, with DEP concurrence and public input.

The selected remedies are one aspect of the overall cleanup strategy for MMR which encompasses the following goals:

- 100% capture of the plume if feasible, where a plume is defined as groundwater contaminated above maximum contaminant levels (MCLs) as defined by multiple samples from multiple wells. In the absence of MCLs, a risk based level will be established; and
- treatment of contaminants and cleanup of the plume to background levels, if technically and economically feasible.

The Remedial Action Objectives (RAOs) for the FS-28 plume consist of the following:

- Prevent or reduce residential exposure to ethylene dibromide (EDB) exceeding 0.02 ug/l in the groundwater.
- Restore the aquifer to its beneficial uses within a reasonable time.
- Prevent worker contact and child and wader contact with the Coonamessett River water containing unacceptable concentrations of EDB.
- Prevent or reduce ingestion of fish exposed to Coonamessett River water containing unacceptable concentrations of EDB.

The RAOs for the FS-29 plume include the following:

- Prevent or reduce residential exposure to EDB exceeding 0.02 ug/l and carbon tetrachloride (CCI_4) exceeding 5 ug/1 in the groundwater.
- Restore the aquifer to its beneficial uses within a reasonable time.

AFCEE has agreed that for active remedies at the FS-28/29 plumes, the following steps will be taken to attain RAOs:

1. Remediate the aquifer to federal and state drinking water standards or other risk-based cleanup levels;
2. When maximum contaminant levels (MCLs), Massachusetts MCLs (MMCLs) or other risk-based cleanup levels are achieved and before the system is shut off, perform a risk assessment to determine if unacceptable ecological and/or human health risks are present; continue system operation and/or pursue additional measures as required to achieve acceptable risks; and
3. Once acceptable risks have been achieved, evaluate the technical and economic feasibility of additional remediation to approach or achieve background concentrations.

The Department concurs with the Record of Decision. The Department's concurrence is based upon representations made to the Department by the AFCEE and assumes that all information provided is substantially complete and accurate. Without limitation, if the Department determines that any material omissions or misstatements exist, if new information becomes available, or if conditions at the Study Area change, resulting in potential or actual human exposure or threats to the environment, the Department reserves its authority under M.G.L. c. 21E, and the Massachusetts Contingency Plan, 310 CMR 40.0000 et seq., and any other applicable law or regulation to require further response actions.

Please incorporate this letter into the Administrative Record for the FS-28 and FS-29 plumes. The Department looks forward to working with you to expedite the cleanup at the MMR. If you have any questions regarding these comments, please contact Leonard J. Pinaud at (508) 946-2871.

Sincerely,

Paul A. Taurasi, P.E.
Regional Director

P/EBJ/mw
Fs2829rodconltr.doc

cc: DEP-SERO
ATTN: Millie Garcia-Surette, Deputy Regional Director
Leonard J. Pinaud, Chief, Federal Facilities Remediation Section

Distributions: SERO
SMB
Plume Containment Team
Public Information Team
Long Range Water Supply PAT
Boards of Selectmen
Boards of Health

APPENDIX D

Transcript of Public Hearing

MASSACHUSETTS MILITARY RESERVATION
INSTALLATION RESTORATION PROGRAM

IN RE: FS-28 and FS-29
Proposed Plan

Unitarian Universalist Fellowship
880 Sandwich Road
Falmouth, MA 02540
Thursday, March 2, 2000
6:32 p.m.

HEARING OFFICER:
Douglas Karson

Mary E. Phillips
Registered Professional Reporter
P.O. Box 160, Sagamore Beach, MA 02562
508.888.6717

ATTENDEES:

Doug Karson, AFCEE
Peggy Alfred
Stephen Ellmann, JBG
Lauren Fraser, Jacobs
R. Freeman, JBG
Dan Miller, Weitech
Charles Kenny, Jr.
Cathy Silver, DEP
Kathy Forgean
Gene and Evelyn Kanter
Bob Lim, EPA
Pat Mark
David Lundgy
Naomi Litvin
Lori Nolin
Richard Koehler
David N. Swartz
David Dow, Sierra Club
Jim Murphy, EPA
Donald Scholowitz
Pat Thacher-Hill
Brian Holbrook
Graham Kirr
Sue Walker
Debby McIntosh
Virginia Valiela

PROCEEDINGS

MR. KARSON: Okay. If we're all set we're going to go ahead. We're now starting the public hearing portion of the meeting. And the official record is now open. And I will be the hearing officer tonight. Could we have the lights up please.

