Superfund Records Center
SITE: Iron Horse Park OU3
BREAK: 4.6
OTHER: 204929

EPA Contract No. 68-W6-0042
EPA Work Assignment No. 029-RICO-0157

EPA Project Officer: Diana King
EPA Remedial Project Manager: Donald McElroy

# FEASIBILITY STUDY

# FINAL REPORT

## Volume I
## Text

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, Massachusetts

March 2003

Metcalf & Eddy

SDMS DocID 000204929

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## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AHPA | Archaeological and Historical Preservation Act |
| AOC | Area Of Concern |
| ARAR | Applicable or Relevant and Appropriate Requirements |
| ARCS | Alternative Remedial Contracting Strategy |
| AWQC | Ambient Water Quality Criteria |
| BACT | Best Available Control Technology |
| BOD | Biochemical Oxygen Demand |
| BTEX | Benzene, Toluene, Ethylbenzene, And Xylene |
| CAA | Clean Air Act |
| CAG | Carcinogenic Assessment Group |
| CERCLA | Comprehensive Environmental Response, Compensation, And Liability Act |
| CFR | Code of Federal Regulations |
| CMR | Code of Massachusetts Regulations |
| COC | Contaminants of Concern |
| COD | Chemical Oxygen Demand |
| CWA | Clean Water Act |
| DCA | Dichloroethane |
| DCE | Dichloroethylene |
| DNAPL | Dense Non-aqueous Phase Liquids |
| DOT | Department of Transportation |
| EPA | Region I Environmental Protection Agency |
| ERL | Effects-Range Low |
| ERM | Effects-Range Median |
| FS | Feasibility Study |
| GAC | Granulated Activated Carbon |
| HMTA | Hazardous Materials Transport Act |
| HSL | Hazardous Substance List |
| HSWA | Hazardous and Solid Waste Amendments |

## ACRONYMS AND ABBREVIATIONS (continued)

| | |
|---|---|
| IRIS | Integrated Risk Information System |
| IWPA | Interim Wellhead Protection Area |
| LDPE | Low Density Polyethylene |
| LEL | Lowest Effect Level |
| LNAPL | Light Non-aqueous Phase Liquids |
| MADEP | Massachusetts Department Of Environmental Protection |
| MBTA | Massachusetts Bay Transportation Authority |
| MCL | Maximum Contaminant Level |
| MCLG | Maximum Contaminant Level Goal |
| MCP | Massachusetts Contingency Plan |
| MHC | Massachusetts Historical Commission |
| M&E | Metcalf & Eddy |
| NAAQS | National Ambient Air Quality Standards |
| NAPL | Non-aqueous Phase Liquids |
| NCP | National Contingency Plan |
| NESHAP | National Emission Standards for Hazardous Air Pollutants |
| NHPA | National Historical Preservation Act |
| NOAA | National Oceanic and Atmospheric Administration |
| NPDES | National Pollutant Discharge Elimination System |
| NSPS | New Source Performance Standards |
| OMEE | Ontario Ministry of Environment and Energy |
| ORS | (Massachusetts) Office of Research Standards |
| ORSG | Office of Research Standards Guidelines |
| OU | Operable Unit |
| PAH | Polynuclear Aromatic Hydrocarbons |
| PCB | Polychlorinated Biphenyls |
| PCE | Perchloroethylene |
| POTW | Publicly Owned Treatment Works |

## ACRONYMS AND ABBREVIATIONS (continued)

| | |
|---|---|
| PRB | Permeable Reactive Barrier |
| PRG | Preliminary Remediation Goal |
| RACS | Response Action Contract Services |
| RAO | Remedial Action Objective |
| RCRA | Resource Conservation and Recovery Act |
| RI | Remedial Investigation |
| ROD | Record of Decision |
| SARA | Superfund Amendments and Reauthorization Act |
| SDWA | Safe Drinking Water Act |
| SEL | Severe Effect Level |
| SQB | Sediment Quality Benchmarks |
| SQC | Sediment Quality Criteria |
| S/S | Stabilization/Solidification |
| SVOC | Semi-volatile Organic Compounds |
| TBC | To be considered |
| TCA | Trichloroethane |
| TCE | Trichloroethylene |
| TLV | Threshold Limit Values |
| TSDF | Treatment, Storage, or Disposal Facility |
| TSS | Total Suspended Solids |
| VOC | Volatile Organic Compounds |

# EXECUTIVE SUMMARY

A feasibility study (FS) was conducted by Metcalf & Eddy (M&E) for the Iron Horse Park Superfund Site, Operable Unit 3 (OU3) (the "Site") located in North Billerica, Massachusetts. The goal of the feasibility study was to provide the U.S. EPA Region I with an evaluation of remedial alternatives and process options potentially applicable for the Site and to serve as technical support for the writing of the Record of Decision (ROD). To accomplish this goal, the feasibility study was conducted to: establish public health and ecological remedial action objectives; identify and screen potential treatment and containment technologies; and develop and evaluate in detail several remedial alternatives that provide varying degrees of protection and control. The primary objective of this FS is to develop and evaluate appropriate remedial options to control the sources and migration of contaminants that pose risk to human health or the environment.

Areas of concern (AOCs) in OU3 consist of the B&M Railroad Landfill, the B&M Shop Disposal Areas (A and B), the RSI Landfill, the Old B&M Oil/Sludge Recycling Area, the Contaminated Soils Area, the asbestos contamination areas (including the Asbestos Landfill and the Asbestos Lagoons), and Surface Water and Sediment contamination by wetland group (West Middlesex, Wetland 2, East Middlesex, Richardson Pond, and Content Brook). Media of concern included surface soil, groundwater, surface water, and sediment. Contaminants detected most frequently on site included volatiles, semi-volatiles, pesticides, PCBs, and metals.

The first phase of the feasibility study was the development of the remediation criteria. In this phase, remedial action objectives were developed to address baseline ecological and human health risks posed by exposure to site contaminants. The primary contaminants posing human health risks are lead in soil (for adult site workers) and inorganics in groundwater (for residents) via the ingestion pathway. Risks were not evaluated for soil exposures to young children, except for the Old B&M Oil/Sludge Recycling Area. For ecological receptors, the compounds posing risk include metals, poly-aromatic hydrocarbons (PAHs), and pesticides. The exposure pathways

include: ingestion and dermal contact for soil invertebrates; ingestion of soil and prey for small mammals; exposure of aquatic receptors to surface water; exposure of benthic invertebrates to sediments; and exposure of birds to the aquatic environment. Applicable or relevant and appropriate requirements (ARARs) of federal, state, and local public health authorities pertinent to the implementation of remedial alternatives were also identified.

During the second step of the feasibility study, potential treatment and containment technologies were identified and screened. Remedial measures encompassing institutional controls, management of migration, source control, collection, in-situ treatment, on-site treatment, and off-site treatment were identified and screened for feasibility of application to Site conditions.

Seventy-two site-wide alternatives were developed and evaluated for effectiveness, implementability, and cost in the screening process. Innovative technologies were considered as part of several alternatives. Quantitative factors were developed for effectiveness and implementability and divided by the total costs (capital plus present worth operation and maintenance) resulting in an environmental benefit-to-cost ratio for each alternative. This ratio was used to select fifteen alternatives listed below that would undergo detailed evaluation.

Alternative #1 - "No Action"
Alternative #3 - "Institutional Action"
Alternative #5 - "Limited Action":
Alternative #8 - "Threshold Effectiveness"
Alternative #15 - "Source Control A"
Alternative #18 - "Source Control B"
Alternative #27 - "Sediment Source Control"
Alternative #31 - "Off-Site Action"
Alternative #43 - "Balanced Remedial Action"
Alternative #46 - "Intensive Remedial Action A"
Alternative #48 - "Intensive Remedial Action B"

Alternative #51 - "Focused Treatment and Remedial Action A"
Alternative #59 - "Focused Treatment and Remedial Action B"
Alternative #67 - "Focused Treatment and Remedial Action C"
Alternative #72 - "Maximum Remedial Action:".

These fifteen alternatives were evaluated in detail based on overall protection of human health and the environment, compliance with ARARs, long-term effectiveness, implementability, reduction of toxicity, mobility, and volume, short term effectiveness, and cost. In order for an alternative to be considered for the ROD, it must at a minimum achieve the first two criteria: overall protection of human health and the environment and compliance with ARARs (although an ARARs waiver may be obtained in very limited circumstances). Table ES-1, Abbreviated Comparative Analysis of the Remedial Alternatives, presents a summary of the primary evaluation factors and a comparative assessment of the 15 alternatives.

Alternatives #1, 3, and 5 fail to meet the threshold criteria for ROD consideration. Alternatives #8, 15, 18, 27, 31, 43, 51, 59, and 67 are protective of human health through treatment or institutional controls, but they do not address potential risk to off-site human receptors from groundwater contamination. For alternatives # 46, 48, and 72, potential risk to off-site receptors will be minimal, since groundwater will be contained. Alternatives #8, 15, 18, 31, 43, 46, 51, 59, and 67 will be partially protective of the environment. Alternatives #27, 48, and 72 will be protective of the environment, since controls are included to remove exposures to contamination in surface soils, surface water and sediments. While none of the alternatives meets all the ARARs, Alternatives #27, 31, 43, 46, 48, 51, 59, 67, and 72 comply with all except those related to groundwater protection. This is due to the calculation that none of the alternatives can attain groundwater criteria within a "reasonable time period." The groundwater remedy proposed for this Site may require a waiver as the groundwater underlying the Site is classified as a potential drinking water source, and it may be technically impractical to attain drinking water standards for inorganics and some pesticides. The requirements that cannot be attained under any scenario are:

- Hazardous/Solid Waste Management – Groundwater Protection, 310 CMR 30.660-675; 310 CMR 19.110 and
- Groundwater Quality Standard, 314 CMR 6.00.

Alternatives #46, 48, and 72 provide long-term effectiveness and permanence against detrimental human health effects. Alternatives #27, 48, and 72 provide long-term effectiveness and permanence against detrimental environmental effects.

Alternatives #8, 15, 18, 27, 31, 43, 46, 48, 51, 59, 67, and 72 would result in short-term risks to human health and the environment, as a result of invasive work at the waste disposal area. However, actions could be taken to mitigate these risks. Based on groundwater modeling results, it is estimated that the time to remediate most site contaminants in the overburden and bedrock groundwater will far exceed 30 years. This estimate also applies to Alternatives #46, 48, and 72, where on-site groundwater treatment will be employed. High retardation factors for many of the contaminants of concern will result in high constituent travel times and, therefore, longer time periods for reduction of source concentrations.

Engineering controls for Alternatives #3, 5, 8, 18 , 31, 43, 51, and 67 are commonly applied or readily available. Innovative or less common technologies included in Alternatives #15, 27, 46, 48, 59 and 72 would contribute to an increase in the complexity of implementation for these alternatives.

There is an intricate set of implementability issues with regard to mitigation of wetland impacts for all alternatives but particularly for Alternatives #27, 48, and 72 which contain the most aggressive sediment remedies. Mitigation of impacts to wetlands from remediation efforts will require comprehensive soil erosion, run-off and sedimentation control measures to minimize siltation impacts to wetlands and surface water bodies. An experienced wetlands contractor/restoration specialist will be required for restoration and/or replication of wetland, stream and pond areas impacted by construction activities.

The total costs (capital plus net present worth O&M over the duration of the remedial action) for the fourteen alternatives with action ranges from $34.2 million to $247.1 million. Costs for the fifteen alternatives are listed below.

- Alternative #1 total cost $0
- Alternative #3 total cost $34.2 million
- Alternative #5 total cost $36.1 million
- Alternative #8 total cost $82.8 million
- Alternative #15 total cost $184.9 million
- Alternative #18 total cost $68.8 million
- Alternative #27 total cost $175.7 million
- Alternative #31 total cost $79.6 million
- Alternative #43 total cost $70.0 million
- Alternative #46 total cost $109.0 million
- Alternative #48 total cost $129.9 million
- Alternative #51 total cost $77.8 million
- Alternative #59 total cost $101.8 million
- Alternative #67 total cost $121.7 million
- Alternative #72 total cost $247.1 million

During detailed evaluation of alternatives, groundwater modeling was performed to determine relative times to achieve remedial action objectives (RAOs) for groundwater cleanup. The approach included applying a groundwater flow model, a particle tracking model, a pore flushing solution, and a screening-level natural attenuation model. The goal of the modeling effort was to compare times to reach RAOs at each AOC for the proposed groundwater remedial actions, varying from monitored natural attenuation to vertical flow barriers and pump-and treat systems and not to predict remediation times of each alternative.

Results of the groundwater modeling indicated that in most cases, the times to achieve RAOs were much greater than the EPA default evaluation time of 30 years. In fact, in may cases, the times were significantly greater than 200 years due to persistent contaminants which do not degrade easily or at all (e.g., inorganics).

As a result of these conclusions from the modeling, EPA has elected to address potential

groundwater exposures by performing source control measures. Groundwater will be monitored to determine if there are any contaminant concentration or migration trends. Unless evaluations show the need, active groundwater remediation is not anticipated to be utilized.

A comparative analysis evaluating the relative performance of each technology/process option versus the nine criteria by AOC was conducted. The process options by AOC and media are presented below.

**B&M Railroad Landfill.** The only media of concern was soil. The technologies/process options for remediation of soil include:

- No Action;
- Inst. Action - Institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures) as well as monitoring;
- InSitu-1 - In-situ remedy of monitored natural attenuation and institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures) as well as monitoring;
- SC-1 - Source control remedy consisting of horizontal containment (*i.e.*, cap).

**RSI Landfill.** Risk limits were not exceeded at this AOC for soil. However, capping (SC-1) as part of source control for groundwater has been established as a technology/process option for remediation in this area, along with the No Action option.

**B&M Locomotive Shop Disposal Areas.** The only media of concern was soil. The technologies/process options for remediation of soil include:

- No Action;
- Inst. Action - Institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures) as well as monitoring;
- InSitu-1 - In-situ remedy of monitored natural attenuation and institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures) as well as monitoring;
- SC-1 - Source control remedy consisting of horizontal containment (*i.e.*, cap).
- SC-2 - Source control remedy consisting of soil/waste excavation and placement

under caps at other on-site AOCs;

- OnSite-1 - Remedy consisting of soil/waste excavation and on-site treatment via solidification/stabilization;
- OnSite-2 - Remedy consisting of soil/waste excavation and on-site treatment via soil washing/chemical extraction.

**Old B&M Oil/Sludge Recycling Area.** The only media of concern was soil. The technologies/process options for remediation of soil include:

- No Action;
- Inst. Action - Institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures) as well as monitoring;
- InSitu-1 - In-situ remedy of monitored natural attenuation and institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures) as well as monitoring;
- SC-1 - Source control remedy consisting of horizontal containment (*i.e.*, cap).
- SC-2 - Source control remedy consisting of soil excavation and placement under caps at other on-site AOCs;
- OnSite-1 - Remedy consisting of soil excavation and on-site treatment via solidification/stabilization;
- OnSite-2 - Remedy consisting of soil excavation and on-site treatment via soil washing/chemical extraction.

**Contaminated Soils Area.** The only media of concern was soil. The technologies/process options for remediation of soil include:

- No Action;
- Inst. Action - Institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures) as well as monitoring;
- InSitu-1 - In-situ remedy of monitored natural attenuation and institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures);
- InSitu-2 - In-situ remedy consisting of solidification/stabilization and access restrictions (*i.e.*, institutional controls) as well as monitoring;
- InSitu-3 - In-situ remedy consisting of soil flushing, enhanced biodegradation, and access restrictions (*i.e.*, institutional controls) as well as monitoring;
- SC-1 - Source control remedy consisting of horizontal containment (*i.e.*, cap).
- Off Site - Remedy consisting of soil excavation and off site treatment/disposal;
- OnSite-1 - Remedy consisting of soil excavation and on-site treatment via solidification/stabilization;
- OnSite-2 - Remedy consisting of soil excavation and on-site treatment via soil washing/chemical extraction.

**Asbestos Landfill.** The only media of concern was soil. The technologies/process options for remediation of soil include:

- No Action;
- Inst. Action - Institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures) as well as monitoring.

**Asbestos Lagoons.** The only media of concern was soil. The technologies/process options for remediation of soil include:

- No Action;
- Inst. Action - Institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures) as well as monitoring;
- SC-1 - Source control remedy consisting of horizontal containment (*i.e.*, cap);
- SC-2 - Source control remedy consisting of soil excavation and placement under caps at other on-site AOCs.

**West Middlesex Canal Group.** The only media of concern was sediment. The technologies/process options for remediation of sediment include:

- No Action;
- Inst. Action - Institutional actions consisting of monitoring;
- InSitu - In-situ remedy of monitored natural attenuation;
- SC-2 - Source control remedy consisting of sediment excavation and placement under caps at other on-site AOCs along with monitored natural attenuation of remaining sediments.

**Wetland 2 Group**. The technologies/process options for remediation of sediment include:

- No Action;
- Inst. Action - Institutional actions consisting of monitoring;
- InSitu - In-situ remedy of monitored natural attenuation;
- SC-1 - Source control remedy consisting of horizontal containment (*e.g.*, natural or engineered cap) along with monitored natural attenuation of remaining sediments;
- SC-2 - Source control remedy consisting of sediment excavation and placement under caps at other on-site AOCs along with monitored natural attenuation of

remaining sediments;

- SC/Off Site - Remedy consisting of sediment excavation and off site treatment/disposal along with monitored natural attenuation of remaining sediments;
- SC/OnSite-1 - Remedy consisting of sediment excavation and on-site treatment via solidification/stabilization along with monitored natural attenuation of remaining sediments;
- SC/OnSite-2 - Remedy consisting of sediment excavation and on-site treatment via sediment washing/chemical extraction along with monitored natural attenuation of remaining sediments.

**Wetland 2 Group.** The technologies/process options for remediation of surface water include:

- No Action;
- Inst. Action - Institutional actions consisting of monitoring;
- InSitu - In-situ remedy of monitored natural attenuation;
- OnSite-1 - Remedy consisting of surface water collection and treatment via phytoremediation, along with monitored natural attenuation of remaining surface water;
- OnSite-2 - Remedy consisting of surface water collection and treatment via biological/physical/chemical methods, along with monitored natural attenuation of remaining surface water.

**East Middlesex Canal Group.** The only media of concern was sediment. The technologies/process options for remediation of sediment include:

- No Action;
- Inst. Action - Institutional actions consisting of monitoring;
- InSitu - In-situ remedy of monitored natural attenuation;
- SC-2 - Source control remedy consisting of sediment excavation and placement under caps at other on-site AOCs along with monitored natural attenuation of remaining sediments.

**Richardson Pond Group**. The technologies/process options for remediation of sediment include:

- No Action;
- Inst. Action - Institutional actions consisting of monitoring;
- InSitu - In-situ remedy of monitored natural attenuation;
- SC-2 - Source control remedy consisting of sediment excavation and placement under caps at other on-site AOCs along with monitored natural attenuation of

remaining sediments.

**Richardson Pond Group**. The technologies/process options for remediation of surface water include:

- No Action;
- Inst. Action - Institutional actions consisting of monitoring;
- InSitu - In-situ remedy of monitored natural attenuation;

**Content Brook Wetland Group.** The technologies/process options for remediation of sediment include:

- No Action;
- Inst. Action - Institutional actions consisting of monitoring;
- InSitu - In-situ remedy of monitored natural attenuation;
- SC-2 - Source control remedy consisting of sediment excavation and placement under caps at other on-site AOCs along with monitored natural attenuation of remaining sediments;
- SC/Off Site - Remedy consisting of sediment excavation and off site treatment/disposal along with monitored natural attenuation of remaining sediments;
- SC/OnSite-1 - Remedy consisting of sediment excavation and on-site treatment via solidification/stabilization along with monitored natural attenuation of remaining sediments;
- SC/OnSite-2 - Remedy consisting of sediment excavation and on-site treatment via soil washing/chemical extraction along with monitored natural attenuation of remaining sediments.

**Content Brook Wetland Group**. The technologies/process options for remediation of surface water include:

- No Action;
- Inst. Action - Institutional actions consisting of monitoring;
- InSitu - In-situ remedy of monitored natural attenuation;
- OnSite-1 - Remedy consisting of surface water collection and treatment via phytoremediation, along with monitored natural attenuation of remaining surface water;
- OnSite-2 - Remedy consisting of surface water collection and treatment via biological/physical/chemical methods, along with monitored natural attenuation of remaining surface water.

An abbreviated comparative analysis of remedial options by media and area of concern for the threshold criteria and costs is presented in Table ES-2.

# SECTION 1.0
# INTRODUCTION

This document is a comprehensive and interpretive feasibility study report prepared as part of the remedial investigation/feasibility study (RI/FS) conducted at the Iron Horse Park Superfund Site operable unit 3 (OU3), for Region I of the U.S. Environmental Protection Agency (EPA). The work was conducted by Metcalf & Eddy (M&E) under EPA's Alternative Remedial Contracting Strategy (ARCS) and Response Action Contract (RAC) programs.

The feasibility study (FS) was undertaken utilizing the remedy selection process with the goal of selecting remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste (40 CFR §300.430(a)(1)(i)). The preliminary objective of the FS is to develop and evaluate appropriate remedial action options for controlling the sources of contamination as an initial response action, and to propose a subsequent final set of options in response to the Site's impact to local groundwater and surface water. The initial sections (Section 1.0 through 4.0) of the FS report describe the process used to develop 72 preliminary alternatives and to select fifteen alternatives for detailed evaluation. In Section 5.0, a detailed evaluation of these fifteen alternatives is presented and a comparative analysis of these selected alternatives is presented in Section 6.0. EPA is the lead agency and decision-maker for the Iron Horse Park Superfund Site.

## 1.1 SITE STUDY AREA

Due to the large size of the Iron Horse Park Superfund Site (greater than 500 acres) and the number of potential source areas, a phased operable unit approach was undertaken to select remedies for each identified source area. The intent of this approach is to remediate the Site more effectively by establishing priorities for potential source areas and then conducting a separate but overlapping RI on each designated source area or "operable unit," rather than attempting to remediate all source areas simultaneously (NUS, 1983).

As a result of the Phase 1A RI, areas of concern identified at the Site were divided into three operable units: the B&M Wastewater Lagoons (operable unit 1), the Shaffer Landfill (operable unit 2), and the remaining areas of concern (operable unit 3) including the B&M Railroad Landfill, B&M Locomotive Shop Disposal Areas (A and B), the Reclamation Services Inc. (RSI) Landfill, the Old B&M Oil/Sludge Recycling Area, the Contaminated Soils Area, the Asbestos Landfill, the Asbestos Lagoons, and Site-Wide Surface Water and Sediment Contamination. Operable unit 3 is addressed in this FS.

The area of study evaluated during the RI (M&E, 1997) included not only the applicable portions of the Site, but also surrounding areas and water bodies that are potentially affected by operable unit 3 (the 3rd operable unit). For this reason, the entire study area evaluated during the RI is referred to throughout this report as "the Site." Figure 1-1 shows the area of study evaluated during the RI.

A hydrogeological report prepared by Metcalf & Eddy (1994a) provided a preliminary evaluation of groundwater flow direction at the Site. In addition, groundwater screening results and soil boring results were discussed. Findings in the hydrogeological report indicated the potential for groundwater contamination at the Site in several source areas. To evaluate groundwater, additional field work was conducted to install monitoring well clusters up and down gradient of each source area for evaluation of potential groundwater contamination by area.

## 1.2 SITE BACKGROUND

This section identifies previous investigations and summarizes information describing the Site and its history. Information presented in this section was summarized from the Phase 1A RI report (CDM, 1987), the CDM memorandum report (CDM, 1989a), and the EPA's Statement of Work for the 3rd operable unit (U.S. EPA, 1992).

### 1.2.1 Site Description

The Site occupies approximately 553 acres of land in North Billerica, Massachusetts, near the Tewksbury town line, approximately 20 miles northwest of Boston (Figure 1-1). The Site is bounded on the north by the B&M railroad tracks, on the west by High Street and an auto salvage yard, on the east by Gray Street, and on the south by a wetland, Pond Street, and the Middlesex Canal (Figure 1-2). The Middlesex Canal flows through the Site to the east, where it joins Content Brook at the southeastern edge of the Shaffer landfill. There are abundant wetlands at the Site.

The Site contains an active industrial complex, called the Iron Horse Industrial Park, and a rail yard with a long history of activities that have resulted in contamination of soils, groundwater, surface water, and air. The Site includes numerous manufacturing operations, open storage areas, landfills, and lagoons, some of which began operating in the early 1900s. Changes in physical characteristics of the Site have occurred during the years of operation, due to the operation and expansion of several landfills, open storage areas, and lagoons. Contaminants known to have been disposed of at the Site include asbestos, polychlorinated biphenyls (PCBs), solvents, waste oils, and other chemicals (CDM, 1987) and are discussed in section 1.2.2 in relation to the areas of concern.

### 1.2.2 Site History

The 553 acres of land that now make up the Site were first purchased by the B&M Railroad (now known as B&M Corporation) in 1911. Prior to that year, the Site consisted of approximately 18 privately owned parcels that B&M Corporation consolidated. Land-use records for these parcels prior to 1911 were not recorded in the county or town archives, according to the Middlesex County Registry of Deeds and the Billerica assessors' office. However, since 1911, a variety of industrial disposal practices have resulted in the creation of numerous lagoons, landfills, and open storage areas which complicate the process of delineating the origin and nature of the current contamination problems. Table 1-1 provides a chronology of activities at the Site.

The B&M Railroad has conducted operations at the Site since 1913, including the operation of an oil and sludge recycling area beginning sometime prior to 1938. At various times over the years, the B&M Corporation has sold or leased several parcels of the land and some of the buildings on the Site to various companies. At the present time, the B&M Corporation's on-site facilities and operations include administrative offices, a locomotive/railroad car maintenance and repair facility, track panel fabrication, and rail welding.

The B&M Railroad has operated the Site's sewage collection system since 1924. The system includes subsurface sewer lines, a dismantled pump house, two unlined filter lagoons (approximately 104 feet by 200 feet by 4 feet), and one overflow lagoon (these wastewater lagoons are operable unit 1). These lagoons received septic waste from B&M facilities and other manufacturing facilities throughout the park. In addition to septic wastes, the lagoons also received industrial/hazardous wastes such as solvents, waste oils, and other chemicals from various floor and yard drains found throughout the industrial park. Sludge from the bottom of these lagoons was periodically dredged during the past 60 years of operation and deposited in piles adjacent to the lagoons.

Prior to 1981, large quantities of hazardous wastes were discharged directly to these wastewater lagoons. After 1981, much of the hazardous waste generated at the Site was disposed of off site at RCRA-permitted treatment, storage, and disposal facilities, in compliance with state and federal hazardous waste regulations. However, wastes from various cleaning and repair operations may have been discharged directly to the lagoons through floor and yard drains (CDM, 1987). The sewage collection system no longer discharges to the lagoons but has been tied into the Billerica sewer system.

In 1944, the B&M Railroad sold approximately 70 acres of land in the western portion of the Site to Johns-Manville Products Corporation, which at that time began to manufacture structural insulating board that contained asbestos. Three unlined lagoons were built to dispose of the resulting asbestos sludge waste. At approximately the same time, the B&M Railroad leased approximately 15 acres of land in the eastern portion of the Site to Johns-Manville to be used as a landfill for asbestos sludge and other asbestos mill wastes generated by their manufacturing operations. EPA capped this landfill

in 1984 as part of an "Immediate Removal Action" under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

In 1961, the Johns-Manville Products Corporation sold the western portion of its land to the General Latex and Chemical Corporation, which manufactured acrylic and vinyl acetate polymers and copolymers used in fabrics, paper, and insulation. Latex and polymerization wastes were treated on site using flocculation, coagulation, and sand filters, producing a filter cake that was disposed of off site at a sanitary landfill. The liquid filtrate was discharged to the ground through sand filters. This practice was discontinued in May 1982, when General Latex was connected to the Billerica sewer system.

Aerial photographs indicate that, by 1952, B&M Railroad began to fill in the wetland area located just east of the rail yard, on the north side of the Middlesex Canal (west of Pond Street), as reported by CDM (1989a). The photographs also indicate that another wetland area owned by the B&M Railroad, located on the east side of Pond Street, was also being filled in. In 1961, the B&M Railroad sold a 23-acre parcel of land containing the oil and sludge recycling area to Omega Trust. In 1962, the B&M Corporation sold approximately 1.2 acres of land and an existing building to Wood Fabricators, Inc. In 1966, the B&M Corporation sold an additional 0.67 acres of land to Wood Fabricators, Inc.

In 1966, the B&M Corporation sold 106 acres of land north of the Middlesex Canal and east of Pond Street to Phillip Shaffer as the Trustee of Gray Pond Realty Trust. This land later became the Shaffer Landfill and is currently the second operable unit of the Site. Prior to 1966, this parcel of land had been used for open burning operations with approval from the Billerica Board of Health. The area was originally a flat wetland area, but it was mostly filled in by 1966. From 1966 to 1968, burning practices continued until the Billerica Board of Health issued regulations in 1968 stating that no further burning could take place. The regulations also required that all refuse be placed above the water table and that daily cover be applied. After that time the area was used as a landfill, referred to as the Shaffer Landfill, and operated by Middlesex Disposal Services, Inc. This landfill received commercial and residential waste materials from private clients, wastewater treatment sludge from the town of Billerica, and domestic waste from Billerica residents. The Shaffer Landfill has been cited for many

violations of federal and state regulations under the Clean Water Act and the Solid Waste Regulations (CDM, 1987). In compliance with a state court order, the landfill stopped receiving waste of any kind in April 1986. More recently, the Massachusetts Department of Environmental Protection (MADEP) has completed interim operation and maintenance (post-closure) at the landfill and at the present time, the Potentially Responsible Parties (PRPs) have nearly completed construction of the remedy for the landfill.

Aerial photographs taken in 1969 indicate that landfill areas located in the central portion of the Site were expanding significantly during that period. These areas included the B&M land being used by Johns-Manville for disposal of asbestos waste, the B&M Railroad landfill north of the Middlesex Canal (west of Pond Street) being used by B&M to dump various kinds of materials, and the Shaffer Landfill. Also according to 1969 aerial photographs, the B&M Railroad Corporation was using a parcel of land located just east of the rail yard on the south side of the Middlesex Canal as a borrow pit for sand and gravel. This borrow pit area was subsequently leased by B&M Corporation to Reclamation Services, Inc., (RSI) for use as a landfill to dispose of municipal and light industrial waste. Aerial photographs taken in 1976 indicate that the expansion of the existing landfill areas had slowed or stopped and that vegetative cover had returned in portions of each landfill.

In 1973, the land containing the Old B&M Oil/Sludge Recycling Area, previously owned by the B&M Corporation, was sold by Omega Trust to the Penn Culvert Company. An aerial photograph taken in 1979 shows that the Old B&M Oil/Sludge Recycling Area, now located on Penn Culvert property, had been cleared, leveled, and filled. The area was formerly a partially paved lot and used as a storage area by Penn Culvert. The current owner, Cooperative Reserve Supply, Inc. is redeveloping the property for use as a timber storage facility.

In 1976, the B&M Corporation sold approximately 150 acres of primarily developed land to the Massachusetts Bay Transportation Authority (MBTA), which has since used the land to operate passenger rail service. The B&M Corporation now leases much of this land from the MBTA.

The B&M Corporation currently owns approximately 100 acres of the Site. Other current landowners and operating companies at the Iron Horse Industrial Park include: MBTA, General Latex, Penn Culvert, Spincraft, Wood Fabricators, BNZ Materials, and Eastern Terminals, Inc. (Figure 1-3).

Historical sampling data for groundwater, surface soil, subsurface soil, surface water, and sediment from nine potential source areas within the Site has indicated the presence of contaminants (CDM, 1987). The CDM memorandum report (CDM, 1989a) describes the current understanding of the Site and addresses concerns associated with the different operable units that were identified in the Phase 1A RI report (CDM, 1987).

The following sections briefly describe contamination previously detected at the areas of concern and in the site-wide surface water and sediment, all of which together comprise the 3rd operable unit (Figure 1-2). The descriptions were written using sections and excerpts from the CDM memorandum report (CDM, 1989b) and from the Statement of Work (SOW) for this assignment (U.S. EPA, 1992). These areas include: the B&M Railroad Landfill, the B&M Locomotive Shop Disposal Areas (A and B), the RSI Landfill, the Old B&M Oil/Sludge Recycling Area, the Contaminated Soils Area, the Asbestos Contamination Areas (including the Asbestos Landfill and Asbestos Lagoons), and Site-Wide Surface Water and Sediment Contamination.

**1.2.2.1 B&M Railroad Landfill.** The B&M Railroad landfill is approximately 14 acres in size and is located in a wetland area, north of the Middlesex Canal and east of the rail yard. The wetland was filled in by the B&M Railroad and used to dispose of various kinds of debris. CDM (1987) observed that this area contains partially buried drums and railroad ties with creosote. Soil samples from this area were not collected during the Phase 1A RI. Surface water and sediment samples were analyzed from two locations in the Middlesex Canal (which borders the area), and the results indicated no detectable levels of contaminants. However, a cluster of groundwater monitoring wells (OW-49/50/51) located on the eastern edge of this wetland revealed detectable levels of volatile organic compounds (VOCs) in the bedrock well (90 ppb) and the deep overburden well (6 ppb).

**1.2.2.2 RSI Landfill.** The 6-acre RSI Landfill, located east of the B&M rail yard near the Johns-Manville Asbestos Landfill, is bounded on the south by an unnamed brook and on the east by a wetland, which the Middlesex Canal drains. This area was used by B&M as a borrow pit for sand and gravel sometime between 1961 and 1969.

The land beneath the RSI Landfill was leased by the B&M Corporation to RSI for a period of three months (from June of 1971 until August of 1971) because of a fire at the RSI plant in Cambridge, Massachusetts. During the fire, some compacted refuse bales were broken apart to extinguish the fire. The Massachusetts Division of Environmental Health granted RSI permission to use the B&M land to dispose of its loose, burnt refuse. The waste disposed of by RSI on B&M land was classified as municipal and light industrial solid wastes from the cities of Cambridge and Somerville. There were no records kept on specific waste characteristics. By 1976, the area was no longer being used, and vegetative cover was returning.

Although soil samples from this area were not analyzed during the Phase 1A RI, samples of surface water and sediment were collected and analyzed from the unnamed brook, at the point where it discharges to an adjacent wetland area. In addition, groundwater samples were collected from a cluster of monitoring wells installed in the adjacent wetland area. Detectable levels of contaminants were not found in nearby surface waters, but detectable levels of VOCs were found in the bedrock well (27 ppb) and the shallow overburden well (6 ppb). A sediment sample collected from the adjacent wetland area contained polynuclear aromatic hydrocarbons (PAHs) (9 ppm) and elevated levels of arsenic (81 ppm) and lead (1,000 ppm).

**1.2.2.3 B&M Locomotive Shop Disposal Areas.** The B&M Locomotive Shop Disposal Areas consist of two disposal areas separated by a manmade channel that flows into an unnamed brook. The first area, located on the north side of the channel and approximately 1 acre in size, was investigated by CDM during the Phase 1A RI. This area is referred to as Area A throughout the report. Various kinds of partially buried debris were observed in Area A. Two soil borings drilled in this area revealed that subsurface soils were visibly contaminated with oily wastes. Chemical analysis for contaminants on the hazardous substance list (HSL) revealed elevated levels of lead and PAH compounds (3,000

ppm and 4 ppm, respectively). Trace levels (5 ppb) of VOCs were also detected. In addition, analysis of surface soils for asbestos revealed levels greater than 1%.

The second area located on the south side of the channels is approximately 3 acres in size and is referred to as Area B. According to the CDM memorandum report (1989a), prior to 1938 and until about 1979, Area B was used to dispose of various kinds of "light and dark-toned materials." CDM observed that the area contains various kinds of debris, including deteriorated drums. The soils in this area were not sampled as part of the Phase 1A RI.

**1.2.2.4 Old B&M Oil/Sludge Recycling Area.** The 6-acre, Old B&M Oil/Sludge Recycling Area was established sometime prior to 1938 for the purpose of recycling oil. A B&M Railroad site plan, dated 1972, shows two adjacent areas designated as "oil and sludge" which appear to be located about 300 feet west of the B&M locomotive shop repair facility (CDM, 1989a). These two areas, where the oil and sludge pooled, had a combined dimension of 600 by 200 feet. In 1973, the Penn Culvert Company purchased the parcel of land containing these two disposal areas and sometime later filled them in.

During a NUS Corporation site inspection and the CDM Phase 1A RI, subsurface soil samples were collected from these areas (CDM, 1989a). A summary of the analytical results is presented in Table 1-2. The results from both sampling rounds revealed that the soils are contaminated with lead (up to 26,900 ppm) and PAHs (0.45 ppm to 9.6 ppm) at depths ranging from zero to six feet. In addition, both NUS and CDM observed that these soils were visibly contaminated with oil (CDM, 1989a).

**1.2.2.5 Contaminated Soils Area.** The Contaminated Soils Area is located in the center of the Iron Horse Park Superfund Site and is approximately 50 acres in size. The Contaminated Soils Area encompasses properties owned by Eastern Terminals, Inc., Wood Fabricators, and the MBTA (Figure 1-3). The area is bounded on the east by the B&M Railroad Landfill, the RSI Landfill, and an unnamed brook, on the west by the Asbestos Lagoons and property owned by Eastern Terminals, Inc., on the south by the Old B&M Oil Sludge Recycling Area and the B&M Locomotive Shop Disposal Areas, and on the north by property owned by the MBTA.

Contaminated soil was first identified as a problem in the central portion of the Iron Horse Park Superfund Site after a random soil boring program conducted across the Site indicated elevated levels of lead (310 to 76,600 ppm) at nine out of forty locations. The results for locations where lead levels exceeded expected background levels (300 ppm; CDM, 1987; 1989a) are presented in Table 1-3. In particular, there are two locations on B&M property where lead concentrations were present at high levels. The extent of contaminated soil was investigated as part of the current RI based on the findings of the random soil boring program.

**1.2.2.6 Asbestos Landfill.** The Site has historically been identified with asbestos contamination due to asbestos landfilling operations conducted by Johns-Manville over a 32-year period. Although EPA capped the Asbestos Landfill in 1984, "asbestos contamination" was identified by CDM (1987) as a potential operable unit because the cap is not currently maintained. The integrity of the cap was evaluated as part of the RI. Asbestos materials have been found outside the limits of the cap, and the entire western boundary of the cap is not fenced.

In 1985, during the Phase 1A RI (CDM, 1987), surficial soils (0 to 3 inches) from 40 random boring locations were analyzed for the presence of asbestos. Asbestos was detected at 28 of the locations sampled and, at eight of these located on Johns-Manville (currently BNZ Materials), Penn Culvert, and B&M properties, asbestos was present at levels greater than 1%. This suggested that wind-blown deposition of asbestos (CDM, 1989a) had occurred in portions of the Site on B&M property adjacent to the landfill, as well as on Johns-Manville (currently BNZ Materials) property where the asbestos waste originated.

An off-site soil sampling program (CDM, 1988) was also conducted to determine the extent, if any, of wind-blown asbestos in residential areas bordering the Site. The results of the off-site soil sampling indicated that, with one exception, there were no detectable levels of asbestos in these residential areas. Therefore, CDM's Draft Phase 1A RI report (1987), concluded that deposition of wind-blown asbestos from the Site on off-site areas most likely did not occur.

The Asbestos Landfill Cap Evaluation Report (M&E, 1994c) was submitted to EPA in February 1994. This report documents the recent evaluation of the current condition of the landfill cap surface and recommends corrective actions to be implemented to protect public health and comply with state and federal regulations.

**1.2.2.7 Asbestos Lagoons.** In addition to the Asbestos Landfill, there are three unlined asbestos lagoons on Johns-Manville (currently BNZ Materials) property. One of these lagoons has been filled and covered. When the lagoons were operated by Johns-Manville, they received an asbestos slurry pumped from the adjacent manufacturing operations. Asbestos from these lagoons was disposed of in the asbestos landfill; however, the lagoons allegedly still contain some asbestos.

The lagoons continued to receive wastewater from Johns-Manville operations after asbestos manufacturing operations closed. While this discharge did not contain asbestos, it may have contained some other hazardous substances (CDM, 1989a).

**1.2.2.8 Site-Wide Surface Water and Sediment Contamination.** Surface water samples were collected across the Site during the Phase 1A and 1C RIs (CDM, 1987 and 1989b). The highest VOC concentrations were generally found to the north of the Shaffer Landfill, on the southern edge of Richardson's Pond, and along Content Brook. The Ambient Water Quality Criteria were exceeded for arsenic in all samples (CDM, 1989b).

Sediment samples were collected across the Site during the Phase 1A and 1C RIs (CDM, 1987 and 1989b). Volatile organic compound concentrations were highest along the northern edge of the Shaffer Landfill and the southern edge of Richardson's Pond. Semivolatile organic compounds were found both upstream and downstream of the landfill. Low levels of pesticides were also detected in the vicinity of the landfill.

### 1.2.3 Previous Studies and Reports

Several studies were conducted at the Site prior to the initiation of the RI. These studies have generated reports and maps concerning the Site. Some of the studies are listed below:

- NUS Corporation (NUS). 1975. *Final Report for Iron Horse Park Site Inspection, North Billerica, MA*
- Ecology and Environment. 1982. *Field Investigations of Uncontrolled Hazardous Waste Sites (FIT Project): Scope of Work for Site Inspection and Investigation, Iron Horse Park, Billerica, MA*
- NUS Corporation (NUS). 1983. *Preliminary Site Assessment of the Iron Horse Park Facility, North Billerica, MA*
- GHR Engineering Corporation. 1984. *Final Environmental Impact Report, Pond Street Sanitary Landfill, Billerica, MA*
- GHR Engineering Corporation. 1985. *Supplemental Final Environmental Impact Report, Pond Street Sanitary Landfill, Billerica, MA*
- Camp Dresser and McKee (CDM). 1987. *Draft Phase 1A Remedial Investigation for the Iron Horse Site, Billerica, MA*
- Goldberg, Zoino, and Associates (GZA). 1987. *PCB Investigation Report, Manville Corporation, North Billerica, MA*
- Camp Dresser and McKee (CDM). 1988. *Draft Phase 1B Remedial Investigation for the Boston and Maine Wastewater Lagoon Area, Iron Horse Park Site, Billerica, MA*
- GHR Engineering Corporation. 1988. *Supplemental Hydrogeologic and Water Quality Assessment at the Pond Street Landfill, Billerica, MA*
- Camp Dresser and McKee (CDM). 1989b. *Draft Phase 1C Remedial Investigation for the Shaffer Landfill, Iron Horse Park Site, Billerica, MA*
- Weston Environmental (Weston) 1989. *Wetland Characterization and Biological Investigations, Iron Horse Park Site, Billerica, MA*
- Camp Dresser and McKee (CDM). 1991. *Final Draft Phase 1C Feasibility Study for the Shaffer Landfill, Iron Horse Park Site, Billerica, MA.*

## 1.3 SITE CHARACTERISTICS

In the following sections, the geographic setting, geology, and hydrogeology of the Site are discussed.

### 1.3.1 Geographic Setting

The Site is located in North Billerica, Massachusetts, approximately 8 miles south of the New Hampshire border, at an elevation of about 115 feet above sea level. The climate is seasonally variable. Based on data collected from 1961 to 1990, the average minimum and maximum daily temperatures at nearby Lowell are 49° F and 60° F, and the Site receives 42 inches of precipitation annually (Owenby and Ezell, 1992).

Located in eastern Massachusetts, the Site is on the western side of the Seaboard Lowland section of the New England physiographic province, a subdivision of the Appalachian Highlands. The Seaboard Lowlands are characterized by extensive glacial outwash and till deposits overlying a complex of igneous and metamorphic rocks (Castle, 1959).

The Site lies on the western edge of the Shawsheen River drainage basin and is approximately 1.5 miles from the northward-flowing Shawsheen River. The Iron Horse Park Superfund Site is surrounded by upland areas on the southeast side, including several small forested hills near Pond Street, and low lying wetland areas on the western, northern, and northeastern side of the Site. Currently, 17% of the Site is characterized as wetlands (M&E, 1995).

Soils on and in the immediate vicinity of the Site are classified as predominantly urban land with other soil types to a lesser extent. These soil types are described in detail in Section 3.1.3 of the final RI Report (M&E, 1997). Urban land is indicated in areas where the soil has been disturbed or altered, is obscured by cultural features (*e.g.*, buildings, industrial areas, roads, rail yards) and where these features cover more than 75% of the surface area.

The Site is used for industrial purposes, with no residential use. The Middlesex Canal is essentially impassable for recreation or economic purposes. Some parts of the Site are fenced, but most is accessible to passers-by. The area within one mile of the Site boundary is primarily forest and residential, consisting primarily of single-family residential properties.

Surface waters in the vicinity of the Shaffer Landfill are classified as Class B waters by the Commonwealth of Massachusetts and are designated for use as warm water fisheries and contact recreation (CDM, 1991). The Middlesex Canal, linking the Merrimack River to the Boston basin, runs through the Site, and some of its original features remain. Histories of the canal indicate that clay was used along the canal banks to limit seepage of the canal water into neighboring lowlands (Clark, 1974). However, use of the clay liner in the canal may have been limited in extent.

A town inventory of historical properties revealed two historical assets within the site boundaries (CDM, 1987). The Small Pox Cemetery, dating back to 1811, is located between the Middlesex Canal and the MBTA commuter railroad line. The Content Brook Mill is located at the eastern end of the Shaffer Landfill property.

Files on five historic locations within or adjacent to the Site are maintained by the Massachusetts Historical Commission (MHC). These include the Pond Street Bridge over the B&M Railroad at the Site boundary (inventoried as BIL.917), the B&M Railroad Billerica Shop Complex (BIL.299), the Equipment Storage Shed (BIL.300), the Maintenance Shed (BIL.301), and the Power Plant (BIL. 302), the last four being centrally located on the Site. These buildings were constructed between 1911 and 1914, and each was recommended as eligible for the National Register during the MBTA Historical Property Survey conducted in 1988, as noted in MHC files.

As shown in Figure 1-4, part of the Site overlies what is expected to be a medium-yield aquifer. The remainder is expected to be a low-yield aquifer. No public water supply sources are located within the medium-yield aquifer on the Site, but the groundwater beneath the medium-yield aquifer is considered a potential drinking water source by both EPA and the Commonwealth of Massachusetts.

Although not currently in use, community public water supply wells are located less than 1 mile east of the Site in Tewksbury. The ½-mile-radius Interim Wellhead Protection Area (IWPA) for one of the Tewksbury wells extends to within approximately 500 feet of the Site on the northeast side (Figure 1-4). Surface water and other groundwater community public water supplies are located at North Billerica on the Concord River, just north of the Route 3A bridge, where a filtration plant is located. The southwestern corner of the Site is close to the ½-mile IWPA for the North Billerica Well (Figure 1-4). However, like the Tewksbury wells, this well is not currently in use.

There may be private wells along Gray Street, which is east of the Shaffer Landfill section of the Site, based on the knowledge of personnel at the Billerica Health Department (M&E, 1996). The town of Billerica does not maintain records for these wells, if they do exist. It is not known whether any such private wells are used as sources of drinking water or for other domestic uses.

### 1.3.2 Geology

Bedrock underlying the Site is comprised of granite, schist, and diorite. Bedrock surface elevations suggest the presence of a trough in the bedrock surface trending northeast from the Old B&M Oil/Sludge Recycling Area to the Unnamed Brook, then northwest toward the Asbestos Lagoons. Bedrock fractures were found trending north-northeast and east-west.

The overburden primarily consists of glacial drift deposits including basal and ablation till and glacial outwash deposits. Basal till was found primarily on the southwestern portion of the Site, and ablation till was found primarily in the western and southern portion of the Site overlying basal till. Glacial outwash deposits were encountered throughout the Site. Peat deposits were encountered underlying fill materials near streams, ponds, and wetlands at the Site.

### 1.3.3 Hydrogeology

The overburden aquifer was subdivided into shallow and deep zones to aid in determining the potential migration pathways. Groundwater is also contained and transmitted in weathered and fractured

bedrock zones. Groundwater in both the overburden and bedrock aquifers generally enters the Site from the southwest and flows to the northeast. Similarly, surface water flows onto the Site from the south and flows to the northeast, where it converges with B&M Pond and associated wetlands. Based on seepage meter, staff gauge, and mini-piezometer results, the potential for groundwater to discharge to surface water was evident throughout most of the Site.

## 1.4 NATURE AND EXTENT OF CONTAMINATION

The distribution of contaminants by media and area of concern, as well as contaminant fate and transport, are described in the following sections. The Asbestos Landfill has been omitted, since analytical samples were not collected in that area.

### 1.4.1 Contaminant Distribution by Media and Area of Concern

In the following sections, contaminant distribution by media (surface soil, subsurface soil, and groundwater) in each area of concern except the Asbestos Landfill are discussed.

**1.4.1.1 B&M Railroad Landfill.** Similar types of organic compounds including VOCs, PAHs, phthalates, petroleum hydrocarbons, and pesticides were detected in surface and subsurface soils, with the highest concentrations occurring in subsurface soils. These contaminants were considerably less prevalent in groundwater. Heavy metal concentrations in surface and subsurface soils were higher than background soils. For soils, the southeastern half of the landfill was more contaminated with both organic compounds and metals. High concentrations of PCBs in subsurface soils suggest that PCB-contaminated material, possibly oils, was disposed of. Aromatic VOCs, PAHs and petroleum hydrocarbons are indicative of petroleum-related products that probably include coal tar and creosote waste.

In groundwater, wells located in the landfill exhibited the highest concentrations of contaminants, especially organic compounds. Aromatic and chlorinated VOCs, PAHs, pesticides, PCBs, and elevated metal concentrations were measured in groundwater, but concentrations were considerably

lower than in soil. Although no non-aqueous phase liquids (NAPLs) were found, oily sands were observed at several depths; in conjunction with the types of organic compounds that were detected, this suggests the presence of NAPL. Degradation of trichloroethylene (TCE) is evidenced by the presence of its potential byproducts, including both isomers of dichloroethylene (DCE).

**1.4.1.2 RSI Landfill.** Waste and fill present in the west-central portion of the landfill include organic compounds and heavy metals, detected in subsurface soils, and pesticides, PCBs, and phthalates, found in subsurface and surface soils. Aromatic VOCs, pesticides, and PCBs were detected in groundwater at low concentrations. The detection of chlorinated VOCs in upgradient, as well as downgradient and vicinity wells, indicates that upgradient sources may be affecting groundwater quality. The presence of elevated vinyl chloride and dichlorinated VOCs directly downgradient of landfilled wastes and near the water table (groundwater screening locations) are indicative of the degradation of chlorinated VOCs. Aromatic VOCs found in a groundwater cluster near the Asbestos Landfill and the RSI Landfill are most likely from the Asbestos Landfill. The basis for this conclusion is: these wells are located immediately downgradient of the Asbestos Landfill, the contaminant concentrations in these wells were consistent between sampling rounds, and concentrations of aromatic compounds at the levels detected in these downgradient wells were not found elsewhere on-site.

**1.4.1.3 B&M Locomotive Shop Disposal Areas.** Heavy metals and organic compounds including pesticides, PAHs, and petroleum hydrocarbons were detected in surface and subsurface soils in both areas, where waste or fill material was found. A few organic compounds (including one VOC, a few pesticides, and one PCB Aroclor) and heavy metals were detected in groundwater in the downgradient and vicinity wells. The detection of organic compounds and some heavy metals in the upgradient cluster indicate that other sources may be present in the vicinity. Mercury and copper were the only detected metals that were not found in the upgradient wells.

**1.4.1.4 Old B&M Oil/Sludge Recycling Area.** Two areas of oil/sludge, located on the northern and southern edges of the area, were found to extend beyond the Penn Culvert fence perimeter, with one area extending onto MBTA property. The predominant types of organic compounds found were consistent with the oil/sludge reportedly disposed of in these areas. Contaminants detected in surface

and subsurface soils consist primarily of PAHs, long-chain alkanes, and petroleum hydrocarbons. Numerous pesticides and PCBs were detected in the northern area, and heavy metals were measured in both areas. Although aromatic VOCs, PAHs, and petroleum hydrocarbons were generally not present in groundwater, chlorinated VOCs and heavy metals were detected. Heavy metals, which were detected primarily in shallow overburden groundwater, include arsenic, chromium, cobalt, lead, mercury, nickel, and zinc. Petroleum hydrocarbons were measured in one well, and several inches of floating product were observed in one piezometer in the southern oil/sludge area.

**1.4.1.5 Contaminated Soils Area.** Since surface soil contamination was of key concern in this area, this was the only medium sampled. Organic compounds, including PAHs, petroleum hydrocarbons, and pesticides, were measured in surface soils in localized areas. Lead and manganese were the heavy metals that were detected most often and in the highest concentrations. Cyanide was detected in a localized area along the southeastern boundary.

**1.4.1.6 Asbestos Lagoons.** Sediment soil samples were collected at these lagoons during the RI. Groundwater contaminants included VOCs (primarily aromatic and chlorinated VOCs), PAHs, PCBs and pesticides. Several of the chlorinated VOCs (perchloroethylene (PCE), trichloroethane (TCA), and dichloroethane (DCA)) and heavy metals (arsenic, cobalt, lead, and zinc) were detected in the shallow overburden, deep overburden and bedrock flow zones. The types of contaminants found were similar to those detected in the 1980s during investigations related to the Johns-Manville stormwater drainage system. Detected heavy metals and organic compounds were primarily found in downgradient wells near the lagoons.

**1.4.1.7 Site-Wide Surface Water and Sediment.** Several VOCs were detected at multiple surface water locations during both sampling rounds. Benzene, toluene, ethylbenzene, and xylene (BTEX) compounds were found at several locations in Richardson Pond. Chlorinated VOCs including TCA, DCE, PCE, and TCE were detected in several surface water locations. In addition to aromatic and chlorinated VOCs, several VOCs that are gases under normal conditions including chloromethane were found at low concentrations. Generally, contaminants including PAHs, pesticides, and metals were detected more often and in higher concentrations in June compared to September, indicating

variability over time. In the vicinity of Shaffer Landfill, specific conductance and heavy metals concentrations were elevated.

Similar to surface water, the frequency of detection and the concentrations of contaminants in sediment including aromatic and chlorinated VOCs, PAHs, pesticides, and PCBs, were generally greater in June than September. Heavy metals were found at similar concentrations during both sampling rounds. Aromatic compounds detected include BTEX and chlorobenzene. Chlorinated VOCs were measured at locations where aromatic VOCs were found, and petroleum hydrocarbons were detected in higher concentrations where PAHs were found. PCBs were detected at more than half the locations in June, with the highest PCB concentration measured at the base of a discharge pipe from the Johns-Manville (currently BNZ Materials) property.

### 1.4.2 Contaminant Fate and Transport

In the following sections, contaminant fate and transport are described by area of concern.

**1.4.2.1 B&M Railroad Landfill.** Since organic materials are prevalent in soils, PCBs, PAHs, and pesticides are not expected to migrate appreciably in the unsaturated zone. It is also expected that the mobility of metals will be limited due to adsorption and other processes in soil. A migration pathway for VOCs in the unsaturated zone may be via vapor phase, since VOCs were detected more often at the water table (in groundwater screening locations) than with depth below it.

With the exception of VOCs, most contaminants found in the saturated zone soils (pesticides, PCBs, PAHs, phthalates, and heavy metals) will not migrate significantly in the dissolved phase as evidenced by the groundwater quality in wells across from B&M Pond. The presence of PCBs and pesticides below the limits of the waste indicate that residual or pooled dense non-aqueous phase liquids (DNAPL) may be present, although none was observed. Groundwater levels and analytical data indicate that groundwater is migrating vertically. Contaminants in the dissolved phase may migrate from the landfill to the B&M Pond to the east and the Middlesex Canal to the south as evidenced by downgradient contamination.

Measured vertical gradients indicate groundwater discharges to the Middlesex Canal and B&M Pond. Contaminants are more prevalent in sediment than surface water due to attenuation processes. Contaminants detected in sediments were also found in upgradient reaches. PCBs in the Middlesex Canal may be a result of historic discharges from the stormwater drainage system at the former Johns-Mansville facility.

**1.4.2.2 RSI Landfill.** Borings indicate that wastes exist above and below the water table. The absence of a low-permeability cover allows for contaminant transport from the unsaturated to the saturated zone. Similar to the B&M Railroad landfill, relatively elevated concentrations of PCBs, PAHs, and phthalates are found in the unsaturated zone. These compounds in percolating water may be highly attenuated through adsorption to organic matter in the soils. Although these compounds may also migrate vertically in DNAPL form, no DNAPL was observed. Most metals are fairly immobile due to adsorption and low solubility; however, leaching is possible. Chlorinated VOCs (DCE and vinyl chloride) detected in groundwater screening samples indicate the partitioning of these compounds to the vapor phase. Therefore, vapor phase movement may be a prominent transport mechanism at the water table.

Most organic compounds with the exception of VOCs often do not migrate significantly in the dissolved phase. Pesticides, PAHs, phthalates, and PCBs adsorb to organic matter in soils. However, due to the presence of sandy soils with less organic material, contaminant transport is of greater concern. Based on the direction of groundwater flow, contaminants in the dissolved phase would likely migrate toward the Middlesex Canal to the northeast and the unnamed brook to the southeast. Although vertical gradients are low, the existence of shallow bedrock facilitates contaminant transport from the overburden to bedrock. The presence of pesticides and PCBs in the deep overburden and bedrock groundwater indicates the potential for localized DNAPL pools; however, this was not confirmed during the field activities.

Pesticides and VOCs were detected in surface water and sediment in the unnamed brook. Overland flow could be the source of this contamination, although upgradient sources also may be contributing.

Measured vertical gradients and seepage velocities indicate discharge from groundwater to the unnamed brook.

**1.4.2.3 B&M Locomotive Shop Disposal Areas.** Borings indicate that wastes exist above and below the water table. PAHs were found in the highest concentrations, especially in subsurface soils, while pesticides, PCBs, VOCs, and petroleum hydrocarbons were found at lower concentrations. The absence of a low-permeability cover facilitates contaminant transport from the unsaturated to the saturated zone. However, pesticides, PCBs and PAHs in percolating water may be highly attenuated through adsorption to organic matter in the soils.

Aromatic VOCs, PAHs, and petroleum hydrocarbons were notably absent in groundwater, although they were prevalent in subsurface soils. The absence of PAHs may be attributed to adsorption to soils. The absence of aromatic VOCs and petroleum hydrocarbons may be due to the placement of well screens below the water table. The potential for biodegradation of chlorinated compounds is evidenced by the existence of the breakdown products DCE and vinyl chloride near the water table. Based on the direction of groundwater flow, contaminants in the dissolved phase from both areas will migrate toward the northeast with potential downgradient discharge to the unnamed brook. Although vertical hydraulic gradients tend to be downward, there is no evidence that vertical migration of contaminants has occurred at this point.

Only pesticides were detected in surface water in the man-made canal. In contrast, PAHs, pesticides, phthalates, PCBs, and petroleum hydrocarbons were measured in sediments in the canal, indicating that adsorption to sediments is occurring. Contaminants in sediments were similar to those measured in surface soils; therefore, overland flow runoff may be contributing to contaminant transport from these disposal areas. Vertical gradients indicate the potential for discharge from both the overburden and bedrock; however, low streambed conductivities may limit discharge.

**1.4.2.4 Old B&M Oil/Sludge Recycling Area.** Subsurface soils exhibited the highest concentrations of contaminants including aromatic VOCs (BTEX compounds), PAHs, petroleum hydrocarbons, and metals. Although some of the area is covered with asphalt, the absence of a low-permeability cover

may facilitate contaminant transport to the saturated zone (especially VOCs). However, PAHs, pesticides, and metals will tend to adsorb to the organic matter (peat) prevalent in soils in this area. Based on observations of free product in the area and the occurrence of PAHs and petroleum hydrocarbons, light non-aqueous phase liquids (LNAPL) in residual or mobile form may be widespread. It was not detected in wells most likely because they are screened as much as 1 foot or more below the water table. The presence of high concentrations of PAHs may also indicate the presence of DNAPL.

Aromatic VOCs, PAHs, and petroleum hydrocarbons were notably absent in groundwater, although they were prevalent in subsurface soils. The absence of PAHs may be attributed to adsorption to soils. The absence of aromatic VOCs and petroleum hydrocarbons may be due to the placement of well screens below the water table. The potential for biodegradation of chlorinated VOCs is evidenced by the existence of the breakdown products DCE and vinyl chloride in groundwater. Based on the direction of groundwater flow, contaminants in the dissolved phase will likely migrate toward the northeast. Vertical hydraulic gradients tend to be downward from shallow overburden and upward from bedrock to deep overburden. The presence of chlorinated VOCs in the deep overburden lends credence to this observation.

No surface water bodies are associated with the Old B&M Oil/Sludge Recycling Area.

**1.4.2.5 Contaminated Soils Area.** Soil contamination is likely the result of surface discharge from various work-related activities and is probably limited to surface soils. Evidence of free product spills included visual observation of oil-soaked or stained soils. Elevated levels of lead were detected throughout the area. Since lead is relatively insoluble and strongly adsorbed, significant migration in the unsaturated zone is not expected.

Pesticides, PAHs, VOCs, and heavy metals (especially lead) were measured in sediment at nearby water bodies. Overland flow runoff is the most likely transport pathway for this area. Based on drainage patterns to the northeast, this area could be contributing to contaminants in surface water and

sediments in the Middlesex Canal, the unnamed brook, wetlands and ponds in the vicinity, as well as drainage ditches that lead to these water bodies.

**1.4.2.6 Asbestos Lagoons.** The limits of waste relative to the water table were not defined, since drilling was not conducted within the lagoons. The predominant types of compounds found in groundwater include pesticides and PAHs, which are likely to be strongly adsorbed to soils. Concentrations of several metals were elevated, with calcium levels most elevated. This was to be expected due to the plasterboard materials that were disposed here.

Several metals, a few chlorinated VOCs, and PAHs were most prevalent in the deep overburden and bedrock groundwater. PCBs were detected in a shallow well adjacent to catch basins. Past wastewater discharges, stormwater drain leakages, and mounding caused by rainfall likely induced vertical migration of contaminants beneath the area. Low concentrations of pesticides in groundwater may be the result of percolating rainwater. Chlorinated VOCs are likely the most mobile contaminants. Groundwater flow is divided, with flow to the northwest toward Middlesex Canal and to the northeast. Vertical gradients tend to be downward from shallow to deep overburden near the lagoons, but upward from bedrock to shallow overburden at the downgradient wells.

Although there seems to be minimal potential for the Asbestos Lagoons to affect surface water and sediment transport, the most significant concern is the residual PCBs remaining in sediment at the Johns-Manville outfall locations in the Middlesex Canal. In the PCB Contamination Evaluation Report (M&E, 1994b), it was concluded that sediments contaminated with PCBs and to a lesser extent SVOCs, VOCs, PAHs, and metals were being transported downstream within the Middlesex Canal.

**1.4.2.7 Site-Wide Surface Water and Sediment.** Discharge of groundwater from the RSI and B&M Railroad Landfills to surface water may be the source of chlorinated VOCs found in the RSI wetland, the Middlesex Canal near the B&M Pond, and the unnamed brook. An outfall discharge pipe in the sedimentation pond on the unnamed brook may have been the source of VOCs detected at that location. The current condition of this discharge pipe is unknown.

The detection of PAHs and elevated lead concentrations in sediment in the southwest corner of Richardson Pond suggests the probable transport of contaminants by overland flow runoff from Shaffer Landfill, Pond Street, and the MBTA railway tracks.

## 1.5 SUMMARY OF BASELINE HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENTS

Summaries of the RI human health and ecological risks are presented in the following sections by media and area of concern. Since analytical samples were not collected in the Asbestos Landfill, human health and ecological risks were not evaluated for that area of concern. In addition, since analytical samples related to ecological risk were not collected in the Asbestos Lagoons, that area was not evaluated separately in the ecological risk assessment. A summary of the supplemental human health risk assessment for the Old B&M Oil/Sludge Recycling Area (Appendix I) is also presented. This supplemental evaluation was conducted for soil at the Old B&M Oil/Sludge Recycling Area to more fully address risks associated with elevated levels of subsurface contaminants.

### 1.5.1 RI Human Health Risk Assessment

This section provides a summary of the baseline human health risk assessment as presented in the Remedial Investigation Final Report (M&E, 1997). The baseline human health risk assessment provides estimates of risk, under both current use and hypothetical future use scenarios, to both the central tendency (CT) and the reasonably maximum exposed (RME) receptor.

Surface soil analytical results were evaluated for five areas of concern (AOCs): B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Contaminated Soils Area. Surface water and sediment analytical results were evaluated for three AOCs: West Middlesex Canal Area, Central Wetlands Area, and East Middlesex Canal and Wetlands Area. Groundwater analytical results from three aquifers (shallow overburden, deep overburden, and bedrock) were evaluated in five AOCs: B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Area, Old B&M Oil/Sludge Recycling Area, and Asbestos Lagoons (*i.e.*, a total of 15 groupings).

For soil, surface water and sediment, the 95% upper concentration limit (UCL) concentration was used as the exposure point concentration (EPC) unless it exceeded the maximum detected value, in which case, the maximum detected value was used as the EPC. For groundwater, the arithmetic mean concentration for each COPC was used in calculating the CT exposure, and the maximum concentration was used to calculate the RME exposure, rather than using the 95% UCL. If the arithmetic mean concentration exceeded the maximum detected concentration, the maximum detected concentration was used for the CT exposure.

To evaluated current exposures, child/teenage (*i.e.*, 7 to 16 years old) trespassers and adult site workers were considered as receptor populations. Exposures of both site workers and trespassers to surface soil through incidental ingestion of and dermal contact with COPCs were evaluated. Since industrial operations at the Site would result in little, if any, contact by site workers with sediment and surface water in the wetlands or water bodies at the Site, exposures of workers to sediment and surface water were not evaluated. However, exposures of child/teenage trespassers to sediment and surface water were evaluated. Since most of the water bodies are shallow, trespassers were assumed to wade, rather than swim. Exposure pathways associated with wading that were evaluated include incidental ingestion of and dermal contact with sediment and dermal contact with surface water. The ingestion of surface water was not assessed since the water is shallow, making it unlikely that a trespasser would ingest more than a negligible amount.

Since water is currently supplied to the Site from alternative sources, exposures to COPCs in groundwater were not assessed under current land-use conditions. However, under a future land-use scenario, it was assumed that area residents would use groundwater from the Site for domestic use. Routes of exposure associated with residential groundwater use may include ingestion of drinking water, inhalation of chemicals that have volatilized from groundwater during use (*e.g.*, while showering), and dermal contact with groundwater during use (*e.g.*, while bathing). Drinking water ingestion exposures of residents were quantitatively evaluated. Potential exposures from other pathways, such as inhalation or dermal contact during bathing, were not quantitatively evaluated.

The following items summarize the pathways evaluated for each exposure scenario.

- Site adult worker scenario, current and future
  Ingestion pathways: surface soil
  Dermal contact pathways: surface soil

- Site child/teenage trespasser scenario, current and future
  Ingestion pathways: surface soil, sediment
  Dermal contact pathways: surface soil, sediment, surface water

- Residential scenario, future
  Ingestion pathways: groundwater

The exposure parameters used for each of the receptors evaluated in the risk assessment are described briefly below and presented in Appendix B. The risk assessment used the default CT exposure parameters to evaluate average exposures and high-end exposure parameters to calculate RME estimates.

For the site worker, the default CT and high-end soil ingestion rates (50 and 100 mg/day, respectively) for noncontact workers were used, since operations at the Site do not typically involve contact-intensive activities (*e.g.*, construction, excavation). Workers were assumed to contact soil with 25% of their body for a surface area of 5,000 $cm^2$ for the CT case and 5,800 $cm^2$ for the RME case. Soil-to-skin adherence factors of 0.2 and 1.0 $mg/cm^2$ were used for the CT exposure and RME cases, respectively. The recommended exposure frequency of 150 days/year for workers was used for both the CT and RME cases. The default high-end exposure duration of 25 years was used for the RME case, while an average employment duration of 15 years was used for the CT exposure case. The default value of 70 kg for an adult body weight was used for both CT and RME cases.

Since no toxicity values are available for lead, lead toxicity was assessed using an interim approach recommended for use with non-residential adult exposures (U.S. EPA, 1996). This method relates soil lead intake to blood lead concentrations in women of childbearing age; this group is assumed to be the most sensitive to lead exposure, among adults. The method does not provide a quantitative estimate of risk; instead it predicts a central estimate of blood lead concentrations in women of child-bearing age that have exposures to soil lead at site concentrations. Risks associated with lead are described by comparing the central estimate of blood lead concentration in women of childbearing age to a goal blood lead concentration associated with a fetal blood lead concentration of 10 μg/dL. For the model,

it was assumed that a typical blood lead concentration in women of child-bearing age in the absence of site exposures was 1.7 μg/dL, which is a low end default assumption. The biokinetic slope factor for lead was assumed to be 0.4 μg/dL per μg/day. A representative intake rate of soil was assumed to be 50 mg/day based on occupational sources including soil in indoor dust. The absolute gastrointestinal absorption fraction for ingested lead in soil and soil-derived dust was assumed to be 0.12. The exposure frequency was assumed to be 219 days per year. Using these assumptions, the goal for the central estimate of blood lead concentration in adults was calculated as 4.2 μg/dL for the Site. Predicted blood concentrations were compared to this value based on Site surface soil concentrations.

For the child/teenage trespasser, many of the exposure parameters were selected based on professional judgement, while others were determined given site-specific information. The default CT and high-end soil ingestion rates of 50 and 100 mg/day were used, which applies to individuals older than 6 years old. These default soil ingestion rates were also used to evaluate sediment contact associated with recreational activities. Trespassers were assumed to contact soil and sediment with 25% of their body surface area (hands, legs, arms, head and neck), which amounts to 4,100 $cm^2$ for RME exposure and 3,300 $cm^2$ for CT exposure. For surface water contact, event times of 1 hour and 2 hours were assumed for the CT exposure and RME cases, respectively. Soil-to-skin adherence factors of 0.2 and 1.0 $mg/cm^2$ were used for the CT and RME cases, respectively. It was assumed that the trespasser ventures onto the site 1 or 2 days per week for 6 months of the year. Therefore, the exposure frequency values used for the CT and RME exposure cases were 26 and 52 days/year, respectively. The exposure duration of 10 years for the RME case assumed that the receptor would trespass onto the Site every year within the given age range, while the receptor was assumed to trespass 5 years for the CT exposure case. The body weight for the child/teenager used for both the RME and CT cases was 45 kg.

For residential drinking water exposures, the default CT and high-end exposure parameters describing drinking water ingestion rates (1.4 and 2 liters/day, respectively), exposure frequency (350 days/year), exposure duration (9 and 30 years, respectively), and body weight (70 kg) were used. For all receptors,

the averaging time for noncarcinogens was set equal to the exposure duration (30 years), and the averaging time for carcinogens was the standard EPA lifetime duration (70 years).

Carcinogenic and noncarcinogenic risks were estimated using both the CT and RME exposure assumptions. The significance of the risk estimates are relative to guidelines set forth in EPA policy (*i.e.*, an incremental lifetime cancer risk [ILCR] above the target risk range of $10^{-6}$ to $10^{-4}$ and a hazard index [HI] above 1). Risk estimates, as presented in the RI for the RME case, are summarized in Appendix B and presented below by AOC.

**1.5.1.1 B&M Railroad Landfill.** In the B&M Railroad Landfill, potential exposures to surface soil and groundwater were evaluated. Health risks from surface soil are expected to be below or within the EPA risk range of $10^{-6}$ to $10^{-4}$ for cancer risk and below a hazard index of 1 for noncancer risk. Health risks from potential future ingestion of groundwater exceed EPA risk guidelines. Groundwater contaminants contributing to risks above EPA risk guidelines, under central tendency and RME scenarios for one or more flow zones, were arsenic and manganese.

**1.5.1.2 RSI Landfill.** In this area, potential exposures to surface soil and groundwater were evaluated. Health risks from surface soil are expected to be below or within the EPA risk range of $10^{-6}$ to $10^{-4}$ for cancer risk and below a hazard index of 1 for noncancer risk. Health risks from potential future ingestion of groundwater exceed EPA risk guidelines. Groundwater constituents contributing to risks above EPA risk guidelines, under central tendency and RME scenarios for one or more flow zones, were arsenic, manganese, benzene, and thallium.

**1.5.1.3 B&M Locomotive Shop Disposal Areas.** In this area, potential exposures to surface soil and groundwater were evaluated. Health risks from surface soil are expected to be below or within the EPA risk range of $10^{-6}$ to $10^{-4}$ for cancer risk and below a hazard index of 1 for noncancer risk. Occupational exposures to lead in soil may result in excess blood lead levels in female workers. Health risks from potential future ingestion of groundwater exceed EPA risk guidelines. Groundwater constituents contributing to risks above EPA risk guidelines, under central tendency and RME scenarios for one or more flow zones, were arsenic and manganese.

**1.5.1.4 Old B&M Oil/Sludge Recycling Area.** In this area, potential exposures to surface soil and groundwater were evaluated. Health risks from surface soil are expected to be below or within the EPA risk range of $10^{-6}$ to $10^{-4}$ for cancer risk and below a hazard index of 1 for noncancer risk. Health risks from potential future ingestion of groundwater exceed EPA risk guidelines. Groundwater constituents contributing to risks above EPA risk guidelines, under an RME scenario for one or more flow zones, were arsenic and manganese.

**1.5.1.5 Contaminated Soils Area.** In this area, potential exposures only to surface soil were evaluated. Health risks from surface soil are expected to be below or within the EPA risk range of $10^{-6}$ to $10^{-4}$ for cancer risk and below a hazard index of 1 for noncancer risk. Estimated occupational blood lead levels were, however, elevated for this area due to the metals hot spot.

**1.5.1.6 Asbestos Lagoons.** In this area, potential exposures only to groundwater were evaluated. Health risks from potential future ingestion of groundwater exceed the EPA risk range of $10^{-6}$ to $10^{-4}$ for cancer risk and a hazard index of 1 for noncancer risk. Groundwater constituents contributing to risks above EPA risk guidelines, under central tendency and RME scenarios for one or more flow zones, were arsenic, beryllium, and manganese

**1.5.1.7 Site-Wide Surface Water and Sediment.** Human health risks associated with potential exposures to surface water and sediment are expected to be within or below EPA risk guidelines.

### 1.5.2 Supplemental Human Health Risk Assessment

This section provides a summary of the supplemental baseline human health risk assessment as presented in Appendix I for the Old B&M Oil/Sludge Recycling Area. The supplemental baseline human health risk assessment provides estimates of risk, under hypothetical future use scenarios, to both the central tendency (CT) and the reasonably maximum exposed (RME) receptor.

Soil analytical results (surface and subsurface soil combined) were evaluated for the Old B&M Oil/Sludge Recycling Area since subsurface levels for some contaminants exceeded levels in surface

soils. It is assumed that future site development results in the movement of soil contaminants, currently at depth, to the surface. For soil, the 95% upper concentration limit (UCL) concentration was used as the exposure point concentration (EPC) unless it exceeded the maximum detected value, in which case, the maximum detected value was used as the EPC.

To evaluated future exposures, child/teenage (*i.e.*, 7 to 16 years old) trespassers, adult site workers, adult utility workers and adult/young child residents were considered as receptor populations. Exposures of receptors to soil through incidental ingestion of and dermal contact with COPCs were evaluated.

The exposure parameters used for each of the receptors evaluated in the supplemental risk assessment are described briefly below. The risk assessment used the default CT exposure parameters to evaluate average exposures and high-end exposure parameters to calculate RME estimates. For all receptors, the averaging time for noncarcinogens was set equal to the exposure duration, and the averaging time for carcinogens was the standard EPA lifetime duration (70 years).

**Child/Teenage Trespasser.** For the child/teenage trespasser (Appendix I, Table 4.1), many of the exposure parameters were selected based on professional judgement, while others were determined given site-specific information. The default CT and high-end soil ingestion rates of 50 and 100 mg/day were used, which applies to individuals older than 6 years old. Trespassers were assumed to contact soil with a body surface area of 4,700 $cm^2$ for the CT and RME cases. Soil-to-skin adherence factors of 0.04 and 0.2 $mg/cm^2$ were used for the CT and RME cases, respectively. At the direction of EPA (USEPA, 1996a), arsenic and carcinogenic PAHs were assessed for dermal exposures to soil through the use of chemical-specific dermal absorption factors. Dermal absorption factors of 1% and 13% for cadmium and PAHs, respectively, were used for both the CT and RME cases. It was assumed that the trespasser ventures onto the site 1 or 2 days per week for 6 months of the year. Therefore, the exposure frequency values used for the CT and RME exposure cases were 26 and 52 days/year, respectively. The exposure duration of 10 years for the RME case assumed that the receptor would trespass onto the site every year within the given age range, while the receptor was assumed to trespass

5 years for the CT exposure case. The body weight for the child/teenager used for both the RME and CT cases was 45 kg.

**Adult Commercial Worker.** For the adult commercial worker (Appendix I, Table 4.2), the default CT and high-end soil ingestion rates (50 and 100 mg/day, respectively) for noncontact workers were used, since operations at the site do not typically involve contact-intensive activities (*e.g.*, construction, excavation). Workers were assumed to contact soil with a body surface area of 3,300 $cm^2$ for the CT and RME cases. Soil-to-skin adherence factors of 0.2 and 0.02 $mg/cm^2$ were used for the RME and CT exposure cases, respectively. Cadmium and carcinogenic PAHs were assessed for dermal exposures to soil as previously described. Exposure frequencies of 219 days/year and 250 days/year for workers were used for the CT and RME cases, respectively. The default high-end exposure duration of 25 years was used for the RME case, while an average employment duration of 9 years was used for the CT exposure case. The default value of 70 kg for an adult body weight was used for both CT and RME cases. Since no toxicity values are available for lead, lead toxicity was assessed using an interim approach recommended for use with non-residential adult exposures, as was done in the RI.

**Adult Utility Worker.** For the adult utility worker (Appendix I, Table 4.3), a soil ingestion rate of 200 mg/day for contact workers was used. Workers were assumed to contact soil with a body surface area of 3,300 $cm^2$ for the CT and RME cases. A soil-to-skin adherence factors of 0.2 $mg/cm^2$ was used for both the RME and CT exposure cases. Cadmium and carcinogenic PAHs were assessed for dermal exposures to soil as previously described. Exposure frequencies of 22 days/year and 66 days/year for utility workers were used for the CT and RME cases, respectively. An exposure duration of 1 year was used for the both the RME and CT exposure cases. The default value of 70 kg for an adult body weight was used for both CT and RME cases.

**Adult/Young Child Residents.** For residential exposures (Appendix I, Table 4.4 for the adult and 4.5 for the child), default CT and high-end soil ingestion rates of 50 and 100 mg/day for the adult and 100 and 200 mg/kg for the young child were used. Adult residents were assumed to contact soil with a body surface area of 5,700 $cm^2$ for the CT and RME cases, while young child residents were assumed to contact soil with a body surface area of 2,800 $cm^2$ for the CT and RME cases. Soil-to-skin

adherence factors of 0.01 and 0.07 mg/cm$^2$ were used for the adult CT and RME cases, respectively. Soil-to-skin adherence factors of 0.04 and 0.2 mg/cm$^2$ were used for the young child CT and RME cases, respectively. Cadmium and carcinogenic PAHs were assessed for dermal exposures to soil as previously described. The exposure frequency value used for the CT and RME exposure cases for both the child and adult residents was 150 days/year. For the adult resident, the exposure duration of 24 years was used for the RME case and 7 years for the CT exposure case. For the child resident, exposure durations of 6 and 2 years, respectively, were used for the RME and CT exposure cases. The body weight for the adult and child receptors used for both the RME and CT cases were 70 kg and 15 kg, respectively.

Since toxicity values are not available for lead, EPA's Integrated Exposure Uptake Biokinetic (IEUBK) model was used to evaluate lead toxicity for the young child resident. The goal of the childhood IEUBK model is to provide reasonably accurate predictions of blood lead levels that will result from residential exposures to soils. Assumptions used in the model include: (1) children are exposed to lead in exterior soil at their residences as well as indoor dust which originated from their yard; (2) there are no major additional sources of lead on the residential properties (*i.e.*, lead paint); (3) the soil-to-dust transfer coefficient is 0.7 (model default); (4) children play outdoors in their yard 150 days/year. During the colder months it is assumed that the ground is frozen or covered with snow. Site soil lead concentrations were used as inputs to the model which then predicts a childhood blood lead level associated with residential exposures to those concentrations. The EPA goal is that exposures to lead in residential soils will not result in more than 5% of children with blood lead levels above 10 μg/dL. Blood concentrations, modeled from site soil concentrations, were compared to this goal in order to determine whether young residential children would be at risk following on-site exposures to lead.

Carcinogenic and noncarcinogenic risks were estimated using both the CT and RME exposure assumptions. The significance of the risk estimates are relative to guidelines set forth in EPA policy (*i.e.*, an incremental lifetime cancer risk [ILCR] above the target risk range of $10^{-6}$ to $10^{-4}$ and a hazard index [HI] above 1). Health risks from soil are expected to be below or within the EPA risk range of $10^{-6}$ to $10^{-4}$ for cancer risk and below a hazard index of 1 for noncancer risk. Estimated occupational

blood lead levels were, however, elevated for this area due to the presence of metals in the subsurface. For the young child resident, soil lead concentrations were also associated with a blood lead level in excess of the blood lead level goal. Therefore, under future commercial or residential site uses, lead would present a risk above regulatory limits.

### 1.5.3 Ecological Risk

The ecological risk assessment for the Site included an evaluation of the potential adverse effects of site COPCs to receptor populations in both terrestrial and aquatic habitats. Adverse effects to soil invertebrates were evaluated using hazard quotients (HQs). Hazard quotients involve dividing a surface soil exposure concentration by a surface soil concentration at which adverse effects are unlikely to occur. Dietary exposures of SVOCs, pesticides, and inorganics to short-tailed shrews from the ingestion of earthworms, surface soil, and surface water at the B&M Railroad Landfill, RSI Landfill, and B&M Locomotive Shop Disposal Areas (Areas A and B) were also evaluated via that hazard quotient method. These measurement endpoints were used to indirectly assess whether COPCs have caused significant reductions in the populations of terrestrial receptors.

Aquatic impacts were evaluated based on a comparison of sediment and surface water concentrations to values below which adverse effects are not expected to occur. Results of a qualitative benthic macroinvertebrate survey were incorporated into the analysis. Dietary exposures of SVOCs, pesticides, PCBs, and inorganics to great blue heron from the ingestion of fish, sediment, and surface water at the West Middlesex Canal Group, Wetland 2 Group, East Middlesex Canal Group, Richardson Pond Group, and Content Brook Wetland Group were evaluated via the hazard quotient method. These measurement endpoints were used to indirectly assess whether COPCs have caused a significant reduction in the populations of aquatic receptors.

The Contaminated Soils Area and the Old B&M Oil/Sludge Recycling Area were not quantitatively evaluated because a qualitative evaluation indicated the lack of significant receptor populations. Habitat in both of these areas is limited, as is the total area over which significant populations of

earthworms and other soil invertebrate would be expected. Without a substantial prey base, shrews would also not be expected to use these areas extensively.

It should be noted that COPCs associated with the Contaminated Soils Area and the Old B&M Oil/Sludge Recycling Area that could be transported were analyzed for in the sediment and surface water of adjacent and downgradient areas. Thus, the COPCs associated with the Contaminated Soils Area and the Old B&M/Sludge Recycling Area were actually accounted for when assessing these adjacent and downgradient areas.

**Overall Terrestrial Summary.** The results of the earthworm and short-tailed shrew analyses indicated the potential for significant reductions in both soil invertebrate and small mammal populations at the B&M Railroad Landfill, and B&M Locomotive Shop Disposal Areas (Areas A and B). In general, inorganics and SVOCs (mostly PAHs) are the two contaminant groups of concern. For soil invertebrates, benzo(a)pyrene and chromium are the two COPCs of most concern in the terrestrial environments at the Site. COPCs for small mammals include antimony, cadmium, iron, and dibenzo(a,h)anthracene. The individual COPC analyses indicated that the B&M Railroad Landfill is the surface soil group with the greatest risks as it had the most HQs greater than 10 for soil invertebrates and small mammals combined. The weight of evidence from evaluation of risks at the B&M Locomotive Shop Disposal Areas (Areas A and B), although not as great as at the B&M Railroad Landfill, also indicated potential significant risk to terrestrial receptor populations including both invertebrates and mammals. Limited evidence was found for significant ecological risks to receptors inhabiting the RSI Landfill.

**Overall Aquatic Summary.** The evaluation of ecological risk in aquatic habitats identified minimal risks from surface water in the Middlesex Canal. Results of the surface water analysis for aquatic receptors indicate there are no COPCs with HQs or HIs greater than 10 in either of the primarily lotic (standing water) water bodies at the Site (*i.e.*, West Middlesex Canal Group and East Middlesex Canal Group). The results of the evaluation of potential risks to benthic receptors due to exposure to sediment COPCs in the Middlesex Canal indicate potential risks in West Middlesex Canal from exposure to SVOCs and also from exposure to copper, lead, PCBs, and pesticides on a limited spacial

scale. No risk to migratory bird populations were identified from potential exposure to contaminants in either canal area (East or West Middlesex Canal). Overall, the weight of evidence suggested that risks to ecological receptor populations inhabiting the Middlesex Canal are not significant.

COPCs with surface water HQs greater than 10 occur in the three lentic areas, indicating the potential for significant reductions in aquatic populations during both high and low flow conditions as a result of the observed concentrations of numerous inorganics in the Wetland 2 Group (barium, iron, lead), Richardson Pond Group (barium, iron, and lead), and Content Brook Wetland Group (barium, aluminum, arsenic, iron, manganese and silver). All three of these surface water groups also had average and maximum HIs greater than 10 for inorganics. The highest HIs occurred in the Content Brook Wetland Group. Thus, aquatic populations are not only at risk from exposure to individual inorganics in each of these surface water bodies, but also from the combined effects of all inorganic COPCs.

Results of the sediment analysis for benthic receptors indicated that significant reductions in benthic populations could occur as a result of the observed concentrations of numerous PAHs and inorganics in the Wetland 2 Group, Richardson Pond Group, and Content Brook Wetland Group. The concentrations of PAHs are of the greatest concern. Support for this conclusion is provided by the average and maximum HIs for SVOCs which were the highest HIs in the Wetland 2 Group and Richardson Pond Group.

The macroinvertebrate surveys did not show any overt adverse effects that appeared to be related to site contaminants and therefore did not add to the weight of evidence indicating that contaminant concentrations in surface water and sediment are significantly affecting the aquatic invertebrate populations in the Site. However, this does not preclude the fact that a more detailed, quantitative analysis could have revealed an association between community structure and contaminant gradient.

A potential for significant reductions in migratory bird populations were indicated by the HQs greater than 10 in the Wetland 2 Group, Richardson Pond Group, and the Content Brook Wetland Group from

exposures to inorganics (particularly mercury and zinc) and SVOCs (particularly dibenzo(a,h)anthracene).

**1.5.3.1 B&M Railroad Landfill.** The results of the analysis for the terrestrial environment indicated potential risk to soil invertebrate populations and small mammals due to exposures to metals (particularly antimony, chromium and mercury) and SVOCs (benzo(a)pyrene and dibenzo(a,h)anthracene) from surface soils at the B&M Railroad Landfill. Although risk was indicated from exposure to high concentrations of iron, there is a large degree of uncertainty with the risk calculation for iron due to the lack of toxicity data for shrews, and risk from exposure to iron may have been over-estimated.

**1.5.3.2 RSI Landfill.** Chromium was the only COPC evaluated at the RSI Landfill which indicated potential impacts to earthworm populations, having an average HQ above 10. The only COPC with an HQ above 10 for the shrew analysis was iron. There is no indication of bioconcentration of chromium in the terrestrial food chain (Carey, 1982 in ATSDR 1987), and the exposure analysis for shrews resulted in an HQ for chromium of less than 1. The ecological risk to the terrestrial ecosystem at the RSI Landfill is restricted mainly to potential reductions in invertebrate soil populations resulting from exposure to chromium. Thus, without further direct evidence of reductions in invertebrate or mammal populations, the weight of evidence from exposure to soil contamination does not indicate significant ecological risk at the RSI Landfill.

**1.5.3.3 B&M Locomotive Shop Disposal Areas.** The weight of evidence from the analyses of exposures to surface soil at the B&M Locomotive Shop Disposal Areas (A and B) indicates potential ecological risk to terrestrial receptors, with potential effects on both invertebrate (benzo(a)pyrene, chromium and copper) and small mammal populations (antimony and iron).

**1.5.3.4 Old B&M Oil/Sludge Recycling Area.** Evaluation of this area indicated lack of complete exposure pathways for terrestrial organisms. This area contains little natural habitat. Although there is potential for transport of soil contaminants to adjacent habitats, particularly wetland areas, the lack of exposure pathways limit the potential for significant risk to ecological receptors.

**1.5.3.5 Contaminated Soils Area.** Evaluation of this area indicated lack of complete exposure pathways for terrestrial organisms. This area contains little natural habitat. Although there is potential for transport of soil contaminants to adjacent habitats, particularly wetland areas, the lack of exposure pathways limit the potential for significant risk to ecological receptors.

**1.5.3.6 Site-Wide Surface Water and Sediment.** The evaluation of ecological risk in aquatic habitats identified minimal risks from surface water in the Middlesex Canal. Potential ecological risk due to exposure of aquatic life to inorganic contaminants in surface water was identified in the three primarily lentic habitats (wetlands/open water) including: Wetland 2 Group (barium, iron, lead), Richardson Pond Wetlands (barium, iron, lead) and Content Brook Wetlands (aluminum, arsenic, barium, manganese, silver; Figure 1-5). In addition, ingestion of surface water did not contribute a major component for the evaluation of exposure of migratory birds for any of the surface water data groupings.

The results of the evaluation of potential risks to aquatic receptors due to exposure to sediment contaminants in the Middlesex Canal indicate potential risk from exposure to inorganic analytes (primarily copper and lead) and SVOCs in sediments in the West Middlesex Canal. In addition, high concentrations of PCBs in limited areas of West Middlesex Canal indicated potential risk to sedentary aquatic receptors. However, no risk to migratory bird populations from potential exposure to contaminants in either canal (East or West Middlesex Canal) were identified.

Greater ecological risks in aquatic habitats were identified for the three primarily lentic (standing water) habitats. Each of these areas (Wetland 2 Group, Richardson Pond Group and Content Brook Group) include large wetland complexes and depositional environments. Ecological risk due to chronic exposure of aquatic life to sediment contaminants was identified in these wetland habitats as follows: Wetland 2 Group (SVOCs and copper), Richardson Pond Wetlands (SVOCs and copper) and Content Brook Wetlands (acenaphthene and arsenic). Potential ecological risk due to exposure of migratory bird populations (great blue heron model) from the incidental ingestion of sediment or ingestion of fish was identified in the three primarily lentic habitats: Wetland 2 Group (mercury, zinc

and dibenzo(a,h)anthracene), Richardson Pond Wetlands (zinc and dibenzo(a,h)anthracene) and Content Brook Wetlands (dibenzo(a,h)anthracene). Potential risk from exposure to dibenzo(a,h)anthracene for the great blue hereon through incidental ingestion of sediments may have been over-estimated in Wetland 2 Group and Richardson Pond wetlands because of high detection limits.