My name is Douglas Karson. I am the hearing officer. The purpose of this hearing is to accept oral comments, testimony as well as written comments. If you have them here tonight you can pass them in to me any time tonight.

And that would be on The Proposed Plan for a Fuel Spill 28 and 29, the groundwater plumes. All the oral testimony that I will take tonight will be transcribed verbatim and become part of the official record of this project.

Each and every comment will be responded to in a Responsiveness Summary that will be issued after the close of the public comment period

A Record of Decision will be issued and contain the Air Force's selected alternative for each plume and the rationale for that selection.

This hearing is different than the informational session that we just completed. It is

exclusively for listening to and reporting your comments. We will not respond to any comments that you make. However, we may ask for clarification if we don't understand what your comment is.

Everyone wanting to comment must come to the microphone and speak into the microphone. I ask that you please state your name and town of residence.

Also if you are interested in getting a copy of the Responsiveness Summary, we want to mail that to everyone who does comment, please provide your mailing address either at the microphone or on the sign up sheet that we have out in the lobby.

And when that Responsiveness Summary is completed later this year it will be mailed out.

The floor is now open to comment on The Proposed Plan for Fuel Spill 28 and 29 groundwater plumes.

Who would like to be first? Just raise your hand please. Yes.

MS. LITVIN: Good evening. Is the mike on?

MR. KARSON: Yup.

MS. LITVIN: My name is Naomi Litvin. My home is in Lochstead in East Falmouth. I'm the

President of the Lochstead Board of Trustees, The Lochstead Association Board of Trustees.

I'm speaking to you here tonight with respect to FS-28 and The Proposed Plan with respect to that particular plume. I'm speaking to you on behalf of the association and the over 60 homes that it represents.

What I say here tonight is also my personal views. And I adopt the association views as my own so that you know that as a resident these are my views.

Now, as you know, from my prior correspondence, Lochstead is a planned residential development. It consists of privately owned house lots and common land. The homeowners are all members of the association. And the association owns and controls Lochstead's common land facilities and all the roads within Lochstead, which are private roads, by the way, not public

Now, I know you've heard from many Lochstead residents already during the comment period. I also know that many Lochstead residents were eager to get on record and mailed in their comments, which arrived in advance of the comment period, and the AFCEE was kind enough to return to me

and ask me to resubmit them in the comment period. And I would like to take the opportunity now to submit 18 letters which are being resubmitted into the record from the following Lochstead residents: Mr and Mrs. Wolfson, Swartz, Morgan, Oilmette, Gould, Levine, Stockman, Veistein, Kaitz, Koris, Blatt, Aserkoff, Kohn with a K, Goldstein, Bycoff, Welch, Tanner, and Linda Hirshman and David Forkosh, if I may approach and give these to you.

MR. KARSON: Yes.

MS. LITVIN: (indicating.) Also at this time I'd like to offer into the record the Association's formal written comments consisting of six pages, a six-page letter dated March 2, 2000, and the exhibits attached thereto.

We will be mailing in a duplicate original to the address provided, but I'd also like to make sure it gets in the record. So I am delivering the duplicate original here as well (indicating).

Finally, I have here the original of a petition signed by virtually all the members of the Lochstead Association. I have provided copies of this towards the end of last year to the AFCEE and I'm going to deliver the original now as per my representation late last year.