# SECTION 2.0

# DEVELOPMENT OF REMEDIATION CRITERIA AND SCREENING OF TECHNOLOGIES

## 2.1 REMEDIAL ACTION OBJECTIVES AND PRELIMINARY REMEDIATION GOALS

Remedial action objectives (RAOs) are developed to address human health and ecological risks posed by exposure to site contaminants. Soil, groundwater, surface water, and sediment were quantitatively evaluated in the RI human health risk assessment (M&E, 1997) and in the supplemental human health risk assessment for the Old B&M Oil/Sludge Recycling Area (Appendix I). Among these, soil and groundwater were determined to be of concern with regard to human health. Surface soil, surface water, and sediment were evaluated for potential ecological effects in the RI report (M&E, 1997). All evaluated media were determined to be of concern with regard to ecological receptors. Sections 1.5.1, 1.5.2, and 1.5.3 provide a summary of the RI and supplemental risk assessment findings for human and ecological receptors.

The human health risk assessment identified the chemicals listed in Table 2-1, presented by AOC and medium, as contributing to excessive potential risks under baseline conditions. Table 2-1 also includes chemicals that contribute to potential ecological risks. Appendix A contains a summary of RI data utilized in creating Table 2-1. Figure 2-1 presents the approximate locations of wetland group AOCs utilized from this point on in the FS process.

### 2.1.1 Human Health RAOs and PRGs

RAOs for protecting human health are presented in this section, followed by preliminary remediation goals (PRGs) associated with public health protection. These human health RAOs and PRGs are based on the RI report (M&E, 1997) and the supplemental risk assessment for the Old B&M Oil/Sludge Recycling Area (Appendix I). The human health risk assessments evaluated potential exposures to contaminated media at the Site, based on current and projected future land use. Current use includes heavy industrial use of the Site, light recreational use of the wetland areas within the Site, and residential and industrial use of land surrounding and in the vicinity of the Site. Future use may

include residential use of more of the surrounding area and the unlikely possibility that site groundwater will be used as a drinking water source. Exposure assumptions used in the RI report (M&E, 1997) have been maintained for the calculation of PRGs. These exposure assumptions are presented in Appendix B.

EPA guidelines for baseline risks at a Superfund site are generally that noncarcinogenic risk should not exceed a total hazard index of one, and that carcinogenic risks should not exceed the target risk range of $10^{-6}$ to $10^{-4}$. RAOs are limited to media, geographic areas, and chemicals for which estimated risk exceeds EPA target risk ranges. The human health risk assessment identified certain media and areas of the Site that may pose risks in excess of EPA risk guidelines. These include soil at the B&M Locomotive Shop Disposal Area, Old B&M Oil/Sludge Recycling Area and Contaminated Soils Area, and site groundwater in the vicinity of five AOCs (B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Area, Old B&M Oil/Sludge Recycling Area, and Asbestos Lagoons). Soil exposure pathways include the inhalation of indoor dust and particulate matter emanating from soil, the pathway of concern for lead. Air was screened out of the human health risk assessment as being unlikely to directly pose significant risks. Estimated risks from surface water and sediment did not exceed a hazard index of one or a cancer risk of $10^{-6}$ to $10^{-4}$. Therefore, because the only media for which risks exceed EPA target risk ranges are soil and groundwater, RAOs are identified for only these two media.

**2.1.1.1 Development of Human Health RAOs.** Human health RAOs are summarized in Table 2-2. The human health RAOs for the Site include specific objectives to reduce risks identified in the baseline risk assessments as above EPA guidelines. Also, in order to prevent risks caused by future contaminant migration, RAOs to reduce contaminant mobility are included. RAOs relevant to protection of human health at the Site are as follows:

- Soil - Prevent ingestion of the lead in B&M Locomotive Shop Disposal Area, Old B&M Oil/Sludge Recycling Area and Contaminated Soils Area soil that results in estimated blood lead levels of greater than 4.2 µg/dL, a site-specific level protective of a 95th percentile fetal blood lead level of 10 µg/dL

- Groundwater - Prevent ingestion of groundwater contamination in excess of chemical-specific drinking water ARARs or, in the absence of ARARs, in excess of the EPA target risk range of $10^{-6}$ to $10^{-4}$ for carcinogenic compounds and the target hazard index of one for noncarcinogenic compounds with similar toxicity endpoints at the following AOCs: B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons.

**2.1.1.2 Development of Human Health PRGs.** Where there are established ARARs for chemical-specific concentrations (*e.g.*, groundwater Maximum Contaminant Levels [MCLs]), these are selected as PRGs. According to U.S. EPA guidance For *Development Of Risk-based Preliminary Remediation Goals* (U.S. EPA, 1991c), it is appropriate to develop PRGs for site media with cumulative cancer risks greater than $10^{-4}$ or hazard indices greater than one, except for media with clearly defined ARARs. Within these media, PRGs are appropriate for each chemical with cumulative cancer risks above $10^{-6}$ or with a hazard index above one. A few contaminants in groundwater without MCLs, and lead in soil are eligible for risk-based PRGs based on this guidance. In each of the site media of human health concern, risk-based PRGs are calculated using current toxicity data. Toxicity data used to calculate risk-based PRGs are presented in Table B.1-9 of Appendix B. Risk-based PRGs are calculated for all analytes for which risks estimated in the RI contribute substantially to total risks above RAOs. The human health PRGs are summarized in Table 2-3.

**Soil.** A preliminary remedial goal for lead in soil was developed to protect a current female site worker of child-bearing age. The PRG is based on the methodology described in *Interim Approach to Assessing Risk Associated with Adult Exposures to Lead in Soil* (U.S. EPA, 1996a). The PRG is based on the site-specific maternal blood lead level of 4.2 µg/dL, developed in the RI risk assessment as a level protective of a 95th percentile fetal blood lead level of 10 µg/dL. The equation shown below is used to derive the risk-based lead PRG for soil:

$$Pb(S) = [Pb(B)_{adult,\ central} - Pb(B)_{adult,\ 0}] \times \frac{AT}{(BKSF \times IR_S \times AF_S \times EF_S)}$$

where:

Pb(S) = soil lead PRG µg/g (mg/kg)

| | | |
|---|---|---|
| $Pb(B)_{adult,central}$ | = | site-specific maternal blood lead level protective of a 95th percentile fetal blood concentration of 10 µg/dL (4.2 µg/dL) |
| $Pb(B)_{adult,0}$ | = | typical blood lead concentration in women of childbearing age in the absence of site exposures (1.7 µg/dL) |
| BKSF | = | biokinetic slope factor relating quasi-steady state adult blood lead concentration to average daily lead uptake (0.4 µg/dL per µg/day) |
| $IR_S$ | = | intake rate of soil, including both outdoor soil and indoor soil-derived dust (0.05 g/day) |
| $AF_S$ | = | absolute gastrointestinal absorption fraction for ingested lead in soil and soil-derived dust (0.12, unitless) |
| $EF_S$ | = | exposure frequency (219 days/year) |
| AT | = | averaging time, selected as 365 days/year for long-term exposures |

**Groundwater.** Table 2-3 shows the proposed risk-based and/or standards-based PRGs corresponding to the groundwater RAOs. The target individual selected to represent exposure to groundwater was a future resident who may ingest groundwater 350 days a year for 30 years. The chemicals for which cleanup is indicated are those chemicals of potential concern (identified in the RI report) for which a cleanup level is below the maximum concentration detected in a particular area of the Site.

The groundwater PRGs shown in Table 2-3 are based on use of the aquifer as a potential drinking water source. Final MCLs and non-zero Maximum Contaminant Level Goals (MCLGs) developed under the Safe Drinking Water Act are used to establish PRGs for groundwater. If no MCLs or non-zero MCLGs are available, the goals are based on the more stringent of a $1 \times 10^{-6}$ excess cancer risk or a hazard quotient of one. Since multiple contaminants are present, the combined excess cancer risk should be in the range of $10^{-6}$ to $10^{-4}$, and the combined hazard index should be less than 10, assuming additivity of risk. The methodology used in determining the groundwater risk-based goals is presented below.

Risk-based PRGs are developed for groundwater to protect a potential future resident who might use groundwater as a drinking water source. The equation shown below was used to derive risk-based PRGs for groundwater:

$$C\ (\mu g/L) = \frac{TR \times BW \times AT \times 365\ days/year \times 1000\ \mu g/mg}{EF \times ED \times TOX \times IR^{w}}$$

where:

| | | |
|---|---|---|
| C | = | Chemical concentration in water |
| TR | = | Target risk: target excess lifetime cancer risk (for carcinogenic effects) of $10^{-6}$ and target hazard index (for noncarcinogenic effects) of 1 |
| BW | = | Adult body weight (70 kg) |
| AT | = | Averaging time for carcinogens (70 years) and noncarcinogens (30 years) |
| EF | = | Exposure frequency (350 days/year) |
| ED | = | Exposure duration (30 years) |
| TOX | = | Toxicity value, which is chemical-specific for both carcinogens and noncarcinogens. Carcinogens are measured as oral slope factor $(mg/kg\text{-}day)^{-1}$ and noncarcinogens are measured as 1/reference dose (RfD) (mg/kg-day). |
| $IR^W$ | = | Daily water ingestion rate (2 L/day) |

Limitations and uncertainty of predicting human health risks were discussed in Section 6.0 of the RI report (M&E, 1997). Much of the uncertainty in the health risk assessment also applies to the human health PRGs, since the PRG development is based on chemicals, media, and areas of concern identified in the RI. Also, the PRGs were developed using the same exposure assumptions and parameters. As a result, the following significant sources of uncertainty apply to the derivation of the PRGs:

- Identification of chemicals, media, and areas of concern
- Fate and transport assumptions
- Dose-response relationships for individual chemicals
- Toxicity interaction between chemicals
- Exposure scenario development
- Target population characteristics

A large number of soil and groundwater samples in the site study area were analyzed for numerous chemicals. The chemicals identified as of potential concern in groundwater and soil are likely to be representative of the toxicity in these media. Dose-response uncertainty is common to all hazardous waste risk assessments. There are many uncertainties regarding the amount of time people spend

visiting the Site or working outdoors in the site study area, and about how much contact there will be in the future.

### 2.1.2 Ecological RAOs and PRGs

RAOs for the protection of ecological receptor populations are presented in this section, followed by PRGs. Ecological RAOs and PRGs were developed to protect those receptor populations that were identified in the RI as having the potential to be impacted by site contaminants (M&E, 1997).

As discussed in Section 1.5.3, a hazard quotient of ten was used in the ecological risk assessment to define those receptors for which contaminants pose an unacceptable risk. However, in accordance with EPA Region I protocols, PRGs were developed to protect receptor populations from medium-specific contaminant concentrations associated with a hazard quotient of one.

Following the comment period of the Draft FS, a supplemental analysis of the ecological risks to receptors in the East and West Middlesex Canal Groups was conducted (Appendix I). The conclusions of the ecological risk assessment presented in the Final RI (M&E, 1997) were determined to be reasonable based on the amount of data collected and the lack of biological effects data. However, while the sediment contaminant concentrations representing the two AOCs did not exceed the thresholds utilized in the ecological risk assessment, some were high enough to justify a recommendation that further confirmation sampling be performed prior to remedial design. This sampling effort would analyze both sediment chemistry and biological effects to determine if hot spot remediation is necessary.

**2.1.2.1 Development of Ecological RAOs.** Ecological RAOs are summarized in Table 2-4. The ecological RAOs for the Site involve preventing exposure to contaminant levels that may impact ecological receptor populations.

**Soil.** The risk assessment indicated that contaminants in soil at B&M Railroad Landfill and the B&M Locomotive Shop Disposal Areas pose a risk to earthworms and short-tailed shrews. To emphasize

the importance of contaminants in the food chain, EPA chose to develop RAOs for small mammals only. The RAO provides protection for short-tailed shrews and other small mammals from exposure to levels of metals associated with a hazard quotient greater than one.

In addition to metals at B&M Railroad Landfill, the potential for dibenz(a,h)anthracene to pose a risk to short-tailed shrews was also identified in the ecological risk assessment (M&E, 1997). However, further review conducted as part of this feasibility study indicated that the reference toxicity value used in the risk assessment was overly conservative (see discussion in Appendix B). Therefore, the ecological RAO for soil at B&M Railroad Landfill does not include a reference to PAHs.

**Surface Water.** The ecological risk assessment indicated that contaminants in surface water from Wetland 2 Group, Richardson Pond Group, and Content Brook Wetland Group pose a risk to aquatic receptor populations and great blue heron. Based on the uncertainty involved with the great blue heron food chain model, EPA chose to frame the RAO around the protection of aquatic receptors populations assuming that this approach would also provide adequate protection for migratory birds. The surface water RAO for aquatic receptor populations provides protection against exposure to levels of metals in excess of National Water Quality Criteria (*i.e.*, Criterion Continuous Concentrations).

**Sediment.** Results of the ecological risk assessment indicated that contaminants in sediment from Wetland 2 Group, Richardson Pond Group, and Content Brook Wetland Group pose a risk to benthic invertebrates. In addition, sediment contamination at Wetland 2 Group and Content Brook Wetland Group was identified as posing a risk to great blue heron. As with surface water, EPA chose not to develop RAOs for the protection of the great blue heron due to the level of uncertainty associated with the food chain model. Rather, EPA chose to develop an RAO for the protection of benthic invertebrate populations under the assumption that this approach would still provide adequate protection for migratory birds. The sediment RAO provides for protection against exposure to levels of PAHs, metals, and pesticides that may be indicative of impact. It alternatively allows for the attainment of background concentrations.

The results of the ecological risk assessment indicate that contaminants in sediment from the East and West Middlesex Canal Groups do not pose a risk to benthic invertebrate populations, based on the level and extent of the exceedances of sediment benchmarks. These two wetland groups are anticipated to be evaluated further via toxicity testing during pre-design activities. In the event that sediment toxicity testing results in documentation of benthic community impairment and evidence of toxicity to test species, an RAO has been included for these AOCs which provides for protection against exposure to COCs which may be indicative of impact.

**2.1.2.2 Development of Ecological PRGs.** For soil contaminants, PRGs were developed by back calculating a soil concentration associated with a hazard quotient of one. For sediment contaminants, toxicity benchmarks and site-specific RI background data were used to develop PRGs. National Water Quality Criteria, which are ARARs, were used as PRGs for surface water contaminants. Additional detail on the PRG development process is provided below, by medium. A summary of the ecological PRGs is presented in Table 2-5.

**Soil.** The development of PRGs for short-tailed shrews involved reviewing the exposure model and toxicity reference values presented in the RI risk assessment to determine: 1) whether they represent an overly conservative assessment, as opposed to a realistic assessment of the potential for impact; and 2) whether literature has been published since the preparation of the RI risk assessment that might assist the development of more accurate estimates of exposure and toxicity. Based on the review of the RI risk assessment and additional primary and secondary literature, preferred food chain model parameters are presented in Table B.2-1 of Appendix B, along with comments regarding how they compare to those used in the RI risk assessment.

For soil contaminants, EPA requested that a range of PRGs be developed for each analyte based on varying one or more important exposure parameters. To achieve this goal, hazard quotients were calculated for three different shrew body weights, 15 g, 22 g and 30 g. Based on the review of several sources, these approximately represent the minimum and maximum adult body weights for the short-tailed shrew, as well as the middle value in the body weight range. Average and maximum case hazard quotients for each body weight scenario are presented in Table B.2-2 of Appendix B, along

with the soil concentration which would correspond to a hazard quotient of one. For each contaminant, the lowest soil concentration among the three was selected as the PRG (Table 2-5).

As discussed in Section 2.1.2.1, earthworm-specific PRGs were not developed. In addition, PRGs for the protection of small mammals were not develped for iron, dibenzo(a,h)anthracene, or antimony. Justification for excluding ecological risk assessment analytes of concern from PRG development is provided in Appendix B.

**Surface Water.** PRGs for surface water are chronic ambient water quality criteria (AWQC) or, if unavailable, Tier II Secondary Chronic Values (Suter and Tsao, 1996) (Table 2-5). As promulgated, most of the chronic AWQC are expressed as dissolved concentrations (*i.e.*, the post-filtering concentration), while the Tier II values are for total concentrations. Additonal information on surface water PRGs is provided in Table B.2-3 of Appendix B, including the site-specific water hardness adjustments and references. Although the majority of the inorganic PRGs are expressed as dissolved concentrations, Table B.2-3 of Appendix B shows the corresponding total concentrations based on EPA dissolved-to-total conversion factors. These total concentration values will be used to determine the extent of PRG exceedances when compared to RI data, which are from unfiltered samples.

As discussed in Section 2.1.2.1, heron-specific PRGs were not developed, nor was a PRG designated for iron. Justication for excluding ecological risk assessment analytes of concern from PRG development is provided in Appendix B.

**Sediment.** Analytes of concern in sediment were those which had an average or maximum exposure case hazard quotient in excess of ten. The development of PRGs for these analytes involved several steps. First, there was consideration regarding the potential for more current data to enhance the accuracy of the heron food chain model. Although more current data in the literature would provide additional support for exposure and toxicity parameters, the many assumptions involved in the heron model would still make results uncertain. As such, EPA chose not to pursue this approach.

Second, EPA requested that the RI benthic invertebrate survey data be reevaluated to determine whether it might provide some support for PRG development. In general, the review did not yield any insights due to the large variation in habitat characteristics at each location and the lack of chemical data for some of the benthic survey locations.

The third step in PRG development was to chart average sediment concentrations against ecological benchmarks and the range of background concentrations (see Figures B.2-1 through B.2-8 of Appendix B) in an attempt to visually assess the relationship between site contaminant levels and possible remediation goals. For those contaminants that were identified as posing a risk under the maximum exposure case only, both the average and maximum concentration were charted.

The following benchmark sources were used in the graphical presentation and for the selection of PRGs:

- USEPA Sediment Quality Criteria (SQC) (USEPA, 1993a)
- USEPA Sediment Quality Benchmarks (SQB) (USEPA, 1996b)
- Ontario Ministry of Environment and Energy (OMEE) Lowest and Severe Effect Levels (LEL and SEL) (Persaud et al., 1993)
- National Oceanic and Atmospheric Administration (NOAA) Effects-Range Low (ERL) and Effects-Range Median (ERM) Values, (Long and Morgan, 1990; Long et al., 1995).

The NOAA and OMEE values are presented as a range (*e.g.*, the bar begins at the LEL and ends at the SEL). Values for benchmarks presented in the bar charts are also presented in Table B.2-4 of Appendix B. Where appropriate, benchmarks were calculated using the site-specific average total organic carbon (TOC) value of 4.9%.

PRGs recommended for benthic invertebrates are listed in Table 2-5. The SQC, if available, was selected as the PRG, followed by the LEL, and then the ERL (there were no SQBs available for any of the contaminants of concern). The maximum background concentration was selected as the PRG if it was greater than the preferred ecological benchmark.

The background value for total PAHs was calculated as follows:

- A list of PAHs detected in the four background sediment samples was generated
- Using the same list for all the samples and one-half the detection limit for non-detected values, the concentrations of individual PAHs were summed for each sample.

As discussed in Section 2.1.2.1, heron-specific PRGs were not developed. In addition, a PRG for endrin aldehyde was not developed for benthic invertebrates. Justication for excluding ecological risk assessment analytes of concern from PRG development is provided in Appendix B. Furthermore, existing results of the ecological risk assessment indicate that contaminants in sediment from the East and West Middlesex Canal Groups do not pose a risk to benthic invertebrate populations, based on the level and extent of the exceedances of sediment benchmarks. While an RAO was developed for these two AOCs, chemical-specific PRGs were not developed. In the event that future sediment toxicity testing results in ecological risk, PRGs would be developed at that time.

## 2.2 GENERAL RESPONSE ACTIONS

General response actions are developed to satisfy the RAOs for the Site. The range of applicable general response actions for each medium's RAOs are as follows:

| | | | |
|---|---|---|---|
| Soil: | No Action<br>Institutional Actions<br>Source Control<br>Treatment: Off-Site<br>Treatment: In-Situ<br>Treatment: On-Site | Groundwater: | No Action<br>Institutional Actions<br>Management of Migration<br>Source Control<br>Collection<br>Treatment: Point-of-Use<br>Treatment: In-Situ<br>Treatment: On-Site<br>Treatment: Off-Site |
| Sediments: | No Action<br>Institutional Actions<br>Source Control<br>Treatment: Off-Site<br>Treatment: In-Situ<br>Treatment: On-Site | Surface Water: | No Action<br>Institutional Actions<br>Collection<br>Treatment: In-Situ<br>Treatment: On-Site<br>Treatment: Off-Site |

## 2.3 PERFORMANCE OF INSTITUTIONAL SCREENING (ARARs)

During the FS process, an analysis is made of legal and policy requirements that could affect the implementation of remedial alternatives. These institutional issues consist mainly of the compliance of each proposed remedial alternative with applicable or relevant and appropriate federal, state, and local public health and environmental requirements (ARARs). Determination of ARARs is site-specific and depends on the chemical contaminants, site/location characteristics, and remedial actions being investigated for site cleanup. Consideration of ARARs is undertaken to fulfill the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended, the National Contingency Plan (NCP), and other requirements of laws that must be addressed by the EPA or parties undertaking the remedial action. In the "Detailed Evaluation of Alternatives" section, each alternative is evaluated with respect to its compliance with the ARARs identified below.

CERCLA, as amended by the Superfund Amendments and Reauthorization Act (SARA, October 1986), governs the liability, cleanup, financial responsibility, and response for hazardous substances released into the environment. CERCLA requires that all remedial actions be consistent with the NCP. The NCP, published as 40 CFR Part 300, specifies procedures, techniques, materials, equipment, and methods to be employed in identifying, removing, or remedying releases of hazardous substances. In particular, the NCP specifies procedures for determining the appropriate type and extent of remedial action at a site in order to effectively mitigate and minimize damage to, and provide adequate protection of, public health, welfare, and the environment.

The national goal of remedy selection is to protect human health and the environment, to maintain that protection over time, and to minimize untreated waste (40 CFR Part 300.430 of the NCP (55 FR 8846)). In accordance with Section 121(d) of CERCLA, site remediation must comply with all applicable or relevant and appropriate laws, regulations, and standards promulgated by the federal government, except where waived. State requirements must also be attained, under Section 121(d)(2)(c), if they are legally enforceable and consistently enforced statewide, and if the state ARAR is more stringent than the federal ARAR and has been presented to the EPA in a timely

manner. Waiver conditions that may be used, if protection of human health and the environment is to be ensured, include the following:

- The remedial action selected is only part of a total remedial action that will attain such level or standard of control when completed
- Compliance with such requirements is technically impracticable from an engineering perspective
- Compliance with such requirement at that facility will result in greater risk to human health and the environment than alternative options
- The remedial action selected will attain, through use of another method or approach, a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, criteria, or limitation
- In the case of a remedial action to be undertaken solely under Section 104, selection of a remedial action that attains such level or standard of control will not provide a balance between the need for protection of public health and welfare and the environment at the facility under consideration, and the availability of money from the fund to respond to other sites, taking into consideration the relative immediacy of such threats
- With respect to a state standard, requirement, criteria, or limitation, the state has not consistently applied (or demonstrated the intention to consistently apply) the standard, requirement, criteria, or limitation in similar circumstances at other remedial action sites within the state

The NCP defines "applicable" and "relevant and appropriate" requirements. Applicable requirements consist of those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. In addition, other environmental and public

health guidelines, although not ARARs, may be considered to help determine what is protective or to determine CERCLA remedies. These guidelines are termed "to be considered" or "TBC".

CERCLA Section 121(e), codified at 40 CFR Part 300.400(e), exempts any response action conducted entirely at the site from having to obtain a federal, state, or local permit, where the action is carried out in compliance with Section 121. Remedial actions conducted on Superfund sites need comply only with the substantive aspects of ARARs and not with the corresponding administrative requirements.

Identification of potential ARARs to be considered for the Site and adjacent wetland areas are organized into three categories, following EPA's *CERCLA Compliance with Other Laws Manual* (Interim Final -- EPA/540/G-89/006, Part II -- EPA/540/G-89/009 guidance (U.S. EPA, 1988 and 1989):

- Chemical-specific
- Location-specific
- Action-specific

The following subsections summarize ARARs for the Site. Each possible ARAR is reviewed to evaluate its potential applicability or relevancy and appropriateness according to the procedures identified in CERCLA Compliance with Other Laws Manual (OSWER Directive 9234.1-01), *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (OSWER Directive 9355.3-01), and *RCRA, Superfund & EPCRA Hotline Training Module: Introduction to Applicable or Relevant and Appropriate Requirements* (OSWER 9205.5-10A).

### 2.3.1 Chemical-Specific ARARs

Chemical-specific ARARs provide criteria for evaluating concentrations of specific hazardous contaminants. They are developed based upon the protection of human health and the environment. These values establish the acceptable amount or concentration of a chemical that may be found in or discharged to the environment. Federal and state laws which may be potential chemical-specific ARARs or TBCs are summarized in Table 2-6 and include:

- Federal Safe Drinking Water Act, MCLs and MCLGs
- Resource Conservation and Recovery Act (RCRA) Maximum Concentration Limits
- Federal Clean Water Act Ambient Water Quality Criteria (AWQC)
- Federal Clean Air Act, NESHAPs
- Massachusetts Groundwater Standards, Groundwater Discharge Permit Program, and Underground Water Source Protection Regulations
- Massachusetts Drinking Water Regulations
- Massachusetts Surface Water Quality Standards and Discharge Permit Program
- Massachusetts Air Pollution Control Regulations
- Massachusetts Solid Waste Management Facility and Regulations
- Federal Criteria and Advisories To Be Considered

A discussion of the applicability or relevancy and appropriateness of each of the potential ARARs or criteria to be considered listed above is provided in this section.

No single set of federal or state criteria dictate acceptable concentrations in drinking water or surface water for all of the contaminants detected within the site study area. Chemical-specific ARARs and TBCs for groundwater are listed in Table 2-7, for surface water in Table 2-8, and for sediment in Table 2-9. There are no numerical soil criteria. For reference, a cross index of contaminants of concern (COCs) and media is provided in Table 2-10.

**2.3.1.1 Safe Drinking Water Act.** The Safe Drinking Water Act (SDWA) of 1974, most recently amended in 1996, was established to protect public drinking water supplies. The major elements of the drinking water program include:

- Drinking water standards and treatment techniques
- Filtration and disinfection of surface supplies and disinfection by-product standards
- Coliform rule
- Radionuclide standards

Section 1424(e) of the SDWA authorizes EPA to determine that an aquifer is the "sole or principal" source of drinking water for an area.

Section 1412 of the SDWA requires the EPA to publish MCLGs and promulgate national drinking water regulations. Under Section 1401, EPA must develop enforceable MCLs and "criteria and procedures to assure a supply of drinking water which dependably complies" with such MCLs. Under Section 1412(b)(7)(a), the use of a best available treatment technique instead of attainment of an MCL is allowed if it is not technically or economically feasible to ascertain the level of a contaminant in drinking water. Primary Drinking Water Regulations are set forth under 40 CFR Part 141 while 40 CFR Part 142 supplies National Primary Drinking Water Implementation Regulations and 40 CFR Part 143 provides National Secondary Drinking Water Regulations. 40 CFR Part 141 Subparts B and F specify MCLs and MCLGs.

MCLs are enforceable chemical-specific drinking water standards, developed under the SDWA. MCLs are based on the use of best technology, treatment techniques, and other factors, including cost. MCLGs are based entirely on health considerations and do not take cost or feasibility into account. MCLGs are set at levels which will result in no known or anticipated health effects, keeping a margin of safety.

Massachusetts has primacy for implementation of the provisions of the Safe Drinking Water Act. The Massachusetts Drinking Water Regulations are found at 310 CMR 22.00 and apply to public drinking water supply systems. Massachusetts Maximum Contaminant Levels and Maximum Contaminant Level Goals are specified for inorganic and organic chemicals. For the most part, the numerical criteria are identical to Federal SDWA MCLs and MCLGs, although there are several additional chemicals that have criteria. Criteria are listed in Table 2-7. Since Site groundwater is not used as a public drinking water supply, the criteria are not applicable. Site groundwater is classified as potable (see Section 2.3.1.5), thus the Massachusetts MCLs are relevant and appropriate for Site groundwater. Since the Site is adjacent to and upgradient of groundwater which is a potential drinking water supply, MCLs and non-zero MCLGs are relevant and appropriate to off-site groundwater. MCLGs set at zero are to be considered.

The Massachusetts Office of Research and Standards (ORS) also issues guidelines for many chemicals that do not have listed Massachusetts MCLs. Massachusetts ORSGs are guidelines to be considered.

**2.3.1.2 Resource Conservation and Recovery Act Maximum Concentration Limits.**

40 CFR §264.94 establishes three categories of federal groundwater protection standards which are considered by Superfund as potentially ARAR: RCRA MCLs, Alternate Concentration Limits (ACLs), and background concentrations. RCRA MCLs have been adopted for 14 toxic compounds, primarily metals and pesticides, as a part of RCRA groundwater protection standards (40 CFR §264.94).

These standards apply to RCRA regulated units that received RCRA hazardous waste after July 26, 1982. If a comparison of indicator concentrations from background and downgradient wells shows a statistically significant increase, a groundwater protection standard is established for all hazardous constituents. The baseline protection standard is the background level of the constituent, one of the 14 RCRA MCLs, or an ACL. ACLs are applied for and granted on a site-by-site basis and must ensure that there will not be a substantial present or potential hazard to human health and the environment.

Discharge of RCRA listed or characteristic hazardous wastes has not been documented in the landfills, disposal areas, recycling areas, asbestos lagoons, and other areas which make up OU3. Undocumented discharge of RCRA hazardous wastes may have occurred, however. Some of these disposal areas may have been RCRA regulated disposal units subject to permitting which received wastes after July 26, 1982. In addition, since the disposal areas may have received waste that under current rules would be considered a hazardous waste, RCRA Subtitle C requirements are considered relevant and appropriate for the disposal areas.

**2.3.1.3 Federal Water Pollution Control Act, as Amended by the Clean Water Act, Ambient Water Quality Criteria.** The Federal Water Pollution Control Act as amended by the Clean Water Act (referred to as the Clean Water Act or CWA) seeks to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (40 CFR 101(a)).

The CWA, as amended, sets forth ambient water quality criteria for the protection of freshwater aquatic life and human health (authorized under CWA Section 304(a)(1) and regulated under 40 CFR 120). Water quality standards are based on the designated use(s) for the water, and the criteria necessary to protect the designated use(s). Federal AWQC developed under Section 304(a) of the CWA are unenforceable guidance criteria based on the latest scientific information to evaluate the effect a toxic pollutant concentration has on a particular aquatic species and/or human health. There are both proposed and final AWQC. With regards to human exposure, there are two categories to consider: ingestion of both contaminated drinking water and contaminated fish, and ingestion of contaminated fish alone. Although AWQC are nonenforceable, and thus cannot be applicable, Section 121 of CERCLA states that remedial actions shall attain AWQC where they are relevant and appropriate. In determining if AWQC are relevant and appropriate, the primary factors to consider are the designated or potential uses of the water, the media affected, the purposes for which the potential requirement are intended and the latest information available.

The AWQC may be relevant and appropriate for the wetlands identified on Site when protection of aquatic life is a concern or human exposure from consumption of fish a concern. In the RI report (M&E, 1997), the West Middlesex Canal posed potential risks to benthic receptors based on exposures

to organic and inorganic chemicals. In the Wetland 2, Richardson Pond, and Content Brook Wetland Groups, inorganics were found to pose risks to aquatic populations. The RI report also specified that human exposures to surface water may include wading and dermal contact but not ingestion of water or consumption of fish. As identified in the ecological assessment of the RI, aquatic organisms appear to be directly and negatively impacted in surface water locations. For this reason, freshwater acute and chronic AWQC for the protection of aquatic life are considered appropriate and relevant for the Site wetlands.

**2.3.1.4 Clean Air Act and Massachusetts Air Pollution Control Regulations.** The federal Clean Air Act directs EPA to promulgate National Emission Standards for Hazardous Air Pollutants (NESHAPs) which apply to stationary sources of specific chemicals. 40 CFR, Subpart M, national emissions standards for asbestos, applies to various sources of airborne asbestos, specifically including inactive waste disposal sites for asbestos mills and manufacturing and fabricating operations (40 CFR 61.151). These regulations, applicable to the asbestos landfill and asbestos lagoons, require that there be no visible emissions. The corresponding Massachusetts Air Pollution Control Regulations are found at 310 CMR 7.15.

**2.3.1.5 Massachusetts Groundwater Quality Standards, Groundwater Discharge Permit Program, and Underground Water Source Protection.** These rules are published as 314 CMR 6.00, 314 CMR 5.00, and 310 CMR 27.00, respectively. Groundwater Quality Standards require that Massachusetts groundwater be assigned as Class I, II, or III, based on the most sensitive use for which it is to be maintained and protected, and establishes limits for certain organic and inorganic chemicals based on the classification. The State has established groundwater at the OU3 area as "Class I": Fresh ground waters designated as a source of potable water supply. Class I Standards are listed in Table 2-7 and are applicable to the Site. The Groundwater Quality Standards also specify standards for discharging wastes or effluent into groundwater, and requires the Massachusetts Department of Environmental Protection (MADEP) to establish discharge limits.

The Massachusetts Groundwater Discharge Permit Program establishes effluent limitations for discharges into Class I and II groundwaters of the state. These effluent limits are generally the same as

the Groundwater Quality Standards noted above; but include the requirement that toxic pollutants not exceed EPA or DEP "Health Advisories," and include secondary effluent limitations based on impairment of use as potable water. Effluent limits would be applicable for any proposed remediation action which involves discharge of treated water to groundwater.

Underground Water Source Protection Rules regulate any underground injection of wastes. The rules prohibit injection of any materials except for specific purposes listed in the rules, or septic systems; and specifies that underground sources of drinking water shall be protected. These rules would be applicable to remedial actions which include deep injection of water.

**2.3.1.6 Massachusetts Surface Water Quality Standards and Discharge Permit Program.** Under the CWA, every state is required to classify waters within its boundaries according to its intended use, establish antidegradation requirements, and develop water quality standards. The Massachusetts Surface Water Quality Standards and Discharge Permit Program, designated under 314 CMR 4.00 and 314 CMR 3.00, respectively, are based on this requirement. The Massachusetts Surface Water Quality Standards classify freshwater surface waters as Class A, B, or C based on the most sensitive water uses to be achieved and protected. The rules set general criteria for aquatic habitat, aesthetics, nutrients, and mixing zones for all surface waters of the state. In addition, class-specific criteria are set for dissolved oxygen, temperature, nutrients, pH, solids, oil, grease, turbidity, fecal coliform bacteria, color, and tastes and odor. As part of the Shawsheen River Basin, Site surface waters are classified as "Class B": habitat for fish, aquatic life and wildlife, and source of treated public water supplies. Surface Water Quality Standards are considered applicable to Site surface waters.

The Massachusetts Surface Water Discharge Permit Program establishes permit requirements for specific discharges into surface waters. The permit program requires that no discharge result in violations of groundwater standards or surface water standards noted above but do not set specific effluent limits. The discharge permit program identifies the list of toxic pollutants to be controlled with effluent limitations. Pollutant discharges must comply with National Pollutant Discharge Elimination System (NPDES) permit requirements. Permit conditions and standards for different classes of water are specified. Permit requirements are not applicable for Superfund sites, but

substantive requirements may be relevant and appropriate for any proposed remediation action which involves discharge of treated water to surface water.

**2.3.1.7. Massachusetts Chapter 21E and the Massachusetts Contingency Plan.** M.G.L. Chapter 21E, the Massachusetts Oil and Hazardous Material Release Prevention and Response Act, is the law regarding cleanup and liability for oil and hazardous material spills. The Massachusetts Contingency Plan (MCP), found at 310 CMR 40.0000, is the set of regulations promulgated pursuant to this act and specifies procedures for reporting, assessing, and remediating releases of oil and hazardous materials.

The MCP includes a specific reference to remediation at CERCLA sites (40.0111) where it is stated that the MCP does not apply to sites adequately regulated under CERCLA, provided that MADEP concurs with the ROD and that CERCLA addresses all contaminants. Thus, if the CERCLA site-specific risk assessment does not consider chemicals, media, exposures, or land uses specified by the MCP, MCP risk criteria for soil and groundwater would be relevant and appropriate for those particular chemicals, media, exposures, or land uses.

The Iron Horse Park OU3 Site human health and ecological risk assessment assessed all chemicals detected during the Site investigation, which is an MCP requirement. Although not all chemicals were quantitatively evaluated, they were compared to risk-based screening concentrations to select those chemicals to be quantitatively evaluated.

**2.3.1.8 Federal Criteria and Advisories To Be Considered.** In addition to the ARARs listed above, there are other important issues and advisories which will require attention prior to and during remedial activities. These criteria and advisories to be considered include:

- **Health Advisories** are generated by the EPA Office of Drinking Water and are estimates of risk due to consumption of contaminated drinking water, based on non-carcinogenic risk.

- **Reference Dose Concentrations** are available for many air and water contaminants on the Integrated Risk Information System (IRIS) on-line database. Where contaminant concentrations do not exceed air or water reference concentrations, adverse health effects other than cancer are unlikely to occur. These values are useful as health-based goals to be considered.

- **Slope Factors and Unit Risks.** Carcinogenic slope factors and unit risks are developed by the EPA Carcinogenic Assessment Group (CAG) from health effects studies using epidemiologic data or from animal testing. Slope factors and unit risks for various carcinogens provide a measure of the strength of a carcinogen; many are available from IRIS. Unit risks may be used to develop target concentrations to correspond to a selected acceptable risk.

- **Federal Groundwater Protection Strategy of 1984.** The EPA developed the Groundwater Protection Strategy in 1984 with the goal of organizing and coordinating the various programs that protect groundwater. The groundwater protection strategy lists several policy statements that emphasize the protection of groundwater resources. The strategy is not a promulgated requirement and, therefore, cannot be a potential ARAR; it does, however, list several policy statements to be considered when developing a protective remedy. To help achieve consistency among programs, groundwater classification guidelines were developed to distinguish between different groundwaters meriting different levels of protection. Class I groundwaters are "special groundwaters" that are highly vulnerable and are either irreplaceable or ecologically vital. Class II groundwaters are current and potential sources of drinking water and waters having other beneficial uses. Class II groundwaters are estimated to comprise 84 to 94% of the nation's groundwater. Class III groundwaters are those that cannot be used for drinking water due to high salinity or widespread naturally occurring contamination.

- **Threshold Limit Values (TLVs).** TLVs refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed to day after day without adverse health effects.

### 2.3.2 Location-Specific ARARs

Location-specific ARARs must be considered when developing the FS as these types of ARARs may affect or restrict remediation and site activities. Generally, location-specific requirements serve to protect individual Site characteristics, resources, and specific environmental features on a site. The following federal and state laws which pertain to the protection of resources and are potential ARARs or criteria TBC for the Site are described below and summarized in Table 2-11:

- Clean Water Act (33 U.S.C. §1251 to 1387), Section 404 and Guidelines for Specification of Disposal Sites of Dredged or Fill Material (33 U.S.C. §1344), Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. §403)

- Executive Order No. 11990, Wetlands Protection

- Statement of Procedures on Floodplain Management and Wetlands Protection (40 CFR 6, Appendix A)
- Federal Fish & Wildlife Coordination Act (16 U.S.C. §661-666c)
- Federal Resource Conservation and Recovery Act, location requirements (40 CFR 264.18)
- Federal Archaeological and Historical Preservation Act of 1974, National Historical Preservation Act of 1966 (16 U.S.C. §470), Archaeologic and Historical Protection
- Massachusetts Wetlands Protection Regulations and Certification for Dredging, Dredge Disposal, and Filling in Waters
- Massachusetts Endangered Wildlife and Wild Plants Regulations
- Executive Order 11988, Floodplain Protection

As there are no wilderness areas, wild or scenic rivers, or coastal areas in the vicinity of Site, the requirements associated with the Wilderness Act, the Wild and Scenic River Act, Coastal Zone Management Act, Marine Mammal Protection Act, and the Marine Protection, Research and Sanctuaries Act were not considered.

No federally listed endangered or threatened species, or critical habitats were identified within the Site (M&E, 1997). Therefore, the requirements of the federal Endangered Species Act are also not considered as ARARs; should any federal endangered or threatened species, or critical habitat, be identified in the vicinity of the Site, this act would become applicable. Also, if any bald eagles or golden eagles are sighted nesting in the vicinity of the Site, the Bald and Golden Eagle Protection Act would become applicable.

**2.3.2.1 Clean Water Act, Rivers and Harbors Act of 1899 (33 U.S.C. §403) and Guidelines for Specification of Disposal Sites of Dredged or Fill Material (33 U.S.C. §1344).** Section 10 of the Rivers and Harbors Act of 1899 requires a permit for construction of structures on or affecting navigable waters of the U.S. For the permit to be issued, the action must not obstruct or alter navigable waters, present a significant adverse effect on the aquatic environment, or result in violations

of water quality criteria. Rivers and Harbors Act requirements are addressed by Clean Water Act regulations. Section 404 of the CWA prohibits discharge of dredged or fill materials into navigable waters of the U.S., including wetlands, without a permit. Under CERCLA, as amended by SARA, remedial activities on a federal Superfund site must comply with the substantive requirements of federal and state laws, regulations, and standards, although actual permits do not need to be obtained or filed. For wetlands, these would include the provisions of the CWA (Section 404). Section 404 prescribes avoidable impacts on aquatic environments and prohibits significant adverse impacts to the aquatic environment. Wetland replication (on a no-net-loss basis) or restoration would be required as mitigation under these regulations if impacts are unavoidable.

If there is a practicable alternative to the discharge which would have a less adverse impact on the aquatic ecosystem it should be implemented, so long as the alternative does not have other significant adverse environmental consequences. Appropriate and practicable steps must be taken which will minimize the potential adverse impacts of the discharge of the dredged materials on the aquatic ecosystem, pursuant to 40 CFR §230.10(a). These guidelines, contained at 40 CFR Part 230 and developed under CWA Sections 404(b)(1) and 501(a), delineate procedures to evaluate the potential impacts of fill material on aquatic ecosystems. These procedures are followed to the extent that a remedial alternative has a potential to adversely affect a river, pond, or wetland on the Site, and are applicable for the Site.

**2.3.2.2 Statement of Procedures on Floodplain Management and Wetland Protection.** EPA policy for carrying out the provisions of Executive Orders 11988 (Floodplain Management) and 11990 (Protection of Wetlands) are set forth in 40 CFR Part 6, Appendix A. These policies are discussed below.

- **Floodplain Management.** Executive Order 11988 directs federal agencies to avoid long- and short-term adverse impacts associated with occupancy and modification of flood plains. Agencies responsible for providing federal assistance for construction and improvements and for conducting programs affecting land use must take actions to accomplish the following:

  - Reduce risk of flood loss

  - Minimize the impacts of floods on human safety, health and welfare

- Restore and preserve the natural and beneficial values served by flood plains

Most of the requirements associated with the order are set forth in the Floodplain Management Guideline, published February 10, 1978, by the Water Resource Council to aid federal agencies in complying with the order. These guidelines include alternative evaluation, impact assessment and mitigation, and public involvement that are already incorporated into the FS process. The only additional substantive requirement contained within these guidelines is that certain projects or portions may be designated as a critical action, which is any activity for which even a slight chance of flooding would be too great. In the case of critical actions, the area requiring consideration is expanded from the 100-year to the 500-year floodplain. EPA indicated in the CERCLA/SARA Environmental Review Manual (January 1988) that all CERCLA/SARA actions are to be considered critical actions and, therefore, the 500-year floodplain is considered potentially applicable.

The 100-year flood zone designated by the Federal Emergency Management Agency, as applied to the Site map, is shown on Figure 1-5.

Floodplain management guidelines are considered applicable for those portions of the Site that are in the 100-year floodplain.

- **Protection of Wetlands.** Executive Order 11990 directs federal agencies to take actions to minimize the destruction, loss, or degradation of wetlands. To preserve and enhance the natural and beneficial values of remediation, potential wetlands in the area must be evaluated. Wetland protection requirements include assessing the impacts of any Proposed actions on the wetlands, evaluating alternatives and their potential effects on the wetlands, and identifying mitigative measures to minimize potential harm to the wetlands. These requirements are included within the FS process and therefore do not result in any additional requirements.

  Wetlands are defined as "areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." (33 CFR §323.2(c)). As portions of the Site contain wetlands, protection of wetlands requirements are applicable.

- **Impacts on Wetlands/Floodplains.** Under 40 CFR Part 6, Appendix A, "Statement of Procedures on Floodplain Management and Wetlands Protection:, before under-taking an Agency action, EPA must determine whether or not the action will be located in or affect wetlands. When it is apparent that a proposed or potential agency action is likely to impact a floodplain or wetland, the public must be informed through appropriate public notice procedures. An assessment must be prepared which describes the proposed action, discusses the effect on the wetlands/floodplain, and describes the alternatives considered.

Once an alternative is selected (in this instance, at the Action Memorandum stage, after public comment on the EE/CA), the Agency must make public a Statement of Findings which includes (1) why the action must be located in or affect the floodplain or wetlands; (2) a description of significant facts considered in making the decision to locate in or affect the floodplain or wetlands including alternative sites and actions; (3) a statement indicating whether the proposed action conforms to applicable State or local floodplain protection standards; (4) a description of the steps taken to design or modify the proposed action to minimize potential harm to or within the floodplain or wetlands; (5) a statement indicating how the proposed action affects the natural or beneficial values of the floodplain or wetlands.

**2.3.2.3 Fish and Wildlife Coordination Act (16 U.S.C. §661 et seq.).** The Fish and Wildlife Coordination Act (FWCA) requires that agencies be consulted and their recommendations be given "full consideration" taken to protect fish and wildlife that may be impacted by diversion, channeling, or other activities that modify a river or stream (16 U.S.C. §662). Specifically, the FWCA, along with the Conservation Act and other advisories, requires federal agencies issuing a permit to modify any off-site body of water to consult with federal and state wildlife agencies to ensure that resources are appropriately protected and that measures are developed to prevent, mitigate, or compensate for losses to fish and wildlife. Consultation and coordination with a number of state and federal agencies would be necessary for those alternatives which may impact area water bodies to prevent, mitigate, or compensate for project-related losses of fish or wildlife. In Massachusetts, those agencies may include the Fish and Wildlife Service (FWS), the Massachusetts Department of Fisheries, Wildlife & Environmental Law, particularly the Division of Fisheries and Wildlife and Enforcement, and MADEP Bureau of Resource Protection, the Division of Wetlands and Waterways.

Throughout the identification, screening, and evaluation of alternatives, the impacts on fish, wildlife, and their habitat are evaluated and mitigation measures that would be employed are discussed.

**2.3.2.4 Massachusetts Endangered Wildlife and Wild Plants Regulations.** These regulations are found at 321 CMR 8.00 and 321 CMR 10.00, and establish the state list of endangered species and species of special concern. Habitat of these species may also be protected by the regulations promulgated under the Massachusetts Wetlands Protection Act. The Endangered Species Act requires actions to be taken that will conserve identified local endangered or threatened species of fish, wildlife, and plants and the significant habitats for these species. Actions must be taken to ensure that the

continued existence of endangered or threatened species is not jeopardized, or significant habitat adversely modified or destroyed. Activity that constitutes an alteration of a significant habitat without a permit is not allowed. Notice of proposed activities in significant habitats must be made to MADEP. The state of Massachusetts has identified the Blue Spotted Salamander as a species of special concern which may be located at the Site and the Content Brook wetlands as a "Natural Heritage Endangered Species Program" wetlands (MADFW, 1998). The requirements of these rules are considered applicable.

**2.3.2.5 Federal Archaeological and Historical Preservation Act (16 U.S.C. §469-469c-1); Federal Historic Sites Building and Antiquities Act (16 U.S.C. §461 to 467); National Historic Preservation Act of 1966, Pub. I., No. 89-665, 80 State. 915 (codified as amended in scattered sections of U.S.C.).** Several statutes govern the preservation of historic, scientific and archaeological sites. EPA policy in complying with such statues is presented in the National Environmental Policy Act, Subpart C.

Under the Archaeological and Historical Preservation Act (AHPA) of 1974, the Department of the Interior is authorized to undertake data recovery and preservation if an EPA activity may cause irreparable losses or destruction of scientific, prehistoric, or archaeological data. The AHPA also established procedures for preservation of historic and archaeological data that might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program (16 U.S.C. §469).

Under the Historic Sites Act of 1935, certain areas are designated as national natural landmarks by the Secretary of the Interior.

Under the National Historical Preservation Act (NHPA) of 1966 and Executive Order 11593, 30 CFR 800, EPA must consider the impact of actions on property that is listed or eligible for listing on the National Register of Historic Places. The NHPA also requires that for any alteration of terrain that may cause irreparable harm, loss, or destruction of significant artifacts or prehistorical, historical, or archaeological data, the project proponent is required to recover and preserve the artifacts and/or data.

The Middlesex Canal is on the National Register of Historic Places making these rules applicable. Furthermore, there are several Massachusetts-listed historical sites near the Site. As identified in Section 1.3.1, several listed historical sites are located near the Site and several Massachusetts Historical Commission-listed and town-listed historical assets are listed near or within the Site boundaries as described in the RI report. Five historic locations within or adjacent to the Site and maintained by the MHC were recommended as eligible for the National register during the MBTA Historical Property Survey conducted in 1988.

**2.3.2.6 Resource Conservation and Recovery Act, Location Standards.** RCRA details several limitations on where on-site hazardous waste treatment, storage, or disposal may occur (40 CFR §264.18). Specifically, RCRA prohibits the placement of new treatment, storage, or disposal facilities within 61 meters of a Holocene fault (40 CFR 264.18(a)) or the placement of hazardous wastes in salt domes, salt bed formations, and underground mines or caves (264.18(c)). Because no such faults have been identified within 61 meters of the Iron Horse Park OU3 area and because none of the formations are present in this area, these requirements are not considered to be potential ARARs for the Site.

In addition, RCRA requires that any facility located within a 100-year floodplain be designed, constructed, operated, and maintained to avoid washout (40 CFR 264.18(b)). Portions of the Site are in the 100-year floodplain. As the Site is not a RCRA-regulated unit, the floodplain requirement is not applicable. However, as some of the disposal areas subject to flooding may contain some RCRA-toxic hazardous substances, the floodplain requirements are considered to be relevant and appropriate.

The floodplain requirements are potentially applicable to the design, construction, operation and maintenance of any new RCRA treatment, storage, or disposal facility that may be constructed or operated within 100 feet of the 100-year floodplain. Any facility built on-site to treat, store, or dispose of material determined to be a RCRA-regulated waste would need to comply with substantive RCRA location standards.

**2.3.2.7 Massachusetts Wetlands Protection Regulations.** These rules and regulations are found at 310 CMR 10.00 and are promulgated pursuant to the Wetlands Protection Act and were amended in 1997 pursuant to the Rivers Protection Act. The regulations set forth a review and decision-making process to regulate activities in these areas in order to contribute to the interests of drinking water supplies, flood control and storm damage protection, pollution prevention, shellfish, fisheries, and wildlife protection. The regulations apply to wetlands and to perennial rivers and streams. Activities in these areas or their buffer zones (within 100 feet) require filing of a notice of intent, followed by public hearings. The regulations set performance standards for activities occurring in these areas which include banks, bordering vegetated wetlands, open water, land subject to flooding, riverfront areas, and estimated habitats of state-determined Rare Wildlife. Wetland functions and values requiring protection include, but are not limited to, the following:

- Protection of life and/or property from flooding or flood flows by retaining, storing, metering, or slowing flood waters from storm events;
- Providing and maintaining surface and/or groundwater supplies by acting as a recharge or discharge area;
- Providing and maintaining valuable wildlife habitats;
- Providing and maintaining high value recreation areas; and
- Protecting and maintaining water quality.

These rules would apply to any remedial action that would impact open water, wetland areas, and any area within 100 feet of these areas.

**2.3.2.8 Massachusetts Antiquities Act and Regulations.** The Massachusetts Antiquities Act and its regulations, found at 950 CMR 70.00 and 71.00, applies to projects which are state-funded, state-licensed, or which are on state property. It requires that projects must eliminate, minimize, or mitigate adverse effect to properties listed in the register of historic places. It establishes requirements for review of impacts and a state register of historic places, and establishes coordination with the Historic Preservation Act. It also requires that actions which may impact the historical, architectural,

archaeological, or cultural qualities of a listed or unlisted property must be coordinated with the Massachusetts Historical Commission.

As listed in Section 1.3.1, there are several historical sites listed near the Site. Five historic locations built between 1911 and 1914 are maintained by the MHC: the Pond Street Bridge; the B&M RR Billerica Shop Complex; the Equipment Storage Shed; the Maintenance Shed; and the Power Plant. Massachusetts historic rules are applicable to any remedial actions that take place in or near these locations. Two additional, inventoried historical assets within the Site boundaries (the Small Pox Cemetery and the Content Brook Mill) may also be eligible for protection under historical preservation rules.

### 2.3.3 Action-Specific ARARs

Action-specific ARARs focus on remedial activities occurring within the Site under investigation. These requirements pertain to technology- or activity-based requirements or limitations, including storage, transportation, and disposal methods of hazardous substances as well as construction of facilities or treatment processes which might be implemented at the Site. Federal and state laws which need to be considered when planning and implementing remedial actions at the Site will continue to be developed throughout the Record of Decision (ROD) process. Potential action-specific ARARs and TBCs listed below are revisited during the detailed evaluation of alternatives (Section 5.0).

- Federal CERCLA Five-Year Review
- Federal Water Pollution Control Act, as amended by the Clean Water Act (33 U.S.C. §1251 *et seq.*), including National Pollutant Discharge Elimination System (NPDES)
- Federal RCRA, as amended (42 U.S.C. §6901 *et seq*)
- Federal Clean Air Act (42 U.S.C. §7401 *et seq.*)
- Federal DOT Hazardous Materials Transport Act (HMTA) (49 U.S.C. §1803 *et seq.*)
- Federal Noise Control Act (42 U.S.C. §4901 *et seq.*)
- Massachusetts Air Pollution Control Laws (MGL c. 111 §2B-2C; MGL c. 21H;

MGL c. 31C; MGL c. 111 §142A-142M)

- Massachusetts Asbestos Abatement and Disposal Laws (MGL c.111 §142A-142E & 150A-150B; MGL c. 111F; MGL c. 21E; MGL c. 149 §6A-G; MGL c. 111 s.2)
- Massachusetts Drinking Water Protection (MGL c. 13; MGL c. 21A; MGL c. 30A; MGL c. 40; MGL c. 111; MGL c. 112; MGL c. 114; MGL c. 140; MGL c. 159; MGL c. 160A-F; MGL c. 162; MGL c. 165; MGL c. 286)
- Massachusetts Hazardous Waste Management Act (MGL c. 21C)
- Massachusetts Hazardous Substances Disclosure by Employers Act (MGL c. 111F)
- Massachusetts Wetlands Protection Act, River Protection Act, Protection of Wetlands & Waterways Laws (MGL c. 131 s. 40; MGL c. 258, Acts of 1996; MGL c. 21 § 26-35; MGL c. 21A §2(7))
- Massachusetts Clean Water Act (MGL c. 21 §26-53)
- Mass. Fire Prevention Law (MGL c. 148), National Fire Protection Association Regulations and Other Local Building Requirements

**2.3.3.1 CERCLA Five-Year Review.** A review of the Site is required every five years, or until contaminant levels allow for unlimited use and unrestricted exposure, after initiation of the remedial action. This review is required by federal statute for any site remedy which results in hazardous substances, pollutants, or contaminants remaining at the sites (CERCLA §121(c); NCP & §300.430 (f)(4)(ii)). Deletion of a site from the NPL does not affect the site's potential need for a five-year review.

The purpose of the five-year review is to: (1) confirm that the remedy as spelled out in the ROD and/or remedial design remains effective at protecting human health and the environment; and (2) to evaluate whether original cleanup levels remain protective of human health and the environment. The focus of the review will depend upon the original goal of the response action.

The level of the review will be determined based on site-specific considerations, including the nature of the response action, the status of on-site response activities, proximity to populated areas and sensitive environmental areas, and the interval since the last review was conducted. Level I is the

lowest level of evaluation of protectiveness, Level II is the intermediate level, and Level III is the highest level of evaluation of protectiveness.

**2.3.3.2 National Pollutant Discharge Elimination System and Massachusetts Pollution Discharge Elimination System Permit Program Regulations.** The CWA established the NPDES permit program as authorized under CWA (regulated at 40 CFR Part 122). Discharges of wastewater to surface water bodies must comply with NPDES requirements. Designated toxic pollutants are listed in 40 CFR 401.14, *General Provisions for Effluent Guidelines and Standards*. Toxic pollutants are subject to effluent limitations arising from the application of the best available technology economically achievable for the application class or point source category. Direct discharges triggering NPDES requirements are:

- Point-source discharge of treated wastewater directly into, or in very close proximity to, a surface water body either on or off a site
- Site-specific water runoff channeled directly to a surface water body via a ditch, culvert, storm sewer, or other means
- Unchanneled, non-point source surface water runoff from a site into surface water

NPDES requirements are applicable to remedial alternatives which generate an effluent requiring discharge to any surface water body, including the Middlesex Canal, Richardson Pond, Content Brook, and the Unnamed Brook. A permit is not required for on-site discharge, although substantive requirements supporting such a permit would be required.

**2.3.3.3 Pretreatment Standards for Discharge to a Publicly Owned Treatment Works.** Pretreatment standards listed under 40 CFR Part 403 are established for pollutant discharge to a publicly owned treatment works (POTW). These national standards are designed to control pollutants which pass through or interfere with treatment processes at a POTW, or which may contaminate sewage sludge. The national standards contain prohibitions on pollutants which create a fire or explosion hazard, cause corrosive structural damage, are solid or viscous, cause high temperatures, or otherwise interfere with POTW operation. Specific effluent limits for such pollutants are developed

by POTWs in accordance with their NPDES use, sludge use, or disposal practices. These rules apply in the event that Site effluent or wastes are connected to the Billerica POTW, or wastewater is transported by tanker to a POTW.

**2.3.3.4 Resource Conservation and Recovery Act, Subtitle D and Solid Waste Management Facility Regulations.** The federal role in the RCRA is to establish the overall regulatory direction, by providing minimum standards for protecting human health and the environment, and to provide technical assistance to the states. An important step in determining ARARs or TBC criteria is determining the RCRA status of a disposal area (Subtitle C, Interim Subtitle C, or Subtitle D). Subtitle D applies to non-hazardous (i.e., municipal solid waste) landfills. Subtitle D of RCRA establishes a framework for federal, state, and local government cooperation in controlling the management and disposal of non-hazardous solid wastes. Direct implementation of Subtitle D is largely a state and local function.

Federal requirements for the disposal of non-hazardous solid waste are listed at 40 CFR Part 257, specified as *Criteria for Classification of Solid Waste Disposal Facilities,* and at 40 CFR Part 258 specified as *Criteria for Municipal Waste Landfills*. Part 257 criteria take into account the following: flood plains; endangered species; surface water quality; groundwater quality; food-chain crops; disease vectors; air quality; and safety of public and property. Waste disposal practices not meeting these criteria constitute open dumping, which is prohibited under Section 4005 of RCRA. Part 258 criteria establish location restrictions, minimum landfill operating criteria, design criteria, groundwater monitoring and corrective actions, closure and post-closure care, and financial assurance criteria. EPA has also issued guidance relative to final solid waste landfill covers, as described in Section 3.0 of this report.

Massachusetts Solid Waste Management Regulations are found at 310 CMR 19.000 and govern solid waste management activities and facilities, including landfills and dumping grounds. The regulations cover prohibitions on open dumps and dumping grounds; solid waste facility planning; solid waste facility design, operation and closure requirements; and solid waste landfill post-closure use. This includes the capping of any areas designated as contaminated, non-hazardous waste areas. The rules

also include a description of gas controls and closure requirements with regard to solid waste facilities, prohibiting methane gas concentrations of greater than 25% of the Lower Explosive Limit (LEL) at the facility property boundary or in facility structures. Design and operational standards include planning, construction, surface and ground water protection, air quality protection, and monitoring requirements. These regulations are relevant and appropriate for remedial activities that include closure or cover of the landfills and disposal areas within the Site.

The Iron Horse Park Site includes numerous manufacturing operations, open storage areas, landfills, and lagoons, some of which began operating in the early 1900s. As discussed previously, contaminants known to have been disposed of at the Site include asbestos, PCBs, solvents, waste oils, and other chemicals. While none of these operations was conducted as RCRA Subtitle C activities after 1981, some of these disposal areas would be considered RCRA Subtitle C facilities under today's rules. The following discussion briefly summarizes the assumed classifications:

- B&M Railroad landfill used to dispose of various kinds of debris, including drums and railroad ties with creosote. The presence of PCBs and pesticides below the limits of the waste indicate that residual or pooled DNAPL may be present. (Subtitle C assumed)

- RSI Landfill used by B&M as a borrow pit for sand and gravel sometime between 1961 and 1969. The RSI Landfill was used to dispose of its loose, burnt refuse classified as municipal and light industrial solid wastes from the cities of Cambridge and Somerville. There were no records kept on specific waste characteristics. (Subtitle D assumed)

- B&M Locomotive Shop Disposal Areas. Heavy metals and organic compounds including pesticides, PAHs, and petroleum hydrocarbons were detected in surface and subsurface soils in both areas, where waste or fill material was found. The detection of organic compounds and some heavy metals in the upgradient cluster indicate that other sources may be present in the vicinity. (Subtitle D assumed)

- Old B&M Oil/Sludge Recycling Area. Established for the purpose of recycling oil, the predominant types of organic compounds found were consistent with the oil/sludge and were primarily PAHs, long-chain alkanes, and petroleum hydrocarbons. Numerous pesticides and PCBs were detected as were heavy metals, including arsenic, chromium, cobalt, lead, mercury, nickel, and zinc. Several inches of floating product was observed in one piezometer in the southern oil/sludge area. (Subtitle D assumed)

- Asbestos Landfill historically identified with asbestos landfilling operations conducted by Johns-Manville over a 32-year period. (Subtitle D assumed)

- Asbestos Lagoons. In addition to the Asbestos Landfill, there are three unlined asbestos lagoons on the Site. When the lagoons were operated by Johns-Manville, they received an asbestos slurry pumped from the adjacent manufacturing operations. Asbestos from these lagoons was disposed of in the asbestos landfill; however, the lagoons allegedly still contain some asbestos. The lagoons continued to receive wastewater from Johns-Manville operations after asbestos manufacturing operations closed. While this discharge did not contain asbestos, it may have contained some other hazardous substances (CDM, 1989a). (Subtitle D assumed)

In addition, from 1961 to 1982, the General Latex and Chemical Corporation, which manufactured acrylic and vinyl acetate polymers and copolymers used in fabrics, paper, and insulation, discharged liquid filtrate from its latex and polymerization waste treatment to the ground on-site.

RCRA Subtitle D and Massachusetts solid waste landfill regulations are applicable to the distinct waste disposal areas. However, some of these waste disposal areas are more appropriately handled under Subtitle C, hazardous waste regulations, as discussed below.

**2.3.3.5 RCRA Subtitle C/HSWA and Massachusetts Rules and Regulations for Hazardous Waste Management.** RCRA regulations (40 CFR Parts 260 through 280), set forth under Subtitle C of the Solid Waste Disposal Act, pertain to the overall management of hazardous wastes. RCRA sets forth criteria for identifying hazardous substances and lists those under its jurisdiction. It also specifies

technical standards and administrative requirements that must be met by hazardous waste generators, transporters, and owners and operators of hazardous waste treatment, storage, disposal and recycling facilities. The Hazardous and Solid Waste Amendments (HSWA) of 1984 extended EPA's authority to remedy problems with any environmental media resulting from past waste management activities at RCRA facilities.

The federal role in RCRA is to establish the overall regulatory direction, by providing minimum standards for protecting human health and the environment, and to provide technical assistance to the states. Subtitle C of RCRA pertains to overall management of hazardous wastes from generation through ultimate disposal. States are authorized by the EPA on a state-by-state basis to administer Subtitle C. Massachusetts' base RCRA program was authorized by EPA in November 1981. Of the remaining HSWA, Toxicity Characteristic and other portions of the RCRA program, 15 rule packages are under review, and 245 rule packages have not been submitted (some of these rule changes were adopted by the state without submittal of a package). For each remedial action for this Site, both state and federal rules would need to be reviewed. The statutory authority for the state program is Chapter 21C of the Massachusetts General Laws.

Section 300.415(b) of the NCP states that when off-site action is taken in connection with a removal action, the facility used for the off-site management must be in compliance with Subtitle C of RCRA. Procedures for implementing these provisions are established in EPA's "Procedures for Planning and Implementing CERCLA Offsite Response Actions" (May 6, 1985), in SARA Section 121 (CERCLA Section 121(a)-(d)), and supported by EPA RI/FS Guidance documents. Specific limitations state that:

- All hazardous substances transported off the Site must be taken to a hazardous waste management facility holding either an applicable RCRA permit or an applicable interim status permit;
- The off-site storage, treatment, and disposal of hazardous substances must be cost-effective in comparison with other protective response actions; and
- A RCRA compliance inspection must be performed at any hazardous waste management facility before it can receive hazardous substances from a CERCLA-funded response. The inspection must demonstrate that the facility has no significant violations.

RCRA generator requirements of 40 CFR Part 262 are applicable if, during the course of implementing remedial actions, any RCRA-designated hazardous waste is distributed off the Site. When the hazardous waste is distributed or moved, the operator is then considered a generator of hazardous waste.

RCRA transportation requirements of 40 CFR Part 263 are applicable to all remedial actions that include the transport of RCRA-designated hazardous waste off of the Site.

Additional RCRA requirements that may potentially be ARARs for certain remedial actions include:

- Toxicity Characteristic (40 CFR Part 261.24).
- 264, Subpart B - General Facility Standards
- 264, Subpart C - Preparedness and Prevention
- 264, Subpart D - Contingency Plan and Emergency Procedures
- 264, Subpart F - Groundwater Protection
- 264, Subpart G - Closure and Post-Closure
- 264, Subpart I - Use and Management of Containers
- 264, Subpart J - Hazardous Waste Storage Tanks
- 264, Subpart N - Landfills
- 268 - Underground Storage Tanks

All Commonwealth of Massachusetts equivilent rules would also need to be examined.

**2.3.3.6 Federal Clean Air Act and Massachusetts Air Pollution Control Regulations.** The Clean Air Act, enacted in 1970 and amended in 1977, is the federal statute mandating the prevention and control of air pollution from both stationary and mobile sources. The Clean Air Act (CAA) requires EPA to establish three types of national standards: NAAQS; New Source Performance Standards; and National Emission Standards for Hazardous Air Pollutants. The purpose of the CAA program, which is usually administered by the state, is to obtain and maintain acceptable levels of ambient air quality. Remedial alternatives which may have an adverse impact on air quality (for example, fugitive dust

emissions generated during excavation activities or emissions generated from active soil venting) are subject to restrictions under this act.

The CAA mandates that states develop State Implementation Plans (SIPs) which regulate emissions from stationary and mobile sources to ensure attainment and maintenance of the NAAQS. The NAAQS establish the allowable ambient concentrations for six priority pollutants (40 CFR Part 50): total suspended particulates; sulfur dioxide; nitrogen oxide; carbon monoxide; ozone; and lead. The NAAQS apply to pollutant concentrations in ambient air, and are not applicable to individual emission sources.

SIP regulations are contained in 40 CFR Parts 51 and 52. The requirements of the state regulations, which are incorporated into the SIP, are designed to achieve the NAAQS standards overall by imposing emission standards and requirements on sources. Massachusetts Air Pollution Control Regulations define and regulate major and minor sources. Both major and minor sources require source approval and may require a study of health risks. All minor stationary sources are required to apply Best Available Control Technology (BACT) for each pollutant it would have the potential to emit. Major sources of VOCs are required to apply Lowest Achievable Emission Rate (LAER) and obtain offsets.

Federal New Source Performance Standards (NSPS) were developed for over 50 specific industrial categories to provide a ceiling for emissions from new sources. They are based on application of the best available technology to reduce emissions. These standards, which include requirements for notification, record keeping, performance tests, maintenance, and monitoring, are contained in 40 CFR Part 60.

National Emission Standards for Hazardous Air Pollutants (NESHAPs) were established to control air pollutants for which no ambient air quality standards are applicable and which may result in an increase in mortality or serious irreversible illness. Standards in 40 CFR Part 61 define emission limits, monitoring requirements, restrictions on material use, worker practice standards, and reporting requirements for hazardous air pollutants. 40 CFR, Subpart M, national emissions standards for

asbestos, applies to various sources of airborne asbestos, specifically including inactive waste disposal sites for asbestos mills and manufacturing and fabricating operations (40 CFR 61.151). These regulations are applicable to the Asbestos Landfill and Asbestos Lagoons. The regulations require that there be no visible emissions, or that the material be covered with covers or barriers. Fencing and posting rules also apply.

Ambient air monitoring methods, detailing reference and equivalent methods approved by EPA for monitoring ambient air pollutants, are contained in 40 CFR Part 53.

The Massachusetts Air Pollution Control Regulations are found at 310 CMR 7.00 and prohibit emissions of quantities of air contaminants which will cause a condition of air pollution. It applies to new or increased emission sources from incinerators, industrial facilities, and power generating facilities. It governs plan approval, and establishes emission limits for various processes and regions withing the state. It also covers dust, odor, construction, and demolition (310 CMR 7.09), noise control, (310 CMR 7.10), and control of asbestos (310 CMR 7.15). These regulations would be applicable to specific remedial actions which may be considered for the Site.

**2.3.3.7 Department of Transportation Hazardous Materials Transportation Act.** The Hazardous Materials Transportation Act (HMTA) provides regulations on the transport of hazardous materials. Under CERCLA Section 306(a), all hazardous substances are listed as hazardous materials under HMTA. The Department of Transportation (DOT) has promulgated regulations under 49 CFR Parts 171 to 179 governing shipment of hazardous materials, which includes RCRA- and CERCLA-generated hazardous wastes. These rules contain requirements for shipping papers, marking, labeling, packaging, and placarding.

The practical effect of the DOT regulations is to require proper record keeping, use of licensed haulers, and proper transportation equipment. The DOT regulates transport by rail and public highway at 49 CFR Parts 174 and 177, respectively. The DOT also provides shipping container and tank car specifications which are located at 49 CFR Parts 178 and 179, respectively.

If materials that contain hazardous wastes are to be removed from the Site, DOT general manifest requirements would apply.

**2.3.3.8 Federal Noise Control Act of 1972 as Amended by the Quiet Act of 1978.** Construction and transportation equipment noise levels, process equipment noise levels and noise levels at the property boundaries of the project are regulated under this act (at 40 CFR 204, 205, and 211) and enforced by the North Billerica Board of Health. Generally, Site perimeter noise levels should not exceed 10 decibels above ambient noise levels.

**2.3.3.9 CERCLA Guidance for Conducting RI/FS on Municipal Landfill Sites.** In an attempt to streamline the process for municipal landfills, the EPA's Office of Emergency Remedial Response has issued guidance for conducting RIs and FSs for these sites (U.S. EPA, 1991a). Because these sites share similar characteristics, they may lend themselves to remediation by similar technologies. Because of factors that are similar for many CERCLA municipal landfill sites, the guidance states that, in general, remedial actions implemented at most CERCLA municipal landfill sites include: containment of landfill contents (*i.e.*, landfill cap); remediation of hot spots; control and treatment of contaminated groundwater and leachate; and control and treatment of landfill gas. This guidance document is to be considered during the RI/FS process at the Iron Horse Park Superfund Site.

**2.3.3.10 National Fire Protection Association Regulations and Other Building Requirements.** All local building codes must be complied with. Also, and of particular note, are National Fire Protection Association (NFPA) regulations, such as NFPA #58 relating to the construction, location and accessories for storage of flammable materials (*e.g.*, propane).

## 2.4 MEDIA POTENTIALLY REQUIRING REMEDIATION

To develop alternatives, it is first necessary to determine areas or volumes of media to which general response actions might be applied. To ensure that alternatives can be assembled to reduce exposure(s) to protective levels, volume(s) or area(s) should be reviewed with respect to the RAOs. Media potentially requiring remediation include soil, groundwater, sediments and surface water. Note that

the Old B&M Oil/Sludge Recycling Area includes both surface and subsurface soil, while other AOCs only include surface soil. Estimated areas and volumes of these media are listed in Table 2-12 and/or defined in the following subsections.

### 2.4.1 Soil

Figure 2-2 presents the surface soil sampling locations which had PRG exceedances as well as the estimated areal extent of these exceedances. Based on the single sample collected at the B&M Locomotive Shop Disposal Area A, the entire disposal area is assumed to contain soil exceeding PRGs. The estimated areal extent of PRG exceedances in the Old B&M Oil/Sludge Recycling Area is presented in Figure 2-3, as the overall extent is defined by subsurface soil.

### 2.4.2 Groundwater

Figure 2-4 presents the groundwater sampling locations which had PRG exceedances. Locations in both overburden and bedrock flow zones were found to have detected concentrations greater than the PRGs. Manganese detected at the background location, MW-200, was also above its PRG.

Table 2-12 also presents the approximate areal extent and/or volume of the disposal areas which comprise each AOC. These estimated values will be used when considering source control remedial actions.

### 2.4.3 Surface Water

Surface water sampling locations which were found to have PRG exceedances are presented in Figure 2-5. In the three wetland groups which had risks associated with them (Wetland 2 Group, Richardson Pond Group, and Content Brook Wetland Group), all locations sampled had at least one PRG exceedance. Therefore, it is assumed that the extent of the PRG exceedances for each wetland group is each group's respective boundary as shown on Figure 2-5.

### 2.4.4 Sediments

Sediment sampling locations which were found to have PRG exceedances are presented in Figure 2-6. In the three wetland groups which had risks associated with them (Wetland 2 Group, Richardson Pond Group, and Content Brook Wetland Group), 21 of 31 locations sampled had at least one PRG exceedance. Most of these samples were collected in open water areas, so the extent of PRG exceedances in bordering emergent wetland areas is currently unknown. The remaining two wetland groups (East and West Middlesex Canal Groups) are anticipated to be evaluated further via toxicity testing during pre-design activities. In the event that sediment toxicity testing results in ecological risk, a nominal amount of sediment has been designated for hot spot removal.

## 2.5 IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS

A preliminary list of potential remedial technologies has been developed for each of the general response actions listed in Section 2.2. These remedial technologies and associated process options are presented and screened in this subsection. Several factors were used to determine feasibility and, in turn, to screen out those technologies that clearly should not be considered for use at the Site. The factors used in this screening process were based on the current EPA guidance for conducting RI/FSs under CERCLA and included, but were not limited to, the following:

- Effectiveness in handling the estimated areas or volumes of media and in meeting the PRGs
- Potential impacts to human health and the environment during construction and implementation
- Proven effectiveness and reliability with respect to the contaminants and conditions at the Site
- Implementability in terms of both the technical and administrative feasibility
- Relative costs as far as technologies or process options that accomplish the same result

The tables provided in this section are organized by media. Table 2-13 presents technology and process option screening for soils. Table 2-14 presents technology and process option screening for groundwater. Table 2-15 presents technology and process option screening for surface water. Table 2-16 presents technology and process option screening for sediments. Each table presents a brief technology description and the justification for the elimination or further consideration of each technology.

# SECTION 3.0
# DEVELOPMENT OF REMEDIAL ALTERNATIVES

Site-specific remedial alternatives are developed in this section. Remedial technologies not screened from further consideration in Section 2.5 have been used as the basis for developing potential site-specific remedial alternatives listed in this section. Section 3.0 is presented in two subsections. Section 3.1 combines the feasible technologies and process options into comprehensive Site remedial alternatives that address the remedial action objectives (RAOs) detailed in Section 2.0. Section 3.2 describes key technical criteria for some of the major technologies and process options.

## 3.1 COMPILATION OF REMEDIATION COMPONENTS INTO REMEDIAL ALTERNATIVES

The National Contingency Plan (NCP) requires that a range of alternatives be developed and evaluated such that an appropriate remedy can be selected. A range of options must be developed that extends from an alternative that remediates the Site to the maximum extent feasible to other alternatives that vary in the degree of treatment. One or more alternative(s) should involve little or no treatment but use engineering or institutional controls to reduce risk (40 CFR 300.430(e)). The NCP further provides for the option of performing an alternative screening step "...when needed to select a reasonable number of alternatives for detailed analysis" (40 CFR 300.430(e)(1)).

In this section, remediation components are combined into remedial alternatives that meet the NCP and guidance requirements, and that address the RAOs developed in Section 2.0. Table 3-1 presents remedial technologies and process options grouped by media such that a progression of effectiveness can be made for each AOC. These groupings are then shown in Table 3-2 as feasible actions to be reviewed for each AOC. Table 3-3 presents a matrix of site-wide remedial alternatives formed using the groupings from Table 3-2 and the risk ranking of each AOC. These risk rankings are presented in Appendix B. Table 3-4 provides the rationale for the progression of Table 3-3.

## 3.2 TECHNICAL DISCUSSION OF MAJOR REMEDIAL ACTION TECHNOLOGIES AND PROCESS OPTIONS REMAINING AFTER SCREENING

This section describes key technical criteria for some of the major feasible remedial action technologies and process options, and provides greater detail than that given in the Section 2.5 screening. Major remedial technologies and process options are organized by media of concern. These discussions focus on technical considerations for the technology. Although there may be some references to regulatory requirements triggered by the technology, detailed discussions of action-specific ARARs will be presented during the detailed evaluation of alternatives in Section 5.0.

### 3.2.1 Soil

**3.2.1.1 Institutional Actions: Monitoring.** Conceptually, implementation of a soil monitoring program must accomplish two objectives:

- Monitor any changes in the source of contamination
- Monitor the success of the remedy

The list of parameters selected to monitor soil at the Site includes COPCs identified in the RI report (M&E, 1997) and parameters required under CERCLA guidance. There are no specific requirements for soil monitoring under federal and state regulations. There are, however, requirements for leachate monitoring and surface soil runoff, under regulations governing solid and hazardous waste disposal facilities, as well as stormwater controls. Regulatory requirements will be identified for each remedial alternative during the screening of alternatives, and monitoring is anticipated to be a component of many alternatives. Assumptions of analytes and monitoring frequencies used for screening and detailed evaluation of alternatives are presented in Appendix D.

Additional monitoring may also include parameters related to monitored natural attenuation to aid in determining the effective performance of the remedy chosen. Site characterization information requires an understanding of source mass, infiltration, rates of biological and non-biological transformation, and an understanding of how all of these factors are likely to vary with time. Guidance

on the use of monitored natural attenuation at Superfund sites has been recently developed by the EPA Office of Solid Waste and Emergency Response (U.S. EPA, 1999a). This, along with other recent studies, will be used to define site-specific monitoring necessary to assess and characterize remedy performance and contaminant attenuation. Assumptions of analytes and monitoring frequencies used for screening and detailed evaluation of alternatives are presented in Appendix D.

Changes to Site conditions, such as future development, may affect the size, levels, and migration pathway(s) of soil and soil contaminants. Monitoring changes in the source area, such as a landfill or railroad bed, may be necessary if the soils are not contained. EPA will review this monitoring program every five years following initial implementation of the chosen remedy, as required under 40 CFR §300.430 (f)(4)(ii), if the remedy selected will not allow for unlimited use and unrestricted exposure. At that time, a review of the number, frequency, and analyses of samples needed to accomplish each objective will be performed. The program may be adjusted to reflect observed patterns, consistencies, or changes in the soil contaminants.

#### 3.2.1.2 Institutional Actions: Access Restrictions -- Institutional Controls, Fencing & Security Measures.

**Institutional Controls.** Institutional controls are non-engineering measures intended to affect human activities in such a way as to prevent or reduce exposure to hazardous substances. Examples of institutional controls cited in the preamble to the 1990 NCP include "land and resource use and deed restrictions, well-drilling prohibitions, building permits and well use advisories and deed notices." 55 Fed. Reg. at 8706 (March 8, 1990). Institutional controls are generally used in conjunction with, or as a supplement to, other measures such as waste treatment or containment.

Different types of institutional controls may be used; (1) proprietary controls which are used to restrict or affect the use of property without the intervention of any federal, state, or local regulatory authority (*e.g.*, easement, covenant, equitable servitude, reversionary interest, deed notice); (2) governmental controls (*e.g.*, land use restrictions including zoning and permitting, groundwater use restrictions including well use restrictions), or (3) other measures (*e.g.*, publically-issued advisories).

As discussed in Section 2.0, there are human health remedial action objectives (RAOs) related to soils at five of the seven upland AOCs; B&M Locomotive Shop Disposal Areas (AOC#3), Old B&M Oil/Sludge Recycling Area (AOC#4), Contaminated Soil Area (AOC#5), Asbestos Landfill (AOC#6), and Asbestos Lagoons (AOC#7). Institutional controls are applied to the five AOCs to meet the human health RAOs for prevention of ingestion and exposure.

**Fencing & Security Measures.** Another type of access restrictions are physical barriers which usually consist of fences, gates, and signs designed to prohibit site entry.

As discussed in Section 2.0 and above for Institutional Controls, there are human health remedial action objectives (RAOs) related to soil at five of the seven upland AOCs: B&M Locomotive Shop Disposal Areas (AOC#3), Old B&M Oil/Sludge Recycling Area (AOC#4), Contaminated Soils Area (AOC#5), Asbestos Landfill (AOC#6), and Asbestos Lagoons (AOC#7). Fencing and security measures would be applied to the five AOCs to meet the human health RAOs for prevention of ingestion and exposure.

There are ecological RAOs related to soil at two of the seven upland AOCs: B&M Railroad Landfill (AOC#1) and B&M Locomotive Shop Disposal Areas (AOC#3). Although there is ecological risk from the soil pathway to ecological receptors, access restrictions (*e.g.*, fencing) are not appropriate to reduce this ecological risk.

**3.2.1.3 Treatment In-situ: Biological Processes -- Monitored Natural Attenuation.** Natural attenuation can be defined as the reduction in contaminant mass and/or concentration which occurs in site media due to natural processes, without human intervention to accelerate those processes. Natural processes that can be included under the term "natural attenuation" are volatilization, adsorption, dispersion, biodegradation, and physical/chemical degradation. Volatilization and adsorption are phase transfer processes (soil or liquid to gas and liquid to soil, respectively), and hence do not result in loss of total contaminant mass, although the mass of contaminants in the liquid phase (*i.e.*, groundwater) is reduced by these mechanisms. Dispersion is a process that reduces contaminant concentrations in fluids by mechanical mixing and diffusion mechanisms. As with volatilization and

adsorption, the total mass of contaminants does not decrease, resulting in no overall mass change. Biodegradation and physical/chemical degradation cause reductions in contaminant mass by transforming the contaminants from one form to another. Biodegradation is recognized as the primary mechanism whereby natural attenuation of petroleum hydrocarbons occurs (Wong *et al.*, 1997).

For soil, immobilized contaminants may persist for decades and thus, if undisturbed, are only slowly removed or not removed at all by natural attenuation. However, wind or water erosion may mobilize the contaminants and transport them to other media (*i.e.*, groundwater, surface water, and sediment). Therefore, long-range soil containment (*i.e.* capping) is typically recommended prior to consideration of natural attenuation as a remedy for contaminated soil.

Natural attenuation of soil may be considered if site-specific factors support its use. The factors include:

- Protection of potential receptors during attenuation,
- Favorable geological and geochemical conditions,
- Documented reduction of degradable contaminant mass in a reasonable time frame in the soil,
- Confirmation in microcosm studies of contaminant cleanup,
- For the persistent or conserved contaminants, ensured containment during and after natural attenuation.

If monitored natural attenuation is selected as a remedy for contaminated soils, a Conceptual Site Model, including site-specific data, is developed during the pre-design stage. Modeling and evaluation of contaminant degradation rates are usually performed to demonstrate that natural processes of contaminant degradation will reduce concentrations below risk-based levels. In addition, monitoring must be conducted during the process to confirm that attenuation is proceeding at rates consistent with cleanup objectives.

Typical target contaminants for natural attenuation are VOCs, SVOCs, and petroleum hydrocarbons. The process may be less effective on pesticides.

Factors which may limit the applicability and effectiveness of natural attenuation include:

- Extensive site characterization and long-term monitoring may be more costly than active remediation.
- Toxicity of degradation / transformation products may be greater than that of the original contaminants.
- Geological characteristics such as fractured bedrock or karst landscapes may prevent assessment of plume control for contaminants leached from soil.
- Contaminants may migrate prior to degradation / transformation.
- Groundwater contaminated by the soil source may not be available for an extended period of time.
- Extensive free product may have to be removed before natural attenuation can restore soil in a reasonable time frame.
- Metals may only be temporarily immobilized.

The extent of contaminant degradation depends on a variety of parameters, such as temperature, moisture, availability of nutrients / electron acceptors, and contaminant concentrations. Data which must be obtained prior to implementation include:

- Chemical and physical characteristics of the contaminants
- Geochemical data to assess the potential for biodegradation of the contaminants
- Lithology and stratigraphic relationships
- Grain-size distribution

Costs associated with natural attenuation include modeling to determine feasibility, appropriate soil containment, and long-term monitoring.

**3.2.1.4 Treatment In-situ: Biological Processes -- Enhanced Biodegradation.** Enhanced biodegradation is a process in which indigenous or inoculated microorganisms degrade contaminants, converting them to innocuous end products. Nutrients, oxygen, or other amendments may be used to enhance bioremediation and contaminant desorption from the media of concern.

The process may be performed in the presence of sufficient oxygen (aerobic) or in the absence of oxygen (anaerobic), with each process ultimately converting the contaminants to different end products. Aerobic biodegradation will ultimately convert many organic contaminants to carbon dioxide, water, and microbial cell mass. Anaerobic biodegradation will ultimately convert organic contaminants to methane, limited amounts of carbon dioxide, and trace amounts of hydrogen gas.

Enhanced biodegradation of soil typically involves the percolation or injection of groundwater or uncontaminated water that is mixed with nutrients and saturated with dissolved oxygen. For shallow contaminated soil, an infiltration gallery or spray irrigation is typically used. Figure 3-1 presents an example of the process which may be used to mix nutrients into water followed by application to soil through spray irrigation.

Biodegradation techniques have been successfully used to remediate soil contaminated with petroleum hydrocarbons, solvents, wood preservatives, and other organic chemicals. While biodegradation cannot degrade inorganic contaminants, it has shown promise in stabilizing or removing inorganics from soil. Although successful in-situ enhanced biodegradation has been demonstrated in cold weather climate, low temperatures slow the remediation process.

Contaminant characteristics which affect enhanced biodegradation in soil include their potential to leach, their chemical reactivity, and their biodegradability. Important soil characteristics include extent and concentration of contaminants, soil type and properties, redox potential, the presence or absence of substances that are toxic to microorganisms, the concentration of nutrients, and the ability of microorganisms to degrade contaminants.

Enhanced biodegradation for soil contaminants may be considered a long-term technology which may take several years for clean-up (Van Deuren *et al.*, 1997).

**3.2.1.5 Treatment In-situ: Chemical Processes -- Solidification / Stabilization.** Solidification/ stabilization (S/S) processes reduce the mobility of soil contaminants in the environment by either trapping them within a stabilized mass or inducing chemical reactions between a stabilizing agent and

the contaminants. In-situ S/S is generally targeted at inorganic contaminants but may also have limited effectiveness against SVOCs and pesticides. Systems designed to be more effective in treating organics are being developed and tested. Leachability testing is typically performed to measure the immobilization of contaminants.

Auger/caisson systems and injector head systems are typical techniques used in soil S/S. They apply S/S agents to soil to trap or immobilize contaminants (Van Deuren *et al.*, 1997). At the Iron Horse Park Superfund Site, the assumed method of application to the contaminated soil is through the use of a modified fertilizer spreader. The S/S agents are then mixed into the soil with a specialized rototiller attachment. Prior to the agent application, existing asphalt must be removed and any necessary regrading performed. Following stabilization, a screened gravel protective layer is placed above the solidified/stabilized soil and is graded and compacted. Previously paved areas are repaved with asphalt. Figure 3-2 presents the S/S process proposed for use at the Iron Horse Park Superfund Site.

Limitations to in-situ S/S include:

- Depth of contaminants may limit some types of application processes.
- Future usage of the Site may "weather" the materials and affect ability to maintain immobilization of contaminants.
- Some processes result in a significant increase in volume.
- Certain wastes are incompatible with variations of this process.
- Reagent delivery and effective mixing are more difficult than for ex-situ applications.

Data needed to evaluate S/S include particle size, Atterberg limits, moisture content, metal concentrations, sulfate concentration, organic content, density, permeability, unconfined compressive strength, leachability, pH, and microstructure analysis. This data is typically collected during a pre-design phase of the project.

The S/S processes are well demonstrated, can be applied to the most common Site and waste types, require conventional materials handling equipment, and are available competitively from a number of

vendors. Most reagents and additives are widely available and relatively inexpensive industrial commodities.

The S/S processes have been demonstrated to have the capability to reduce the mobility of contaminated waste by greater than 95%. However, the long-term effects of weathering (*e.g.*, freeze-thaw cycles, acid precipitation, and wind erosion), groundwater infiltration, and physical disturbance associated with uncontrolled future land use can significantly affect the integrity of the stabilized mass and contaminant mobility in ways that cannot be predicted by laboratory tests (Van Deuren *et al.*, 1997).

**3.2.1.6 Treatment In-situ: Chemical Processes -- Soil Flushing.** Soil flushing involves removing contaminants from soil by passing water or another suitable aqueous fluid through the soil using an injection or infiltration process. The contaminants are leached into the groundwater, which is then typically collected and treated. Whenever possible, the recovered fluid is reused in the flushing process.

An alternative called co-solvent flushing involves injecting a mixture of water plus a miscible organic solvent such as alcohol. The co-solvent mixture is normally infiltrated through the contaminated area and the solvent with dissolved contaminants is collected downgradient and treated above ground. The recovered fluids may need treatment to meet appropriate discharge standards prior to release or recycling.

Soil flushing is primarily targeted at inorganics. The technology can also be used to treat VOCs, SVOCs, fuels, and pesticides, but it may be less cost-effective than alternative technologies for these contaminant groups. Addition of an environmentally compatible surfactant may increase the solubility of some organic compounds; however, surfactants can adhere to the soil, thereby reducing the effective soil porosity and decreasing the effectiveness of the process. Low permeability and heterogeneous soil can be difficult to treat.

Treatability tests are required to determine the effectiveness of this technology on site-specific contaminants and soil. Soil characterization data requirements include soil permeability, structure, texture, porosity, moisture content, total organic carbon, cation exchange capacity, pH, and buffering capacity. This data is typically collected during a pre-design phase of the project. Contaminant characterization data requirements include concentration, solubility, partition coefficient, reduction potential, and complex stability constants (Van Deuren *et al.*, 1997).

At the Iron Horse Park Superfund Site, this process option is proposed in combination with enhanced biodegradation of soil (Section 3.2.1.4) to remediate contaminants which may not be readily biodegraded (*e.g.*, inorganics). Following treatability studies, flushing solvents would be added to the mixing process shown in Figure 3-1, and application would be similar to enhanced biodegradation (spray irrigation truck). Contaminants that may reach the groundwater due to the flushing process are assumed to be treated by the groundwater remediation technologies.

**3.2.1.7 Source Control: Horizontal Containment -- Composite / Double Barrier Cap, Single Barrier Landfill Cap, Single Barrier Cap.** This section describes the horizontal containment, the remedial technology that would be used for contaminant source control. The composite / double barrier cap and single barrier landfill cap addresses RAOs by 1) reducing the leaching of contaminants from buried waste or contaminated soil by minimizing water infiltration, and 2) restricting or controlling migration of landfill gas (U.S. EPA, 1991b). A single barrier cap can also be used to reduce the leaching of contaminants from contaminated soil in rail yard areas by minimizing water infiltration. Capping will also prevent receptors from coming in direct contact with waste or contaminated soil by providing a physical barrier between the waste or soil and potential receptors.

The proposed composite / double layer cap consists of the following components: vegetation/topsoil, cover layer, drainage geocomposite, 60 mil. low density polyethylene (LDPE) geomembrane, low permeability soil layer, and if gas generation from the waste is possible, a (passive) gas vent layer above the graded waste. The capped area would be revegetated following cap installation. Figure 3-3 illustrates the proposed double-barrier cap design utilized for cost purposes. Figure 3-3a presents the

proposed single-barrier landfill cap utilized for cost purposes. The only difference between the two designs is the removal of the low permeability soil layer below the geomembrane.

Substitutions may be made to component materials based on availability during the design/construction phase; however, state and federal standards must be met. Design considerations should also include the possible reduction in the area requiring capping through cut and fill methods. Cost reductions achieved through this process must be weighed against costs incurred to reduce unacceptable nuisance odors which may be created during the implementation of this action. The composite / double barrier cap would be supplemented by the installation of an 8-foot-high chain-link fence to protect the caps (complying with RCRA regulations), as well as the posting of signs to indicate appropriate hazards.

The proposed single layer cap consists of the following components: concrete or granite curbing or edging around the perimeter, bituminous concrete surface course, bituminous concrete binder course, and a gravel base course above the existing contaminated soil. Figure 3-4 presents the proposed single barrier cap which would be used in the rail yard area of the Site (AOC #5 - Contaminated Soils Area). This cap is proposed to allow Site activities to continue as they do presently, while decreasing the area through which precipitation can infiltrate and contact contaminated soil.

Prior to cap installation over waste disposal areas, grading is required to meet RAOs and comply with ARARs. Regulations governing grading on disposal facilities are designed to ensure positive drainage from the waste area, prevent surface water run-on from upgradient areas, prevent erosion of cover material, prevent downstream flooding or sedimentation of receiving water bodies, and ensure the slope stability of the landfill. Minimum and maximum slope requirements are often stipulated to accomplish these objectives. EPA guidance for hazardous waste landfills (RCRA Subtitle C) specifies a minimum slope of 3 to 5% and a maximum slope of 33% for the barrier layer (U.S. EPA, 1991b). Applicable regulations also require that measures be taken to prevent run-on, prevent sedimentation, and provide flood control for a 24-hour, 100-year storm event.

**3.2.1.8 Source Control: Excavation & On-Site Disposal -- Protective Cap.** This option involves excavation of contaminated soil or waste materials, followed by placement below an on-site protective cap constructed to cover another AOC. Section 3.2.1.7 provides a description of the protective cap that would be utilized to meet RAOs in AOCs with large waste disposal areas. Only smaller AOCs (such as the Asbestos Lagoons, B&M Locomotive Shop Disposal Areas, and Old B&M Oil/Sludge Recycling Area) are considered for excavation and on-site disposal of contaminated soil. Following removal of the contaminant source, backfilling, grading and vegetation may be required.

**3.2.1.9 Treatment Off-site: Excavation & Off-Site Treatment / Disposal -- Solidification / Stabilization Facility, RCRA Subtitle C / D Landfill.** Similar to on-site disposal described in the previous section, this option involves excavation of contaminated soil or waste materials, followed by transportation to an off-site treatment, storage, or disposal facility (TSDF). Off-site disposal options are typically less desirable due to the possibility of future liability. However, off-site treatment of soil through solidification / stabilization (such as asphalt batch processing) is a recycling option with proven results. This option is considered at the Iron Horse Park Superfund Site for use at AOC #5 - Contaminated Soils Area, which has soil and contaminants that are well-suited for recycling. The option is also considered for disposal of any hazardous wastes which may be encountered during excavation at other Site AOCs.

At AOC #5, the process begins with removal and disposal of existing asphalt, excavation of the contaminated soil, backfilling with clean soil and gravel, and replacing asphalt in previously paved areas. The excavated material is then transported to an off-site TSDF for final disposition.

**3.2.1.10 Treatment On-site: Chemical Processes -- Solidification / Stabilization.** Solidification / stabilization (S/S) refers to mixing contaminated soil with binding / stabilizing agents in order to trap contaminants and prevent them from leaching out of the stabilized material. The resulting material can be reused as a subbase material for paving, landfill capping material, and other potential uses.

There are many innovations in the S/S technology. Most of the innovations are modifications of proven processes and are directed to encapsulation or immobilizing the contaminants. Nine distinct

innovate processes or groups of processes include: (1) bituminization, (2) emulsified asphalt, (3) modified sulfur cement, (4) polyethylene extrusion, (5) pozzolan/Portland cement, (6) radioactive waste solidification, (7) sludge stabilization, (8) soluble phosphates, and (9) vitrification/molten glass (Van Deuren *et al.*, 1997).

Treatability tests must be performed prior to selection of the best S/S process, but based on current Site data, the emulsified asphalt (*i.e.*, asphalt batch processing) process has been selected for cost purposes at the Iron Horse Park Superfund Site. This process is described below.

Asphalt emulsions are fine droplets of asphalt dispersed in water that are stabilized by chemical emulsifying agents. The emulsions are available as either cationic or anionic emulsions. The emulsified asphalt process involves adding these emulsions having the appropriate charge to hydrophilic liquid or semiliquid soils at ambient temperature. After mixing, the emulsion breaks, the water in the soil is released, and the organic phase forms a continuous matrix of hydrophobic asphalt around the solids. In some cases, additional neutralizing agents, such as lime or gypsum, may be required. After given sufficient time to set and cure, the soil is uniformly distributed throughout the resulting solid asphalt, which is then impermeable to water (Van Deuren *et al.*, 1997).

At the Iron Horse Park Superfund Site, the process of on-site S/S involves excavation and stockpiling of contaminated soil. A grizzly separator is used to separate out oversized debris (> 6 inch diameter) for disposal. A trommel separator is used to further separate out stone with greater than 3/4-inch diameter for disposal. Suitably sized particles are carried by conveyor belt to the pugmill, where they are mixed with asphalt emulsion and any pozzolanic additives which may improve the S/S process. The resulting solidified / stabilized material is then stockpiled for curing and reuse on-site. Figure 3-5 presents a schematic of the proposed process.

The target contaminant group for S/S is inorganics. Most S/S technologies have limited effectiveness against organics and pesticides (Van Deuren *et al.*, 1997). However, the selected asphalt emulsion technology uses similar PAH constituents to those found at the Iron Horse Park Superfund Site in its

S/S process. It has also been used to bind hydrocarbon contaminants in diesel fuel-contaminated soil (Gladdys, 1996).

Limitations of this technology include the following:

- Environmental conditions may affect the long-term immobilization of contaminants.
- There may be a significant increase in volume.

Data requirements include soil particle size, Atterberg limits, moisture content, sulfate concentration, organic content, density, permeability, unconfined compressive strength, leachability, microstructure analysis, and physical and chemical durability (Van Deuren *et al.*, 1997).

#### 3.2.1.11 Treatment On-site: Chemical Processes -- Soil Washing, Chemical Extraction.

Soil washing is a technology that uses water, sometimes combined with chemical additives such as surfactants, and a mechanical process to scrub soils. The process removes contaminants from soils in one of two ways:

- By dissolving or suspending them in the wash solution (which can be sustained by chemically manipulating the solution pH).
- By concentrating the contaminants into a smaller volume of soil through particle size separation, gravity separation, and attrition scrubbing. This is similar to techniques used in sand and gravel operations.

The concept of reducing soil contamination through the use of particle size separation is based on the finding that most organic and inorganic contaminants tend to bind to clay, silt, and organic soil particles. The silt and clay, in turn, are attached to sand and gravel particles by physical processes, such as compaction and adhesion. The soil washing processes that separate the fine clay and silt particles from the coarser sand and gravel soil particles effectively concentrate the contaminants into a smaller volume of soil that can be further treated or disposed of. The spent washwater needs to be treated and can be recycled for further use.

Complex mixtures of contaminants in the soil and heterogeneous contaminant distribution throughout the soil mixture make it difficult to utilize a standard soil washing process at all sites. Therefore, sequential washing which uses different wash formulations and/or different soil-to-wash fluid ratios, may be required (Van Deuren *et al.*, 1997). Contaminants which are not removed utilizing the various water-based soil washing techniques may be removed using other chemical extraction methods.

The physical separation steps utilized during soil washing are the same when performing chemical extraction. The difference between the two processes is only in the extractant used and the residuals which require treatment following the extraction. Soil washing uses water, while chemical extraction may use acid or other solvents. Standard water treatment techniques are used to recycle soil washing water. Other precipitation and/or extraction techniques are required for recycling of chemical extraction acids or solvents.

Both soil washing and chemical extraction can be used to treat a wide range of contaminants. They both work best when the soil does not contain a large amount of silt or clay. Data needs for both processes include particle size distribution (optimum range - 0.24 to 2 mm), soil type, handling properties, moisture content, organic content, cation exchange capacity, pH, and buffering capacity. In both cases, bench scale treatability tests should be performed prior to applying the technology as a remedial solution (Van Deuren *et al.*, 1997).

Figure 3-6 presents the proposed soil washing process for the Iron Horse Park Superfund Site. The contaminants are currently assumed to be amenable to water-based removal. However, the option for a treatment stage which includes chemical extraction may be substituted if found to be necessary during treatability tests. Contaminated soil is excavated and a grizzly separator is used to separate out oversized debris (> 6 inch diameter) for disposal. A trommel separator is used to further separate out stone with greater than 3/4 inch diameter for disposal prior to the fine particle soil washing stage.

### 3.2.2 Groundwater

Potential remedial actions taken to prevent ingestion of groundwater exceeding preliminary remediation goals (PRGs) include institutional controls such as restrictions on groundwater usage. Monitoring of groundwater and surface water/sediment is a required component to verify the success of the selected alternative.

**3.2.2.1 Institutional Actions: Monitoring.** Conceptually, implementation of a groundwater monitoring program must accomplish three objectives:

- Monitor the migration of the plume
- Monitor the success of the remedy
- Monitor water quality in the residential wells

The list of parameters selected to monitor groundwater quality at the Site includes all COPCs identified in the RI (M&E, 1997) and parameters required under action-specific ARARs and CERCLA guidance. Groundwater monitoring is required under federal and state requirements for waste management facilities. The groundwater monitoring program must comply with potentially applicable federal requirements including governing solid and hazardous waste disposal facilities. These requirements might include: RCRA Subtitle C groundwater monitoring at 40 CFR 264.97 and 264.310, RCRA Subtitle D groundwater monitoring at 40 CFR 258.50, and Massachusetts groundwater monitoring requirements under 310 CMR 30.000 and 310 CMR 19.000. Assumptions of analytes and monitoring frequencies used for screening and detailed evaluation of alternatives are presented in Appendix D.

Monitoring the migration of the plume is necessary to track changes in size and contaminant levels over time. Changing Site conditions such as future development, future increases or decreases in groundwater use , and migration from any future off-site sources may affect the size, contaminant levels, and migration pathway of the plume.

Surface and groundwater monitoring locations will be established as required under state and federal regulations. Upgradient and downgradient groundwater monitoring locations have been selected in the overburden and bedrock aquifers at locations to detect the migration of groundwater contamination.

Additional monitoring may also include elements of monitored natural attenuation to aid in determining the effectiveness of the chosen remedy. Site characterization information requires an understanding of source mass, groundwater flow, rates of biological and non-biological transformation and an understanding of how all of these factors are likely to vary with time. Guidance on the use of monitored natural attenuation at Superfund sites has been recently developed by the EPA Office of Solid Waste and Emergency Response (U.S. EPA, 1999a). This, along with other recent studies, will be used to define site-specific monitoring necessary to assess and characterize remedy performance and contaminant attenuation. Assumptions of analytes and monitoring frequencies used for screening and detailed evaluation of alternatives are presented in Appendix D.

EPA will review this monitoring program every five years following initial implementation of the chosen remedy, as required under 40 CFR §300.430 (f)(4)(ii), if the remedy selected will not allow for unlimited use and unrestricted exposure. The five-year timeframe should allow enough time for sufficient data collection to support a data trend evaluation. Additionally, the timeframe coincides with a 5-year review, which is required under CERCLA. At that time, a review of the number, frequency, and analyses of samples needed to accomplish each objective will be performed. The program may be adjusted to reflect observed patterns, consistencies, or changes in groundwater contaminants.

**3.2.2.2 Institutional Actions: Access Restrictions -- Institutional Controls**. Institutional controls are non-engineering measures intended to affect human activities in a way as to prevent or reduce exposure to hazardous substances. Examples of institutional controls cited in the preamble to the 1990 NCP include "land and resource use and deed restrictions, well-drilling prohibitions, building permits and well use advisories and deed notices." 55 Fed. Reg. at 8706 (March 8, 1990). Institutional controls are generally used in conjunction with, or as a supplement to, other measures such as waste treatment or containment.

Different types of institutional controls may be used: (1) proprietary controls which are used to restrict or affect the use of property without the intervention of any federal, state, or local regulatory authority (*e.g.*, easement, covenant, equitable servitude, reversionary interest, deed notice); (2) governmental controls (*e.g.*, land use restrictions including zoning and permitting, groundwater use restrictions including well use restrictions), or (3) other measures (*e.g.*, publically-issued advisories).

As discussed in Section 2.0, there are human health remedial action objectives (RAOs) related to groundwater at several AOCs. Institutional controls are applied to these AOCs to minimize the potential for exposure to contaminated groundwater. They may also prevent interference with natural groundwater attenuation, which could occur through surface and subsurface development and groundwater use. Furthermore, the institutional controls would protect the public from exposure to site-related hazards and protect the integrity of remediation processes or structures.

**3.2.2.3 Treatment In-situ: Biological Processes -- Monitored Natural Attenuation.** Section 3.2.1.3 provides a description of monitored natural attenuation which is applicable for all media of concern.

**3.2.2.4 Treatment In-situ: Biological Processes -- Enhanced Biodegradation.** Similar to the technology described previously for soil in Section 3.2.1.4, enhanced biodegradation is a process in which indigenous or inoculated microorganisms degrade contaminants, converting them to innocuous end products. Nutrients, oxygen, or other amendments may be used to enhance bioremediation and contaminant desorption from the media of concern.

Enhanced biodegradation of groundwater typically involves the use of groundwater injection wells to inject a bio-solution into the groundwater. A bio-solution could be a mixture of water, nutrients, and a substrate solution. An acid or caustic solution can be added to adjust the pH for optimal conditions. Figure 3-1 presents an example of the process which may be used to mix nutrients into water followed by application to groundwater through injection wells.

While the theory behind enhanced biodegradation of groundwater is the same as for soil, there are additional methods available for introducing enhancements to the groundwater beyond those noted for soil. For example, rather than enhancing oxygen through application of water saturated with dissolved oxygen, air sparging below the water table is also possible.

Target contaminants for enhanced biodegradation in groundwater are similar to those in soil, as are many of the limitations. For example, heterogeneous soil limits the delivery of amendments throughout the contaminated zone. Also, high iron content in subsurface materials can rapidly reduce concentrations of hydrogen peroxide, thereby reducing the zone of influence.

Characteristics that should be investigated prior to design of an enhanced biodegradation groundwater system include soil permeability, hydrology, dissolved oxygen content, pH, redox conditions, temperature, biodegradability of contaminants, and the presence of a competent biodegrading population of microorganisms.

Enhanced biodegradation for groundwater contaminants is considered a long-term technology which may take several years for clean-up (Van Deuren *et al.*, 1997).

**3.2.2.5 Treatment In-situ: Physical Processes -- Hydraulic & Pneumatic Fracturing.**
Hydraulic and pneumatic fracturing are processes which are used in combination with other remediation technologies to improve their effectiveness. Fractures are created in the subsurface media to serve as avenues for biodegradation, chemical oxidation, and contaminant recovery, as well as improving pumping efficiency and delivery for other in-situ processes (U.S. EPA, 1995).

The technologies involve injection of pressurized water or air through wells to develop cracks or fissures in consolidated or low permeability unconsolidated materials. This increases the permeability of the material to liquids or vapors.

For hydraulic fracturing, water is pumped into a sealed borehole until the pressure of the water exceeds the soil overburden pressure and a fracture is created. A slurry of water, sand and a thick gel is then

injected as the fracture grows away from the well. The residual gel biodegrades, and the resultant fracture is a permeable sand-filled lens that may be as large as 60 feet in diameter. Other materials such as graphite can be used instead of sand to create fractures with different properties.

For pneumatic fracturing, high pressure air is injected into a sealed borehole until the pressure exceeds the soil overburden pressure and a fracture is created. This process is typically utilized to extend existing fractures or to create a secondary network of fissures and channels.

Limitations to the processes include the following:

- These processes should not be used in bedrock susceptible to seismic activity.
- Nearby underground utilities, structures, or trapped free product must be investigated.
- The potential exists to open new pathways leading to the spread of contaminants such as DNAPLs.
- Pockets of low permeability are likely to remain after use of these processes.
- Control of the final location or size of the fractures is low.
- Fractures may be anticipated to collapse due to overburden pressures.

At the Iron Horse Park Superfund Site, these technologies may be used along with in-situ chemical oxidation (Section 3.2.2.7) if design analysis finds that permeability improvement is necessary.

**3.2.2.6 Treatment In-situ: Physical Processes -- Passive / Reactive Treatment Wall.** Passive / reactive treatment walls are installed in an aquifer to intercept the flow path of a contaminant plume. As water passes through the wall, media in the wall treats the contaminants passively. Media in the wall can degrade, sorb, precipitate, or remove chlorinated solvents, metals, radionuclides, and other pollutants. The wall may contain reactants for degrading volatile organics, chelators for immobilizing metals, nutrients and oxygen to enhance bioremediation, or other agents.

Most walls, typically called permeable reactive barriers (PRBs), currently use zero-valent iron ($Fe^0$) as the reactive media for converting contaminants to less toxic or immobile species. $Fe^0$ can reductively

dehalogenate hydrocarbons, such as converting trichloroethylene (TCE) to ethylene, and reductively precipitate anions and oxyanions, such as converting soluble $Cr^{+6}$ oxides to insoluble $Cr^{+3}$ hydroxides.

There are two basic designs for these walls: (1) the funnel-and-gate and (2) the continuous trench. Other techniques, such as hydrofracturing and driving mandrels, are also being used. The funnel-and-gate system uses impermeable walls, such as interlocking sheet pilings or slurry walls, to direct (funnel) the contaminant plume through a treatment zone (gate), containing the reactive media. The continuous trench system is installed across the entire path of the plume and is filled with reactive media (U.S. EPA, 1999b).

Limitations of PRBs include the following:

- Reactive capacity of the treatment media will be lost over time, requiring replacement of the media.
- PRB permeability may decrease due to precipitation of metal salts or due to biological activity.
- The PRB should key into a subsurface aquitard (such as bedrock or clay) at a depth that is within the vertical limits of available excavation or trenching equipment.
- The width of the wall must be designed such that the residence time is sufficient for the reaction to achieve completion.
- The volume of treatment media required may be cost prohibitive depending on the size of the PRB and reactions required for the existing contaminants.

Data needs of PRBs include hydraulic gradient, contaminant characteristics, depth and anticipated fluctuations of groundwater, depth of subsurface aquitard, water quality, flow rate and direction, soil permeability, and buffering capacity (Van Deuren *et al.*, 1997). Monitoring wells should be installed on both sides of the PRB to assess performance of the technology.

Figure 3-7 presents the proposed PRB for the Iron Horse Park Superfund Site. A funnel-and-gate system would be used to channel the groundwater through the treatment media. A soil / bentonite slurry wall that runs from the unsaturated zone down to the bedrock will funnel the groundwater to the

gate. The gate has driven sheet piling for the side walls, and gabion baskets which hold the treatment media. These gabion baskets are used to ease the process of media replacement. A drainage trench is also included as part of the system to provide a more permeable path for the groundwater in front of the barrier wall. A trench on the downgradient side of the PRB may also be necessary to assist with water distribution. Two treatment zones of reactive media have been shown on the figure, but the actual number of zones, type of media, and thickness of the zones will be determined through treatability testing.

**3.2.2.7 Treatment In-situ: Chemical Processes -- Chemical Oxidation.** In-situ chemical oxidation involves the delivery of chemical oxidants to contaminated media in order to either destroy the contaminants or convert them to innocuous compounds commonly found in nature. A concentrated oxidant solution is mixed with water and injected into the groundwater through injection wells. The oxidants that can be used are readily available, and treatment time is generally shorter than many other remedial options. Oxidants typically used in this process include hydrogen peroxide, potassium permanganate, ozone, and, to a lesser extent, dissolved oxygen.

Typical field applications utilize Fenton's Reagent, whereby hydrogen peroxide is applied with an iron catalyst creating a hydroxyl free radical. The hydroxyl free radical is capable of oxidizing complex organic compounds. Residual hydrogen peroxide decomposes into water and oxygen in the subsurface, and any remaining iron precipitates out.

In-situ chemical oxidation can be used to treat a variety of contaminants including VOCs and SVOCs, BTEX compounds, PAHs, pesticides, and PCBs. Dissolved oxygen has also been used to oxidize arsenic.

In terms of chemical handling, potassium permanganate is a stable oxidant in both solid and solution form. While hydrogen peroxide can be costly and may require protective measures due to its potential for instability in the presence of impurities, the faster reaction rate for this oxidant may save on labor and operating costs.

The methods for delivery of the chemical include injection through either wells or an injector head directly into the subsurface. The oxidants could be mixed with a catalyst or stabilizer prior to delivery, or combined with groundwater extracted from the Site as part of a recirculation system (U.S. EPA, 1998).

Figure 3-8 presents a schematic of the proposed chemical oxidation system for use at the Iron Horse Park Superfund Site. Oxidant will be mixed with water and injected through wells to the groundwater zones requiring remediation. This process may be used in both the overburden and bedrock flow zones and may also be improved through the use of hydraulic and/or pneumatic fracturing described in Section 3.2.2.5.

**3.2.2.8 Management of Migration: Horizontal Containment -- Composite / Double Barrier Cap, Single Barrier Cap.** A protective cap can be placed over a contaminated zone to reduce infiltration of rainwater or other surface waters and thus reduce the production of leachate from buried wastes or contaminated soil. Discussion of this technology and proposed designs for the Iron Horse Park Superfund Site are presented in Section 3.2.1.7.

**3.2.2.9 Management of Migration: Vertical Containment -- Slurry Walls, Vertical Geomembrane.** Vertical barriers are commonly used to contain groundwater flow so that downgradient migration of contaminants is limited. In the case of the Iron Horse Park Superfund Site, they are proposed as part of any groundwater pump-and-treat system to prevent pumping of nearby surface water.

Slurry walls are excavated trenches in which a mixture of bentonite and water (a slurry) is used to prevent collapse during excavation. A soil-bentonite backfill material is then placed in the trench where it creates the containment wall, which is a low permeability, chemical-resistant barrier. Other additives can be used to create a slurry wall with different strength or chemical compatibility. For containment situations, the slurry wall is most effective if based on or keyed into a low permeability layer such as clay or bedrock to decrease the leakage potential beneath it (Van Deuren *et al.*, 1997).

Vertical geomembranes may also be used as groundwater flow barriers. The selected material would be based on contaminant compatibility. Installation may be done either by specialized trenching equipment, which excavates the trench, inserts the geomembrane, and then backfills the trench, or by insertion of interlocking geomembrane panels into an excavated trench. In either case, keying the geomembrane into a subsurface aquitard is important to create an efficient barrier (Magnuson, 1995).

Factors that should be considered in designing either a slurry wall or vertical geomembrane include depth of the containment required to key into a subsurface aquitard, available working area, compatibility of contaminants in contact with wall materials, soil characteristics, anticipated hydraulic gradients, and maximum allowable permeability.

For cost purposes, slurry cutoff walls are proposed for use at the Iron Horse Park Superfund Site. However, this may not be the most cost-effective solution for each AOC and should be reviewed further during design.

**3.2.2.10 Collection -- Extraction Wells, Subsurface Drains.** This section describes technologies used for the collection of contaminated groundwater: extraction wells and subsurface drains.

Subsurface collection drains can be used to intercept shallow groundwater on the downgradient side of a plume or to completely surround contaminated material. The three basic types of subsurface drains are perforated pipe, gravel (French), and tile. Pipe and gravel are the materials most commonly used for drains. Pipe drains are used for high groundwater flow rates, while gravel is used for sites with lower flow rates. Even with a pipe drain, gravel is typically used to surround the pipe in the bedding trench so that flow into the drain will be increased and a buildup of sediments in the drain line will be reduced (U.S. EPA, 1985).

Similar to subsurface drains, extraction wells can be used to remove, divert, and/or contain a plume. However, wells are more easily applied to deeper groundwater applications.

Drains and wells have similar operational problems with regard to reduction in flow. Silts enter the systems, chemicals precipitate, and biological growth can occur. Therefore, systems should be designed to facilitate routine maintenance, particularly in subsurface drains. The pipe size, slope and bends should be designed to permit mechanical cleaning, and access by manholes should be provided for visual inspections (Swartzbaugh *et al.*, 1993).

For costing purposes, extraction wells have been assumed at the Iron Horse Park Superfund Site. However, due to the shallow groundwater in many areas of the Site, subsurface drains may be utilized more efficiently.

Groundwater flow estimates for each AOC are presented in Appendix C.

**3.2.2.11 Treatment On-site: Biological Processes -- Phytoremediation.** Phytoremediation is a process that uses natural processes associated with plants to remove contaminants from the source media. The form of phytoremediation most commonly used for ex-situ water treatment is constructed wetlands. Mechanisms for pollutant removal include sedimentation, filtration, adsorption, precipitation, volatilization, microbial decomposition, and vegetative uptake. Compared to mechanical systems, constructed wetland treatment systems typically are easy and inexpensive to construct, operate and maintain. Other benefits of constructed wetlands include habitat for wildlife, enhanced aesthetics, and opportunities for public recreation, education, and research. These benefits often improve the public relations of water treatment projects.

Treatment wetlands effectively remove a variety of pollutants, including biochemical oxygen demand (BOD), total suspended solids (TSS), nutrients, and metals. In addition, several treatment wetlands have been successful in removing hydrocarbons from waters. For example, oil refinery wastewaters have received polishing in treatment wetlands at Amoco's Mandan, North Dakota facility for over 20 years (Litchfield, 1990, 1993). The wetlands maintain high reductions in hexavalent chromium, phenols, oil and grease, and BOD and chemical oxygen demand (COD). The facility also has received awards for its considerable wildlife value. Little data are available on the removal of pesticides or VOCs in treatment wetlands. In general, wetlands provide little effective mechanism for degradation

of chlorinated organics, but wetlands can act as traps for the particulates that carry most of the load (Kadlec and Knight, 1996).

Both surface flow and subsurface flow wetlands have been constructed to improve water quality. Since open water in surface flow treatment wetlands allows free movement of biota between treatment wetlands and adjacent environments, organisms may be exposed to potentially harmful levels of metals. Subsurface flow wetlands with dense monotypic stands of vegetation minimize the opportunity for ingestion of metals by biota.

Subsurface flow wetlands typically consist of an impermeable liner, pea-size gravel or other media, and emergent vegetation such as rushes (*Scirpus* sp.) and cattails (*Typha* sp.). These plants, particularly cattails, are robust aggressive species that are well suited for the removal of contaminants. Cattails have deeply rooted, strong, and densely intertwined rhizomes which provide a large surface area for nutrient absorption and microbial attachment.

To design and construct the treatment wetlands, preliminary information would need to be collected and evaluated. Information which must be collected includes the following:

- a topographical survey of the site for treatment wetlands;
- the size of the land available for the proposed treatment wetlands;
- the current status of the Site (*i.e.*, is it currently a wetland or does it receive floodwaters from nearby surface waters);
- a site-specific soil investigation to a depth of at least 8 feet, including soil thickness and depth, classification and composition, drainage characteristics, erosion potential, and variability;
- estimates of soil permeability from infiltration tests to ensure the wetlands will retain water;
- a hydrogeological investigation, to determine: depth to high groundwater, groundwater flow direction and rate of flow, vertical and horizontal gradients, presence and extent of perched groundwater, depth to bedrock and type of bedrock;

- vegetative surveys of nearby areas and/or nurseries to identify the source of vegetation to be transplanted to the treatment wetland; and
- identification of the quantity and quality of any existing discharges to the area, such as storm water runoff.

Figure 3-9 presents the constructed wetlands system proposed for use at the Iron Horse Park Superfund Site. A subsurface flow wetland, it would have two cells to accommodate flow variations and maintenance operations. Ideally, these wetland cells would be planted with vegetation from nearby wetlands. Planting seedlings, rather than seeds, will assist with the rapid establishment of vegetation in the wetlands. The inlet structure will be designed to disperse, rather than channelize, flow through the wetlands. Controlled dispersion of the influent flow with proper diffuser pipe design can help to insure low velocities for solids removal and even loading to the wetland so that anoxic conditions are prevented at the inlet area.

**3.2.2.12 Treatment On-site: Chemical Processes -- Coagulation / Flocculation and Precipitation, UV / Chemical Oxidation.** Following collection, groundwater is pumped to an on-site treatment plant with a variety of processes utilized to remove contaminants prior to discharge. The treatment train presented in Figure 3-10 is proposed for the Iron Horse Park Superfund Site based on the typical contaminants. Modifications to the system may be made during design based on the specific AOC groundwater contaminants. The major chemical processes included in the treatment train are described in this section. Coagulation / flocculation and precipitation are recommended for inorganic contaminants, while ultraviolet/chemical oxidation is recommended for organic contaminants. Both are proven technologies used in many water treatment systems. If effluent polishing is necessary, carbon adsorption is proposed and described in the next section.

**Coagulation / Flocculation and Precipitation.** Precipitation is a process where dissolved contaminants are transformed into insoluble solids through the addition of pH-adjusting chemicals. Typically, metals are precipitated from solution as hydroxides, sulfides, or carbonates. Hydroxide precipitation with lime or caustic is most common. However, because the optimum pH for precipitation as the hydroxide is different for each metal ion, treatment of aqueous waste streams

containing mixed metals requires compromise. Generally, hydroxide precipitation is performed at a pH between 9.5 and 12. Metal sulfides are generally much less soluble than hydroxides, thereby promoting better removal efficiencies. Sulfide can also be used to precipitate metals over a broader pH range than for hydroxide precipitation (M&E, 1985).

The precipitation process can generate fine particles that are held in suspension by electrostatic surface charges. These charges cause clouds of counter-ions to form around the particles, thereby preventing aggregation and reducing the effectiveness of any subsequent solid-liquid separation processes. Therefore, coagulants are typically added to overcome the repulsive forces of the particles. There are three main types of coagulants: inorganic electrolytes (such as alum, lime, ferric chloride, and ferrous sulfate); organic polymers; and synthetic polyelectrolytes with anionic or cationic functional groups. The addition of coagulants is typically followed by low-sheer mixing in a flocculator to promote contact between the particles, allowing particle growth. As flocculation occurs, the particles increase in mass and settle at a faster rate (Van Deuren *et al.*, 1997).

The flocculation process is then followed by sedimentation, which typically occurs in a clarifier. The settled sludge is then dewatered and disposed of at a permitted TSDF.

**Ultraviolet/Chemical Oxidation.** UV/chemical oxidation is a process applicable for the treatment of aqueous streams which contain less than 1% oxidizable compounds. It may be used to pretreat waste streams, to break down refractory organics (*i.e.*, those resistant to biological oxidation), or as a polishing step after other treatment processes to oxidize untreated organics. UV/chemical oxidation is an applicable treatment technology for contaminated water containing a wide variety of organic compounds such as halogenated organics, phenols, pesticides, and PCBs (Sundstrom *et al.*, 1989; Ku and Ho, 1990; Topudurti *et al.*, 1993; and U.S. EPA, 1993).

The key principle of UV/chemical oxidation is the generation of hydroxyl radicals through UV photolysis of oxidizing agents such as hydrogen peroxide and ozone (Topudurti *et al.*, 1993). Hydroxyl radicals are powerful oxidizing agents for destroying organic contaminants. UV light is first used to create hydroxyl radicals from the hydrogen peroxide ($H_2O_2$) and ozone ($O_3$). Then the

hydroxyl radicals, in combination with UV light, start to break bonds in oxidizing the organic contaminants. Formation of the radicals is shown as follows:

| HYDROGEN PEROXIDE | | ULTRAVIOLET LIGHT | | HYDROXYL RADICAL |
|---|---|---|---|---|
| $H_2O_2$ | + | $h\nu$ | → | 2OH• |

| OZONE | | ULTRAVIOLET LIGHT | | WATER | | HYDROGEN PEROXIDE | | OXYGEN |
|---|---|---|---|---|---|---|---|---|
| $O_3$ | + | $h\nu$ | + | $H_2O$ | → | $H_2O_2$ | + | $O_2$ |

THEN SIMILARLY:

$H_2O_2$ + $h\nu$ → 2OH•

The UV/chemical oxidation process is carried out in a reaction vessel separated into chambers by baffles. Each chamber contains mercury vapor lamps encased in quartz as the UV source. Water flow is perpendicular to the lamps. Each chamber may also have a sparger for ozone enriched air dispersion along the length of the chamber. Hydrogen peroxide is added to the water influent line. The size of the reaction chamber and the water flow rate can be adjusted to achieve the desired retention time.

**3.2.2.13 Treatment On-site: Physical Processes -- Adsorption.** In adsorption, contaminants concentrate or sorb onto the surface of an adsorbent, thereby reducing their concentration in the liquid or gas phase. The waste stream being treated is typically fed through vessels containing the adsorbent, but it is also sometimes added to the waste stream itself and then separated out later. The most common adsorbent is granulated activated carbon (GAC). Other adsorbents include activated alumina, forage sponge, lignins, sorption clays, and synthetic resins.

To reduce the frequency of adsorbent replacement or regeneration, adsorption is best used for waste streams with low contaminant concentrations. For waste streams containing high concentrations of contaminants, adsorption is best used as a polishing step following other treatment processes. Adsorbent media is typically disposed of as a hazardous waste if regeneration is not practical.

Adsorption processes are targeted at most organic contaminants and selected inorganic contaminants from liquid and gas streams. Activated alumina can remove fluoride and heavy metals. The forage sponge is used to remove heavy metals. Lignin clays treat organics, inorganics and heavy metals in

aqueous waste streams. Synthetic resins are better suited for thermally unstable compounds (*e.g.*, explosives) than GAC, due to the resins' non-thermal regeneration requirements. Water-soluble compounds and small molecules are not adsorbed well (Van Deuren *et al.*, 1997).

As part of water treatment at the Iron Horse Park Superfund Site, adsorption is proposed for use on both liquid and gas streams. Off-gas from water treatment tanks will flow through vapor-phase adsorbers prior to discharge. Any liquid-phase polishing which may be necessary prior to discharge will be handled through adsorption. While GAC has been used for cost purposes, the most applicable adsorbent will be selected based on the contaminants which remain following the water treatment processes described in the previous section.

**3.2.2.14 Treatment On-site: Discharge of Treated Water -- Groundwater, Surface Water, POTW.** Three discharge process options were retained for further consideration in Section 2.0: discharge to groundwater, discharge to surface water, and discharge to a publicly owned treatment works (POTW). Discharge to the Billerica POTW is being considered as the primary choice as there is a nearby sewer line. The ultimate selection of a discharge option would be made during remedial design. The remainder of this section discusses considerations relevant to this determination.

Discharge to a nearby sewer line would require further communication with the POTW to determine minimum discharge requirements. Pretreatment standards listed under 40 CFR Part 403 are necessary prior to discharge, and Massachusetts rules regarding discharge of treated water to sewers must be reviewed further in relation to the specific alternative.

Discharge to groundwater must comply with the substantive provisions of Massachusetts Groundwater Quality Controls and state Underground Injection Control Regulations. These regulations are designed to maintain high quality groundwater sources and prevent the further degradation of lower quality sources. To implement these objectives the state has developed a groundwater classification system and a set of groundwater quality standards, as discussed in Section 2.0. It must be demonstrated during design that the injection of treated groundwater would not lower the groundwater quality classification or result in the groundwater being further degraded. It is likely that this could be

demonstrated because the treatment system can be designed such that the treated effluent levels will meet the groundwater quality standards. It is also necessary that the operation of the discharge system be incorporated into the design of any groundwater collection system.

If discharge to surface water were to be utilized, it must comply with the provisions of Massachusetts Pollution Discharge Elimination System Permit Program Regulations. These regulations, similar to those for groundwater, are designed to preserve a level of water quality consistent with its use as indicated by a Water Use Classification for the water body. The Middlesex Canal has been classified as a Class B water body, which designates it for use as a public water supply with appropriate treatment, as a fish and wildlife habitat, and for agriculture, bathing, and other primary contact recreational activities. To discharge to the Middlesex Canal, it must be demonstrated that the ambient concentration of a pollutant in the water body would not exceed the Ambient Water Quality Guidelines or other Massachusetts Water Pollution Control regulations, as discussed in Section 2.0. The proposed treated effluent concentrations of the water treatment plant would be below these guidelines for all compounds in the discharge.

All three discharge options are implementable. The selection will be made during design based upon relative human health protectiveness, ecological protectiveness, and cost. It has been assumed for costing of alternatives that any treated water will be discharged via groundwater injection wells.

### 3.2.3 Surface Water

**3.2.3.1 Institutional Actions: Monitoring.** Conceptually, implementation of a surface water monitoring program must accomplish two objectives:

- Monitor the migration of Site contaminants
- Monitor the success of the remedy

The list of parameters selected to monitor surface water quality at the Site includes all COPCs identified in the RI report (M&E, 1997) and parameters required under RCRA Subtitle C regulations

and CERCLA guidance. The surface water monitoring program is based upon federal and state requirements for waste management facilities. The potentially applicable federal requirements include regulations governing solid and hazardous waste disposal facilities. These requirements might include RCRA Subtitle C and D defined in 40 CFR Parts 258 and 264. Massachusetts requirements fall under 310 CMR 19.000 and 30.000. Assumptions of analytes and monitoring frequencies used for screening and detailed evaluation of alternatives are presented in Appendix D.

Monitoring the migration of the Site contaminants is necessary to track contaminant levels as they change over time. Changing Site conditions such as future development, future increases or decreases in groundwater use , and migration from any future off-site sources may affect the size, contaminant levels, and migration pathway of the contaminant plume. Surface water monitoring locations will be established as required for protection of human health and the environment and as required under state and federal regulations.

Additional monitoring may also include elements of monitored natural attenuation to aid in determining the effectiveness of the chosen remedy. Site characterization information requires an understanding of source mass, hydrology, rates of biological and non-biological transformation and an understanding of how all of these factors are likely to vary with time. Guidance on the use of monitored natural attenuation at Superfund sites has been recently developed by the EPA Office of Solid Waste and Emergency Response (U.S. EPA, 1999a). This, along with other recent studies, will be used to define site-specific monitoring necessary to assess and characterize remedy performance and contaminant attenuation. Assumptions of analytes and monitoring frequencies used for screening and detailed evaluation of alternatives are presented in Appendix D.

If the remedy selected will not allow for unlimited use and unrestricted exposure, EPA will review this monitoring program every five years following initial implementation of the chosen remedy, as required under 40 CFR §300.430 (f)(4)(ii). At that time, a review of the number, frequency, and analyses of samples needed to accomplish each objective will be performed. The program may be adjusted to reflect observed patterns, consistencies, or changes in the surface water contaminants.

**3.2.3.2 Treatment In-situ: Biological Processes -- Monitored Natural Attenuation.** Section 3.2.1.3 provides a description of monitored natural attenuation which is applicable for all media of concern.

**3.2.3.3 Collection -- Pumps, Diversion Weirs / Channels.** Collection of surface water for treatment may be performed using a variety of methods, either alone or in combination with each other. Pumps, diversion weirs, and channels are typical methods used.

Figure 3-11 presents a proposed collection system for use at the Iron Horse Park Superfund Site. The collection system would be built at the boundary between any wetland and open water areas. Surface water flows into two corrugated / slotted polyethylene pipes and is carried into a pump station where it is then pumped to the treatment system. A geotextile sock placed around the piping filters larger particles suspended in the surface water. Valves on the collection pipes control the flow of surface water into the pump station. Concrete block tie-downs are used to hold the collection system in place. This proposed system is flexible since it can be used both in wetlands and open water areas. However, other designs may be more appropriate depending on the best intake location determined during design.

**3.2.3.4 Treatment On-site: Biological Processes -- Phytoremediation.** Phytoremediation of contaminated surface water would be accomplished using constructed wetlands, as described in Section 3.2.2.11.

**3.2.3.5 Treatment On-site: Biological Processes -- Suspended Growth Aerobic Process.** In an activated sludge suspended growth process, the aqueous waste stream is fed into an aeration tank where a microbial population aerobically degrades organic matter. The degradation produces $CO_2$, $H_2O$ and new cells. The cells form a sludge, which is settled out in a clarifier (*i.e.*, sedimentation tank). A portion of the sludge is recycled to the aeration tank to maintain desired microbial mass, and the remainder is disposed. A polymer can be added as the water stream enters the clarifier in order to aid in settling (see coagulation / flocculation in Section 3.2.2.12).

This type of process is used primarily to treat SVOCs, fuel hydrocarbons, and any biodegradable organic material. The process may be less effective for some pesticides. It may be necessary to add nutrients and/or substrate if the waste stream will not support an adequate microbial population density. Other factors to consider are that low ambient temperatures can significantly decrease biodegradation rates, and very high contaminant concentrations may be toxic to the microorganisms. The activated sludge suspended growth process can be followed by other treatment processes to further remove contaminants targeted in this process as well as other types of contaminants (Van Deuren *et al.*, 1997).

When treating surface water at the Iron Horse Park Superfund Site, this technology is proposed as an initial-stage addition to the treatment train previously presented for groundwater in Section 3.2.2.12. Figure 3-12 presents the proposed treatment train for use on surface water. The reason for this additional technology is to remove most of the suspended organic matter prior to treatment via precipitation and UV/chemical oxidation. Depending on the contaminant concentrations, UV/chemical oxidation may not even be necessary if the organic COPCs are removed during the suspended growth aerobic treatment process.

**3.2.3.6 Treatment On-site: Chemical Processes -- Coagulation / Flocculation and Precipitation.** A description of coagulation / flocculation and precipitation processes is presented in Section 3.2.2.12.

**3.2.3.7 Treatment On-site: Physical Processes -- Sedimentation, Adsorption.** A description of the adsorption process is presented in Section 3.2.2.13.

As described in Section 3.2.3.5, cells in a suspended growth aerobic process form a sludge, which is settled out in a clarifier prior to being either recycled to the aeration tank or disposed. This settling process is called sedimentation. Depending on the amount and types of organic matter collected for treatment, the suspended growth process may not be necessary, and sedimentation alone can be used to remove suspended solids from the water.

**3.2.3.8 Treatment On-site: Discharge of Treated Water -- Groundwater, Surface Water, POTW.** Refer to section 3.2.2.14 for a discussion of technical criteria related to discharge of treated water.

### 3.2.4 Sediments

**3.2.4.1 Institutional Actions: Monitoring.** This section outlines the conceptual scope of sediment monitoring. Implementation of a sediment monitoring program must accomplish two objectives:

- Monitor the success of the remedy
- Monitor contaminant migration

The sediment monitoring program is based upon federal and state requirements for waste management facilities, as discussed for surface water monitoring. Potentially applicable or relevant and appropriate requirements will be described in detail for each remedial alternative during the screening of alternatives. Monitoring is anticipated to be a component of many alternatives.

The list of parameters selected to monitor sediment quality at the Site includes all COPCs identified in the RI report (M&E, 1997) and parameters required under action-specific ARARs and CERCLA guidance. Changing Site conditions such as future development, future Site use, and migration from any future off-site sources may affect the size, contaminant levels, and migration pathway of the contaminants. Assumptions of analytes and monitoring frequencies used for screening and detailed evaluation of alternatives are presented in Appendix D.

Additional monitoring may also include elements of monitored natural attenuation to aid in determining the effectiveness of the chosen remedy. Site characterization information requires an understanding of source mass, hydrology, rates of biological and non-biological transformation, and an understanding of how all of these factors are likely to vary with time. Guidance on the use of monitored natural attenuation at Superfund sites has been recently developed by the EPA Office of Solid Waste and Emergency Response (U.S. EPA, 1999a). This, along with other recent studies, will be used to define site-specific monitoring necessary to assess and characterize remedy performance

and contaminant attenuation. Assumptions of analytes and monitoring frequencies used for screening and detailed evaluation of alternatives are presented in Appendix D.

If the remedy selected will not allow for unlimited use and unrestricted exposure, EPA will review this monitoring program every five years following initial implementation of the chosen remedy, as required under 40 CFR §300.430 (f)(4)(ii). At that time, a review of the number, frequency, and analyses of samples needed to accomplish each objective will be performed. The program may be adjusted to reflect observed patterns, consistencies, or changes in the sediment contaminants.

**3.2.4.2 Treatment In-situ: Biological Processes -- Monitored Natural Attenuation.** Section 3.2.1.3 provides a description of monitored natural attenuation which is applicable for all media of concern.

**3.2.4.3 Source Control: Horizontal Containment -- Natural Cap, Engineered Cap.** Capping of sediments is a source control measure which 1) prevents contact between environmental receptors and the contaminated sediments, and 2) prevents migration of contaminated sediments. Two forms of caps, natural or engineered, may be used for this purpose. Natural capping consists of a deposition of natural sediment material over the contaminated sediments. An engineered cap utilizes physical layers, such as clay, geotextile, gravel or cobbles, placed over the contaminated sediments (Mohan, 1996).

In both cases, the cap must be thick enough to chemically and biologically isolate the contaminated sediments and to account for erosion and bioturbation. Based on conventional equipment and their related placement accuracies, a minimum cap thickness should be 50-60 cm (approximately 2 feet). Also, to ensure cap integrity, this technology is typically used only in areas not exposed to high erosive forces such as strong currents, waves, upwelling groundwater, and scour caused by navigation (U.S. EPA, 1994).

At the Iron Horse Park Superfund Site, both methods of capping are proposed for different areas of the Site. Figure 3-13 presents diagrams of potential capping designs and installation methods. Since there

is better control of protectiveness with engineered caps, these are proposed for use in most of the small streams. Geotextile, gravel and cobbles would be used to create a cap which is protective, yet amenable to sustaining environmental organisms. Larger open water areas, such as B&M Pond, would be capped with natural sediments, placed by a clamshell bucket attached to a crane. In either case, the stream or pond bank would be cut back in order to make up for the wetland volume lost due to installation of the cap.

**3.2.4.4 Source Control: Dredging, Dry Excavation.** Removal of contaminated sediments can be performed either with the surface water remaining in place (dredging) or after diverting the surface water elsewhere (dry excavation). This section briefly discusses both methods which could potentially be used at the Iron Horse Park Superfund Site. Figure 3-14 presents examples of both methods.

**Dredging**. Dredging involves mechanically penetrating, grabbing, raking, cutting, or hydraulically scouring the bottom of a waterway to dislodge the sediment. Once dislodged, the sediment is lifted out of the water either mechanically (*e.g.*, clamshell), or hydraulically, through a pipe. The basic difference between mechanical and hydraulic dredging is that mechanical dredges remove the sediments at nearly the same solids content as the in situ material; little additional water is entrained in the sediments as they are removed. In contrast, hydraulic dredges remove and transport sediment in slurry form. The total volume of material is greatly increased, because the solids content of the slurry is much less than that of the in situ sediments.

Production rates for mechanical dredges are typically lower than for hydraulic dredges. However, high productivity is not typically the main priority for dredging of contaminated sediments. Mechanical dredging is often selected for small projects in confined areas and provides one of the few effective methods for removing large debris. Of the major types of mechanical dredges, the bucket ladder, dipper, and dragline dredges operate in a manner that would lead to high sediment resuspension rates. The clamshell bucket and backhoe dredges are typically used when removing contaminated sediments.

Hydraulic dredges provide an economical means of removing large quantities of sediments. The most commonly used hydraulic dredges include the conventional cutterhead, dustpan, and bucket-wheel.

Certain hydraulic dredges have been specifically developed to reduce resuspension at the point of dredging. There are small portable hydraulic dredges available for use in isolated, hard-to-reach areas as well as very shallow water (approximately 0.5 m) (U.S. EPA, 1994).

At the Iron Horse Park Superfund Site, dredging is proposed for use in any large bodies of water, such as B&M Pond. Mechanical dredging with a clamshell bucket, either from a barge or from shore, would be used to minimize sediment resuspension and to minimize the volume of material requiring treatment. The dredged material would be stockpiled so that water could drain from the sediments and be collected and treated or disposed.

**Dry Excavation.** Dry excavation requires water to be diverted/removed from the working area. Sheet piling, coffer dams, dikes, berms and water tubes are all methods of blocking surface water from entering the working area. Piping, pumps and channels are methods used to divert the water around the working area in a stream. Figure 3-14 presents the proposed method for use at the Iron Horse Park Superfund Site when excavating contaminated sediments from the streams and channels. Following sheet piling installation, water is pumped around the working area, which is at the same time dewatered using pumps. The sediments are excavated and, similar to dredging, are stockpiled so that water can drain prior to treatment or disposal.

Two of the biggest advantages of using dry excavation instead of dredging are 1) the operator has better control over the removal operation (*i.e.*, can see what is being excavated), and 2) confirmatory sampling is much easier. Dry excavation is proposed for use at the Iron Horse Park Superfund Site in most areas due to these advantages and since the Site is amenable to this form of sediment removal.

**3.2.4.5 Source Control: On-Site Disposal -- Composite / Double Barrier Cap, Single Barrier Cap.** This option involves excavation of contaminated sediments, either through dredging or dry excavation, followed by placement below an on-site protective cap constructed to cover another AOC. Section 3.2.1.7 provides a description of the cap which would be utilized to meet RAOs in AOCs with large waste disposal areas. Only small volumes of sediment are considered for on-site disposal.

**3.2.4.6 Treatment Off-site: Treatment / Disposal Facility -- Solidification / Stabilization Facility, RCRA Subtitle C / D Landfill.** Similar to on-site disposal described in the previous section, this option involves excavation of contaminated sediments, followed by transportation to an off-site TSDF. Off-site disposal options are typically less desirable due to the possibility of future liability. However, off-site treatment of sediments through solidification / stabilization (such as asphalt batch processing) is a recycling option with proven results.

**3.2.4.7 Treatment On-site: Chemical Processes -- Solidification / Stabilization.** The process described in Section 3.2.1.10 for on-site solidification / stabilization of contaminated soil is the same that would be applied to contaminated sediments.

**3.2.4.8 Treatment On-site: Chemical Processes -- Soil Washing, Chemical Extraction.** The process described in Section 3.2.1.11 for soil washing and chemical extraction of contaminated soil is the same that would be applied to contaminated sediments.

# SECTION 4.0

# SELECTION OF THE REMEDIAL ALTERNATIVES

This section describes the process for evaluating and screening the seventy-two site-wide remedial alternatives developed in Section 3.0 and selection of the final fifteen (15) alternatives that will undergo detailed evaluation.

## 4.1 EVALUATION AND SCREENING CRITERIA

In accordance with EPA's feasibility study guidance (U.S. EPA, 1988), the screening process involves an evaluation of the seventy-two site-wide remedial alternatives with respect to the short and long-term aspects of three broad criteria: effectiveness, implementability, and cost. Short-term refers to the construction and implementation period, while long-term refers to the period after construction of the remedial action is complete (*e.g.*, monitoring, operation and maintenance (O&M)). These criteria are described in detail below.

All seventy-two remedial alternatives were quantitatively rated for the three broad criteria: effectiveness, implementability, and cost. Quantitative evaluation of both "effectiveness" and "implementability" of each site-wide remedial alternative proved to be necessary due to the number of areas of concern (AOCs), media of concern, and remedial alternatives requiring evaluation. It was infeasible to qualitatively or subjectively evaluate what was best for the overall site with ten AOCs, four media of concern, and seventy-two alternatives. Quantification of the three broad criteria allowed a direct relative comparison between the seventy-two remedial alternatives.

The quantification of "effectiveness" and "implementability" involved assigning numeric values to each of the technology/process option grouping codes for a given AOC and media of concern. These individual values were then summed up for all the AOCs and media of concern and combined to generate a total score for the remedial alternative. The quantification of "costs" was straightforward with the total cost of the remedial alternative being utilized including total capital costs plus present worth O&M costs.

Table 4-1 summarizes the quantitative ratings of "effectiveness", "implementability," and "cost" developed for each site-wide remedial alternative. Table 4-2 and Appendix D provide more detail on development of the total costs. Appendix E provides more detail on development of the quantitative rankings for effectiveness, implementability, and cost.

### 4.1.1 Effectiveness

A key aspect of the screening evaluation is determining the effectiveness of each remedial alternative. As noted in EPA's feasibility study guidance (U.S. EPA, 1988), effectiveness includes the following aspects:

- overall protection of human health
- overall protection of the environment
- compliance with ARARs
- long-term effectiveness and permanence
- reductions in toxicity, mobility and volume through treatment
- short-term effectiveness

Overall protection of human health and the environment refers to mitigation of existing human health and ecological risks. Compliance with ARARs refers to the effectiveness of each remedial alternative in complying with applicable or relevant and appropriate federal, state and local public health and environmental requirements and regulations. Long-term effectiveness and permanence refer to the ability of the remedy to maintain protection of human health and the environment after remedial action objectives have been met. Reductions in toxicity, mobility and volume refer to changes in contaminants or contaminated media through treatment. For example, does treatment only immobilize the toxic contaminants, or are contaminants changed or reacted to reduce their toxicity or total volume? Short-term effectiveness refers to protection of the community, environment, and workers during remedial action/construction efforts.

To allow easy comparison and evaluation between alternatives, the overall effectiveness of each site-wide remedial alternative was determined quantitatively. Factors to describe the overall effectiveness of each remedial alternative ($F_{EFF}$) were calculated by summing up quantitative factors for overall

protection of human health ($F_{HH}$) and the environment ($F_{ECO}$), compliance with ARARs ($F_A$), long-term effectiveness and permanence ($F_{TECH1}$), reductions in toxicity, mobility, and volume through treatment ($F_{TECH2}$), and short-term effectiveness ($F_{TECH3}$). Breakdown of effectiveness into these factors is in accordance with EPA's feasibility study guidance (U.S. EPA, 1988) and is shown graphically in Figure E-1 of Appendix E.

Each of the effectiveness factors ($F_{HH}$, $F_{ECO}$, $F_A$, $F_{TECH1}$, $F_{TECH2}$, $F_{TECH3}$) is estimated as a dimensionless, quantitative value in the range of zero to ten. This range can be intuitively described as follows: the value of zero represents the least probability of achieving the particular effectiveness factor, and the value of ten represents the highest probability. Quantitative values of the overall effectiveness ($F_{EFF}$), therefore, could range from zero to sixty.

The quantification of effectiveness factors ($F_{HH}$, $F_{ECO}$, $F_A$, $F_{TECH1}$, $F_{TECH2}$, $F_{TECH3}$) involved assigning numeric values to each of the technology/process option grouping codes for a given media of concern and effectiveness factor. The effectiveness factors for each remedial alternative are then calculated by adding the individual, weighted contributions of the various remedial technology/process option grouping codes for each AOC and media of concern. Appendix E, sections E.3 and E.4 contain the mathematical formulas and an example calculation which illustrates this quantification process in detail.

The quantification process is best illustrated by a simple example. The technology/process option grouping code *OnSite-1* for groundwater involves collection of contaminated groundwater using extraction wells or subsurface drains, on-site treatment using biological processes (*e.g.*, phytoremediation), discharge of treated water, and follow-up groundwater monitoring. For the effectiveness factor of reduction of toxicity, mobility, and volume through treatment ($F_{TECH2}$), *OnSite-1* was assigned a factor of "8" due to its high level of treatment and detoxification of the groundwater contaminants of concern. The technology/process option grouping code of *InSitu-1* involves implementation of institutional controls, treatment via natural attenuation and groundwater monitoring. *InSitu-1* was only assigned an $F_{TECH2}$ factor of "1" since natural attenuation is substantially less effective at reduction of toxicity, mobility, and volume of groundwater contaminants. The assigned

factors of one and eight have no meaning by themselves but are useful when comparisons between technology/process option grouping codes are needed to determine the more "effective" remedy. Table E-1 in Appendix E illustrates the zero to ten factors assigned to various technology/process option grouping codes by media of concern.

In general, effectiveness has a direct relationship with the complexity and intensity of a remedial alternative. The more intensive the remedial technologies/process options used, the more effective the remedy is at protecting human health, the environment, meeting ARARs.

### 4.1.2 Implementability

Implementability is a measure of both the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative. Administrative feasibility refers to the ability to obtain regulatory approvals and permits; the availability of treatment, storage and disposal facilities (TSDFs) for waste residuals; and the availability of specific equipment and technical specialists. Technical feasibility refers to the ability to construct, reliably operate, and meet technology-specific regulations for process options until a remedial action is complete. Technical feasibility also includes O&M, replacement, and monitoring of technical components of the selected remedy.

Similar to "effectiveness" , the implementability of each site-wide remedial alternative was determined quantitatively to allow easy comparison and evaluation between alternatives. Overall factors of the implementability of each remedial alternative ($F_I$) were calculated by summing up the quantitative implementability factors for each AOC. The implementability factors are estimated as dimensionless, quantitative values in the range of zero to ten. The value of zero represents the lowest probability for implementation, and the value of ten represents the highest probability of implementation of the selected remedy.

Similar to effectiveness, the quantification of the implementability factor ($F_I$) involved assigning numeric values to each of the technology/process option grouping codes for a given media of concern.

The implementability factor for each remedial alternative is calculated by adding the individual, weighted contributions of the various remedial technology/process option grouping codes for each AOC and media of concern. Appendix E, sections E.3 and E.4, contain the mathematical formulas and an example calculation which illustrates this quantification process in detail.

For example, the technology/process option grouping code *Inst. Action* for soil involves implementation of institutional actions in the form of access restrictions (*e.g.*, institutional controls and fencing and security measures) to minimize pathways to human health receptors as well as long-term monitoring. For the implementability factor ($F_I$), *Inst. Action* was assigned a value of "9" due to its relative ease to implement and conduct as a selected remedy. The technology/process option grouping code of *Off Site* involves excavation of contaminated on-site soils, followed by transport to an off-site treatment/disposal facility (*e.g.*, RCRA subtitle C or D landfill; solidification/stabilization facility) and confirmatory monitoring. *Off Site* was assigned an $F_I$ factor of only "3" due to the greater effort that would be required to obtain the necessary permits, coordinate with other regulatory agencies, locate and evaluate off-site disposal facilities and plan/execute appropriate transportation routes that minimize traffic disturbances and impacts to the community. Similar to "effectiveness", the assigned factors of three and nine have no meaning by themselves but are only useful when comparisons between technology/process option grouping codes are needed to determine the more "implementable" remedy. Table E-1 in Appendix E illustrates the zero to ten factors assigned to various technology/process option grouping codes by media of concern.

In general, implementability has an inverse relationship with the complexity of a remedial alternative. The less complex an alternative is, the more easy it is to implement, while a more complex alternative is more difficult to implement. For example, a complex remedial alternative involving multiple site media and remedial technologies requires more regulatory approvals and permits, generates more waste residuals and requires more remedial components to operate, maintain and monitor.

### 4.1.3 Cost

Total costs were developed for each site-wide remedial alternative in accordance with the EPA guidance on feasibility studies (U.S. EPA, 1988). The cost estimates address both short-term and long-term aspects of the remedial alternatives and include the following:

Short-Term Costs:

- Allowances for remedial design, bidding and engineering supervision during construction
- Allowance for EPA / MADEP oversight (*i.e.*, assumes Potentially Responsible Party-led site remediation)
- Direct construction costs including material, labor and equipment breakdowns for the each of the remedial technologies/process options
- Remediation contractor overhead and profit
- Construction contingency costs @ 20%

Long-Term Costs:

- Annual O&M costs converted to a present worth lump sum cost and incorporating annual rate of inflation (3.0%) and interest rates (7.0%)
- O&M costs including monitoring, labor, utilities, costs of chemicals and residuals disposal, general maintenance, and capital repair & replacement for each of the remedial technologies/process options
- O&M cost contingency @15%

The estimated cost accuracy developed for this phase of the feasibility study is +50% to -30%. Costs for each site-wide remedial alternative are shown in Table 4-2 with detail provided in Appendix D. Costs were developed for each AOC and technology/process option grouping code and were summed to generate the total cost of each remedial alternative.

An additional cost tool, the ratio of environmental benefit-to-costs ($R_{BC}$ ), was developed to assist with comparison and selection of the remedial alternatives for detailed evaluation. The environmental benefit of each site-wide remedial alternative is equal to the sum of quantitative factors for effectiveness ($F_{EFF}$) and implementability ($F_I$) and thus represents: overall protection of human health and the environment, compliance with ARARs, short and long-term effectiveness, reductions in toxicity, mobility and volume of contaminants and overall implementability of the selected remedy. The sum of quantitative factors for effectiveness ($F_{EFF}$) and implementability ($F_I$) are divided by total

costs ($C_T$) resulting in the environmental benefit-to-cost ratio, $R_{BC}$. Total costs for an alternative are equal to the site-wide remedial alternatives costs for both capital plus present worth (O&M). Mathematical formulation of the ratio of environmental benefit-to-costs is illustrated in detail in Appendix E.

Higher values of environmental benefit are better than lower values. Therefore, high values of $R_{BC}$ indicate a greater environmental benefit per dollar spent whereas lower values indicate less benefit per dollar spent. It is important to note that the values of environmental benefit-to-costs can only be used when comparing one remedial alternative to another. The $R_{BC}$ values in and of themselves will have no meaning if taken out of this context. Tables E-2 and E-3 in Appendix E present $R_{BC}$ values for each alternative as well as rank alternatives from highest to lowest $R_{BC}$ values.

## 4.2 SELECTION OF THE REMEDIAL ALTERNATIVES

Selection of the site-wide remedial alternatives that would proceed to detailed evaluation was based on the following criteria. Alternatives that met the largest number of these criteria were viewed the most favorably.

a. Alternatives with high "Effectiveness" scores, especially with regards to the threshold factors of overall protection of human health and the environment, and compliance with ARARs.

b. Alternatives with high "Implementability" scores.

c. Alternatives with high relative cost effectiveness; *i.e.*, those alternatives that were in the top thirty values of environmental benefit-to-cost ratios ($R_{BC}$).
   - Highly cost effective remedy: an alternative within the top 15 site-wide remedial alternatives ranked by $R_{BC}$ values
   - Cost effective remedy: an alternative within the top 30 alternatives ranked by $R_{BC}$ values

d. Alternatives that provided a full range of feasible remedies for detailed evaluation including "No Action," "Limited Action," "Off-Site," and "Intensive/Maximum Remedial Action" remedies.

All seventy-two (72) site-wide remedial alternatives were evaluated based on the selection requirements and criteria noted in sections 4.1 and 4.2. At review meetings held in June and July 1999, the fifteen alternatives selected for detailed evaluation included: #1, #3, #5, #8, #15, #18, #27, #31, #43, #46, #48, #51, #59, #67 and #72.

## 4.3 DESCRIPTION OF THE REMEDIAL ALTERNATIVES FOR DETAILED EVALUATION

This section describes the remedial components of each of the site-wide remedial alternatives selected for detailed evaluation. As described in section 4.2, remedial alternatives noted as "cost effective" are within the top 30 alternatives as ranked by the ratio of environmental-benefit-to costs ($R_{BC}$). Alternatives noted as "highly cost effective" are within the top 15 alternatives as ranked by $R_{BC}$.

### 4.3.1 Alternative #1 - "No Action"

Alternative #1, by regulatory definition, is the "No Action" alternative required by the National Contingency Plan and EPA's feasibility study guidance (U.S. EPA, 1988). No remedial actions (including monitoring) will be conducted at any of the AOCs under this alternative. Alternative #1 represents the baseline human health and ecological risks determined during the Remedial Investigation (M&E, 1997).

### 4.3.2 Alternative #3 - "Institutional Action"

Alternative #3 represents the "Institutional Action" alternative. This alternative would be the most intensive site-wide remedy that could be implemented by using institutional controls, fencing, and monitoring. Institutional controls, fencing and/or monitoring will be applied to all AOCs including site-wide surface water and sediment. Alternative #3 is a highly cost effective remedy.

Alternative #3 includes the following remedial actions by media of concern and AOC:

Soil:

- Institutional actions consisting of access restrictions (*i.e.,* institutional controls, fencing and security measures) as well as monitoring will be implemented at the highest risk-ranked AOCs (#1 - B&M Railroad Landfill, #3- B&M Locomotive Shop Disposal Areas, #4 - Old B&M Oil/Sludge Recycling Area, #5 - Contaminated Soils Area, #6- Asbestos Landfill, #7 - Asbestos Lagoons).
- No remedial actions for soil will be necessary at the remaining AOC (#2 - RSI Landfill) since contaminant concentrations are within acceptable human health and ecological risk levels for soil.

Groundwater:

- Institutional actions consisting of access restrictions (*e.g.,* institutional controls) as well as monitoring will be implemented at the highest human health risk-ranked AOCs (#2 - RSI Landfill, #5 - Contaminated Soils Area, #6 - Asbestos Landfill). All other AOCs will be limited to institutional actions consisting of monitoring only.

Surface Water and Sediment:

- Monitoring will be implemented at all three AOCs showing risk (#8b - Wetland 2 Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group). No remedial actions for surface water will be necessary at all remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) since contaminant concentrations are within acceptable human health and ecological risk levels. Sediment monitoring is included at these two AOCs as a provision if future toxicity testing results in ecological risk.

### 4.3.3 Alternative #5 - "Limited Action"

Alternative #5 is defined as the "Limited Action" alternative. Active remedial efforts will be applied to the highest human health risk-ranked AOCs, with monitored natural attenuation or institutional actions used for the remaining AOCs. No remedial actions will be undertaken at the wetlands AOCs for surface water and sediment. This alternative was chosen for further evaluation based on its cost effectiveness.

Alternative #5 includes the following remedial actions by media of concern and AOC:

Soil:

- In-situ treatment consisting of chemical processes (*e.g.,* solidification/stabilization) will utilized at the highest human health risk-ranked AOC (#5 - Contaminated Soils Area).
- In-situ remedies of monitored natural attenuation and institutional actions consisting of access restrictions (*i.e.,* institutional controls, fencing and security measures) as well as

monitoring will be implemented at the middle human health risk-ranked AOCs (#1 - B&M Railroad Landfill, #3 - B&M Locomotive Shop Disposal Areas, #4 - Old B&M Oil/Sludge Recycling Area).

- Institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures) as well as monitoring will be implemented at the remaining AOCs (#6 - Asbestos Landfill, #7 - Asbestos Lagoons).
- No remedial actions for soil will be necessary at the remaining AOC (#2 - RSI Landfill) since contaminant concentrations are within acceptable human health and ecological risk levels for soil.

Groundwater:

- In-situ remedies consisting of monitored natural attenuation as well as institutional actions consisting of access restrictions (*e.g.*, institutional controls) and monitoring will be implemented at all AOCs.

Surface Water and Sediment:

- No remedial actions will be taken at the three AOCs exhibiting risk (#8b - Wetland 2 Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group).

### 4.3.4 Alternative #8 - "Threshold Effectiveness"

Alternative #8 is the first alternative that meets the "threshold" effectiveness factors of: a) protective of human health and the environment and b) compliance with ARARs. This alternative represents the first remedy where installation of horizontal containment caps or waste removal will be conducted at all disposal area AOCs. This alternative was chosen for further evaluation based on its cost effectiveness.

Alternative #8 includes the following remedial actions by media of concern and AOC:

Soil:

- Source control remedies consisting of horizontal containment (*i.e.*, caps) will be implemented at disposal area AOCs [#1 - B&M Railroad Landfill, #2 - RSI Landfill (for groundwater source management), #6 - Asbestos Landfill, #7 - Asbestos Lagoons] to address risk and/or meet ARAR requirements.
- Contaminated soil at AOCs #3 (B&M Locomotive Shop Disposal Areas) and #4 (Old B&M Oil/Sludge Recycling Area) will be excavated and relocated for ultimate disposal under one of the caps installed for AOCs #1, 2, 6, or 7.
- Due to on-going, active use of AOC #5 (Contaminated Soils Area), in-situ treatment consisting of chemical and biological processes (*e.g.*, soil flushing, enhanced biodegradation) will be utilized along with institutional actions consisting of access

restrictions (*i.e.*, institutional controls, fencing and security measures) and monitoring to meet preliminary remediation goals.

Groundwater:

- An in-situ remedy consisting of monitored natural attenuation, physical processes (hydraulic and pneumatic fracturing), and chemical oxidation will be applied to the highest human health risk-ranked AOC (#5 - Contaminated Soils Area). This remedy also includes institutional actions consisting of access restrictions (*e.g.*, institutional controls) as well as monitoring.
- In-situ remedies consisting of monitored natural attenuation as well as institutional actions consisting of access restrictions (*e.g.*, institutional controls) and monitoring will be implemented at all remaining AOCs.

Surface Water and Sediment:

- Institutional actions consisting of monitoring will be implemented at all three AOCs showing risk (#8b-Wetland 2 Group, #8d-Richardson Pond Group, #8e-Content Brook Wetland Group). No remedial actions for surface water will be necessary at all remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) since contaminant concentrations are within acceptable human health and ecological risk levels. Sediment monitoring is included at these two AOCs as a provision if future toxicity testing results in ecological risk.

### 4.3.5 Alternative #15 - "Source Control A"

Alternative #15 is the first of two "source control" remedies that maximize containment-type remedial actions (*e.g.*, caps) on soil and source AOCs (*e.g.*, landfill/waste disposal areas) while applying maximum in-situ remedies to the highest risk-ranked groundwater AOCs. This alternative applies in-situ remedies to all surface water and sediment AOCs exhibiting risk. Alternative #15 was selected for further evaluation due to its level of protectiveness and ARAR compliance.

Alternative #15 includes the following remedial actions by media of concern and AOC:

Soil:

- Source control remedies consisting of horizontal containment (*e.g.*, caps) will be implemented at disposal area AOCs [#1 - B&M Railroad Landfill, #2 - RSI Landfill (for groundwater source management), #6 - Asbestos Landfill] to address human health and ecological risk and/or meet ARAR requirements.
- Contaminated soil at AOC #3 (B&M Locomotive Shop Disposal Areas), AOC #4 (Old B&M Oil/Sludge Recycling Area), and AOC #7 (Asbestos Lagoons) will be excavated and relocated for ultimate disposal under one of the caps installed for AOCs #1, 2, or 6.

- Due to on-going, active use of AOC #5 (Contaminated Soils Area), in-situ treatment consisting of chemical and biological processes (*e.g.*, soil flushing, enhanced biodegradation) will be utilized along along with institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing, and security measures) and monitoring to meet preliminary remediation goals.

Groundwater:

- An in-situ remedy consisting of monitored natural attenuation, physical processes for aquifer hydraulic and pneumatic fracturing and chemical oxidation will be applied to the highest human health risk-ranked AOC (#5 - Contaminated Soils Area) and at AOC #3 (B&M Locomotive Shop Disposal Areas) where soil/waste source areas will be removed. This remedy also includes institutional actions consisting of access restrictions (institutional controls) as well as monitoring.
- In-situ remedies consisting of physical processes (*e.g.*, passive/reactive treatment walls) and biological processes (*e.g.*, enhanced biodegradation) will be applied to disposal site AOCs where contaminated groundwater can be feasibly contained (#1 - B&M Railroad Landfill, #2 - RSI Landfill, #4 - Old B&M Oil/Sludge Recycling Area, #6 - Asbestos Landfill, #7 - Asbestos Lagoons). Institutional actions consisting of access restrictions (*e.g.*, institutional controls) and monitoring are part of this remedy as well.

Surface Water and Sediment:

- In-situ remedies consisting of monitored natural attenuation will be implemented at all three AOCs showing risk (#8b - Wetland 2 Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group). No remedial actions for surface water will be necessary at all remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) since contaminant concentrations are within acceptable human health and ecological risk levels. Monitored natural attenuation is included at these two AOCs as a provision if future toxicity testing results in ecological risk.

### 4.3.6 Alternative #18 - "Source Control B"

Alternative #18 is the second "source control" remedy that maximizes containment-type remedial actions (*e.g.*, caps) on soil and source AOCs (*e.g.*, landfill/waste disposal areas), while applying in-situ remedies to groundwater and institutional actions to surface water and sediment. Alternative #18 was selected for further evaluation based on its protectiveness, cost effectiveness, and ARAR compliance.

Alternative #18 includes the following remedial actions by media of concern and AOC:

Soil:

- Source control remedies consisting of horizontal containment (*e.g.*, caps) will be implemented at all disposal area AOCs [#1 - B&M Railroad Landfill, #2 - RSI Landfill

(for groundwater source management), #5 - Contaminated Soils Area, #6 - Asbestos Landfill, #7 - Asbestos Lagoons] to address human health and ecological risk and/or meet ARAR requirements.

- Contaminated soil at AOC #3 (B&M Locomotive Shop Disposal Areas) and AOC #4 (Old B&M Oil/Sludge Recycling Area) will be excavated and relocated for ultimate disposal under one of the caps installed for AOCs #1, 2, 6, or 7. This remedy also includes institutional actions for monitoring to confirm appropriate source cleanup.

Groundwater:

- In-situ remedies consisting of monitored natural attenuation as well as institutional actions consisting of access restrictions (*e.g.*, institutional controls) and monitoring will be implemented at all AOCs.

Surface Water and Sediment:

- Institutional actions consisting of monitoring will be implemented at all three AOCs showing risk (#8b - Wetland 2 Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group). No remedial actions for surface water will be necessary at all remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) since contaminant concentrations are within acceptable human health and ecological risk levels. Sediment monitoring is included at these two AOCs as a provision if future toxicity testing results in ecological risk.

### 4.3.7 Alternative #27 - "Sediment Source Control"

Alternative #27 is the first remedy to apply more active measures to mitigate contaminated sediments via source control methods. This alternative is similar to Alternative #15 except that source control remedial technologies/process options are applied to sediments in affected wetlands AOCs. Surface water will be addressed by in-situ remedies. This alternative was selected for further evaluation based on its being protective of human health and the environment and compliance with ARARs.

Alternative #27 includes the following remedial actions by media of concern and AOC:

Soil:

- Source control remedies consisting of horizontal containment (*e.g.*, caps) will be implemented at disposal area AOCs [#1 - B&M Railroad Landfill, #2 - RSI Landfill (for groundwater source management), #5 - Contaminated Soils Area, #6 - Asbestos Landfill] to address human health and ecological risk and/or meet ARAR requirements.
- Contaminated soil at AOC #3 (B&M Locomotive Shop Disposal Areas), AOC #4 (Old B&M Oil/Sludge Recycling Area) and AOC #7 (Asbestos Lagoons) will be excavated and relocated for ultimate disposal under one of the caps installed for AOCs #1, 2, or 6.

Further institutional actions related to monitoring will be conducted at AOCs #3, #4, and #7 to confirm source mitigation.

Groundwater:

- In-situ remedies consisting of physical processes (*e.g.*, passive/reactive treatment walls) and biological processes (*e.g.*, enhanced biodegradation) will be applied to disposal site AOCs where contaminated groundwater can be feasibly contained (#1 - B&M Railroad Landfill, #2 - RSI Landfill, #4-Old B&M Oil/Sludge Recycling Area, #6 - Asbestos Landfill, #7 - Asbestos Lagoons). Institutional actions consisting of access restrictions (*e.g.*, institutional controls) and monitoring are part of this remedy as well.
- An in-situ remedy consisting of monitored natural attenuation, physical processes for aquifer hydraulic and pneumatic fracturing and chemical oxidation will be applied to AOC #3 (B&M Locomotive Shop Disposal Areas). This remedy also includes institutional actions consisting of access restrictions (institutional controls) as well as monitoring.
- Due to capping of source area contaminated soil, only in-situ monitored natural attenuation of groundwater and institutional action access restrictions (*e.g.*, institutional controls) will be conducted at AOC #5 (Contaminated Soils Area).

Surface Water:

- In-situ remedies consisting of monitored natural attenuation will be implemented at all three AOCs showing risk (#8b - Wetland 2 Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group).

Sediment:

- Source control remedies consisting of in-place, horizontal containment of contaminated sediments with in-situ actions for monitored natural attenuation will be implemented at the highest ecological risk-ranked AOC (#8b - Wetland 2 Group).
- Source control remedies consisting of dredging/dry excavation of "hot spot" locations will be applied to contaminated sediments in the remaining AOCs (#8d-Richardson Pond Group, #8e - Content Brook Wetland Group). Excavated sediments are disposed on-site via relocation under one of the caps installed for AOCs #1, 2, or 6. Remaining lesser contaminated sediments will be mitigated through in-situ means via monitored natural attenuation. Similarly, the same actions are included at the remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) as a provision if future toxicity testing results in ecological risk.

### 4.3.8 Alternative #31 - "Off-Site Action"

Alternative #31 maximizes the use of process options and remedial technologies available at existing off-site treatment, storage and disposal facilities (TSDFs). This alternative is protective of human

health and the environment while meeting ARARs. Alternative #31 was selected for further evaluation based on its cost-effectiveness.

Alternative #31 includes the following remedial actions by media of concern and AOC:

Soil:

- At AOC #5 (Contaminated Soils Area), soil will be excavated, transported and disposed of using off-site treatment facilities (*e.g.*, solidification/stabilization facility, RCRA Subtitle C/D landfill). Institutional actions involving monitoring will be used to confirm removal of affected areas.
- Source control remedies consisting of horizontal containment (*e.g.*, caps) will be implemented at disposal area AOCs [#1 - B&M Railroad Landfill, #2 - RSI Landfill (for groundwater source management), #6 - Asbestos Landfill, #7 - Asbestos Lagoons] to address human health and ecological risk and/or meet ARAR requirements.
- Contaminated soil at AOC #3 (B&M Locomotive Shop Disposal Areas) and AOC #4 (Old B&M Oil/Sludge Recycling Area) will be excavated and relocated for ultimate disposal under one of the caps installed for AOCs #1, 2, 6, or 7. Further institutional actions related to monitoring are conducted at AOCs #3 to confirm source mitigation.

Groundwater:

- An in-situ remedy consisting of monitored natural attenuation, physical processes for aquifer hydraulic and pneumatic fracturing and chemical oxidation will be applied to the highest human health risk-ranked AOC (#5 - Contaminated Soils Area). This remedy also includes institutional actions consisting of access restrictions (institutional controls) as well as monitoring.
- In-situ remedies consisting of monitored natural attenuation as well as institutional actions consisting of access restrictions (*e.g.*, institutional controls) and monitoring will be implemented at all remaining AOCs.

Surface Water and Sediment:

- Institutional actions consisting of monitoring will be implemented at all three AOCs showing risk (#8b - Wetland 2 Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group). No remedial actions for surface water will be necessary at all remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) since contaminant concentrations are within acceptable human health and ecological risk levels. Sediment monitoring is included at these two AOCs as a provision if future toxicity testing results in ecological risk.

### 4.3.9 Alternative #43 - Balanced Remedial Action

Alternative #43 offers a balanced mixture of institutional actions, in-situ remedies, source control and on-site treatment remedial technologies/process options to address the highest risk-ranked AOCs. Alternative #43 is protective of human health, the environment and meets ARARs and addresses all site media of concern. Alternative #43 was selected for further evaluation based on its cost-effectiveness.

Alternative #43 includes the following remedial actions by media of concern and AOC:

Soil:

- Source control remedies consisting of horizontal containment (*i.e.*, caps) will be implemented at all disposal area AOCs [#1 - B&M Railroad Landfill, #2 - RSI Landfill (for groundwater source management), #5 - Contaminated Soils Area, #6 - Asbestos Landfill, #7 - Asbestos Lagoons] to address human health and ecological risk and/or meet ARAR requirements.
- Contaminated soil at AOC #3 (B&M Locomotive Shop Disposal Areas) and AOC #4 (Old B&M Oil/Sludge Recycling Area) will be excavated and relocated for ultimate disposal under one of the caps installed for AOCs #1, 2, 6, or 7. This remedy also includes institutional actions for monitoring to confirm appropriate source cleanup.

Groundwater:

- An on-site pump and treat remedy consisting of collection of contaminated groundwater (*e.g.*, extraction wells/subsurface drains) and treatment on-site using biological processes (phytoremediation) followed by discharge will be applied to the highest human health risk-ranked AOC (#5 - Contaminated Soils Area). This remedy also includes institutional actions for groundwater monitoring.
- In-situ remedies consisting of monitored natural attenuation as well as institutional actions consisting of access restrictions (*e.g.*, institutional controls) and monitoring will be implemented at all remaining AOCs.

Surface Water and Sediment:

- Institutional actions consisting of monitoring will be implemented at all three AOCs showing risk (#8b - Wetland 2 Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group). No remedial actions for surface water will be necessary at all remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) since contaminant concentrations are within acceptable human health and ecological risk levels. Sediment monitoring is included at these two AOCs as a provision if future toxicity testing results in ecological risk.

### 4.3.10 Alternative #46 - "Intensive Remedial Action A"

Alternative #46 is similar to Alternative #15 in that source control remedies will be maximized for soil and disposal areas, while on-site treatment will be applied to all on-site groundwater. In-situ remedies will be applied to all sediment and surface water AOCs exhibiting risk. Alternative #46 is protective of human health and the environment and meets ARARs. Alternative #46 was selected for further evaluation based on its cost-effectiveness.

Alternative #46 includes the following remedial aspects by media of concern and AOC:

Soil:

- Source control remedies consisting of horizontal containment (*i.e.*, caps) will be implemented at disposal area AOCs [#1 - B&M Railroad Landfill, #2 - RSI Landfill (for groundwater source management), #5 - Contaminated Soils Area, #6 - Asbestos Landfill] to address human health and ecological risk and/or meet ARAR requirements.

- Contaminated soil at AOCs #3 (B&M Locomotive Shop Disposal Areas), #4 (Old B&M Oil/Sludge Recycling Area), and #7 (Asbestos Lagoons) will be excavated and relocated for ultimate disposal under one of the caps installed for AOCs #1, 2, or 6. This remedy also includes institutional actions for monitoring to confirm appropriate source cleanup.

Groundwater:

- An on-site pump and treat remedy consisting of collection of contaminated groundwater (*e.g.*, extraction wells/subsurface drains) and treatment on-site using biological processes (phytoremediation) followed by discharge will be applied to all AOCs. Vertical containment will be used where necessary to prevent wetland dewatering during groundwater collection. This remedy also includes institutional actions for groundwater monitoring.

Surface Water and Sediment:

- In-situ remedies consisting of monitored natural attenuation will be implemented at all three AOCs showing risk (#8b - Wetland 2 Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group). No remedial actions for surface water will be necessary at all remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) since contaminant concentrations are within acceptable human health and ecological risk levels. Monitored natural attenuation of sediment is included at these two AOCs as a provision if future toxicity testing results in ecological risk.

### 4.3.11 Alternative #48 - "Intensive Remedial Action B"

Alternative #48 is similar to Alternative #46 except that source control remedies will be extended to include sediments along with soil and disposal areas, while on-site treatment will be extended to include both groundwater and surface water. Alternative #48 was selected for further evaluation based on it being protective of human health and the environment, compliance with ARARs, and cost-effectiveness.

Alternative #48 includes the following remedial actions by media of concern and AOC:

Soil:

- Source control remedies consisting of horizontal containment (*e.g.*, caps) will be implemented at disposal area AOCs [#1 - B&M Railroad Landfill, #2 - RSI Landfill (for groundwater source management), #5 - Contaminated Soils Area, #6 - Asbestos Landfill] to address human health and ecological risk and/or meet ARAR requirements.
- Contaminated soil at AOCs #3 (B&M Locomotive Shop Disposal Areas), #4 (Old B&M Oil/Sludge Recycling Area), and #7 (Asbestos Lagoons) will be excavated and relocated for ultimate disposal under one of the caps installed for AOCs #1, 2, or 6. This remedy also includes institutional actions for monitoring to confirm appropriate source cleanup.

Groundwater:

- An on-site pump and treat remedy consisting of collection of contaminated groundwater (*e.g.*, extraction wells/subsurface drains) and treatment on-site using biological processes (phytoremediation) followed by discharge will be applied to all AOCs. Vertical containment will be used where necessary to prevent wetland dewatering during groundwater collection. This remedy will also include institutional actions for groundwater monitoring.

Surface Water:

- An on-site collection and treatment remedy consisting of collection of contaminated surface water (*e.g.*, pumps, diversion weirs/channels) and treatment on-site using biological processes (phytoremediation) followed by discharge will be applied to AOCs #8b (Wetland 2 Group) and #8e (Content Brook Wetland Group). This remedy also includes institutional actions for surface water monitoring.
- In-situ remedies consisting of monitored natural attenuation will be implemented at AOC #8d (Richardson Pond Group).

Sediment:

- Source control remedies consisting of dredging/dry excavation of "hot spot" locations will be applied to contaminated sediments in all AOCs exhibiting risk (#8b - Wetland 2

Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group). Excavated sediments will be disposed on-site via relocation under one of the caps installed for AOCs#1, 2, or 6. Remaining lesser contaminated sediments will be mitigated through in-situ means via monitored natural attenuation. Similarly, the same actions are included at the remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) as a provision if future toxicity testing results in ecological risk.

### 4.3.12 Alternative #51 - "Focused Treatment and Remedial Action A"

Alternative #51 focuses intensive treatment technologies/process options on those AOCs with the highest human health risk while utilizing source control, in-situ and institutional action remedies on the remaining AOCs. This alternative results in a balance of good overall "Effectiveness" and "Implementability" while maintaining a high degree of cost effectiveness.

Alternative #51 includes the following remedial actions by media of concern and AOC:

Soil:

- Source control remedies consisting of horizontal containment (*i.e.*, caps) will be implemented at all disposal area AOCs [#1 - B&M Railroad Landfill, #2 - RSI Landfill (for groundwater source management), #5 - Contaminated Soils Area, #6 - Asbestos Landfill, #7 - Asbestos Lagoons] to address human health and ecological risk and/or meet ARAR requirements.
- Contaminated soil at AOC #3 (B&M Locomotive Shop Disposal Areas) and AOC #4 (Old B&M Oil/Sludge Recycling Area) will be excavated and relocated for ultimate disposal under one of the caps installed for AOCs#1, 2, 6, or 7. This remedy will also include institutional actions for monitoring to confirm appropriate source cleanup.

Groundwater:

- An on-site pump and treat remedy consisting of collection of contaminated groundwater (*e.g.*, extraction wells/subsurface drains) and treatment on-site using chemical and physical processes (coagulation / flocculation and precipitation, UV/chemical oxidation, adsorption technology) followed by discharge of treated water will be implemented at the highest human health risk-ranked AOC (#5 - Contaminated Soils Area). This remedy will also include institutional actions for groundwater monitoring.
- In-situ remedies consisting of monitored natural attenuation as well as institutional actions consisting of access restrictions (*e.g.*, institutional controls) and monitoring will be implemented at all remaining AOCs.

Surface Water and Sediment:

- Institutional actions consisting of monitoring will be implemented at all three AOCs showing risk (#8b - Wetland 2 Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group). No remedial actions for surface water will be necessary at all remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) since contaminant concentrations are within acceptable human health and ecological risk levels. Sediment monitoring is included at these two AOCs as a provision if future toxicity testing results in ecological risk.

### 4.3.13 Alternative #59 - "Focused Treatment and Remedial Action B"

Alternative #59 is similar to Alternative #51 in that intensive treatment technologies/process options will be focused on those AOCs with the highest human health risk while utilizing source control, in-situ and institutional action remedies on the remaining AOCs. Alternative #59 adds additional on-site treatment of soil to the remedy presented in Alternative #51. This results in a balance of good overall "Effectiveness" and "Implementability" while still maintaining cost effectiveness.

Alternative #59 includes the following remedial actions by media of concern and AOC:

Soil:

- Contaminated soil at AOCs #3 (B&M Locomotive Shop Disposal Areas), #4 (Old B&M Oil/Sludge Recycling Area), and #5 (Contaminated Soils Area) will be excavated and treated using chemical processes (solidification/stabilization). This remedy will also include institutional actions for monitoring to confirm appropriate source cleanup.
- Source control remedies consisting of horizontal containment (*e.g.*, caps) will be implemented at disposal area AOCs [#1-B&M Railroad Landfill, #2 - RSI Landfill (for groundwater source management), #6 - Asbestos Landfill, #7 - Asbestos Lagoons] to address human health and ecological risk and/or meet ARAR requirements.

Groundwater:

- An on-site pump and treat remedy consisting of collection of contaminated groundwater (*e.g.*, extraction wells/subsurface drains) and treatment on-site using biological processes (phytoremediation) followed by discharge will be applied to the highest human health risk-ranked AOC (#5-Contaminated Soils Area). This remedy will also include institutional actions for groundwater monitoring.
- In-situ remedies consisting of monitored natural attenuation as well as institutional actions consisting of access restrictions (*e.g.*, institutional controls) and monitoring will be implemented at all remaining AOCs.

Surface Water and Sediment:

- Institutional actions consisting of monitoring will be implemented at all three AOCs showing risk (#8b - Wetland 2 Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group). No remedial actions for surface water will be necessary at all remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) since contaminant concentrations are within acceptable human health and ecological risk levels. Sediment monitoring is included at these two AOCs as a provision if future toxicity testing results in ecological risk.

### 4.3.14 Alternative #67- "Focused Treatment and Remedial Action C"

Alternative #67 is similar to Alternative #59 in that intensive treatment technologies/process options are focused on those AOCs with the highest human health risk while utilizing source control, in-situ and institutional action remedies on the remaining AOCs. Alternative #67 uses an alternate on-site treatment approach to the remedy presented in Alternative #59. This results in a balance of good overall "Effectiveness" and "Implementability" while still maintaining cost effectiveness.