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This particular petition specifically
renders the Lochstead objection in opposition to the
location of any extraction wells, re-injection wells
or any other kind of hazardous substances extraction
or treatment facility or device within the borders of
Lochstead (indicating).
It comes as no surprise that tonight I'm
going to speak to you about why Alternative 6 is not
a good alternative and why we concur with the
proposed plans rejection of that Alternative.
I won't be belabor the point, because I
have six pages there which I've delivered to you for
the Air Force, DEP, EPA to read. But I want to point
out some of the highlights of that letter, because I
think it's important to understand that we're not
just talking about community resistance here, which
The Proposed Plan mentions.
But in our view there's a lot of criteria
that are not met by coming into Lochstead that are
much better satisfied by Alternative 3 and even
Alternative 7, which is what the choice is of The
Proposed Plan.
I noted today that in looking at the JPAT
comments that they're not happy with Alternative 7.
And to the extent that they're urging you to

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reconsider putting Alternative 6 back on the map, we
urge you just the opposite.
We don't think that they understand the
impact that it has on a community or the environment
of that community or the inhabitants of that
community.
Now, we at Lochstead are not professionals
in this field. We're relying on what the final study
has said, many of us have read the final study. And
we realize that not only has a final study been done
by an engineering company, but it's been looked at by
experts at the DEP and EPA and The Air Force.
And in that final study it's remarkable to
find the statement that or statements to the effect
that there is nothing more effective or that reduces
risk or that protects the public health better than
Alternative 3.
So to the extent that Alternative 6 is
being considered, it seems as it's only being
considered for a quicker remediation process.
But the down side of that is it will damage
the environment in and of itself, whereas Alternative
3 doesn't do that. It will damage the environment in
Lochstead.
You know, JPAT points out various parts of

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the environment that Alternative 7 will damage. We
say to you that it will damage the same sort of
things in Lochstead.
Lochstead is a very natural environment.
The homes are built within the natural setting.
There are a lot of animals in that area. It's a
natural habitat for a lot of animals. So to the
extent that the ecology will be improved by speeding
an aquifer restoration, it will be harmed to even
reach that goal. Alternative 3 doesn't harm anything
in reaching that goal.
So to us there's no question that the
environment, the environment of Lochstead will be
harmed. But there is a question of human health and
well-being here that's affected by Alternative 6.
Human health and well-being is not being
effected by Alternative 7. And that is of a small
community within a confined space in which there
would be a huge invasion of equipment and trucks
causing a great disruption to the lives of the people
who live there, many of them elderly and not that
well.
Now, beyond the disruption we've got this
issue Surely, by bringing contaminants to the
surface you are exposing the people in that community

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to a danger that doesn't exist by leaving those
contaminants a hundred feet below the surface
traveling to the point where they're being
effectively treated where they can be treated no
better than Alternative 3.
UNIDENTIFIED PERSON: (inaudible.)
MR. KARSON: Please one person at a time.
MS. LITVIN: In addition to whatever
dangers there may be for contaminants, should there
be a break in the line, should there be any accident
on the property. We've got issues of traffic and
dangers which can happen from all the activity on the
property, liability issues, issues which don't exist
with Alternative 3 or even with Alternative 7 because
it is in a conservation area that is uninhabited.
Now, we examined all of these issues in
that document I gave you in conjunction with the
various criteria. And we question whether
Alternative 6 even meets the threshold criteria when
you consider how well it does or does not protect the
human health and the environment.
Certainly it doesn't reach anywhere near
the effectiveness for that criteria with Alternative
— as Alternative 3. And also we question the
balancing criteria and would urge you that when it

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comes to doing it just speed for speed sake you can't
sacrifice a community, the health or the
environment.
Now, Alternative 6 requires the spending of
an extra $8 million and will have adverse effects
that will not occur under Alternative 3 and yet it
does nothing more than Alternative 3 in the very
end.
So we are gratified and commend you for
rejecting Alternative 6. We endorse your choice in
the sense, in this sense, and we urge you not to
accede to any request of the JPAT to reconsider 6.
The JPAT's criticism of 7 is equally
applicable to 6. And to the extent that speed is a
criteria here, which, I suggest one thing.
You know, we're talking about restoration
within a reasonable timeframe. And when you have
circumstances like this, where the longer timeframe
does no damage, but the shorter timeframe does
damage; then it's the longer timeframe that becomes
the reasonable one, and the shorter one becomes the
unreasonable one.
So clearly in our view Alternative 6 is
totally unreasonable. But if speed still is an
issue, a faster restoration is still an issue then