Alternative #67 includes the following remedial actions by media of concern and AOC:

Soil:

- Contaminated soil at AOCs #3 (B&M Locomotive Shop Disposal Areas), #4 (Old B&M Oil/Sludge Recycling Area) and #5 (Contaminated Soils Area) will be excavated and treated using chemical processes (chemical extraction, soil washing). This remedy will also include institutional actions for monitoring to confirm appropriate source cleanup.
- Source control remedies consisting of horizontal containment (*e.g.*, caps) will be implemented at disposal area AOCs [#1 - B&M Railroad Landfill, #2 - RSI Landfill (for groundwater source managment), #6 - Asbestos Landfill, #7 - Asbestos Lagoons] to address human health and ecological risk and/or meet ARAR requirements.

Groundwater:

- An on-site pump and treat remedy consisting of collection of contaminated groundwater (*e.g.*, extraction wells/subsurface drains) and treatment on-site using chemical and physical processes (coagulation / flocculation and precipitation, UV/chemical oxidation, adsorption technology) followed by discharge of treated water will be applied to the highest human health risk-ranked AOC (#5 - Contaminated Soils Area). This remedy also includes institutional actions for groundwater monitoring.
- In-situ remedies consisting of monitored natural attenuation as well as institutional actions consisting of access restrictions (*e.g.*, institutional controls) and monitoring will be implemented at all remaining AOCs.

Surface Water and Sediment:

- Institutional actions consisting of monitoring are implemented at all three AOCs showing risk (#8b - Wetland 2 Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group). No remedial actions for surface water will be necessary at all remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) since contaminant concentrations are within acceptable human health and ecological risk levels. Sediment monitoring is included at these two AOCs as a provision if future toxicity testing results in ecological risk.

### 4.3.15 Alternative #72- "Maximum Remedial Action"

Alternative #72 represents the remedy with the highest overall "Effectiveness" and "Implementability" and offers the most extensive combination of remedial technologies and process options.

Alternative #72 includes the following remedial actions by media of concern and AOC:

Soil:

- Source control remedies consisting of horizontal containment (*e.g.*, caps) will be implemented at disposal area AOCs [#1 - B&M Railroad Landfill, #2 - RSI Landfill (for groundwater source management), #6 - Asbestos Landfill] to address human health and ecological risk or meet ARAR requirements.
- Contaminated soil will be treated on-site using chemical processes (*e.g.*, chemical extraction/soil washing) at AOCs #3 (B&M Locomotive Shop Disposal Areas), #4 (Old B&M Oil/Sludge Recycling Area), and #5 (Contaminated Soils Area). This remedy includes monitoring as part of institutional actions to confirm achievement of soil PRGs.
- Contaminated soil at AOC #7 (Asbestos Lagoons) will be excavated and relocated for ultimate disposal under the cap installed for AOC #6. This remedy also includes institutional actions for monitoring to confirm appropriate source cleanup.

Groundwater:

- An on-site pump and treat remedy consisting of collection of contaminated groundwater (*e.g.*, extraction wells/subsurface drains) and treatment on-site using chemical and physical processes (coagulation/flocculation and precipitation, UV/chemical oxidation, adsorption technology) followed by discharge of treated water will be implemented at all AOCs. Vertical containment will be used where necessary to prevent wetland dewatering during groundwater collection. This remedy will also include institutional actions for groundwater monitoring.

Surface Water:

- An on-site collection and treatment remedy consisting of collection of contaminated surface water (*e.g.*, pumps, diversion weirs/channels) and treatment on-site using biological processes (suspended growth aerobic processes) and chemical/physical processes (sedimentation, coagulation/flocculation and precipitation, adsorption technology) followed by discharge will be applied to AOCs #8b (Wetland 2 Group) and #8e (Content Brook Wetland Group). This remedy will also include institutional actions for surface water monitoring.
- In-situ remedies consisting of monitored natural attenuation will be implemented at AOC #8d (Richardson Pond Group).

Sediment:

- Source control remedies consisting of dredging/dry excavation of "hot spot" locations and on-site treatment using chemical processes (chemical extraction, soil washing) will be applied to contaminated sediments in AOCs #8b (Wetland 2 Group) and #8e (Content Brook Wetland Group). Remaining lesser contaminated sediments will be mitigated through in-situ means via monitored natural attenuation.
- Source control remedies consisting of dredging/dry excavation of "hot spot" locations will be applied to contaminated sediments in AOC #8d (Richardson Pond Group). Excavated sediments are disposed of on-site via relocation under one of the caps installed for AOCs #1, 2, or 6. Remaining lesser contaminated sediments will be mitigated through in-situ means via monitored natural attenuation. Similarly, the same actions are included at the remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) as a provision if future toxicity testing results in ecological risk.

# SECTION 5.0

# DETAILED EVALUATION OF THE REMEDIAL ALTERNATIVES

Detailed evaluation of the fifteen (15) alternatives remaining after screening is needed to provide decision-makers with the necessary information to compare remedial alternatives and select an appropriate remedy for the Site that demonstrates satisfaction of the CERCLA requirements. Nine evaluation criteria have been developed to address the CERCLA requirements and to address the additional technical and policy considerations that have proven to be important for selecting amongst remedial alternatives. These evaluation criteria serve as the basis for conducting the detailed analyses during the FS and for subsequently selecting an appropriate remedial action as part of the Record of Decision. These nine feasibility study criteria are as follows:

- overall protection of human health and the environment
- compliance with Applicable, or Relevant and Appropriate Requirements (ARARs)
- long-term effectiveness and permanence
- reduction of toxicity, mobility or volume
- short-term effectiveness
- implementability
- cost
- state acceptance
- community acceptance

A detailed discussion of the specific attributes of each FS criteria is presented in Table 5-1.

Sections 5.1 through 5.15 discuss the detailed evaluation of each of the remaining fifteen (15) remedial alternatives.

## 5.1 ALTERNATIVE #1 - "NO ACTION"

Alternative #1, by regulatory definition, is the "No Action" alternative required by the National Contingency Plan and EPA's feasibility study guidance (U.S. EPA, 1988). No remedial actions (including monitoring) will be conducted at any of the AOCs under this alternative. Alternative #1 represents the baseline human health and ecological risks determined during the Remedial Investigation. Even though the Remedial Investigation did not evaluate the Asbestos Landfill and Asbestos Lagoons, Alternative #1 also represents risks associated with these two AOCs, which are likely to contain surficial asbestos contamination.

Detailed evaluation of Alternative #1 with respect to the nine FS criteria is presented in Sections 5.1.1 through 5.1.9.

### 5.1.1 Overall Protection of Human Health and the Environment for Alternative #1

Alternative #1 will not provide any protection of human health and the environment from risks identified in the baseline human health and ecological risk assessments (M&E, 1997), or from potential risks due to the Asbestos Landfill and Asbestos Lagoons. Therefore, Alternative #1 fails to meet all RAOs for the Site, as defined in Section 2.1, and will not reduce risks to human health and the environment. The protection of human health and the environment for Alternative #1 are discussed in Sections 5.1.1.1 and 5.1.1.2, respectively.

**5.1.1.1 Human Health Protection.** Alternative #1 will not provide any protection of human health from risks identified in the baseline human health risk assessment (M&E, 1997). Current baseline risks to human health at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and the Contaminated Soils Area for a female site worker of child-bearing age from exposure to lead in soil are associated with a site-specific maternal blood level exceeding that protective of a 95$^{th}$ percentile fetal blood lead level of 10 µg/dl. Even though not evaluated in the baseline risk assessment, potential risks due to the possible presence of surficial asbestos contamination are associated with the Asbestos Landfill and Asbestos Lagoons. Future baseline risks to human health

from ingestion of COCs in groundwater at the Site will be in excess of the EPA risk management criteria for carcinogenic and non-carcinogenic effects under the assumed use of the aquifers as potential drinking water sources. Based on the groundwater classification for the Site, future consumption of groundwater from the Site and vicinity is possible. Because there will be no removal or containment of soil or groundwater contamination on-site, and no reduction in potential exposures with this alternative, risks to potential receptors at the Site will continue, and risk to receptors in the vicinity of the Site will be possible. There will be no additional short-term human health risks associated with this alternative. Specific long-term and short-term human health risks are discussed in Sections 5.1.3.1 and 5.1.5.1, respectively.

**5.1.1.2 Ecological Protection.** The "No Action" alternative does not provide adequate protection of the environment. The ecological risks identified on-site are not eliminated, reduced or controlled. This alternative provides no reduction in short-term or long-term risk to ecological receptors relative to baseline conditions for exposures to soil, surface water or sediments. Documented risks to small mammals from metals in soils will not be reduced at the B&M Railroad Landfill and the B&M Locomotive Shop Disposal Areas. Adverse impacts on aquatic receptors from exposure to inorganics in surface waters will not be reduced at Wetland 2 Group, Richardson Pond Group and Content Brook Wetland Group. Natural processes resulting in the gradual removal or dispersal of metals from source areas will be slow, and the reduction in elevated concentrations of metals in the surface waters will be minor over time in the "No Action" alternative. Impacts on benthic invertebrate populations from exposure to contaminants in sediment will not be reduced in the Wetland 2 Group, Richardson Pond Group and Content Brook Wetland Group since the concentrations of contaminants in the sediments in these habitats will not be reduced by this alternative.

### 5.1.2 Compliance with ARARs for Alternative #1

Chemical-specific ARARs and TBCs for the Site are discussed at length in Section 2.3.1. A summary of the implications of each chemical-specific ARAR for this "No Action" alternative include:

- Safe Drinking Water Act and Massachusetts Drinking Water Regulations. Federal and Massachusetts MCLs are relevant and appropriate for site groundwater. This alternative would not provide any means for attaining Federal SDWA MCLs or Massachusetts Maximum Contaminant Levels for inorganic and organic chemicals.

- Resource Conservation and Recovery Act Maximum Concentration Limits. RCRA groundwater corrective action requirements are relevant and appropriate requirements at the point of compliance at the limit of the waste management areas. The potential for contaminants to migrate from the area would not be limited by this alternative.

- Federal Water Pollution Control Act, as Amended by the Clean Water Act, Ambient Water Quality Criteria (AWQC). Freshwater acute and chronic AWQC for the protection of aquatic life are considered appropriate and relevant for the site wetlands. AWQC may be exceeded due to leachate outbreaks and surface water runoff.

- Clean Air Act and Massachusetts Air Pollution Control Regulations. Dust or other potential emissions that may result from excavation of waste materials are controlled under this alternative. There is no indication that ARARs for air will be exceeded by this alternative.

- Massachusetts Groundwater Quality Standards. Current, applicable "Class I" enforcement standards would not be met under this alternative. Groundwater quality standards are exceeded.

- Massachusetts Surface Water Quality Standards. As part of the Shawsheen River Basin, site surface waters are classified as "Class B" habitat for fish, aquatic life and wildlife, and a source of public water supplies if treated. Surface water quality standards are considered applicable to site surface waters, and will not be attained under this alternative.

- Federal Criteria and Advisories To Be Considered. In addition to the ARARs listed above, there are other important issues and advisories which will require attention prior to and during remedial activities. These criteria and advisories to be considered include:

- *Health Advisories.* Carcinogenic and non-carcinogenic risk levels due to consumption of contaminated drinking water will be exceeded.
- *Federal Groundwater Protection Strategy of 1984.* Current, applicable "Class I" enforcement standards are not met under this alternative. Groundwater quality standards are exceeded.
- *Threshold Limit Values (TLVs).* There is no indication that these levels will be exceeded for site remediation workers under this alternative.

Location-specific ARARs and TBCs relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2), are not met under the "No Action" alternative. Although the wetlands and floodplains will not be disturbed and no surface water discharges will occur, since the on-site wetlands will be allowed to remain in a degraded (contaminated) state, the "No Action" alternative will not meet the intent of Executive Order 11990. This ARAR requires federal agencies to minimize wetland degradation and to preserve and enhance the beneficial uses of wetlands. The "No Action" alternative leaves the wetlands and ecological habitats intact but also leaves chemicals of concern in place.

The presence of the landfills on-site are the trigger for the majority of action-specific ARARs for this "No Action" alternative. Requirements that are not met under this alternative are those relating to landfill capping, environmental monitoring, closure, and post-closure care. The alternative does not attain action-specific ARARs, specifically:

- Hazardous/Solid Waste Management - Closure – 310 CMR 30.580 (Applicable for AOC #1); 310 CMR 19.140 (Applicable for AOCs #2, 3, 6, and 7): Closure performance standards are spelled out. This includes disposal or decontamination of equipment, recording survey plat, and certification of closure.

- Hazardous/Solid Waste Management - Post-Closure – 310 CMR 30.590 (Applicable for AOC #1); 310 CMR 19.142 (Applicable for AOCs #2, 3, 6, and 7): Specifies post-closure care and use of property where hazardous/solid waste and hazardous/solid waste residues will remain after closure. Maintenance and monitoring is required. Requires that a certified land survey plat of the location

and dimensions of disposal units be recorded at the Registry of Deeds and submitted to the Billerica Board of Health.

- Hazardous/Solid Waste Management - Groundwater Protection – 310 CMR 30.660 - 30.675 (Applicable for AOC #1); 310 CMR 19.110 (Applicable for AOCs #2, 3, 6, and 7): General groundwater monitoring requirements are specified. Groundwater protection standards are set and maximum concentrations of constituents for groundwater protection are specified.

- Hazardous Waste Management - Landfill Closure, 310 CMR 30.633 (Applicable for AOC #1): Landfill closure standards will not be met under this alternative.

### 5.1.3 Long-Term Effectiveness and Permanence for Alternative #1

This alternative is evaluated below in terms of the risk remaining at the Site after RAOs are addressed. This portion of the evaluation focuses on the extent and effectiveness of the controls required to manage the risk posed by treatment residuals and/or untreated contamination.

**5.1.3.1 Magnitude of Residual Risk: Human Health.** Alternative #1 implements no controls to reduce exposure of workers to soil, to prevent human contact with groundwater, or to contain contaminated groundwater on-site. Residual risks will include those risks identified in Section 5.1.1.1 as there will be no reduction of human health risks with this alternative. Media associated with baseline health risks include soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill and Asbestos Lagoons, and groundwater associated with AOCs #1 through 7.

Exposure of female site workers of child-bearing age to lead in soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and the Contaminated Soils Area was predicted to result in a maternal blood lead level exceeding that protective of a 95$^{th}$ percentile fetal blood lead level of 10 μg/dl. Potential soil risk, though not estimated, is also associated with the likely presence

of surficial asbestos contamination at the Asbestos Landfill and Asbestos Lagoons. Carcinogenic and noncarcinogenic risks estimated based on future use of site groundwater as a potential drinking water source exceeded EPA risk management guidelines for groundwater associated with the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill and Asbestos Lagoons. Even though natural degradative processes will slowly reduce the levels of soil and groundwater contamination, the magnitude of the reduction is likely to be minimal. Therefore, baseline risks will persist for Alternative #1. Because there will be no containment of groundwater contamination with this alternative, groundwater risk to off-site receptors is possible.

**5.1.3.2 Magnitude of Residual Risk: Ecological.** Alternative #1 will not result in a quantifiable long-term reduction in risk to ecological receptors. Residual risks will include all risks identified in the baseline ecological risk assessment. The concentration of contaminants in soil, surface water and on-site sediments will not be reduced substantially under the "No Action" alternative. Metals in soil are relatively immobile, so removal of metals from soils by leaching will not result in a substantial reduction in total concentrations of metals in soil over time. Consequently, there will not be a significant reduction in risk to small mammal receptors at the B&M Railroad Landfill and the B&M Locomotive Shop Disposal Areas over time.

The sources of contaminants in surface water will not be significantly reduced over time, and therefore residual risk to aquatic receptors will not be lowered substantially below baseline conditions for Alternative #1. Similarly, the concentration of contaminants in on-site sediments will not be reduced under the "No Action" alternative and the risk to benthic invertebrates will not be reduced below baseline conditions. Natural processes will tend to degrade organic contaminants (PAHs, pesticides) in sediments, and disperse all the contaminants (metals, PAHs, pesticides) through resuspension of sediments, transport downstream, deposition of new material, and vertical mixing by organisms in sediment. However, these processes are slow, and the source of contaminants for additional accumulation in sediment will not be substantially reduced over time. The potential for downstream migration of contaminants exists, however, the quantities are likely to be very low. Overall, the reduction in concentration of contaminants resulting from natural processes will not be substantial.

### 5.1.4 Reduction of Toxicity, Mobility and Volume through Treatment for Alternative #1

Alternative #1 is the "No Action" alternative. At all AOCs for all media, no remedial actions have been selected.

**5.1.4.1 Treatment/Recycling Processes to be Utilized.** No treatment/recycling processes will be utilized under this alternative.

**5.1.4.2 Amount of Hazardous Materials to be Treated or Recycled.** No amount of hazardous materials will be treated or recycled under this alternative.

**5.1.4.3 Degree of Expected Reductions in Toxicity, Mobility and Volume.** "No Action" will not confirm reductions or treatment of waste materials. Therefore, there are no expected reductions in toxicity, mobility and volume under this alternative.

**5.1.4.4 Reversibility.** Reversibility is not applicable to the "No Action" alternative.

**5.1.4.5 Type and Quantity of Residuals.** "No Action" will not confirm reductions or treatment of waste materials. Therefore, it must be assumed that the original contamination at the Site will remain unchanged.

### 5.1.5 Short-Term Effectiveness for Alternative #1

This alternative is evaluated for effectiveness in protecting the community and local workers, site remediation workers, and the environment during construction and implementation of the remedy.

**5.1.5.1 Protection of Community and Workers During Remedial Actions.** Since this alternative involves no construction or monitoring measures, there will be no additional risk to the community or to workers from exposure to contamination.

**5.1.5.2 Environmental Impacts.** There are no adverse, short-term environmental impacts associated with the implementation of the "No Action" alternative. The alternative does not include any construction or other activities associated with implementation that will modify, remove, or enhance the natural habitat from the existing baseline conditions. No mitigation measures will be implemented with the "No Action" alternative, consequently there will be no resulting improvement of water quality, wildlife habitat or overall environmental quality.

**5.1.5.3 Time Until Remedial Action Objectives are Achieved.** Of the RAOs presented in Section 2, those for groundwater will take the longest to achieve. Through the use of groundwater flow modeling and contaminant retardation concepts (Appendix G), approximate times to achieve PRGs were calculated for the Site contaminants at each AOC. It should be noted that the mobility of inorganics is highly sensitive to site specific geochemistry. Other factors such as pH, dissolution, and colloidal transport could have significant impacts on mobility of inorganics. Therefore, these times should only be used for relative comparison and not for accurate representations of cleanup times.

Although no remedial actions will be implemented with Alternative #1, the "No Action" alternative, natural processes, such as dispersion, are predicted to reduce contaminant concentrations over time. Approximate cleanup times, assuming no biodegradation, for each AOC with contaminants above PRGs are presented below:

| Overburden | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | 110 | ND | >200 | >200 |
| AOC #2 - RSI Landfill | >200 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | 24 | ND | ND | >200 |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | 195 |
| AOC #5 - Contaminated Soils Area | >200 | >200 | >200 | >200 |
| AOC #6 - Asbestos Landfill | 56 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 26 | >200 | ND | >200 |

| Bedrock | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | >200 | >200 | ND | >200 |
| AOC #2 - RSI Landfill | 22 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | ND | ND | ND | ND |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | >200 |

| | | | | |
|---|---|---|---|---|
| AOC #5 - Contaminated Soils Area | >200 | >200 | ND | >200 |
| AOC #6 - Asbestos Landfill | 10 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 161 | >200 | ND | >200 |

Note: ND = Not detected at a concentration greater than PRGs at this AOC and flow zone

Some cleanup times reported above are high (i.e., greater than 200 years). This simply means that the compounds are essentially immobile. For example, arsenic and thallium have very high retardation coefficients and, ultimately, high cleanup times.

It should also be noted that the only SVOC detected above PRGs at all AOCs was bis(2-ethylhexyl)phthalate and the only pesticide was aldrin. The high retardation factors of these compounds increase the time of travel and source contaminant reduction. Evaluations assumed that the Contaminated Soils Area contained contaminants similar to the B&M Railroad Landfill, RSI Landfill, and the Asbestos Lagoons. The two compounds noted above are therefore assumed to be found at this AOC above PRGs. However, further evaluation may determine that this is not the case. Furthermore, the evaluations assumed that the maximum detections from the three nearby AOCs were also detected at the Contaminated Soils Area. Similarly, data from the RSI Landfill was used to characterize the Asbestos Landfill.

### 5.1.6 Implementability for Alternative #1

This section summarizes the technical and administrative feasibility of implementing Alternative #1, the "No Action" alternative, and the availability of various services and material required for its implementation.

**5.1.6.1 Technical Feasibility.** Evaluation of the technical feasibility of Alternative #1 includes an assessment of three factors described in EPA's feasibility study guidance: 1) the ability to construct and operate the technologies, 2) the reliability of the technologies and 3) the ease of undertaking additional remedial actions, if necessary. These aspects are described in detail below:

Ability to Construct and Operate the Technologies. Since no technologies are implemented as part of Alternative #1, the "No Action" alternative, there are no implementability constraints with regards to construction and operation of the remedy.

Reliability of the Technologies. Similar to above, there are no implementability issues with regards to reliability of technologies since none are employed as part of Alternative #1, the "No Action" alternative.

Ease of Undertaking Additional Remedial Actions. Since no activity is occurring as part of the "No Action" alternative, any additional remedial actions, if necessary, could be accommodated without implementability problems arising from actions that have occurred earlier.

**5.1.6.2 Administrative Feasibility.** Evaluation of the administrative feasibility of Alternative #1 involves assessing the steps required to coordinate with other state, federal and local agencies as well as any permits that may be required. Under Superfund, permits are not required for remediation activities, but compliance with substantive requirements is required.

Since Alternative #1 involves neither remedial action nor monitoring at the Site, the primary implementation hurdle to achieve with regard to implementing administrative feasibility is for concurrence and agreement among the applicable regulatory agencies (local, state and federal) that no remedial action is warranted at the Site.

**5.1.6.3 Availability of Services and Materials.** Evaluation of the availability of services and materials for Alternative #1 includes an assessment of three factors in accordance with EPA's feasibility study guidance: 1) the availability of treatment, storage capacity and disposal services, 2) the availability of necessary equipment and specialists, and 3) the availability of prospective technologies. These aspects are described in detail below:

Availability of TSDF Services. Since no remedial action is implemented as part of Alternative #1, the "No Action" alternative, there is no need for treatment, storage capacity or disposal services. Therefore, there are no implementability constraints with regards to this issue for implementation of this alternative.

Availability of Necessary Equipment and Specialists. Since no remedial action is implemented as part of Alternative #1, the "No Action" alternative, there is no need for availability of

specialized equipment or specialists. Therefore, there are no implementability constraints with regards to this issue for implementation of this alternative.

Availability of Prospective Technologies. Since no remedial action is implemented as part of Alternative #1, the "No Action" alternative, there is no need to assess the availability and demonstrated performance of prospective technologies. Therefore, there are no implementability constraints with regards to this issue for implementation of this alternative.

### 5.1.7 Cost for Alternative #1

As there are no actions associated with this alternative, there are no capital or operation and maintenance (O&M) costs.

### 5.1.8 State Acceptance for Alternative #1

Acceptance of the selected, site-wide remedial alternative by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 5.1.9 Community Acceptance for Alternative #1

Acceptance of the selected, site-wide remedial alternative by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 5.2 ALTERNATIVE #3 - "INSTITUTIONAL ACTION"

Alternative #3 represents the "Institutional Action" alternative. This alternative would be the most intensive site-wide remedy that could be implemented by relying solely on institutional action technologies/process options. Institutional actions will be applied to all AOCs exhibiting human health or ecological risk including site-wide surface water and sediment.

The overview of remedial action components for Alternative #3 is presented in Table 5-2 and Appendix F. Figure 5-1 details the remedial action site plan for this alternative. Alternative #3 includes the following remedial actions by media of concern and AOC:

Soil:

- Institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures) as well as monitoring will be implemented at the highest risk-ranked AOCs (#1 - B&M Railroad Landfill, #3- B&M Locomotive Shop Disposal Areas, #4 - Old B&M Oil/Sludge Recycling Area, #5 - Contaminated Soils Area, #6-Asbestos Landfill, #7 - Asbestos Lagoons).
- No remedial actions for soil will be necessary at the remaining AOC (#2 - RSI Landfill) since contaminant concentrations are within acceptable human health and ecological risk levels for soil.

Groundwater:

- Institutional actions consisting of access restrictions (*e.g.*, institutional controls) as well as monitoring will be implemented at the highest human health risk-ranked AOCs (#2 - RSI Landfill, #5 - Contaminated Soils Area, #6 - Asbestos Landfill). All other AOCs will be limited to institutional actions consisting of monitoring only.

Surface Water and Sediment:

- Monitoring will be implemented at all three AOCs showing risk (#8b - Wetland 2 Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group). No remedial actions for surface water will be necessary at all remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) since contaminant concentrations are within acceptable human health and ecological risk levels. Sediment monitoring is included at these two AOCs as a provision if future toxicity testing results in ecological risk.

The detailed evaluation of Alternative #3 with respect to the nine FS criteria is presented in Sections 5.2.1 through 5.2.9.

### 5.2.1 Overall Protection of Human Health and the Environment for Alternative #3

Alternative #3 will provide limited overall protection of human health and the environment by reducing some risks identified in the baseline risk assessment. An increase in the overall protection of human health from implementation of Alternative #3 will result from the reduction of exposures to COCs in soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill and Asbestos Lagoons and the elimination of exposures to COCs in groundwater at the RSI Landfill, Contaminated Soils Area, and Asbestos Landfill using institutional controls. Reduction or prevention of human exposures to COCs in groundwater at the B&M Railroad Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Asbestos Lagoons will not occur since Alternative #3 specifies for groundwater monitoring only at these four AOCs. Identified ecological risks from exposures to soil, surface water, and sediment will not be eliminated, reduced, or controlled by this alternative. Therefore, Alternative #3 fails to meet all RAOs for the Site, as defined in Section 2.1, and only partially reduces risks to human health and the environment. The protection of human health and the environment are discussed in Sections 5.2.1.1 and 5.2.1.2, respectively.

**5.2.1.1 Human Health Protection.** Alternative #3 will provide limited overall protection of human health by reducing risks identified in the baseline risk assessment for certain AOCs. Current baseline risks to human health at the B&M Locomotive Shop Disposal Areas, the Old B&M Oil/Sludge Recycling Area, and the Contaminated Soils Area for female site workers of child-bearing age from exposure to lead in soil via indoor dust will be partially reduced as a result of access fencing since fugitive dust generation from human activity in the areas will be largely eliminated. However, fugitive dust generation from wind will not be controlled and maternal blood levels exceeding those protective of a 95$^{th}$ percentile fetal blood lead level of 10 µg/dl will still be expected to occur. Likewise for the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will only be partially abated by fencing, since windborne exposures to asbestos fibers will continue.

The potential for future risks from ingestion of COCs in groundwater at the RSI Landfill, Contaminated Soils Area and Asbestos Landfill will be eliminated by institutional controls (restrictions on the future use of groundwater from these AOCs as a drinking water source). However, future risk from exposure to groundwater at the B&M Railroad Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Asbestos Lagoons will not be reduced or eliminated since Alternative #3 specifies for groundwater monitoring only at these four AOCs. Since there will be no removal or containment of groundwater contamination with this alternative, risk to off-site receptors is possible. Groundwater COC concentrations will attenuate naturally over time due to biodegradation and dispersion. However, because the most significant groundwater risk drivers are inorganics (arsenic and manganese) which attenuate slowly (195 to >200 years to achieve PRGs; see *Section 5.2.5.3 and Appendix G), it is unlikely that groundwater-associated risks to on-site or off-site* receptors will decrease significantly.

Additional short-term risks to workers will result from the installation of fencing and the performance of periodic soil monitoring at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons and from the monitoring of groundwater COC concentrations at AOCs #1 through 7. These risks will be mitigated by the use of appropriate personal protection equipment as needed. Specific long-term and short-term human health risks are discussed in Sections 5.2.3.1 and 5.2.5.1, respectively.

**5.2.1.2 Ecological Protection.** Alternative #3 does not provide adequate protection of the environment. The ecological risks identified on-site are not eliminated, reduced or controlled by this alternative. Remedial measures include only institutional controls, fencing & security measures, and monitoring which will not provide reductions in short-term or long-term risk to ecological receptors relative to baseline conditions for exposures to soil, surface water or sediments. Documented risks to small mammals from metals in soils will not be reduced at the B&M Railroad Landfill and the B&M Railroad Locomotive Shop Disposal Areas. Adverse impacts on aquatic receptors from exposure to inorganics in surface waters will not be reduced at Wetland 2 Group, the Richardson Pond Group and Content Brook Wetland Group. Natural processes resulting in the gradual removal or dispersal of metals from source areas will be very slow, and the reduction in elevated concentrations of metals in

the surface waters will be minor over time in Alternative #3. Impacts on benthic invertebrate populations from exposure to contaminants in sediment will not be reduced in the Wetland 2 Group, the Richardson Pond Group and Content Brook Wetland Group since the concentrations of contaminants in the sediments in these habitats will not be reduced by this alternative.

### 5.2.2 Compliance with ARARs for Alternative #3

Chemical-specific ARARs and TBCs for the Site are discussed at length in Section 2.3.1. A summary of the implications of each chemical-specific ARAR for this "Institutional Action" alternative include:

- Safe Drinking Water Act and Massachusetts Drinking Water Regulations. Federal and Massachusetts MCLs are relevant and appropriate for Site groundwater. This alternative would not provide any means for attaining Federal SDWA MCLs or Massachusetts Maximum Contaminant Levels for inorganic and organic chemicals.

- Resource Conservation and Recovery Act Maximum Concentration Limits. RCRA groundwater corrective action requirements are relevant and appropriate requirements at the point of compliance at the limit of the waste management areas. The potential for contaminants to migrate from the area will not be limited by this alternative. Monitoring will be conducted to track exposure-based limits at the point of compliance. This alternative will not attain RCRA MCLs in a reasonable timeframe.

- Federal Water Pollution Control Act, as Amended by the Clean Water Act, Ambient Water Quality Criteria (AWQC). Freshwater acute and chronic AWQC for the protection of aquatic life are considered appropriate and relevant for the Site wetlands. AWQC may be exceeded due to leachate outbreaks and surface water runoff.

- Clean Air Act and Massachusetts Air Pollution Control Regulations. Dust or other potential emissions that may result from excavation of waste materials are controlled under this alternative. There is no indication that ARARs for air will be exceeded by this alternative.

- Massachusetts Groundwater Quality Standards. Current, applicable "Class I" enforcement standards would not be met under this alternative. Groundwater quality standards are exceeded.

- Massachusetts Surface Water Quality Standards. As part of the Shawsheen River Basin, Site surface waters are classified as "Class B" habitat for fish, aquatic life and wildlife, and source of treated public water supplies. Surface water quality standards are considered applicable to Site surface waters, and will not be attained under this alternative.

- Federal Criteria and Advisories To Be Considered. In addition to the ARARs listed above, there are other important issues and advisories which will require attention prior to and during remedial activities. These criteria and advisories to be considered include:
  - *Health Advisories*. Carcinogenic and non-carcinogenic risk levels due to consumption of contaminated drinking water will be exceeded.
  - *Federal Groundwater Protection Strategy of 1984*. Current, applicable "Class I" enforcement standards are not met under this alternative. Groundwater quality standards are exceeded.
  - *Threshold Limit Values (TLVs)*. There is no indication that these levels will be exceeded for Site remediation workers under this alternative.

Location-specific ARARs and TBCs relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2), are considered under this "Institutional Action" alternative. Wetlands and floodplains will not be disturbed and no surface water discharges will occur. Monitoring will be conducted to check the protectiveness of the remedy. The "Institutional Action" alternative leaves the wetlands and ecological habitats intact but also leaves chemicals of concern in place. Since the on-site wetlands will be allowed to remain in a degraded (contaminated) state, the "Institutional Action" alternative will not meet the intent of Executive Order 11990 which requires federal agencies to minimize wetland degradation and to preserve and enhance the beneficial uses of wetlands.

The presence of the landfills on-site are the trigger for the majority of action-specific ARARs for this "Institutional Action" alternative. Table 5-3 lists the action-specific ARARs for this alternative. The alternative does not attain the following action-specific ARARs:

- Hazardous/Solid Waste Management - Groundwater Protection, 310 CMR 30.660 - 30.675; 310 CMR 19.110 (AOCs #1, 2, 3, 6, and 7): Although a groundwater monitoring program will be implemented at the Site, corrective measures will not be conducted. Thus, this alternative will not meet these requirements.

- Hazardous/Solid Waste Management – Closure, 310 CMR 30.580; 310 CMR 19.140 (AOCs #1, 2, 3, 6, and 7): These requirements will be partially attained under this alternative. A record will be placed in the Registry of Deeds recording the location and dimensions of the landfill as well as other applicable information. A copy will be submitted to the Billerica Board of Health. Other closure performance standards will not, however, be met.

- Hazardous/Solid Waste Management - Post-Closure, 310 CMR 30.590; 310 CMR 19.142 (AOCs #1, 2, 3, 6, and 7): These requirements will be partially met under this alternative. Upon completion of remedial actions at each AOC, a land survey plat certified by a professional land surveyor certified in Massachusetts will be prepared and submitted to the North Billerica zoning authority. Groundwater monitoring and security measures will be conducted. Other post-closure standards, however, will not be met under this alternative.

- Hazardous Waste Management - Landfill Closure, 310 CMR 30.633 (AOC #1): Landfill closure standards will not be met under this alternative.

### 5.2.3 Long-Term Effectiveness and Permanence for Alternative #3

This alternative is evaluated below in terms of risk remaining at the Site after RAOs are addressed. This portion of the evaluation focuses on the extent and effectiveness of the controls required to manage the risk posed by treatment residuals and/or untreated contamination.

**5.2.3.1 Magnitude of Residual Risk: Human Health.** Alternative #3 will not implement controls to significantly reduce exposure of workers to soil COCs or to prevent human contact with groundwater at certain AOCs. It also will not remove or effectively contain contamination on the Site. Under this alternative, the magnitude of residual risks will depend on the enforcement and reliability of institutional controls to reduce or prevent future human exposure to COCs in soil and groundwater.

Under this alternative, exposure of female site workers of child-bearing age to lead in indoor dust from soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Contaminated Soils Area, which was estimated to result in a maternal blood level exceeding that protective of a 95$^{th}$ percentile fetal blood lead level of 10 µg/dl, will be slightly reduced by fencing because fugitive dust generation from human activity in the areas will be reduced. However, fugitive dust generation from wind will not be controlled. Likewise for the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will only be partially abated by fencing, since windborne exposures to asbestos fibers will continue. Therefore, residual risks from these pathways may be equal to or only slightly less than risks presented in the baseline risk assessment.

Residual human health risks to a resident from ingestion of COCs in groundwater from the RSI Landfill, Contaminated Soils Area and Asbestos Landfill will be eliminated by the implementation of institutional controls (groundwater access restrictions) at these AOCs as long as long-term enforcement of the groundwater institutional controls is maintained. Since Alternative #3 will not include institutional controls for groundwater from the B&M Railroad Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area and Asbestos Lagoons, carcinogenic and noncarcinogenic risk estimates based on future potable use of groundwater from these AOCs, which exceeded EPA risk management guidelines, will persist for Alternative #3. Contaminated groundwater will not be contained with this alternative, even though COC concentrations will be monitored. Therefore, groundwater risk to off-site receptors will be possible. Groundwater concentrations will decline over time as natural degradative processes reduce COC concentrations, resulting in a partial lowering of residual risks to potential off-site receptors and to on-site receptors, should access restrictions not be maintained in the future. However, this attenuation is likely to occur

slowly for the most significant risk drivers (195 to >200 years to achieve PRGs for arsenic and manganese; see Section 5.2.5.3 and Appendix G).

**5.2.3.2 Magnitude of Residual Risk: Ecological.** Alternative #3 will not result in a quantifiable long-term reduction in risk to ecological receptors. Residual risks will include all those risks identified in the baseline ecological risk assessment. The concentration of contaminants in soil, surface water and sediments on the Site will not be reduced substantially under this alternative. The metals in soils are relatively immobile, so removal of metals from soils by leaching will not result in a substantial reduction in total concentrations of metals in soil over time. Consequently, there will not be a significant reduction in risk to small mammal receptors at the B&M Railroad Landfill and the B&M Locomotive Shop Disposal Areas over time. Fencing of these areas will not restrict small mammal exposure to soils.

The sources of contaminants in surface water will not be significantly reduced over time, and therefore residual risk to aquatic receptors will not be lowered substantially below baseline conditions for Alternative #3. Access to surface water for waterfowl, and other potential aquatic and semi-aquatic receptors will not be reduced from baseline conditions.

Similarly, the concentration of contaminants in on-site sediments will not be reduced under Alternative #3 and the risk to benthic invertebrates will not be reduced below baseline conditions. Natural processes will tend to degrade organic contaminants (PAHs, pesticides) in sediments, and disperse all the contaminants (metals, PAHs, pesticides) through resuspension of sediments, transport downstream, deposition of new material, and vertical mixing by organisms in sediment. However, these processes are slow, and the source of contaminants for additional accumulation in sediment will not be substantially reduced over time. The potential for downstream migration of contaminants exists, however, the quantities are likely to be very low. Overall, the reduction in concentration of contaminants resulting from natural processes will not be substantial.

### 5.2.4 Reduction of Toxicity, Mobility and Volume through Treatment for Alternative #3

Table 5-4 provides a summary of the treatment and process options selected, quantities of waste materials to be remediated, expected reductions in toxicity, mobility and volume, and residuals following treatment for Alternative #3. No human health or ecological risk was determined for soil at AOC #2 (RSI Landfill). Likewise, no risk was determined for surface water at AOC #8a (West Middlesex Canal Group) and AOC #8c (East Middlesex Canal Group). Therefore, reductions in toxicity, mobility and volume were not evaluated for these media at these AOCs.

**5.2.4.1 Treatment/Recycling Processes to be Utilized.** Alternative #3 is the "Institutional Action" alternative. No treatment/recycling processes will be utilized under this alternative.

**5.2.4.2 Amount of Hazardous Materials to be Treated or Recycled.** No amount of hazardous materials will be treated or recycled under this alternative.

**5.2.4.3 Degree of Expected Reductions in Toxicity, Mobility and Volume.** There are no expected reductions in toxicity, mobility and volume under this alternative.

**5.2.4.4 Reversibility.** Institutional actions will not provide treatment. However, all institutional actions to be implemented under this alternative can be discontinued (*i.e.*, institutional controls, fencing & security measures and monitoring), making these processes reversible.

**5.2.4.5 Type and Quantity of Residuals.** Institutional Actions will not confirm reductions or treatment of waste materials. Therefore, it must be assumed that the original contamination at the Site will remain unchanged.

### 5.2.5 Short-Term Effectiveness for Alternative #3

This alternative is evaluated for effectiveness in protecting the community and local workers, site remediation workers, and the environment during the construction and implementation of the remedy.

**5.2.5.1 Protection of Community and Workers During Remedial Actions.** The construction measures proposed under this alternative include only implementation of fencing, and monitoring of soil and groundwater. The implementation of these measures will potentially result in only minimal additional short-term risk to the community from exposure to soil contaminants. Exposure to COCs in soil during installation of fencing and soil and groundwater COCs during monitoring will potentially result in a nominal health risk to workers. Use of personal protection equipment will be employed to reduce exposure if applicable OSHA standards are exceeded during these activities.

**5.2.5.2 Environmental Impacts.** Some minor, short-term disturbances are associated with the implementation of Alternative #3. The alternative includes construction of fencing and installation of monitoring wells. Fencing will be placed around B&M Railroad Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. Wetlands are located around the border of a portion of each of these areas, with the exceptions of the Old B&M Oil/Sludge Recycling Area and Contaminated Soils Area. Installation of fencing will cause minor removal of vegetation adjacent to wetland boundaries resulting in minor, insignificant impacts. Installation of groundwater monitoring wells in the vicinity of the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons may include some minor, temporary impacts to wetlands. Mitigation measures will include avoidance and minimization of temporary construction disturbance in wetlands during construction of fencing and installation of monitoring wells. Impacts will be further reduced by minimizing tree clearing and instituting proper construction and erosion control methods.

**5.2.5.3 Time Until Remedial Action Objectives are Achieved.** Of the RAOs presented in Section 2, those for groundwater will take the longest to achieve. Through the use of groundwater flow modeling and contaminant retardation concepts (Appendix G), approximate times to achieve PRGs were calculated for the Site contaminants at each AOC. It should be noted that the mobility of inorganics is highly sensitive to site specific geochemistry. Other factors such as pH, dissolution, and colloidal transport could have significant impacts on mobility of inorganics. Therefore, these times should only be used for relative comparison and not for accurate representations of cleanup times.

Only limited institutional actions will be implemented with Alternative #3. Similar to Alternative #1, natural processes, such as dispersion, are predicted to reduce contaminant concentrations over time. Approximate cleanup times, assuming no biodegradation, for each AOC with contaminants above PRGs are presented below:

| Overburden | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | 110 | ND | >200 | >200 |
| AOC #2 - RSI Landfill | >200 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | 24 | ND | ND | >200 |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | 195 |
| AOC #5 - Contaminated Soils Area | >200 | >200 | >200 | >200 |
| AOC #6 - Asbestos Landfill | 56 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 26 | >200 | ND | >200 |

| Bedrock | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | >200 | >200 | ND | >200 |
| AOC #2 - RSI Landfill | 22 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | ND | ND | ND | ND |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | >200 |
| AOC #5 - Contaminated Soils Area | >200 | >200 | ND | >200 |
| AOC #6 - Asbestos Landfill | 10 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 161 | >200 | ND | >200 |

Note: ND = Not detected at a concentration greater than PRGs at this AOC and flow zone

Some cleanup times reported above are high (i.e., greater than 200 years). This simply means that the compounds are essentially immobile. For example, arsenic and thallium have very high retardation coefficients and, ultimately, high cleanup times.

It should also be noted that the only SVOC detected above PRGs at all AOCs was bis(2-ethylhexyl)phthalate and the only pesticide was aldrin. The high retardation factors of these compounds increase the time of travel and source contaminant reduction. Evaluations assumed that the Contaminated Soils Area contained contaminants similar to the B&M Railroad Landfill, RSI Landfill, and the Asbestos Lagoons. The two compounds noted above are therefore assumed to be found at this AOC above PRGs. However, further evaluation may determine that this is not the case.

Furthermore, the evaluations assumed that the maximum detections from the three nearby AOCs were also detected at the Contaminated Soils Area. Similarly, data from the RSI Landfill was used to characterize the Asbestos Landfill.

### 5.2.6 Implementability for Alternative #3

This section summarizes the technical and administrative feasibility of implementing Alternative #3, the "Institutional Action" alternative, and the availability of various services and materials required for its implementation.

**5.2.6.1 Technical Feasibility.** Evaluation of the technical feasibility of Alternative #3 includes an assessment of three factors described in EPA's feasibility study guidance: 1) the ability to construct and operate the technologies, 2) the reliability of the technologies and 3) the ease of undertaking additional remedial actions, if necessary. These aspects are described in detail below:

Ability to Construct and Operate the Technologies. Alternative #3 only involves limited construction of fencing and security measures as part of remedial action efforts at AOCs #1, 3, 4, 5, 6, and 7. The security fencing is expected to be chain-link type with appropriate warning or cautionary signage added. Construction of this type of fencing will be readily available from appropriate local contractors. Furthermore, only routine, periodic maintenance of signs and fencing to repair vandalism or other damage will be required as part of long-term O&M. Therefore, there are no implementability constraints with regards to construction and operation of these measures for Alternative #3.

Reliability of the Technologies. Evaluation of the reliability of the technologies for Alternative #3 includes assessment of the reliability of fencing and monitoring. The objective of the security fencing and signage is to alert workers or residents to the potential hazards and prevent access to potentially contaminated soils within the disposal areas. While fencing, if properly maintained, is effective in preventing site access to the general public and workers, it is much less effective in mitigating access to determined trespassers. Although institutional controls are not exactly technologies, their reliability will depend upon enforcement by the responsible agencies involved.

Ease of Undertaking Additional Remedial Actions. Since only limited remedial actions are occurring (*i.e.*, fencing and security measures and institutional controls) under the "Institutional Action" alternative, further remedial actions, if necessary, could be accommodated without implementability problems arising from activities that have been previously installed and constructed as part of this alternative.

**5.2.6.2 Administrative Feasibility.** Evaluation of the administrative feasibility of Alternative #3 involves assessing the steps required to coordinate with other federal, state and local governmental entities. It should be noted that under Superfund, permits are not required for remediation activities, but compliance with substantive requirements is required.

The principal administrative feasibility issue with regard to Alternative #3 involves implementation of institutional controls in order to prohibit subsurface disturbance and the use of groundwater. If proprietary controls are used, coordination with the individual property owners of the affected parcels will be required. For example, implementation of a negative easement would require the property owner to convey to a third party (typically EPA) the right to limit how the landowner can use his or her property. Here the limitations would likely include prohibitions against subsurface digging and the use of groundwater from wells on the property.

If governmental controls are used, coordination with federal, state and local government (the ATSDR, the Commonwealth of Massachusetts and/or the Town of Billerica) will be required. For example, implementation of land use restrictions may require the exercise of zoning authority by the Town of Billerica to prohibit residential development in a contaminated area, or the adoption of a building permit ordinance in the Town of Billerica requiring anyone seeking a building permit for construction activities in a particular area to be notified of contamination in the area and of any relevant management standards - such an ordinance could also be used to prohibit types of construction that would result in unacceptable exposures (e.g., excavation in areas where subsurface contamination has not been fully removed). Implementation of groundwater use restrictions may require action by the Commonwealth of Massachusetts to prohibit or limit certain uses of groundwater in particular areas, or require closing or capping of wells. Implementation of advisories may also require action by the ATSDR or Commonwealth of Massachusetts to publically issue warnings that provide notice to potential users of land, surface water or groundwater of some existing or impending risk associated with their use.

**5.2.6.3 Availability of Services and Materials.** Evaluation of the availability of services and materials for Alternative #3 includes an assessment of three factors in accordance with EPA's

feasibility study guidance: 1) the availability of treatment, storage capacity and disposal services, 2) the availability of necessary equipment and specialists, and 3) the availability of prospective technologies. These aspects are described in detail below:

Availability of TSDF Services. Since no remedial actions requiring transport, storage or disposal are to be implemented as part of Alternative #3, the "Institutional Action" alternative, there are no implementability constraints with regards to this issue for selection of this alternative.

Availability of Necessary Equipment and Specialists. The availability of supplies and trained contractors for installation of fencing, even on a CERCLA site, should not pose any implementation concerns for Alternative #3. Fencing and security measures have been routinely installed on other CERCLA sites throughout the region. The highest need for specialists in Alternative #3 is for specialized legal counsel or legal assistance for implementation of the institutional controls. Although implementation of the institutional controls is expected to be a time-consuming process, this is not expected to pose significant implementability concerns that will prevent selection of this alternative as the final remedy.

Availability of Prospective Technologies. Since no specialized treatment technologies are required as part of the remedial action efforts of Alternative #3, there is no need to assess their availability and demonstrated performance. Therefore, there are no implementability constraints with regards to this issue for selection of this alternative.

### 5.2.7 Cost for Alternative #3

Total estimated capital cost associated with this alternative is $1.3 million. This estimate assumes a contingency of 20%. The present value of all O&M costs would be $36.7 million. This estimate assumes an inflation rate of 3%, an interest rate of 7%, and a contingency of 15%. The maximum duration of site remedial actions is assumed to be 30 years, in accordance with RI/FS guidance (U.S. EPA, 1988). Total present worth costs would therefore be $38.0 million. Detailed costs for this alternative are presented in Appendix D. The costs associated with each alternative selected for detailed evaluation are summarized in Table H-1 of Appendix H.

### 5.2.8 State Acceptance for Alternative #3

Acceptance of the selected, site-wide remedial alternative by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 5.2.9 Community Acceptance for Alternative #3

Acceptance of the selected, site-wide remedial alternative by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 5.3 ALTERNATIVE #5 - "LIMITED ACTION"

Alternative #5 is defined as the "Limited Action" alternative. Active remedial efforts will be applied to the highest risk-ranked AOCs, with monitored natural attenuation or institutional actions used for the remaining AOCs. No remedial actions will be undertaken at the wetlands AOCs for surface water and sediment.

The overview of remedial action components for Alternative #5 is presented in Table 5-5 and Appendix F. Figure 5-2 details the remedial action site plan for this alternative. Alternative #5 includes the following remedial actions by media of concern and AOC:

Soil:

- In-situ treatment consisting of chemical processes (*e.g.*, solidification/stabilization) will be utilized at the highest human health risk-ranked AOC (#5 - Contaminated Soils Area).
- In-situ remedies of monitored natural attenuation and institutional actions consisting of access restrictions (*i.e.,* institutional controls, fencing and security measures) as well as monitoring will be implemented at the middle human health risk-ranked AOCs (#1 - B&M Railroad Landfill, #3 - B&M Locomotive Shop Disposal Areas, #4 - Old B&M Oil/Sludge Recycling Area).
- Institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures) as well as monitoring will be implemented at the remaining AOCs (#6 - Asbestos Landfill, #7 - Asbestos Lagoons).
- No remedial actions for soil will be necessary at the remaining AOC (#2 - RSI Landfill) since contaminant concentrations are within acceptable human health and ecological risk levels for soil.

Groundwater:

- In-situ remedies consisting of monitored natural attenuation as well as institutional actions consisting of access restrictions (*e.g.*, institutional controls) and monitoring will be implemented at all AOCs.

Surface Water and Sediment:

- No remedial actions will be taken at the three AOCs exhibiting risk (#8b - Wetland 2 Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group).

The detailed evaluation of Alternative #5 with respect to the nine FS criteria is presented in Sections 5.3.1 through 5.3.9.

### 5.3.1 Overall Protection of Human Health and the Environment for Alternative #5

Alternative #5 will provide limited overall protection of human health and the environment by reducing some risks identified in the baseline risk assessment. An increase in the overall protection of human health from implementation of Alternative #5 will result from the elimination of exposures to COCs in soil at the Contaminated Soils Area, the partial reduction of exposures to COCs in soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Asbestos Landfill, and Asbestos Lagoons and the elimination of exposure to COCs in groundwater at AOCs #1 through 7 using institutional controls and monitored natural attenuation. Identified ecological risks from exposures to soil, surface water and sediment will not be substantially reduced by this alternative. Therefore, Alternative #5 fails to meet all RAOs for the Site, as defined in Section 2.1, and only partially reduces risks to human health and the environment. The protection of human health and the environment are discussed in Sections 5.3.1.1 and 5.3.1.2, respectively.

**5.3.1.1 Human Health Protection.** Alternative #5 will provide limited overall protection of human health by reducing risks identified in the baseline risk assessment for certain AOCs. Current baseline risks to human health at the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area for female site workers of child-bearing age from exposure to lead in soil via indoor dust will be partially reduced as a result of access restrictions (fencing) since fugitive dust generation from human activity in the area will be largely eliminated. However, fugitive dust generation from wind will not be controlled and maternal blood levels exceeding those protective of a 95$^{th}$ percentile fetal blood lead level of 10 µg/dl will still be expected to occur. Likewise for the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will only be partially abated by fencing, since windborne exposures to asbestos fibers will continue. For the current female site worker of child-bearing age at the Contaminated Soils Area, baseline risks to human health from exposure to lead in soil via indoor dust will be eliminated as a result of in-situ solidification/stabilization and access restrictions since fugitive dust generation will be reduced to negligible levels. This conclusion is based on information reported in Section 5.3.4.3 documenting a 95% to 99% reduction in the mobility of inorganic COCs.

The potential for future risks from ingestion of COCs in groundwater at the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons will be eliminated by restrictions on the future use of groundwater from these AOCs as a drinking water source. Since there will be no removal or containment of groundwater contamination with this alternative, risk to off-site receptors will be possible. Reductions in groundwater COC concentrations are expected to occur over time due to natural degradative processes. However, since the most significant groundwater risk drivers are inorganics (arsenic and manganese), attenuation is likely to occur slowly (195 to >200 years to achieve PRGs; see Section 5.3.5.3 and Appendix G).

Additional short-term risks to workers will result from the installation of fencing at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons, from worker exposures during in-situ solidification/stabilization at the Contaminated Soils Area, and from soil and groundwater contact during monitoring. These risks will be mitigated by the use of appropriate personal protection equipment as needed. Specific long-term and short-term human health risks are discussed in Sections 5.3.3.1 and 5.3.5.1, respectively.

**5.3.1.2 Ecological Protection.** Alternative #5, the Limited Action Alternative, does not provide adequate protection of the environment. The ecological risks identified on-site are not substantially reduced by this alternative. Remedial measures include stabilization of the Contaminated Soils Area and institutional actions for other areas of concern. These measures will not provide reductions in short-term or long-term risk to ecological receptors relative to baseline conditions for exposures to soil or sediments. Documented risks to small mammals from metals in soils will not be reduced at the B&M Railroad Landfill and the B&M Locomotive Shop Disposal Areas. Adverse impacts on aquatic receptors from exposure to inorganics in surface waters will not be substantially reduced at the Richardson Pond Group and Content Brook Wetland Group. The stabilization of the Contaminated Soils Area may slightly reduce concentration of metals discharged from groundwater or from surface runoff to the Wetland 2 Group. Since a portion of the observed load of metals in the surface water may result from resuspension of sediments which will not be affected by this alternative, the

concentration of metals in surface water is assumed to be reduced from baseline conditions, but the magnitude of the reduction may be small. Impacts on benthic invertebrate populations from exposure to contaminants in sediment will not be reduced in the Wetland 2 Group, the Richardson Pond Group and Content Brook Wetland Group since the concentrations of contaminants in the sediments in these habitats will not be reduced by this alternative.

### 5.3.2 Compliance with ARARs for Alternative #5

Chemical-specific ARARs and TBCs for the Site are discussed at length in Section 2.3.1. A summary of the implications of each chemical-specific ARAR for this "Limited Action" alternative include:

- Safe Drinking Water Act and Massachusetts Drinking Water Regulations. Federal and Massachusetts MCLs are relevant and appropriate for site groundwater. This alternative sets attainment of Federal SDWA MCLs and Massachusetts Maximum Contaminant Levels for inorganic and organic chemicals as groundwater remediation goals. Monitored natural attenuation, however, is not anticipated to be able to attain Federal SDWA MCLs or Massachusetts Maximum Contaminant Levels for inorganic chemicals in a reasonable time frame.

- Resource Conservation and Recovery Act Maximum Concentration Limits. RCRA groundwater corrective action requirements are relevant and appropriate requirements at the point of compliance at the limit of the waste management areas. The potential for contaminants to migrate from the area will be monitored by this alternative. Monitoring will be conducted to track exposure-based limits at the point of compliance. This alternative will not attain RCRA MCLs in a reasonable time frame.

- Federal Water Pollution Control Act, as Amended by the Clean Water Act, Ambient Water Quality Criteria (AWQC). Freshwater acute and chronic AWQC for the protection of aquatic life are considered appropriate and relevant for the site wetlands. AWQC may be exceeded due to leachate outbreaks and surface water runoff.

- Clean Air Act and Massachusetts Air Pollution Control Regulations. Dust or other potential emissions that may result from excavation of waste materials will be controlled under this alternative. There is no indication that ARARs for air will be exceeded by this alternative.

- Massachusetts Groundwater Quality Standards. Actions will be taken under this alternative in an attempt to attain applicable "Class I" enforcement standards. Although levels of organic compounds in groundwater are anticipated to be reduced within a reasonable time frame, this alternative is not anticipated to be able to attain groundwater standards in a reasonable time frame.

- Massachusetts Surface Water Quality Standards. As part of the Shawsheen River Basin, site surface waters are classified as "Class B" habitat for fish, aquatic life and wildlife, and a source of treated public water supplies. Surface water quality standards are considered applicable to site surface waters, and will not be attained under this alternative.

- Federal Criteria and Advisories To Be Considered. In addition to the ARARs listed above, there are other important issues and advisories which will require attention prior to and during remedial activities. These criteria and advisories to be considered include:
    - *Health Advisories.* Carcinogenic and non-carcinogenic risk levels due to consumption of contaminated drinking water will be exceeded.
    - *Federal Groundwater Protection Strategy of 1984.* Current, applicable "Class I" enforcement standards are not met under this alternative. Groundwater quality standards are exceeded.
    - *Threshold Limit Values (TLVs).* There is no indication that these levels will be exceeded for site remediation workers under this alternative.

Location-specific ARARs and TBCs relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2) will not be met under the "Limited Action" alternative. The "Limited Action" alternative leaves the wetlands and ecological habitats intact, but also leaves chemicals of concern in place. As the on-site wetlands would be allowed to remain in a degraded (contaminated)

state, and the sources of contamination would not be controlled, the "Limited Action" alternative will not attain the intent of Executive Order 11990.

Table 5-6 lists the action-specific ARARs for this institutional action alternative. The alternative does not attain the following action-specific ARARs:

- Hazardous/Solid Waste Management – Closure, 310 CMR 30.580; 310 CMR 19.140 (AOCs #1, 2, 3, 6, and 7): These requirements will be partially attained under this alternative. A record will be placed in the Registry of Deeds recording the location and dimensions of the landfill as well as other applicable information. A copy will be submitted to the Billerica Board of Health. Other closure performance standards will not, however, be met.

- Hazardous/Solid Waste Management - Post-Closure, 310 CMR 30.590; 310 CMR 19.142 (AOCs #1, 2, 3, 6, and 7): These requirements will be partially met under this alternative. Upon completion of remedial actions at each AOC, a land survey plat certified by a professional land surveyor certified in Massachusetts will be prepared and submitted to the North Billerica zoning authority. Groundwater monitoring and security measures will be conducted. Other post-closure standards, however, will not be met under this alternative.

- Hazardous Waste Management - Landfill Closure, 310 CMR 30.633 (AOC #1): Landfill closure standards will not be met under this alternative.

There is also some question as to the attainment of groundwater protections standards. Corrective actions must be completed within a "reasonable time period." The difference between this alternative and the institutional action alternative, in terms of groundwater remediation, is "monitored natural attenuation" which is implemented through increased monitoring of site groundwater. Demonstration of this approach will need to be performed at the Site. It remains to be demonstrated if the following action-specific ARAR will be attained:

- Hazardous/Solid Waste Management - Groundwater Protection, 310 CMR 30.660 - 30.675; 310 CMR 19.110 (AOCs #1, 2, 3, 6, and 7): A groundwater monitoring program will be implemented at the Site. Corrective measures consist of monitored natural attenuation. Leachate generation from the landfill will not be controlled. Monitoring will need to be conducted to determine attainment of this requirement.

### 5.3.3 Long-Term Effectiveness and Permanence for Alternative #5

This alternative is evaluated below in terms of risk remaining at the Site after RAOs are addressed. This portion of the evaluation focuses on the extent and effectiveness of the controls required to manage the risk posed by treatment residuals and/or untreated contamination.

**5.3.3.1 Magnitude of Residual Risk: Human Health.** Alternative #5 implements controls to effectively eliminate exposure of workers to soil COCs at the Contaminated Soils Area. However, it does not implement controls to significantly reduce worker exposures to soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Asbestos Landfill, and Asbestos Lagoons. For groundwater, Alternative #5 implements controls to prevent human contact with COCs. However, these controls are not expected to effectively remove or contain groundwater contamination on the Site. Under this alternative, the magnitude of residual risks will depend largely on the enforcement and reliability of institutional controls to reduce or prevent future human exposure to COCs in soil and groundwater.

Under this alternative, exposure of female site workers of child-bearing age to lead in indoor dust from soil at the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area, which was estimated to result in a maternal blood level exceeding that protective of a 95$^{th}$ percentile fetal blood lead level of 10 µg/dl, will be slightly reduced by access restrictions (fencing) because fugitive dust generation from human activity in the area will be reduced. However, fugitive dust generation from wind will not be controlled. Likewise for the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will only be partially abated by fencing, since windborne exposures to asbestos fibers will continue. Therefore, residual risks from these

pathways will be equal to or only slightly less than risks presented in the baseline risk assessment. For the Contaminated Soils Area, the use of in-situ solidification/stabilization and access restrictions will eliminate the estimated risk for female site workers to soil by effectively preventing fugitive dust generation (see Section 5.3.4.3).

Residual human health risks to a resident from ingestion of COCs in groundwater from AOCs #1 through 7 will be eliminated by the implementation of groundwater access restrictions as long as long-term enforcement of the groundwater access restrictions is maintained. Contaminated groundwater will not be contained with this alternative, even though COC concentrations will be monitored. Therefore, risk to off-site receptors will be possible. Groundwater concentrations will decline over time as monitored natural attenuation processes reduce COC concentrations, resulting in a partial lowering of residual risks to potential off-site receptors, and to on-site receptors should access restrictions not be maintained in the future. However, attenuation that occurs naturally is likely to occur slowly for the most significant groundwater risk drivers (195 to >200 years to achieve PRGs for arsenic and manganese; see Section 5.3.5.3 and Appendix G).

**5.3.3.2 Magnitude of Residual Risk: Ecological.** Alternative #5 will not result in a quantifiable long-term reduction of risk to ecological receptors. The concentration of contaminants in soil, surface water and sediments on-site will not be reduced substantially under this alternative. No remedial action other than fencing will be implemented at B&M Railroad Landfill and the B&M Locomotive Shop Disposal Areas. The metals in soils are relatively immobile and the processes that result in the removal of metals from soils are slow; this results in a relatively slow reduction in total concentrations of metals in soil over time. Consequently, there will not be a significant reduction in risk to small mammal receptors at the B&M Railroad Landfill and the B&M Locomotive Shop Disposal Areas over time. Fencing of these areas will not restrict small mammal exposure to soils. The stabilization of the Contaminated Soils Area may slightly reduce concentration of contaminants discharged to the Wetland 2 Group. The reduction in risk to ecological receptors at the Wetland 2 Group will not be substantial. The sources of contaminants in surface water will not be significantly reduced over time at Content Brook Wetland or Richardson Pond Wetland Groups. Therefore residual risk to aquatic receptors will not be lowered substantially below baseline conditions for Alternative #5. Similarly, the concentration

of contaminants in on-site sediments will not be reduced under Alternative #5 and the risk to benthic invertebrates will not be reduced below baseline conditions.

### 5.3.4 Reduction of Toxicity, Mobility and Volume through Treatment for Alternative #5

Table 5-7 provides a summary of the treatment and process options selected, quantities of waste materials to be remediated, expected reductions in toxicity, mobility and volume, and residuals following treatment for Alternative #5. No human health or ecological risk was determined for soil at AOC #2 (RSI Landfill). Likewise, no risk was determined for surface water at AOC #8a (West Middlesex Canal Group) and AOC #8c (East Middlesex Canal Group). Therefore, reductions in toxicity, mobility and volume were not evaluated for these media at these AOCs.

**5.3.4.1 Treatment/Recycling Processes to be Utilized.** Alternative #5 consists of institutional actions and in-situ remedies for soil, including monitored natural attenuation and solidification/ stabilization. Monitored natural attenuation will be utilized for groundwater at all AOCs. No treatment/recycling processes will be utilized for surface water and sediment under this alternative. A more detailed description of the treatment/recycling processes utilized under Alternative #5 is provided in Section 5.3. Refer to Table 5-7 for specific treatment/recycling processes to be utilized at each AOC.

**5.3.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The following amounts of hazardous materials treated for Alternative #5 are provided below by media of concern and AOC. Values are only given if the remedial action will provide treatment. Monitored natural attenuation is considered a treatment process in this evaluation, since it typically results in reductions in contamination over time. Institutional actions are not considered treatment processes.

<u>Soil</u>

- AOC #1 - B&M Railroad Landfill 3,100 $yd^3$
- AOC #3 - B&M Locomotive Shop Disposal Areas 150,800 $yd^3$
- AOC #4 - Old B&M Oil/Sludge Recycling Area 63,800 $yd^3$
- AOC #5 - Contaminated Soils Area 10,800 $yd^3$

Groundwater (areal extent of source)

- AOC #1 - B&M Railroad Landfill 12.4 acres
- AOC #2 - RSI Landfill 2.5 acres
- AOC #3 - B&M Locomotive Shop Disposal Areas 4.7 acres
- AOC #4 - Old B&M Oil/Sludge Recycling Area 7.0 acres
- AOC #5 - Contaminated Soils Area 6.7 acres
- AOC #6 - Asbestos Landfill 13.3 acres
- AOC #7 - Asbestos Lagoons 1.9 acres

**5.3.4.3 Degree of Expected Reductions in Toxicity, Mobility and Volume.** The degree of treatment and expected reductions for each treatment technology/process option type under Alternative #5 are provided below by media of concern and AOC. Reductions from monitored natural attenuation are provided for the U.S. EPA default time period, 30 years.

Monitored natural attenuation and in-situ solidification/stabilization are expected to treat all of the contaminated soils at AOCs #1, 3, 4, and 5. Institutional actions will provide no treatment to the soils at AOCs #6 and 7. The following reductions in toxicity, mobility and volume are expected for soil:

Toxicity

- Monitored natural attenuation is expected to reduce the toxicity of the contaminated soil relative to a specific contaminant proportional to the reduction in that specific contaminant volume at AOCs #1, 3 and 4. More toxic intermediate products may result if incomplete degradation of original contaminants occurs.
- The toxicity of the contaminated media at AOC #5 will not be reduced through the in-situ solidification/stabilization process.
- Institutional actions, as implemented at AOCs #6 and 7, will not confirm reductions in the toxicity of the contaminated media.

Mobility

- In-situ solidification/stabilization processes are expected to provide approximately 85% to 99% (U.S. EPA, 1998a) reduction in the mobility of organic COCs and a 95% to 99% (U.S. EPA, 1998c) mobility reduction for inorganic COCs in the treated soil at AOC #5. The range of organic COC mobility reduction may be skewed high. Volatile organic compounds are likely to be released to air during the mixing of stabilization additives to soil.
- There are no expected reductions in mobility of organic and inorganic COCs at AOCs #1, 3, 4, 6, and 7 through monitored natural attenuation processes and institutional actions.

Volume

- At AOC #5, the volume of the contaminated media is expected to increase by up to 100% due to the addition of solidification/stabilization agents (FRTR, 1997). Organic and inorganic COCs are not expected to exhibit any significant change in volume through the solidification/stabilization process.
- The volume of contaminated media will not be reduced through monitored natural attenuation at AOCs #1, 3, and 4. Over a period of 30 years, a low volume reduction of both organic and inorganic COCs is expected. Some organic COCs are expected to be degraded by microbes. Inorganics with less affinity for adsorption are likely to be diluted and dispersed over time, via transfer to lower-lying soils or groundwater as a result of precipitation infiltration. Inorganics that are sorbed to soil may be dispersed to areas outside the AOCs by wind erosion.
- Institutional actions, as implemented at AOCs #6 and 7, will not confirm reductions in the volume of the contaminated media or COCs.

Monitored natural attenuation is expected to treat all of the contaminated groundwater at AOCs #1 through 7. Reductions in toxicity, mobility and volume expected for groundwater are provided below. There are no organics above PRGs at AOC #4. Therefore, reductions for organics at AOC #4 were not calculated.

Toxicity

- Monitored natural attenuation is expected to reduce the toxicity of the contaminated groundwater relative to a specific contaminant proportional to the volume reduction of that specific contaminant at all AOCs. Intermediate products that are more toxic than parent compounds may result if incomplete biodegradation of original contaminants occurs.

Mobility

- Monitored natural attenuation will not provide reductions in mobility of COCs at all AOCs.

Volume

- Monitored natural attenuation will not reduce the volume of the contaminated media at all AOCs.
- Organic COCs reductions in volume are expected to range from less than 15% to 100% across the Site. This broad range is due to differing physical and chemical properties on a compound by compound basis. Greater reductions of organics are possible due to biodegradation. Specific compounds used in the MODFLOW simulations, as well as BIOSCREEN results which additionally consider biodegradation rates, can be found in Appendix G. Table 5-7 provides estimated volume reductions for each AOC.
- Expected volume reductions from monitored natural attenuation for inorganic COCs are less than or equal to 15% across the Site. These low reductions may be attributed to adsorption of compounds to the soils within the aquifer. For specific compounds used

the MODFLOW modeling, reference Appendix G. Inorganic volume reductions by AOC are provided in Table 5-7.

There are no expected reductions in toxicity, mobility and volume in surface water and sediment at AOCs #8a through 8e. Reductions or treatment of waste materials are not confirmed when no remedial actions are taken.

**5.3.4.4 Reversibility.** The reversibility of each treatment process to be implemented under Alternative #5 is discussed below by media of concern and AOC. Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. Institutional actions are not considered treatment processes, and therefore, reversibility of treatment is not applicable.

The reversibility of soil treatment technologies/process options utilized in Alternative #5 is the following:

- Most monitored natural attenuation processes to be implemented at AOCs #1, 3 and 4 are not considered reversible. Organic contaminants are degraded over time. Inorganics are dispersed through monitored natural attenuation, a process that is generally not reversible under normal conditions.
- Environmental conditions, such as weathering or heavy impacts, may affect the integrity of the stabilized mass resulting from in-situ solidification/stabilization technologies to be implemented at AOC #5.

Monitored natural attenuation, to be implemented for groundwater at all AOCs, is not considered a reversible process. Organic contaminants are degraded over time. Inorganic contaminants, on the other hand, may only be temporarily immobilized and later released.

Reversibility is not applicable when remedial action is not taken, the selected process option for surface water and sediment at all AOCs under Alternative #5.

**5.3.4.5 Type and Quantity of Residuals.** The types and quantities of contaminant residuals by media of concern and AOC expected after treatment in Alternative #5 are summarized below.

Approximately 10,800 to 21,600 $yd^3$ of stabilized soil will remain at AOC #5 following treatment by in-situ solidification/stabilization. Within the treated soil, 1% to 15% of the organic COCs and 1% to 5% of the inorganic COCs will have the potential to leach into lower-lying soils and groundwater. Most of the contaminants will remain sorbed to the soil at AOCs #1, 3, and 4 following treatment by monitored natural attenuation. The original contaminated soil at AOCs #6 and 7 is expected to remain unchanged after institutional actions have been implemented.

In groundwater, more toxic intermediate products may remain at all AOCs if incomplete degradation of original contaminants occurs. For monitored natural attenuation, estimated residuals following treatment for a 30 year period, the U.S. EPA default time period, are provided. As stated above, the high degree of variability in the reductions, and thus the residuals, is due to differing physical and chemical properties of compounds.

- It is expected that 0% to greater than 85% of the organic COCs and greater than 85% of the inorganic COCs will remain in the groundwater at AOCs #1, 2, 5, and 7.
- Greater than 85% of the inorganic COCs are expected to remain at AOC #3 following treatment by monitored natural attenuation.
- At AOC #4, it is expected that greater than or equal to 85% of the inorganic COCs will remain in the groundwater after treatment.
- An estimated 0% to 47% of the organic COCs and greater than 85% of the inorganic COCs will remain in the groundwater at AOC #6 following treatment.

No remedial actions are proposed to be undertaken for sediment and surface water at all AOCs. Since not implementing remedial actions will not confirm reductions or treatment of waste materials, it is assumed that the original contamination at AOCs #8a, 8b, 8c, 8d, and 8e, will remain unchanged.

### 5.3.5 Short-Term Effectiveness for Alternative #5

This alternative is evaluated for effectiveness in protecting the community and local workers, site remediation workers, and the environment during the construction and implementation of the remedy.

**5.3.5.1 Protection of Community and Workers During Remedial Actions.** The construction measures proposed under this alternative include implementation of access restrictions (fencing), in-situ solidification/stabilization, and monitoring of soil and groundwater. The implementation of these

measures will potentially result in only minimal additional short-term risk to the community from exposure to soil contaminants. Exposure to COCs in soil and groundwater during installation of fencing, in-situ solidification/stabilization, and monitoring will potentially result in a nominal health risk to workers. Use of personal protection equipment will be employed to reduce exposure if applicable OSHA standards are exceeded during these activities.

**5.3.5.2 Environmental Impacts.** Some minor, short-term disturbances are associated with the implementation of Alternative #5. The alternative includes installation of monitoring wells, construction of fencing around B&M Railroad Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Asbestos Landfill and Asbestos Lagoons and the solidification/stabilization of the Contaminated Soils Area. Wetlands are located around the border of a portion of each of these areas, with the exception of the Old B&M Oil/Sludge Recycling Area and Contaminated Soils Area. Installation of fencing will cause minor removal of vegetation adjacent to wetland boundaries but impacts are considered to be temporary and insignificant. Mitigation measures will include avoidance and minimization of temporary construction disturbance in wetlands during construction of fencing and of monitoring wells, and minimization of tree removal. Proper construction and erosion control methods will be utilized to minimize ecological impact to surrounding habitats.

Solidification/stabilization of the Contaminated Soils Area will not substantially alter the habitats on-site. An area of structures, pavement, disturbed soil and railroad tracks will be graded, stabilized and re-paved. Implementation will include dust control. No significant adverse environmental impacts from these operations are anticipated. Mitigation measures will include avoidance and minimization of temporary construction disturbance in adjacent wetlands during construction and by minimizing tree removal and instituting proper construction and erosion control methods.

**5.3.5.3 Time Until Remedial Action Objectives are Achieved.** Of the RAOs presented in Section 2, those for groundwater will take the longest to achieve. Through the use of groundwater flow modeling and contaminant retardation concepts (Appendix G), approximate times to achieve PRGs were calculated for the Site contaminants at each AOC. It should be noted that the mobility of inorganics is

highly sensitive to site specific geochemistry. Other factors such as pH, dissolution, and colloidal transport could have significant impacts on mobility of inorganics. Therefore, these times should only be used for relative comparison and not for accurate representations of cleanup times.

Alternative #5 includes monitored natural attenuation as a groundwater treatment process. Similar to Alternatives #1 and 3, natural processes, such as dispersion, are predicted to reduce contaminant concentrations over time. However, additional contaminant reduction is expected to occur due to biodegradation. This aspect of monitored natural attenuation was evaluated using the BIOSCREEN natural attenuation decision support system (Appendix G). While improved cleanup times were estimated for a few compounds at the Site, these times were similar to those without biodegradation. Approximate cleanup times, assuming no biodegradation, for each AOC with contaminants above PRGs are presented below:

| Overburden | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | 110 | ND | >200 | >200 |
| AOC #2 - RSI Landfill | >200 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | 24 | ND | ND | >200 |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | 195 |
| AOC #5 - Contaminated Soils Area | >200 | >200 | >200 | >200 |
| AOC #6 - Asbestos Landfill | 56 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 26 | >200 | ND | >200 |

| Bedrock | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | >200 | >200 | ND | >200 |
| AOC #2 - RSI Landfill | 22 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | ND | ND | ND | ND |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | >200 |
| AOC #5 - Contaminated Soils Area | >200 | >200 | ND | >200 |
| AOC #6 - Asbestos Landfill | 10 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 161 | >200 | ND | >200 |

Note: ND = Not detected at a concentration greater than PRGs at this AOC and flow zone

Some cleanup times reported above are high (i.e., greater than 200 years). This simply means that the compounds are essentially immobile. For example, arsenic and thallium have very high retardation coefficients and, ultimately, high cleanup times.

It should also be noted that the only SVOC detected above PRGs at all AOCs was bis(2-ethylhexyl)phthalate and the only pesticide was aldrin. The high retardation factors of these compounds increase the time of travel and source contaminant reduction. Evaluations assumed that the Contaminated Soils Area contained contaminants similar to the B&M Railroad Landfill, RSI Landfill, and the Asbestos Lagoons. The two compounds noted above are therefore assumed to be found at this AOC above PRGs. However, further evaluation may determine that this is not the case. Furthermore, the evaluations assumed that the maximum detections from the three nearby AOCs were also detected at the Contaminated Soils Area. Similarly, data from the RSI Landfill was used to characterize the Asbestos Landfill.

### 5.3.6 Implementability for Alternative #5

This section summarizes the technical and administrative feasibility of implementing Alternative #5, the "Limited Action" alternative, and the availability of various services and materials required for its implementation.

**5.3.6.1 Technical Feasibility.** Evaluation of the technical feasibility of Alternative #5 includes an assessment of three factors described in EPA's feasibility study guidance: 1) the ability to construct and operate the technologies, 2) the reliability of the technologies and 3) the ease of undertaking additional remedial actions, if necessary. These aspects are described in detail below:

> Ability to Construct and Operate the Technologies. Alternative #5 includes an active soil treatment remedy in the form of in-situ solidification/stabilization for AOC #5. The implementability issue for construction of this technology is the limitation of conducting work within the Contaminated Soils Area while maintaining active use of the rail yard and rail spurs and roads that transect it. Several measures may be required such as: temporary structural supports for tracks near the work zone, temporary use restrictions for tracks or roadways next to soil treatment zones and temporary relocation of tracks and bedding material for treatment of soils beneath rail beds. No formal "operational" effort is required for the solidification/ stabilization technology but maintenance inspections will be required on a periodic basis to confirm the integrity of the treated soil matrix. Implementing construction of this portion of the remedy at AOC #5 will require close cooperation between rail yard users and the contractor and involve temporary disruptions to the rail yard. The construction and maintenance requirements are straightforward issues commonly faced and solved by experienced remediation and

construction contractors and are not sufficient to prevent consideration of this alternative as the selected remedy.

Alternative #5 includes the use of monitored natural attenuation to remediate contaminated groundwater at AOCs #1 through 7. Construction of this technology only requires installation of groundwater monitoring wells and "operation" only requires monitoring efforts to sample and analyze the groundwater. There are no implementability constraints with regards to monitored natural attenuation.

For Alternative #5, the remaining remedial construction efforts at AOCs #1, 3, 4, 6, and 7 involve construction of fencing (chain-link type) and security measures (warning signage) and are the same as previously described for Alternative #3. Construction of this type of fencing will be readily available from appropriate local contractors and only routine, periodic maintenance of signs and fencing to repair vandalism or other damage will be required as part of long-term O&M. Therefore, there are no implementability constraints with regards to construction and operation of the prescribed remedy for these AOCs in Alternative #5.

Reliability of the Technologies. For in-situ stabilization/solidification of soils at AOC #5, the design is expected to define the most appropriate solidification/stabilization matrix and reagents to chemically encapsulate the contaminants of concern. Once this is achieved, the reliability of the technology is directly dependent on two factors: 1) the ability to gain access to all of the contaminated soils due to the limitations of the "in-situ" method, and 2) the protection of the treated soil matrix from long-term damage from heavy truck/rail loads and impacts. The solidified/stabilized material must include appropriate structural protection from the heavy truck and rail loads while construction of the remedy must "get to" all of the contaminated soils that need treatment.

The reliability of monitored natural attenuation to remediate contaminated groundwater at AOCs #1 through 7 should be considered "high" since there is no external equipment nor treatment systems that could break down. The reliability of the technology to meet PRGs, however, should not be confused with "implementability" but is more appropriately discussed under "effectiveness." The reader is directed to the "treatment efficiency" and the "time required to remediate" discussions in Sections 5.3.4, 5.3.5, and Appendix G.

The remaining technologies for Alternative #5 include fencing and security measures, and monitoring. The reliability of these technologies will be the same as described in Alternative #3. Fencing, if properly maintained, is effective in preventing site access to the general public and workers, but much less effective in mitigating access to determined trespassers. Although institutional controls are not exactly technologies, their reliability will depend upon enforcement by the responsible agencies involved.

Ease of Undertaking Additional Remedial Actions. Applying additional remedial actions for contaminated soils treated by in-situ solidification/stabilization at AOC #5 will be severely

restricted since this is a largely "irreversible" technology. It will be very difficult to 'take apart" the chemical matrix and try an alternative technology for the contaminated soils.

Additional remedial actions could be accommodated in place of monitored natural attenuation of groundwater at AOCs #1 through 7. The only implementability limitation will be to replace any groundwater monitoring wells that were impacted or eliminated during construction of the new remedial action.

Since only limited remedial actions are occurring (*i.e.*, fencing and security measures and institutional controls) at the remaining AOCs under the "Limited Action" alternative, further remedial actions, if necessary, could be accommodated without implementability problems arising from activities that have been installed and constructed as part of this alternative.

**5.3.6.2 Administrative Feasibility.** Evaluation of the administrative feasibility of Alternative #5 involves assessing the steps required to coordinate with other federal, state and local governmental entities. It should be noted that under Superfund, permits are not required for remediation activities, but compliance with substantive requirements is required.

The principal administrative feasibility issue with regard to Alternative #5, described previously for Alternative #3, involves implementation of institutional controls in order to prohibit subsurface disturbance and the use of groundwater. If proprietary controls are used, coordination with the individual property owners of the affected parcels, will be required. For example, implementation of a negative easement would require the property owner to convey to a third party (typically EPA) the right to limit how the landowner can use his or her property. Here the limitations would likely include prohibitions against subsurface digging and the use of groundwater from wells on the property.

If governmental controls are used, coordination with federal, state and local government (the ATSDR, the Commonwealth of Massachusetts and/or the Town of Billerica) will be required. For example, implementation of land use restrictions may require the exercise of zoning authority by the Town of Billerica to prohibit residential development in a contaminated area, or the adoption of a building permit ordinance in the Town of Billerica requiring anyone seeking a building permit for construction activities in a particular area to be notified of contamination in the area and of any relevant management standards - such an ordinance could also be used to prohibit types of construction that would result in unacceptable exposures (e.g., excavation in areas where subsurface contamination has

not been fully removed). Implementation of groundwater use restrictions may require action by the Commonwealth of Massachusetts to prohibit or limit certain uses of groundwater in particular areas, or require closing or capping of wells. Implementation of advisories may also require action by the ATSDR or Commonwealth of Massachusetts to publically issue warnings that provide notice to potential users of land, surface water or groundwater of some existing or impending risk associated with their use.

An additional administrative issue is to reach agreement between federal, state and local agencies on the specifics of implementing the monitored natural attenuation program. Under Alternative #5, this program will address contaminated soils and groundwater at several site AOCs. Concurrence among the various agencies will be required in defining the program (*e.g.*, number and type of monitoring locations, analytical/test parameters, frequency of testing, etc.) as well as interpretation of results and conclusions regarding the overall success of monitored natural attenuation.

**5.3.6.3 Availability of Services and Materials.** Evaluation of the availability of services and materials for Alternative #5 includes an assessment of three factors in accordance with EPA's feasibility study guidance: 1) the availability of treatment, storage capacity and disposal services, 2) the availability of necessary equipment and specialists, and 3) the availability of prospective technologies. These aspects are described in detail below:

> Availability of TSDF Services. Since no remedial actions requiring transport, storage or disposal are to be implemented as part of Alternative #5, the "Limited Action" alternative, there are no implementability constraints with regards to this issue for selection of this alternative.
>
> Availability of Necessary Equipment and Specialists. The highest need for specialists in Alternative #5 is for two areas: 1) specialized legal counsel or legal assistance for implementation of the institutional controls and 2) consultants experienced in monitored natural attenuation of soils and groundwater. As stated previously in Alternative #3, implementation of the institutional controls is expected to be a time-consuming process but should not pose significant implementability concerns that will prevent selection of this alternative as the final remedy. Legal specialists experienced in both CERCLA and non-CERCLA sites are available to facilitate this process. Similarly, monitored natural attenuation has been a technology employed at CERCLA sites in the last 10 years and there is a substantial number of environmental consultants with familiarity in implementing such a program. Thus, availability of consultants

familiar with monitored natural attenuation should not prevent selection of this alternative as the final remedy.

Similar to Alternative #3, installation of fencing and security measures, even on a CERCLA site, should not pose any implementation concerns for Alternative #5 as these have been routinely installed on other CERCLA sites throughout the region.

Availability of Prospective Technologies. Alternative #5 will employ the use of in-situ stabilization/solidification at AOC #5 which is the only specialized remedial technology/process option required for this alternative. Although this technology is not as "exotic" as many innovative technologies, it is still relatively uncommon and will require effort to identify and procure appropriate expertise, equipment and skilled personnel. Therefore, availability of this technology will be the limiting factor in the overall implementability of this alternative.

### 5.3.7 Cost for Alternative #5

Total estimated capital cost associated with this alternative is $2.0 million. This estimate assumes a contingency of 20%. The present value of all O&M costs would be $35.1 million. This estimate assumes an inflation rate of 3%, an interest rate of 7%, and a contingency of 15%. The maximum duration of site remedial actions is assumed to be 30 years, in accordance with RI/FS guidance (U.S. EPA, 1988). However, in-situ solidification stabilization activities are expected to be performed in less than one year. Total present worth costs would therefore be $37.1 million. Detailed costs for this alternative are presented in Appendix D. The costs associated with each alternative selected for detailed evaluation are summarized in Table H-1 of Appendix H.

### 5.3.8 State Acceptance for Alternative #5

Acceptance of the selected, site-wide remedial alternative by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 5.3.9 Community Acceptance for Alternative #5

Acceptance of the selected, site-wide remedial alternative by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 5.4 ALTERNATIVE #8 - "THRESHOLD EFFECTIVENESS"

Alternative #8 is the first alternative that seeks to address the "threshold effectiveness" factors of: a) protective of human health and the environment and b) compliance with ARARs. This alternative represents the first remedy where either installation of horizontal containment caps or waste removal will be conducted at all disposal area AOCs.

The overview of remedial action components for Alternative #8 is presented in Table 5-8 and Appendix F. Figure 5-3 details the remedial action site plan for this alternative. Alternative #8 includes the following remedial actions by media of concern and AOC:

Soil:

- Source control remedies consisting of horizontal containment (*i.e.*, caps) will be implemented at disposal area AOCs [#1 - B&M Railroad Landfill, #2 - RSI Landfill (for groundwater source management), #6 - Asbestos Landfill, #7 - Asbestos Lagoons] to address risk and/or meet ARAR requirements.
- Contaminated soil at AOCs #3 (B&M Locomotive Shop Disposal Areas) and #4 (Old B&M Oil/Sludge Recycling Area) will be excavated and relocated for ultimate disposal under one of the caps installed for AOCs #1, 2, 6, or 7.
- Due to on-going, active use of AOC #5 (Contaminated Soils Area), in-situ treatment consisting of chemical and biological processes (*e.g.*, soil flushing, enhanced biodegradation) will be utilized along with institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures) and monitoring to meet preliminary remediation goals.

Groundwater:

- An in-situ remedy consisting of monitored natural attenuation, physical processes (hydraulic and pneumatic fracturing), and chemical oxidation will be applied to the highest human health risk-ranked AOC (#5 - Contaminated Soils Area). This remedy also includes institutional actions consisting of access restrictions (*e.g.*, institutional controls) as well as monitoring.
- In-situ remedies consisting of monitored natural attenuation as well as institutional actions consisting of access restrictions (e.g., institutional controls) and monitoring will be implemented at all remaining AOCs.

Surface Water and Sediment:

- Monitoring will be implemented at all three AOCs showing risk (#8b-Wetland 2 Group, #8d-Richardson Pond Group, #8e-Content Brook Wetland Group). No remedial actions for surface water will be necessary at all remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) since contaminant concentrations are

within acceptable human health and ecological risk levels. Sediment monitoring is included at these two AOCs as a provision if future toxicity testing results in ecological risk.

The detailed evaluation of Alternative #8 with respect to the nine FS criteria is presented in Sections 5.4.1 through 5.4.9.

### 5.4.1 Overall Protection of Human Health and the Environment for Alternative #8

Alternative #8 will provide some overall protection of human health and the environment by reducing some risks identified in the baseline risk assessment. For soil, overall protection of human health from implementation of Alternative #8 will result from the elimination of exposures to COCs in soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Asbestos Landfill and Asbestos Lagoons, and a significant reduction in exposures to COCs in soil at the Contaminated Soils Area. In addition, the elimination of exposures to groundwater at AOCs #1 through 7 using institutional controls and monitored natural attenuation along with reduced COC concentrations from in-situ treatment at the Contaminated Soils Area will provide overall protection of human health from groundwater exposures. Identified ecological risks from exposures to soil will be significantly reduced, and exposures to surface waters will be gradually reduced. In sediment, however, only minor reductions of risk to ecological receptors will be expected. Therefore, Alternative #8 fails to meet all RAOs for the Site, as defined in Section 2.1, and only partially reduces risks to human health and the environment. The protection of human health and the environment are discussed in Sections 5.4.1.1 and 5.4.1.2, respectively.

**5.4.1.1 Human Health Protection.** Alternative #8 will provide overall protection of human health by significantly reducing or eliminating risks identified in the baseline risk assessment. Current baseline risks to human health at the Contaminated Soils Area for female site workers of child-bearing age from exposure to lead in soil via indoor dust will be eliminated as a result of in-situ enhanced biodegradation, soil flushing, and access restrictions (fencing). This conclusion is based on information reported in Section 5.4.4.3 documenting a 70% to 95% reduction in soil inorganic levels by enhanced biodegradation and soil flushing. For the current female site worker of child-bearing age

at the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area, baseline risks to human health from exposure to lead in soil via indoor dust will be eliminated as a result of excavation and relocation for ultimate disposal under one of the caps installed for AOCs #1, 2, 6 or 7. For the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will be abated by capping, since windborne exposure to asbestos will be eliminated. However, since no contaminant removal is performed with capping, the risk will return to baseline levels if the caps are not maintained.

The potential for future risks from ingestion of COCs in groundwater at the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons will be eliminated by restrictions on the future use of groundwater as a drinking water source. Significant reductions in groundwater concentrations for most organic COCs, with negligible reductions in inorganic COC concentration are expected to occur at the Contaminated Soils Area by the use of in-situ chemical oxidation. Information in Section 5.4.5.3 and Appendix G documents times to achieve PRGs of from 1 year to >200 years for organic COCs in contrast to remedial times of >200 years for inorganic COCs at the Contaminated Soils Area. These times are based on flushing only and the in-situ chemical oxidation is expected to reduce most organic COCs to concentrations below PRGs in less than 30 years. Reductions in groundwater COC concentrations are also expected to occur over time at AOCs #1, 2, 3, 4, 6, and 7 due to the removal of contaminated soil (at AOCs #3 and #4) and placement of caps (at AOCs #1, 2, 6, and 7). Excavation and capping activities lower groundwater COC concentrations by limiting the potential leaching of soil contaminants to groundwater. Natural degradative processes also contribute to the lowering of groundwater COC concentrations over time. However, attenuation that occurs naturally is likely to occur slowly for the most significant risk drivers (>200 years to achieve PRGs for arsenic and manganese; see Section 5.4.5.3 and Appendix G). Since there will be no on-site containment of groundwater contamination with this alternative, risk to off-site receptors will be possible.

Additional short-term risks to workers will result from the installation of fencing and the use of in-situ remediation techniques at the Contaminated Soils Area, excavation and/or capping of AOCs #1, 2, 3, 4, 6, and 7, and from soil and groundwater contact during monitoring. These risks will be mitigated by

the use of appropriate personal protection equipment as needed. Specific long-term and short-term human health risks are discussed in Sections 5.4.3.1 and 5.4.5.1, respectively.

**5.4.1.2 Ecological Protection.** Alternative #8 will provide reductions in short-term and long-term risk to ecological receptors relative to baseline conditions for exposures to soil. Treatment of source areas will reduce long-term risk of exposure to aquatic receptors from surface water contaminants. The reduction of risk to ecological receptors in sediments is expected to be minor.