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Alternative 7, which is the choice of the AFCEE is
the choice to stay with because it's cheaper than
Alternative 6. It's faster than Alternative 6. And
it doesn't do the damage to human beings and their
environment that would Alternative 6.
We thank you for your courtesies and for
listening to us in the past. And we urge you that
when you reconsider these issues or when you consider
these issues that you leave Alternative 6 exactly
where it is, out of the loop Thank you.
MR. KARSON: Thank you. Who will be next?
Mr. Dow.
MR. DOW: The following --
MR. KARSON: State your name and town.
MR. DOW: David Dow, East Falmouth. The
following is submitted on behalf of the Cape Cod
Group Sierra Club by the Treasurer David Dow 18
Treetop Lane, East Falmouth.
For the FS-28 plume we favor continued
operation of the current Extraction, Treatment,
Reinjection system at the point where the plume
discharges into the Coonamessett River EW-1 and the
204 shallow well-point system, which operates down
gradient.
This component of Alternative 3 has

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1 resulted in no detectable ethylene dibromide
2 detections in the Coonamesset River since May of
3 1999, which we find encouraging.
4 We are not supportive of the Air Force
5 Center for Environmental Excellence's program to use
6 berms to separate the cranberry bogs from the river
7 and feel that these areas should either return to
8 natural wetlands habitat or utilize dry harvesting,
9 organic farming practices, if they are maintained as
10 cranberry bogs.
11 The current berm system tends to channelize
12 the water flow which alters a natural hydrology of
13 the river and releases the herbicides and pesticides
14 back into the river after their applications to the
15 bogs, which is not good for the ecology.
16 We support the continued operation of the
17 well-head treatment system at the Town of Falmouth's
18 Coonamesset Water Supply Well and the operation of
19 sentinel wells to detect potential EDP contamination
20 of this public water supply system. Thus we favor
21 the proposed Alternative 3 with the exception noted
22 above.
23 We have a number of concerns in regards to
24 the proposed options for installing up gradient ETR
25 systems in order to expedite aquifer restoration of

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1 this plume. Even though aquifer restoration is
2 something that should be pursued where feasible, we
3 don't feel that either of the proposed Alternatives 6
4 and 7 are desirable.
5 Given the strong community opposition in
6 Lochstead to Alternative 6, this is a non-starter.
7 And the option of taking this land by eminent domain
8 would be tied up in the courts for a long period of
9 time which would counteract the goal of expedited
10 clean up.
11 Alternative 7 for installing three ETR
12 systems in the Souza Conservation Area has many
13 problems, including potential disruption of the
14 hydrologic balance in the Coonamesset Pond and the
15 portion of the river emanating from the pond; change
16 in the River's physical, chemical, biological
17 characteristics immediately down gradient from the
18 pond, which could alter its role as a passageway for
19 anadromous fish populations; and potential
20 interactions between the Coonamessett water supply
21 well and the proposed ETR systems, which will extract
22 comparable flow volumes from the groundwater.
23 Also, the Souza Conservation Area is a
24 pristine region which should not be disrupted.
25 And in regards to FS-29 we could not come

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1 to any consensus on a preferred option, especially in
2 light of the limited knowledge in regard to whether
3 this plume is actually in equilibrium and the
4 potential property access issues at Ballymeade.
5 MR. KARSON: Thank you.
6 MR. SOMOLOWITZ: Thank you, Mr. Chairman.
7 My name is Ronald Somolowitz. I own Coonamesset Farm
8 which abuts this Souza Conservation Area. My
9 comments will be regarding FS-28.
10 The farm is a 20-acre operation. It's not
11 as heavily populated as Lochstead. It's my wife
12 Roxanne and my son Joshua, three sheep, Delilah,
13 Zachariah, three goats and two alpaca.
14 I think that looking over all the
15 information and reading it, after discussion with the
16 folks that had showed up at my house regarding
17 Alternative 7, that I would strongly recommend
18 Alternative 3.
19 It meets all the criteria. It has all the
20 nice black circles. And I see no rush from a
21 timeframe standpoint on a need to clean up this
22 plume. It is -- this general area is not going to be
23 used as a water supply. It's not bothering anybody.
24 It is contained. And it will be cleaned up.
25 My biggest concern is the damage that's