Capping the B&M Railroad Landfill and excavating the B&M Locomotive Shop Disposal Areas will prevent future potential for exposure of terrestrial mammals to metal concentrations, resulting in a significant reduction in ecological risk from exposure to soil.

Adverse impacts on aquatic receptors from exposure to inorganics in surface waters will be reduced at the Wetland 2 Group, Richardson Pond Group, and Content Brook Wetland Group. The removal or control of all the major source areas on-site will reduce the potential for discharge of metals in surface water runoff and gradually reduce concentrations of contaminants discharged from groundwater. These mechanisms will reduce the concentration of metals contributing to risk to aquatic receptors in surface water over time. Resuspension of sediments, not treated by this alternative, still remains a potential source of metals in surface water. Impacts on benthic invertebrate populations from exposure to contaminants in sediment will not be reduced in the Wetland 2 Group, Richardson Pond Group, and Content Brook Wetland Group since the concentrations of contaminants in the sediments in these habitats will not be substantially reduced by this alternative.

The capping of the B&M Railroad Landfill, RSI Landfill, and Asbestos Landfill, excavation of the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area, and in-situ remediation of the Contaminated Soils Area will result in temporary, minor ecological impacts during construction.

### 5.4.2 Compliance with ARARs for Alternative #8

Chemical-specific ARARs and TBCs for the Site are discussed at length in Section 2.3.1. A summary of the implications of each chemical-specific ARAR for this "Threshold Effectiveness" alternative include:

- Safe Drinking Water Act and Massachusetts Drinking Water Regulations. Federal and Massachusetts MCLs are relevant and appropriate for site groundwater. This alternative sets attainment of Federal SDWA MCLs and Massachusetts Maximum Contaminant Levels for inorganic and organic chemicals as groundwater remediation goals. Monitored natural attenuation, however, is not anticipated to be able to attain Federal SDWA MCLs or Massachusetts Maximum Contaminant Levels for inorganic chemicals in a reasonable time frame.

- Resource Conservation and Recovery Act Maximum Concentration Limits. RCRA groundwater corrective action requirements are relevant and appropriate requirements at the point of compliance at the limit of the waste management areas. The potential for contaminants to migrate from the area will be monitored by this alternative. Monitoring will be conducted to track exposure-based limits at the point of compliance. Monitored natural attenuation, however, is not anticipated to be able to attain Federal RCRA MCLs for inorganic chemicals in a reasonable time frame.

- Federal Water Pollution Control Act, as Amended by the Clean Water Act, Ambient Water Quality Criteria (AWQC). Freshwater acute and chronic AWQC for the protection of aquatic life are considered appropriate and relevant for the site wetlands. Leachate outbreaks and surface water runoff are controlled under this alternative, thereby reducing the probability that AWQC may be exceeded.

- Clean Air Act and Massachusetts Air Pollution Control Regulations. Dust or other potential emissions that may result from excavation of waste materials will be controlled under this alternative. There is no indication that ARARs for air will be exceeded by this alternative.

- Massachusetts Groundwater Quality Standards. Actions will be taken at AOC #5 in an attempt to attain applicable "Class I" enforcement standards under this alternative. Groundwater quality standards are exceeded at other AOCs.

- Massachusetts Surface Water Quality Standards. As part of the Shawsheen River Basin, site surface waters are classified as "Class B" habitat for fish, aquatic life and wildlife, and a source of treated public water supplies. Surface water quality standards are considered applicable to site surface waters. Leachate outbreaks and surface water runoff will be controlled under this alternative, thereby reducing the probability that surface water quality standards may be exceeded.

- Federal Criteria and Advisories To Be Considered. In addition to the ARARs listed above, there are other important issues and advisories which will require attention prior to and during remedial activities. These criteria and advisories to be considered include:
    - *Health Advisories.* Carcinogenic and non-carcinogenic risk levels due to consumption of contaminated drinking water will be exceeded.
    - *Federal Groundwater Protection Strategy of 1984.* Current, applicable "Class I" enforcement standards are not met under this alternative. Groundwater quality standards are exceeded.
    - *Threshold Limit Values (TLVs).* There is no indication that these levels will be exceeded for site remediation workers under this alternative.

Location-specific ARARs and TBCs relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2), will not be met under this alternative. Although the minor impacts to wetlands and floodplains during cap construction will be mitigated, and no surface water discharges will occur, because the on-site wetlands will be allowed to remain in a degraded (contaminated) state, this "Threshold Effectiveness" alternative will not meet the intent of Executive Order 11990. This ARAR requires federal agencies to minimize wetland degradation and to preserve and enhance the beneficial uses of wetlands. This alternative leaves the wetlands and ecological habitats intact but also leaves chemicals of concern in place.

Table 5-9 lists the action-specific ARARs for this "Threshold Effectiveness" alternative. The alternative attains action-specific ARARs except those related to wetlands and groundwater protection. Corrective actions must be completed within a "reasonable time period." At AOCs #1, 2, 3, 4, and 6 monitored natural attenuation will be the only groundwater remedy implemented. Demonstrating that the action-specific ARAR listed below can be attained will require long-term monitoring and evaluation. In the event that this ARAR cannot be attained within the designated time period agreed upon for the Monitored Natural Attenuation program, then the groundwater remedy proposed for this alternative will need to be modified by means of a Technical Impracticability (TI) Waiver and/or Explanation of Significant Difference (ESD) to the Record of Decision.

- Hazardous/Solid Waste Management - Groundwater Protection, 310 CMR 30.660 - 30.675; 310 CMR 19.110 (AOCs #1 through 7): A groundwater monitoring program will be implemented at the Site. Corrective measures consist of monitored natural attenuation. Leachate generation from the landfill will not be controlled. Monitoring will need to be conducted to determine attainment of this requirement.

In addition, hazardous waste management landfill stabilization/solidification (310 CMR 30.632) regulations require that all wastes disposed of in a landfill are treated to the maximum extent practicable to minimize the potential for wastes migrating from the landfill site. This alternative includes excavation of materials from AOC #3 and subsequent on-site disposal. Currently, the alternative does not include stabilization/solidification of these wastes. If, however, after sampling, the excavated material is shown to be a hazardous waste, further treatment may be warranted and this remedy revisited. This alternative includes sampling and analysis adequate to make this determination and, thus, attains this action-specific ARAR.

### 5.4.3 Long-Term Effectiveness and Permanence for Alternative #8

This alternative is evaluated below in terms of risk remaining at the Site after RAOs are addressed. This portion of the evaluation focuses on the extent and effectiveness of the controls required to manage the risk posed by treatment residuals and/or untreated contamination.

**5.4.3.1 Magnitude of Residual Risk: Human Health.** Alternative #8 implements controls to eliminate exposure of workers to soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. For groundwater, Alternative #8 implements access restrictions to prevent human contact with COCs. In addition, the use of in-situ groundwater treatment at the Contaminated Soils Area and the use of excavation and/or capping at AOCs #1, 2, 3, 4, 6, and 7 are expected to partially reduce groundwater contamination at the Site. However, on-site groundwater containment is not expected. Under this alternative, the magnitude of residual risks will depend on the enforcement and reliability of institutional controls to prevent future human exposure to COCs in groundwater as well as the efficiency of the remedial measures at eliminating exposures to soil COCs.

Under this alternative, exposure of female site workers of child-bearing age to lead in indoor dust from soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Contaminated Soils Area, which was estimated to result in a maternal blood level exceeding that protective of a 95$^{th}$ percentile fetal blood lead level of 10 µg/dl, will be significantly reduced (70% to 95%) by in-situ enhanced biodegradation, soil flushing and access restrictions at the Contaminated Soils Area, and eliminated through excavation and relocation of soils under capping for the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area. Likewise for the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will be eliminated by capping because fugitive dust generation will be prevented. Therefore, the use of capping or in-situ remediation techniques at these AOCs will effectively eliminate the estimated risk for site workers to soils, unless the caps are not maintained.

Potential future residual human health risks to a resident from ingestion of COCs in groundwater from AOCs #1 through 7 will be eliminated by the implementation of groundwater access restrictions as long as long-term enforcement of the groundwater access restrictions is maintained. Should access restrictions not be maintained, the use of in-situ chemical oxidation at the Contaminated Soils Area is expected to partially reduce groundwater residual risks by reducing the levels of most organic COCs (see Section 5.4.1.1). However, little reduction in the levels of inorganic COCs is expected. Contaminated groundwater will not be contained with this alternative, even though COC concentrations will be monitored. Therefore, groundwater risk to off-site receptors will be possible.

As groundwater concentrations at AOCs #1, 2, 3, 4, 6, and 7 decline over time, there will be a partial lowering of residual risks to potential off-site receptors, and to on-site receptors should access restrictions not be maintained in the future. However, concentration reduction is likely to occur slowly for the most significant risk drivers (>200 years to achieve PRGs for arsenic and manganese; see Section 5.4.5.3 and Appendix G).

**5.4.3.2 Magnitude of Residual Risk: Ecological.** Alternative #8 will result in a quantifiable long-term reduction in risk to ecological receptors in soil and surface water, but not from sediments. The potential for exposure of small mammals to contaminants in soil will be removed at the B&M Railroad Landfill and the B&M Locomotive Shop Disposal Areas.

The removal or control of all the major source areas on-site will reduce the potential for discharge of metals in surface water runoff and gradually reduce concentration of contaminants discharged from groundwater. In the long-term, these mechanisms will reduce the concentration of metals contributing to risk to aquatic receptors in surface water. The risk to aquatic receptors from exposure to metals in surface water will persist until substantial decreases in contaminant discharge are achieved. Resuspension of sediments, not treated by this alternative, still remains a potential source of metals in surface water. Therefore, residual risk to aquatic receptors will not be lowered substantially below baseline conditions for Alternative #8 in the short-term, but are expected to improve in the long-term.

Since no measures are taken in Alternative #8 to directly remove/reduce exposure from contaminants in sediments, the only effects on the concentration of contaminants will be dilution/dispersal through slow, natural processes and a minor reduction in the deposition of additional contamination from surface water over time. Consequently, the concentration of contaminants in on-site sediments will not be substantially reduced under Alternative #8 and the risk to benthic invertebrates will not be reduced below baseline conditions.

### 5.4.4 Reduction of Toxicity, Mobility and Volume through Treatment for Alternative #8

Table 5-10 provides a summary of the treatment and process options selected, quantities of waste materials to be remediated, expected reductions in toxicity, mobility and volume, and residuals

following treatment for Alternative #8. No human health or ecological risk was determined for soil at AOC #2 (RSI Landfill). Likewise, no risk was determined for surface water at AOC #8a (West Middlesex Canal Group) and AOC #8c (East Middlesex Canal Group). Therefore, reductions in toxicity, mobility and volume were not evaluated for these media at these AOCs. As a provision if future sediment toxicity testing results in ecological risk, actions are included in the alternative for AOCs #8a and #8c and evaluated below.

**5.4.4.1 Treatment/Recycling Processes to be Utilized.** For soil, treatment processes to be implemented under Alternative #8 include in-situ enhanced biodegradation and soil flushing. Source control, as well as excavation and on-site disposal, also will be utilized. However, these processes are not considered treatment processes. Groundwater treatment processes to be utilized include monitored natural attenuation, as a stand-alone process, with management of migration, and in addition to in-situ chemical oxidation. Institutional actions, which do not provide treatment, will be implemented at all AOCs showing risk in surface water and sediment, as well as at AOCs #8a and 8c, where future sediment toxicity testing results may result in ecological risk. A more detailed description of the treatment/recycling processes to be utilized under Alternative #8 is provided in Section 5.4. Refer to Table 5-10 for specific treatment/recycling processes to be utilized at each AOC.

**5.4.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The following amounts of hazardous materials to be treated for Alternative #8 are provided below by media of concern and AOC. Values are only given if the remedial action will provide treatment. Monitored natural attenuation is considered a treatment process in this evaluation, since it typically results in reductions in contamination over time. Source control, excavation and on-site disposal, and institutional actions are not considered treatment processes.

<u>Soil</u>

- AOC #5 - Contaminated Soils Area 10,800 $yd^3$

<u>Groundwater (areal extent of source)</u>

- AOC #1 - B&M Railroad Landfill 12.4 acres
- AOC #2 - RSI Landfill 2.5 acres
- AOC #3 - B&M Locomotive Shop Disposal Areas 4.7 acres
- AOC #4 - Old B&M Oil/Sludge Recycling Area 7.0 acres

- AOC #5 - Contaminated Soils Area 6.7 acres
- AOC #6 - Asbestos Landfill 13.3 acres
- AOC #7 - Asbestos Lagoons 1.9 acres

**5.4.4.3 Degree of Expected Reductions in Toxicity, Mobility and Volume.** The degree of treatment and expected reductions for each treatment process under Alternative #8 are provided below by media of concern and AOC. Reductions expected from source control and excavation and on-site disposal are not discussed, since these processes are not considered treatment. Reductions from monitored natural attenuation are provided for the U.S. EPA default time period, 30 years.

All of the contaminated soil at AOC #5 will be treated under Alternative #8. The following reductions in toxicity, mobility and volume are expected for soil:

Toxicity

- In-situ enhanced biodegradation and soil flushing is expected to reduce the toxicity of the contaminated soil relative to a specific contaminant proportional to the volume reduction of that specific contaminant at AOC #5. However, flushing will further contaminate the groundwater, through the transfer of contaminants from soil to groundwater. Groundwater treatment processes will then be utilized to remove these contaminants.

Mobility

- Inorganic COCs are expected to exhibit a mobility increase through the in-situ enhanced biodegradation and soil flushing process. This increase is anticipated since soil flushing desorbs contaminants from soil and releases them to groundwater. Groundwater treatment processes will then be utilized to remove these contaminants.

Volume

- At AOC #5, the volume of the contaminated media will not be reduced by the in-situ enhanced biodegradation and soil flushing process. Organic COCs are expected to be reduced in volume by 92% to 100% (U.S. EPA, 1998c) through the enhanced biodegradation process. There is no expected reduction of inorganic COCs. However, soil flushing is expected to transfer approximately 70% to 95% (U.S. EPA, 1990) of inorganics to another media, groundwater. Groundwater treatment processes will then utilized to remove these contaminants.

Monitored natural attenuation is expected to treat the total quantity of contaminated groundwater at AOCs #1 through 4, 6, and 7. The amount of contaminated groundwater to be treated by the in-situ chemical oxidation process at AOC #5 will be dependent on the density of the oxidant injection network. Reductions in toxicity, mobility and volume expected for groundwater are provided below.

There are no organics above PRGs at AOC #4. Therefore, reductions for organics at AOC #4 were not calculated.

Toxicity

- Monitored natural attenuation is expected to reduce the toxicity of the contaminated groundwater relative to a specific contaminant proportional to the volume reduction of that specific contaminant at AOCs #1 through 4, 6, and 7. Intermediate products that are more toxic than parent compounds may result if incomplete biodegradation of original contaminants occurs.
- At AOC #5, the toxicity of the contaminated groundwater relative to a specific contaminant will be reduced proportional to the volume reduction of that specific contaminant resulting from in-situ chemical oxidation.

Mobility

- Monitored natural attenuation will not provide reductions in mobility of COCs at AOCs #1 through 4, 6, and 7.
- There will be no COC mobility reductions through the in-situ chemical oxidation process at AOC #5.

Volume

- Monitored natural attenuation will not reduce the volume of the contaminated media at AOCs #1 through 4, 6, and 7.
- Organic COCs reductions in volume are expected to range from less than 15% to 100% across the Site. This broad range is due to differing physical and chemical properties on a compound by compound basis. Greater reductions of organics are possible due to biodegradation. Specific compounds used in the MODFLOW simulations, as well as BIOSCREEN results which additionally consider biodegradation rates, can be found in Appendix G. Table 5-10 provides estimated volume reductions at each AOC.
- Expected volume reductions from monitored natural attenuation for inorganic COCs are less than or equal to 15% across the Site. These low reductions may be attributed to adsorption of compounds to the soils within the aquifer. For specific compounds used the MODFLOW modeling, reference Appendix G. Inorganic volume reductions by AOC are provided in Table 5-10.
- In-situ chemical oxidation is expected to provide a 94% to 99% (U.S. EPA, 1998e, Bryant et al, 1998) reduction in the volume of organic COCs at AOC #5. Inorganics at AOC #5 will be reduced by less than 15% through monitored natural attenuation.

There are no expected reductions in toxicity, mobility and volume in surface water and sediment at AOCs #8a through 8e. Institutional actions will not confirm reductions or treatment of waste materials.

**5.4.4.4 Reversibility.** The reversibility of each treatment process to be implemented under Alternative #8 is discussed below by media of concern and AOC. Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. Since source control, excavation and on-site disposal, and institutional actions are not considered treatment processes, reversibility of treatment is not applicable to these processes.

For soil, treatment processes will only be utilized at AOC #5. In-situ enhanced biodegradation and soil flushing processes to be implemented at this AOC are not considered reversible. Enhanced biodegradation degrades organic compounds through breakdown by microbes. Soil flushing removes inorganic contaminants from the soil via transfer to groundwater.

Monitored natural attenuation, to be implemented for groundwater at all AOCs, is not considered a reversible process. Organic contaminants are degraded over time. Inorganic contaminants, on the other hand, may only be temporarily immobilized and later released. At AOC #5, the chemical oxidation process will physically alter contaminants, and therefore, is not considered reversible.

Institutional actions, which do not provide treatment, are the only process option to be implemented for surface water and sediment at all AOCs showing risk, as well as at AOCs #8a and 8c, where future sediment toxicity testing results may result in ecological risk. Therefore, reversibility of treatment is not applicable to the remedies selected for surface water and sediment under this alternative.

**5.4.4.5 Type and Quantity of Residuals.** The types and quantities of contaminant residuals by media of concern and AOC expected after completion of the treatment technologies/process options implemented in Alternative #8 are summarized below. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are discussed briefly in Table 5-10.

Following treatment by in-situ enhanced biodegradation and soil flushing, approximately 5% to 30% of the inorganic COCs and up to 8% of the organic COCs will remain in the soil at AOC #5. All of the contaminated soils at AOCs #1, 6, and 7, as well as the soils to be excavated from AOCs #3 and 4, will remain untreated but contained under a protective cap.

Approximately 1% to 6% of organic COCs will remain in the groundwater at AOC #5 after in-situ chemical oxidation treatment. Following treatment by monitored natural attenuation, greater than 85% of inorganics will remain at AOC #5.

More toxic intermediate products may remain in groundwater at AOCs #1, 2, 3, 6, and 7, resulting from the incomplete degradation of original organic contaminants. For monitored natural attenuation, estimated residuals following treatment for a 30 year period, the U.S. EPA default time period utilized to allow equal comparisons between alternatives, are provided below. As stated above, the high degree of variability in the reductions, and thus the residuals, is due to differing physical and chemical properties of compounds.

- It is expected that 0% to greater than 85% of the organic COCs and greater than or equal to 85% of the inorganic COCs will remain in the groundwater at AOC #1.
- The groundwater at AOC #2 is expected to contain 0% to 81% of the organic COCs and greater than 85% of the inorganic COCs after treatment.
- Greater than 85% of the inorganic COCs are expected to remain at AOC #3 following treatment by monitored natural attenuation.
- At AOC #4, it is expected that greater than 85% of the inorganic COCs will remain in the groundwater after treatment. There are no organics exceeding PRGs at AOC #4. Therefore, organic reductions were not evaluated.
- An estimated 0% to 45% of the organic COCs and greater than 85% of the inorganic COCs will remain in the groundwater at AOC #6 following treatment.
- It is anticipated that 0% to greater than 85% of the organic COCs and greater than 85% of the inorganic COCs will remain in the groundwater at AOC #7.

Institutional actions will be undertaken at all AOCs showing risk in surface water and sediment, as well as at AOCs #8a and 8c, where future sediment toxicity testing results may result in ecological risk. Since institutional actions will not confirm reductions or treatment of waste materials, it is assumed that the original contamination at AOCs #8a through 8e will remain unchanged.

### 5.4.5 Short-Term Effectiveness for Alternative #8

This alternative is evaluated for effectiveness in protecting the community and local workers, site remediation workers, and the environment during the construction and implementation of the remedy.

**5.4.5.1 Protection of Community and Workers During Remedial Actions.** The construction and remediation measures proposed under this alternative include implementation of access restrictions (fencing) and in-situ remediation of soil and groundwater at the Contaminated Soils Area, excavation and placement of soils from the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area beneath a cap, capping of the B&M Railroad Landfill, RSI Landfill, Asbestos Landfill, and Asbestos Lagoons, and monitoring of soil and groundwater at AOCs #1 through 7.

The implementation of these construction/remedial measures will potentially result in additional short-term risk to the community from exposure to soil contaminants associated with dust generation during soil disturbances at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. Precautions will be implemented to prevent or limit fugitive dust generation during excavation/remedial activities. Worker exposure to COCs in soil and groundwater during the installation of fencing and remedial measures at the Contaminated Soils Area, excavation/capping at AOCs #1, 2, 3, 4, 6, and 7, and monitoring will also result in potential health risk to workers. Use of personal protection equipment will be employed to reduce exposure if applicable OSHA standards are exceeded during these activities.

**5.4.5.2 Environmental Impacts.** The capping of the B&M Railroad Landfill, RSI Landfill, Asbestos Landfill, Asbestos Lagoons, and excavation of the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area will all require removal of vegetation. Wetlands are located around the border of a portion of each of these areas, with the exception of the Old B&M Oil/Sludge Recycling Area. The extent of excavation or fill in wetland is estimated to be minimal for each alternative. Mitigation measures will include avoidance and minimization of temporary construction disturbance in adjacent wetlands during construction of landfill caps. Tree removal will be minimized, and proper construction and erosion control methods will be utilized. Mitigation will include restoration of upland habitat, and minimization of wetland impacts. Any unavoidable wetland loss will be mitigated by restoration or creation of on-site wetlands. Changes in hydrology resulting from construction of landfill caps will be mitigated by properly designed stormwater retention systems to maintain release of water close to existing conditions.

The alternative includes installation of monitoring wells throughout the Site, construction of fencing around the Contaminated Soils Area, and construction of other technologies at that AOC. Mitigation measures will include avoidance and minimization of temporary construction disturbance in adjacent wetland during construction of monitoring wells, and minimization of tree removal. Proper construction and erosion control methods will be utilized to minimize ecological impact to surrounding habitats.

The excavation of soil adjacent to the unnamed brook in B&M Locomotive Shop Disposal Area A may potentially cause disturbance to the stream bank. Mitigation measures will include avoidance and minimization of temporary construction disturbance in the stream channel and returning impacted areas to previous grades. Any unavoidable wetland loss from excavation will be mitigated by restoration or creation of on-site wetlands.

**5.4.5.3 Time Until Remedial Action Objectives are Achieved.** Of the RAOs presented in Section 2, those for groundwater will take the longest to achieve. Through the use of groundwater flow modeling and contaminant retardation concepts (Appendix G), approximate times to achieve PRGs were calculated for the Site contaminants at each AOC. It should be noted that the mobility of inorganics is highly sensitive to site specific geochemistry. Other factors such as pH, dissolution, and colloidal transport could have significant impacts on mobility of inorganics. Therefore, these times should only be used for relative comparison and not for accurate representations of cleanup times.

Alternative #8 includes monitored natural attenuation as a groundwater treatment process at all AOCs. Additionally, in-situ chemical oxidation will be used at AOC #5, the Contaminated Soils Area. This is expected to lower the times for reduction of organics at this AOC significantly. However, injection of oxidant solution may also change the Site hydrology such that contaminants will not disperse as fast at another AOC. Site hydrology may also be impacted by caps placed on AOCs #1, 2, 6, and 7.

Modeling was performed similar to Alternatives #1, 3, and 5, to predict the reduction of contaminant concentrations over time due to natural processes, such as dispersion. However, additional contaminant reduction is expected to occur due to biodegradation. This aspect of monitored natural attenuation was evaluated using the BIOSCREEN natural attenuation decision support system

(Appendix G). While improved cleanup times were estimated for a few compounds at the Site, these times were similar to those without biodegradation. Approximate cleanup times, assuming no biodegradation, for each AOC with contaminants above PRGs are presented below:

| Overburden | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | 132 | ND | >200 | >200 |
| AOC #2 - RSI Landfill | 161 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | 27 | ND | ND | >200 |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | >200 |
| AOC #5 - Contaminated Soils Area* | 33 | 153 | >200 | >200 |
| AOC #6 - Asbestos Landfill | 54 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 23 | 189 | ND | >200 |

| Bedrock | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | >200 | >200 | ND | >200 |
| AOC #2 - RSI Landfill | 19 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | ND | ND | ND | ND |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | >200 |
| AOC #5 - Contaminated Soils Area* | 107 | 128 | ND | >200 |
| AOC #6 - Asbestos Landfill | 12 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 155 | >200 | ND | >200 |

Notes: ND = Not detected at a concentration greater than PRGs at this AOC and flow zone
* - Times for organics are expected to be greatly reduced due to in-situ chemical oxidation

Some cleanup times reported above are high (i.e., greater than 200 years). This simply means that the compounds are essentially immobile. For example, arsenic and thallium have very high retardation coefficients and, ultimately, high cleanup times.

It should also be noted that the only SVOC detected above PRGs at all AOCs was bis(2-ethylhexyl)phthalate and the only pesticide was aldrin. The high retardation factors of these compounds increase the time of travel and source contaminant reduction. Evaluations assumed that the Contaminated Soils Area contained contaminants similar to the B&M Railroad Landfill, RSI Landfill, and the Asbestos Lagoons. The two compounds noted above are therefore assumed to be found at this AOC above PRGs. However, further evaluation may determine that this is not the case.

Furthermore, the evaluations assumed that the maximum detections from the three nearby AOCs were also detected at the Contaminated Soils Area. Similarly, data from the RSI Landfill was used to characterize the Asbestos Landfill.

### 5.4.6 Implementability for Alternative #8

This section summarizes the technical and administrative feasibility of implementing Alternative #8, the "Threshold Effectiveness" alternative, and the availability of various services and materials required for its implementation.

**5.4.6.1 Technical Feasibility.** Evaluation of the technical feasibility of Alternative #8 includes an assessment of three factors described in EPA's feasibility study guidance: 1) the ability to construct and operate the technologies, 2) the reliability of the technologies and 3) the ease of undertaking additional remedial actions, if necessary. These aspects are described in detail below:

> Ability to Construct and Operate the Technologies. For Alternative #8, the major implementability issue with regards to technical feasibility is the construction of landfill caps at AOCs #1, 2, 6, and 7. Alternative #8 also includes the excavation and removal of waste soil/waste fill from AOCs #3 and 4 with relocation and regrading of these materials below one of the caps constructed at AOCs #1, 2, 6, or 7.
>
> The capping and excavation remedies at AOCs #1, 2, 3, 4, 6, and 7 will require a substantial civil engineering/earthwork component. The key implementability issue is the location of sensitive wetland areas or water bodies adjacent to most of these AOCs. This will require comprehensive soil erosion, run-off and sedimentation control measures to minimize siltation impacts to wetland areas and water bodies. In addition, proper location and construction of temporary and permanent haul roads will be required to minimize impacts to wetland areas and water bodies. It is expected that the remediation contractor(s) will utilize the existing rail network to move equipment and materials to the largest degree possible. This rail network is closely situated to five of the six "earthwork" AOCs (*i.e.*, #1, 2, 3, 4, and 6). This will minimize truck traffic through neighborhoods and the need for new roads. While the scope of the earthwork and transportation required for the capping and excavation activities is large, these are common problems faced and solved by experienced engineers and constructors. Maintenance of the capped and excavated areas is straightforward requiring only periodic inspections, vegetation control (*e.g.*, mowing) and filling of areas of settlement. As a result, no implementability constraints are expected with regards to construction and operation of the soil remedy for AOCs #1, 2, 3, 4, 6, and 7 in Alternative #8.

The primary implementability concern for soil treatment at AOC #5 using in-situ soil flushing and in-situ enhanced biodegradation is the limitation of conducting work within the Contaminated Soils Area while maintaining active use of the rail yard, rail spurs and roads that transect it. Alternative #8 will require implementability measures such as temporary use restrictions for tracks or roadways next to active soil remediation areas and temporary relocation of tracks and bedding material, if necessary. Implementing this remedy at AOC #5 will require close cooperation between rail yard users and the contractor and involve temporary disruptions to the rail yard. These are straightforward issues commonly faced and solved as part of construction efforts and are not sufficient to prevent consideration of this alternative as the selected remedy.

The primary implementability concerns for groundwater treatment at AOCs #5 using in-situ chemical oxidation is the limitation of conducting work within the Contaminated Soils Area while maintaining active use of the rail yard as discussed above. Implementability measures such as: temporary structural supports for tracks near the work zone, temporary use restrictions for tracks or roadways next to active work areas and temporary relocation of tracks and bedding material may be necessary for both construction and maintenance of the pipelines and vertical injection wells conveying the oxidant solutions. Additional use restrictions will be necessary if hydraulic & pneumatic fracturing was utilized during drilling and installation of the vertical injection wells. Implementation of this remedy at AOC #5 will require close cooperation between rail yard users and the remediation contractor. Alternative #8 further incorporates the use of monitored natural attenuation as a method to remediate any residual contaminated groundwater not addressed by in-situ oxidation. As discussed previously for Alternative #5, construction of this technology only requires installation of groundwater monitoring wells and "operation" only requires monitoring efforts to sample and analyze the groundwater so there will be no implementability constraints with regards to these issues for monitored natural attenuation.

Alternative #8 also includes the use of monitored natural attenuation to remediate contaminated groundwater at AOCs #1, 2, 3, 4, 6, and 7. Construction of this technology only requires installation of groundwater monitoring wells and "operation" only requires monitoring efforts to sample and analyze the groundwater. There are no implementability constraints with regards to monitored natural attenuation.

Reliability of the Technologies. Reliability of the horizontal caps installed for AOCs #1, 2, 6, and 7 will be considered high if normal periodic maintenance of the cap is conducted. The high reliability will also apply to the excavation and removal of waste soils/waste fill from AOCs #3 and 4 with relocation and regrading of these materials below one of the caps constructed at AOCs #1, 2, 6, or 7.

For in-situ soil flushing and in-situ enhanced biodegradation of soils as well as in-situ oxidation of groundwater at AOC #5, the reliability of these technologies is expected to be proportional to the reliability of the treatment delivery systems. These delivery systems will convey soil flushing solutions, bio-nutrients or chemical oxidation solutions from a central "mixing plant" via pipelines and/or tanker vehicles to the groundwater or contaminated soils. The reliability of these delivery systems will be similar to the reliability of industrial process/or wastewater treatment plants. Some "downtime" is to be expected in these systems for equipment

repair/replacement whether planned or unplanned. As long as the facilities are designed, constructed and operated in a manner appropriate to accommodate periodic planned/unplanned shutdowns, reliability concerns should not prove sufficient to prevent selection of this alternative as the final remedy.

As stated previously under Alternative #5, the reliability of monitored natural attenuation to remediate contaminated groundwater at AOCs #1 through 7 for Alternative #8 should be considered "high" since there is no external equipment nor treatment systems that could breakdown. The reliability of the technology to meet PRGs, however, should not be confused with "implementability" but is more appropriately discussed under "effectiveness" . The reader is directed to the "treatment efficiency" and the "time required to remediate" discussions in Sections 5.4.4, 5.4.5 and Appendix G.

The remaining technologies for Alternative #8 include fencing and security measures at AOC #5 and monitoring. The reliability of these technologies will be the same as described in Alternatives #3 through 5. Fencing, if properly maintained, is effective in preventing site access to the general public and workers, although much less effective in mitigating access to determined trespassers. Although the institutional controls which will be applied to AOCs #1 through 7 are not exactly technologies, their reliability will depend upon enforcement by the responsible agencies involved.

Ease of Undertaking Additional Remedial Actions. Applying additional remedial actions for contaminated soils contained by the horizontal caps installed at AOCs #1, 2, 6, and 7 will be severely restricted since installation of the caps are largely permanent remediation technologies. This conclusion will also apply to the excavation and removal of waste soils/waste fill from AOCs #3 and 4 with relocation and regrading of these materials below one of the caps constructed at AOCs #1, 2, 6, or 7.

Applying additional remedial actions for contaminated soils treated by in-situ soil flushing/enhanced biodegradation at AOC #5 will be reasonably implementable if the in-situ technologies weren't adequate to meet PRGs. This conclusion will also apply to treatment of contaminated groundwater using in-situ oxidation.

Additional remedial actions could be accommodated in place of monitored natural attenuation of groundwater at AOCs #1, 2, 3, 4, 6, and 7. The only implementability limitation is that the new groundwater remediation technologies will need to be installed outside the limits of the existing horizontal caps installed at AOCs #1, 2, 6, and 7.

**5.4.6.2 Administrative Feasibility.** Evaluation of the administrative feasibility of Alternative #8 involves assessing the steps required to coordinate with other federal, state and local governmental entities. It should be noted that under Superfund, permits are not required for remediation activities, but compliance with substantive requirements is required.

The principal administrative feasibility issue with regard to Alternative #8, described previously for Alternatives #3 through 5, involves implementation of institutional controls in order to prohibit subsurface disturbance and the use of groundwater. If proprietary controls are used, coordination with the individual property owners of the affected parcels, will be required. For example, implementation of a negative easement would require the property owner to convey to a third party (typically EPA) the right to limit how the landowner can use his or her property. Here the limitations would likely include prohibitions against subsurface digging and the use of groundwater from wells on the property.

If governmental controls are used, coordination with federal, state and local government (the ATSDR, the Commonwealth of Massachusetts and/or the Town of Billerica) will be required. For example, implementation of land use restrictions may require the exercise of zoning authority by the Town of Billerica to prohibit residential development in a contaminated area, or the adoption of a building permit ordinance in the Town of Billerica requiring anyone seeking a building permit for construction activities in a particular area to be notified of contamination in the area and of any relevant management standards - such an ordinance could also be used to prohibit types of construction that would result in unacceptable exposures (e.g., excavation in areas where subsurface contamination has not been fully removed). Implementation of groundwater use restrictions may require action by the Commonwealth of Massachusetts to prohibit or limit certain uses of groundwater in particular areas, or require closing or capping of wells. Implementation of advisories may also require action by the ATSDR or Commonwealth of Massachusetts to publically issue warnings that provide notice to potential users of land, surface water or groundwater of some existing or impending risk associated with their use.

An additional administrative issue is to reach agreement between federal, state and local governmental entities on the specifics of implementing the monitored natural attenuation program. Under Alternative #8, this program will address groundwater at AOCs #1 through 7. Concurrence among the various agencies will be required in defining the program (*e.g.*, number and type of monitoring locations, analytical/test parameters, frequency of testing, etc.) as well as interpretation of results and conclusions regarding the overall success of monitored natural attenuation.

**5.4.6.3 Availability of Services and Materials.** Evaluation of the availability of services and materials for Alternative #8 includes an assessment of three factors in accordance with EPA's feasibility study guidance: 1) the availability of treatment, storage capacity and disposal services, 2) the availability of necessary equipment and specialists, and 3) the availability of prospective technologies. These aspects are described in detail below:

Availability of TSDF Services. Since no remedial actions requiring off-site transport, storage or disposal are to be implemented as part of Alternative #8, the "Threshold Effectiveness" alternative, there are no implementability constraints with regards to this issue for selection of this alternative.

Availability of Necessary Equipment and Specialists. A substantial quantity of heavy, earthmoving equipment as well as transport vehicles (both truck and rail variety) will be required for Alternative #8 during excavation of waste soils/waste fill from AOCs #3 and 4 and construction of the caps at AOCs #1, 2, 6, and 7. The numbers of equipment and vehicles required will be proportional to the number of caps/excavations being conducted simultaneously in a given construction season.

A type of specialized vehicle may be required for the in-situ treatment of soils at AOC #5 using soil flushing and enhanced biodegradation. It was anticipated that these solutions will be "sprayed" onto the contaminated soils via tanker truck but, due to the many rail lines that criss-cross the area, a rail-based tanker may be more appropriate. A rail-based tanker may require special fabrication to accomplish the same task. Since rail tankers carrying chemical solutions are commonly used, this equipment modification will not be expected to cause a substantial implementation problem.

As previously described for Alternatives #3 through 5, the highest need for specialists in Alternative #8 is for two areas: 1) specialized legal counsel/assistance for implementation of the institutional controls and 2) consultants experienced in monitored natural attenuation of groundwater. Implementation of the institutional controls is expected to be a time-consuming process but should not pose significant implementability concerns that will prevent selection of this alternative as the final remedy. Legal specialists experienced in both CERCLA and non-CERCLA sites are available to facilitate this process. Similarly, monitored natural attenuation has been a technology employed at CERCLA sites in the last 10 years and there is a substantial number of environmental consultants with familiarity in implementing such a program. Thus, availability of consultants familiar with monitored natural attenuation should not prevent selection of this alternative as the final remedy.

Availability of Prospective Technologies. Alternative #5 will employ the use of in-situ soil washing/in-situ enhanced biodegradation for soils and in-situ chemical oxidation for groundwater at AOC #5. These are the only specialized technologies associated with Alternative #8. In addition, the infiltration wells associated with in-situ oxidation may require use of hydraulic & pneumatic fracturing during drilling and well installation if the geologic strata under the

Contaminated Soils Area are too "tight" to facilitate in-situ infiltration to the required degree. Although these technologies are not as "exotic" as many innovative technologies, they are still relatively uncommon and will require effort to identify and procure appropriate expertise, equipment and skilled personnel familiar with their design, construction and O&M. Therefore, these technologies will be the limiting factor in the overall implementability with regards to "availability" for this alternative.

### 5.4.7 Cost for Alternative #8

Total estimated capital cost associated with this alternative is $35.1 million. This estimate assumes a contingency of 20%. The present value of all O&M costs would be $55.0 million. This estimate assumes an inflation rate of 3%, an interest rate of 7%, and a contingency of 15%. The maximum duration of site remedial actions is assumed to be 30 years, in accordance with RI/FS guidance (U.S. EPA, 1988). However, in-situ activities such as soil flushing and chemical oxidation are expected to be performed in less than the 30-year time period. Total present worth costs would therefore be $90.1 million. Detailed costs for this alternative are presented in Appendix D. The costs associated with each alternative selected for detailed evaluation are summarized in Table H-1 of Appendix H.

### 5.4.8 State Acceptance for Alternative #8

Acceptance of the selected, site-wide remedial alternative by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 5.4.9 Community Acceptance for Alternative #8

Acceptance of the selected, site-wide remedial alternative by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 5.5 ALTERNATIVE #15 - "SOURCE CONTROL A"

Alternative #15 is the first of two source control remedies that maximize containment-type remedial actions (*e.g.*, caps) on soil and source AOCs (*e.g.*, landfill/waste disposal areas) while applying maximum in-situ remedies to the highest risk-ranked groundwater AOCs. This alternative, herein called "Source Control A", applies in-situ remedies to all surface water and sediment AOCs exhibiting risk.

The overview of remedial action components for Alternative #15 is presented in Table 5-11 and Appendix F. Figure 5-4 details the remedial action site plan for this alternative. Alternative #15 includes the following remedial actions by media of concern and AOC:

Soil:

- Source control remedies consisting of horizontal containment (*e.g.*, caps) will be implemented at disposal area AOCs [#1 - B&M Railroad Landfill, #2 - RSI Landfill (for groundwater source management), #6 - Asbestos Landfill] to address human health and ecological risk and/or meet ARAR requirements.
- Contaminated soil at AOC #3 (B&M Locomotive Shop Disposal Areas), AOC #4 (Old B&M Oil/Sludge Recycling Area), and AOC #7 (Asbestos Lagoons) will be excavated and relocated for ultimate disposal under one of the caps installed for AOCs #1, 2, or 6.
- Due to on-going, active use of AOC #5 (Contaminated Soils Area), in-situ treatment consisting of chemical and biological processes (*e.g.*, soil flushing, enhanced biodegradation) will be utilized along along with institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing, and security measures) and monitoring to meet preliminary remediation goals.

Groundwater:

- An in-situ remedy consisting of monitored natural attenuation, physical processes for aquifer hydraulic and pneumatic fracturing and chemical oxidation will be applied to the highest human health risk-ranked AOC (#5 - Contaminated Soils Area) and at AOC #3 (B&M Locomotive Shop Disposal Areas) where soil/waste source areas will be removed. This remedy also includes institutional actions consisting of access restrictions (institutional controls) as well as monitoring.
- In-situ remedies consisting of physical processes (*e.g.*, passive/reactive treatment walls) and biological processes (*e.g.*, enhanced biodegradation) will be applied to disposal site AOCs where contaminated groundwater can be feasibly contained (#1 - B&M Railroad Landfill, #2 - RSI Landfill, #4 - Old B&M Oil/Sludge Recycling Area, #6 - Asbestos Landfill, #7 - Asbestos Lagoons). Institutional actions consisting of access restrictions (*e.g.*, institutional controls) and monitoring are part of this remedy as well.

Surface Water and Sediment:

- In-situ remedies consisting of monitored natural attenuation will be implemented at all three AOCs showing risk (#8b - Wetland 2 Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group). No remedial actions for surface water will be necessary at all remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) since contaminant concentrations are within acceptable human health and ecological risk levels. Monitored natural attenuation is included at these two AOCs as a provision if future sediment toxicity testing results in ecological risk.

The detailed evaluation of Alternative #15 with respect to the nine FS criteria is presented in Sections 5.5.1 through 5.5.9.

### 5.5.1 Overall Protection of Human Health and the Environment for Alternative #15

Alternative #15 will provide some overall protection of human health and the environment by reducing some risks identified in the baseline risk assessment. For soil, overall protection of human health from implementation of Alternative #15 will result from the elimination of exposures to COCs in soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Asbestos Landfill, and Asbestos Lagoons, and a significant reduction in exposures to COCs in soil at the Contaminated Soils Area. In addition, the elimination of exposures to groundwater at AOCs #1 through 7 using institutional controls along with reduced COC concentrations from in-situ treatment and monitored natural attenuation will provide overall protection of human health from groundwater exposures. Identified ecological risks from exposures to soil will be significantly reduced, and exposures to surface waters will be gradually reduced. In sediment, however, only minor reductions of risk to ecological receptors will be expected. Therefore, Alternative #15 fails to meet all RAOs for the Site, as defined in Section 2.1, and only partially reduces risks to human health and the environment. The protection of human health and the environment are discussed in Sections 5.5.1.1 and 5.5.1.2, respectively.

**5.5.1.1 Human Health Protection.** Alternative #15 will provide overall protection of human health by significantly reducing or eliminating risks identified in the baseline risk assessment. Current baseline risks to human health at the Contaminated Soils Area for female site workers of child-bearing

age from exposures to lead in soil via indoor dust will be significantly reduced as a result of in-situ enhanced biodegradation, soil flushing, and access restrictions (fencing). This conclusion is based on information reported in Section 5.5.4.3 documenting a 70% to 95% reduction in soil inorganic levels by enhanced biodegradation and soil flushing. For the current female site worker of child-bearing age at the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area, baseline risks to human health from exposure to lead in soil via indoor dust will be eliminated as a result of excavation and relocation for ultimate disposal under one of the caps installed for AOCs #1, 2, or 6. Likewise for the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will be abated by excavation and/or capping, since windborne exposure to asbestos will be eliminated. However, since no contaminant removal is performed with capping, the risk will return to baseline levels if the caps are not maintained.

The potential for future risks from ingestion of COCs in groundwater at the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons will be eliminated by restrictions on the future use of groundwater from these AOCs as a drinking water source. Significant reductions in groundwater organic COC concentrations in both overburden and bedrock aquifers are expected to occur at AOCs #1 through 7 through the use of in-situ treatment. The in-situ treatments include chemical oxidation, use of treatment walls, and enhanced biodegradation. For inorganic COCs, negligible reductions are expected, with times to achieve PRGs estimated as 87 years to >200 years (see Section 5.5.5.3 and Appendix G). Reductions in groundwater COC concentrations at AOCs #1 through 7 will be contributed to by the removal of contaminated soil (at AOCs #3, 4, and 7) and the placement of caps (at AOCs #1, 2, and 6). Excavation and capping will lower groundwater COC concentrations by limiting the potential leaching of soil contaminants to groundwater. Natural degradative processes will also contribute to the lowering of groundwater COC concentrations over time. Since there will be only partial on-site containment of groundwater contamination with this alternative, risk to off-site receptors will be possible.

Additional short-term risks to workers will result from the installation of fencing and the use of in-situ remediation techniques at the Contaminated Soils Area, excavation and/or capping of AOCs #1, 2, 3,

4, 6, and 7, the placement of treatment walls at AOCs #1, 2, 4, 6, and 7, and from worker exposures during in-situ groundwater treatment and monitoring of soil and groundwater at AOCs #1 through 7. These risks will be mitigated by the use of appropriate personal protection equipment as needed. Specific long-term and short-term human health risks are discussed in Sections 5.5.3.1 and 5.5.5.1, respectively.

**5.5.1.2 Ecological Protection.** Alternative #15 will provide reductions in short-term and long-term risk to ecological receptors relative to baseline conditions for exposures to soil. Treatment of source areas will reduce long-term risk of exposure to aquatic receptors from surface water contaminants. The reduction of risk to ecological receptors in sediments is expected to be minor.

Capping the B&M Railroad Landfill and excavating the B&M Locomotive Shop Disposal Areas will prevent future potential for exposure of terrestrial mammals to metal concentrations, resulting in a significant reduction in ecological risk from exposure to soils.

Adverse impacts on aquatic receptors from exposure to inorganics in surface waters will be reduced at the Wetland 2 Group, the Richardson Pond Group, and the Content Brook Wetland Group. The removal or control of all the major source areas on-site will reduce the potential for discharge of metals in surface water runoff and gradually reduce concentration of contaminants discharged from groundwater. These mechanisms will reduce the concentration of metals contributing to risk to aquatic receptors in surface water over time. Resuspension of sediments, not treated by this alternative, still remains a potential source of metals in surface water. Impacts on benthic invertebrate populations from exposure to contaminants in sediment will not be reduced in the Wetland 2 Group, the Richardson Pond Group, and Content Brook Wetland Group since the concentrations of contaminants in the sediments in these habitats will not be substantially reduced by this alternative.

The capping of B&M Railroad Landfill, RSI Landfill, Asbestos Landfill, excavation of the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Asbestos Lagoons, and in-situ remediation of the Contaminated Soils Area will all result in temporary, minor ecological impacts during construction.

### 5.5.2 Compliance with ARARs for Alternative #15

Chemical-specific ARARs and TBCs for the Site are discussed at length in Section 2.3.1. A summary of the implications of each chemical-specific ARAR for this "Source Control A" alternative include:

- Safe Drinking Water Act and Massachusetts Drinking Water Regulations. Federal and Massachusetts MCLs are relevant and appropriate for site groundwater. This alternative sets attainment of Federal SDWA MCLs and MMCLs for inorganic and organic chemicals as groundwater remediation goals. Although levels of some organic compounds in groundwater are anticipated to be reduced within a reasonable time frame, this alternative is not anticipated to be able to attain Federal SDWA MCLs or Massachusetts Maximum Contaminant Levels for inorganic chemicals in a reasonable time frame.

- Resource Conservation and Recovery Act Maximum Concentration Limits. RCRA groundwater corrective action requirements are relevant and appropriate requirements at the point of compliance at the limit of the waste management areas. The potential for contaminants to migrate from the area will be reduced by this alternative. Monitoring will be conducted to track exposure-based limits at the point of compliance, and to verify a reduction in the migration of contaminants. Although levels of some organic compounds in groundwater are anticipated to be reduced within a reasonable time frame, this alternative is not anticipated to be able to attain Federal RCRA MCLs for inorganic chemicals in a reasonable time frame.

- Federal Water Pollution Control Act, as Amended by the Clean Water Act, Ambient Water Quality Criteria (AWQC). Freshwater acute and chronic AWQC for the protection of aquatic life are considered appropriate and relevant for the site wetlands. Leachate outbreaks and surface water runoff are controlled under this alternative, thereby reducing the probability that AWQC may be exceeded.

- Clean Air Act and Massachusetts Air Pollution Control Regulations. Dust or other potential emissions that may result from excavation of waste materials will be controlled under this alternative. There is no indication that ARARs for air will be exceeded by this alternative.

- Massachusetts Groundwater Quality Standards. Actions will be taken under this alternative in an attempt to attain applicable "Class I" enforcement standards. Although levels of some organic compounds in groundwater are anticipated to be attainable within a reasonable time frame, this alternative is not anticipated to be able to attain standards for inorganic chemicals in a reasonable time frame.

- Massachusetts Surface Water Quality Standards. As part of the Shawsheen River Basin, site surface waters are classified as "Class B" habitat for fish, aquatic life and wildlife, and source of treated public water supplies. Surface water quality standards are considered applicable to site surface waters. Leachate outbreaks and surface water runoff will be controlled under this alternative, thereby reducing the probability that surface water quality standards may be exceeded.

- Federal Criteria and Advisories To Be Considered. In addition to the ARARs listed above, there are other important issues and advisories which will require attention prior to and during remedial activities. These criteria and advisories to be considered include:
    - *Health Advisories.* Carcinogenic and non-carcinogenic risk levels due to consumption of contaminated drinking water will be exceeded.
    - *Federal Groundwater Protection Strategy of 1984.* Current, applicable "Class I" enforcement standards are not met under this alternative. Groundwater quality standards are exceeded.
    - *Threshold Limit Values (TLVs).* There is no indication that these levels will be exceeded for site remediation workers under this alternative.

Location-specific ARARs and TBCs relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2), would not be expected to be met under this alternative. Although the minor impacts to wetlands and floodplains during cap construction will be mitigated, and no surface

water discharges will occur, because the on-site wetlands will be allowed to remain in a degraded (contaminated) state, this "Source Control A" alternative will not meet the intent of Executive Order 11990. This ARAR requires federal agencies to minimize wetland degradation and to preserve and enhance the beneficial uses of wetlands. This alternative controls the source and leaves the wetlands and ecological habitats intact, but also leaves chemicals of concern in place. It will also introduce enhanced monitoring for assessing natural attenuation of surface water and sediment. Monitoring will be conducted to determine if future actions will be necessary to minimize wetland degradation and to preserve and enhance the beneficial uses of wetlands. If monitoring provides support that no further remedial actions are necessary to meet the intent of Executive Order 11990, the alternative would attain this ARAR.

Table 5-12 lists the action-specific ARARs for this "Source Control A" alternative. The alternative attains most action-specific ARARs. Notable exceptions are those related to groundwater protection and corrective action. Corrective actions must be completed within a "reasonable time period." In terms of groundwater remediation at AOC #3, monitored natural attenuation is to be implemented through increased monitoring of site groundwater. *Demonstrating that the action-specific ARAR* detailed below can be attained will require long-term monitoring and evaluation. In the event that this ARAR cannot be attained within the designated time period agreed upon for the monitored natural attenuation program, then the groundwater remedy proposed for this alternative will need to be modified by means of a Technical Impracticability (TI) Waiver and/or Explanation of Significant Difference (ESD) to the Record of Decision.

- Hazardous/Solid Waste Management - Groundwater Protection, 310 CMR 30.660 - 30.675; 310 CMR 19.110 (AOCs #1, 2, 3, 6, and 7): A groundwater monitoring program will be implemented at the Site. Corrective measures consist of monitored natural attenuation. Leachate generation from the landfill will be reduced but not eliminated. Monitoring will need to be conducted to determine attainment of this requirement.

In addition, hazardous waste management landfill stabilization/solidification (310 CMR 30.632) regulations require that all wastes disposed of in a landfill are treated to the maximum extent practicable to minimize the potential for wastes migrating from the landfill site. This alternative

includes excavation of materials from AOCs #3 and 7, and subsequent on-site disposal. Currently, the alternative does not include stabilization/solidification of these wastes. If, however, after sampling, the excavated material are shown to be a hazardous waste, further treatment may be warranted and this remedy revisited. This alternative includes sampling and analysis adequate to make this determination and, thus, attains this action-specific ARAR.

### 5.5.3 Long-Term Effectiveness and Permanence for Alternative #15

This alternative is evaluated below in terms of risk remaining at the Site after RAOs are addressed. This portion of the evaluation focuses on the extent and effectiveness of the controls required to manage the risk posed by treatment residuals and/or untreated contamination.

**5.5.3.1 Magnitude of Residual Risk: Human Health.** Alternative #15 implements controls to effectively eliminate exposure of workers to soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. For groundwater, Alternative #15 implements access restrictions to prevent human contact with COCs. In addition, the use of in-situ groundwater treatment at AOCs #1 through 7, the installation of treatment walls at AOCs #1, 2, 4, 6 and 7, and excavation and/or capping at AOCs #1, 2, 3, 4, 6, and 7 are expected to partially reduce groundwater contamination at the Site. On-site groundwater containment will be partially expected. Under this alternative, the magnitude of residual risks will depend on the enforcement and reliability of institutional controls to prevent future human exposure to COCs in groundwater as well as the efficiency of the remedial measures at removal of soil COCs, and removal/containment of groundwater COCs.

Under this alternative, exposure of female site workers of child-bearing age to lead in indoor dust from soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Contaminated Soils Area, which was estimated to result in a maternal blood level exceeding that protective of a 95$^{th}$ percentile fetal blood lead level of 10 μg/dl, will be significantly reduced (70% to 95%) by in-situ enhanced biodegradation, soil flushing, and access restrictions at the Contaminated Soils Area, and eliminated through excavation and relocation of soils under capping for the B&M

Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area. Likewise for the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will be significantly reduced by excavation and/or capping because fugitive dust generation will be prevented. Therefore, the use of capping or in-situ remediation techniques at these AOCs will effectively eliminate the estimated risk for site workers to soils, unless the caps are not maintained.

Potential future residual human health risks to a resident from ingestion of COCs in groundwater from AOCs #1 through 7 will be eliminated by the implementation of groundwater access restrictions as long as long-term enforcement of the groundwater access restrictions are maintained. Should access restrictions not be maintained, the use of in-situ chemical oxidation at the B&M Locomotive Shop Disposal Areas and Contaminated Soils Area and the use of a treatment wall at AOCs #1, 2, 4, 6, and 7 will be expected to partially reduce residual risks by reducing the levels of organic COCs (times to achieve PRGs of 1 year to >200 years; see Section 5.5.5.3 and Appendix G). However, little reduction in the levels of inorganic COCs is expected. Contaminated groundwater will be partially contained with this alternative, due to the use of treatment walls at AOCs #1, 2, 4, 6, and 7. However, groundwater risk to off-site receptors will be possible. As groundwater concentrations at AOCs #1 through 7 decline over time, there will be a partial lowering of residual risks to potential off-site receptors, and to on-site receptors should access restrictions not be maintained in the future. However, concentration reduction will be expected to occur slowly for the most significant risk drivers (87 to >200 years to achieve PRGs for arsenic and manganese; see Section 5.5.5.3 and Appendix G).

**5.5.3.2 Magnitude of Residual Risk: Ecological.** Alternative #15 will result in a quantifiable long-term reduction in risk to ecological receptors in soil and surface water, but not in sediments. The potential for exposure of small mammals to contaminants in soil will be removed at the B&M Railroad Landfill and the B&M Locomotive Shop Disposal Areas.

The removal or control of all the major source areas on the Site will reduce the potential for discharge of metals in surface water runoff and gradually reduce concentration of contaminants discharged from groundwater. In the long-term, these mechanisms will reduce the concentration of metals contributing to risk to aquatic receptors in surface water. The risk to aquatic receptors from exposure to metals in

surface water will persist until substantial decreases in contaminant discharge are achieved. Resuspension of sediments, not treated by this alternative, will still remain a potential source of metals in surface water. Therefore, residual risk to aquatic receptors will not be lowered substantially below baseline conditions for Alternative #15 in the short-term, but are expected to improve in the long-term.

Since no measures will be are taken in Alternative #15 to directly remove/reduce exposure from contaminants in sediments, the only effects on the concentration of contaminants will be dilution/dispersal through slow, natural processes and a minor reduction in the deposition of additional contamination from surface water over time. Consequently, the concentration of contaminants in sediments on the Site will not be substantially reduced under Alternative #15 and the risk to benthic invertebrates will not be reduced below baseline conditions.

### 5.5.4 Reduction of Toxicity, Mobility and Volume through Treatment for Alternative #15

Table 5-13 provides a summary of the treatment and process options selected, quantities of waste materials to be remediated, expected reductions in toxicity, mobility and volume, and residuals following treatment for Alternative #15. No human health or ecological risk was determined for soil at AOC #2 (RSI Landfill). Likewise, no risk was determined for surface water at AOC #8a (West Middlesex Canal Group) and AOC #8c (East Middlesex Canal Group). Therefore, reductions in toxicity, mobility and volume were not evaluated for these media at these AOCs. As a provision if future sediment toxicity testing results in ecological risk, actions are included in the alternative for AOCs #8a and #8c and evaluated below.

**5.5.4.1 Treatment/Recycling Processes to be Utilized.** For soil, treatment processes to be implemented under Alternative #15 include in-situ enhanced biodegradation and soil flushing. Source control, as well as excavation and on-site disposal, also will be utilized. However, these processes are not considered treatment processes. Groundwater treatment processes to be utilized include in-situ chemical oxidation with monitored natural attenuation and passive/reactive treatment walls with enhanced biodegradation. Monitored natural attenuation will be implemented at all AOCs showing risk in surface water and sediment. Monitored natural attenuation for sediment is also included at

AOCs #8a and 8c as a provision if future sediment toxicity testing results in ecological risk. A more detailed description of the treatment/recycling processes to be utilized under Alternative #15 is provided in Section 5.5. Refer to Table 5-13 for specific treatment/recycling processes to be utilized at each AOC.

**5.5.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The following amounts of hazardous materials to be treated for Alternative #15 are provided below by media of concern and AOC. Values are only given if the remedial action will provide treatment. Monitored natural attenuation is considered a treatment process in this evaluation, since it typically results in reductions in contamination over time. Source control, excavation and on-site disposal, and institutional actions are not considered treatment processes. Limited sediment sampling was conducted in the wetland areas, AOCs #8a through 8e, to determine the extent of contamination. Approximate amounts resulting from this determination are provided below.

<u>Soil</u>

| | |
|---|---|
| • AOC #5 - Contaminated Soils Area | 10,800 $yd^3$ |

<u>Groundwater (areal extent of source)</u>

| | |
|---|---|
| • AOC #1 - B&M Railroad Landfill | 12.4 acres |
| • AOC #2 - RSI Landfill | 2.5 acres |
| • AOC #3 - B&M Locomotive Shop Disposal Areas | 4.7 acres |
| • AOC #4 - Old B&M Oil/Sludge Recycling Area | 7.0 acres |
| • AOC #5 - Contaminated Soils Area | 6.7 acres |
| • AOC #6 - Asbestos Landfill | 13.3 acres |
| • AOC #7 - Asbestos Lagoons | 1.9 acres |

<u>Sediment</u>

| | |
|---|---|
| • AOC #8a - West Middlesex Canal Group | all contaminated sediments |
| • AOC #8b - Wetland Group 2 | all contaminated sediments |
| • AOC #8c - East Middlesex Canal Group | all contaminated sediments |
| • AOC #8d - Richardson Pond Group | all contaminated sediments |
| • AOC #8e - Content Brook Wetland Group | all contaminated sediments |

<u>Surface Water</u>

| | |
|---|---|
| • AOC #8b - Wetland Group 2 | 7.6 acres |
| • AOC #8d - Richardson Pond Group | 107 acres |
| • AOC #8e - Content Brook Wetland Group | 1.4 acres |

**5.5.4.3 Degree of Expected Reductions in Toxicity, Mobility and Volume.** The degree of treatment and expected reductions for each treatment process under Alternative #15 are provided below by media of concern and AOC. Reductions expected from source control and excavation and on-site disposal are not discussed, since these processes are not considered treatment. Reductions from monitored natural attenuation are provided for the U.S. EPA default time period, 30 years. For surface water and sediment, reductions are provided in general terms. Intensive transport modeling required to provide quantifiable reductions is beyond the scope of this FS. Only limited case studies, which can not provide a comprehensive, quantitative estimate, are available in technical literature.

All of the contaminated soil at AOC #5 will be treated under Alternative #15. The following reductions in toxicity, mobility and volume are expected for soil:

Toxicity

- In-situ enhanced biodegradation and soil flushing is expected to reduce the toxicity of the contaminated soil relative to a specific contaminant proportional to the volume reduction of that specific contaminant at AOC #5. However, some of the contaminants will be transferred to groundwater through this process. Groundwater treatment processes will then be utilized to remove these contaminants.

Mobility

- Inorganic COCs are expected to exhibit a mobility increase at AOC #5 through the in-situ enhanced biodegradation and soil flushing process. Flushing desorbs inorganic contaminants from soil and releases them to groundwater. Groundwater treatment processes will then be utilized to remove these contaminants.

Volume

- At AOC #5, the volume of the contaminated media will not be reduced by the in-situ enhanced biodegradation and soil flushing process. Enhanced biodegradation may be expected to reduce organic COCs in volume by 92% to 100% (U.S. EPA, 1998c). There will be no expected reduction of inorganic COCs. However, approximately 70% to 95% (U.S. EPA, 1990) of inorganics are expected to be transferred to groundwater through soil flushing. Groundwater treatment processes will then be utilized to remove these contaminants.

Passive/reactive treatment walls are expected to treat near 100% of the overburden groundwater at AOCs #1, 2, 4, 6, and 7. The degree of treatment of in-situ enhanced biodegradation, to be implemented to treat bedrock groundwater at the same AOCs, will be dependent on the density of the injection network. The amount of contaminated groundwater to be treated at AOC #3 and 5 through

in-situ chemical oxidation will likewise be dependent on the density of the injection network. Reductions in toxicity, mobility and volume expected for groundwater are provided below. There are no organics above PRGs at AOC #4. Therefore, the passive/reactive treatment wall implemented at AOC #4 will consist of only one medium for the treatment of inorganics.

Toxicity

- Passive/reactive treatment walls and in-situ enhanced biodegradation are expected to reduce the toxicity of the contaminated groundwater relative to a specific contaminant proportional to the volume reduction of that specific contaminant at AOCs #1, 2, 4, 6, and 7.
- At AOCs #3 and 5, the toxicity of the contaminated groundwater relative to a specific contaminant will be reduced proportional to the volume reduction of that specific contaminant through the in-situ chemical oxidation process.

Mobility

- At AOCs #1, 2, 4, 6, and 7, passive/reactive treatment walls will reduce the mobility of overburden contaminants by near 100%. In-situ enhanced biodegradation will not provide a reduction in mobility of bedrock contaminants.
- In-situ chemical oxidation and monitored natural attenuation will not provide reductions in the mobility of contaminants at AOCs #3 and 5.

Volume

- Expected volume reductions for passive/reactive treatment walls presented below represent the upper bound limits upon completion of the groundwater remedy. Lesser values will result during the interim period prior to this endpoint.
- Passive/reactive treatment walls are expected to reduce the volume of organic COCs by 94% to 99% (Bryda and Morris, 1997) and inorganic COCs by 87% to 99% (U.S. EPA, 1999) in the overburden groundwater at AOCs #1, 2, 6, and 7. Inorganic COCs at AOC #4 are expected to exhibit an equivalent volume reduction as stated above in the overburden groundwater.
- In-situ enhanced biodegradation will be expected to reduce organic COCs in the bedrock groundwater by 87% to 93% (Grindstaff, 1998) at AOCs #1, 2, 6, and 7.
- The volume of organic COCs at AOCs #3 and 5 is expected to be reduced by approximately 94% to 99% (U.S. EPA, 1998e, Bryant et al, 1998) by in-situ chemical oxidation. Inorganics at AOCs #3 and 5 will be reduced by 16% and less than 15%, respectively, through natural flushing processes, as determined through MODFLOW modeling (Appendix G).

Monitored natural attenuation will be expected to treat the total quantity of contaminated surface water and sediment at AOCs #8b, 8d, and 8e, as well as all of the sediment at AOCs #8a and 8c. In both surface water and sediment, the toxicity of the contaminated media relative to a specific contaminant

will be reduced proportional to the volume reduction of that specific contaminant. The mobility of the contaminants and the volume of the contaminated media will not be reduced through monitored natural attenuation. The volume of both organic and inorganic COCs is expected to be reduced over time in surface water and sediment.

**5.5.4.4 Reversibility.** The reversibility of each treatment process to be implemented under Alternative #15 is discussed below by media of concern and AOC. Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. Since source control, excavation and on-site disposal, and institutional actions are not considered treatment processes, reversibility of treatment is not applicable to these processes.

In-situ enhanced biodegradation and soil flushing processes to be implemented at AOC #5 is not considered reversible. Organic compounds are degraded by microbes through the enhanced biodegradation process. Soil flushing removes inorganic contaminants from the soil by transferring them to groundwater.

In groundwater, passive/reactive treatment walls, to be implemented at AOCs #1, 2, 4, 6, and 7, typically degrade volatile organics and immobilize inorganics, dependent on the treatment media. Degradation structurally alters contaminants, a process that is not considered to be reversible. Inorganics are immobilized through sorption to the treatment media and are not readily released. In bedrock groundwater at the above mentioned AOCs, in-situ enhanced biodegradation will also utilize degradation and therefore is not considered reversible.

In-situ chemical oxidation, to be implemented at AOCs #3 and 5, is not considered a reversible process. Contaminants are oxidized and thereby physically altered. Monitored natural attenuation, to be utilized in addition to chemical oxidation, is not considered reversible. Organic contaminants are degraded over time. Inorganic contaminants, on the other hand, may only be temporarily immobilized and later released.

Monitored natural attenuation of surface water and sediment is not considered a reversible process as contaminants are degraded and eliminated over time.

**5.5.4.5 Type and Quantity of Residuals.** The types and quantities of contaminant residuals by media of concern and AOC expected after completion of the treatment technologies/process options implemented in Alternative #15 are summarized below. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are provided in Table 5-13. Residuals for all groundwater treatments, except monitored natural attenuation, are provided in terms of remaining contaminants upon completion of the groundwater remedy. Greater amounts than the values provided below will be expected during the interim period prior to this endpoint.

Following treatment by in-situ enhanced biodegradation and soil flushing, approximately 5% to 30% of the inorganic COCs and up to 8% of the organic COCS will remain in the soil at AOCs #5. All of the contaminated soils at AOCs #1 and 6, and the soils to be excavated from AOC #3, 4, and 7, will remain untreated but contained under a protective cap.

An estimated 1% to 6% of organic COCs and 1% to 13% of inorganic COCs will remain in the overburden groundwater at AOCs #1, 2, 6, and 7 upon completion of the groundwater remedy. Greater amounts than these values provided for passive/reactive treatment walls will be expected during the interim period prior to this endpoint. The overburden groundwater AOC #4 is expected to contain 1% to 13% of the original inorganic COCs. In bedrock groundwater at AOCs #1, 2, 6, and 7, approximately 7% to 13% of organic COCs will remain after treatment by in-situ enhanced biodegradation.

Approximately 1% to 6% of organic COCs remain in the groundwater at AOCs #3 and 5 after in-situ chemical oxidation treatment. The inorganics remaining after 30 years of natural flushing processes are greater than 85% at AOC #5 and 84% at AOC #3.

Contaminant residuals in surface water and sediment following treatment by monitored natural attenuation were not determined due to the lack of a comprehensive, quantitative reduction estimate.

### 5.5.5 Short-Term Effectiveness for Alternative #15

This alternative is evaluated for effectiveness in protecting the community and local workers, site remediation workers, and the environment during the construction and implementation of the remedy.

**5.5.5.1 Protection of Community and Workers During Remedial Actions.** The construction and remediation measures proposed under this alternative include implementation of access restrictions (fencing) and in-situ remediation of soil at the Contaminated Soils Area, excavation and placement of soils from the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Asbestos Lagoons beneath a cap, capping of the B&M Railroad Landfill, RSI Landfill, and Asbestos Landfill, and in-situ groundwater treatment and monitoring of soil and groundwater at AOCs #1 through 7.

The implementation of these construction/remedial measures will potentially result in additional short-term risk to the community from exposure to soil contaminants associated with dust generation during soil disturbances at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. Precautions will be implemented to prevent or limit fugitive dust generation during excavation/remedial activities. Worker exposure to COCs in soil and groundwater during installation of fencing, in-situ treatment, excavation/capping, and monitoring will also result in potential health risk to workers. Use of personal protection equipment will be employed to reduce exposure if applicable OSHA standards are exceeded during these activities.

**5.5.5.2 Environmental Impacts.** The capping of B&M Railroad Landfill, RSI Landfill, Asbestos Landfill, excavation of B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area, and in-situ remediation of the Contaminated Soils Area will all require removal of vegetation. Injection wells and attendant facilities will be installed at the Old B&M Oil/Sludge Recycling Area. Passive/reactive treatment walls will also be constructed between the edge of the landfill and the wetlands at B&M Railroad Landfill, RSI Landfill, the Asbestos Landfill and Asbestos Lagoons. Wetlands are located around the border of a portion of most of these areas, with the exception of the

Asbestos Lagoons. The extent of excavation or fill in wetland is estimated to be minimal for each alternative. Mitigation measures will include avoidance and minimization of temporary construction disturbance in adjacent wetlands during construction of landfill caps or treatment walls. Tree removal will be minimized, and proper construction and erosion control methods will be utilized. Mitigation will include restoration of upland habitat, and minimization of wetland impacts. Any unavoidable wetland loss will be mitigated by restoration or creation of on-site wetlands. Changes in hydrology resulting from construction of landfill caps and treatment walls will be mitigated by properly designed stormwater retention systems and maintenance of flows of water close to existing conditions. Potential alterations in the hydrology and seasonal water levels in the adjacent wetlands will be minimized. Pumping rates and re-injection rates of water to wells will be implemented that are predicted via modeling to have minimal effects on water elevations in wetlands.

The alternative will include installation of monitoring wells throughout the Site, construction of fencing around the Contaminated Soils Area, and construction of other technologies at that AOC. Installation of fencing will cause minor removal of vegetation adjacent to wetland boundaries but impacts are considered to be temporary and insignificant. Mitigation measures will include avoidance and minimization of temporary construction disturbance in wetlands during construction of fencing and of monitoring wells, and minimization of tree removal. Proper construction and erosion control methods will be utilized to minimize ecological impact to surrounding habitats.

*The excavation of soil adjacent to the unnamed brook in B&M Locomotive Shop Disposal Area A* may potentially cause disturbance to the stream bank. Mitigation measures will include avoidance and minimization of temporary construction disturbance in the stream channel and returning impacted areas to previous grades. Any unavoidable wetland loss from excavation will be mitigated by restoration or creation of on-site wetlands.

**5.5.5.3 Time Until Remedial Action Objectives are Achieved.** Of the RAOs presented in Section 2, those for groundwater will take the longest to achieve. Through the use of groundwater flow modeling and contaminant retardation concepts (Appendix G), approximate times to achieve PRGs were calculated for the Site contaminants at each AOC. It should be noted that the mobility of inorganics is

highly sensitive to site specific geochemistry. Other factors such as pH, dissolution, and colloidal transport could have significant impacts on mobility of inorganics. Therefore, these times should only be used for relative comparison and not for accurate representations of cleanup times.

Alternative #15 includes monitored natural attenuation as a groundwater treatment process at AOCs #3 and 5. Additionally, in-situ chemical oxidation will be used at these two AOCs. This is expected to lower the times for reduction of organics at these AOCs significantly. However, injection of oxidant solution may also change the Site hydrology such that contaminants will not disperse as fast at other AOCs.

An in-situ groundwater remedy consisting of passive/reactive treatment walls and enhanced biodegredation will also be applied to AOCs #1, 2, 4, 6, and 7. Furthermore, site hydrology may be impacted by caps placed on AOCs #1, 2, and 6. The treatment walls are designed to be right on the edge of the disposal areas, so the distance for contaminant migration/treatment is typically less than previous alternatives which did not have the walls. For those alternatives, nearby wetlands were typical discharge points selected for time calculations.

Modeling was performed to predict the reduction of contaminant concentrations over time due to natural processes, such as dispersion. However, additional contaminant reduction is expected to occur due to biodegradation. This aspect of monitored natural attenuation was evaluated using the BIOSCREEN natural attenuation decision support system (Appendix G). While improved cleanup times were estimated for a few compounds at the Site, these times were similar to those without biodegradation. Approximate cleanup times, assuming no biodegradation, for each AOC with contaminants above PRGs are presented below:

| Overburden | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | 55 | ND | >200 | >200 |
| AOC #2 - RSI Landfill | 50 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas* | 8 | ND | ND | 183 |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | 87 |
| AOC #5 - Contaminated Soils Area* | 33 | 153 | >200 | >200 |
| AOC #6 - Asbestos Landfill | 20 | ND | ND | >200 |

| | | | | |
|---|---|---|---|---|
| AOC #7 - Asbestos Lagoons | 18 | 153 | ND | >200 |

| Bedrock | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | 104 | 75 | ND | 146 |
| AOC #2 - RSI Landfill | 15 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | ND | ND | ND | ND |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | 180 |
| AOC #5 - Contaminated Soils Area* | 107 | 128 | ND | >200 |
| AOC #6 - Asbestos Landfill | 8 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 51 | >200 | ND | >200 |

Notes: ND = Not detected at a concentration greater than PRGs at this AOC and flow zone
* - Times for organics are expected to be greatly reduced due to in-situ chemical oxidation

Some cleanup times reported above are high (i.e., greater than 200 years). This simply means that the compounds are essentially immobile. For example, arsenic and thallium have very high retardation coefficients and, ultimately, high cleanup times.

It should also be noted that the only SVOC detected above PRGs at all AOCs was bis(2-ethylhexyl)phthalate and the only pesticide was aldrin. The high retardation factors of these compounds increase the time of travel and source contaminant reduction. Evaluations assumed that the Contaminated Soils Area contained contaminants similar to the B&M Railroad Landfill, RSI Landfill, and the Asbestos Lagoons. The two compounds noted above are therefore assumed to be found at this AOC above PRGs. However, further evaluation may determine that this is not the case. Furthermore, the evaluations assumed that the maximum detections from the three nearby AOCs were also detected at the Contaminated Soils Area. Similarly, data from the RSI Landfill was used to characterize the Asbestos Landfill.

### 5.5.6 Implementability for Alternative #15

This section summarizes the technical and administrative feasibility of implementing Alternative #15, the "Source Control A" alternative, and the availability of various services and materials required for its implementation.

**5.5.6.1 Technical Feasibility.** Evaluation of the technical feasibility of Alternative #15 includes an assessment of three factors described in EPA's feasibility study guidance: 1) the ability to construct and operate the technologies, 2) the reliability of the technologies and 3) the ease of undertaking additional remedial actions, if necessary. These aspects are described in detail below:

Ability to Construct and Operate the Technologies. For Alternative #15, similar to Alternative #8, the major implementability issue with regard to technical feasibility is the construction of landfill caps at AOCs #1, 2, and 6 and the excavation and removal of waste soil/waste fill from AOCs #3 , 4, and 7 with relocation and regrading of these materials below one of the caps constructed at AOCs #1 or 2, and AOC #6, respectively.

As discussed previously for Alternative #8, the capping and excavation remedies for Alternative #15 at AOCs #1, 2, 3, 4, 6, and 7 will require a substantial civil engineering/earthwork component. The key implementability issue will be the location of sensitive wetland areas or water bodies adjacent to every one of these AOCs. This will require comprehensive soil erosion, runoff and sedimentation control measures to minimize siltation impacts to wetland areas or water bodies. In addition, proper location and construction of temporary and permanent haul roads will be required to minimize impacts to wetland areas and water bodies. It is expected that the remediation contractor(s) will utilize the existing rail network to move equipment and materials to the largest degree possible. This rail network will be closely situated to five of the six "earthwork" AOCs (*i.e.*, #1, 2, 3, 4, and 6). While the scope of the earthwork and transportation required for the capping and excavation activities is large, these are common problems faced and solved by experienced engineers and constructors. Maintenance of the capped and excavated areas will be straightforward requiring only periodic inspections, vegetation control (*e.g.*, mowing) and filling of areas of settlement. As a result, no implementability constraints will be expected with regard to construction and operation of the soil remedy for AOCs #1, 2, 3, 4, 6, and 7 in Alternative #15.

The primary implementability concern for soil treatment at AOC #5 using in-situ soil flushing and in-situ enhanced biodegradation will be the limitation of conducting work within the Contaminated Soils Area while maintaining active use of the rail yard, rail spurs and roads that transect it. As previously discussed for Alternatives #5 through 8, Alternative #15 will require implementability measures such as temporary use restrictions for tracks or roadways next to active soil remediation areas and temporary relocation of tracks and bedding material, if necessary. Implementing this remedy at AOC #5 will require close cooperation between rail yard users and the contractor and involve temporary disruptions to the rail yard. These are straightforward issues commonly faced and solved as part of construction efforts and will not be sufficient to prevent consideration of this alternative as the selected remedy.

The primary implementability issues for construction of the of the groundwater remedies (*i.e.*, in-situ passive/reactive treatment walls, in-situ enhanced biodegradation) at AOCs #1, 2, 4, 6, and 7 are: 1) the close proximity of sensitive wetland or surface water areas and 2) the need to coordinate with soil "earthwork" remedies (*e.g.*, landfill caps, waste soils/waste fill excavations).

Installation of groundwater remedies will require both deep and shallow trenching and drilling of vertical injection wells adjacent to wetlands or surface water bodies at AOCs #1, 2, 6, and 7. Comprehensive soil erosion, run-off and sedimentation controls will be required to minimize siltation impacts to wetlands and surface water bodies. The proposed locations of groundwater remedies also coincide closely with the limits of horizontal caps or waste soil/waste fill excavations at AOCs #1, 2, 3, 4, 6, and 7. Although it will be a challenge to implement/construct this portion of the groundwater remedy, close cooperation amongst the remediation engineers and contractor(s) should bring about successful construction at these tight junctures. Ensuring appropriate erosion control and proper construction phasing and coordination are aspects commonly faced and solved by experienced engineers and constructors. For these AOCs, operation & maintenance concerns for groundwater will be less of an issue than constructability concerns. Periodic replacement of spent treatment media will be a required O&M activity for the passive/reactive treatment walls. The in-situ enhanced biodegradation mixing plant and distribution system (*e.g.*, pipelines and vertical injection wells) will require necessary, but typical, O&M activities appropriate to these types of groundwater treatment facilities. As a result, no implementability constraints are expected with regard to construction and operation of the groundwater remedy for AOCs #1, 2, 4, 6, and 7 in Alternative #15.

The primary implementability concerns for groundwater treatment at AOCs #3 and 5 using in-situ chemical oxidation is the limitation of conducting work within the Contaminated Soils Area while maintaining active use of the rail yard as discussed previously. Implementability measures such as: temporary structural supports for tracks near the work zone, temporary use restrictions for tracks or roadways next to active work areas and temporary relocation of tracks and bedding material may be necessary for both construction and maintenance of the pipelines and vertical injection wells conveying the oxidant solutions. As before, implementing this remedy at AOC #5 will require close cooperation between rail yard users and the remediation contractor. Alternative #15 further incorporates the use of monitored natural attenuation as a method to remediate any residual contaminated groundwater not addressed by in-situ oxidation at AOCs #3 and 5. As discussed previously for Alternatives #5 through 8, construction of this technology only requires installation of groundwater monitoring wells and "operation" only requires monitoring efforts to sample and analyze the groundwater.

There will be no implementability concerns with respect to construction or operation of monitored natural attenuation for contaminated sediments at AOCs #8a through 8e and surface water at AOCs #8b, 8d, and 8e. No structures will be required for construction and operation only requires periodic field testing, sampling and analysis.

Reliability of the Technologies. Reliability of the horizontal caps installed for AOCs #1, 2, and 6 will be considered high if normal periodic maintenance of the cap is conducted. The high reliability will also apply to the excavation and removal of waste soils/waste fill from AOCs #3, 4, and 7 with relocation and regrading of these materials below one of the caps constructed at AOCs #1, 2, or 6.

For in-situ soil flushing and in-situ enhanced biodegradation of soils at AOC #5, the reliability of these technologies, discussed previously for Alternative #8, is expected to be proportional to the

reliability of the treatment delivery systems. These delivery systems will convey soil flushing solutions, bio-nutrients or chemical oxidation solutions from a central "mixing plant" via pipelines and/or tanker vehicles to the groundwater or contaminated soils. The reliability of these delivery systems will be similar to the reliability of industrial process/or wastewater treatment plants. Some portion of both planned and unplanned downtime is expected in these systems for equipment repair/replacement. As long as the facilities are designed, constructed and operated in a manner appropriate to accommodate periodic shutdowns, reliability concerns should not prove sufficient to prevent selection of this alternative as the final remedy.

The reliability of passive/reactive treatment walls for AOCs #1, 2, 4, 6, and 7 will be relatively high as will be expected for an in-situ technology. This assessment is dependent on conducting periodic monitoring of the adsorbent media to determine if contaminant "breakthrough" has occurred and timely replacement of spent adsorbent media within the treatment wall gates. The only other significant reliability concern will be long-term clogging or fouling of the treatment wall french drains and gates which will limit the effectiveness of the technology. The potential for clogging could be monitored by periodic water level measurements of piezometers associated with the treatment wall.

For in-situ oxidation of groundwater at AOCs #3 and 5 under Alternative #15, the reliability of this technology is expected to be proportional to the reliability of the treatment delivery systems that convey chemical oxidation solutions from a central "mixing plant" via pipelines and/or tanker vehicles to contaminated groundwater. As discussed earlier for soils, as long as the facilities are designed, constructed and operated in a manner appropriate to accommodate periodic shutdowns, reliability concerns should not prove sufficient to prevent selection of this alternative as the final remedy. As stated previously under Alternative #5, the reliability of monitored natural attenuation to remediate any residual contaminated groundwater at AOCs #3 and 5 should be considered "high" since there is no external equipment nor treatment systems that could breakdown. The reliability of the technology to meet PRGs, however, should not be confused with "implementability" but is more appropriately discussed under "effectiveness". The reader is directed to the "treatment efficiency" and the "time required to remediate" discussions in Sections 5.5.4, 5.5.5 and Appendix G.

The remaining technologies for Alternative #15 include fencing and security measures at AOC #5 and monitoring. The reliability of these technologies will be the same as described in Alternatives #3 through 8. Fencing, if properly maintained, is effective in preventing site access to the general public and workers, although much less effective in mitigating access to determined trespassers. Although the institutional controls which will be applied to AOCs #1 through 7 are not exactly technologies, their reliability will depend upon enforcement by the responsible agencies involved.

Ease of Undertaking Additional Remedial Actions. Applying additional remedial actions for contaminated soils contained by the horizontal caps installed at AOCs #1, 2 and 6 will be severely restricted since installation of the caps are largely "irreversible" remediation technologies. This conclusion will also apply to the excavation and removal of waste soils/waste

fill from AOCs #3, 4, and 7 with relocation and regrading of these materials below one of the caps constructed at AOCs #1, 2, or 6.

Applying additional remedial actions for contaminated soils treated by in-situ soil flushing/enhanced biodegradation at AOC #5 will be reasonably implementable if the in-situ technologies weren't adequate to meet PRGs. This conclusion will also apply to treatment of contaminated groundwater using in-situ chemical oxidation.

Additional remedial actions could be accommodated to a limited degree in place of passive/reactive treatment walls and in-situ enhanced biodegradation of groundwater at AOCs #1, 2, 4, 6, and 7. The passive/reactive treatment walls are permanently installed but alternate types of adsorbent media could be installed within the treatment wall gates. In addition, an alternate reactant solution could be used in-place of the bio-nutrient solution injected into the groundwater for in-situ enhanced biodegradation. Installation of an on-site groundwater pump and treat remedy will require major modifications to implement, especially if located adjacent to the AOC boundary. The passive/reactive treatment walls and gates will have to be blocked or grouted tight to prevent groundwater short-circuiting of the extraction well system. Additional groundwater remedies will be best implemented downgradient from the existing treatment structures at AOCs #1, 2, 4, 6, and 7.

Additional remedial actions could be accommodated in place of in-situ chemical oxidation and monitored natural attenuation of groundwater at AOCs #3 and 5. The only implementability limitation is that the new groundwater remediation technologies will need to accommodate the active, working area of the Contaminated Soils Area rail yard.

Additional remedial actions could be accommodated in place of monitored natural attenuation of sediments at AOCs #8a through 8e and surface water at AOCs #8b, 8d, and 8e without any implementability concerns.

**5.5.6.2 Administrative Feasibility.** Evaluation of the administrative feasibility of Alternative #15 involves assessing the steps required to coordinate with other federal, state and local governmental entities. It should be noted that under Superfund, permits are not required for remediation activities, but compliance with substantive requirements is required.

The principal administrative feasibility issue with regard to Alternative #15, described previously for Alternatives #3 through 8, involves implementation of institutional controls in order to prohibit subsurface disturbance and the use of groundwater. If proprietary controls are used, coordination with the individual property owners of the affected parcels, will be required. For example, implementation of a negative easement would require the property owner to convey to a third party (typically EPA) the

right to limit how the landowner can use his or her property. Here the limitations would likely include prohibitions against subsurface digging and the use of groundwater from wells on the property.

If governmental controls are used, coordination with federal, state and local government (the ATSDR, the Commonwealth of Massachusetts and/or the Town of Billerica) will be required. For example, implementation of land use restrictions may require the exercise of zoning authority by the Town of Billerica to prohibit residential development in a contaminated area, or the adoption of a building permit ordinance in the Town of Billerica requiring anyone seeking a building permit for construction activities in a particular area to be notified of contamination in the area and of any relevant management standards - such an ordinance could also be used to prohibit types of construction that would result in unacceptable exposures (e.g., excavation in areas where subsurface contamination has not been fully removed). Implementation of groundwater use restrictions may require action by the Commonwealth of Massachusetts to prohibit or limit certain uses of groundwater in particular areas, or require closing or capping of wells. Implementation of advisories may also require action by the ATSDR or Commonwealth of Massachusetts to publically issue warnings that provide notice to potential users of land, surface water or groundwater of some existing or impending risk associated with their use.

An additional administrative issue will be to reach agreement between federal, state and local governmental entities on the specifics of implementing the monitored natural attenuation program. Under Alternative #15, this program will address groundwater at AOCs #3 and 5 and sediments at AOCs #8a through 8e and surface water at AOCs #8b, 8d, and 8e. Concurrence among the various agencies will be required in defining the program (*e.g.*, number and type of monitoring locations, analytical/test parameters, frequency of testing, etc.) as well as interpretation of results and conclusions regarding the overall success of monitored natural attenuation.

**5.5.6.3 Availability of Services and Materials.** Evaluation of the availability of services and materials for Alternative #15 includes an assessment of three factors in accordance with EPA's feasibility study guidance: 1) the availability of treatment, storage capacity and disposal services, 2) the

availability of necessary equipment and specialists, and 3) the availability of prospective technologies. These aspects are described in detail below:

Availability of TSDF Services. Since no remedial actions requiring off-site transport, storage or disposal are to be implemented as part of Alternative #15, the "Source Control A" alternative, there are no implementability constraints with regard to this issue for selection of this alternative.

Availability of Necessary Equipment and Specialists. A substantial quantity of heavy, earthmoving equipment as well as transport vehicles (both truck and rail variety) will be required for Alternative #15 during excavation of waste soils/waste fill from AOCs #3, 4, and 7 and construction of the caps at AOCs #1, 2, and 6. The numbers of equipment and vehicles required will be proportional to the number of caps/excavations being conducted simultaneously in a given construction season.

As discussed previously for Alternative #8, a type of specialized vehicle may be required for the in-situ treatment of soils at AOC #5 using soil flushing and enhanced biodegradation. It was anticipated that these solutions will be "sprayed" onto the contaminated soils via tanker truck but, due to the many rail lines that criss-cross the area, a rail-based tanker may be more appropriate. A rail-based tanker may require special fabrication to accomplish the same task. Since rail tankers carrying chemical solutions are commonly used, this equipment modification will not be expected to cause a substantial implementation problem.

The highest need for specialists in Alternative #15 will be for three areas: 1) specialized legal counsel/assistance for implementation of the institutional controls, 2) consultants experienced in monitored natural attenuation of groundwater, surface water and sediment, and 3) engineers and contractors familiar with both civil sitework excavation and asbestos abatement . Implementation of the institutional controls is expected to be a time-consuming process but should not pose significant implementability concerns that will prevent selection of this alternative as the final remedy. Legal specialists experienced in both CERCLA and non-CERCLA sites are available to facilitate this process. Similarly, monitored natural attenuation has been a technology employed at CERCLA sites in the last 10 years and there is a substantial number of environmental consultants with familiarity in implementing such a program. Thus, availability of consultants familiar with monitored natural attenuation should not prevent selection of this alternative as the final remedy. Engineers and contractors familiar with both civil excavation/waste removal and asbestos abatement will be required for waste soil/waste fill removal from the Asbestos Lagoons with transfer to the Asbestos Landfill. An appropriate remediation team with experienced contractors of both types could be reasonably assembled to address this concern.

Availability of Prospective Technologies. Alternative #15 will employ the use of in-situ soil washing/in-situ enhanced biodegradation for soils at AOC #5 and in-situ chemical oxidation for groundwater at AOCs #3 and 5. In addition, passive/reactive treatment walls to control contaminated groundwater will be installed at AOCs #1, 2, 4, 6, and 7. These are the only specialized technologies associated with Alternative #15. Although these technologies are not as

"exotic" as many innovative technologies, they are still relatively uncommon and will require effort to identify and procure appropriate expertise, equipment and skilled personnel familiar with their design, construction and O&M. Therefore, these technologies will be the limiting factor in the overall implementability with regard to "availability" for this alternative.

### 5.5.7 Cost for Alternative #15

Total estimated capital cost associated with this alternative is $85.9 million. This estimate assumes a contingency of 20%. The present value of all O&M costs would be $106.1 million. This estimate assumes an inflation rate of 3%, an interest rate of 7%, and a contingency of 15%. The maximum duration of site remedial actions is assumed to be 30 years, in accordance with RI/FS guidance (U.S. EPA, 1988). However, in-situ activities such as soil flushing and chemical oxidation are expected to be performed in less than the 30-year time period. Total present worth costs would therefore be $192.1 million. Detailed costs for this alternative are presented in Appendix D. The costs associated with each alternative selected for detailed evaluation are summarized in Table H-1 of Appendix H.

An analysis was performed to determine the cost savings associated with combining similar treatment processes used at different AOCs. The cost savings associated with the combination of treatment plants for in-situ enhanced biodegredation (groundwater) and for in-situ chemical oxidation (groundwater) will be approximately $14.3 million. This reduces the alternative's total costs to $177.8 million. This analysis is presented in Appendix H.

### 5.5.8 State Acceptance for Alternative #15

Acceptance of the selected, site-wide remedial alternative by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 5.5.9 Community Acceptance for Alternative #15

Acceptance of the selected, site-wide remedial alternative by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 5.6 ALTERNATIVE #18 - "SOURCE CONTROL B"

Alternative #18 is the second source control remedy that maximizes containment-type remedial actions (*e.g.*, caps) on surface soil and source AOCs (*e.g.*, landfill/waste disposal areas), while applying in-situ remedies to groundwater and institutional actions to surface water and sediment.