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1 going to be done on Alternative 7 to the conservation
2 land to the east of my farm.
3 Already there's been an extensive amount of
4 damage over the last 10 years by contractors to the
5 military coming in there and sinking wells and laying
6 roads, clear -- cutting trees out of the way.
7 They've made a tremendous amount of roads. If
8 anybody goes in there, they're not official roads,
9 but they're cleared and they were for just well
10 trucks.
11 Your proposal, which is incomplete, because
12 it doesn't show the final construction that will be
13 necessary for this alternative to take place, which
14 is very large road going right up through that area
15 to allow large trucks to get in either the
16 construction of a facility or the construction of a
17 pipeline in addition to the three wells that are
18 marked.
19 So this will be a major construction
20 project that will ruin that conservation area in
21 perpetuity.
22 So I strongly urge that Alternative 3 be
23 the alternative that is considered. Thank you.
24 MR. KARSON: Thank you.
25 MS. VALIELA: I'm Virginia Valiela,

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1 Selectman in Falmouth.
2 I am a member of The Senior Management
3 Board for the Town of Falmouth. And I'm also The
4 Water Commissioner in Falmouth, one on The Board of
5 Selectmen. I want to strongly support Alternative 3
6 and I want to an oppose Alternative 6 and 7.
7 Alternative 3 captures 99.7 percent of the
8 plume, which is as close to a hundred percent as any
9 system I can think of.
10 Alternative 7 does no better. But
11 Alternative 7 has significant environmental impacts.
12 And I think they are very detrimental to the area.
13 The only benefit to it is a shorter timeframe. And
14 I'm going to come back to that point.
15 For the price of speed, we will
16 significantly alter a really beautiful section of
17 conservation land, woods in the town of Falmouth. It
18 is a woodland park. And I agree with the former
19 speaker, it's already been affected by roads that
20 have been put in there just for monitoring wells.
21 I do not think that it be should be altered
22 any further. Alternative 7 calls for extraction
23 wells along the pond. I believe that will stress the
24 Coonamessett River, which already has stress and flow
25 problems. I think that it has the potential to alter

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1 the hydrological dynamics around the Coonamessett
2 Well, which is a major water supply well for the
3 town. That is a risk I absolutely do not want to
4 take.
5 Even though the proposed extraction wells
6 are, I have been told, to be outside of the Zone 1 of
7 the Coonamessett Well, which is a 400-foot radius, I
8 understand that there will be piping to and from
9 those wells,, that will go through the Zone 1. And I
10 am very much opposed to that as well.
11 I think for a sense of proportion these
12 three extraction wells will take out about 600
13 gallons per minute. That's nearly 900,000 gallons a
14 day and the Coonamesset Well is a million gallons a
15 day, so we are, in effect, extracting water nearly
16 equal to the water supply well that is very close
17 by. I think that is a very unwise.
18 I note the recommendation of the SPAT for
19 Alternative 3. The Senior Management Board looks to
20 its teams for their advice and comment. I thought
21 they gave a very thorough analysis of Alternative 7,
22 and looking at the whole picture recommended
23 Alternative 3. I concur.
24 I think this whole process of public
25 comment and weighing is a critical process when you

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have such trade-offs, significant trade-offs as we do here. The reasonable timeframe of 18 -- of doing a shorter period of time, in this case really seems to me to be unreasonable and it is the longer timeframe which is Alternative 3 that we should go with.

As far as Fuel Spill 29, I believe that that should really continue to be monitored, but that there should be no active system constructed there. Again, that's a 600 gallon per minute system. It is an extremely dilute plume and it's actually in two pieces with clean water in between.

I think it will be difficult to capture in a meaningful way. I think you will be moving around a great deal of water, again, nearly a million gallons a day. And I don't see much gain for that.

The system of monitoring would allow us to revisit the issue if there should be further problem. Thank you for your time.

MR. KARSON: Thank you. Sir, did you have your hand up?

MR. KANTER: My name is Gene Kanter. I am a resident of Lochstead. I am a member of The Board. And I can do nothing more than say I agree with Naomi Litvin 100 percent, plus the other speakers that I have heard here this evening.

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But if I could just reiterate one point on FS-28 plume as it again relates to the Lochstead community.

If there was any plan to bring this hazardous material from below the ground up to the surface, I can only foresee somewhere in the distant future or immediate future once this is done a problem with pipes, leaks and hazardous material now on the surface.

So now there's got to be a second sub plan put into effect to get rid of the material that has yet to leach down into the ground to be pulled out again and now it's in a community where we have over 60 homes.

So to put the bottom line to it, Alternative 3 is certainly the way to go. You've from what I can see from all of your data and if I'm correct in remembering the numbers about 85 percent of the material in FS-28 is now past Lochstead. So to bring it back in and up seems to be ludicrous. Thanks.

MR. KARSON: Thank you. Anyone else wishing to give testimony tonight on The Proposed Plans -- yes, sir.

MR. SWARTZ: My name is David Swartz. I

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live in Lochstead, East Falmouth, Mass.

I need a moment of your time to address personal problems that have been brought to the floor because of the discussion of the various options.

I have multiple myeloma Waldenstrom's, a form of leukemia. I am on a clock. I have to the extent that if what just happened twice I had to be hospitalized I am immediately placed into a private room, because I have no immune system.

One of the reasons that we went into Lochstead was because of the regulations preventing individual homeowners like myself from using damaging -- back off for a minute -- from using chemicals that might be damaging to Coonamessett Pond.

None of us have private lawns. And I am asking you for in your considerations to allow me to have as much of a lifespan as I can have without these chemicals that will be or have the possibility of being a part of the atmosphere.

I also am a disabled veteran of the Air Force, World War 2, certified disability discharge. Thank you for your time.

MR. KARSON: Thank you, sir. Anyone else wishing to give testimony tonight? Yes, ma'am.

MS. THATCHER-HILL: I am Pat

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Thatcher-Hill. My husband Graham Hill and I live in Lochstead.

We also moved there because it is an environmentally conscious area. And we would like to go on record as voting for Alternative 3, definitely over Alternative 6. We don't see any justification for that at all. And preferably over Alternative 7 also.

MR. KARSON: Thank you. Anyone else wishing to give testimony tonight on The Proposed Plan? Yes.

MS. WALKER: My name is Susan Walker from Sandwich. And I'm on the Board of Directors of the Association for the Preservation for Cape Cod.

APCC Board of Directors at their Monday night meeting did discuss FS-28 in that we are concerned that Alternative 6 is unacceptable because of residential feeling about that particular plan.

We find Alternative 7 unacceptable because what it would do to the Souza Conservation Area and because of the impacts to the Coonamessett River.

Are we're concerned about fish and levels of the water in the river.

For that reason we support Alternative 3 but we find the amount of time for Alternative 3 to

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be unacceptable at 18 years. And we are hoping that AFCEE will come up with another alternative that everyone would find acceptable and that would be shorter than the 18 years.

We support Alternative 3 for FS-29, so that there's more of a clean up. Thank you very much.

MR. KARSON: Thank you. Anyone else wishing to give testimony tonight?

(No response.)

MR. KARSON: I would ask again, is there anyone here tonight that would like to give testimony on The Proposed Plan for FS-28 and 29?

(No response.)

MR. KARSON: Okay. Before I close the official record, I do want to point out and I forgot to do that earlier that we do have representation here not only from the Air Force but from the regulatory agencies Cathy Kiley from the State Department of Environmental Protection is here. And Mr. Bob Lim from the United States Environmental Protection Agency is here.