The overview of remedial action components for Alternative #18 is presented in Table 5-14 and Appendix F. Figure 5-5 details the remedial action site plan for this alternative. Alternative #18 includes the following remedial actions by medium of concern and AOC:

Soil:

- Source control remedies consisting of horizontal containment (*e.g.*, caps) will be implemented at all disposal area AOCs [#1 - B&M Railroad Landfill, #2 - RSI Landfill (for groundwater source management), #5 - Contaminated Soils Area, #6 - Asbestos Landfill, #7 - Asbestos Lagoons] to address human health and ecological risk and/or meet ARAR requirements.
- Contaminated soil at AOC #3 (B&M Locomotive Shop Disposal Areas) and AOC #4 (Old B&M Oil/Sludge Recycling Area) will be excavated and relocated for ultimate disposal under one of the caps installed for AOCs #1, 2, 6, or 7. This remedy also includes institutional actions for monitoring to confirm appropriate source cleanup.

Groundwater:

- In-situ remedies consisting of monitored natural attenuation as well as institutional actions consisting of access restrictions (*e.g.*, institutional controls) and monitoring will be implemented at AOCs #1 through 7.

Surface Water and Sediment:

- Monitoring will be implemented at all three AOCs showing risk (#8b - Wetland 2 Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group). No remedial actions for surface water will be necessary at all remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) since contaminant concentrations are within acceptable human health and ecological risk levels. Sediment monitoring is included at these two AOCs as a provision if future toxicity testing results in ecological risk.

The detailed evaluation of Alternative #18 with respect to the nine FS criteria is presented in Sections 5.6.1 through 5.6.9.

### 5.6.1 Overall Protection of Human Health and the Environment for Alternative #18

Alternative #18 will provide some overall protection of human health and the environment by reducing some risks identified in the baseline risk assessment. For soil, overall protection of human health from implementation of Alternative #18 will result from the elimination of exposures to COCs in soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill and Asbestos Lagoons. In addition, the elimination of exposures to groundwater at AOCs #1 through 7 using institutional controls and monitored natural attenuation will provide overall protection of human health from groundwater exposures. Identified ecological risks from exposures to soil will be significantly reduced, and exposures to surface water will be gradually reduced. In sediment, however, only minor reductions of risk to ecological receptors will be expected. Therefore, Alternative #18 fails to meet all RAOs for the Site, as defined in Section 2.1, and only partially reduces risks to human health and the environment. The protection of human health and the environment are discussed in Sections 5.6.1.1 and 5.6.1.2, respectively.

**5.6.1.1 Human Health Protection.** Alternative #18 will provide overall protection of human health by eliminating risks identified in the baseline risk assessment. Current baseline risks to human health at the Contaminated Soils Area for female site workers of child-bearing age from exposure to lead in soil via indoor dust will be eliminated as a result of capping since windborne exposures to lead will be eliminated. For the current female site worker of child-bearing age at the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area, baseline risks to human health from exposure to lead in soil via indoor dust will be eliminated as a result of excavation and relocation for ultimate disposal under one of the caps installed for AOCs #1, 2, 6, or 7. For the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will be abated by capping, since windborne exposure to asbestos will be eliminated. However, since no contaminant removal will be performed with capping, the risk will return to baseline levels if the caps are not maintained.

The potential for future risks from ingestion of COCs in groundwater at the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area,

Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons will be eliminated by restrictions on the future use of groundwater from these AOCs as a drinking water source. Since there will be no on-site containment of groundwater contamination with this alternative, risk to off-site receptors will be possible. Reductions in groundwater COC concentrations are expected to occur over time at AOCs #1 through 7 due to the removal of contaminated soil (at AOCs #3 and 4) and placement of caps (at AOCs #1, 2, 5, 6, and 7). Excavation and capping will lower groundwater COC concentrations by limiting the potential leaching of soil contaminants to groundwater. Natural degradative processes are also expected to result in a lowering of groundwater COC concentrations over time. However, since the most significant risk drivers are inorganics (arsenic and manganese), attenuation that occurs naturally is likely to occur slowly (195 to >200 years to achieve PRGs; see Section 5.6.5.3 and Appendix G).

Additional short-term risks to workers will result from the excavation and/or capping of AOCs #1, 2, 3, 4, 5, 6, and 7, and from soil and groundwater contact during monitoring. These risks will be mitigated by the use of appropriate personal protection equipment as needed. Specific long-term and short-term human health risks are discussed in Sections 5.6.3.1 and 5.6.5.1, respectively.

**5.6.1.2 Ecological Protection.** Alternative #18 will provide reductions in short-term and long-term risk to ecological receptors relative to baseline conditions for exposures to soil. Treatment of source areas will reduce long-term risk of exposure to aquatic receptors from surface water contaminants. The reduction of risk to ecological receptors in sediments is expected to be minor.

Capping the B&M Railroad Landfill and excavating the B&M Locomotive Shop Disposal Areas will prevent future potential for exposure of terrestrial mammals to metal concentrations, resulting in a significant reduction in ecological risk from exposure to soils.

Adverse impacts on aquatic receptors from exposure to inorganics in surface waters will be reduced at the Wetland 2 Group, the Richardson Pond Group and the Content Brook Wetland Group. The removal or control of all the major source areas on site will reduce the potential for discharge of metals in surface water runoff and gradually reduce concentration of contaminants discharged from

groundwater. These mechanisms will reduce the concentration of metals contributing to risk to aquatic receptors in surface water over time. Resuspension of sediments, not treated by this alternative, still remains a potential source of metals in surface water. Impacts on benthic invertebrate populations from exposure to contaminants in sediment will not be reduced in the Wetland 2 Group, the Richardson Pond Group, and Content Brook Wetland Group since the concentrations of contaminants in the sediments in these habitats will not be substantially reduced by this alternative.

The capping of B&M Railroad Landfill, RSI Landfill, Asbestos Lagoons, Contaminated Soils Area, and excavation of B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area will result in temporary, minor ecological impacts.

### 5.6.2 Compliance with ARARs for Alternative #18

Chemical-specific ARARs and TBCs for the Site are discussed at length in Section 2.3.1. A summary of the implications of each chemical-specific ARAR for this "Source Control B" alternative include:

- Safe Drinking Water Act and Massachusetts Drinking Water Regulations. Federal and Massachusetts MCLs are relevant and appropriate for site groundwater. This alternative sets attainment of Federal SDWA MCLs and MMCLs for inorganic and organic chemicals as groundwater remediation goals. Monitored natural attenuation, however, is not anticipated to be able to attain Federal SDWA MCLs or Massachusetts Maximum Contaminant Levels in a reasonable time frame.

- Resource Conservation and Recovery Act Maximum Concentration Limits. RCRA groundwater corrective action requirements are relevant and appropriate requirements at the point of compliance at the limit of the waste management areas. The potential for contaminants to migrate from the area will be reduced by this alternative. Monitoring will be conducted to track exposure-based limits at the point of compliance, and to verify a reduction in the migration of contaminants. Monitored natural attenuation, however, is not anticipated to be able to attain Federal RCRA MCLs in a reasonable time frame.

- Federal Water Pollution Control Act, as Amended by the Clean Water Act, Ambient Water Quality Criteria (AWQC). Freshwater acute and chronic AWQC for the protection of aquatic life are considered appropriate and relevant for the site wetlands. Leachate outbreaks and surface water runoff will be controlled under this alternative, thereby reducing the probability that AWQC may be exceeded.

- Clean Air Act and Massachusetts Air Pollution Control Regulations. Dust or other potential emissions that may result from excavation of waste materials will be controlled under this alternative. There is no indication that ARARs for air will be exceeded by this alternative.

- Massachusetts Groundwater Quality Standards. Actions will be taken under this alternative in an attempt to attain applicable "Class I" enforcement standards. Although levels of some organic compounds in groundwater are anticipated to be reduced within a reasonable time frame, this alternative is not anticipated to be able to attain groundwater standards in a reasonable time frame.

- Massachusetts Surface Water Quality Standards. As part of the Shawsheen River Basin, site surface waters are classified as "Class B" habitat for fish, aquatic life and wildlife, and source of treated public water supplies. Surface water quality standards are considered applicable to site surface waters. Leachate outbreaks and surface water runoff will be controlled under this alternative, thereby reducing the probability that surface water quality standards may be exceeded.

- Federal Criteria and Advisories To Be Considered. In addition to the ARARs listed above, there are other important issues and advisories which will require attention prior to and during remedial activities. These criteria and advisories to be considered include:
    - *Health Advisories.* Carcinogenic and non-carcinogenic risk levels due to consumption of contaminated drinking water will be exceeded.
    - *Federal Groundwater Protection Strategy of 1984.* Current, applicable "Class I" enforcement standards are not met under this alternative. Groundwater quality standards are exceeded.

- *Threshold Limit Values (TLVs).* There is no indication that these levels will be exceeded for site remediation workers under this alternative.

Location-specific ARARs and TBCs relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2), will not be met under this alternative. Although the minor impacts to wetlands and floodplains during cap construction will be mitigated, and no surface water discharges will occur, because the on-site wetlands will be allowed to remain in a degraded (contaminated) state, this "Source Control B" alternative will not meet the intent of Executive Order 11990. This ARAR requires federal agencies to minimize wetland degradation and to preserve and enhance the beneficial uses of wetlands. This alternative controls the source and leaves the wetlands and ecological habitats intact, but also leaves chemicals of concern in place.

Table 5-15 lists the action-specific ARARs for this "Source Control B" alternative. The alternative attains most action-specific ARARs. Notable exceptions are those related to wetlands, groundwater protection, and corrective action. Corrective actions must be completed within a "reasonable time period." In terms of groundwater remediation under this alternative, monitored natural attenuation is to be implemented at all AOCs through increased monitoring of site groundwater. Demonstrating that the action-specific ARAR detailed below can be attained will require long-term monitoring and evaluation. In the event that this ARAR cannot be attained within an agreed-upon, designated time period, then the groundwater remedy proposed for this alternative will need to be modified by means of a Technical Impracticability (TI) Waiver and/or Explanation of Significant Difference (ESD) to the Record of Decision.

- Hazardous/Solid Waste Management - Groundwater Protection, 310 CMR 30.660 - 30.675; 310 CMR 19.110 (AOCs #1, 2, 3, 6, and 7): A groundwater monitoring program will be implemented at the Site. Corrective measures will consist of monitored natural attenuation. Leachate generation from the landfill will be reduced but not eliminated. Monitoring will need to be conducted to determine attainment of this requirement.

In addition, hazardous waste management landfill stabilization/solidification (310 CMR 30.632) regulations require that all wastes disposed of in a landfill are treated to the maximum extent

practicable to minimize the potential for wastes migrating from the landfill site. This alternative includes excavation of materials from AOC #3 and subsequent on-site disposal. Currently, the alternative does not include stabilization/solidification of these wastes. If, however, after sampling the excavated material is shown to be a hazardous waste, further treatment may be warranted and this remedy revisited. This alternative includes sampling and analysis adequate to make this determination and, thus, attains this action-specific ARAR.

### 5.6.3 Long-Term Effectiveness and Permanence for Alternative #18

This alternative is evaluated below in terms of risk remaining at the Site after RAOs are addressed. This portion of the evaluation focuses on the extent and effectiveness of the controls required to manage the risk posed by treatment residuals and/or untreated contamination.

**5.6.3.1 Magnitude of Residual Risk: Human Health.** Alternative #18 implements controls to eliminate exposure of workers to soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. For groundwater, Alternative #18 implements access restrictions to prevent human contact with COCs. In addition, the use of excavation and/or capping at AOCs #1, 2, 3, 4, 5, 6, and 7 are expected to partially reduce groundwater contamination at the Site. However, these controls are not expected to effectively contain groundwater contamination on the Site. Under this alternative, the magnitude of residual risks will depend on the enforcement and reliability of institutional controls to prevent future human exposure to COCs in groundwater as well as the efficiency of the remedial measures at eliminating exposures to soil COCs.

Under this alternative, exposure of female site workers of child-bearing age to lead in indoor dust from soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Contaminated Soils Area, which was estimated to result in a maternal blood level exceeding that protective of a 95$^{th}$ percentile fetal blood lead level of 10 µg/dl, will be eliminated by capping the Contaminated Soils Area, and eliminated through excavation and relocation of soils under capping for the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area. Likewise for

the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will be eliminated by capping because fugitive dust generation will be prevented. Therefore, the use of capping at these AOCs will effectively eliminate the estimated risk for site workers to soils, unless the caps are not maintained.

Potential future residual human health risks to a resident from ingestion of COCs in groundwater from AOCs #1 through 7 will be eliminated by the implementation of groundwater access restrictions as long as long-term enforcement of the groundwater access restrictions are maintained. Contaminated groundwater will not be contained with this alternative, even though COC concentrations will be monitored. Therefore, groundwater risk to off-site receptors will be possible. Groundwater concentrations will decline over time as monitored natural attenuation processes reduce COC concentrations, resulting in a partial lowering of residual risks to potential off-site receptors and to on-site receptors should access restrictions not be maintained in the future. However, attenuation that occurs naturally is likely to occur slowly for the most significant risk drivers (195 to >200 years to achieve PRGs for arsenic and manganese; see Section 5.6.5.3 and Appendix G).

**5.6.3.2 Magnitude of Residual Risk: Ecological.** Alternative #18 will result in a quantifiable long-term reduction in risk to ecological receptors in soil and surface water, but not from sediments. The potential for exposure of small mammals to contaminants in soil will be removed at the B&M Railroad Landfill and the B&M Locomotive Shop Disposal Areas.

The removal or control of all the major source areas on-site will reduce the potential for discharge of metals in surface water runoff and gradually reduce concentration of contaminants discharged from groundwater. In the long-term, these mechanisms will reduce the concentration of metals contributing to risk to aquatic receptors in surface water. The risk to aquatic receptors from exposure to metals in surface water will persist until substantial decreases in contaminant discharge are achieved. Resuspension of sediments, not treated by this alternative still remains a potential source of metals in surface water. Therefore, residual risk to aquatic receptors will not be lowered substantially below baseline conditions for Alternative #18 in the short-term, but are expected to improve in the long-term.

Since no measures are taken in Alternative #18 to directly remove/reduce exposure from contaminants in sediments, the only effects on the concentration of contaminants will be dilution/dispersal through slow, natural processes and a minor reduction in the deposition of additional contamination from surface water over time. Consequently, the concentration of contaminants in on-site sediments will not be substantially reduced under Alternative #18 and the risk to benthic invertebrates will not be reduced below baseline conditions.

### 5.6.4 Reduction of Toxicity, Mobility and Volume through Treatment for Alternative #18

Table 5-16 provides a summary of the treatment and process options selected, quantities of waste materials to be remediated, expected reductions in toxicity, mobility and volume, and residuals following treatment for Alternative #18. No human health or ecological risk was determined for soil at AOC #2 (RSI Landfill). Likewise, no risk was determined for surface water at AOC #8a (West Middlesex Canal Group) and AOC #8c (East Middlesex Canal Group). Therefore, reductions in toxicity, mobility and volume were not evaluated for these media at these AOCs. As a provision if future sediment toxicity testing results in ecological risk, actions are included in the alternative for AOCs #8a and #8c and evaluated below.

**5.6.4.1 Treatment/Recycling Processes to be Utilized.** Alternative #18 consists of source control remedies for soil, monitored natural attenuation for groundwater, and institutional actions for surface water and sediment. Source control remedies and institutional actions are not considered treatment processes. A more detailed description of the treatment/recycling processes to be utilized under Alternative #18 is provided in Section 5.6. Refer to Table 5-16 for specific treatment/ recycling processes to be utilized at each AOC.

**5.6.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The following amounts of hazardous materials to be treated for Alternative #18 are provided below by media of concern and AOC. Values are only given if the remedial action will provide treatment. Monitored natural attenuation is considered a treatment process in this evaluation, since it typically results in reductions in contamination over time. Source control, excavation and on-site disposal, and institutional actions are not considered treatment processes.

Groundwater (areal extent of source)

- AOC #1 - B&M Railroad Landfill 12.4 acres
- AOC #2 - RSI Landfill 2.5 acres
- AOC #3 - B&M Locomotive Shop Disposal Areas 4.7 acres
- AOC #4 - Old B&M Oil/Sludge Recycling Area 7.0 acres
- AOC #5 - Contaminated Soils Area 6.7 acres
- AOC #6 - Asbestos Landfill 13.3 acres
- AOC #7 - Asbestos Lagoons 1.9 acres

**5.6.4.3 Degree of Expected Reductions in Toxicity, Mobility and Volume.** The degree of treatment and expected reductions for each treatment process under Alternative #18 are provided below by media of concern and AOC. Reductions expected from source control and excavation and on-site disposal are not discussed, since these processes are not considered treatment. Reductions from monitored natural attenuation are provided for the U.S. EPA default time period, 30 years.

At all AOCs, no contaminated soil is treated under Alternative #18. Therefore, no reductions in toxicity, mobility and volume are expected for soil at all AOCs.

Monitored natural attenuation is expected to treat all of the contaminated groundwater at all AOCs. The following reductions in toxicity, mobility and volume are expected for groundwater:

Toxicity

- Monitored natural attenuation is expected to reduce the toxicity of the contaminated groundwater relative to a specific contaminant proportional to the volume reduction of that specific contaminant at all AOCs. Intermediate products that are more toxic than parent compounds may result if incomplete biodegradation of original contaminants occurs.

Mobility

- Monitored natural attenuation will not provide reductions in mobility at all AOCs.

Volume

- Monitored natural attenuation will not reduce the volume of the contaminated media at all AOCs.
- Organic COCs reductions in volume are expected to vary from less than 15% to 100% across the Site. This broad range is due to differing physical and chemical properties on a compound by compound basis. Greater reductions of organics are possible due to

biodegradation. Specific compounds used in the MODFLOW simulations, as well as BIOSCREEN results which additionally consider biodegradation rates, can be found in Appendix G. Table 5-16 provides estimated volume reductions for each AOC.

- Expected volume reductions from monitored natural attenuation for inorganic COCs are expected to be less than or equal to 15% across the Site. These low reductions may be attributed to adsorption of compounds to the soils within the aquifer. For specific compounds used the MODFLOW modeling, reference Appendix G. Inorganic volume reductions by AOC are provided in Table 5-16.

There will not be any expected reductions in toxicity, mobility and volume in surface water and sediment at AOCs #8b, 8d, and 8e and sediment at AOCs #8a and 8c. Institutional actions will not confirm reductions or treatment of waste materials.

**5.6.4.4 Reversibility.** The reversibility of each treatment process to be implemented under Alternative #18 is provided below by media of concern and AOC. Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. Since source control, excavation and on-site disposal, and institutional actions are not considered treatment processes, reversibility of treatment is not applicable to these processes.

Monitored natural attenuation processes, to be implemented to treat groundwater at all AOCs, are generally not considered reversible as the organic contaminants will be degraded over time. Inorganic contaminants, on the other hand, may only be temporarily immobilized and later released.

**5.6.4.5 Type and Quantity of Residuals.** The types and quantities of contaminant residuals by media of concern and AOC expected after completion of the treatment technologies/process options implemented in Alternative #18 are summarized below. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are discussed briefly in Table 5-16.

At all AOCs where horizontal containment will be implemented (AOCs #1, 5, 6, and 7), the total amount of contaminated soil at each respective AOC will remain untreated but contained under the cap. The total amount of contaminated soil excavated from AOCs #3 and 4, will also remain

untreated but contained under an on-site cap. Section 5.6.4.2 describes the amounts of contaminated soil treated.

In groundwater, more toxic intermediate products may remain at all AOCs if incomplete degradation of original contaminants occurs. For monitored natural attenuation, estimated residuals following treatment for a 30 year period, the U.S. EPA default time period, are provided. As stated above, the high degree of variability in the reductions, and thus the residuals, is due to differing characteristics of compounds.

- It is expected that 0% to greater than 85% of the organic COCs and greater than 85% of the inorganic COCs will remain in the groundwater at AOC #1.
- The groundwater at AOC #2 is expected to contain 0% to greater than 85% of the organic COCs and greater than 85% of the inorganic COCs after treatment.
- Approximately 16% of the organic COCs and greater than 85% of the inorganic COCs will remain at AOC #3 following treatment by monitored natural attenuation.
- At AOC #4, it is expected that greater than or equal to 85% of the inorganic COCs will remain in the groundwater after treatment. There are no organics exceeding PRGs at AOC #4. Therefore, organic reductions were not evaluated.
- It is expected that 0% to greater than 85% of organic COCs and greater than 85% of inorganic COCs will remain at AOC #5 following treatment.
- An estimated 0% to 49% of the organic COCs and greater than 85% of the inorganic COCs will remain in the groundwater at AOC #6 following treatment.
- It is anticipated that 18% to greater than 85% of the organic COCs and greater than 85% of the inorganic COCs will remain in the groundwater at AOC #7.

Institutional actions will be implemented at all AOCs showing human health and ecological risk in surface water and sediment, as well as at AOCs #8a and 8c, where future sediment toxicity testing results may result in ecological risk. Since institutional actions do not involve treatment, the original amounts of contaminated surface water and sediment will be assumed to remain at all AOCs.

### 5.6.5 Short-Term Effectiveness for Alternative #18

This alternative is evaluated for effectiveness in protecting the community and local workers, site remediation workers, and the environment during the construction and implementation of the remedy.

**5.6.5.1 Protection of Community and Workers During Remedial Actions.** The construction and remediation measures proposed under this alternative include excavation and placement of soils from the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area beneath a cap, capping of the B&M Railroad Landfill, RSI Landfill, Contaminated Soils Area, Asbestos Landfill and Asbestos Lagoons and groundwater monitoring at AOCs #1 through 7.

The implementation of these construction/remedial measures will potentially result in additional short-term risk to the community from exposure to soil contaminants primarily associated with dust generation during soil disturbances at the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. Precautions will be implemented to prevent or limit fugitive dust generation during excavation/remedial activities. Worker exposure to COCs in soil and groundwater during excavation/capping at AOCs #1, 2, 3, 4, 5, 6, and 7, and monitoring will also result in potential health risk to workers. Use of personal protection equipment will be employed to reduce exposure if applicable OSHA standards are exceeded during these activities.

**5.6.5.2 Environmental Impacts.** The capping of B&M Railroad Landfill, RSI Landfill, Asbestos Lagoons, Contaminated Soils Area, and excavation of B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area will all require removal of vegetation. Wetlands are located around the border of a portion of each of these areas, with the exception of the Contaminated Soils Area and Old B&M Oil/Sludge Recycling Area. The extent of excavation or fill in wetland is estimated to be minimal for each alternative. Mitigation measures will include avoidance and minimization of temporary construction disturbance in adjacent wetlands during construction of landfill caps. Tree removal will be minimized, and proper construction and erosion control methods will be utilized. Mitigation will include restoration of upland habitat, and minimization of wetland impacts. Any unavoidable wetland loss will be mitigated by restoration or creation of on-site wetlands. Changes in hydrology resulting from construction of landfill caps will be mitigated by properly designed stormwater retention systems and maintenance of flows of water close to existing conditions.

The alternative will include installation of monitoring wells throughout the Site. Mitigation measures will include avoidance and minimization of temporary construction disturbance in wetlands during construction of monitoring wells, and minimization of tree removal. Proper construction and erosion control methods will be utilized to minimize ecological impact to surrounding habitats.

The excavation of soil adjacent to the unnamed brook in B&M Locomotive Shop Disposal Area A may potentially cause disturbance to the stream bank. Mitigation measures will include avoidance and minimization of temporary construction disturbance in the stream channel and returning impacted areas to previous grades. Any unavoidable wetland loss from excavation will be mitigated by restoration or creation of on-site wetlands.

**5.6.5.3 Time Until Remedial Action Objectives are Achieved.** Of the RAOs presented in Section 2, those for groundwater will take the longest to achieve. Through the use of groundwater flow modeling and contaminant retardation concepts (Appendix G), approximate times to achieve PRGs were calculated for the Site contaminants at each AOC. It should be noted that the mobility of inorganics is highly sensitive to site specific geochemistry. Other factors such as pH, dissolution, and colloidal transport could have significant impacts on mobility of inorganics. Therefore, these times should only be used for relative comparison and not for accurate representations of cleanup times.

Alternative #18 includes monitored natural attenuation as a groundwater treatment process at all AOCs. Furthermore, site hydrology may be impacted by caps placed on AOCs #1, 2, 5, 6, and 7.

Modeling was performed to predict the reduction of contaminant concentrations over time due to natural processes, such as dispersion. However, additional contaminant reduction is expected to occur due to biodegradation. This aspect of monitored natural attenuation was evaluated using the BIOSCREEN natural attenuation decision support system (Appendix G). While improved cleanup times were estimated for a few compounds at the Site, these times were similar to those without biodegradation. Approximate cleanup times, assuming no biodegradation, for each AOC with contaminants above PRGs are presented below:

| Overburden | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | 132 | ND | >200 | >200 |
| AOC #2 - RSI Landfill | >200 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | 36 | ND | ND | >200 |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | 195 |
| AOC #5 - Contaminated Soils Area | >200 | >200 | >200 | >200 |
| AOC #6 - Asbestos Landfill | 59 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 37 | >200 | ND | >200 |

| Bedrock | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | >200 | >200 | ND | >200 |
| AOC #2 - RSI Landfill | 24 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | ND | ND | ND | ND |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | >200 |
| AOC #5 - Contaminated Soils Area | >200 | >200 | ND | >200 |
| AOC #6 - Asbestos Landfill | 12 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | >200 | >200 | ND | >200 |

Notes: ND = Not detected at a concentration greater than PRGs at this AOC and flow zone

Some cleanup times reported above are high (i.e., greater than 200 years). This simply means that the compounds are essentially immobile. For example, arsenic and thallium have very high retardation coefficients and, ultimately, high cleanup times.

It should also be noted that the only SVOC detected above PRGs at all AOCs was bis(2-ethylhexyl)phthalate and the only pesticide was aldrin. The high retardation factors of these compounds increase the time of travel and source contaminant reduction. Evaluations assumed that the Contaminated Soils Area contained contaminants similar to the B&M Railroad Landfill, RSI Landfill, and the Asbestos Lagoons. The two compounds noted above are therefore assumed to be found at this AOC above PRGs. However, further evaluation may determine that this is not the case. Furthermore, the evaluations assumed that the maximum detections from the three nearby AOCs were also detected at the Contaminated Soils Area. Similarly, data from the RSI Landfill was used to characterize the Asbestos Landfill.

### 5.6.6 Implementability for Alternative #18

This section summarizes the technical and administrative feasibility of implementing Alternative #18, the "Source Control B" alternative, and the availability of various services and materials required for its implementation.

**5.6.6.1 Technical Feasibility.** Evaluation of the technical feasibility of Alternative #18 includes an assessment of three factors described in EPA's feasibility study guidance: 1) the ability to construct and operate the technologies, 2) the reliability of the technologies and 3) the ease of undertaking additional remedial actions, if necessary. These aspects are described in detail below:

Ability to Construct and Operate the Technologies. For Alternative #18, similar to Alternatives #8 thorough 15, the major implementability issue with regard to technical feasibility will be the construction of landfill caps at AOCs #1, 2, 5, 6, and 7 and the excavation and removal of waste soil/waste fill from AOCs #3 and 4 with relocation and regrading of these materials below one of the caps constructed at AOCs #1, 2, 6, or 7.

As discussed previously for Alternatives #8 through 15, the capping and excavation remedies for Alternative #18 at AOCs #1, 2, 3, 4, 6, and 7 will require a substantial civil engineering/earthwork component. The key implementability issue will be the location of sensitive wetland areas or water bodies adjacent to every one of these AOCs. This will require comprehensive soil erosion, runoff and sedimentation control measures to minimize siltation impacts to wetland areas or water bodies. In addition, proper location and construction of temporary and permanent haul roads will be required to minimize impacts to wetland areas and water bodies. It is expected that the remediation contractor(s) will utilize the existing rail network to move equipment and materials to the largest degree possible. This rail network will be closely situated to five of the six "earthwork" AOCs (#1, 2, 3, 4, and 6). While the scope of the earthwork and transportation required for the capping and excavation activities will be large, these are common problems faced and solved by experienced engineers and constructors. Maintenance of the capped and excavated areas will be straightforward requiring only periodic inspections, vegetation control (*e.g.*, mowing) and filling of areas of settlement. As a result, no implementability constraints are expected with regard to construction and operation of the soil remedy for AOCs #1, 2, 3, 4, 6, and 7 in Alternative #18.

As discussed in prior alternatives, the primary implementability concern for placement of the single-barrier cap at AOC #5 will be the limitation of conducting work within the Contaminated Soils Area while maintaining active use of the rail yard, rail spurs and roads that transect it. Placement of a single-barrier cap will require sitework adjacent to active railbeds and tracks. Therefore, Alternative #18 will require measures such as temporary structural supports, temporary use restrictions for tracks or roadways next to active work areas and temporary

relocation of tracks and bedding material, if necessary. Implementing this remedy at AOC #5 will require close cooperation between rail yard users and the remediation engineer/contractor(s) and involve temporary disruptions to the rail yard operations. These are straightforward issues commonly faced and solved as part of construction efforts and are not sufficient to prevent consideration of this alternative as the selected remedy.

Alternative #18 will also include the use of monitored natural attenuation to remediate contaminated groundwater at AOCs #1 through 7. Construction of this technology will only require installation of groundwater monitoring wells, and operation only requires monitoring efforts to sample and analyze the groundwater. There will be no implementability constraints with regard to monitored natural attenuation.

Reliability of the Technologies. Reliability of the horizontal caps installed for AOCs #1, 2, 6, and 7 will be considered high if normal periodic maintenance of the cap will be conducted. The high reliability will also apply to the excavation and removal of waste soils/waste fill from AOCa #3 and 4 with relocation and regrading of these materials below one of the caps constructed at AOCs #1, 2, 6, or 7. The reliability of the single-barrier cap installed for AOC #5 will be less than the landfill caps and much more sensitive to proper inspection and maintenance. Due to the heavy rail and truck loads and the complex pattern of drainage that will be required to address stormwater runoff, a more intensive O&M program of inspection, maintenance and repair will be required to ensure appropriate integrity of the single-barrier cap.

As stated previously under Alternatives #5 through 15, the reliability of monitored natural attenuation to remediate any residual contaminated groundwater at AOCs #1 through 7 should be considered "high" since there will be no external equipment nor treatment systems that could breakdown. The reliability of the technology to meet PRGs, however, should not be confused with "implementability" but is more appropriately discussed under "effectiveness". The reader is directed to the "treatment efficiency" and the "time required to remediate" discussions in Sections 5.6.4, 5.6.5 and Appendix G.

Although the institutional controls which will be applied to AOCs #1 through 7 are not exactly technologies, their reliability will depend upon enforcement by the responsible agencies involved.

Ease of Undertaking Additional Remedial Actions. Applying additional remedial actions for contaminated soils contained by the horizontal caps installed at AOCs #1, 2, 5, 6, and 7 will be severely restricted since installation of the caps are largely permanent remediation technologies. This conclusion will also apply to the excavation and removal of waste soils/waste fill from AOCs #3 and 4 with relocation and regrading of these materials below one of the caps constructed at AOCs #1, 2, 6, or 7.

Additional remedial actions could be accommodated in place of monitored natural attenuation of groundwater at AOCs #1 through 7. The only implementability limitation is that the new groundwater remediation technologies will need to accommodate the active, working area of the

Contaminated Soils Area rail yard and not require installation within the confines of previously capped AOCs #1, 2, 6, and 7.

Additional remedial actions could be accommodated in place of routine monitoring of sediments at AOCs #8a through 8e and surface water at AOCs #8b, 8d, and 8e without any implementability concerns.

**5.6.6.2 Administrative Feasibility.** Evaluation of the administrative feasibility of Alternative #18 involves assessing the steps required to coordinate with other federal, state and local governmental entities. It should be noted that under Superfund, permits are not required for remediation activities, but compliance with substantive requirements is required.

The principal administrative feasibility issue with regard to Alternative #18, described previously for Alternatives #3 through 15, involves implementation of institutional controls in order to prohibit the use of groundwater. If proprietary controls are used, coordination with the individual property owners of the affected parcels, will be required. For example, implementation of a negative easement would require the property owner to convey to a third party (typically EPA) the right to limit how the landowner can use his or her property. Here the limitations would likely include prohibitions against the use of groundwater from wells on the property.

If governmental controls are used, coordination with federal, state and local government (the ATSDR, the Commonwealth of Massachusetts and/or the Town of Billerica) will be required. For example, implementation of land use restrictions may require the exercise of zoning authority by the Town of Billerica to prohibit residential development in a contaminated area, or the adoption of a building permit ordinance in the Town of Billerica requiring anyone seeking a building permit for construction activities in a particular area to be notified of contamination in the area and of any relevant management standards - such an ordinance could also be used to prohibit types of construction that would result in unacceptable exposures (e.g., excavation in areas where subsurface contamination has not been fully removed). Implementation of groundwater use restrictions may require action by the Commonwealth of Massachusetts to prohibit or limit certain uses of groundwater in particular areas, or require closing or capping of wells. Implementation of advisories may also require action by the ATSDR or Commonwealth of Massachusetts to publically issue warnings that provide notice to

potential users of land, surface water or groundwater of some existing or impending risk associated with their use.

An additional administrative issue will be to reach agreement between federal, state and local governmental entities on the specifics of implementing the monitored natural attenuation program. Under Alternative #18, this program will address groundwater at AOCs #1 through 7. Concurrence among the various agencies will be required in defining the program (*e.g.*, number and type of monitoring locations, analytical/test parameters, frequency of testing, etc.) as well as interpretation of results and conclusions regarding the overall success of monitored natural attenuation.

**5.6.6.3 Availability of Services and Materials.** Evaluation of the availability of services and materials for Alternative #18 includes an assessment of three factors in accordance with EPA's feasibility study guidance: 1) the availability of treatment, storage capacity and disposal services, 2) the availability of necessary equipment and specialists, and 3) the availability of prospective technologies. These aspects are described in detail below:

Availability of TSDF Services. Since no remedial actions requiring off-site transport, storage or disposal are to be implemented as part of Alternative #18, the "Source Control B" alternative, there are no implementability constraints with regard to this issue for selection of this alternative.

Availability of Necessary Equipment and Specialists. A substantial quantity of heavy, earthmoving equipment as well as transport vehicles (both truck and rail variety) will be required for Alternative #18 during excavation of waste soils/waste fill from AOCs #3 and 4 and construction of the caps at AOCs #1, 2, 5, 6, and 7. The numbers of equipment and vehicles required will be proportional to the number of caps/excavations being conducted simultaneously in a given construction season.

Experienced pavement engineers and contractors will be required to install the single-barrier pavement-type cap at AOC #5. This remediation team will be require experience in pavement installations adjacent to multiple rail and spur lines.

The highest need for specialists in Alternative #18 will be for two areas: 1) specialized legal counsel/assistance for implementation of the institutional controls and 2) consultants experienced in monitored natural attenuation of groundwater. Implementation of the institutional controls is expected to be a time-consuming process but should not pose significant implementability concerns that will prevent selection of this alternative as the final remedy. Legal specialists experienced in both CERCLA and non-CERCLA sites are available to facilitate this process.

Similarly, monitored natural attenuation has been a technology employed at CERCLA sites in the last 10 years and there will be a substantial number of environmental consultants with familiarity in implementing such a program. Thus, availability of consultants familiar with monitored natural attenuation should not prevent selection of this alternative as the final remedy.

Availability of Prospective Technologies. Alternative #18 will not require any specialized or innovative technologies and, therefore, there will be no implementability limitation with regard to availability of prospective technologies.

### 5.6.7 Cost for Alternative #18

Total estimated capital cost associated with this alternative is $33.3 million. This estimate assumes a contingency of 20%. The present value of all O&M costs would be $42.8 million. This estimate assumes an inflation rate of 3%, an interest rate of 7%, and a contingency of 15%. The maximum duration of site remedial actions is assumed to be 30 years, in accordance with RI/FS guidance (U.S. EPA, 1988). Total present worth costs would therefore be $76.1 million. Detailed costs for this alternative are presented in Appendix D. The costs associated with each alternative selected for detailed evaluation are summarized in Table H-1 of Appendix H.

### 5.6.8 State Acceptance for Alternative #18

Acceptance of the selected, site-wide remedial alternative by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 5.6.9 Community Acceptance for Alternative #18

Acceptance of the selected, site-wide remedial alternative by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 5.7 ALTERNATIVE #27 - "SEDIMENT SOURCE CONTROL"

Alternative #27 is the first remedy to apply more active measures to mitigate contaminated sediments via source control methods. This alternative is similar to Alternative #15 except that source control remedial technologies/process options are applied to sediments in affected wetlands AOCs. Surface water will be addressed by in-situ remedies.

The overview of remedial action components for Alternative #27 is presented in Table 5-17 and Appendix F. Figure 5-6 details the remedial action site plan for this alternative. Alternative #27 includes the following remedial actions by media of concern and AOC:

Soil:

- Source control remedies consisting of horizontal containment (*e.g.*, caps) will be implemented at disposal area AOCs [#1 - B&M Railroad Landfill, #2 - RSI Landfill (for groundwater source management), #5 - Contaminated Soils Area, #6 - Asbestos Landfill] to address human health and ecological risk and/or meet ARAR requirements.
- Contaminated soil at AOC #3 (B&M Locomotive Shop Disposal Areas), AOC #4 (Old B&M Oil/Sludge Recycling Area) and AOC #7 (Asbestos Lagoons) will be excavated and relocated for ultimate disposal under one of the caps installed for AOCs #1, 2, or 6. Monitoring will be conducted at AOCs #3, #4, and #7 to confirm source mitigation.

Groundwater:

- In-situ remedies consisting of physical processes (*e.g.*, passive/reactive treatment walls) and biological processes (*e.g.*, enhanced biodegradation) will be applied to disposal site AOCs where contaminated groundwater can be feasibly contained (#1 - B&M Railroad Landfill, #2 - RSI Landfill, #4-Old B&M Oil/Sludge Recycling Area, #6 - Asbestos Landfill, #7 - Asbestos Lagoons). Institutional actions consisting of access restrictions (*e.g.*, institutional controls) and monitoring are part of this remedy as well.
- An in-situ remedy consisting of monitored natural attenuation, physical processes for aquifer hydraulic and pneumatic fracturing and chemical oxidation will be applied to AOC #3 (B&M Locomotive Shop Disposal Areas). This remedy also includes institutional actions consisting of access restrictions (institutional controls) as well as monitoring.
- Due to capping of source area contaminated soil, only in-situ monitored natural attenuation of groundwater and institutional action access restrictions (*e.g.*, institutional controls) will be conducted at AOC #5 (Contaminated Soils Area).

Surface Water:

- In-situ remedies consisting of monitored natural attenuation will be implemented at all three AOCs showing risk (#8b - Wetland 2 Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group).

Sediment:

- Source control remedies consisting of in-place, horizontal containment (capping) of contaminated sediments with in-situ actions for monitored natural attenuation will be implemented at the highest ecological risk-ranked AOC (#8b - Wetland 2 Group).
- Source control remedies consisting of dredging/dry excavation of "hot spot" locations will be applied to contaminated sediments in the remaining AOCs (#8d-Richardson Pond Group, #8e - Content Brook Wetland Group). Excavated sediments are disposed on-site via relocation under one of the caps installed for AOCs #1, 2, or 6. Remaining lesser contaminated sediments will be mitigated through in-situ means via monitored natural attenuation. Similarly, the same actions are included at the remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) as a provision if future toxicity testing results in ecological risk.

The detailed evaluation of Alternative #27 with respect to the nine FS criteria is presented in Sections 5.7.1 through 5.7.9.

### 5.7.1 Overall Protection of Human Health and the Environment for Alternative #27

Alternative #27 will provide some overall protection of human health and the environment by reducing some risks identified in the baseline risk assessment. For soil, overall protection of human health from implementation of Alternative #27 will result from the elimination of exposures to COCs in soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. In addition, the elimination of exposures to groundwater at AOCs #1 through 7 using institutional controls along with reduced COC concentrations from in-situ treatment and monitored natural attenuation at all AOCs will provide overall protection of human health from groundwater exposures. Identified ecological risks from exposures to soil will be removed. Long-term reduction in exposure of aquatic receptors to surface water will be achieved and the exposure of benthic organisms to sediment contaminants will be significantly reduced. Therefore, Alternative #27 meets all RAOs for the Site, as defined in Section 2.1, and significantly reduces risks to human health and the environment. The protection of human health and the environment are discussed in Sections 5.7.1.1 and 5.7.1.2, respectively.

**5.7.1.1 Human Health Protection.** Alternative #27 will provide overall protection of human health by eliminating risks identified in the baseline risk assessment. Current baseline risks to human health at the Contaminated Soils Area for female site workers of child-bearing age from exposures to lead in soil via indoor dust will be eliminated as a result of capping since windborne exposures to lead will be eliminated. For the current female site worker of child-bearing age at the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area, baseline risks to human health from exposure to lead in soil via indoor dust will be eliminated as a result of excavation and relocation for ultimate disposal under one of the caps installed for AOCs #1, 2, or 6. Likewise for the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will be abated by excavation and/or capping, since windborne exposure to asbestos will be eliminated. However, since no contaminant removal will be performed with capping, the risk will return to baseline levels if the caps are not maintained.

The potential for future risks from ingestion of COCs in groundwater at the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons will be eliminated by restrictions on the future use of groundwater as a drinking water source. Significant reductions in groundwater organic COC concentrations in both overburden and bedrock aquifers are expected to occur at AOCs #1, 2, 3, 4, 6 and 7 through the use of in-situ treatment. In-situ treatments include chemical oxidation, use of treatment walls, and enhanced biodegradation. For inorganic COCs, negligible reductions are expected with times to achieve PRGs estimated from 87 to >200 years for most COCs (see Section 5.7.5.3 and Appendix G). Reductions in groundwater COC concentrations at AOCs #1 through 7 will be contributed to by the removal of contaminated soil (at AOCs #3, 4, and 7) and the placement of caps (at AOCs #1, 2, 5, and 6). Excavation and capping will lower groundwater COC concentrations by limiting the potential leaching of soil contaminants to groundwater. Natural degradative processes will also contribute to the lowering of groundwater COC concentrations over time. Since there will by only partial containment of groundwater contamination with this alternative, risk to off-site receptors will be possible.

Additional short-term risks to workers will result from the excavation and/or capping of AOCs #1, 2, 3, 4, 5, 6 and 7, the placement of treatment walls at AOCs #1, 2, 4, 6, and 7, and from worker exposures during in-situ groundwater treatment at AOCs #1, 2, 3, 4, 6 and 7, and monitoring of soil and groundwater at AOCs #1 through 7. These risks will be mitigated by the use of appropriate personal protection equipment as needed. Specific long-term and short-term human health risks are discussed in Sections 5.7.3.1 and 5.7.5.1, respectively.

**5.7.1.2 Ecological Protection.** Alternative #27 will provide reductions in short-term and long-term risk to ecological receptors relative to baseline conditions for exposures to soil, surface water and sediment. Capping the B&M Railroad Landfill and excavating the B&M Locomotive Shop Disposal Areas will prevent future potential for exposure of terrestrial mammals to metal concentrations, resulting in a significant reduction in ecological risk from exposure to soils.

The ecological risks identified on the Site for surface water and sediment will be reduced over time by this alternative. Adverse impacts on aquatic receptors from exposure to inorganics in surface waters will be reduced at the Wetland 2 Group, Richardson Pond Group and Content Brook Wetland Group. Capping or treatment of the major source areas on-site will be likely to reduce the potential discharge of contaminants from surface runoff and from groundwater discharge slowly over time. Capping or dredging of the sediments will reduce the potential for resuspension of metals from sediments in the long term. Impacts on benthic invertebrate populations from exposure to contaminants in sediment will be reduced for AOCs #8a through 8e. Specific long-term and short-term reductions in ecological risks are discussed in Section 5.7.3.2.

The capping of B&M Railroad Landfill, RSI Landfill, Asbestos Landfill, Contaminated Soils Area, and excavation of the Asbestos Lagoons, B&M Locomotive Shop Disposal Areas, and Old B&M Oil/Sludge Recycling Area will result in temporary, minor ecological impacts. Capping, dredging and excavation of portions of AOCs #8a through 8e will result in both temporary and permanent loss of wetland habitats. These impacts will be mitigated by restoration or creation of on-site wetlands.

### 5.7.2 Compliance with ARARs for Alternative #27

Chemical-specific ARARs and TBCs for the Site are discussed at length in Section 2.3.1. A summary of the implications of each chemical-specific ARAR for this "Sediment Source Control" alternative include:

- Safe Drinking Water Act and Massachusetts Drinking Water Regulations. Federal and Massachusetts MCLs are relevant and appropriate for site groundwater. This alternative sets attainment of Federal SDWA MCLs and MMCLs for inorganic and organic chemicals as groundwater remediation goals. Although levels of some organic compounds in groundwater are anticipated to be reduced within a reasonable time frame, this alternative is not anticipated to be able to attain Federal SDWA MCLs or Massachusetts Maximum Contaminant Levels for inorganic chemicals in a reasonable time frame.

- Resource Conservation and Recovery Act Maximum Concentration Limits. RCRA groundwater corrective action requirements are relevant and appropriate requirements at the point of compliance at the limit of the waste management areas. The potential for contaminants to migrate from the area will be reduced by this alternative. Monitoring will be conducted to track exposure-based limits at the point of compliance, and to verify a reduction in the migration of contaminants. Although levels of some organic compounds in groundwater are anticipated to be reduced within a reasonable time frame, this alternative is not anticipated to be able to attain Federal RCRA MCLs for inorganic chemicals in a reasonable time frame.

- Federal Water Pollution Control Act, as Amended by the Clean Water Act, Ambient Water Quality Criteria (AWQC). Freshwater acute and chronic AWQC for the protection of aquatic life are considered appropriate and relevant for the site wetlands. Leachate outbreaks and surface water runoff will be controlled under this alternative, thereby reducing the probability that AWQC may be exceeded.

- Clean Air Act and Massachusetts Air Pollution Control Regulations. Dust or other potential emissions that may result from excavation of waste materials will be controlled under this alternative. There is no indication that ARARs for air will be exceeded by this alternative.

- Massachusetts Groundwater Quality Standards. Actions will be taken under this alternative in an attempt to attain applicable "Class I" enforcement standards. Although levels of some organic compounds in groundwater are anticipated to be reduced within a reasonable time frame, this alternative is not anticipated to be able to attain groundwater standards for inorganic chemicals in a reasonable time frame.

- Massachusetts Surface Water Quality Standards. As part of the Shawsheen River Basin, site surface waters are classified as "Class B" habitat for fish, aquatic life and wildlife, and source of treated public water supplies. Surface water quality standards are considered applicable to site surface waters. Leachate outbreaks and surface water runoff will be controlled under this alternative, thereby reducing the probability that surface water quality standards may be exceeded.

- Federal Criteria and Advisories To Be Considered. In addition to the ARARs listed above, there are other important issues and advisories which will require attention prior to and during remedial activities. These criteria and advisories to be considered include:
    - *Health Advisories.* Carcinogenic and non-carcinogenic risk levels due to consumption of contaminated drinking water will be exceeded.
    - *Federal Groundwater Protection Strategy of 1984.* Current, applicable "Class I" enforcement standards will not be met under this alternative. Groundwater quality standards are exceeded.
    - *Threshold Limit Values (TLVs).* There is no indication that these levels will be exceeded for site remediation workers under this alternative.

In terms of wetland remediation under this alternative, excavation of contaminated sediments at the Richardson Pond Group and Content Brook and capping in Wetland 2 Group will be supplemented with monitored natural attenuation. To mitigate unavoidable wetland impacts, a site restoration plan

will need to be developed. Included within this plan will be specifications for restoration of areas impacted by the remedial action, revegetation standards, and wetlands monitoring for at least three growing seasons after remediation is completed.

Location-specific ARARs and TBCs relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2), will be met under this alternative as long as monitoring provides support that no further remedial actions will be necessary to meet the intent of Executive Order 11990, and as long as mitigation of excavated or capped wetlands is completed.

Table 5-18 lists the action-specific ARARs for this "Sediment Source Control" alternative. The alternative attains all action-specific ARARs except those related to groundwater protection. Corrective actions must be completed within a "reasonable time period." In terms of groundwater remediation under this alternative, monitored natural attenuation is to be implemented at AOCs #3 and 5 through increased monitoring of site groundwater. Demonstrating that the action-specific ARAR detailed below can be attained will require long-term monitoring and evaluation. In the event that this ARAR cannot be attained within an agreed-upon, designated time period, then the groundwater remedy proposed for this alternative will need to be modified by means of a Technical Impracticability (TI) Waiver and/or Explanation of Significant Difference (ESD) to the Record of Decision.

- Hazardous/Solid Waste Management - Groundwater Protection, 310 CMR 30.660 - 30.675, 310 CMR 19.110 (AOCs #1, 2, 3, 6, and 7): A groundwater monitoring program will be implemented at the Site. Corrective measures consist of monitored natural attenuation. Leachate generation from the landfill will be reduced but not eliminated. Monitoring will need to be conducted to determine attainment of this requirement.

In addition, hazardous waste management landfill stabilization/solidification (310 CMR 30.632) regulations require that all wastes disposed of in a landfill be treated to the maximum extent practicable to minimize the potential for wastes migrating from the landfill site. This alternative includes excavation of materials from AOC #3 and 7, and subsequent on-site disposal. Currently, the alternative does not include stabilization/solidification of these wastes. If, however, after sampling the excavated material is shown to be a hazardous waste, further treatment may be warranted and this

remedy revisited. This alternative includes sampling and analysis adequate to make this determination and, thus, attains this action-specific ARAR.

### 5.7.3 Long-Term Effectiveness and Permanence for Alternative #27

This alternative is evaluated below in terms of risk remaining at the Site after RAOs are addressed. This portion of the evaluation focuses on the extent and effectiveness of the controls required to manage the risk posed by treatment residuals and/or untreated contamination.

**5.7.3.1 Magnitude of Residual Risk: Human Health.** Alternative #27 implements controls to effectively eliminate exposure of workers to soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. For groundwater, Alternative #27 implements access restrictions to prevent human contact with COCs. In addition, the use of in-situ groundwater treatment at AOCs #1, 2, 3, 4, 6, and 7, the installation of treatment walls at AOCs #1, 2, 4, 6, and 7, and excavation and/or capping at AOCs #1, 2, 3, 4, 5, 6, and 7 are expected to partially reduce groundwater contamination at the Site. On-site groundwater containment will be partially expected. Under this alternative, the magnitude of residual risks will depend on the enforcement and reliability of institutional controls to prevent future human exposure to COCs in groundwater as well as the efficiency of the remedial measures at removal of soil COCs, and removal/containment of groundwater COCs.

Under this alternative, exposure of female site workers of child-bearing age to lead in indoor dust from soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Contaminated Soils Area, which was estimated to result in a maternal blood level exceeding that protective of a 95$^{th}$ percentile fetal blood lead level of 10 µg/dl, will be eliminated by capping at the Contaminated Soils Area, and eliminated through excavation and relocation of soils under capping for the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area. Likewise for the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will be significantly reduced by excavation and/or capping because fugitive dust

generation will be prevented. Therefore, the use of capping at these AOCs will effectively eliminate the estimated risk for site workers to soils, unless the caps are not maintained.

Potential future residual human health risks to a resident from ingestion of COCs in groundwater from AOCs #1 through 7 will be eliminated by the implementation of groundwater access restrictions as long as long-term enforcement of the groundwater access restrictions will be maintained. Should access restrictions not be maintained, the use of in-situ chemical oxidation at the B&M Locomotive Shop Disposal Areas and the use of a treatment wall at AOCs #1, 2, 4, 6, and 7 is expected to partially reduce residual risks by reducing the levels of some organic COCs (times to achieve PRGs of 1 year to >200 years; see Section 5.7.5.3 and Appendix G). However, little reduction in the levels of inorganic COCs is expected. Contaminated groundwater will be partially contained with this alternative, due to the use of treatment walls at AOCs #1, 2, 4, 6, and 7. However, risk to off-site receptors will be possible. As groundwater concentrations at AOCs #1 through 7 decline over time, there will be a partial lowering of residual risks to potential off-site receptors, and to on-site receptors should access restrictions not be maintained in the future. However, contaminant reduction will likely occur slowly for the most significant risk drivers (87 years to >200 years to achieve PRGs for arsenic and manganese; see Section 5.7.5.3 and Appendix G).

**5.7.3.2 Magnitude of Residual Risk: Ecological.** Alternative #27 will result in a quantifiable long-term reduction in risk to ecological receptors in soil, surface water and from sediments. The potential for exposure of small mammals to contaminants in soil will be removed at the B&M Railroad Landfill and the B&M Locomotive Shop Disposal Areas.

The removal or control of all the major source areas on-site will reduce the potential for discharge of metals in surface water runoff and gradually reduce concentration of contaminants discharged from groundwater. In the long-term, these mechanisms will reduce the concentration of metals contributing to risk to aquatic receptors in surface water. The risk to aquatic receptors from exposure to metals in surface water will persist until substantial decreases in contaminant discharge are achieved.

Resuspension of sediments, not treated by this alternative, will still remain a potential source of metals in surface water. However, capping of sediment in open water areas of Wetland 2 Group will further reduce the potential for resuspension or release of metals to surface water, thereby further reducing ecological risk to aquatic receptors in the long-term. Short-term, temporary increases in concentration of contaminants in surface water will be possible during capping in Wetland 2 Group, spot excavation in Richardson Pond Group, East Middlesex Canal Group and West Middlesex Canal Group, and excavation/dredging of sediment in open water areas of Content Brook Wetland Group. The residual risk to aquatic receptors will not be lowered substantially below baseline conditions for Alternative #27 in the short-term, but will be expected to improve in the long-term after soil, groundwater, and sediment source controls become effective. These measures will result in quantifiable reduction of risk to aquatic receptors.

Since direct measures will be taken in Alternative #27 to remove/reduce exposure from contaminants in sediments, this alternative will result in a substantial reduction of risk to benthic invertebrates. The open water areas of the Wetland 2 Group, including the unnamed brook, the associated pond west of the B&M Wastewater Lagoons (OU1), and the B&M Pond, will be capped. The capping will result in the reduction of mobility of total PAHs, 4,4'-DDD, antimony, copper and lead from contaminated sediments in the treated areas. The RAO for protection of exposure of benthic invertebrates from contaminants will be achieved in these areas. However, there will be residual risk to benthic invertebrates inhabiting adjacent emergent wetlands, where analytes continue to exceed PRGs. The overall reduction of risk to benthic invertebrates will be substantial; the amount of remaining risk is unknown since the extent of area that will continue to exceed PRGs is unknown.

Spot excavation of isolated areas of sediment with high concentrations of PAHs in Richardson Pond will substantially reduce risk to benthic invertebrates. Exposure of benthic invertebrates to PAHs will be eliminated in the areas of excavation. Residual risk will remain in any areas in which concentrations of PAHs in sediments exceeding the PRG of 4.5 mg/kg will not be excavated. It is assumed that the majority of the sediments of the pond with total PAH concentrations above the PRG will be removed and the ecological RAO will be attained for Richardson Pond.

Removing the contaminated sediments from open water and "hot spot" areas in Content Brook Wetland Group will result in achieving the RAO for protection of exposure of benthic invertebrates in these areas. There will be residual risk to benthic invertebrates inhabiting adjacent emergent wetlands, where arsenic may continue to exceed PRGs. The reduction of risk to benthic invertebrates will be substantial, however, the amount of remaining risk is unknown since the extent of area that will continue to exceed PRGs is unknown.

The only effects on the concentration of contaminants in areas outside of dredging and capping activities will be dilution/dispersal through slow, natural processes and a minor reduction in the deposition of additional contamination from surface water over time. Consequently, the concentration of contaminants in sediments outside of open water areas on-site will continue to pose a risk to benthic invertebrates under Alternative #27. The overall risk to benthic invertebrates site-wide will be substantially reduced below baseline conditions under Alternative #27.

### 5.7.4 Reduction of Toxicity, Mobility and Volume through Treatment for Alternative #27

Table 5-19 provides a summary of the treatment and process options selected, quantities of waste materials to be remediated, expected reductions in toxicity, mobility and volume, and residuals following treatment for Alternative #27. No human health or ecological risk was determined for soil at AOC #2 (RSI Landfill). Likewise, no risk was determined for surface water at AOC #8a (West Middlesex Canal Group) and AOC #8c (East Middlesex Canal Group). Therefore, reductions in toxicity, mobility and volume were not evaluated for these media at these AOCs. As a provision if future sediment toxicity testing results in ecological risk, actions are included in the alternative for AOCs #8a and #8c and evaluated below.

**5.7.4.1 Treatment/Recycling Processes to be Utilized.** Alternative #27 consists of horizontal containment and excavation and on-site disposal remedies for soil, which are not considered treatment processes. Groundwater treatment processes to be utilized include monitored natural attenuation, as a stand-alone process and in addition to in-situ chemical oxidation, and passive/reactive treatment walls with enhanced biodegradation. Monitored natural attenuation will be implemented at all AOCs

showing risk in surface water. Source control methods, consisting of in-situ capping and dry excavation/dredging and on-site disposal, as well as monitored natural attenuation, will be utilized to address contaminated sediment. Source control methods for sediment are not considered treatment processes. A more detailed description of the treatment/recycling processes to be utilized under Alternative #27 is provided in Section 5.7. Refer to Table 5-19 for specific treatment/recycling processes to be utilized at each AOC.

**5.7.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The following amounts of hazardous materials to be treated for Alternative #27 are provided below by media of concern and AOC. Values are only given if the remedial action will provide treatment. Monitored natural attenuation is considered a treatment process in this evaluation, since it typically results in reductions in contamination over time. Source control remedies and institutional actions are not considered treatment processes.

<u>Groundwater (areal extent of source)</u>

| | |
|---|---|
| • AOC #1 - B&M Railroad Landfill | 12.4 acres |
| • AOC #2 - RSI Landfill | 2.5 acres |
| • AOC #3 - B&M Locomotive Shop Disposal Areas | 4.7 acres |
| • AOC #4 - Old B&M Oil/Sludge Recycling Area | 7.0 acres |
| • AOC #6 - Asbestos Landfill | 13.3 acres |
| • AOC #7 - Asbestos Lagoons | 1.9 acres |

<u>Sediment</u>

| | |
|---|---|
| • AOC #8a - West Middlesex Canal Group | non-excavated sediments |
| • AOC #8b - Wetland Group 2 | non-open water sediments |
| • AOC #8c - East Middlesex Canal Group | non-excavated sediments |
| • AOC #8d - Richardson Pond Group | non-excavated sediments |
| • AOC #8e - Content Brook Wetland Group | non-open water sediments |

<u>Surface Water</u>

| | |
|---|---|
| • AOC #8b - Wetland Group 2 | 7.6 acres |
| • AOC #8d - Richardson Pond Group | 107 acres |
| • AOC #8e - Content Brook Wetland Group | 1.4 acres |

**5.7.4.3 Degree of Expected Reductions in Toxicity, Mobility and Volume.** The degree of treatment and expected reductions for each treatment process under Alternative #27 are provided below by media of concern and AOC. Reductions expected from source control and excavation and on-site

disposal are not discussed, since these processes are not considered treatment. Reductions from monitored natural attenuation are provided for the U.S. EPA default time period, 30 years. For surface water and lesser contaminated sediments in the wetlands, reductions are provided in general terms. Intensive transport modeling required to provide quantifiable reductions is beyond the scope of this FS. Only limited case studies, which can not provide a comprehensive, quantitative estimate, are available in technical literature.

At all AOCs, no contaminated soil is treated under Alternative #18. Therefore, no reductions in toxicity, mobility and volume are expected for soil at all AOCs.

Passive/reactive treatment walls are expected to treat near 100% of the overburden groundwater at AOCs #1, 2, 4, 6, and 7. The degree of treatment of in-situ enhanced biodegradation, to be implemented to treat bedrock groundwater at these same AOCs, will be dependent on the density of the injection network. The amount of contaminated groundwater to be treated at AOC #3 through in-situ chemical oxidation will likewise be dependent on the density of the injection network. The total amount of contaminated groundwater at AOC #5 will be treated by monitored natural attenuation under Alternative #27. There are no organics above PRGs at AOC #4. Therefore, the passive/reactive treatment wall to be implemented at AOC #4 consists of only one media for the treatment of inorganics. Reductions in toxicity, mobility and volume expected for groundwater are provided below.

Toxicity

- Passive/reactive treatment walls and in-situ enhanced biodegradation are expected to reduce the toxicity of the contaminated groundwater relative to a specific contaminant proportional to the volume reduction of that specific contaminant at AOCs #1, 2, 4, 6, and 7.
- At AOC #3, the toxicity of the contaminated groundwater relative to a specific contaminant will be reduced proportional to the volume reduction of that specific contaminant through the in-situ chemical oxidation process.
- Monitored natural attenuation will be expected to reduce the toxicity of the contaminated groundwater relative to a specific contaminant proportional to the volume reduction of that specific contaminant at AOC #5.

Mobility

- At AOCs #1, 2, 4, 6, and 7, passive/reactive treatment walls will reduce the mobility of overburden contaminants to outside of each respective AOC by near 100%. In-situ

enhanced biodegradation will provide no reduction in mobility of bedrock contaminants.

- In-situ chemical oxidation with monitored natural attenuation and monitored natural attenuation alone will not provide reductions in the mobility of contaminants at AOCs #3 and 5, respectively.

Volume

- The volume reductions provided below for passive/reactive treatment walls represent the upper bound limits upon completion of the groundwater remedy. Lesser values will result during the interim period prior to this endpoint.
- Passive/reactive treatment walls are expected to reduce the volume of organic COCs by 94% to 99% (Bryda and Morris, 1997) and inorganic COCs by 87% to 99% (U.S. EPA, 1999) in the overburden groundwater at AOCs #1, 2, 6, and 7. Inorganic COCs at AOC #4 are expected to exhibit an equivalent volume reduction as stated above in the overburden groundwater.
- In-situ enhanced biodegradation will be expected to reduce organic COCs in the bedrock groundwater by 87% to 93% (Grindstaff, 1998) at AOCs #1, 2, 6, and 7.
- The volume of organic COCs at AOC #3 will be expected to be reduced by approximately 94% to 99% (U.S. EPA, 1998e, Bryant et al, 1998) by in-situ chemical oxidation. Inorganics at AOC #3 will be reduced by approximately 16% through natural flushing processes, as determined through MODFLOW modeling (Appendix G).
- Organic COCs reductions in volume are expected to range from less than 15% to 100% at AOC #5. This broad range is due to differing physical and chemical properties on a compound by compound basis. Greater reductions of organics are possible due to biodegradation. Specific compounds used in the MODFLOW simulations, as well as BIOSCREEN results which additionally consider biodegradation rates, can be found in Appendix G. Inorganics are expected to be reduced by less than 15% at AOC #5 through monitored natural attenuation. These low reductions may be attributed to adsorption of compounds to the soils within the aquifer. For specific compounds used the MODFLOW modeling, reference Appendix G.

Monitored natural attenuation will be expected to treat the total quantity of contaminated surface water at AOCs #8b, 8d, and 8e. The toxicity of the contaminated surface water relative to a specific contaminant will be reduced proportional to the volume reduction of that specific contaminant. The mobility of the contaminants and the volume of the contaminated media will not be reduced through monitored natural attenuation. The volume of both organic and inorganic COCs will be expected to be reduced over time in surface water.

Only non-excavated sediments in AOCs #8a, 8c, and 8d and non-open water sediments in AOCs #8b and 8e are treated under Alternative #27 via monitored natural attenuation. Sediments addressed through in-situ capping, to be implemented at AOC #8b, as well as spot excavation and open-water dry excavation/dredging, to be implemented at AOCs #8a, 8c, 8d and 8e, will not be treated. Monitored natural attenuation is expected to reduce the volume of contaminants at all AOCs over time. The toxicity reduction of the contaminated sediments relative to a specific contaminant is expected to be reduced proportional to the volume reduction of that specific contaminant at each respective AOC through monitored natural attenuation. There will be no mobility reduction of COCs in the lesser contaminated sediments addressed through monitored natural attenuation at all AOCs.

**5.7.4.4 Reversibility.** The reversibility of each treatment process to be implemented under Alternative #27 is discussed below by media of concern and AOC. Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. Since source control, excavation and on-site disposal, and institutional actions are not considered treatment processes, reversibility of treatment is not applicable to these processes.

In groundwater, passive/reactive treatment walls, to be implemented at AOCs #1, 2, 4, 6, and 7, typically degrade volatile organics and immobilize inorganics, dependent on the treatment media. Degradation structurally alters contaminants, a process that is not considered reversible. Inorganics are immobilized through sorption to the treatment media and are not readily released. In bedrock groundwater at the above mentioned AOCs, in-situ enhanced biodegradation will also utilize degradation and therefore, is not considered reversible.

In-situ chemical oxidation, to be implemented at AOCs #3, is not considered a reversible process. Contaminants are oxidized and thereby physically altered. Monitored natural attenuation, to be utilized in addition to chemical oxidation at AOC #3 and as a stand-alone process at AOC #5, is not considered reversible. Organic contaminants are degraded over time. Inorganic contaminants, on the other hand, may only be temporarily immobilized and later released.

In surface water, monitored natural attenuation processes to be implemented at all AOCs are not considered reversible. Contaminants are degraded and dispersed over time.

Monitored natural attenuation of lesser contaminated sediments is not considered reversible, as the contaminants are degraded over time.

**5.7.4.5 Type and Quantity of Residuals.** The types and quantities of contaminant residuals by media of concern and AOC expected after completion of the treatment technologies/process options implemented in Alternative #27 are summarized below. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are discussed briefly in Table 5-19. The contaminant residuals for all groundwater treatment processes except monitored natural attenuation presented below represent the expected amounts remaining at the given AOC upon completion of the groundwater remedy. Residuals in greater amounts will be expected during the interim period prior to this endpoint.

All of the contaminated soils at AOCs #1, 5, and 6, along with the soils to be excavated from AOCs #3, 4, and 7, will remain untreated but contained under a cap.

An estimated 1% to 6% of organic COCs and 1% to 13% of inorganic COCs will remain in the overburden groundwater at AOCs #1, 2, 6, and 7 following treatment by passive/reactive treatment walls. The overburden groundwater at AOC #4 is expected to contain 1% to 13% of the original inorganic COCs. These residuals resulting from groundwater treatment by passive/reactive treatment walls represent remaining COCs upon completion of the groundwater remedy. Residuals in greater amounts are expected in the interim period prior to this endpoint. In bedrock groundwater at AOCs #1, 2, 6, and 7, approximately 7% to 13% of organic COCs will remain after treatment by in-situ enhanced biodegradation.

At AOC #3, approximately 1% to 6% of organics and 84% of inorganics will remain in the groundwater following treatment by in-situ chemical oxidation and monitored natural attenuation. An estimated 0% to greater than 85% of organic COCs will remain in the groundwater at AOC #5 after 30 years of treatment by monitored natural attenuation. Compounds that are resistant to degradation will

persist after treatment, while readily degradable compounds will not. Inorganics at AOC #5 remaining after treatment by monitored natural attenuation are expected to be greater than 85%.

Contaminant residuals in surface water following treatment by monitored natural attenuation were not determined due to the lack of a comprehensive, quantitative reduction estimate.

The most contaminated sediments at AOC #8b will remain untreated but contained under an in-situ cap. Sediments excavated from AOCs #8a, 8c, 8d, and 8e will be removed from the wetlands, but remain untreated under an on-site protective cap. The residuals from monitored natural attenuation of lesser contaminated sediments at all AOCs were not determined because a reduction estimate was not quantified.

### 5.7.5 Short-Term Effectiveness for Alternative #27

This alternative is evaluated for effectiveness in protecting the community and local workers, site remediation workers, and the environment during the construction and implementation of the remedy.

**5.7.5.1 Protection of Community and Workers During Remedial Actions.** The construction and remediation measures proposed under this alternative include excavation and placement of soils from the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Asbestos Lagoons beneath a cap, capping of the B&M Railroad Landfill, RSI Landfill, Contaminated Soils Area and Asbestos Landfill, in-situ groundwater treatment at AOCs #1, 2, 3, 4, 6 and 7, and groundwater monitoring at AOCs #1 through 7. The implementation of these construction/remedial measures will potentially result in additional short-term risk to the community from exposure to soil contaminants primarily associated with dust generation during soil disturbances at the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. Precautions will be implemented to prevent or limit fugitive dust generation during excavation/remedial activities. Worker exposure to COCs in soil and groundwater during in-situ treatment, excavation/capping and monitoring will also

result in potential health risk to workers. Use of personal protection equipment will be employed to reduce exposure if applicable OSHA standards are exceeded during these activities.

**5.7.5.2 Environmental Impacts.** The capping of B&M Railroad Landfill, RSI Landfill, Contaminated Soils Area, Asbestos Landfill and excavation of the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Asbestos Lagoons will all require removal of vegetation. Injection wells and attendant facilities will be installed at the Old B&M Oil/Sludge Recycling Area. Passive/reactive treatment walls will also be constructed between the edge of the landfill and the wetlands at B&M Railroad Landfill, RSI Landfill, the Asbestos Landfill, the Old B&M Oil/Sludge Recycling Area, and the Asbestos Lagoons. Wetlands are located around the border of a portion of each of these areas, with the exception of the Old B&M Oil/Sludge Recycling Area. The extent of excavation or fill in wetland is estimated to be minimal for each alternative. Mitigation measures will include avoidance and minimization of temporary construction disturbance in adjacent wetlands during construction of landfill caps or treatment walls. Tree removal will be minimized, and proper construction and erosion control methods will be utilized. Mitigation will further include restoration of upland habitat, and minimization of wetland impacts. Any unavoidable wetland loss will be mitigated by restoration or creation of on-site wetlands. Changes in hydrology resulting from construction of landfill caps and treatment walls will be mitigated by properly designed stormwater retention systems and maintenance of flows of water close to existing conditions. Potential alterations in the hydrology and seasonal water levels in the adjacent wetlands will be minimized. Pumping rates and re-injection rates of water to wells will be implemented which are predicted, via modeling, to have minimal effects on water elevations in wetlands.

The alternative will include installation of monitoring wells throughout the Site. Mitigation measures will include avoidance and minimization of temporary construction disturbance in adjacent wetlands during construction of monitoring wells, and minimization of tree removal. Proper construction and erosion control methods will be utilized to minimize ecological impact to surrounding habitats.

Sediment capping at Wetland 2 will also result in temporary wetland impacts for access roads and significant wetland impacts resulting from placement of cap material. The loss of pond and stream

habitat will result in a loss of flood storage capacity, sediment/toxicant retention capacity, and wildlife habitat in Wetland 2 Group. Mitigation will include minimization of impacts in wetland areas and restoration of access roads by returning impacted areas to previous grades and restoring wetland vegetation. Any unavoidable wetland loss from capping will be mitigated by restoration or creation of on-site wetlands. The size and location of wetland mitigation areas will be determined during design based on the estimated wetland loss (approximately 10 acres). Appropriate erosion control techniques will be implemented to prevent impacts to adjacent wetland areas during construction.

Spot excavation and on-site disposal of sediments in Richardson Pond Group, West Middlesex Canal Group, and East Middlesex Canal Group will also result in temporary wetland impacts for access roads and additional areas of wetland impacts resulting from dredging of wetland sediments. Mitigation will include minimization of wetland impacts and restoration of access roads by returning impacted areas to previous grades and restoring wetland vegetation. Any unavoidable wetland loss from dredging will be mitigated by restoration or creation of on-site wetlands. The majority of the dredged areas will be restored to grade after dredging by backfilling with suitable material to replace the substrate. Appropriate erosion control techniques will be implemented to prevent impacts to adjacent wetland areas during dredging, and prevent downstream discharge of sediment.

Excavation and on-site disposal of sediments from open channel areas in Content Brook Wetland Group will also result in wetland impacts. Sediment removal will result in temporary wetland impacts for access roads and additional areas of wetland impacts resulting from dredging of wetland sediments. Mitigation will include minimization of wetland impacts, restoration of impacted areas to previous grades and restoration of wetland vegetation. Any unavoidable wetland loss from dredging will be mitigated by restoration or creation of on-site wetlands (approximately 1.5 acres). The majority of the dredged areas will be restored to grade after dredging by backfilling with suitable material to replace the substrate. Appropriate erosion control techniques will be implemented to prevent impacts to adjacent wetland areas during dredging, and prevent downstream discharge of sediment.

**5.7.5.3 Time Until Remedial Action Objectives are Achieved.** Of the RAOs presented in Section 2, those for groundwater will take the longest to achieve. Through the use of groundwater flow modeling

and contaminant retardation concepts (Appendix G), approximate times to achieve PRGs were calculated for the Site contaminants at each AOC. It should be noted that the mobility of inorganics is highly sensitive to site specific geochemistry. Other factors such as pH, dissolution, and colloidal transport could have significant impacts on mobility of inorganics. Therefore, these times should only be used for relative comparison and not for accurate representations of cleanup times.

Alternative #27 includes monitored natural attenuation as a groundwater treatment process at AOCs #3 and 5. Additionally, in-situ chemical oxidation will be used at these AOC #3. This is expected to lower the times for reduction of organics at this AOC significantly. However, injection of oxidant solution may also change the Site hydrology such that contaminants will not disperse as fast at other AOCs.

An in-situ groundwater remedy consisting of passive/reactive treatment walls and enhanced biodegredation will also be applied to AOCs #1, 2, 4, 6, and 7. Furthermore, site hydrology may be impacted by caps placed on AOCs #1, 2, 5, and 6. As described for Alternative #18, the treatment walls are designed to be right on the edge of the disposal areas, so the distance for contaminant migration/treatment is typically less than previous alternatives which did not have the walls. For those alternatives, nearby wetlands were typical discharge points selected for time calculations.

Modeling was performed to predict the reduction of contaminant concentrations over time due to natural processes, such as dispersion. However, additional contaminant reduction is expected to occur due to biodegradation. This aspect of monitored natural attenuation was evaluated using the BIOSCREEN natural attenuation decision support system (Appendix G). While improved cleanup times were estimated for a few compounds at the Site, these times were similar to those without biodegradation. Approximate cleanup times, assuming no biodegradation, for each AOC with contaminants above PRGs are presented below:

| Overburden | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | 55 | ND | >200 | >200 |
| AOC #2 - RSI Landfill | 50 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas* | 8 | ND | ND | 183 |

| | | | | |
|---|---|---|---|---|
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | 87 |
| AOC #5 - Contaminated Soils Area | 33 | 153 | >200 | >200 |
| AOC #6 - Asbestos Landfill | 20 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 18 | 153 | ND | >200 |

| Bedrock | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | 104 | 75 | ND | 146 |
| AOC #2 - RSI Landfill | 15 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | ND | ND | ND | ND |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | 180 |
| AOC #5 - Contaminated Soils Area | 107 | 128 | ND | >200 |
| AOC #6 - Asbestos Landfill | 8 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 51 | >200 | ND | >200 |

Notes: ND = Not detected at a concentration greater than PRGs at this AOC and flow zone
* - Times for organics are expected to be greatly reduced due to in-situ chemical oxidation

Some cleanup times reported above are high (i.e., greater than 200 years). This simply means that the compounds are essentially immobile. For example, arsenic and thallium have very high retardation coefficients and, ultimately, high cleanup times.

It should also be noted that the only SVOC detected above PRGs at all AOCs was bis(2-ethylhexyl)phthalate and the only pesticide was aldrin. The high retardation factors of these compounds increase the time of travel and source contaminant reduction. Evaluations assumed that the Contaminated Soils Area contained contaminants similar to the B&M Railroad Landfill, RSI Landfill, and the Asbestos Lagoons. The two compounds noted above are therefore assumed to be found at this AOC above PRGs. However, further evaluation may determine that this is not the case. Furthermore, the evaluations assumed that the maximum detections from the three nearby AOCs were also detected at the Contaminated Soils Area. Similarly, data from the RSI Landfill was used to characterize the Asbestos Landfill.

### 5.7.6 Implementability for Alternative #27

This section summarizes the technical and administrative feasibility of implementing Alternative #27, the "Sediment Source Control" alternative, and the availability of various services and materials required for its implementation.

**5.7.6.1 Technical Feasibility.** Evaluation of the technical feasibility of Alternative #27 includes an assessment of three factors described in EPA's feasibility study guidance: 1) the ability to construct and operate the technologies, 2) the reliability of the technologies and 3) the ease of undertaking additional remedial actions, if necessary. These aspects are described in detail below:

Ability to Construct and Operate the Technologies. For Alternative #27, similar to Alternatives #8 through 18, a major implementability issue with regard to technical feasibility will be the construction of caps at AOCs #1, 2, 5, and 6 and the excavation and removal of waste soil/waste fill from AOCs #3, 4, and 7 with relocation and regrading of these materials below one of the caps constructed at AOCs #1 or 2, and AOC #6, respectively.

As discussed previously for Alternatives #8 through 18, the capping and excavation remedies for Alternative #27 at AOCs #1, 2, 3, 4, 6, and 7 will require a substantial civil engineering/earthwork component. The key implementability issue will be the location of sensitive wetland areas or water bodies adjacent to every one of these AOCs. This will require comprehensive soil erosion, runoff and sedimentation control measures to minimize siltation impacts to wetland areas or water bodies. In addition, proper location and construction of temporary and permanent haul roads will be required to minimize impacts to wetland areas and water bodies. It is expected that the remediation contractor(s) will utilize the existing rail network to move equipment and materials to the largest degree possible. This rail network will be closely situated to five of the six "earthwork" AOCs (*i.e.*, #1, 2, 3, 4, and 6). While the scope of the earthwork and transportation required for the capping and excavation activities will be large, these are common problems faced and solved by experienced engineers and constructors. Maintenance of the capped and excavated areas will be straightforward requiring only periodic inspections, vegetation control (*e.g.*, mowing) and filling of areas of settlement. As a result, no implementability constraints are expected with regard to construction and operation of the soil remedy for AOCs #1, 2, 3, 4, 6, and 7 in Alternative #27.

As discussed previously for Alternative #18, the primary implementability concern for placement of the single-barrier cap at AOC #5 will be the limitation of conducting work within the Contaminated Soils Area while maintaining active use of the rail yard, rail spurs and roads that transect it. Placement of a single-barrier cap will require sitework adjacent to active railbeds and tracks. Therefore, Alternative #27 will require measures such as temporary structural supports, temporary use restrictions for tracks or roadways next to active work areas and temporary

relocation of tracks and bedding material, if necessary. Implementing this remedy at AOC #5 will require close cooperation between rail yard users and the remediation engineer/contractor(s) and involve temporary disruptions to the rail yard operations. These are straightforward issues commonly faced and solved as part of construction efforts and are not sufficient to prevent consideration of this alternative as the selected remedy.

As discussed previously for Alternative #15, the primary implementability issues for construction of the of the groundwater remedies (*e.g.*, passive/reactive treatment walls, in-situ enhanced biodegradation) at AOCs #1, 2, 4, 6, and 7 are: 1) the close proximity of sensitive wetland or surface water areas and 2) the need to coordinate with soil "earthwork" remedies (*e.g.*, landfill caps, waste soils/waste fill excavations). Installation of groundwater remedies will require both deep and shallow trenching and drilling of vertical injection wells adjacent to wetlands or surface water bodies at AOCs #1, 2, 6, and 7. Comprehensive soil erosion, run-off and sedimentation controls will be required to minimize siltation impacts to wetlands and surface water bodies. The proposed locations of groundwater remedies also coincide closely with the limits of horizontal caps or waste soil/waste fill excavations at AOCs #1, 2, 3, 4, 6, and 7. Close cooperation will be required amongst the remediation engineers and contractor(s) to bring about successful construction at these tight junctures. Ensuring appropriate erosion control and proper construction phasing and coordination are aspects commonly faced and solved by experienced engineers and constructors. For these AOCs, operation & maintenance concerns for groundwater will be less of an issue than constructability concerns. Periodic replacement of spent treatment media will be a required O&M activity for the passive/reactive treatment walls. The in-situ enhanced biodegradation mixing plant and distribution system (*e.g.*, pipelines and vertical injection wells) will require necessary, but typical, O&M activities appropriate to these types of groundwater treatment facilities. As a result, no implementability constraints are expected with regard to construction and operation of the groundwater remedy for AOCs #1, 2, 4, 6, and 7 in Alternative #27.

The primary implementability concerns for groundwater treatment at AOC #3 using in-situ chemical oxidation will be the limitation of constructing the injection wells and distribution piping while materials from this AOC are excavated and removed for placement under one of the caps installed for AOCs #1, 2, or 6. Alternative #27 further incorporates the use of monitored natural attenuation as a method to remediate any residual contaminated groundwater not addressed by in-situ oxidation at AOC #3 and the single-barrier cap installed at AOC #5. As discussed previously for Alternatives #5 through 18, construction of monitored natural attenuation only requires installation of groundwater monitoring wells and "operation" only requires monitoring efforts to sample and analyze the groundwater.

For Alternative #27, several implementability issues will need to be addressed with regard to construction and maintenance of the sediment cap at AOC #8b in portions of the unnamed brook and associated pond west of the B&M Wastewater Lagoons (OU1). Initial construction efforts will require removal of large obstructions such as boulders, trees, shrubs and secondary growth from the streambed, pond bottom and, at least a portion of, the adjacent banks. Access roads will need to be constructed along the banks adjacent to the areas to be capped to allow transport of materials, access for construction equipment and personnel and as a means for future

inspection and maintenance activities. The streambed and pond areal extent will need to be widened to maintain the same water elevations, flow capacity and overall drainage hydrology after the cap installation. Temporary silt control measures will be required to prevent downstream impacts during sediment cap construction activities. Work within the wetland, stream and pond areas will be limited to low-flow seasonal periods (late summer/early fall). Periodic, heavy storms will require suspension of work and temporary stabilization measures if construction were still in-progress. At the close of construction activities, wetlands, stream and pond restoration activities will be required for those areas impacted by construction. After construction completion, sediment cap maintenance will be required as part of O&M and will include periodic cap inspection and repair of any damage.

The sediment excavation and stream dredging activities at AOCs #8a, 8c, 8d, and 8e will also need to address similar construction implementability issues noted above: 1) installation of temporary access roads, 2) minimization of downstream siltation, 3) work limitations to seasonal low-flow periods, and 4) wetlands, streambed and pond restoration. In addition, the sediment mitigation activities at AOC #8e will require temporary diversion of Content Brook to allow efficient "dry" sediment excavation from source areas rather than dredging.

There are no implementability concerns with respect to construction or operation of monitored natural attenuation for the residual contaminated sediments at AOCs #8a through 8e and surface water at AOCs #8b, 8d, and 8e. No structures are required for construction and "operation" only requires periodic field testing, sampling and analysis.

Reliability of the Technologies. Reliability of the horizontal caps installed for AOCs #1, 2, and 6 will be considered high if normal periodic maintenance of the cap is conducted. The high reliability will also apply to the excavation and removal of waste soils/waste fill from AOCs #3, 4, and 7 with relocation and regrading of these materials below one of the caps constructed at AOCs #1, 2, or 6. The reliability of the single-barrier cap installed for AOC #5 will be less than the landfill caps and much more sensitive to proper inspection and maintenance. Due to the heavy rail and truck loads and the complex pattern of drainage that will be required to address stormwater runoff, a more intensive O&M program of inspection, maintenance and repair will be required to ensure appropriate integrity of the single-barrier cap.

As discussed previously for Alternative #15, the reliability of passive/reactive treatment walls for AOCs #1, 2, 4, 6, and 7 will be relatively high as will be expected for an in-situ technology. This assessment will be dependent on conducting periodic monitoring of the absorbent media to determine if contaminant "breakthrough" has occurred and timely replacement of spent adsorbent media within the treatment wall gates. The only other significant reliability concern will be long-term clogging or fouling of the treatment wall french drains and gates which will limit the effectiveness of the technology. The potential for clogging could be monitored by periodic water level measurements of piezometers associated with the treatment wall.

For in-situ oxidation of groundwater at AOC #3 under Alternative #27, the reliability of this technology is expected to be proportional to the reliability of the treatment delivery systems that

convey chemical oxidation solutions from a central "mixing plant" via pipelines and/or tanker vehicles to contaminated groundwater. As discussed for Alternative #15, if the facilities are designed, constructed and operated in a manner appropriate to accommodate periodic shutdowns, reliability concerns should not prove sufficient to prevent selection of this alternative as the final remedy. As stated previously under Alternative #5, the reliability of monitored natural attenuation to remediate any residual contaminated groundwater at AOCs #3 and 5 should be considered "high" since there will be no external equipment nor treatment systems that could breakdown. The reliability of the technology to meet PRGs, however, should not be confused with "implementability" but is more appropriately discussed under "effectiveness". The reader is directed to the "treatment efficiency" and the "time required to remediate" discussions in Sections 5.7.4, 5.7.5 and Appendix G.

The remaining soil and groundwater technologies for Alternative #27 include monitoring and institutional controls. Although the institutional controls which will be applied to AOCs #1 through 7 are not exactly technologies, their reliability will depend upon enforcement by the responsible agencies involved.

If appropriately designed and constructed to withstand storm and high flow conditions and properly maintained, the sediment cap for AOC #8b in Alternative #27 should approach the same reliability as the disposal area caps for AOCs #1, 2, and 6. The reliability of sediment excavation/dredging for AOCs #8a, 8c, 8d, and 8e will be equal to the long-term reliability of the caps for AOCs #1, 2, or 6 where these materials will be placed for ultimate disposal.

Ease of Undertaking Additional Remedial Actions. Applying additional remedial actions for contaminated soils contained by the horizontal caps installed at AOCs #1, 2, 5, and 6 will be severely restricted since installation of the caps are largely permanent remediation technologies. This conclusion will also apply to the excavation and removal of waste soils/waste fill from AOCs #3, 4, and 7 with relocation and regrading of these materials below one of the caps constructed at AOCs #1, 2, or 6.

Additional remedial actions could be accommodated to a limited degree in place of passive/reactive treatment walls and in-situ enhanced biodegradation of groundwater at AOCs #1, 2, 4, 6, and 7. The passive/reactive treatment walls are permanently installed but alternate types of absorbent media could be installed within the treatment wall gates. In addition, an alternate reactant solution could be used in-place of the bio-nutrient solution injected into the groundwater for in-situ enhanced biodegradation. Installation of an on-site groundwater pump and treat remedy will require major modifications to implement, especially if located adjacent to the AOC boundary. The passive/reactive treatment walls and gates will have to be blocked or grouted tight to prevent groundwater short-circuiting of the extraction well system. Additional groundwater remedies will be best implemented downgradient from the existing treatment structures at AOCs #1, 2, 4, 6, and 7.

Additional remedial actions could be accommodated in place of in-situ chemical oxidation and monitored natural attenuation of groundwater at AOC #3 and the single-barrier cap installed at AOC #5. The only implementability limitation will be that the new groundwater remediation

technologies will need to accommodate the active, working area of the Contaminated Soils Area rail yard.

For Alternative #27, applying additional remedial actions to the contaminated sediments contained by the cap at AOC #8b, or sediments that were excavated/dredged from AOCs #8a, 8c, 8d, and 8e and placed under caps at AOCs #1, 2, or 6 will be severely limited. For practical purposes, the technologies applied to these sediments are largely permanent. Additional technologies, however, could be used in place of monitored natural attenuation of remaining contaminated sediments at AOCs, #8a through 8e, or surface water at AOCs #8b, 8d, and 8e without any major implementability concerns.

**5.7.6.2 Administrative Feasibility.** Evaluation of the administrative feasibility of Alternative #27 involves assessing the steps required to coordinate with other federal, state and local governmental entities. It should be noted that under Superfund, permits are not required for remediation activities, but compliance with substantive requirements is required.

A major administrative feasibility issue with regard to Alternative #27, described previously for Alternatives #3 through 18, involves implementation of institutional controls in order to prohibit the use of groundwater. If proprietary controls are used, coordination with the individual property owners of the affected parcels, will be required. For example, implementation of a negative easement would require the property owner to convey to a third party (typically EPA) the right to limit how the landowner can use his or her property. Here the limitations would likely include prohibitions against the use of groundwater from wells on the property.

If governmental controls are used, coordination with federal, state and local government (the ATSDR, the Commonwealth of Massachusetts and/or the Town of Billerica) will be required. For example, implementation of land use restrictions may require the exercise of zoning authority by the Town of Billerica to prohibit residential development in a contaminated area, or the adoption of a building permit ordinance in the Town of Billerica requiring anyone seeking a building permit for construction activities in a particular area to be notified of contamination in the area and of any relevant management standards - such an ordinance could also be used to prohibit types of construction that would result in unacceptable exposures (e.g., excavation in areas where subsurface contamination has not been fully removed). Implementation of groundwater use restrictions may require action by the

Commonwealth of Massachusetts to prohibit or limit certain uses of groundwater in particular areas, or require closing or capping of wells. Implementation of advisories may also require action by the ATSDR or Commonwealth of Massachusetts to publically issue warnings that provide notice to potential users of land, surface water or groundwater of some existing or impending risk associated with their use.

Another administrative feasibility issue for Alternative #27 involves the sediment source control remedies. The sediment remedies (*e.g.*, capping, dredging, excavation and on-site disposal) conducted at AOCs #8a through 8e will all require a substantial administrative component to ensure that the design, construction and long-term maintenance are in accordance with the substantive ARAR requirements for wetland, stream and pond areas. Appropriate lead-times will be required during both the design and construction-phases to interact with the various agencies involved and to reach agreement on the specifics of the remedies.

The sediment remedy at Richardson Pond will further require coordination between the remediation contractor, Boston & Maine Railroad (B&M) as well as the Massachusetts Bay Transportation Authority (MBTA). This will be required since AOC #8d will be the only area of concern north of the B&M/MBTA tracks and all site access points lie south of the tracks. At a minimum, remediation vehicles will need access to use the B&M/MBTA rail right-of-way.

Due to the relative locations of the Richardson Pond and the Content Brook wetland groups, sediment remedies at AOCs #8c, 8d, and 8e will need to be coordinated with the selected remedy at Operable Unit 2 of the Iron Horse Park CERCLA Site (*i.e.*, Shaffer Landfill). The OU2 remedy selected, and currently under construction, is capping of Shaffer Landfill along with construction of an upgraded landfill gas flare station. As part of the remedy, there will be construction of access roads and stormwater detention basins at various points around the landfill perimeter.

An additional administrative issue will be to reach agreement between federal, state and local governmental entities on the specifics of implementing the monitored natural attenuation program. Under Alternative #27, this program will address groundwater at AOCs #3 and 5, residual sediment

contamination at AOCs #8a through 8e, and surface water at AOCs #8b, 8d, and 8e. Concurrence among the various governmental enitities will be required in defining the program (*e.g.*, number and type of monitoring locations, analytical/test parameters, frequency of testing) as well as interpretation of results and conclusions regarding the overall success of monitored natural attenuation.

**5.7.6.3 Availability of Services and Materials.** Evaluation of the availability of services and materials for Alternative #27 includes an assessment of three factors in accordance with EPA's feasibility study guidance: 1) the availability of treatment, storage capacity and disposal services, 2) the availability of necessary equipment and specialists, and 3) the availability of prospective technologies. These aspects are described in detail below:

Availability of TSDF Services. Since no remedial actions requiring off-site transport, storage or disposal are to be implemented as part of Alternative #27, the "Sediment Source Control " alternative, there are no implementability constraints with regard to this issue for selection of this alternative.