They've heard all the comments voiced here tonight. And all the written comments that were submitted tonight as well as the ones that come in

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during the comment period will also be shared with the regulatory agencies and fully considered and addressed later on in the Responsiveness Summary.

So I want to thank you all for coming tonight. And at this time I now close the official record for oral testimony. The record is now closed.

(Whereupon the deposition concluded at 7:24 p.m.)

1 CERTIFICATE
2
3 I, MARY E. PHILLIPS, Registered Professional
4 Reporter, do hereby certify that the foregoing transcript,
5 pages 2 through 25 inclusive, was taken by me
6 stenographically and thereafter under my direction was
7 reduced to typewriting and is a true record of the testimony
8 of the proceedings to the best of my ability.
9
10
11 Dated at Bourne, Massachusetts, this 28th
12 day of March, 2000.
13
14
15
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17
18
19
20
21 MARY E. PHILLIPS, RPR
22
23
24
25

APPENDIX E

Full Text of Written Formal Comments

Available in the Administrative Record File
at the Installation Restoration Program (IRP) Office
322 East Inner Road
Otis ANGB, MA 02542-5028
(508) 968-4678 Ext. 4678

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Letter from Fay and Jack Tepper dated February 15, 2000
Letter from Janet and John J. Kelley, Jr. dated February 15, 2000
Letter from Warren H. and Violet Bree dated February 15, 2000
Letter from Barry and Sandy Levitt dated February 18, 2000
Letter from Kevin H. and Amy S. Mulvey dated February 21, 2000
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Letter from Kathleen A. and Jack R. Foreman, Jr. dated February 23, 2000
Letter from Mitchell C. and Carol O. Kur dated February 24, 2000
Proposed Plan Comment Form from James Burns received on February 24, 2000
Letter from Mrs. Herbert R. Field received February 25, 2000
Letter from Graham K. Hill and Patricia Thatcher-Hill dated February 27, 2000
Letter from the Lochstead Association dated March 2, 2000 and signed by Naomi G. Litvin, President of the Lochstead Association Board of Trustees. Included are the following exhibits:
- Exhibit 1: Letter from the Air Force Center for Environmental Excellence dated March 1, 1999
- Exhibits 2a and 2b: Letters from the Lochstead Association dated March 9, 1999 and April 2, 1999
- Exhibits 3a, 3b, and 3c: Letters from the Lochstead Association dated May 3, 1999, July 14, 1999, and September 30, 1999
- Exhibits 4a through 4hh: Letters from Lochstead residents
- Exhibit 5: Petition signed by Lochstead residents concerning alternatives for remediation of the FS-28 plume (approximately 102 individuals)

Letter from the Consensus Building Institute Inc. dated March 2, 2000 signed by Patrick Field, and containing recommendations from the Joint Process Action Team
Email message from David Potter, Chairman, Falmouth Conservation Commission sent March 2, 2000
Written comments from the Cape Cod Group Sierra Club presented by their treasurer David D. Dow at the March 2, 2000 public hearing
Note from Deborah B. McIntosh dated March 2, 2000
Email message from Richard Hugus sent March 3, 2000
Letter from Delores G. Backe dated March 3, 2000
Letter from Linda R. Hirshman received March 3, 2000
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Letter from Donna Dupee Jewett dated March 10, 2000
Email from the Massachusetts Military Reservation Natural Resource Trustee Council dated March 10, 2000
Letter from Charles S. Innis, Jr. dated March 15, 2000
Typed notes from Joel Feigenbaum and Richard Hugus responding to questions from Patrick Field dated March 15, 2000
Letter from Phyllis and Howie Cohen dated April 4, 2000
Letter from A. William Rhodes dated April 7, 2000
Letter from Elizabeth K. Leavey dated April 21, 2000
Letter from the Lochstead Association dated April 21, 2000 and signed by Naomi G. Litvin, President, Lochstead Association Board of Trustees
Letter from the Massachusetts Military Reservation Natural Resources Trustee Council dated April 25, 2000