Availability of Necessary Equipment and Specialists. A substantial quantity of heavy, earthmoving equipment as well as transport vehicles (both truck and rail variety) will be required for Alternative #27 during excavation of waste soils/waste fill from AOCs #3, 4, and 7, construction of the caps at AOCs #1, 2, 5, and 6 and installation of passive/reactive treatment walls at AOCs #1, 2, 4, 6, and 7. The numbers of equipment and vehicles required will be proportional to the number of caps/excavations/treatment walls being conducted simultaneously in a given construction season.

Experienced pavement engineers and contractors will be required to install the single-barrier pavement-type cap at AOC #5. This remediation team will be require experience in pavement installations adjacent to multiple rail and spur lines.

The highest need for specialists related to soil and groundwater remediation in Alternative #27 will be for three areas: 1) specialized legal counsel/assistance for implementation of the institutional controls, 2) consultants experienced in monitored natural attenuation of groundwater, surface water and sediment, and 3) engineers and contractors familiar with both civil sitework excavation and asbestos abatement. Implementation of the institutional controls is expected to be a time-consuming process but should not pose significant implementability concerns that will prevent selection of this alternative as the final remedy. Legal specialists experienced in both CERCLA and non-CERCLA sites are available to facilitate this process. Similarly, monitored natural attenuation has been a technology employed at CERCLA sites in the last 10 years and there will be a substantial number of environmental consultants with familiarity in implementing such a program. Thus, availability of consultants familiar with monitored natural attenuation should not prevent selection of this alternative as the final remedy. Engineers

and contractors familiar with both civil excavation/waste removal and asbestos abatement will be required for waste soil/waste fill removal from the Asbestos Lagoons with transfer to the Asbestos Landfill. An appropriate remediation team with experienced contractors of both types could be reasonably assembled to address this concern.

The sediment source control remedies for Alternative #27 will require specialists and some specialized equipment. The design/remediation contractor(s) will need to include a hydrology consultant on the team who will be familiar with the regional drainage patterns. This will be needed so that the sediment remedies (*e.g.*, sediment caps) do not impact overall site and area drainage. An experienced wetlands contractor will be an additional and necessary member of the team for restoration of wetland, stream and pond areas impacted by construction activities. The wetlands contractor will also be expected to provide appropriate guidance on diversion of Content Brook for sediments excavation at AOC #8e. Specialized equipment will include tracked or other low-ground pressure vehicles which resist "bogging down"during work in wetland areas of concern. Barge-mounted equipment is likely to be required for the sediment capping operations in open water ponds in AOC #8b.

Availability of Prospective Technologies. Alternative #27 will employ the use of in-situ chemical oxidation for groundwater at AOC #3, and passive/reactive treatment walls to mitigate contaminated groundwater at AOCs #1, 2, 4, 6, and 7. In addition, a sediment cap will be installed in portions of the unnamed brook and associated pond at AOC #8b. These are the only specialized technologies associated with Alternative #27. Although these technologies are not as "exotic" as many innovative technologies, they are still relatively uncommon and will require effort to identify and procure appropriate expertise, equipment and skilled personnel familiar with their design, construction and O&M. Therefore, these technologies will be the limiting factor in the overall implementability with regard to "availability" for this alternative.

### 5.7.7 Cost for Alternative #27

Total estimated capital cost associated with this alternative is $89.3 million. This estimate assumes a contingency of 20%. The present value of all O&M costs would be $94.1 million. This estimate assumes an inflation rate of 3%, an interest rate of 7%, and a contingency of 15%. The maximum duration of site remedial actions will be assumed to be 30 years, in accordance with RI/FS guidance (U.S. EPA, 1988). Total present worth costs would therefore be $183.4 million. Detailed costs for this alternative are presented in Appendix D. The costs associated with each alternative selected for detailed evaluation are summarized in Table H-1 of Appendix H.

An analysis was performed to determine the cost savings associated with combining similar treatment processes used at different AOCs. The cost savings associated with the combination of treatment plants for in-situ enhanced biodegradation (groundwater) are approximately $11.6 million. This reduces the alternative's total costs to $171.7 million. This analysis is presented in Appendix H.

### 5.7.8 State Acceptance for Alternative #27

Acceptance of the selected, site-wide remedial alternative by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 5.7.9 Community Acceptance for Alternative #27

Acceptance of the selected, site-wide remedial alternative by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 5.8 ALTERNATIVE #31 - "OFF-SITE ACTION"

Alternative #31 maximizes the use of process options and remedial technologies available at existing off-site treatment, storage and disposal facilities (TSDFs).

The overview of remedial action components for Alternative #31 is presented in Table 5-20 and Appendix F. Figure 5-7 details the remedial action site plan for this alternative. Alternative #31 includes the following remedial actions by media of concern and AOC:

Soil:

- At AOC #5 (Contaminated Soils Area), soil will be excavated, transported and disposed of using off-site treatment facilities (*e.g.,* solidification/stabilization facility, RCRA Subtitle C/D landfill). Monitoring will be used to confirm removal of affected areas.
- Source control remedies consisting of horizontal containment (*e.g.*, caps) will be implemented at disposal area AOCs [#1 - B&M Railroad Landfill, #2 - RSI Landfill (for groundwater source management), #6 - Asbestos Landfill, #7 - Asbestos Lagoons] to address human health and ecological risk and/or meet ARAR requirements.
- Contaminated soil at AOC #3 (B&M Locomotive Shop Disposal Areas) and AOC #4 (Old B&M Oil/Sludge Recycling Area) will be excavated and relocated for ultimate disposal under one of the caps installed for AOCs #1, 2, 6, or 7. Monitoring are conducted atAOCs #3 to confirm source mitigation.

Groundwater:

- An in-situ remedy consisting of monitored natural attenuation, physical processes for aquifer hydraulic and pneumatic fracturing and chemical oxidation will be applied to the highest human health risk-ranked AOC (#5 - Contaminated Soils Area). This remedy also includes institutional actions consisting of access restrictions (institutional controls) as well as monitoring.
- In-situ remedies consisting of monitored natural attenuation as well as institutional actions consisting of access restrictions (*e.g.*, institutional controls) and monitoring will be implemented at all remaining AOCs.

Surface Water and Sediment:

- Monitoring will be implemented at all three AOCs showing risk (#8b - Wetland 2 Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group). No remedial actions for surface water will be necessary at all remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) since contaminant concentrations are within acceptable human health and ecological risk levels. Sediment monitoring is included at these two AOCs as a provision if future toxicity testing results in ecological risk.

The detailed evaluation of Alternative #31 with respect to the nine FS criteria is presented in Sections 5.8.1 through 5.8.9.

### 5.8.1 Overall Protection of Human Health and the Environment for Alternative #31

Alternative #31 will provide some overall protection of human health and the environment by reducing some risks identified in the baseline risk assessment. For soil, overall protection of human health from implementation of Alternative #31 will result from the elimination of exposures to COCs in soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. In addition, the elimination of exposures to groundwater at AOCs #1 through 7 using institutional controls and monitored natural attenuation along with reduced COC concentrations from in-situ treatment at the Contaminated Soils Area will provide overall protection of human health from groundwater exposures. Identified ecological risks from exposures to soil will be significantly reduced, and exposures to surface water will be gradually reduced. In sediment, however, only minor reductions of risk to ecological receptors will be expected. Therefore, Alternative #31 fails to meet all RAOs for the Site, as defined in Section 2.1, and only partially reduces risks to human health and the environment. The protection of human health and the environment are discussed in Sections 5.8.1.1 and 5.8.1.2, respectively.

**5.8.1.1 Human Health Protection.** Alternative #31 will provide overall protection of human health by eliminating risks identified in the baseline risk assessment. Current baseline risks to human health at the Contaminated Soils Area for female site workers of child-bearing age from exposure to lead in soil via indoor dust will be eliminated as a result of soil excavation and off-site disposal. For the current female site worker of child-bearing age at the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area, baseline risks to human health from exposure to lead in soil via indoor dust will be eliminated as a result of excavation and relocation for ultimate disposal under one of the caps installed for AOCs #1, 2, 6 or 7. For the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will be abated by capping, since windborne exposure to asbestos will be eliminated. However, since no contaminant removal is performed with capping, the risk will return to baseline levels if the caps are not maintained.

The potential for future risks from ingestion of COCs in groundwater at the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons will be eliminated by restrictions on the future use of groundwater from these AOCs as a drinking water source. Significant reductions in groundwater concentrations for most organic COCs, with negligible reductions in inorganic COC concentration are expected to occur at the Contaminated Soils Area by the use of in-situ chemical oxidation. Information in Section 5.8.5.3 and Appendix G documents times to achieve PRGs of from 1 years to >200 years for organic COCs in contrast to remedial times of >200 years for inorganic COCs. These times are based on flushing only and the in-situ chemical oxidation is expected to reduce most organic COCs to concentrations below PRGs in less than 30 years. Reductions in groundwater COC concentrations are also expected to occur over time at AOCs #1, 2, 3, 4, 6 and 7 due to the removal of contaminated soil (at AOCs #3, 4, and 5) and placement of caps (at AOCs #1, 2, 6 and 7). Excavation and capping will lower groundwater COC concentrations by limiting the potential leaching of soil contaminants to groundwater. Natural processes will also contribute to the lowering of groundwater COC concentrations over time. However, contaminant reduction will likely occur slowly for the most significant risk drivers (>200 years to achieve PRGs for arsenic and manganese; see Section 5.8.5.3 and Appendix G). Since there will be no on-site containment of groundwater contamination with this alternative, risk to off-site receptors will be possible.

Additional short-term risks to workers will result from the use of in-situ remediation techniques at the Contaminated Soils Area, excavation and/or capping of AOCs #1, 2, 3, 4, 5, 6 and 7, and from soil and groundwater contact during monitoring. These risks will be mitigated by the use of appropriate personal protection equipment as needed. Specific long-term and short-term human health risks are discussed in Sections 5.8.3.1 and 5.8.5.1, respectively.

**5.8.1.2 Ecological Protection.** Alternative #31 will provide reductions in short-term and long-term risk to ecological receptors relative to baseline conditions for exposures to soil. Treatment of source areas will reduce long-term risk of exposure to aquatic receptors from surface water contaminants. The reduction of risk to ecological receptors in sediments is expected to be minor.

Capping the B&M Railroad Landfill and excavating the B&M Locomotive Shop Disposal Areas will prevent future potential for exposure of terrestrial mammals to metal concentrations, resulting in a significant reduction in ecological risk from exposure to soils.

Adverse impacts on aquatic receptors from exposure to inorganics in surface waters will be reduced at the Wetland 2 Group, the Richardson Pond Group and the Content Brook Wetland Group. The removal or control of all the major source areas on site will reduce the potential for discharge of metals in surface water runoff, and gradually reduce concentration of contaminants discharged from groundwater. These mechanisms will reduce the concentration of metals contributing to risk to aquatic receptors in surface water over time. Resuspension of sediments, not treated by this alternative, will still remain a potential source of metals in surface water. Impacts on benthic invertebrate populations from exposure to contaminants in sediment will not be reduced in the Wetland 2 Group, the Richardson Pond Group and Content Brook Wetland Group since the concentrations of contaminants in the sediments in these habitats will not be substantially reduced by this alternative. The PRGs for benthic invertebrates in wetlands will not be met.

The capping of B&M Railroad Landfill, RSI Landfill, Asbestos Landfill, Asbestos Lagoons, and excavation of the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area will all result in minor ecological impacts during construction.

### 5.8.2 Compliance with ARARs for Alternative #31

Chemical-specific ARARs and TBCs for the Site are discussed at length in Section 2.3.1. A summary of the implications of each chemical-specific ARAR for this "Off-Site Action" alternative include:

- Safe Drinking Water Act and Massachusetts Drinking Water Regulations. Federal and Massachusetts MCLs are relevant and appropriate for site groundwater. This alternative sets attainment of Federal SDWA MCLs and MMCLs for inorganic and organic chemicals as groundwater remediation goals. Monitored natural attenuation, however, is not anticipated to be

able to attain Federal SDWA MCLs or Massachusetts Maximum Contaminant Levels for inorganic chemicals in a reasonable time frame.

- Resource Conservation and Recovery Act Maximum Concentration Limits. RCRA groundwater corrective action requirements are relevant and appropriate requirements at the point of compliance at the limit of the waste management areas. The potential for contaminants to migrate from the area will be reduced by this alternative. Monitoring will be conducted to track exposure-based limits at the point of compliance, and to verify a reduction in the migration of contaminants. Monitored natural attenuation, however, is not anticipated to be able to attain Federal RCRA MCLs for inorganic chemicals in a reasonable time frame.

- Federal Water Pollution Control Act, as Amended by the Clean Water Act, Ambient Water Quality Criteria (AWQC). Freshwater acute and chronic AWQC for the protection of aquatic life are considered appropriate and relevant for the site wetlands. Leachate outbreaks and surface water runoff are controlled under this alternative, thereby reducing the probability that AWQC may be exceeded.

- Clean Air Act and Massachusetts Air Pollution Control Regulations. Dust or other potential emissions that may result from excavation of waste materials will be controlled under this alternative. There is no indication that ARARs for air will be exceeded by this alternative.

- Massachusetts Groundwater Quality Standards. Actions will be taken under this alternative in an attempt to attain applicable "Class I" enforcement standards. Although levels of some organic compounds in groundwater are anticipated to be reduced, this alternative is not anticipated to be able to attain groundwater standards for inorganic chemicals in a reasonable time frame.

- Massachusetts Surface Water Quality Standards. As part of the Shawsheen River Basin, site surface waters are classified as "Class B" habitat for fish, aquatic life and wildlife, and source of treated public water supplies. Surface water quality standards are considered applicable to site

surface waters. Leachate outbreaks and surface water runoff are controlled under this alternative, thereby reducing the probability that surface water quality standards may be exceeded.

- Federal Criteria and Advisories To Be Considered. In addition to the ARARs listed above, there are other important issues and advisories which will require attention prior to and during remedial activities. These criteria and advisories to be considered include:
    - *Health Advisories.* Carcinogenic and non-carcinogenic risk levels due to consumption of contaminated drinking water will be exceeded.
    - *Federal Groundwater Protection Strategy of 1984.* Current, applicable "Class I" enforcement standards will not be met under this alternative. Groundwater quality standards are exceeded.
    - *Threshold Limit Values (TLVs).* There is no indication that these levels will be exceeded for Site remediation workers under this alternative.

Location-specific ARARs and TBCs relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2), will not be met under this alternative. Although the minor impacts to wetlands and floodplains during cap construction will be mitigated, and no surface water discharges will occur, because the on-site wetlands will be allowed to remain in a degraded (contaminated) state, the "Off-Site Action" alternative for wetlands will not meet the intent of Executive Order 11990. This ARAR requires federal agencies to minimize wetland degradation and to preserve and enhance the beneficial uses of wetlands. This alternative will control the source of contamination and leave the wetlands and ecological habitats intact, but will also leave chemicals of concern in place.

Table 5-21 lists the action-specific ARARs for this alternative. The alternative attains most action-specific ARARs. Notable exceptions are those related to groundwater protection and corrective action. Corrective actions must be completed within a "reasonable time period." In terms of groundwater remediation under this alternative, monitored natural attenuation is to be implemented at all AOCs through increased monitoring of site groundwater. Demonstrating that the action-specific ARAR detailed below can be attained will require long-term monitoring and evaluation. In the event that this ARAR cannot be attained within an agreed-upon, designated time period, then the groundwater

remedy proposed for this alternative will need to be modified by means of a Technical Impracticability (TI) Waiver and/or Explanation of Significant Difference (ESD) to the Record of Decision.

- Hazardous/Solid Waste Management - Groundwater Protection, 310 CMR 30.660 - 30.675; 310 CMR 19.110 (AOCs #1, 2, 3, 6, and 7): A groundwater monitoring program will be implemented at the Site. Corrective measures consist of monitored natural attenuation. Leachate generation from the landfill will be reduced but not eliminated. Monitoring will need to be conducted to determine attainment of this requirement.

In addition, hazardous waste management landfill stabilization/solidification (310 CMR 30.632) regulations require that all wastes disposed of in a landfill are treated to the maximum extent practicable to minimize the potential for wastes migrating from the landfill site. This alternative includes excavation of materials from AOC #3 and subsequent on-site disposal. Currently, the alternative does not include stabilization/solidification of these wastes. If, however, after sampling the excavated material is shown to be a hazardous waste, further treatment may be warranted and this remedy revisited. This alternative includes sampling and analysis adequate to make this determination and, thus, attains this action-specific ARAR.

### 5.8.3 Long-Term Effectiveness and Permanence for Alternative #31

This alternative is evaluated below in terms of risk remaining at the Site after RAOs are addressed. This portion of the evaluation focuses on the extent and effectiveness of the controls required to manage the risk posed by treatment residuals and/or untreated contamination.

**5.8.3.1 Magnitude of Residual Risk: Human Health.** Alternative #31 implements controls to eliminate exposure of workers to soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. For groundwater, Alternative #31 implements access restrictions to prevent human contact with COCs. In addition, the use of in-situ groundwater treatment at the Contaminated Soils Area and the use of excavation and/or capping at AOCs #1, 2, 3, 4, 5, 6, and 7 are expected to partially reduce or contain groundwater contamination at the Site. However, on-site groundwater containment is not expected.

Under this alternative, the magnitude of residual risks will depend on the enforcement and reliability of institutional controls to prevent future human exposure to COCs in groundwater as well as the efficiency of the remedial measures at eliminating exposures to soil COCs.

Under this alternative, exposure of female site workers of child-bearing age to lead in indoor dust from soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Contaminated Soils Area, which was estimated to result in a maternal blood level exceeding that protective of a 95$^{th}$ percentile fetal blood lead level of 10 µg/dl, will be eliminated by soil excavation and off-site disposal at the Contaminated Soils Area, and eliminated through excavation and relocation of soils under capping for the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area. Likewise for the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will be eliminated by capping because fugitive dust generation will be prevented. Therefore, the use of excavation and/or capping at these AOCs will effectively eliminate the estimated risk for site workers to soils, unless the caps are not maintained.

Potential future residual human health risks to a resident from ingestion of COCs in groundwater from AOCs #1 through 7 will be eliminated by the implementation of groundwater access restrictions as long as long-term enforcement of the groundwater access restrictions is maintained. Should access restrictions not be maintained, the use of in-situ chemical oxidation at the Contaminated Soils Area is expected to partially reduce groundwater residual risks by significantly reducing the levels of organic COCs (see Section 5.8.1.1). However, little reduction in the levels of inorganic COCs is expected. Contaminated groundwater will not be contained with this alternative, even though COC concentrations will be monitored. Therefore, risk to off-site receptors will be possible. As groundwater concentrations decline over time, there will be a partial lowering of residual risks to potential off-site receptors, and to on-site receptors should access restrictions not be maintained in the future. However, concentration reduction is expected to occur slowly for the most significant risk drivers (>200 years to achieve PRGs for arsenic and manganese; see Section 5.8.5.3 and Appendix G).

**5.8.3.2 Magnitude of Residual Risk: Ecological.** Alternative #31 will result in a quantifiable long-term reduction in risk to ecological receptors in soil and surface water, but not from sediments. The

potential for exposure of small mammals to contaminants in soil will be removed at the B&M Railroad Landfill and the B&M Locomotive Shop Disposal Areas.

The removal or control of all the major source areas on site will reduce the potential for discharge of metals in surface water runoff and gradually reduce concentration of contaminants discharged from groundwater. In the long-term, these mechanisms will reduce the concentration of metals contributing to risk to aquatic receptors in surface water. The risk to aquatic receptors from exposure to metals in surface water will persist until substantial decreases in contaminant discharge are achieved.

Resuspension of sediments, not treated by this alternative, will still remain a potential source of metals in surface water. Therefore, residual risk to aquatic receptors will not be lowered substantially below baseline conditions for Alternative #31 in the short-term, but are expected to improve in the long-term.

Since no measures will be taken in Alternative #31 to directly remove/reduce exposure from contaminants in sediments, the only effects on the concentration of contaminants will be dilution/dispersal through slow, natural processes and a minor reduction in the deposition of additional contamination from surface water over time. Consequently, the concentration of contaminants in sediments on site will not be substantially reduced under Alternative #31 and the risk to benthic invertebrates will not be reduced below baseline conditions. The PRGs and RAOs for sediment will not be met.

### 5.8.4 Reduction of Toxicity, Mobility and Volume through Treatment for Alternative #31

Table 5-22 provides a summary of the treatment and process options selected, quantities of waste materials to be remediated, expected reductions in toxicity, mobility and volume, and residuals following treatment for Alternative #31. No human health or ecological risk was determined for soil at AOC #2 (RSI Landfill). Likewise, no risk was determined for surface water at AOC #8a (West Middlesex Canal Group) and AOC #8c (East Middlesex Canal Group). Therefore, reductions in toxicity, mobility and volume were not evaluated for these media at these AOCs. As a provision if

future sediment toxicity testing results in ecological risk, actions are included in the alternative for AOCs #8a and #8c and evaluated below.

**5.8.4.1 Treatment/Recycling Processes to be Utilized.** Alternative #31 consists of source control remedies, consisting of in-situ capping, and excavation with disposal both on- and off-site for soil. In-situ capping and excavation with disposal on-site are not considered a treatment processes. Soils that are excavated and transported off-site are assumed in this evaluation to be treated. Groundwater treatment processes to be utilized include monitored natural attenuation, as the sole treatment and in addition to chemical oxidation. Institutional actions to be implemented for surface water and sediment are not considered treatment processes. A more detailed description of the treatment/recycling processes to be utilized under Alternative #31 is provided in Section 5.8. Refer to Table 5-22 for specific treatment/recycling processes to be utilized at each AOC.

**5.8.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The following amounts of hazardous materials to be treated for Alternative #31 are provided below by media of concern and AOC. Values are only given if the remedial action will provide treatment. Monitored natural attenuation is considered a treatment process in this evaluation, since it typically results in reductions in contamination over time. In-situ capping, excavation with on-site disposal, and institutional actions are not considered treatment processes.

<u>Soil</u>

- AOC #5 - Contaminated Soils Area 10,800 $yd^3$

<u>Groundwater (areal extent of source)</u>

- AOC #1 - B&M Railroad Landfill 12.4 acres
- AOC #2 - RSI Landfill 2.5 acres
- AOC #3 - B&M Locomotive Shop Disposal Areas 4.7 acres
- AOC #4 - Old B&M Oil/Sludge Recycling Area 7.0 acres
- AOC #5 - Contaminated Soils Area 6.7 acres
- AOC #6 - Asbestos Landfill 13.3 acres
- AOC #7 - Asbestos Lagoons 1.9 acres

**5.8.4.3 Degree of Expected Reductions in Toxicity, Mobility and Volume.** The degree of treatment and expected reductions for each treatment process under Alternative #31 are provided below by

media of concern and AOC. Reductions expected from in-situ capping and excavation with on-site disposal are not discussed, since these processes are not considered treatment. Reductions from monitored natural attenuation are provided for the U.S. EPA default time period, 30 years.

All of the contaminated soil at AOC #5 will be treated under Alternative #31. The total volume of contaminated soils at AOC #5 is expected to be removed from the Site, thereby eliminating the contaminated media toxicity. The contaminant mobility at AOC #5 will also be eliminated through excavation and off-site treatment/disposal.

Monitored natural attenuation is expected to treat all of the contaminated groundwater at AOCs #1 through 4, 6, and 7. The amount of contaminated groundwater to be treated by in-situ chemical oxidation and monitored natural attenuation will be dependent on the density of the injection network. The following reductions in toxicity, mobility and volume will be expected for groundwater:

Toxicity

- Monitored natural attenuation is expected to reduce the toxicity of the contaminated groundwater relative to a specific contaminant proportional to the volume reduction of that specific contaminant at AOCs #1 through 4, 6, and 7. Intermediate products that are more toxic than parent compounds may result if incomplete biodegradation of original contaminants occurs.
- At AOC #5, the toxicity of the contaminated groundwater relative to a specific contaminant will be reduced proportional to the volume reduction of that specific contaminant through the in-situ chemical oxidation process.

Mobility

- Monitored natural attenuation will not provide reductions in mobility of COCs at AOCs #1 through 4, 6, and 5.

Volume

- In-situ chemical oxidation and monitored natural attenuation will not reduce the volume of contaminated media at AOC #5. The volume of organic COCs at AOC #5 is expected to be reduced by approximately 94% to 99% (U.S. EPA, 1998e, Bryant et al, 1998) by in-situ chemical oxidation. Inorganics at AOC #5 will be reduced by less than 15% through monitored natural attenuation, as determined through MODFLOW modeling (Appendix G).
- Monitored natural attenuation, with and without management of migration, will not reduce the volume of the contaminated media at AOCs #1 through 4, 6, and 7.
- Organic COCs reductions in volume are expected to range from less than 15% to 100% across the Site. This broad range is due to differing physical and chemical properties on

a compound by compound basis. Greater reductions of organics are possible due to biodegradation. Specific compounds used in the MODFLOW simulations, as well as BIOSCREEN results which additionally consider biodegradation rates, can be found in Appendix G. Table 5-22 provides estimated volume reductions for each AOC.

- Expected volume reductions from monitored natural attenuation for inorganic COCs are less than 15% across the Site. These low reductions may be attributed to adsorption of compounds to the soils within the aquifer. For specific compounds used the MODFLOW modeling, reference Appendix G. Inorganic volume reductions by AOC are provided in Table 5-22.

There will not be any expected reductions in toxicity, mobility and volume in surface water and sediment at AOCs #8b, 8d, and 8e and sediment at AOCs #8a and 8c. Institutional actions will not confirm reductions or treatment of waste materials.

**5.8.4.4 Reversibility.** The reversibility of each treatment process to be implemented under Alternative #31 is provided below by media of concern and AOC. Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. Since in-situ capping, excavation and on-site disposal, and institutional actions are not considered treatment processes, reversibility of treatment is not applicable to these processes.

The contaminated soils at AOC #5 will be removed from the Site, a process that is not considered reversible.

In-situ chemical oxidation, to be implemented at AOC #5, is not considered a reversible process. Contaminants are oxidized and thereby physically altered. Monitored natural attenuation, to be utilized in addition to chemical oxidation at AOC #5 and as a stand-alone process at AOCs #1 through 4, 6, and 7, is not considered reversible. Organic contaminants are degraded over time. Inorganic contaminants, on the other hand, may only be temporarily immobilized and later released.

**5.8.4.5 Type and Quantity of Residuals.** The types and quantities of contaminant residuals by media of concern and AOC expected after completion of the treatment technologies/process options

implemented in Alternative #31 are summarized below. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are discussed briefly in Table 5-22.

At all AOCs where horizontal containment will be implemented (AOCs #1, 6, and 7), the total amount of contaminated soil at each respective AOC will remain untreated but contained under the cap. The total amount of contaminated soil to be excavated from AOCs #3 and 4, will likewise remain untreated but contained, under an on-site cap. The contaminated soils from AOC #5 will be transported off-site, and monitoring will be utilized to confirm that no residuals will remain on-site.

At AOC #5, approximately 1% to 6% of organics will remain in the groundwater following treatment by in-situ chemical oxidation. Inorganic residuals following monitored natural attenuation are expected to be greater than 90%. In groundwater at all remaining AOCs (#1 through 4, 6, and 7), more toxic intermediate products may remain if incomplete degradation of original contaminants occurs through monitored natural attenuation. Estimated residuals following a monitored natural attenuation treatment period of 30 years, the U.S. EPA default time period, are provided below. As stated above, the high degree of variability in the reductions, and thus the residuals, is due to differing characteristics of compounds.

- It is expected that 0% to greater than 85% of the organic COCs and greater than 85% of the inorganic COCs will remain in the groundwater at AOC #1.
- The groundwater at AOC #2 is expected to contain 0% to 81% of the organic COCs and greater than 85% of the inorganic COCs after treatment.
- Greater than 85% of the inorganic COCs will remain at AOC #3 following treatment by monitored natural attenuation. No organic residuals are expected to remain at AOC #3.
- At AOC #4, it is expected that greater than 85% of the inorganic COCs will remain in the groundwater after treatment. There are no organics exceeding PRGs at AOC #4. Therefore, organic reductions were not evaluated.
- An estimated 0% to 45% of the organic COCs and greater than 85% of the inorganic COCs will remain in the groundwater at AOC #6 following treatment.
- It is anticipated that 0% to greater than 85% of the organic COCs and greater than 85% of the inorganic COCs will remain in the groundwater at AOC #7.

Institutional actions will be implemented at all AOCs showing human health and ecological risk in surface water and sediment, as well as at AOCs #8a and 8c, where future sediment toxicity testing results may result in ecological risk. Since institutional actions do not involve treatment, the original amounts of contaminated surface water and sediment will be assumed to remain at all AOCs.

### 5.8.5 Short-Term Effectiveness for Alternative #31

This alternative is evaluated for effectiveness in protecting the community and local workers, site remediation workers, and the environment during the construction and implementation of the remedy.

**5.8.5.1 Protection of Community and Workers During Remedial Actions.** The construction and remediation measures proposed under this alternative include implementation of in-situ remediation of groundwater at the Contaminated Soils Area, excavation and placement of soils from the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area beneath a cap, excavation and off-site disposal of soils from the Contaminated Soils Area, capping of the B&M Railroad Landfill, RSI Landfill, Asbestos Landfill, and Asbestos Lagoons, and monitoring of soil and groundwater.

The implementation of these construction/remedial measures will potentially result in additional short-term risk to the community from exposure to soil contaminants associated with dust generation during soil disturbances at the B&M Locomotive Shop Disposal Area, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. Precautions will be implemented to prevent or limit fugitive dust generation during excavation/remedial activities. Worker exposure to COCs in soil and groundwater during the remedial measures at the Contaminated Soils Area, excavation/capping at AOCs #1, 2, 3, 4, 5, 6 and 7, and monitoring will also result in potential health risk to workers. Use of personal protection equipment will be employed to reduce exposure if applicable OSHA standards are exceeded during these activities.

**5.8.5.2 Environmental Impacts.** The capping of B&M Railroad Landfill, RSI Landfill, Asbestos Landfill, Asbestos Lagoons, excavation of B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and the Contaminated Soils Area will all require removal of vegetation. Wetlands are located around the border of a portion of each of these areas, with the exception of the Old B&M Oil/Sludge Recycling Area and Contaminated Soils Area. The extent of excavation or fill in wetland is estimated to be minimal for each alternative. Mitigation measures will include avoidance and minimization of temporary construction disturbance in adjacent wetlands during construction of

landfill caps. Tree removal will be minimized, and proper construction and erosion control methods will be utilized. Mitigation will include restoration of upland habitat, and minimization of wetland impacts. Any unavoidable wetland loss will be mitigated by restoration or creation of wetlands on site. Changes in hydrology resulting from construction of landfill caps will be mitigated by properly designed stormwater retention systems and maintenance of flows of water close to existing conditions.

The alternative includes installation of monitoring wells throughout the site. Mitigation measures will include avoidance and minimization of temporary construction disturbance in wetlands during installation of monitoring wells, and minimization of tree removal. Proper construction and erosion control methods will be utilized to minimize ecological impact to surrounding habitats.

The excavation of soil adjacent to the unnamed brook in B&M Locomotive Shop Disposal Area A may potentially cause disturbance to the stream bank. Mitigation measures will include avoidance and minimization of temporary construction disturbance in the stream channel and returning impacted areas to previous grades. Any unavoidable wetland loss from excavation will be mitigated by restoration or creation of wetlands on site.

**5.8.5.3 Time Until Remedial Action Objectives are Achieved.** Of the RAOs presented in Section 2, those for groundwater will take the longest to achieve. Through the use of groundwater flow modeling and contaminant retardation concepts (Appendix G), approximate times to achieve PRGs were calculated for the site contaminants at each AOC. It should be noted that the mobility of inorganics is highly sensitive to site specific geochemistry. Other factors such as pH, dissolution, and colloidal transport could have significant impacts on mobility of inorganics. Therefore, these times should only be used for relative comparison and not for accurate representations of cleanup times.

Alternative #31 includes monitored natural attenuation as a groundwater treatment process at all AOCs. Additionally, in-situ chemical oxidation will be used at AOC #5, the Contaminated Soils Area. This is expected to lower the times for reduction of organics at this AOC significantly. However, injection of oxidant solution may also change the site hydrology such that contaminants will not

disperse as fast at another AOC. Site hydrology may also be impacted by caps placed on AOCs #1, 2, 6, and 7.

Modeling was performed to predict the reduction of contaminant concentrations over time due to natural processes, such as dispersion. However, additional contaminant reduction is expected to occur due to biodegradation. This aspect of monitored natural attenuation was evaluated using the BIOSCREEN natural attenuation decision support system (Appendix G). While improved cleanup times were estimated for a few compounds at the site, these times were similar to those without biodegradation. Approximate cleanup times, assuming no biodegradation, for each AOC with contaminants above PRGs are presented below:

| Overburden | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | 132 | ND | >200 | >200 |
| AOC #2 - RSI Landfill | 161 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | 27 | ND | ND | >200 |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | >200 |
| AOC #5 - Contaminated Soils Area* | 33 | 153 | >200 | >200 |
| AOC #6 - Asbestos Landfill | 54 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 23 | 189 | ND | >200 |

| Bedrock | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | >200 | >200 | ND | >200 |
| AOC #2 - RSI Landfill | 19 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | ND | ND | ND | ND |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | >200 |
| AOC #5 - Contaminated Soils Area* | 107 | 128 | ND | >200 |
| AOC #6 - Asbestos Landfill | 12 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 155 | >200 | ND | >200 |

Notes: ND = Not detected at a concentration greater than PRGs at this AOC and flow zone
* - Times for organics are expected to be greatly reduced due to in-situ chemical oxidation

Some cleanup times reported above are high (i.e., greater than 200 years). This simply means that the compounds are essentially immobile. For example, arsenic and thallium have very high retardation coefficients and, ultimately, high cleanup times.

It should also be noted that the only SVOC detected above PRGs at all AOCs was bis(2-ethylhexyl)phthalate and the only pesticide was aldrin. The high retardation factors of these compounds increase the time of travel and source contaminant reduction. Evaluations assumed that the Contaminated Soils Area contained contaminants similar to the B&M Railroad Landfill, RSI Landfill, and the Asbestos Lagoons. The two compounds noted above are therefore assumed to be found at this AOC above PRGs. However, further evaluation may determine that this is not the case. Furthermore, the evaluations assumed that the maximum detections from the three nearby AOCs were also detected at the Contaminated Soils Area. Similarly, data from the RSI Landfill was used to characterize the Asbestos Landfill.

### 5.8.6 Implementability for Alternative #31

This section summarizes the technical and administrative feasibility of implementing Alternative #31, the "Off-Site Action" alternative, and the availability of various services and materials required for its implementation.

**5.8.6.1 Technical Feasibility.** Evaluation of the technical feasibility of Alternative #31 includes an assessment of three factors described in EPA's feasibility study guidance: 1) the ability to construct and operate the technologies, 2) the reliability of the technologies and 3) the ease of undertaking additional remedial actions, if necessary. These aspects are described in detail below:

> Ability to Construct and Operate the Technologies. For Alternative #31, a substantial implementability issue with regard to technical feasibility is the construction of landfill caps at AOCs #1, 2, 6, and 7. Alternative #31 also includes the excavation and removal of waste soil/waste fill from AOCs #3 and 4 with relocation and regrading of these materials below one of the caps constructed at AOCs #1, 2, 6, or 7.
>
> As discussed previously for Alternatives #8 through 27, the capping and excavation remedies at AOCs #1, 2, 3, 4, 6, and 7 will require a substantial civil engineering/earthwork component. The key implementability issue is the location of sensitive wetland areas or water bodies adjacent to every one of these AOCs. This will require comprehensive soil erosion, run-off and sedimentation control measures to minimize siltation impacts to wetland areas and water bodies. In addition, proper location and construction of temporary and permanent haul roads will be required to minimize impacts to wetland areas and water bodies. It is expected that the remediation contractor(s) will utilize the existing rail network to move equipment and materials

to the largest degree possible. This rail network is closely situated to five of the six "earthwork" AOCs (*i.e.*, #1, 2, 3, 4, and 6). This will minimize truck traffic through neighborhoods and the need for new roads. While the scope of the earthwork and transportation required for the capping and excavation activities is large, these are common problems faced and solved by experienced engineers and constructors. Maintenance of the capped and excavated areas is straightforward requiring only periodic inspections, vegetation control (*e.g.*, mowing) and filling of areas of settlement. As a result, no implementability constraints are expected with regard to construction and operation of the soil remedy for AOCs #1, 2, 3, 4, 6, and 7 in Alternative #31.

Excavation of soils within AOC #5 will require extensive impacts to the existing rail yard operations. Alternative #31 will require some or possibly all of the following implementability measures: temporary use restrictions and temporary structural supports for spurs adjacent to excavation areas, temporary and/or permanent relocation of tracks and bedding material, in-situ "lifting" of existing tracks and ties to excavate contaminated soils and rail bedding material for those rail spurs that cannot be relocated, placement and compaction of clean fill soil in excavated areas and replacement of ballast stone, ties and rails. The remediation contractor will need to coordinate closely with the rail yard users to successfully accomplish excavation within these areas. Off-site transport of excavated contaminated soils and rail bedding materials is expected to occur via a combination of rail and truck methods. For example, staging of soils during excavation may be conducted via use of rail cars rather than static soil piles. Loaded rail cars could then be moved to other, more appropriate, unloading areas accessible by semi-tractor trailer vehicles. These vehicles could then transport the contaminated soils to the appropriate off-site treatment/disposal facility via designated routes.

The primary implementability concerns for groundwater treatment at AOCs #5 using in-situ chemical oxidation will be the limitation of conducting work within the Contaminated Soils Area while maintaining active use of the rail yard as discussed above. Implementability measures such as: temporary structural supports for tracks near the work zone, temporary use restrictions for tracks or roadways next to active work areas and temporary relocation of tracks and bedding material may be necessary for both construction and maintenance of the pipelines and vertical injection wells conveying the oxidant solutions. Additional use restrictions will be necessary if hydraulic & pneumatic fracturing was utilized during drilling and installation of the vertical injection wells. Implementation of this remedy at AOC #5 will require close cooperation between rail yard users and the remediation contractor. Alternative #31 further incorporates the use of monitored natural attenuation as a method to remediate any residual contaminated groundwater not addressed by in-situ oxidation. As discussed previously for Alternatives #5 through 27, construction of this technology only requires installation of groundwater monitoring wells and "operation" only requires monitoring efforts to sample and analyze the groundwater so there will be no implementability constraints with regard to these issues for monitored natural attenuation.

Alternative #31 also includes the use of monitored natural attenuation to remediate contaminated groundwater at AOCs #1, 2, 3, 4, 6, and 7. Construction of this technology only requires installation of groundwater monitoring wells and "operation" only requires monitoring efforts to

sample and analyze the groundwater. Therefore, there are no implementability constraints with regard to monitored natural attenuation.

Reliability of the Technologies. Reliability of the horizontal caps installed for AOCs #1, 2, 6, and 7 will be considered high if normal periodic maintenance of the cap is conducted. The high reliability will also apply to the excavation and removal of waste soils/waste fill from AOCs #3 and 4 with relocation and regrading of these materials below one of the caps constructed at AOCs #1, 2, 6, or 7.

Reliability of off-site treatment and disposal will be proportional to the remediation technologies utilized as well as the reliability of the transportation methods used to convey the contaminated soils.

For in-situ oxidation of groundwater at AOC #5, the reliability of this technology is expected to be proportional to the reliability of the treatment delivery systems. These delivery systems will convey chemical oxidation solutions from a central "mixing plant" via pipelines to the groundwater or contaminated soils. The reliability of the delivery system will be similar to the reliability of industrial process/or wastewater treatment plants. Some "downtime" is to be expected in these systems for equipment repair/replacement whether planned or unplanned. As long as the facilities are designed, constructed and operated in a manner appropriate to accommodate periodic planned/unplanned shutdowns, reliability concerns should not prove sufficient to prevent selection of this alternative as the final remedy.

As stated previously under Alternative #5, the reliability of monitored natural attenuation to remediate contaminated groundwater at AOCs #1 through 7 for Alternative #31 should be considered "high" since there is no external equipment nor treatment systems that could breakdown. The reliability of the technology to meet PRGs, however, should not be confused with "implementability" but is more appropriately discussed under "effectiveness". The reader is directed to the "treatment efficiency" and the "time required to remediate" discussions in Sections 5.8.4, 5.8.5 and Appendix G.

The remaining technologies for Alternative #31 include monitoring and institutional controls. Although the institutional controls which will be applied to AOCs #1 through 7 are not exactly technologies, their reliability will depend upon enforcement by the responsible agencies involved.

Ease of Undertaking Additional Remedial Actions. Applying additional remedial actions for contaminated soils contained by the horizontal caps installed at AOCs #1, 2, 6, and 7 will be severely restricted since installation of the caps are largely permanent remediation technologies. This conclusion will also apply to the excavation and removal of waste soils/waste fill from AOCs #3 and 4 with relocation and regrading of these materials below one of the caps constructed at AOCs #1, 2, 6, or 7.

Applying additional remedial actions for excavation and off-site treatment/disposal of contaminated soils at AOC #5 will only be possible, to a limited degree, at the off-site location.

For example, an alternate solidification/stabilization method or reagents could be used if the initial treatment was inadequate or did not achieve standards (*e.g.*, TCLP). Off-site disposal, however, will be considered largely permanent, similar to on-site capping.

Additional remedial actions could be applied in-place of groundwater treatment using in-situ oxidation and monitored natural attenuation at AOC #5. The only implementability limitation is that the new groundwater technology will need to accommodate the active, working area of the Contaminated Soils Area rail yard.

Additional remedial actions could be accommodated in place of monitored natural attenuation of groundwater at AOCs #1, 2, 3, 4, 6, and 7. The only implementability limitation is that the new groundwater remediation technologies will need to be installed outside the limits of the existing horizontal caps installed at AOCs #1, 2, 6, and 7.

**5.8.6.2 Administrative Feasibility.** Evaluation of the administrative feasibility of Alternative #31 involves assessing the steps required to coordinate with other state, federal and local governmental entities. It should be noted that under Superfund, permits are not required for remediation activities, but compliance with substantive requirements is required.

The primary implementability issues of Alternative #31 with regard to administrative feasibility involve the off-site transport, treatment and disposal of contaminated soils and related materials from AOC #5. The Commonwealth of Massachusetts and the Town of Billerica need to be included in reviewing remedial design plans for the transportation of contaminated soils to off-site treatment and disposal facilities. A key point of the transportation planning will be to agree upon daily schedule limitations and appropriate truck routes through the Town of Billerica. Hazardous waste transporters conducting work at Iron Horse Park should be registered with the Massachusetts Department of Environmental Protection, Bureau of Waste Prevention's Business Compliance Division (MADEP, 1999c).

Policies for the Commonwealth of Massachusetts emphasize that contaminated soils treated off-site be reused or recycled to the greatest extent possible rather than being placed within existing landfills which impacts available landfill capacity (MADEP, 1997). As a result, contaminated soils from Iron Horse Park should be taken to off-site recycling facilities within the Commonwealth or at other

locations (*e.g.*, solidification/stabilization facilities such as asphalt batching plants), if feasible, to allow recycling of contaminated soil materials rather than landfilling.

An additional, administrative feasibility issue with regard to Alternative #31, described previously for Alternatives #3 through 27, involves implementation of institutional controls in order to prohibit the use of groundwater. If proprietary controls are used, coordination with the individual property owners of the affected parcels, will be required. For example, implementation of a negative easement would require the property owner to convey to a third party (typically EPA) the right to limit how the landowner can use his or her property. Here the limitations would likely include prohibitions against the use of groundwater from wells on the property.

If governmental controls are used, coordination with federal, state and local government (the ATSDR, the Commonwealth of Massachusetts and/or the Town of Billerica) will be required. For example, implementation of land use restrictions may require the exercise of zoning authority by the Town of Billerica to prohibit residential development in a contaminated area, or the adoption of a building permit ordinance in the Town of Billerica requiring anyone seeking a building permit for construction activities in a particular area to be notified of contamination in the area and of any relevant management standards - such an ordinance could also be used to prohibit types of construction that would result in unacceptable exposures (e.g., excavation in areas where subsurface contamination has not been fully removed). Implementation of groundwater use restrictions may require action by the Commonwealth of Massachusetts to prohibit or limit certain uses of groundwater in particular areas, or require closing or capping of wells. Implementation of advisories may also require action by the ATSDR or Commonwealth of Massachusetts to publically issue warnings that provide notice to potential users of land, surface water or groundwater of some existing or impending risk associated with their use.

A further administrative issue is to reach agreement between federal, state and local governmental entities on the specifics of implementing the monitored natural attenuation program. Under Alternative #31, this program will address groundwater at AOCs #1 through 7. Concurrence among the various agencies will be required in defining the program (*e.g.*, number and type of monitoring

locations, analytical/test parameters, frequency of testing) as well as interpretation of results and conclusions regarding the overall success of monitored natural attenuation.

**5.8.6.3 Availability of Services and Materials.** Evaluation of the availability of services and materials for Alternative #31 includes an assessment of three factors in accordance with EPA's feasibility study guidance: 1) the availability of treatment, storage capacity and disposal services, 2) the availability of necessary equipment and specialists, and 3) the availability of prospective technologies. These aspects are described in detail below:

Availability of TSDF Services. Alternative #31 will require transport, storage and disposal facility (TSDF) contractors to facilitate the off-site disposal of contaminated soils and, potentially, hazardous wastes, from AOC #5. There are many registered and qualified TSDF contractors conducting similar work with contaminated media and hazardous materials within the state (MADEP, 1999c). Additional information specific to the individual contractors is available from the Massachusetts Department of Environmental Protection, Bureau of Waste Prevention, Business Compliance Division via the world wide web (www.magnet.state.ma.us/dep/). Several off-site stabilization/solidification vendors in the form of asphalt batching plants currently operate within the Commonwealth. Non-hazardous materials removed from AOC #5 (*e.g.*, rails, ties, ballast stone) may be able to be recycled or disposed of as normal solid waste or demolition waste. The state maintains documents on commercially available solid waste/demolition waste landfills (MADEP, 1999a) as well as industrial recyclers for concrete, metals, etc. (MADEP, 1999b). Currently, no landfills capable of accepting hazardous wastes are licensed in the Commonwealth of Massachusetts although, as discussed above, there are many firms that will provide TSDF services as "intermediates" for disposal out of state.

Availability of Necessary Equipment and Specialists. A substantial quantity of heavy, earthmoving equipment as well as transport vehicles (both truck and rail variety) will be required for Alternative #31 during excavation of waste soils/waste fill from AOC #3 and construction of the caps at AOCs #1, 2, 6, and 7. The numbers of equipment and vehicles required will be proportional to the number of caps/excavations being conducted simultaneously in a given construction season.

A specialized railroad vehicle may be required for the excavation of contaminated soils at AOC #5. This vehicle allows the existing rail lines and ties to be "lifted" temporarily to allow excavation of contaminated soil and materials and backfill of clean soils and ballast stone from directly below the rail lines. The remediation contractor will need to work directly with the rail yard users to implement this specialized vehicle in those areas requiring excavation directly below existing rail lines.

As previously described for Alternatives #3 through 27, the highest need for specialists in Alternative #31 is for two areas: 1) specialized legal counsel/assistance for implementation of the institutional controls and 2) consultants experienced in monitored natural attenuation of groundwater. Implementation of the institutional controls is expected to be a time-consuming process but should not pose significant implementability concerns that will prevent selection of this alternative as the final remedy. Legal specialists experienced in both CERCLA and non-CERCLA sites are available to facilitate this process. Similarly, monitored natural attenuation has been a technology employed at CERCLA sites in the last 10 years and there is a substantial number of environmental consultants with familiarity in implementing such a program. Thus, availability of consultants familiar with monitored natural attenuation should not prevent selection of this alternative as the final remedy.

Availability of Prospective Technologies. Alternative #31 will employ the use of excavation and off-site treatment/disposal for soils and in-situ chemical oxidation for groundwater at AOC #5. These are the only specialized technologies associated with Alternative #31. In addition, the infiltration wells associated with in-situ oxidation may require use of hydraulic & pneumatic fracturing during drilling and well installation if the geologic strata under the Contaminated Soils Area are too "tight" to facilitate in-situ infiltration to the required degree. Although these technologies are not as "exotic" as many innovative technologies, they are still relatively uncommon and will require effort to identify and procure appropriate expertise, equipment and skilled personnel familiar with their design, construction and O&M. These technologies will be the limiting factor in the overall implementability with regard to "availability" for this alternative.

### 5.8.7 Cost for Alternative #31

Total estimated capital cost associated with this alternative is $40.2 million. This estimate assumes a contingency of 20%. The present value of all O&M costs would be $46.7 million. This estimate assumes an inflation rate of 3%, an interest rate of 7%, and a contingency of 15%. The maximum duration of site remedial actions is assumed to be 30 years, in accordance with RI/FS guidance (U.S. EPA, 1988). Total present worth costs would therefore be $86.8 million. Detailed costs for this alternative are presented in Appendix D. The costs associated with each alternative selected for detailed evaluation are summarized in Table H-1 of Appendix H.

### 5.8.8 State Acceptance for Alternative #31

Acceptance of the selected, site-wide remedial alternative by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 5.8.9 Community Acceptance for Alternative #31

Acceptance of the selected, site-wide remedial alternative by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 5.9 ALTERNATIVE #43 - "BALANCED REMEDIAL ACTION"

Alternative #43 offers a balanced mixture of institutional actions, in-situ remedies, source control and on-site treatment remedial technologies/process options to address the highest risk-ranked AOCs. Alternative #43 addresses all site media of concern.

The overview of remedial action components for Alternative #43 is presented in Table 5-23 and Appendix F. Figure 5-8 details the remedial action site plan for this alternative. Alternative #43 includes the following remedial actions by media of concern and AOC:

Soil:

- Source control remedies consisting of horizontal containment (*i.e.*, caps) will be implemented at all disposal area AOCs [#1 - B&M Railroad Landfill, #2 - RSI Landfill (for groundwater source management), #5 - Contaminated Soils Area, #6 - Asbestos Landfill, #7 - Asbestos Lagoons] to address human health and ecological risk and/or meet ARAR requirements.
- Contaminated soil at AOC #3 (B&M Locomotive Shop Disposal Areas) and AOC #4 (Old B&M Oil/Sludge Recycling Area) will be excavated and relocated for ultimate disposal under one of the caps installed for AOCs #1, 2, 6, or 7. This remedy also includes monitoring to confirm appropriate source cleanup.

Groundwater:

- An on-site pump and treat remedy consisting of collection of contaminated groundwater (*e.g.*, extraction wells/subsurface drains) and treatment on-site using biological processes (phytoremediation) followed by discharge will be applied to the highest human health risk-ranked AOC (#5 - Contaminated Soils Area). This remedy also includes institutional actions for groundwater monitoring.
- In-situ remedies consisting of monitored natural attenuation as well as institutional actions consisting of access restrictions (*e.g.*, institutional controls) and monitoring will be implemented at all remaining AOCs.

Surface Water and Sediment:

- Monitoring will be implemented at all three AOCs showing risk (#8b - Wetland 2 Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group). No remedial actions for surface water will be necessary at all remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) since contaminant concentrations are within acceptable human health and ecological risk levels. Sediment monitoring is included at these two AOCs as a provision if future toxicity testing results in ecological risk.

The detailed evaluation of Alternative #43 with respect to the nine FS criteria is presented in Sections 5.9.1 through 5.9.9.

### 5.9.1 Overall Protection of Human Health and the Environment for Alternative #43

Alternative #43 will provide some overall protection of human health and the environment by reducing some risks identified in the baseline risk assessment. For soil, overall protection of human health from implementation of Alternative #43 will result from the elimination of exposures to COCs in soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill and Asbestos Lagoons. In addition, the elimination of exposures to groundwater at AOCs #1 through 7 using institutional controls and monitored natural attenuation along with reduced COC concentrations from an on-site pump and treat remedy at the Contaminated Soils Area will provide overall protection of human health from groundwater exposures. Identified ecological risks from exposures to soil will be significantly reduced, and exposures to surface water will be gradually reduced. In sediment, however, only minor reductions of risk to ecological receptors will be expected. Therefore, Alternative #43 fails to meet all RAOs for the Site, as defined in Section 2.1, and only partially reduces risks to human health and the environment. The protection of human health and the environment are discussed in Sections 5.9.1.1 and 5.9.1.2, respectively.

**5.9.1.1 Human Health Protection.** Alternative #43 will provide overall protection of human health by eliminating risks identified in the baseline risk assessment. Current baseline risks to human health at the Contaminated Soils Area for female site workers of child-bearing age from exposure to lead in soil via indoor dust will be eliminated as a result of capping since windborne exposures to lead will be eliminated. For the current female site worker of child-bearing age at the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area, baseline risks to human health from exposure to lead in soil via indoor dust will be eliminated as a result of excavation and relocation for ultimate disposal under one of the caps installed for AOCs #1, 2, 6, or 7. For the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will be abated by capping, since windborne exposure to asbestos will be eliminated. However, since no

contaminant removal is performed with capping, the risk will return to baseline levels if the caps are not maintained.

The potential for future risks from ingestion of COCs in groundwater at the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons will be eliminated by restrictions on the future use of groundwater from these AOCs as a drinking water source. Significant reductions in groundwater concentrations for some organic COCs with negligible reductions in inorganic COC concentrations are expected to occur at the Contaminated Soils Area through the use of an on-site pump and treat remedy. Information in Section 5.9.5.3 and Appendix G documents times to achieve PRGs of from 2 years to >200 years for organic COCs in contrast to remedial times of >200 years for inorganic COCs using collection and treatment by phytoremediation. Reductions in groundwater COC concentrations are also expected to occur over time at AOCs #1, 2, 3, 4, 6, and 7 due to the removal of contaminated soil (at AOCs #3 and 4) and placement of caps (at AOCs #1, 2, 5, 6, and 7). Excavation and capping will lower groundwater COC concentrations by limiting the potential leaching of soil contaminants to groundwater. Natural degradation processes will also contribute to the lowering of groundwater COC concentrations over time. However, attenuation that occurs naturally is likely to occur slowly for the most significant risk drivers (175 years to >200 years to achieve PRGs for arsenic and manganese; see Section 5.9.5.3 and Appendix G). Since there will be only partial containment of groundwater contamination with this alternative, risk to off-site receptors will be possible.

Additional short-term risks to workers will result from the excavation and/or capping of AOCs #1, 2, 3, 4, 5, 6 and 7, on-site groundwater treatment at the Contaminated Soils Area, and from soil and groundwater contact during monitoring. These risks will be mitigated by the use of appropriate personal protection equipment as needed. Specific long-term and short-term human health risks are discussed in Sections 5.9.3.1 and 5.9.5.1, respectively.

**5.9.1.2 Ecological Protection.** Alternative #43 will provide reductions in short-term and long-term risk to ecological receptors relative to baseline conditions for exposures to soil. Treatment of source

areas will reduce long-term risk of exposure to aquatic receptors from surface water contaminants. The reduction of risk to ecological receptors in sediments is expected to be minor.

Capping the B&M Railroad Landfill and excavating the B&M Locomotive Shop Disposal Areas will prevent future potential for exposure of terrestrial mammals to metal concentrations, resulting in a significant reduction in ecological risk from exposure to soils.

Adverse impacts on aquatic receptors from exposure to inorganics in surface waters will be reduced at the Wetland 2 Group, the Richardson Pond Group, and the Content Brook Wetland Group. The removal or control of all the major source areas on-site will reduce the potential for discharge of metals in surface water runoff, and gradually reduce concentration of contaminants discharged from groundwater. These mechanisms will reduce the concentration of metals contributing to risk to aquatic receptors in surface water over time. Resuspension of sediments, not treated by this alternative, still will remain a potential source of metals in surface water. Impacts on benthic invertebrate populations from exposure to contaminants in sediment will not be reduced in the Wetland 2 Group, the Richardson Pond Group, and Content Brook Wetland Group since the concentrations of contaminants in the sediments in these habitats will not be substantially reduced by this alternative. The PRGs for benthic invertebrates in wetlands will not be met.

The capping of B&M Railroad Landfill, RSI Landfill, Contaminated Soils Area, Asbestos Landfill, Asbestos Lagoons, and excavation of the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area will all result in minor ecological impacts during construction.

### 5.9.2 Compliance with ARARs for Alternative #43

Chemical-specific ARARs and TBCs for the Site are discussed at length in Section 2.3.1. A summary of the implications of each chemical-specific ARAR for this "Balanced Remedial Action" alternative include:

- Safe Drinking Water Act and Massachusetts Drinking Water Regulations. Federal and Massachusetts MCLs are relevant and appropriate for site groundwater. This alternative sets attainment of Federal SDWA MCLs and MMCLs for inorganic and organic chemicals as groundwater remediation goals. Although levels of some organic compounds in groundwater are anticipated to be reduced, this alternative is not anticipated to be able to attain Federal SDWA MCLs or Massachusetts Maximum Contaminant Levels for inorganic chemicals in a reasonable time frame.

- Resource Conservation and Recovery Act Maximum Concentration Limits. RCRA groundwater corrective action requirements are relevant and appropriate requirements at the point of compliance at the limit of the waste management areas. The potential for contaminants to migrate from the area is reduced by this alternative. Monitoring will be conducted to track exposure-based limits at the point of compliance, and to verify a reduction in the migration of contaminants. Although levels of some organic compounds in groundwater are anticipated to be reduced, this alternative is not anticipated to be able to attain Federal RCRA MCLs for inorganic chemicals in a reasonable time frame.

- Federal Water Pollution Control Act, as Amended by the Clean Water Act, Ambient Water Quality Criteria (AWQC). Freshwater acute and chronic AWQC for the protection of aquatic life are considered appropriate and relevant for the site wetlands. Leachate outbreaks and surface water runoff are controlled under this alternative, thereby reducing the probability that AWQC may be exceeded.

- Clean Air Act and Massachusetts Air Pollution Control Regulations. Dust or other potential emissions that may result from excavation of waste materials are controlled under this alternative. There is no indication that ARARs for air will be exceeded by this alternative.

- Massachusetts Groundwater Quality Standards. Actions are taken under this alternative in an attempt to attain applicable "Class I" enforcement standards. Although levels of some organic

compounds in groundwater are anticipated to be reduced, this alternative is not anticipated to be able to attain groundwater standards for inorganic chemicals in a reasonable time frame.

- Massachusetts Surface Water Quality Standards. As part of the Shawsheen River Basin, site surface waters are classified as "Class B" habitat for fish, aquatic life and wildlife, and source of treated public water supplies. Surface water quality standards are considered applicable to site surface waters. Leachate outbreaks and surface water runoff are controlled under this alternative, thereby reducing the probability that surface water quality standards may be exceeded.

- Federal Criteria and Advisories To Be Considered. In addition to the ARARs listed above, there are other important issues and advisories which will require attention prior to and during remedial activities. These criteria and advisories to be considered include:
    - *Health Advisories.* Carcinogenic and non-carcinogenic risk levels due to consumption of contaminated drinking water will be exceeded.
    - *Federal Groundwater Protection Strategy of 1984.* Current, applicable "Class I" enforcement standards are not met under this alternative. Groundwater quality standards are exceeded.
    - *Threshold Limit Values (TLVs).* There is no indication that these levels will be exceeded for site remediation workers under this alternative.

Location-specific ARARs and TBCs relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2), will not be met under this alternative. Although the minor impacts to wetlands and floodplains during cap construction will be mitigated, and no surface water discharges will occur, because the on-site wetlands will be allowed to remain in a degraded (contaminated) state, this "Balanced Remedial Action" alternative will not meet the intent of Executive Order 11990. This ARAR requires federal agencies to minimize wetland degradation and to preserve and enhance the beneficial uses of wetlands. This alternative will control the source of contamination and leave the wetlands and ecological habitats intact, but will also leave chemicals of concern in place.

Table 5-24 lists the action-specific ARARs for this alternative. The alternative attains all action-specific ARARs except those related to groundwater protection. Corrective actions must be completed within a "reasonable time period." Demonstrating that the action-specific ARARs detailed below can be attained will require long-term monitoring and evaluation. In the event that these ARARs cannot be attained within an agreed-upon, designated time period, then the groundwater remedy proposed for this alternative will need to be modified by means of a Technical Impracticability (TI) Waiver and/or Explanation of Significant Difference (ESD) to the Record of Decision.

- Hazardous/Solid Waste Management - Groundwater Protection, 310 CMR 30.660 - 30.675; 310 CMR 19.110 (AOCs #1, 2, 3, 6, and 7): A groundwater monitoring program will be implemented at the Site. Corrective measures consist of treatment at AOC #5 and monitored natural attenuation at all remaining AOCs. Leachate generation from the landfill will be reduced but not eliminated. Monitoring will need to be conducted to determine attainment of this requirement.

- Ground Water Quality Standards, 314 CMR 6.00 (AOC #5): Groundwater in the vicinity of the Site is designated as Class I, fresh groundwaters as a source of potable water. Actions consist of treatment at AOC #5 and monitored natural attenuation at all other AOCs. Monitoring is planned and will need to be conducted to determine attainment of this requirement.

In addition, hazardous waste management landfill stabilization/solidification (310 CMR 30.632) regulations require that all wastes disposed of in a landfill are treated to the maximum extent practicable to minimize the potential for wastes migrating from the landfill site. This alternative includes excavation of materials from AOC #3 and subsequent on-site disposal. Currently, the alternative does not include stabilization/solidification of these wastes. If, however, after sampling the excavated material is shown to be a hazardous waste, further treatment may be warranted and this remedy revisited. This alternative includes sampling and analysis adequate to make this determination and, thus, attains this action-specific ARAR.

### 5.9.3 Long-Term Effectiveness and Permanence for Alternative #43

This alternative is evaluated below in terms of risk remaining at the Site after RAOs are addressed. This portion of the evaluation focuses on the extent and effectiveness of the controls required to manage the risk posed by treatment residuals and/or untreated contamination.

**5.9.3.1 Magnitude of Residual Risk: Human Health.** Alternative #43 implements controls to eliminate exposure of workers to soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. For groundwater, Alternative #43 implements access restrictions to prevent human contact with COCs at AOCs #1 through 7. In addition, the use of an on-site pump and treat remedy at the Contaminated Soils Area and the use of excavation and/or capping at AOCs #1, 2, 3, 4, 5, 6, and 7 are expected to partially reduce groundwater contamination at the Site. However, only partial containment of on-site groundwater contamination is expected. Under this alternative, the magnitude of residual risks will depend on the enforcement and reliability of institutional controls to prevent future human exposure to COCs in groundwater as well as the efficiency of the remedial measures at eliminating exposures to soil and groundwater COCs.

Under this alternative, exposure of female site workers of child-bearing age to lead in indoor dust from soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Contaminated Soils Area, which was estimated to result in a maternal blood level exceeding that protective of a 95$^{th}$ percentile fetal blood lead level of 10 μg/dl, will be eliminated by capping the Contaminated Soils Area, and eliminated through excavation and relocation of soils under capping for the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area. Likewise for the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will be eliminated by capping because fugitive dust generation will be prevented. Therefore, the use of capping at these AOCs will effectively eliminate the estimated risk for site workers to soils, unless the caps are not maintained.

Potential future residual human health risks to a resident from ingestion of COCs in groundwater from AOCs #1 through 7 will be eliminated by the implementation of groundwater access restrictions as long as long-term enforcement of the groundwater access restrictions is maintained. Should access restrictions not be maintained, the use of on-site groundwater treatment at the Contaminated Soils Area is expected to partially reduce groundwater residual risks by reducing the levels of organic COCs (times to achieve PRGs from 2 years to >200 years; see Section 5.9.5.3 and Appendix G). However, little reduction is the levels of inorganic COCs is expected. Contaminated groundwater will be partially contained with this alternative due to the on-site treatment of groundwater at the Contaminated Soils Area. However, groundwater risk to off-site receptors will be possible. As groundwater concentrations decline over time, there will be a partial lowering of residual risks to potential off-site receptors, and to on-site receptors should access restriction not be maintained in the future. However, concentration reduction is expected to occur slowly for the most significant risk drivers (175 years to >200 years to achieve PRGs for arsenic and manganese; see Section 5.9.5.3 and Appendix G).

**5.9.3.2 Magnitude of Residual Risk: Ecological.** Alternative #43 will result in a quantifiable long-term reduction in risk to ecological receptors in soil and surface water, but not from sediments. The potential for exposure of small mammals to contaminants in soil will be removed at the B&M Railroad Landfill and the B&M Locomotive Shop Disposal Areas.

The removal or control of all the major source areas on-site will reduce the potential for discharge of metals in surface water runoff and gradually reduce concentration of contaminants discharged from groundwater. In the long-term, these mechanisms will reduce the concentration of metals contributing to risk to aquatic receptors in surface water. The risk to aquatic receptors from exposure to metals in surface water will persist until substantial decreases in contaminant discharge are achieved. Resuspension of sediments, not treated by this alternative, still will remain a potential source of metals in surface water. Therefore, residual risk to aquatic receptors will not be lowered substantially below baseline conditions for Alternative #43 in the short-term, but are expected to improve in the long-term.

Since no measures are taken in Alternative #43 to directly remove/reduce exposure from contaminants in sediments, the only effects on the concentration of contaminants will be dilution/dispersal through slow, natural processes and a minor reduction in the deposition of additional contamination from surface water over time. Consequently, the concentration of contaminants in on-site sediments will not be substantially reduced under Alternative #43 and the risk to benthic invertebrates will not be reduced below baseline conditions. The PRGs and RAOs for sediment will not be met.

### 5.9.4 Reduction of Toxicity, Mobility and Volume through Treatment for Alternative #43

Table 5-25 provides a summary of the treatment and process options selected, quantities of waste materials to be remediated, expected reductions in toxicity, mobility and volume, and residuals following treatment for Alternative #43. No human health or ecological risk was determined for soil at AOC #2 (RSI Landfill). Likewise, no risk was determined for surface water at AOC #8a (West Middlesex Canal Group) and AOC #8c (East Middlesex Canal Group). Therefore, reductions in toxicity, mobility and volume were not evaluated for these media at these AOCs. As a provision if future sediment toxicity testing results in ecological risk, actions are included in the alternative for AOCs #8a and #8c and evaluated below.

**5.9.4.1 Treatment/Recycling Processes to be Utilized.** Alternative #43 consists of source control remedies, including in-situ capping, and excavation with on-site disposal for soil, which are not considered treatment processes. Groundwater treatment processes to be utilized include collection and treatment by phytoremediation, and monitored natural attenuation, both with and without management of migration. Institutional actions to be implemented for surface water and sediment are not considered treatment processes. A more detailed description of the treatment/recycling processes to be utilized under Alternative #43 is provided in Section 5.9. Refer to Table 5-25 for specific treatment/recycling processes to be utilized at each AOC.

**5.9.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The following amounts of hazardous materials to be treated for Alternative #43 are provided below by media of concern and AOC. Values are only given if the remedial action will provide treatment. Monitored natural

attenuation is considered a treatment process in this evaluation, since it typically results in reductions in contamination over time. Source control through in-situ capping and excavation with on-site disposal and institutional actions are not considered treatment processes.

Groundwater (areal extent of source)

- AOC #1 - B&M Railroad Landfill 12.4 acres
- AOC #2 - RSI Landfill 2.5 acres
- AOC #3 - B&M Locomotive Shop Disposal Areas 4.7 acres
- AOC #4 - Old B&M Oil/Sludge Recycling Area 7.0 acres
- AOC #5 - Contaminated Soils Area 6.7 acres
- AOC #6 - Asbestos Landfill 13.3 acres
- AOC #7 - Asbestos Lagoons 1.9 acres

**5.9.4.3 Degree of Expected Reductions in Toxicity, Mobility and Volume.** The degree of treatment and expected reductions for each treatment process under Alternative #43 are provided below by media of concern and AOC. Reductions expected from in-situ capping and excavation with on-site disposal are not discussed, since these processes are not considered treatment. Reductions from monitored natural attenuation are provided for the U.S. EPA default time period, 30 years.

At all AOCs, no contaminated soil is treated under Alternative #43. Therefore, no reductions in toxicity, mobility and volume are expected for soil at all AOCs.

Monitored natural is expected to treat all of the contaminated groundwater at AOCs #1 through 4, 6, and 7. The amount of contaminated groundwater to be collected and treated by phytoremediation will be dependent on the density of the collection network. The following reductions in toxicity, mobility and volume are expected for groundwater:

Toxicity

- Monitored natural attenuation is expected to reduce the toxicity of the contaminated groundwater relative to a specific contaminant proportional to the volume reduction of that specific contaminant at AOCs #1 through 4, 6, and 7. Intermediate products that are more toxic than parent compounds may result if incomplete biodegradation of original contaminants occurs.
- At AOC #5, the toxicity of the contaminated groundwater relative to a specific contaminant will be reduced proportional to the volume reduction of that specific contaminant through collection and treatment by phytoremediation.

Mobility

- Monitored natural attenuation will not provide reductions in mobility of COCs at AOCs #1 through 4, 6 and 7.
- The mobility reduction of the contaminants at AOC #5 will be dependent on the density of the groundwater collection network. If the extraction wells are positioned so as to prevent the migration of contaminated groundwater beyond the network, contaminant mobility will be limited to AOC #5.

Volume

- Monitored natural attenuation will not reduce the volume of the contaminated media at AOCs #1 through 4, 6, and 7.
- Organic COCs reductions in volume are expected to range from less than 15% to 100% across the Site. This broad range is due to differing physical and chemical properties on a compound by compound basis. Greater reductions of organics are possible due to biodegradation. Specific compounds used in the MODFLOW simulations, as well as BIOSCREEN results which additionally consider biodegradation rates, can be found in Appendix G. Table 5-25 provides estimated volume reductions for each AOC.
- Expected volume reductions from monitored natural attenuation for inorganic COCs vary from less than 15% to 17% across the Site. These low reductions may be attributed to adsorption of compounds to the soils within the aquifer. For specific compounds used the MODFLOW modeling, reference Appendix G. Inorganic volume reductions by AOC are provided in Table 5-25.
- Upon completion of the groundwater remedy at AOC #5, phytoremediation processes are expected to reduce the volume of organic and inorganic COCs by 90% to 95% (Gordon, 1998) and 84% to 99% (FRTR, 1997), respectively. Lesser reductions are expected during the interim period prior to groundwater clean-up.

There are no expected reductions in toxicity, mobility and volume in surface water and sediment at AOCs #8b, 8d, and 8e and sediment at AOCs #8a and 8c. Institutional actions will not confirm reductions or treatment of waste materials.

**5.9.4.4 Reversibility.** The reversibility of each treatment process to be implemented under Alternative #43 is provided below by media of concern and AOC. Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. Since in-situ capping, excavation and on-site disposal, and institutional actions are not considered treatment processes, reversibility of treatment is not applicable to these processes.

Collection of contaminated groundwater and treatment by phytoremediation, to be implemented at AOC #5, is not considered a reversible process. Contaminants taken up by plants are not readily released under normal conditions. Monitored natural attenuation, to be utilized at all remaining AOCs (#1 through 4, 6, and 7), is not considered reversible. Organic contaminants are degraded over time. Inorganic contaminants, on the other hand, may only be temporarily immobilized and later released.

**5.9.4.5 Type and Quantity of Residuals.** The types and quantities of contaminant residuals by media of concern and AOC expected after completion of the treatment technologies/process options implemented in Alternative #43 are summarized below. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are discussed briefly in Table 5-25.

At all AOCs where horizontal containment will be implemented (AOCs #1, 5, 6, and 7), the total amount of contaminated soil at each respective AOC remains untreated but contained under the cap. The total amount of contaminated soil to be excavated from AOCs #3 and 4, will likewise remain untreated but contained, under an on-site cap.

At AOC #5, approximately 1% to 16% of organics and 5% to 10% of inorganics will remain in the groundwater following collection and treatment by phytoremediation upon completion of the groundwater remedy. Contaminant residuals in greater amounts than the above stated percentages will result during the interim period prior to this endpoint. At all remaining AOCs (#1 through 4, 6, and7), more toxic intermediate products may remain if incomplete degradation of original contaminants occurs through monitored natural attenuation. Estimated residuals following monitored natural attenuation treatment for a 30 year period, the U.S. EPA default time, are provided below. As stated above, the wide range in the reductions, and thus the residuals, is due to differing physical and chemical characteristics of compounds.

- It is expected that 0% to greater than 85% of the organic COCs and greater than 85% of the inorganic COCs will remain in the groundwater at AOC #1.
- The groundwater at AOC #2 is expected to contain 0% to 66% of the organic COCs and greater than 85% of the inorganic COCs after treatment.
- Approximately 4% of the organic COCs and greater than 85% of the inorganic COCs will remain at AOC #3 following treatment by monitored natural attenuation.

- At AOC #4, it is expected that 83% to greater than 85% of the inorganic COCs will remain in the groundwater after treatment. There are no organics exceeding PRGs at AOC #4. Therefore, organic reductions were not evaluated.
- An estimated 0% to 52% of the organic COCs and greater than 85% of the inorganic COCs will remain in the groundwater at AOC #6 following treatment.
- It is anticipated that 35% to greater than 85% of the organic COCs and greater than 85% of the inorganic COCs will remain in the groundwater at AOC #7.

Institutional actions will be implemented at all AOCs showing human health and ecological risk in surface water and sediment, as well as at AOCs #8a and 8c, where future sediment toxicity testing results may result in ecological risk. Since institutional actions will not involve treatment, the original amounts of contaminated surface water and sediment will be assumed to remain at all AOCs.

### 5.9.5 Short-Term Effectiveness for Alternative #43

This alternative is evaluated for effectiveness in protecting the community and local workers, site remediation workers, and the environment during the construction and implementation of the remedy.

**5.9.5.1 Protection of Community and Workers During Remedial Actions.** The construction and remediation measures proposed under this alternative include excavation and placement of soils from the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area beneath a cap, capping of the B&M Railroad Landfill, RSI Landfill, Contaminated Soils Area, Asbestos Landfill and Asbestos Lagoons, on-site groundwater treatment at the Contaminated Soils Area, and groundwater monitoring at AOCs #1 through 7.

The implementation of these construction/remedial measures will potentially result in additional short-term risk to the community from exposure to soil contaminants primarily associated with dust generation during soil disturbances at the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. Precautions will be implemented to prevent or limit fugitive dust generation during excavation/remedial activities. Worker exposure to COCs in soil during excavation/capping at AOCs #1, 2, 3, 4, 5, 6, and 7, in groundwater during on-site treatment at the Contaminated Soils Area, and in soil and groundwater during monitoring will also result in potential

health risk to workers. Use of personal protection equipment will be employed to reduce exposure if applicable OSHA standards are exceeded during these activities.

**5.9.5.2 Environmental Impacts.** The capping of B&M Railroad Landfill, RSI Landfill, Asbestos Landfill, Asbestos Lagoons, Contaminated Soils Area and the excavation of B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area will all require removal of vegetation. Wetlands are located around the border of a portion of each of these areas, with the exception of the Old B&M Oil/Sludge Recycling Area and Contaminated Soils Area. The extent of excavation or fill in wetland is estimated to be minimal for each alternative. Mitigation measures will include avoidance and minimization of temporary construction disturbance in adjacent wetlands during construction of landfill caps. Tree removal will be minimized, and proper construction and erosion control methods will be utilized. Mitigation will include restoration of upland habitat, and minimization of wetland impacts. Any unavoidable wetland loss will be mitigated by restoration or creation of on-site wetlands. Changes in hydrology resulting from construction of landfill caps will be mitigated by properly designed stormwater retention systems and maintenance of flows of water close to existing conditions. Potential impacts to wetlands resulting from changes in hydrology from operation of the groundwater treatment and phytoremediation system for the Contaminated Soils Area will be mitigated by maintenance of flows of water close to existing conditions. Potential alterations in the hydrology and seasonal water levels in the adjacent wetlands will be minimized. Pumping rates and re-injection rates of water to wells will be implemented that are predicted, via modeling, to have minimal effects on water elevations in wetlands.

The alternative includes installation of monitoring wells throughout the Site. Mitigation measures will include avoidance and minimization of temporary construction disturbance in wetlands during installation of monitoring wells, and minimization of tree removal. Proper construction and erosion control methods will be utilized to minimize ecological impact to surrounding habitats.

The excavation of soil adjacent to the unnamed brook in B&M Locomotive Shop Disposal Area A may potentially cause disturbance to the stream bank. Mitigation measures will include avoidance and minimization of temporary construction disturbance in the stream channel and returning impacted

areas to previous grades. Any unavoidable wetland loss from excavation will be mitigated by restoration or creation of on-site wetlands.

**5.9.5.3 Time Until Remedial Action Objectives are Achieved.** Of the RAOs presented in Section 2, those for groundwater will take the longest to achieve. Through the use of groundwater flow modeling and contaminant retardation concepts (Appendix G), approximate times to achieve PRGs were calculated for the site contaminants at each AOC. It should be noted that the mobility of inorganics is highly sensitive to site specific geochemistry. Other factors such as pH, dissolution, and colloidal transport could have significant impacts on mobility of inorganics. Therefore, these times should only be used for relative comparison and not for accurate representations of cleanup times.

Alternative #43 includes monitored natural attenuation as a groundwater treatment process at all AOCs except AOC #5, the Contaminated Soils Area. Active groundwater collection will be used here prior to treatment and reinjection. Furthermore, site hydrology may be impacted by caps placed on AOCs #1, 2, 5, 6, and 7.

Modeling was performed to predict the reduction of contaminant concentrations over time due to natural processes, such as dispersion. However, additional contaminant reduction is expected to occur due to biodegradation. This aspect of monitored natural attenuation was evaluated using the BIOSCREEN natural attenuation decision support system (Appendix G). While improved cleanup times were estimated for a few compounds at the site, these times were similar to those without biodegradation. Approximate cleanup times, assuming no biodegradation, for each AOC with contaminants above PRGs are presented below:

| Overburden | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | 55 | ND | >200 | >200 |
| AOC #2 - RSI Landfill | 87 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | 31 | ND | ND | >200 |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | 175 |
| AOC #5 - Contaminated Soils Area | 96 | >200 | >200 | >200 |
| AOC #6 - Asbestos Landfill | 63 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 46 | >200 | ND | >200 |

| Bedrock | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | >200 | >200 | ND | >200 |
| AOC #2 - RSI Landfill | 16 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | ND | ND | ND | ND |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | >200 |
| AOC #5 - Contaminated Soils Area | 182 | >200 | ND | >200 |
| AOC #6 - Asbestos Landfill | 24 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 186 | >200 | ND | >200 |

Notes: ND = Not detected at a concentration greater than PRGs at this AOC and flow zone

Some cleanup times reported above are high (i.e., greater than 200 years). This simply means that the compounds are essentially immobile. For example, arsenic and thallium have very high retardation coefficients and, ultimately, high cleanup times.

It should also be noted that the only SVOC detected above PRGs at all AOCs was bis(2-ethylhexyl)phthalate and the only pesticide was aldrin. The high retardation factors of these compounds increase the time of travel and source contaminant reduction. Evaluations assumed that the Contaminated Soils Area contained contaminants similar to the B&M Railroad Landfill, RSI Landfill, and the Asbestos Lagoons. The two compounds noted above are therefore assumed to be found at this AOC above PRGs. However, further evaluation may determine that this is not the case. Furthermore, the evaluations assumed that the maximum detections from the three nearby AOCs were also detected at the Contaminated Soils Area. Similarly, data from the RSI Landfill was used to characterize the Asbestos Landfill.

### 5.9.6 Implementability for Alternative #43

This section summarizes the technical and administrative feasibility of implementing Alternative #43, the "Balanced Remedial Action" alternative, and the availability of various services and materials required for its implementation.

**5.9.6.1 Technical Feasibility.** Evaluation of the technical feasibility of Alternative #43 includes an assessment of three factors described in EPA's feasibility study guidance: 1) the ability to construct

and operate the technologies, 2) the reliability of the technologies and 3) the ease of undertaking additional remedial actions, if necessary. These aspects are described in detail below:

Ability to Construct and Operate the Technologies. For Alternative #43, similar to Alternatives #8 thorough 31, a major implementability issue with regard to technical feasibility is the construction of caps at AOCs #1, 2, 5, 6, and 7 and the excavation and removal of waste soil/waste fill from AOCs #3 and 4 with relocation and regrading of these materials below one of the caps constructed at AOCs #1, 2, 6, or 7.

As discussed previously for Alternatives #8 through 31, the capping and excavation remedies for Alternative #18 at AOCs #1, 2, 3, 4, 6, and 7 will require a substantial civil engineering/earthwork component. The key implementability issue is the location of sensitive wetland areas or water bodies adjacent to every one of these AOCs. This will require comprehensive soil erosion, runoff and sedimentation control measures to minimize siltation impacts to wetland areas or water bodies. In addition, proper location and construction of temporary and permanent haul roads will be required to minimize impacts to wetland areas and water bodies. It is expected that the remediation contractor(s) will utilize the existing rail network to move equipment and materials to the largest degree possible. This rail network is closely situated to five of the six "earthwork" AOCs (*i.e.*, #1, 2, 3, 4, and 6). While the scope of the earthwork and transportation required for the capping and excavation activities is large, these are common problems faced and solved by experienced engineers and constructors. Maintenance of the capped and excavated areas is straightforward requiring only periodic inspections, vegetation control (*e.g.*, mowing) and filling of areas of settlement. As a result, no implementability constraints are expected with regard to construction and operation of the soil remedy for AOCs #1, 2, 3, 4, 6, and 7 in Alternative #43.

As discussed in prior alternatives, the primary implementability concern for placement of the single-barrier cap at AOC #5 is the limitation of conducting work within the Contaminated Soils Area while maintaining active use of the rail yard, rail spurs and roads that transect it. Placement of a single-barrier cap will require sitework adjacent to active railbeds and tracks. Therefore, Alternative #43 will require measures such as temporary structural supports, temporary use restrictions for tracks or roadways next to active work areas and temporary relocation of tracks and bedding material, if necessary. Implementing this remedy at AOC #5 will require close cooperation between rail yard users and the remediation engineer/contractor(s) and involve temporary disruptions to the rail yard operations. These are straightforward issues commonly faced and solved as part of construction efforts and are not sufficient to prevent consideration of this alternative as the selected remedy.

Construction, operation, and maintenance of the on-site groundwater remedy at AOC #5 will need to address some key implementability issues. Drilling and installation of the groundwater extraction wells and installation of the horizontal trench and collection piping will require temporary disruptions and/or use restrictions within the active rail yard similar to those previously described for installation of the single-barrier cap. Construction of the phytoremediation treatment plant (*i.e.*, engineered wetland) will require a large areal extent as

well as careful attention to design elevations and hydraulics to ensure that gravity-driven flows through the wetland media achieve the proper velocity to maximize removal efficiencies. Construction of the phytoremediation chamber should be completed by late spring to allow proper establishment of the environmental media during summer and fall. Since the phytoremediation technology is a biological system, "shock" loading conditions should be avoided as part of O&M. Shock loading conditions would include radical changes such as: rapid changes in groundwater flows, contaminant concentrations or temperatures, infestation of other plant or insect species or attack on the biological media by bacteria agents. Periodic "harvesting" or removal of the biological media (*e.g.*, plants, roots, soils) followed by proper disposal will be required as part of the routine O&M when contaminant uptake has been maximized. Due to the nature of the phytoremediation technology, periodic cleaning of the groundwater recharge wells will be required as part of O&M to prevent biofouling.

Alternative #43 also includes the use of monitored natural attenuation to remediate contaminated groundwater at AOCs #1, 2, 3, 4, 6, and 7. Construction of this technology only requires installation of groundwater monitoring wells and "operation" only requires monitoring efforts to sample and analyze the groundwater. Therefore, there are no implementability constraints with regard to monitored natural attenuation.

Reliability of the Technologies. Reliability of the horizontal caps installed for AOCs #1, 2, 6, and 7 will be considered high if normal periodic maintenance of the cap is conducted. The high reliability will also apply to the excavation and removal of waste soils/waste fill from AOCs #3 and 4 with relocation and regrading of these materials below one of the caps constructed at AOCs #1, 2, 6, or 7. The reliability of the single-barrier cap installed for AOC #5 will be less than the landfill caps and much more sensitive to proper inspection and maintenance. Due to the heavy rail and truck loads and the complex pattern of drainage that will be required to address stormwater runoff, a more intensive O&M program of inspection, maintenance and repair will be required to ensure appropriate integrity of the single-barrier cap.

The reliability of on-site groundwater treatment using phytoremediation will be directly dependent on proper operation and maintenance to avoid the "shock" loading conditions (*i.e.*, rapid changes in flow rate, temperature, and contaminant concentrations, infestation of hostile species of plants, insects or bacterial agents) that would reduce performance. In addition, since the wetlands media has a finite capacity to adsorb or absorb site contaminants, periodic removal and replacement as part of O&M is required to maintain system reliability.

As stated previously under Alternatives #5 through 31, the reliability of monitored natural attenuation to remediate any residual contaminated groundwater at AOCs #1, 2, 3, 4, 6, and 7 systems that could breakdown. The reliability of the technology to meet PRGs, however, should not be confused with "implementability" but is more appropriately discussed under "effectiveness". The reader is directed to the "treatment efficiency" and the "time required to remediate" discussions in Sections 5.9.4, 5.9.5 and Appendix G.

The remaining technologies for Alternative #43 include monitoring and institutional controls. Although the institutional controls which will be applied to AOCs #1 through 7 are not exactly

technologies, their reliability will depend upon enforcement by the responsible agencies involved.

Ease of Undertaking Additional Remedial Actions. Applying additional remedial actions for contaminated soils contained by the horizontal caps installed at AOCs #1, 2, 5, 6, and 7 will be severely restricted since installation of the caps are largely permanent remediation technologies. This conclusion will also apply to the excavation and removal of waste soils/waste fill from AOCs #3 and 4 with relocation and regrading of these materials below one of the caps constructed at AOCs #1, 2, 6, or 7.

Additional remedial actions could be accommodated to a limited degree to modify on-site groundwater treatment using phytoremediation. Alternate combinations of wetlands media (*i.e.*, plant species, soil types) could be installed within the phytoremediation chamber in an attempt to improve system performance. If this proved to be insufficient, then an alternate on-site treatment remedy (*e.g.*, physical-chemical) could be constructed that could utilize the existing groundwater collection and recharge systems.

Further remedial actions could be accommodated in place of monitored natural attenuation of groundwater. The only implementability limitation is that the new groundwater remediation technologies will need to accommodate the active, working area of the Contaminated Soils Area rail yard and not require installation within the confines of previously capped AOCs #1, 2, 6, and 7.

Additional remedial actions could be accommodated in place of routine monitoring of sediments at AOCs #8a through 8e and surface water at AOCs #8b, 8d, and 8e without any implementability concerns.

**5.9.6.2 Administrative Feasibility.** Evaluation of the administrative feasibility of Alternative #43 involves assessing the steps required to coordinate with other state, federal and local governmental entities. It should be noted that under Superfund, permits are not required for remediation activities, but compliance with substantive requirements is required.

The principal administrative feasibility issue with regard to Alternative #43, described previously for Alternatives #3 through 31, involves implementation of institutional controls in order to prohibit the use of groundwater. If proprietary controls are used, coordination with the individual property owners of the affected parcels, will be required. For example, implementation of a negative easement would require the property owner to convey to a third party (typically EPA) the right to limit how the landowner can use his or her property. Here the limitations would likely include prohibitions against the use of groundwater from wells on the property.

If governmental controls are used, coordination with federal, state and local government (the ATSDR, the Commonwealth of Massachusetts and/or the Town of Billerica) will be required. For example, implementation of land use restrictions may require the exercise of zoning authority by the Town of Billerica to prohibit residential development in a contaminated area, or the adoption of a building permit ordinance in the Town of Billerica requiring anyone seeking a building permit for construction activities in a particular area to be notified of contamination in the area and of any relevant management standards - such an ordinance could also be used to prohibit types of construction that would result in unacceptable exposures (e.g., excavation in areas where subsurface contamination has not been fully removed). Implementation of groundwater use restrictions may require action by the Commonwealth of Massachusetts to prohibit or limit certain uses of groundwater in particular areas, or require closing or capping of wells. Implementation of advisories may also require action by the ATSDR or Commonwealth of Massachusetts to publically issue warnings that provide notice to potential users of land, surface water or groundwater of some existing or impending risk associated with their use.

An additional administrative issue is to reach agreement between federal, state and local governmental entities on the specifics of implementing the monitored natural attenuation program. Under Alternative #43, this program will address groundwater at AOCs #1, 2, 3, 4, 6, and 7. Concurrence among the various governmental entities will be required in defining the program (*e.g.*, number and type of monitoring locations, analytical/test parameters, frequency of testing) as well as interpretation of results and conclusions regarding the overall success of monitored natural attenuation.

**5.9.6.3 Availability of Services and Materials.** Evaluation of the availability of services and materials for Alternative #43 includes an assessment of three factors in accordance with EPA's feasibility study guidance: 1) the availability of treatment, storage capacity and disposal services, 2) the availability of necessary equipment and specialists, and 3) the availability of prospective technologies. These aspects are described in detail below:

Availability of TSDF Services. Since no remedial actions requiring off-site transport, storage or disposal are to be implemented as part of Alternative #43, the "Balanced Remedial Action"

alternative, there are no implementability constraints with regard to this issue for selection of this alternative.

Availability of Necessary Equipment and Specialists. A substantial quantity of heavy, earthmoving equipment as well as transport vehicles (both truck and rail variety) will be required for Alternative #43 during excavation of waste soils/waste fill from AOCs #3 and 4 and construction of the caps at AOCs #1, 2, 5, 6, and 7. The numbers of equipment and vehicles required will be proportional to the number of caps/excavations being conducted simultaneously in a given construction season.

Experienced pavement engineers and contractors will be required to install the single-barrier pavement-type cap at AOC #5. This remediation team will require experience in pavement installations adjacent to multiple rail and spur lines.

The highest need for specialists in Alternative #43 is for two areas: 1) specialized legal counsel/assistance for implementation of the institutional controls and 2) consultants experienced in monitored natural attenuation of groundwater. Implementation of the institutional controls is expected to be a time-consuming process but should not pose significant implementability concerns that will prevent selection of this alternative as the final remedy. Legal specialists experienced in both CERCLA and non-CERCLA sites are available to facilitate this process. Similarly, monitored natural attenuation has been a technology employed at CERCLA sites in the last 10 years and there is a substantial number of environmental consultants with familiarity in implementing such a program. Thus, availability of consultants familiar with monitored natural attenuation should not prevent selection of this alternative as the final remedy.

Availability of Prospective Technologies. On-site groundwater treatment using phytoremediation is the only specialized technology implemented for Alternative #43. This technology requires only routine and commonly available construction materials and methods but requires ecological/engineering specialists familiar with the proper selection and installation of the environmental media. In addition, some of the environmental media (*e.g.*, wetlands plant types) may require specialized development and procurement.

### 5.9.7 Cost for Alternative #43

Total estimated capital cost associated with this alternative is $34.7 million. This estimate assumes a contingency of 20%. The present value of all O&M costs would be $42.6 million. This estimate assumes an inflation rate of 3%, an interest rate of 7%, and a contingency of 15%. The maximum duration of site remedial actions is assumed to be 30 years, in accordance with RI/FS guidance (U.S. EPA, 1988). However, in-situ activities such as soil flushing and chemical oxidation are expected to be performed in less than the 30-year time period. Total present worth costs would therefore be $77.3

million. Detailed costs for this alternative are presented in Appendix D. The costs associated with each alternative selected for detailed evaluation are summarized in Table H-1 of Appendix H.

### 5.9.8 State Acceptance for Alternative #43

Acceptance of the selected, site-wide remedial alternative by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 5.9.9 Community Acceptance for Alternative #43

Acceptance of the selected, site-wide remedial alternative by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 5.10 ALTERNATIVE #46 - "INTENSIVE REMEDIAL ACTION A"

Alternative #46 is similar to Alternative #15 in that source control remedies will be maximized for soil and disposal areas, while on-site treatment will be applied to all on-site groundwater. For this "Intensive Remedial Action A" alternative, in-situ remedies are applied to all sediment and surface water AOCs exhibiting risk.

The overview of remedial action components for Alternative #46 is presented in Table 5-26 and Appendix F. Figure 5-9 details the remedial action site plan for this alternative. Alternative #46 includes the following remedial actions by media of concern and AOC:

Soil:

- Source control remedies consisting of horizontal containment (*i.e.*, caps) will be implemented at disposal area AOCs [#1 - B&M Railroad Landfill, #2 - RSI Landfill (for groundwater source management), #5 - Contaminated Soils Area, #6 - Asbestos Landfill] to address human health and ecological risk and/or meet ARAR requirements.

- Contaminated soil at AOCs #3 (B&M Locomotive Shop Disposal Areas), #4 (Old B&M Oil/Sludge Recycling Area), and #7 (Asbestos Lagoons) will be excavated and relocated for ultimate disposal under one of the caps installed for AOCs #1, 2, or 6. This remedy also includes monitoring to confirm appropriate source cleanup.

Groundwater:

- An on-site pump and treat remedy consisting of collection of contaminated groundwater (*e.g.*, extraction wells/subsurface drains) and treatment on-site using biological processes (phytoremediation) followed by discharge will be applied to all AOCs. Vertical containment will be used where necessary to prevent wetland dewatering during groundwater collection. This remedy also includes institutional actions for groundwater monitoring.

Surface Water and Sediment:

- In-situ remedies consisting of monitored natural attenuation will be implemented at all three AOCs showing risk (#8b - Wetland 2 Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group). No remedial actions for surface water will be necessary at all remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) since contaminant concentrations are within acceptable human health and ecological risk levels. Monitored natural attenuation of sediment is included at these two AOCs as a provision if future toxicity testing results in ecological risk.

The detailed evaluation of Alternative #46 with respect to the nine FS criteria is presented in Sections 5.10.1 through 5.10.9.

### 5.10.1 Overall Protection of Human Health and the Environment for Alternative #46

Alternative #46 will provide some overall protection of human health and the environment by reducing some risks identified in the baseline risk assessment. For soil, overall protection of human health from implementation of Alternative #46 will result from the elimination of exposures to COCs in soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill and Asbestos Lagoons. In addition, the elimination of exposures to groundwater at AOCs #1 through 7 using institutional controls along with reduced COC concentrations from an on-site pump and treat remedy at the Contaminated Soils Area will provide overall protection of human health from groundwater exposures. Identified ecological risks from exposures to soil will be significantly reduced, and exposures to surface water will be gradually reduced. In sediment, however, only minor reductions of risk to ecological receptors will be expected. Therefore, Alternative #46 fails to meet all RAOs for the Site, as defined in Section 2.1, and only partially reduces risks to human health and the environment. The protection of human health and the environment are discussed in Sections 5.10.1.1 and 5.10.1.2, respectively.

**5.10.1.1 Human Health Protection.** Alternative #46 will provide overall protection of human health by eliminating risks identified in the baseline risk assessment. Current baseline risks to human health at the Contaminated Soils Area for female site workers of child-bearing age from exposure to lead in soil via indoor dust will be eliminated as a result of capping since windborne exposures to lead will be eliminated. For the current female site worker of child-bearing age at the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area, baseline risks to human health from exposure to lead in soil via indoor dust will be eliminated as a result of excavation and relocation for ultimate disposal under one of the caps installed for AOCs #1, 2, or 6. For the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will be abated by excavation and/or capping, since windborne exposure to asbestos will be eliminated.

However, since no contaminant removal is performed with capping, the risk will return to baseline levels if the caps are not maintained.

The potential for future risks from ingestion of COCs in groundwater at the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons will be eliminated by restrictions on the future use of groundwater from these AOCs as a drinking water source. Significant reductions in groundwater concentrations for some organic COCs, with negligible reductions in inorganic COC concentrations are expected by the use of an on-site pump and treat remedy. Information in Section 5.10.5.3 and Appendix G documents times to achieve PRGs of from <1 year to >200 years for organic COCs in contrast to remedial times of 44 years to >200 years for inorganic COCs using collection and treatment by phytoremediation. Reductions in groundwater COC concentrations will occur over time due to the excavation of contaminated soil (at AOCs #3, 4, and 7) and placement of caps (at AOCs #1, 2, 5 and 6). Excavation and capping will lower groundwater COC concentrations by limiting the potential leaching of soil contaminants to groundwater. Natural degradative processes will also contribute to the lowering of groundwater COC concentrations over time. However, contaminant reduction is expected to occur slowly for the most significant risk drivers (44 years to >200 years to achieve PRGs for arsenic and manganese; see Section 5.10.5.3 and Appendix G). Since there will be significant containment of groundwater with this alternative, potential risk to off-site receptors will be minimal.

Additional short-term risks to workers will result from the excavation and/or capping of AOCs #1, 2, 3, 4, 5, 6, and 7, on-site groundwater treatment at AOCs #1 through 7, and from soil and groundwater contact during monitoring. These risks will be mitigated by the use of appropriate personal protection equipment as needed. Specific long-term and short-term human health risks are discussed in Sections 5.10.3.1 and 5.10.5.1, respectively.

**5.10.1.2 Ecological Protection.** Alternative #46 will provide reductions in short-term and long-term risk to ecological receptors relative to baseline conditions for exposures to soil. Treatment of source

areas will reduce long-term risk of exposure to aquatic receptors from surface water contaminants. The reduction of risk to ecological receptors in sediments is expected to be minor.

Capping the B&M Railroad Landfill and excavating the B&M Locomotive Shop Disposal Areas will prevent future potential for exposure of terrestrial mammals to metal concentrations, resulting in a significant reduction in ecological risk from exposure to soils.

Adverse impacts on aquatic receptors from exposure to inorganics in surface waters will be reduced at the Wetland 2 Group, the Richardson Pond Group, and the Content Brook Wetland Group. The removal or control of all the major source areas on-site will reduce the potential for discharge of metals in surface water runoff, and gradually reduce concentration of contaminants discharged from groundwater. These mechanisms will reduce the concentration of metals contributing to risk to aquatic receptors in surface water over time. Resuspension of sediments, not treated by this alternative, still will remain a potential source of metals in surface water. Impacts on benthic invertebrate populations from exposure to contaminants in sediment will not be reduced in the Wetland 2 Group, the Richardson Pond Group, and Content Brook Wetland Group since the concentrations of contaminants in the sediments in these habitats will not be substantially reduced by this alternative. The PRGs for benthic invertebrates in wetlands will not be met.

The capping of B&M Railroad Landfill, RSI Landfill, Contaminated Soils Area, Asbestos Landfill, and excavation of the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Asbestos Lagoons will all result in minor ecological impacts during construction. Potential impacts to wetlands from withdrawal discharge of treated groundwater will be mitigated by maintaining water levels near existing conditions.

### 5.10.2 Compliance with ARARs for Alternative #46

Chemical-specific ARARs and TBCs for the Site are discussed at length in Section 2.3.1. A summary of the implications of each chemical-specific ARAR for this "Intensive Remedial Action A" alternative include:

- Safe Drinking Water Act and Massachusetts Drinking Water Regulations. Federal and Massachusetts MCLs are relevant and appropriate for site groundwater. This alternative sets attainment of Federal SDWA MCLs and MMCLs for inorganic and organic chemicals as groundwater remediation goals. Although levels of some organic compounds in groundwater are anticipated to be reduced, this alternative is not anticipated to be able to attain Federal SDWA MCLs or Massachusetts Maximum Contaminant Levels for inorganic chemicals in a reasonable time frame.

- Resource Conservation and Recovery Act Maximum Concentration Limits. RCRA groundwater corrective action requirements are relevant and appropriate requirements at the point of compliance at the limit of the waste management areas. The potential for contaminants to migrate from the area is reduced by this alternative. Monitoring will be conducted to track exposure-based limits at the point of compliance, and to verify a reduction in the migration of contaminants. Although levels of some organic compounds in groundwater are anticipated to be reduced, this alternative is not anticipated to be able to attain Federal RCRA MCLs for inorganic chemicals in a reasonable time frame.

- Federal Water Pollution Control Act, as Amended by the Clean Water Act, Ambient Water Quality Criteria (AWQC). Freshwater acute and chronic AWQC for the protection of aquatic life are considered appropriate and relevant for site wetlands. Leachate outbreaks and surface water runoff are controlled under this alternative, thereby reducing the probability that AWQC may be exceeded.

- Clean Air Act and Massachusetts Air Pollution Control Regulations. Dust or other potential emissions that may result from excavation of waste materials are controlled under this alternative. There is no indication that ARARs for air will be exceeded by this alternative.

- Massachusetts Groundwater Quality Standards. Actions are taken under this alternative to attain applicable "Class I" enforcement standards. Although levels of some organic compounds in

groundwater are anticipated to be reduced, this alternative is not anticipated to be able to attain groundwater standards for inorganic chemicals in a reasonable time frame.

- Massachusetts Surface Water Quality Standards. As part of the Shawsheen River Basin, site surface waters are classified as "Class B" habitat for fish, aquatic life and wildlife, and source of treated public water supplies. Surface water quality standards are considered applicable to site surface waters. Leachate outbreaks and surface water runoff are controlled under this alternative, thereby reducing the probability that surface water quality may be exceeded.

- Federal Criteria and Advisories To Be Considered. In addition to the ARARs listed above, there are other important issues and advisories which will require attention prior to and during remedial activities. These criteria and advisories to be considered include:
    - *Health Advisories.* Carcinogenic and non-carcinogenic risk levels due to consumption of contaminated drinking water will be exceeded.
    - *Federal Groundwater Protection Strategy of 1984.* Current, applicable "Class I" enforcement standards are not met under this alternative. Groundwater quality standards are exceeded.
    - *Threshold Limit Values (TLVs).* There is no indication that these levels will be exceeded for site remediation workers under this alternative.

This alternative will leave the wetlands and ecological habitats intact and will introduce enhanced monitoring for assessing natural attenuation. Monitoring will be conducted to determine if, at any time in the future, actions will be necessary to minimize wetland degradation and to preserve and enhance the beneficial uses of wetlands.

Location-specific ARARs and TBCs relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2) will be met under this alternative as long as monitoring provides support that no further remedial actions are necessary to meet the intent of Executive Order 11990. The "Intensive Remedial Action A" alternative will leave the wetlands and ecological habitats intact and will introduce enhanced monitoring for assessing natural attenuation. Monitoring will be conducted to determine if, at any time in the future, actions will be necessary to minimize wetland

degradation and to preserve and enhance the beneficial uses of wetlands. Location-specific ARARs and TBCs relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2), are not met under this alternative. Impacts to wetlands and floodplains during cap construction will be mitigated.

Table 5-26 lists the action-specific ARARs for this alternative. The design of the alternative is to attain all action-specific ARARs. The alternative attains all action-specific ARARs except those related to groundwater protection. Corrective actions must be completed within a "reasonable time period." Demonstrating that the action-specific ARAR detailed below can be attained will require long-term monitoring and evaluation. In the event that this ARAR cannot be attained within an agreed upon, designated time period, the groundwater remedy proposed for this alternative will need to be modified by means of a Technical Impracticability (TI) Waiver and/or Explanation of Significant Difference (ESD) to the Record of Decision. Although corrective measures under this alternative includes groundwater treatment, attainment of remedial action objectives for inorganic chemicals may be difficult to achieve in a reasonable time frame. This would affect attainment of the following ARAR:

- Hazardous/Solid Waste Management - Groundwater Protection, 310 CMR 30.660 - 30.675; 310 CMR 19.110 (AOCs #1, 2, 3, 6, and 7).

Hazardous waste management landfill stabilization/solidification (310 CMR 30.632) regulations require that all wastes disposed of in a landfill are treated to the maximum extent practicable to minimize the potential for wastes migrating from the landfill site. This alternative includes excavation of materials from AOCs #3 and 7, with subsequent on-site disposal. Currently, the alternative does not include stabilization/solidification of these wastes. If, however, after sampling the excavated material is shown to be a hazardous waste, further treatment may be warranted and this remedy revisited. This alternative includes sampling and analysis adequate to make this determination and, thus, attains this action-specific ARAR.

### 5.10.3 Long-Term Effectiveness and Permanence for Alternative #46

This alternative is evaluated below in terms of risk remaining at the Site after RAOs are addressed. This portion of the evaluation focuses on the extent and effectiveness of the controls required to manage the risk posed by treatment residuals and/or untreated contamination.

**5.10.3.1 Magnitude of Residual Risk: Human Health.** Alternative #46 implements controls to eliminate exposure of workers to soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. For groundwater, Alternative #46 implements access restrictions to prevent human contact with COCs at AOCs #1 through 7. In addition, the use of an on-site pump and treat remedy at AOCs #1 through 7 and the use of excavation and/or capping at AOCs #1, 2, 3, 4, 5, 6, and 7 are expected to partially reduce groundwater contamination at the Site. Significant containment of groundwater contamination is expected. Under this alternative, the magnitude of residual risks will depend on the enforcement and reliability of institutional controls to prevent human exposures to COCs in groundwater as well as the efficiency of the remedial measures at eliminating exposures to soil and groundwater COCs.

Under this alternative, exposure of female site workers of child-bearing age to lead in indoor dust from soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Contaminated Soils Area, which was estimated to result in a maternal blood level exceeding that protective of a 95$^{th}$ percentile fetal blood lead level of 10 μg/dl, will be eliminated by capping the Contaminated Soils Area, and eliminated through excavation and relocation of soils under capping for the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area. Likewise for the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will be eliminated by excavation and/or capping because fugitive dust generation will be prevented. Therefore, the use of capping at these AOCs will effectively eliminate the estimated risk for site workers to soils, unless the caps are not maintained.

Potential future residual human health risks to a resident from ingestion of COCs in groundwater from AOCs #1 through 7 will be eliminated by the implementation of groundwater access restrictions as

long as long-term enforcement of the groundwater access restrictions is maintained. Should access restrictions not be maintained, the use of on-site groundwater treatment is expected to partially reduce groundwater residual risks by reducing the levels of some organic COCs (times to achieve PRGs of from <1 year to >200 years). However, little reduction in the levels of inorganic COCs is expected. Contaminated groundwater will be largely contained with this alternative due to the on-site pump and treat remedy for AOCs #1 through 7. Therefore, potential risk to off-site receptors will be minimal. As groundwater concentrations decline over time, there will be a partial lowering of residual risks to potential off-site receptors, and to on-site receptors should access restrictions not be maintained in the future. However, concentration reduction is expected to occur slowly for the most significant risk drivers (44 to >200 years to achieve PRGs for arsenic and manganese; see Section 5.10.5.3 and Appendix G).

**5.10.3.2 Magnitude of Residual Risk: Ecological.** Alternative #46 will result in a quantifiable long-term reduction in risk to ecological receptors in soil and surface water, but not from sediments. The potential for exposure of small mammals to contaminants in soil will be removed at the B&M Railroad Landfill and the B&M Locomotive Shop Disposal Areas.

The removal or control of all the major source areas on-site will reduce the potential for discharge of metals in surface water runoff and gradually reduce concentration of contaminants discharged from groundwater. In the long-term, these mechanisms will reduce the concentration of metals contributing to risk to aquatic receptors in surface water. The risk to aquatic receptors from exposure to metals in surface water will persist until substantial decreases in contaminant discharge are achieved. Resuspension of sediments, not treated by this alternative, still will remain a potential source of metals in surface water. Therefore, residual risk to aquatic receptors will not be lowered substantially below baseline conditions for Alternative #46 in the short-term, but are expected to improve in the long-term.

Since no measures are taken in Alternative #46 to directly remove/reduce exposure from contaminants in sediments, the only effects on the concentration of contaminants will be dilution/dispersal through slow, natural processes and a minor reduction in the deposition of additional contamination from surface water over time. Consequently, the concentration of contaminants in on-site sediments will

not be substantially reduced under Alternative #46 and the risk to benthic invertebrates will not be reduced below baseline conditions. The PRGs and RAOs for sediment will not be met.

### 5.10.4 Reduction of Toxicity, Mobility and Volume through Treatment for Alternative #46

Table 5-28 provides a summary of the treatment and process options selected, quantities of waste materials to be remediated, expected reductions in toxicity, mobility and volume, and residuals following treatment for Alternative #46. No human health or ecological risk was determined for soil at AOC #2 (RSI Landfill). Likewise, no risk was determined for surface water at AOC #8a (West Middlesex Canal Group) and AOC #8c (East Middlesex Canal Group). Therefore, reductions in toxicity, mobility and volume were not evaluated for these media at these AOCs. As a provision if future sediment toxicity testing results in ecological risk, actions are included in the alternative for AOCs #8a and #8c and evaluated below.

**5.10.4.1 Treatment/Recycling Processes to be Utilized.** Alternative #46 consists of source control remedies for soil, including horizontal containment and excavation with on-site disposal, which are not considered treatment processes. Groundwater treatment processes to be utilized include collection and treatment by phytoremediation, both with and without management of migration. Monitored natural attenuation will be implemented for surface water and sediment. A more detailed description of the treatment/recycling processes to be utilized under Alternative #46 is provided in Section 5.10. Refer to Table 5-28 for specific treatment/ recycling processes to be utilized at each AOC.

**5.10.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The following amounts of hazardous materials to be treated for Alternative #46 are provided below by media of concern and AOC. Values are only given if the remedial action will provide treatment. Monitored natural attenuation is considered a treatment process in this evaluation, since it typically results in reductions in contamination over time. Source control through in-situ capping and excavation with on-site disposal are not considered treatment processes. Limited sediment sampling was conducted in the wetland areas, AOCs #8b, 8d and 8e, to determine the extent of contamination. Approximate amounts resulting from this determination are provided below.

Groundwater (areal extent of source)

| | |
|---|---|
| • AOC #1 - B&M Railroad Landfill | 12.4 acres |
| • AOC #2 - RSI Landfill | 2.5 acres |
| • AOC #3 - B&M Locomotive Shop Disposal Areas | 4.7 acres |
| • AOC #4 - Old B&M Oil/Sludge Recycling Area | 7.0 acres |
| • AOC #5 - Contaminated Soils Area | 6.7 acres |
| • AOC #6 - Asbestos Landfill | 13.3 acres |
| • AOC #7 - Asbestos Lagoons | 1.9 acres |

Sediment

| | |
|---|---|
| • AOC #8a - West Middlesex Canal Group | all contaminated sediments |
| • AOC #8b - Wetland Group 2 | all contaminated sediments |
| • AOC #8c - East Middlesex Canal Group | all contaminated sediments |
| • AOC #8d - Richardson Pond Group | all contaminated sediments |
| • AOC #8e - Content Brook Wetland Group | all contaminated sediments |

Surface Water

| | |
|---|---|
| • AOC #8b - Wetland Group 2 | 7.6 acres |
| • AOC #8d - Richardson Pond Group | 107 acres |
| • AOC #8e - Content Brook Wetland Group | 1.4 acres |

**5.10.4.3 Degree of Expected Reductions in Toxicity, Mobility and Volume.** The degree of treatment and expected reductions for each treatment process under Alternative #46 are provided below by media of concern and AOC. Reductions expected from in-situ capping and excavation with on-site disposal are not discussed, since these processes are not considered treatment. Reductions from monitored natural attenuation are provided for the U.S. EPA default time period, 30 years. For surface water and sediment, reductions are provided in general terms. Intensive transport modeling required to provide quantifiable reductions is beyond the scope of this FS. Only limited case studies, which can not provide a comprehensive, quantitative estimate, are available in technical literature.

At all AOCs, no contaminated soil is treated under Alternative #46. Therefore, no reductions in toxicity, mobility and volume are expected for soil at all AOCs.

Groundwater at all AOCs will be collected and treated by phytoremediation, either with or without management of migration. Although management of migration is not treatment, it is beneficial to consider it in the evaluation of the amount of contaminated groundwater treated by a pump and treat

system. For groundwater collection processes, management of migration typically consists of not only horizontal containment through capping to reduce further source contamination to groundwater, but also a vertical slurry wall downgradient of the extraction wells. At AOC #7, management of migration will consist only of vertical slurry walls. Although vertical slurry walls will primarily serve to minimize pumping impacts to the neighboring wetlands, they also will provide vertical containment of overburden contaminated groundwater. Therefore, at the AOCs where vertical slurry walls will be utilized in addition to collection and treatment by phytoremediation (AOCs #1, 2, 6, and 7), all of the overburden groundwater is expected to be treated. Vertical slurry walls will be keyed into the top of bedrock, and will not extend through the bedrock. Therefore, bedrock groundwater will not be contained by slurry walls and the degree of treatment of the bedrock groundwater at AOCs #1, 2, 6, and 7 will be dependent on the density of the collection network. At the AOCs where collection and treatment by phytoremediation will be utilized in the absence of management of migration (AOCs #3, 4, and 5), the amount of both overburden and bedrock groundwaters that will be collected for treatment by phytoremediation is dependent on the density of the collection network.

At all AOCs, the toxicity of the contaminated groundwater relative to a specific contaminant is expected to be reduced proportionally to the volume reduction of that specific contaminant provided by phytoremediation processes. At AOCs #1, 2, 6, and 7, contaminant mobility in the overburden groundwater will be limited to each respective AOC by vertical slurry walls. In bedrock groundwater at AOCs #1, 2, 6, and 7, the mobility of organic and inorganic COCs will be dependent on the groundwater collection network Likewise, at the AOCs which will utilize collection and treatment by phytoremediation without management of migration (AOCs #3, 4, and 5), contaminant mobility in both overburden and bedrock groundwaters will be dependent on the density of the collection network. Phytoremediation is expected to reduce the volume of organic COCs by 90% to 95% (Gordon, 1998) and inorganic COCs by 84% to 99% (FRTR, 1997) at all AOCs upon completion of the groundwater remedy. Lesser reductions are expected during the interim period prior to this endpoint.

Monitored natural attenuation is expected to treat the total quantity of contaminated surface water and sediment at AOCs #8b, 8d, and 8e and sediment at AOCs #8a and 8c. Monitored natural attenuation is expected to reduce the toxicity of the contaminated media relative to a specific contaminant

proportional to the volume reduction of that specific contaminant. The mobility of the contaminants and the volume of the contaminated media will not be reduced through monitored natural attenuation. The volume of both organic and inorganic COCs is expected to be reduced over time in surface water and sediment.

**5.10.4.4 Reversibility.** The reversibility of each treatment process to be implemented under Alternative #46 is provided below by media of concern and AOC. Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. Since in-situ capping and excavation with on-site disposal are not considered treatment processes, reversibility of treatment is not applicable to these processes.

Collection of contaminated groundwater and treatment by phytoremediation, to be implemented at all AOCs, is not considered a reversible process. Contaminants taken up by plants are not readily released under normal conditions.

Monitored natural attenuation of surface water and sediment is not considered a reversible process. Contaminants are dispersed and degraded over time.

**5.10.4.5 Type and Quantity of Residuals.** The types and quantities of contaminant residuals by media of concern and AOC expected after completion of the treatment technologies/process options implemented in Alternative #46 are summarized below. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are discussed briefly in Table 5-28.

At all AOCs where horizontal containment will be implemented (AOCs #1, 5, and 6), the total amount of contaminated soil at each respective AOC will remain untreated but contained under the cap. The total amount of contaminated soil to be excavated from AOCs #3, 4, and 7, will likewise remain untreated but contained, under an on-site cap.

Approximately 1% to 16% of organics and 5% to 10% of inorganics will remain at all AOCs following groundwater collection and treatment by phytoremediation upon completion of the groundwater remedy. Greater amounts of COCs than the above stated residuals will result during the interim period prior to this endpoint.

Contaminant residuals in surface water and sediment following treatment by monitored natural attenuation were not determined due to the lack of a comprehensive, quantitative reduction estimate.

### 5.10.5 Short-Term Effectiveness for Alternative #46

This alternative is evaluated for effectiveness in protecting the community and local workers, site remediation workers, and the environment during the construction and implementation of the remedy.

**5.10.5.1 Protection of Community and Workers During Remedial Actions.** The construction and remediation measures proposed under this alternative include excavation and placement of soils from the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Asbestos Lagoons beneath a cap, capping of the B&M Railroad Landfill, RSI Landfill, Contaminated Soils Area, and Asbestos Landfill, on-site groundwater treatment and monitoring at AOCs #1 through 7.

The implementation of these construction/remedial measures will potentially result in additional short-term risk to the community from exposure to soil contaminants primarily associated with dust generation during soil disturbances at the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. Precautions will be implemented to prevent or limit fugitive dust generation during excavation/remedial activities. Worker exposure to COCs in soil during excavation/capping at AOCs #1, 2, 3, 4, 5, 6, and 7, in groundwater during on-site treatment at AOCs #1 through 7, and in soil and groundwater during monitoring will also result in potential health risk to workers. Use of personal protection equipment will be employed to reduce exposure if applicable OSHA standards are exceeded during these activities.

**5.10.5.2 Environmental Impacts.** The capping of B&M Railroad Landfill, RSI Landfill, Asbestos Landfill, Contaminated Soils Area and excavation of B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Asbestos Lagoons will all require removal of vegetation. Wetlands are located around the border of a portion of each of these areas, with the exception of the Old B&M Oil/Sludge Recycling Area and Contaminated Soils Area. The extent of excavation or fill in wetland is estimated to be minimal for each alternative. Mitigation measures will include avoidance and minimization of temporary construction disturbance in adjacent wetlands during construction of landfill caps, slurry walls, and phytoremediation channels. Tree removal will be minimized, and proper construction and erosion control methods will be utilized. Mitigation will include restoration of upland habitat, and minimization of wetland impacts. Any unavoidable wetland loss will be mitigated by restoration or creation of on-site wetlands.

Changes in hydrology resulting from construction of landfill caps will be mitigated by properly designed stormwater retention systems and maintenance of flows of water close to existing conditions. Potential impacts to wetlands resulting from changes in hydrology from operation of the groundwater treatment and phytoremediation systems for the B&M Railroad Landfill, RSI Landfill, Asbestos Landfill, Asbestos Lagoons, Old B&M Oil/Sludge Recycling Area, B&M Locomotive Shop Disposal Areas and Contaminated Soils Area will be mitigated by maintenance of flows of water close to existing conditions. Impacts from the potential alterations to seasonal water levels in the adjacent wetlands will be minimized. Pumping rates and re-injection rates of water to wells will be implemented that are predicted, via modeling, to have minimal effects on water elevations in wetlands.

The alternative includes installation of monitoring wells throughout the Site. Mitigation measures will include avoidance and minimization of temporary construction disturbance in wetlands during installation of monitoring wells, and minimization of tree removal. Proper construction and erosion control methods will be utilized to minimize ecological impact to surrounding habitats.

The excavation of soil adjacent to the unnamed brook in B&M Locomotive Shop Disposal Area A may potentially cause disturbance to the stream bank. Mitigation measures will include avoidance and minimization of temporary construction disturbance in the stream channel and returning impacted

areas to previous grades. Any unavoidable wetland loss from excavation will be mitigated by restoration or creation of on-site wetlands.

**5.10.5.3 Time Until Remedial Action Objectives are Achieved.** Of the RAOs presented in Section 2, those for groundwater will take the longest to achieve. Through the use of groundwater flow modeling and contaminant retardation concepts (Appendix G), approximate times to achieve PRGs were calculated for the Site contaminants at each AOC. It should be noted that the mobility of inorganics is highly sensitive to site specific geochemistry. Other factors such as pH, dissolution, and colloidal transport could have significant impacts on mobility of inorganics. Therefore, these times should only be used for relative comparison and not for accurate representations of cleanup times.

Alternative #46 utilizes active groundwater collection at all AOCs, followed by treatment and reinjection. To minimize wetland impacts from groundwater pumping, slurry walls are located at the edge of AOCs #1, 2, 6, and 7. Furthermore, site hydrology may be impacted by caps placed on AOCs #1, 2, 5, and 6.

Modeling was performed to predict the reduction of contaminant concentrations over time due to natural processes, such as dispersion. Approximate cleanup times, assuming no biodegradation, for each AOC with contaminants above PRGs are presented below:

| Overburden | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | 14 | ND | >200 | 187 |
| AOC #2 - RSI Landfill | 37 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | 13 | ND | ND | >200 |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | 187 |
| AOC #5 - Contaminated Soils Area | 86 | >200 | >200 | >200 |
| AOC #6 - Asbestos Landfill | 10 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 10 | 81 | ND | 137 |

| Bedrock | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | 31 | 22 | ND | 44 |
| AOC #2 - RSI Landfill | 3 | ND | ND | 182 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | ND | ND | ND | ND |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | 91 |

| | | | | |
|---|---|---|---|---|
| AOC #5 - Contaminated Soils Area | >200 | >200 | ND | >200 |
| AOC #6 - Asbestos Landfill | 2 | ND | ND | 89 |
| AOC #7 - Asbestos Lagoons | 33 | >200 | ND | >200 |

Notes: ND = Not detected at a concentration greater than PRGs at this AOC and flow zone

Some cleanup times reported above are high (i.e., greater than 200 years). This simply means that the compounds are essentially immobile. For example, arsenic and thallium have very high retardation coefficients and, ultimately, high cleanup times.

It should also be noted that the only SVOC detected above PRGs at all AOCs was bis(2-ethylhexyl)phthalate and the only pesticide was aldrin. The high retardation factors of these compounds increase the time of travel and source contaminant reduction. Evaluations assumed that the Contaminated Soils Area contained contaminants similar to the B&M Railroad Landfill, RSI Landfill, and the Asbestos Lagoons. The two compounds noted above are therefore assumed to be found at this AOC above PRGs. However, further evaluation may determine that this is not the case. Furthermore, the evaluations assumed that the maximum detections from the three nearby AOCs were also detected at the Contaminated Soils Area. Similarly, data from the RSI Landfill was used to characterize the Asbestos Landfill.

### 5.10.6 Implementability for Alternative #46

This section summarizes the technical and administrative feasibility of implementing Alternative #46, the "Intensive Remedial Action A" alternative, and the availability of various services and materials required for its implementation.

**5.10.6.1 Technical Feasibility.** Evaluation of the technical feasibility of Alternative #46 includes an assessment of three factors described in EPA's feasibility study guidance: 1) the ability to construct and operate the technologies, 2) the reliability of the technologies and 3) the ease of undertaking additional remedial actions, if necessary. These aspects are described in detail below:

Ability to Construct and Operate the Technologies. For Alternative #46, similar to Alternatives #8 through 43, a major implementability issue with regard to technical feasibility is the construction of caps at AOCs #1, 2, 5, and 6 and the excavation and removal of waste soil/waste fill from AOCs #3, 4, and 7 with relocation and regrading of these materials below one of the caps constructed at AOCs #1 or 2, and 6, respectively.

As discussed previously for Alternatives #8 through 43, the capping and excavation remedies for Alternative #46 at AOCs #1, 2, 3, 4, 6, and 7 will require a substantial civil engineering/earthwork component. The key implementability issue is the location of sensitive wetland areas or water bodies adjacent to every one of these AOCs. This will require comprehensive soil erosion, runoff and sedimentation control measures to minimize siltation impacts to wetland areas or water bodies. In addition, proper location and construction of temporary and permanent haul roads will be required to minimize impacts to wetland areas and water bodies. It is expected that the remediation contractor(s) will utilize the existing rail network to move equipment and materials to the largest degree possible. This rail network is closely situated to five of the six "earthwork" AOCs (*e.g.*, #1, 2, 3, 4, and 6). While the scope of the earthwork and transportation required for the capping and excavation activities is large, these are common problems faced and solved by experienced engineers and constructors. Maintenance of the capped and excavated areas is straightforward requiring only periodic inspections, vegetation control (*e.g.*, mowing) and filling of areas of settlement. As a result, no implementability constraints are expected with regard to construction and operation of the soil remedy for AOCs #1, 2, 3, 4, 6, and 7 in Alternative #46.

As discussed in prior alternatives, the primary implementability concern for placement of the single-barrier cap at AOC #5 is the limitation of conducting work within the Contaminated Soils Area while maintaining active use of the rail yard, rail spurs and roads that transect it. Placement of a single-barrier cap will require sitework adjacent to active railbeds and tracks. Therefore, Alternative #46 will require measures such as temporary structural supports, temporary use restrictions for tracks or roadways next to active work areas and temporary relocation of tracks and bedding material, if necessary. Implementing this remedy at AOC #5 will require close cooperation between rail yard users and the remediation engineer/contractor(s) and involve temporary disruptions to the rail yard operations. These are straightforward issues commonly faced and solved as part of construction efforts and are not sufficient to prevent consideration of this alternative as the selected remedy.

Construction, operation and maintenance of the on-site groundwater remedies at AOCs #1 through 7 will need to address several, key implementability issues. Drilling and installation of the groundwater extraction wells and installation of the horizontal trenches and collection piping will require careful construction coordination at AOCs #1, 2, 3, 6, and 7. At these AOCs, well installation must occur within a narrow strip between cap installation or waste fill excavation and bordering wetlands and/or the area for installation of vertical containment (*e.g.*, slurry walls). At AOC #5, drilling and installation of the groundwater collection wells/header pipes will need to occur within the active rail yard thereby requiring temporary use restrictions and/or disruptions similar to those described for installation of the single-barrier cap. Construction of the vertical containment barriers in the overburden soils at AOCs #1, 2, 6, and 7 will require comprehensive

soil erosion, run-off and sedimentation controls to minimize siltation impacts to adjacent wetlands and surface water bodies.

As described previously for Alternative #43 construction of each phytoremediation treatment plant will require a large areal extent as well as careful attention to design elevations and hydraulics to ensure proper flow velocity through the wetland media. Construction of the phytoremediation chamber should be completed by late spring to allow proper establishment of the wetlands media during summer and fall. Proper O&M of the phytoremediation system should seek to minimize shock loading conditions such as: rapid changes in groundwater flows, contaminant concentrations or temperatures, infestation of competitive plant or insect species or attack on the biological media by bacterial agents. Periodic harvesting or removal of the biological media (*e.g.*, plants, roots, soils) followed by proper disposal will be a required part of O&M when contaminant uptake has been maximized. Due to the nature of the phytoremediation technology, periodic cleaning of groundwater recharge wells may be required to prevent biofouling.

There will be no implementability concerns with respect to construction or operation of monitored natural attenuation of contaminated sediments at AOCs #8a through 8e and surface water at AOCs #8b, 8d, and 8e. No structures will be required for construction and operation only requires periodic field testing, sampling and analysis.

Reliability of the Technologies. Reliability of the horizontal caps installed for AOCs #1, 2, and 6 will be considered high if normal periodic maintenance of the cap is conducted. The high reliability will also apply to the excavation and removal of waste soils/waste fill from AOCs #3, 4, and 7 with relocation and regrading of these materials below one of the caps constructed at AOCs #1 or 2, and 6, respectively. The reliability of the single-barrier cap installed for AOC #5 will be less than the landfill caps and much more sensitive to proper inspection and maintenance. Due to the heavy rail and truck loads and the complex pattern of drainage that will be required to address stormwater runoff, a more intensive O&M program of inspection, maintenance and repair will be required to ensure appropriate integrity of the single-barrier cap.

The reliability of on-site groundwater treatment using phytoremediation will be directly dependent on proper operation and maintenance to avoid the "shock" loading conditions (*e.g.*, rapid changes in flowrate, temperature, and contaminant concentrations, infestation of hostile species of plants, insects or bacterial agents) that would reduce performance. In addition, since the wetlands media has a finite capacity to adsorb or absorb site contaminants, periodic removal and replacement as part of O&M is required to maintain system reliability. The reliability of vertical containment of groundwater will be very high since little or no maintenance is required for this in-situ technology if appropriate construction procedures were followed.

As discussed previously for Alternatives #5 through 43, although the institutional controls which will be applied to AOCs #1 through 7 are not exactly technologies, their reliability will depend upon enforcement by the responsible agencies involved.

The reliability of monitored natural attenuation to remediate any residual sediment at AOCs #8a through 8e or surface water contamination at AOCs #8b, 8d, and 8e should be considered "high" since there is no external equipment nor treatment systems that could breakdown. The reliability of the technology to meet PRGs, however, should not be confused with "implementability" but is more appropriately discussed under "effectiveness." the reader is directed to the "treatment efficiency" and the "time required to remediate" discussions in Sections 5.10.4 and 5.10.5.

Ease of Undertaking Additional Remedial Actions. Applying additional remedial actions for contaminated soils contained by the horizontal caps installed at AOCs #1, 2, 5, and 6 will be severely restricted since installation of the caps are largely permanent remediation technologies. This conclusion will also apply to the excavation and removal of waste soils/waste fill from AOCs #3, 4, and 7 with relocation and regrading of these materials below one of the caps constructed at AOCs #1, 2, or 6.

Additional remedial actions could be accommodated to a limited degree to modify on-site groundwater treatment using phytoremediation. Alternate combinations of wetlands media (*e.g.*, plant species, soil types) could be installed within the phytoremediation chamber in an attempt to improve system performance. If this proved to be insufficient, then an alternate on-site treatment remedy (*e.g.*, physical-chemical, for example) could be constructed that could utilize the existing groundwater collection and recharge systems.

If an alternate on-site groundwater treatment remedy is chosen, then the only implementability limitation is that the new technologies will need to accommodate the active, working area of the Contaminated Soils Area rail yard and not require installation within the confines of previously capped AOCs #1, 2, and 6. An additional limit is that they be able to accommodate the existing overburden vertical containment walls installed at AOCs #1, 2, 6, and 7.

Additional remedial actions could be accommodated in place of monitored natural attenuation of sediment at AOCs #8a through 8e and surface water at AOCs #8b, 8d, and 8e without any implementability concerns.

**5.10.6.2 Administrative Feasibility.** Evaluation of the administrative feasibility of Alternative #46 involves assessing the steps required to coordinate with other state, federal and local governmental entities. It should be noted that under Superfund, permits are not required for remediation activities, but compliance with substantive requirements is required.

The principal administrative feasibility issue with regard to Alternative #46, described previously for Alternatives #3 through 43, involves implementation of institutional controls in order to prohibit the use of groundwater. If proprietary controls are used, coordination with the individual property owners of the affected parcels, will be required. For example, implementation of a negative easement would

require the property owner to convey to a third party (typically EPA) the right to limit how the landowner can use his or her property. Here the limitations would likely include prohibitions against the use of groundwater from wells on the property.

If governmental controls are used, coordination with federal, state and local government (the ATSDR, the Commonwealth of Massachusetts and/or the Town of Billerica) will be required. For example, implementation of land use restrictions may require the exercise of zoning authority by the Town of Billerica to prohibit residential development in a contaminated area, or the adoption of a building permit ordinance in the Town of Billerica requiring anyone seeking a building permit for construction activities in a particular area to be notified of contamination in the area and of any relevant management standards - such an ordinance could also be used to prohibit types of construction that would result in unacceptable exposures (e.g., excavation in areas where subsurface contamination has not been fully removed). Implementation of groundwater use restrictions may require action by the Commonwealth of Massachusetts to prohibit or limit certain uses of groundwater in particular areas, or require closing or capping of wells. Implementation of advisories may also require action by the ATSDR or Commonwealth of Massachusetts to publically issue warnings that provide notice to potential users of land, surface water or groundwater of some existing or impending risk associated with their use.

An additional administrative issue is to reach agreement between federal, state and local governmental entities on the specifics of implementing the monitored natural attenuation program addressing sediments and surface water at AOCs #8b, 8d, and 8e. Concurrence among the various agencies will be required in defining the program (*e.g.*, number and type of monitoring locations, analytical/test parameters, frequency of testing, etc.) as well as interpretation of results and conclusions regarding the overall success of monitored natural attenuation.

**5.10.6.3 Availability of Services and Materials.** Evaluation of the availability of services and materials for Alternative #46 includes an assessment of three factors in accordance with EPA's feasibility study guidance: 1) the availability of treatment, storage capacity and disposal services, 2) the

availability of necessary equipment and specialists, and 3) the availability of prospective technologies. These aspects are described in detail below:

Availability of TSDF Services. Since no remedial actions requiring off-site transport, storage or disposal are to be implemented as part of Alternative #46, the "Intensive Remedial Action A" alternative, there are no implementability constraints with regard to this issue for selection of this alternative.

Availability of Necessary Equipment and Specialists. A substantial quantity of heavy, earthmoving equipment as well as transport vehicles (both truck and rail variety) will be required for Alternative #46 during excavation of waste soils/waste fill from AOCs #3, 4, and 7 and construction of the caps at AOCs #1, 2, 5, and 6. The numbers of equipment and vehicles required will be proportional to the number of caps/excavations being conducted simultaneously in a given construction season.

Experienced pavement engineers and contractors will be required to install the single-barrier pavement-type cap at AOC #5. This remediation team will require experience in pavement installations adjacent to multiple rail and spur lines.

The highest need for specialists in Alternative #46 is for two areas: 1) specialized legal counsel/assistance for implementation of the institutional controls and 2) consultants experienced in monitored natural attenuation of sediments and surface water. Implementation of the institutional controls is expected to be a time-consuming process but should not pose significant implementability concerns that will prevent selection of this alternative as the final remedy. Legal specialists experienced in both CERCLA and non-CERCLA sites are available to facilitate this process. Similarly, monitored natural attenuation has been a technology employed at CERCLA sites in the last 10 years and there is a substantial number of environmental consultants with familiarity in implementing such a program. Thus, availability of consultants familiar with monitored natural attenuation should not prevent selection of this alternative as the final remedy.

Availability of Prospective Technologies. On-site groundwater treatment using phytoremediation is the only specialized technology implemented for Alternative #46. This technology requires only routine and commonly available construction materials and methods but requires ecological/engineering specialists familiar with the proper selection and installation of the environmental media. In addition, some of the environmental media (*e.g.*, wetlands plant types) may require specialized development and procurement.

### 5.10.7 Cost for Alternative #46

Total estimated capital cost associated with this alternative is $66.9 million. This estimate assumes a contingency of 20%. The present value of all O&M costs would be $49.4 million. This estimate

assumes an inflation rate of 3%, an interest rate of 7%, and a contingency of 15%. The maximum duration of site remedial actions is assumed to be 30 years, in accordance with RI/FS guidance (U.S. EPA, 1988). Total present worth costs would therefore be $116.3 million. Detailed costs for this alternative are presented in Appendix D. The costs associated with each alternative selected for detailed evaluation are summarized in Table H-1 of Appendix H.

An analysis was performed to determine the cost savings associated with combining similar treatment processes used at different AOCs. The cost savings associated with the combination of treatment plants for on-site phytoremediation (groundwater) are approximately $4.8 million. This reduces the alternative's total costs to $111.5 million. This analysis is presented in Appendix H.

### 5.10.8 State Acceptance for Alternative #46

Acceptance of the selected, site-wide remedial alternative by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 5.10.9 Community Acceptance for Alternative #46

Acceptance of the selected, site-wide remedial alternative by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 5.11 ALTERNATIVE #48 - "INTENSIVE REMEDIAL ACTION B"

Alternative #48 is similar to Alternative #46 except that source control remedies will be extended to include sediments along with soils and disposal areas, while on-site treatment will be extended to include both surface water along with groundwater.

The overview of remedial action components for Alternative #48 is presented in Table 5-29 and Appendix F. Figure 5-10 details the remedial action site plan for this alternative. Alternative #48 includes the following remedial actions by media of concern and AOC:

Soil:

- Source control remedies consisting of horizontal containment (*e.g.*, caps) will be implemented at disposal area AOCs [#1 - B&M Railroad Landfill, #2 - RSI Landfill (for groundwater source management), #5 - Contaminated Soils Area, #6 - Asbestos Landfill] to address human health and ecological risk and/or meet ARAR requirements.
- Contaminated soil at AOCs #3 (B&M Locomotive Shop Disposal Areas), #4 (Old B&M Oil/Sludge Recycling Area), and #7 (Asbestos Lagoons) will be excavated and relocated for ultimate disposal under one of the caps installed for AOCs #1, 2, or 6. This remedy also includes institutional actions for monitoring to confirm appropriate source cleanup.

Groundwater:

- An on-site pump and treat remedy consisting of collection of contaminated groundwater (*e.g.*, extraction wells/subsurface drains) and treatment on-site using biological processes (phytoremediation) followed by discharge will be applied to all AOCs. Vertical containment will be used where necessary to prevent wetland dewatering during groundwater collection. This remedy will also include institutional actions for groundwater monitoring.

Surface Water:

- An on-site collection and treatment remedy consisting of collection of contaminated surface water (*e.g.*, pumps, diversion weirs/channels) and treatment on-site using biological processes (phytoremediation) followed by discharge will be applied to AOCs #8b (Wetland 2 Group) and #8e (Content Brook Wetland Group). This remedy also includes surface water monitoring.
- In-situ remedies consisting of monitored natural attenuation will be implemented at AOC #8d (Richardson Pond Group).

Sediment:

- Source control remedies consisting of dredging/dry excavation of "hot spot" locations will be applied to contaminated sediments in all AOCs exhibiting risk (#8b - Wetland 2

Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group). Excavated sediments will be disposed on-site via relocation under one of the caps installed for AOCs#1, 2, or 6. Remaining lesser contaminated sediments will be mitigated through in-situ means via monitored natural attenuation. Similarly, the same actions are included at the remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) as a provision if future toxicity testing results in ecological risk.

The detailed evaluation of Alternative #48 with respect to the nine FS criteria is presented in Sections 5.11.1 through 5.11.9.

### 5.11.1 Overall Protection of Human Health and the Environment for Alternative #48

Alternative #48 will provide some overall protection of human health and the environment by reducing some risks identified in the baseline risk assessment. For soil, overall protection of human health from implementation of Alternative #48 will result from the elimination of exposures to COCs in surface soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill and Asbestos Lagoons. In addition, the elimination of exposures to groundwater at AOCs #1 through 7 using institutional controls along with reduced COC concentrations at AOCs #1 through 7 using an on-site pump and treat remedy will provide overall protection of human health from groundwater exposures. Identified ecological risks from exposures to soil will be removed. Long-term reduction in exposure of aquatic receptors to surface water will be achieved, and the exposure of benthic organisms to sediment contaminants will be significantly reduced. Therefore, Alternative #48 meets all RAOs for the Site, as defined in Section 2.1, and significantly reduces risks to human health and the environment. The protection of human health and the environment are discussed in Sections 5.11.1.1 and 5.11.1.2, respectively.

**5.11.1.1 Human Health Protection.** Alternative #48 will provide overall protection of human health by eliminating risks identified in the baseline risk assessment. Current baseline risks to human health at the Contaminated Soils Area for female site workers of child-bearing age from exposure to lead in soil via indoor dust will be eliminated as a result of capping since windborne exposures to lead will be eliminated. For the current female site worker of child-bearing age at the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area, baseline risks to human health from exposure to lead in soil via indoor dust will be eliminated as a result of excavation and relocation for

ultimate disposal under one of the caps installed for AOCs #1, 2, 5 or 6. For the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will be abated by excavation and/or capping, since windborne exposure to asbestos will be eliminated. However, since no contaminant removal is performed with capping, the risk will return to baseline levels if the caps are not maintained.

The potential for future risks from ingestion of COCs in groundwater at the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons will be eliminated by restrictions on the future use of groundwater from these AOCs as a drinking water source. Significant reductions in groundwater concentrations for some organic COCs, with negligible reductions in inorganic COC concentrations, are expected to occur by the use of an on-site pump and treat remedy. Information in Section 5.11.5.3 and Appendix G documents times to achieve PRGs of from <1 year to >200 years for organic COCs in contrast to remedial times of 54 years to >200 years for inorganic COCs using collection and treatment by phytoremediation. Reductions in groundwater COC concentrations will occur over time due to the excavation of contaminated soil (at AOCs #3, 4, and 7) and placement of caps (at AOCs #1, 2, 5 and 6). Excavation and capping will lower groundwater COC concentrations by limiting the potential leaching of soil contaminants to groundwater. Natural degradative processes will also contribute to the lowering of groundwater COC concentrations over time. However, contaminant reduction is expected to occur slowly for the most significant risk drivers (54 to >200 years to achieve PRGs for arsenic and manganese; see Section 5.11.5.3 and Appendix G). Since there will be significant containment of contaminated groundwater with this alternative, potential risk to off-site receptors will be minimal.

Additional short-term risks to workers will result from the excavation and/or capping of AOCs #1, 2, 3, 4, 5, 6 and 7, on-site groundwater treatment at AOCs #1 through 7, and from soil and groundwater contact during monitoring. These risks will be mitigated by the use of appropriate personal protection equipment as needed. Specific long-term and short-term human health risks are discussed in Sections 5.11.3.1 and 5.11.5.1, respectively.

**5.11.1.2 Ecological Protection.** Alternative #48 will provide reductions in short-term and long-term risk to ecological receptors relative to baseline conditions for exposures to soil, surface water and sediment. Capping the B&M Railroad Landfill and excavating the B&M Locomotive Shop Disposal Areas will prevent future potential for exposure of terrestrial mammals to metal concentrations, resulting in a significant reduction in ecological risk from exposure to soils.

The ecological risks identified on site for surface water and sediment will also be reduced by this alternative. Adverse impacts on aquatic receptors from exposure to inorganics in surface waters will be reduced at the Wetland 2 Group, Richardson Pond Group and Content Brook Wetland Group. Direct collection and treatment of surface water will reduce metals concentrations in Wetland 2 Group and Content Brook Wetland Group. In addition, capping or treatment of the major source areas on-site is likely to reduce the potential future discharge of contaminants from surface runoff and from groundwater. Dredging of the sediments will reduce the potential for resuspension of metals from sediments in the long term. Impacts on benthic invertebrate populations from exposure to contaminants in sediment will be reduced for Wetland 2 Group, the Richardson Pond Group, and Content Brook Wetland Group. Specific long-term and short-term reductions in ecological risks are discussed in Section 5.11.3.2.

The capping of B&M Railroad Landfill, RSI Landfill, Asbestos Landfill, Contaminated Soils Area, and excavation of the Asbestos Lagoons, B&M Railroad Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area will result in temporary, minor ecological impacts. Construction of groundwater extraction and injection systems and phytoremediation systems will also result in temporary, minor ecological impacts. Dredging and excavation of portions of AOCs #8a through 8e will result in temporary and permanent loss of wetland habitats. These impacts will be mitigated by restoration or creation of wetlands on site.

### 5.11.2 Compliance with ARARs for Alternative #48

Chemical-specific ARARs and TBCs for the Site are discussed at length in Section 2.3.1. A summary of the implications of each chemical-specific ARAR for this "Intensive Remedial Action B" alternative include:

- Safe Drinking Water Act and Massachusetts Drinking Water Regulations. Federal and Massachusetts MCLs are relevant and appropriate for site groundwater. This alternative sets attainment of Federal SDWA MCLs and MMCLs for inorganic and organic chemicals as groundwater remediation goals. Although levels of some organic compounds in groundwater are anticipated to be reduced, this alternative is not anticipated to be able to attain Federal SDWA MCLs or Massachusetts Maximum Contaminant Levels for inorganic chemicals in a reasonable time frame.

- Resource Conservation and Recovery Act Maximum Concentration Limits. RCRA groundwater corrective action requirements are relevant and appropriate requirements at the point of compliance at the limit of the waste management areas. The potential for contaminants to migrate from the area is reduced by this alternative. Monitoring will be conducted to track exposure-based limits at the point of compliance, and to verify a reduction in the migration of contaminants. Although levels of some organic compounds in groundwater are anticipated to be reduced, this alternative is not anticipated to be able to attain Federal RCRA MCLs for inorganic chemicals in a reasonable time frame.

- Federal Water Pollution Control Act, as Amended by the Clean Water Act, Ambient Water Quality Criteria (AWQC). Freshwater acute and chronic AWQC for the protection of aquatic life are considered appropriate and relevant for the site wetlands. Leachate outbreaks and surface water runoff are controlled under this alternative, thereby reducing the probability that AWQC may be exceeded.

- Clean Air Act and Massachusetts Air Pollution Control Regulations. Dust or other potential emissions that may result from excavation of waste materials are controlled under this alternative. There is no indication that ARARs for air will be exceeded by this alternative.

- Massachusetts Groundwater Quality Standards. Actions are taken under this alternative in an attempt to attain applicable "Class I" enforcement standards. Although levels of some organic compounds in groundwater are anticipated to be reduced, this alternative is not anticipated to be able to attain groundwater standards for inorganic chemicals in a reasonable time frame.

- Massachusetts Surface Water Quality Standards. As part of the Shawsheen River Basin, site surface waters are classified as "Class B" habitat for fish, aquatic life and wildlife, and source of treated public water supplies. Surface water quality standards are considered applicable to site surface waters. Leachate outbreaks and surface water runoff are controlled under this alternative, thereby reducing the probability that surface water quality may be exceeded.

- Federal Criteria and Advisories To Be Considered. In addition to the ARARs listed above, there are other important issues and advisories which will require attention prior to and during remedial activities. These criteria and advisories to be considered include:
    - *Health Advisories.* Carcinogenic and non-carcinogenic risk levels due to consumption of contaminated drinking water will be exceeded.
    - *Federal Groundwater Protection Strategy of 1984.* Current, applicable "Class I" enforcement standards are not met under this alternative. Groundwater quality standards are exceeded.
    - *Threshold Limit Values (TLVs).* There is no indication that these levels will be exceeded for site remediation workers under this alternative.

In terms of wetland remediation under this alternative, excavation of contaminated sediments at the Richardson Pond Group, Wetland Group 2, and Content Brook will be supplemented with monitored natural attenuation. To mitigate unavoidable wetland impacts, a site restoration plan will need to be developed. Included within this plan will be specifications for restoration of areas impacted by the

remedial action, revegetation standards, and wetlands monitoring for at least three growing seasons after remediation is completed.

Location-specific ARARs and TBCs relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2), are met under this alternative as long as monitoring provides support that no further remedial actions are necessary to meet the intent of Executive Order 11990, and as long as mitigation of excavated wetlands is completed. Impacts to wetlands and floodplains during cap construction will be mitigated.

Table 5-29 lists the action-specific ARARs for this alternative. The design of the alternative is to attain all action-specific ARARs. The alternative attains all action-specific ARARs except those related to groundwater protection. Corrective actions must be completed within a "reasonable time period." Demonstrating that the action-specific ARAR detailed below can be attained will require long-term monitoring and evaluation. In the event that this ARAR cannot be attained within an agreed upon, designated time period, the groundwater remedy proposed for this alternative will need to be modified by means of a Technical Impracticability (TI) Waiver and/or Explanation of Significant Difference (ESD) to the Record of Decision. Although corrective measures under this alternative includes groundwater treatment , attainment of remedial action objectives for inorganic chemicals may be difficult to achieve in a reasonable time frame. This would affect attainment of the following ARAR:

- Hazardous/Solid Waste Management - Groundwater Protection, 310 CMR 30.660 - 30.675; 310 CMR 19.110 (AOCs #1, 2, 3, 6, and 7).

Hazardous waste management landfill stabilization/solidification (310 CMR 30.632) regulations require that all wastes disposed of in a landfill are treated to the maximum extent practicable to minimize the potential for wastes migrating from the landfill site. This alternative includes excavation of materials from AOC #3 and 7, with subsequent on-site disposal. Currently, the alternative does not include stabilization/solidification of these wastes. If, however, after sampling the excavated material is shown to be a hazardous waste, further treatment may be warranted and this remedy revisited. This

alternative includes sampling and analysis adequate to make this determination and, thus, attains this action-specific ARAR.

### 5.11.3 Long-Term Effectiveness and Permanence for Alternative #48

This alternative is evaluated below in terms of risk remaining at the Site after RAOs are addressed. This portion of the evaluation focuses on the extent and effectiveness of the controls required to manage the risk posed by treatment residuals and/or untreated contamination.

**5.11.3.1 Magnitude of Residual Risk: Human Health.** Alternative #48 implements controls to eliminate exposure of workers to soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. For groundwater, Alternative #48 implements access restrictions to prevent human contact with COCs at AOCs #1 through 7. In addition, the use of an on-site pump and treat remedy at AOCs #1 through 7, and the use of excavation and/or capping at AOCs #1, 2, 3, 4, 5, 6, and 7 are expected to partially reduce groundwater contamination at the Site. Significant containment of groundwater contamination is expected. Under this alternative, the magnitude of residual risks will depend on the enforcement and reliability of institutional controls to prevent human exposures to COCs in groundwater and on the efficiency of the remedial measures at eliminating exposures to soil and groundwater COCs.

Under this alternative, exposure of female site workers of child-bearing age to lead in indoor dust from soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Contaminated Soils Area, which was estimated to result in a maternal blood level exceeding that protective of a 95$^{th}$ percentile fetal blood lead level of 10 µg/dl, will be eliminated by capping the Contaminated Soils Area, and eliminated through excavation and relocation of soils under capping for the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area. Likewise for the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will be eliminated by excavation and/or capping because fugitive dust generation will be prevented. Therefore, the use of capping at these AOCs will effectively eliminate the estimated risk for site workers to soils, unless the caps are not maintained.

Potential future residual human health risks to a resident from ingestion of COCs in groundwater from AOCs #1 through 7 will be eliminated by the implementation of groundwater access restrictions as long as long-term enforcement of the groundwater access restrictions in maintained. Should access restrictions not be maintained, the use of on-site groundwater treatment is expected to partially reduce groundwater residual risks by reducing the levels of some organic COCs (times to achieve PRGs of from <1 year to >200 years). However, little reduction in the levels of inorganic COCs is expected. Contaminated groundwater will be largely contained with this alternative due to the on-site pump and treat remedy for AOCs #1 through 7. Therefore, potential risk to off-site receptors will be minimal. As groundwater concentrations decline over time, there will be a partial lowering of residual risks to potential off-site receptors, and to on-site receptors should access restrictions not be maintained in the future. However, concentration reduction is expected to occur slowly for the most significant risk drivers (54 to >200 years to achieve PRGs for arsenic and manganese; see Section 5.11.5.3 and Appendix G).

**5.11.3.2 Magnitude of Residual Risk: Ecological.** Alternative #48 will result in a quantifiable long-term reduction in risk to ecological receptors in soil, surface water and from sediments. The potential for exposure of small mammals to contaminants in soil will be removed at the B&M Railroad Landfill and the B&M Railroad Locomotive Shop Disposal Areas.

The removal or control of all the major source areas on site will reduce the potential for discharge of metals in surface water runoff and gradually reduce concentration of contaminants discharged from groundwater. In addition, a portion of the surface water at the Wetland 2 Group and Content Brook Wetland Group will be collected and treated. Based on estimates of treatment efficiencies for metals in surface water for Alternative #48 (Table 5-31), the toxicity of metals in surface water will be reduced 80% through 99%, but only a small the portion of the water will be collected and treated. Surface water treatment, combined with source reduction, will substantially reduce risk to aquatic receptors from exposure to metals in surface water. Resuspension of sediments, not treated by this alternative, still remains a potential source of metals in surface water. However, dredging of sediment in open water areas of Wetland 2 Group and Content Brook Wetland Group will further reduce the potential for resuspension or release of metals to surface water, thereby further reducing ecological risk

to aquatic receptors. Short-term, temporary increases in concentration of contaminants in surface water are possible during dredging in Wetland 2 Group, spot excavation in Richardson Pond Group, East Middlesex Canal Group, and West Middlesex Canal Group, and dredging of sediment in open water areas of Content Brook Wetland Group. The residual risk to aquatic receptors will be lowered substantially below baseline conditions for Alternative #48, and are expected to continue to improve in the long-term after both soil, groundwater and sediment source controls are effective. These measures will result in quantifiable reduction of risk to aquatic receptors.

Since direct measures will be taken in Alternative #48 to remove/reduce exposure from contaminants in sediments, this alternative will result in a substantial reduction of risk to benthic invertebrates. The open water areas of the Wetland 2 Group, including the unnamed brook, the associated pond west of the B&M Wastewater Lagoons (OU1), and the B&M Pond, will be dredged. The dredging will result in the reduction of mobility of total PAHs, 4,4'-DDD, antimony, copper, and lead from contaminated sediments in the treated areas. The RAO for protection of exposure of benthic invertebrates from contaminants will be achieved in these areas. Spot excavation in adjacent emergent wetlands will further reduce risk to benthic invertebrates. If spot excavation in adjacent wetlands is unable to remove all sediments that exceed PRGs, it is possible that small areas will remain with residual risk to benthic invertebrates. The overall reduction of risk to benthic invertebrates will be substantial; the amount of remaining risk is unknown since the extent of area that will continue to exceed PRGs is unknown, but expected to be minor.

Spot excavation of isolated areas of sediment with high concentrations of PAHs in Richardson Pond will substantially reduce risk to benthic invertebrates. Exposure of benthic invertebrates to PAHs will be eliminated in the areas of excavation. Residual risk will remain in any areas in which concentrations of PAHs in sediments exceeding the PRG of 4.5 mg/kg are not excavated. It is assumed that the majority of the sediments of the pond with total PAH concentrations above the PRG will be removed and the ecological RAO will be attained for Richardson Pond.

Removing the contaminated sediments from open water and "hot spot" areas in Content Brook Wetland Group will result in achieving the RAO for protection of exposure of benthic invertebrates in

these areas. However, there will be residual risk to benthic invertebrates inhabiting adjacent emergent wetlands, where arsenic may continue to exceed PRGs. The reduction of risk to benthic invertebrates will be substantial. However, the amount of remaining risk is unknown since the extent of area that will continue to exceed PRGs is unknown.

The only effects on the concentration of contaminants in areas outside of dredging and capping activities will be dilution/dispersal through slow, natural processes and a minor reduction in the deposition of additional contamination from surface water over time. Consequently, the concentration of contaminants in sediments outside of open water areas on site will continue to pose a risk to benthic invertebrates under Alternative #48. However, the overall risk to benthic invertebrates site-wide will be substantially reduced below baseline conditions under this Alternative.

### 5.11.4 Reduction of Toxicity, Mobility and Volume through Treatment for Alternative #48

Table 5-31 provides a summary of the treatment and process options selected, quantities of waste materials to be remediated, expected reductions in toxicity, mobility and volume, and residuals following treatment for Alternative #48. No human health or ecological risk was determined for soil at AOC #2 (RSI Landfill). Likewise, no risk was determined for surface water at AOC #8a (West Middlesex Canal Group) and AOC #8c (East Middlesex Canal Group). Therefore, reductions in toxicity, mobility and volume were not evaluated for these media at these AOCs. As a provision if future sediment toxicity testing results in ecological risk, actions are included in the alternative for AOCs #8a and #8c and evaluated below.

**5.11.4.1 Treatment/Recycling Processes to be Utilized.** Alternative #48 consists of source control remedies for soil, including horizontal containment and excavation with on-site disposal, which are not considered treatment processes. Groundwater treatment processes to be utilized include collection and treatment by phytoremediation, both with and without management of migration. Monitored natural attenuation, both as a stand-alone process and in addition to collection and treatment by phytoremediation, will be utilized for surface water. Source control methods, consisting of dry excavation/dredging of "hot spots" and open water areas with on-site disposal, as well as monitored

natural attenuation, will be utilized to address contaminated sediment. Source control methods for sediment are not considered treatment processes. A more detailed description of the treatment/recycling processes to be utilized under Alternative #48 is provided in Section 5.11. Refer to Table 5-31 for specific treatment/recycling processes to be utilized at each AOC.

**5.11.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The following amounts of hazardous materials to be treated for Alternative #48 are provided below by media of concern and AOC. Values are only given if the remedial action will provide treatment. Monitored natural attenuation is considered a treatment process in this evaluation, since it typically results in reductions in contamination over time. Source control methods and institutional actions are not considered treatment processes. Limited sediment sampling was conducted in the wetland areas, AOCs #8a, 8b, 8c, 8d, and 8e, to determine the extent of contamination. Approximate amounts resulting from this determination are provided below.

<u>Ground Water (areal extent of source)</u>

| | |
|---|---|
| • AOC #1 - B&M Railroad Landfill | 12.4 acres |
| • AOC #2 - RSI Landfill | 2.5 acres |
| • AOC #3 - B&M Locomotive Shop Disposal Areas | 4.7 acres |
| • AOC #4 - Old B&M Oil/Sludge Recycling Area | 7.0 acres |
| • AOC #5 - Contaminated Soils Area | 6.7 acres |
| • AOC #6 - Asbestos Landfill | 13.3 acres |
| • AOC #7 - Asbestos Lagoons | 1.9 acres |

<u>Sediment</u>

| | |
|---|---|
| • AOC #8a - West Middlesex Canal Group | non-excavated sediments |
| • AOC #8b - Wetland Group 2 | non-open water sediments |
| • AOC #8c - East Middlesex Canal Group | non-excavated sediments |
| • AOC #8d - Richardson Pond Group | non-excavated sediments |
| • AOC #8e - Content Brook Wetland Group | non-open water sediments |

<u>Surface Water</u>

| | |
|---|---|
| • AOC #8b - Wetland Group 2 | 7.6 acres |
| • AOC #8d - Richardson Pond Group | 107 acres |
| • AOC #8e - Content Brook Wetland Group | 1.4 acres |

**5.11.4.3 Degree of Expected Reductions in Toxicity, Mobility and Volume.** The degree of treatment and expected reductions for each treatment processes under Alternative #48 are provided

below by media of concern and AOC. Reductions expected from source control methods are not discussed, since these processes are not considered treatment. Reductions from monitored natural attenuation are provided for the U.S. EPA default time period, 30 years. For surface water and sediment, reductions are provided in general terms. Intensive transport modeling required to provide quantifiable reductions is beyond the scope of this FS. Only limited case studies, which can not provide a comprehensive, quantitative estimate, are available in technical literature.

At all AOCs, no contaminated soil is treated under Alternative #48. Therefore, no reductions in toxicity, mobility and volume are expected for soil at all AOCs.

Groundwater at all AOCs will be collected and treated by phytoremediation, either with or without management of migration. Although management of migration is not treatment, it is beneficial to consider it in the evaluation of the amount of contaminated groundwater treated by a pump and treat system. For groundwater collection processes, management of migration typically consists of both horizontal containment through capping and vertical containment through slurry walls. At AOC #7, management of migration will consist only of vertical slurry walls. The primary purpose for the installation of vertical slurry walls is to minimize pumping impacts to the neighboring wetlands. However, they will also provide vertical containment of overburden contaminated groundwater. Therefore, at AOCs #1, 2, 6, and 7, where vertical slurry walls will be utilized in addition to collection and treatment by phytoremediation, all of the overburden groundwater is expected to be treated. Vertical slurry walls will not extend through the bedrock, and therefore will not contain bedrock groundwater. Thus, the degree of treatment of the bedrock groundwater at AOCs #1, 2, 6, and 7 will be dependent on the density of the collection network. At the AOCs where collection and treatment by phytoremediation will be utilized in the absence of management of migration (AOCs #3, 4, and 5), the amount of both overburden and bedrock groundwaters collected for treatment by phytoremediation will likewise be dependent on the collection network.

Through the phytoremediation process, the toxicity of the contaminated groundwater relative to a specific contaminant is expected to be reduced proportionally to the volume reduction of that specific contaminant at all AOCs. At AOCs #1, 2, 6, and 7, vertical slurry walls will limit contaminant mobility in the overburden groundwater to each respective AOC. In bedrock groundwater at AOCs #1,

2, 6, and 7, the mobility of organic and inorganic COCs will be dependent on the groundwater collection network Likewise, at AOCs which will utilize collection and treatment by phytoremediation without management of migration (AOCs #3, 4, and 5), contaminant mobility in both overburden and bedrock groundwaters will be dependent on the density of the collection network. Phytoremediation processes to be implemented at all AOCs are expected to reduce the volume of organic COCs by 90% to 95% (Gordon, 1998), while inorganic COCs volume reduction is anticipated to be 84% to 99% (FRTR, 1997) upon completion of the groundwater remedy. Lesser volume reductions will be expected during the interim period prior to this endpoint.

Collection and treatment by phytoremediation is expected to treat a portion of the surface waters at AOCs #8b and 8e. Monitored natural attenuation will treat the remaining portions at AOCs #8b and 8e, as well as the total quantity of surface water at AOC #8d. Both phytoremediation and monitored natural attenuation processes are expected to reduce the toxicity of the contaminated surface water relative to a specific contaminant proportional to the volume reduction of that specific contaminant. The mobility of the contaminants at AOCs #8b and 8e will be reduced proportional to the amount collected. Monitored natural attenuation will provide no contaminant mobility reduction in the remaining surface waters of AOC #8b and 8e, and all of the surface water at AOC #8d. The volume of the contaminated media will not be reduced through phytoremediation and monitored natural attenuation. AOC #8b and 8e surface waters collected and treated by phytoremediation are likely to exhibit a 90% to 95% and 84% to 99% reduction in volume of organic and inorganic COCs, respectively. In the remaining, uncollected portion of surface waters at AOCs #8b and 8e, and in all of the surface water at AOC #8d, the volume of both organic and inorganic COCs is expected to be reduced over time by monitored natural attenuation.

Only non-excavated sediments in AOCs #8a, 8c, and 8d and non-open water sediments in AOCs #8b and 8e are treated under Alternative #48 via monitored natural attenuation. Sediments addressed through source control methods including spot excavation and open-water dry excavation/dredging, to be implemented at all AOCs, will not be treated. Monitored natural attenuation is expected to reduce the volume of contaminants at all AOCs over time. The toxicity reduction of the contaminated sediments relative to a specific contaminant is expected to be reduced proportionally to the volume

reduction at that specific contaminant at each respective AOC through monitored natural attenuation. There will be no mobility reduction of COCs in the lesser contaminated sediments addressed through monitored natural attenuation at all AOCs.

**5.11.4.4 Reversibility.** The reversibility of each treatment process to be implemented under Alternative #48 is provided below by media of concern and AOC. Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. Since source control methods are not considered treatment processes, reversibility of treatment is not applicable to these processes.

Collection of contaminated groundwater and treatment by phytoremediation, to be implemented at all AOCs, is not considered a reversible process. Contaminants taken up by plants are not readily released under normal conditions.

As with groundwater, collection of contaminated surface water at AOCs #8b and 8e, and treatment by phytoremediation is not considered reversible. Monitored natural attenuation processes, to be utilized to address remaining surface waters at AOCs #8b and 8e, and all surface water at AOC #8d, are not considered reversible. Contaminants are degraded and dispersed over time.

Monitored natural attenuation of non-excavated and non-open water sediments is not considered reversible, as the contaminants are degraded over time.

**5.11.4.5 Type and Quantity of Residuals.** The types and quantities of contaminant residuals by media of concern and AOC expected after completion of the treatment technologies/process options implemented in Alternative #48 are summarized below. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are discussed briefly in Table 5-31.

At all AOCs where horizontal containment will be implemented (AOCs #1, 5, and 6), all of contaminated soil at each respective AOC will remain untreated but contained under the cap.

Likewise, the total amount of contaminated soil to be excavated from AOCs #3, 4 and 7, will remain untreated but contained under one of the caps implemented at AOCs #1, 2, or 6.

Following groundwater collection and treatment by phytoremediation, approximately 1% to 16% of organics and 5% to 10% of inorganics will remain at all AOCs. These values represent the remaining contaminant residuals upon completion of the groundwater remedy. Greater amounts will be expected during the interim period prior to this endpoint.

Approximately 1% to 16% of inorganics and 5% to 10% of inorganics will remain in the discharged surface water following collection and treatment by phytoremediation at AOCs #8b and 8e. Contaminant residuals in the uncollected portion of AOC #8b and 8e surface water, as well as all of the surface water at AOC #8d following treatment by monitored natural attenuation, were not determined due to the lack of a comprehensive, quantitative reduction estimate following treatment by monitored natural attenuation.

Sediments to be excavated from all AOCs will be removed from the wetlands, but remain untreated under an on-site protective cap. The residuals from monitored natural attenuation of lesser contaminated sediments at all AOCs were not determined because a reduction estimate was not quantified.

### 5.11.5 Short-Term Effectiveness for Alternative #48

This alternative is evaluated for effectiveness in protecting the community and local workers, site rededication workers, and the environment during the construction and implementation of the remedy.

**5.11.5.1 Protection of Community and Workers During Remedial Actions.** The construction and remediation measures proposed under this alternative include excavation and placement of soils from the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Asbestos Lagoons beneath a cap, capping of the B&M Railroad Landfill, RSI Landfill, Contaminated Soils Area, and Asbestos Landfill, on-site groundwater treatment and monitoring at AOCs #1 through 7.

The implementation of these construction/remedial measures will potentially result in additional short-term risk to the community from exposure to soil contaminants primarily associated with dust generation during soil disturbances at the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. Precautions will be implemented to prevent or limit fugitive dust generation during excavation/remedial activities. Worker exposure to COCs in soil during excavation/capping at AOCs #1, 2, 3, 4, 5, 6, and 7, in groundwater during on-site treatment at AOCs #1 through 7, and in soil and groundwater during monitoring will also result in potential health risk to workers. Use of personal protection equipment will be employed to reduce exposure if applicable OSHA standards are exceeded during these activities.

**5.11.5.2 Environmental Impacts.** The capping of B&M Railroad Landfill, RSI Landfill, Contaminated Soils Area, Asbestos Landfill and excavation of B&M Railroad Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Asbestos Lagoons will all require removal of vegetation. Vertical containment walls will also be constructed between the edge of the landfill and the wetlands at B&M Railroad Landfill, RSI Landfill, the Asbestos Landfill, and the Asbestos Lagoons. Wetlands are located around the border of a portion of each of these areas, with the exception of the Old B&M Oil/Sludge Recycling Area. The extent of excavation or fill in wetland is estimated to be minimal for installation of the caps and walls. Mitigation measures will include avoidance and minimization of temporary construction disturbance in adjacent wetlands during construction of landfill caps or treatment walls. Tree removal will be minimized, and proper construction and erosion control methods will be utilized. Mitigation will include restoration of upland habitat, and minimization of wetland impacts. Any unavoidable wetland loss will be mitigated by restoration or creation of wetlands on site. Changes in hydrology resulting from construction of landfill caps and groundwater treatment systems will be mitigated by properly designed stormwater retention systems and maintenance of flows of water close to existing conditions. Potential alterations in the hydrology and seasonal water levels in the adjacent wetlands will be minimized. Pumping rates and re-injection rates of water to wells will be implemented that are predicted, via modeling, to have minimal effects on water elevations in wetlands.

The alternative includes installation of monitoring wells throughout the Site. Mitigation measures will include avoidance and minimization of temporary construction disturbance in adjacent wetlands during construction of monitoring wells, and minimization of tree removal. Proper construction and erosion control methods will be utilized to minimize ecological impact to surrounding habitats.

Sediment removal at Wetland 2 will also result in temporary wetland impacts for access roads and significant wetland impacts resulting from dredging of approximately 1 ft. of sediment from open water areas. Mitigation will include minimization of wetland impacts and restoration of access roads by returning impacted areas to previous grades and restoring wetland vegetation. Any unavoidable wetland loss from dredging will be mitigated by restoration or creation of wetlands on site. The majority of the dredged areas will be restored to grade after dredging by backfilling with suitable material to replace the substrate. The size and location of wetland mitigation areas will be determined during design based on the estimated wetland loss (approximately 2.5 acres). Appropriate erosion control techniques will be implemented to prevent impacts to adjacent wetland areas during dredging, and prevent downstream discharge of sediment.

Spot excavation and on-site disposal of sediments in Richardson Pond Group, West Middlesex Canal Group, and East Middlesex Canal Group will also result in temporary wetland impacts for access roads and additional areas of wetland impacts resulting from dredging of wetland sediments. Mitigation will include minimization of wetland impacts and restoration of access roads by returning impacted areas to previous grades and restoring wetland vegetation. Any unavoidable wetland loss from dredging will be mitigated by restoration or creation of wetlands on site. The majority of the dredged areas will be restored to grade after dredging by backfilling with suitable material to replace the substrate. Appropriate erosion control techniques will be implemented to prevent impacts to adjacent wetland areas during dredging, and prevent downstream discharge of sediment.

Excavation and on-site disposal of sediments from open channel areas in Content Brook Wetland Group will also result in wetland impacts. Mitigation will include minimization of wetland impacts and restoration of impacted areas to previous grades and restoring wetland vegetation. Any unavoidable wetland loss from dredging will be mitigated by restoration or creation of wetlands on site

(approximately 1.5 acres). The majority of the dredged areas will be restored to grade after dredging by backfilling with suitable material to replace the substrate. Appropriate erosion control techniques will be implemented to prevent impacts to adjacent wetland areas during dredging, and prevent downstream discharge of sediment.

**5.11.5.3 Time Until Remedial Action Objectives are Achieved.** Of the RAOs presented in Section 2, those for groundwater will take the longest to achieve. Through the use of groundwater flow modeling and contaminant retardation concepts (Appendix G), approximate times to achieve PRGs were calculated for the Site contaminants at each AOC. It should be noted that the mobility of inorganics is highly sensitive to site specific geochemistry. Other factors such as pH, dissolution, and colloidal transport could have significant impacts on mobility of inorganics. Therefore, these times should only be used for relative comparison and not for accurate representations of cleanup times.

Similar to Alternative #46, Alternative #48 utilizes active groundwater collection at all AOCs, followed by treatment and reinjection. To minimize wetland impacts from groundwater pumping, slurry walls are located at the edge of AOCs #1, 2, 6, and 7. Furthermore, site hydrology may be impacted by caps placed on AOCs #1, 2, 5, and 6. Additional hydrology impacts may be realized from groundwater injection of treated surface water.

Modeling was performed to predict the reduction of contaminant concentrations over time due to natural processes, such as dispersion. Approximate cleanup times, assuming no biodegradation, for each AOC with contaminants above PRGs are presented below:

| Overburden | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | 17 | ND | >200 | >200 |
| AOC #2 - RSI Landfill | 36 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | 13 | ND | ND | >200 |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | >200 |
| AOC #5 - Contaminated Soils Area | 88 | >200 | >200 | >200 |
| AOC #6 - Asbestos Landfill | 10 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 10 | 84 | ND | 141 |

| Bedrock | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | 38 | 28 | ND | 54 |
| AOC #2 - RSI Landfill | 3 | ND | ND | 187 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | ND | ND | ND | ND |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | 85 |
| AOC #5 - Contaminated Soils Area | >200 | >200 | ND | >200 |
| AOC #6 - Asbestos Landfill | 2 | ND | ND | 93 |
| AOC #7 - Asbestos Lagoons | 32 | >200 | ND | >200 |

Notes: ND = Not detected at a concentration greater than PRGs at this AOC and flow zone

Some cleanup times reported above are high (i.e., greater than 200 years). This simply means that the compounds are essentially immobile. For example, arsenic and thallium have very high retardation coefficients and, ultimately, high cleanup times.

It should also be noted that the only SVOC detected above PRGs at all AOCs was bis(2-ethylhexyl)phthalate and the only pesticide was aldrin. The high retardation factors of these compounds increase the time of travel and source contaminant reduction. Evaluations assumed that the Contaminated Soils Area contained contaminants similar to the B&M Railroad Landfill, RSI Landfill, and the Asbestos Lagoons. The two compounds noted above are therefore assumed to be found at this AOC above PRGs. However, further evaluation may determine that this is not the case. Furthermore, the evaluations assumed that the maximum detections from the three nearby AOCs were also detected at the Contaminated Soils Area. Similarly, data from the RSI Landfill was used to characterize the Asbestos Landfill.

### 5.11.6 Implementability for Alternative #48

This section summarizes the technical and administrative feasibility of implementing Alternative #48, the "Intensive Remedial Action B" alternative, and the availability of various services and materials required for its implementation.

**5.11.6.1 Technical Feasibility.** Evaluation of the technical feasibility of Alternative #48 includes an assessment of three factors described in EPA's feasibility study guidance: 1) the ability to construct

and operate the technologies, 2) the reliability of the technologies and 3) the ease of undertaking additional remedial actions, if necessary. These aspects are described in detail below:

Ability to Construct and Operate the Technologies. For Alternative #48, similar to Alternatives #8 through 46, a major implementability issue with regard to technical feasibility is the construction of caps at AOCs #1, 2, 5, and 6 and the excavation and removal of waste soil/waste fill from AOCs #3, 4, and 7 with relocation and regrading of these materials below one of the caps constructed at AOCs #1 or 2, and 6, respectfully.

As discussed previously for Alternatives #8 through 46, the capping and excavation remedies for Alternative #48 at AOCs #1, 2, 3, 4, 6, and 7 will require a substantial civil engineering/earthwork component. The key implementability issue is the location of sensitive wetland areas or water bodies adjacent to every one of these AOCs. This will require comprehensive soil erosion, runoff and sedimentation control measures to minimize siltation impacts to wetland areas or water bodies. In addition, proper location and construction of temporary and permanent haul roads will be required to minimize impacts to wetland areas and water bodies. It is expected that the remediation contractor(s) will utilize the existing rail network to move equipment and materials to the largest degree possible. This rail network is closely situated to five of the six "earthwork" AOCs (*e.g.*, #1, 2, 3, 4, and 6). While the scope of the earthwork and transportation required for the capping and excavation activities is large, these are common problems faced and solved by experienced engineers and constructors. Maintenance of the capped and excavated areas is straightforward requiring only periodic inspections, vegetation control (*e.g.*, mowing) and filling of areas of settlement. As a result, no implementability constraints are expected with regard to construction and operation of the soil remedy for AOCs #1, 2, 3, 4, 6, and 7 in Alternative #48.

As discussed in prior alternatives, the primary implementability concern for placement of the single-barrier cap at AOC #5 is the limitation of conducting work within the Contaminated Soils Area while maintaining active use of the rail yard, rail spurs and roads that transect it. Placement of a single-barrier cap will require sitework adjacent to active railbeds and tracks. Therefore, Alternative #48 will require measures such as temporary structural supports, temporary use restrictions for tracks or roadways next to active work areas and temporary relocation of tracks and bedding material, if necessary. Implementing this remedy at AOC #5 will require close cooperation between rail yard users and the remediation engineer/contractor(s) and involve temporary disruptions to the rail yard operations. These are straightforward issues commonly faced and solved as part of construction efforts and are not sufficient to prevent consideration of this alternative as the selected remedy.

Construction, operation and maintenance of the on-site groundwater remedies at AOCs #1 through 7 will need to address several, key implementability issues. Drilling and installation of the groundwater extraction wells and installation of the horizontal trenches and collection piping will require careful construction coordination at AOCs #1, 2, 3, 6, and 7. At these AOCs, well installation must occur within a narrow strip between cap installation or waste fill excavation and bordering wetlands and/or the area for installation of vertical containment (*e.g.*, slurry walls). At

AOC #5, drilling and installation of the groundwater collection wells/header pipes will need to occur within the active rail yard thereby requiring temporary use restrictions and/or disruptions similar to those described for installation of the single-barrier cap. Construction of the vertical containment barriers in the overburden soils at AOCs #1, 2, 6, and 7 will require comprehensive soil erosion, run-off and sedimentation controls to minimize siltation impacts to adjacent wetlands and surface water bodies.

As described previously for Alternative #43, construction of each phytoremediation treatment plant will require a large areal extent as well as careful attention to design elevations and hydraulics to ensure proper flow velocity through the wetland media. Construction of the phytoremediation chamber should be completed by late spring to allow proper establishment of the wetlands media during summer and fall. Proper O&M of the phytoremediation system should seek to minimize shock loading conditions such as: rapid changes in groundwater flows, contaminant concentrations or temperatures, infestation of competitive plant or insect species or attack on the biological media by bacterial agents. Periodic harvesting or removal of the biological media (*e.g.*, plants, roots, soils) followed by proper disposal will be a required part of O&M when contaminant uptake has been maximized. Due to the nature of the phytoremediation technology, periodic cleaning of groundwater recharge wells may be required to prevent biofouling.

The sediment excavation and stream dredging activities at AOCs #8a through 8e will need to address the following construction implementability issues: 1) installation of temporary access roads, 2) minimization of downstream siltation, 3) work limitations to seasonal low-flow periods, and 4) wetlands, streambed and pond restoration. In addition, the sediment mitigation activities at AOCs #8b and 8e will require temporary diversion of water to allow efficient "dry" sediment excavation from source areas rather than dredging. Access roads will need to be constructed along the banks adjacent to the work areas to allow transport of materials, access for construction equipment, and access for remediation personnel. Temporary silt control measures will be required to prevent downstream impacts during excavation activities. Work within the wetland, stream, and pond areas will be limited to low-flow seasonal periods (late summer/early fall). Periodic, heavy storms will require suspension of work and temporary stabilization measures if construction efforts are still in-progress. At the close of construction activities, wetlands, streambank, streambed and pond restoration activities will be required for those areas impacted by construction. The goal of the restoration will be to return these areas to the same water elevations, flow capacity and overall drainage hydrology as existed before.

On-site treatment of contaminated surface water using phytoremediation will have the same implementability issues with regard to construction, operation and maintenance as discussed previously for groundwater treatment. An exception to this will be collection of surface water which will occur by direct diversion from the surface water body.

There are no implementability concerns with respect to construction or operation of monitored natural attenuation for the residual contaminated sediments and surface water at AOCs #8b, 8d, and 8e. No structures are required for construction and "operation" only requires periodic field testing, sampling and analysis.

Reliability of the Technologies. Reliability of the horizontal caps installed for AOCs #1, 2, and 6 will be considered high if normal periodic maintenance of the cap is conducted. The high reliability will also apply to the excavation and removal of waste soils/waste fill from AOCs #3, 4, and 7 with relocation and regrading of these materials below one of the caps constructed at AOCs #1 and 2, or 6, respectfully. The reliability of the single-barrier cap installed for AOC #5 will be less than the landfill caps and much more sensitive to proper inspection and maintenance. Due to the heavy rail and truck loads and the complex pattern of drainage that will be required to address stormwater runoff, a more intensive O&M program of inspection, maintenance and repair will be required to ensure appropriate integrity of the single-barrier cap.

The reliability of on-site groundwater treatment using phytoremediation will be directly dependent on proper operation and maintenance to avoid the "shock" loading conditions (*e.g.*, rapid changes in flowrate, temperature, and contaminant concentrations, infestation of hostile species of plants, insects or bacterial agents) that would reduce performance. In addition, since the wetlands media has a finite capacity to adsorb or absorb site contaminants, periodic removal and replacement as part of O&M is required to maintain system reliability. The reliability of vertical containment of groundwater will be very high since little or no maintenance is required for this in-situ technology if appropriate construction procedures were followed.

As discussed previously for Alternatives #5 through 46, although the institutional controls which will be applied to AOCs #1 through 7 are not exactly technologies, their reliability will depend upon enforcement by the responsible agencies involved.

The reliability of sediment excavation/dredging for AOCs #8a through 8e will be equal to the long-term reliability of the caps for AOCs #1, 2, or 6 where these materials will be placed for ultimate disposal. The reliability of on-site surface water treatment using phytoremediation will be essentially the same as described previously for on-site groundwater. Proper operation and maintenance of the phytoremediation system to avoid "shock" loads such as rapid changes in flowrate, temperature and contaminant concentrations or infestation by hostile plant or insect species will be needed for reliable performance. In addition, periodic "harvesting" or removal of system plants that have maximized contaminant uptake followed by proper disposal is a necessary maintenance activity to maximize performance.

The reliability of monitored natural attenuation to remediate any residual sediment or surface water contamination at AOCs #8a through 8e should be considered "high" since there is no external equipment nor treatment systems that could break down. The reliability of the technology to meet PRGs, however, should not be confused with "implementability" but is more appropriately discussed under "effectiveness." The reader is directed to the "treatment efficiency" and the "time required to remediate" discussions in Sections 5.11.4 and 5.11.5.

Ease of Undertaking Additional Remedial Actions. Applying additional remedial actions for contaminated soils contained by the horizontal caps installed at AOCs #1, 2, 5, and 6 will be severely restricted since installation of the caps are largely permanent remediation technologies. This conclusion will also apply to the excavation and removal of waste soils/waste fill from

AOCs #3, 4, and 7 with relocation and regrading of these materials below one of the caps constructed at AOCs #1, 2, or 6.

Additional remedial actions could be accommodated to a limited degree to modify on-site groundwater and surface water treatment using phytoremediation. Alternate combinations of wetlands media (*e.g.*, plant species, soil types) could be installed within the phytoremediation chamber in an attempt to improve system performance. If this proved to be insufficient, then an alternate on-site treatment remedy (*e.g.*, physical-chemical, for example) could be constructed that could utilize the existing groundwater and surface water collection and recharge systems.

For Alternative #48, applying additional remedial actions to the contaminated sediments that were excavated/dredged from AOCs #8a through 8e and placed under caps at AOCs #1, 2, or 6 will be severely limited. For practical purposes, the technologies applied to these sediments are largely permanent. Additional technologies, however, could be used in place of monitored natural attenuation of remaining contaminated sediments at AOCs #8a through 8e or surface water at AOCs #8b, 8d, and 8e without any major implementability concerns.

**5.11.6.2 Administrative Feasibility.** Evaluation of the administrative feasibility of Alternative #48 involves assessing the steps required to coordinate with other state, federal and local governmental entities. It should be noted that under Superfund, permits are not required for remediation activities, but compliance with substantive requirements is required.

The principal administrative feasibility issue with regard to Alternative #48, described previously for Alternatives #3 through 46, involves implementation of institutional controls in order to prohibit the use of groundwater. If proprietary controls are used, coordination with the individual property owners of the affected parcels, will be required. For example, implementation of a negative easement would require the property owner to convey to a third party (typically EPA) the right to limit how the landowner can use his or her property. Here the limitations would likely include prohibitions against the use of groundwater from wells on the property.

If governmental controls are used, coordination with federal, state and local government (the ATSDR, the Commonwealth of Massachusetts and/or the Town of Billerica) will be required. For example, implementation of land use restrictions may require the exercise of zoning authority by the Town of Billerica to prohibit residential development in a contaminated area, or the adoption of a building permit ordinance in the Town of Billerica requiring anyone seeking a building permit for construction

activities in a particular area to be notified of contamination in the area and of any relevant management standards - such an ordinance could also be used to prohibit types of construction that would result in unacceptable exposures (e.g., excavation in areas where subsurface contamination has not been fully removed). Implementation of groundwater use restrictions may require action by the Commonwealth of Massachusetts to prohibit or limit certain uses of groundwater in particular areas, or require closing or capping of wells. Implementation of advisories may also require action by the ATSDR or Commonwealth of Massachusetts to publically issue warnings that provide notice to potential users of land, surface water or groundwater of some existing or impending risk associated with their use.

Another administrative feasibility issue for Alternative #48 involves the sediment and surface water remedies. The sediment remedies (*e.g.*, dredging, excavation and on-site disposal) conducted at AOCs #8b, 8d, and 8e will all require a substantial administrative component to ensure that the design, construction and demonstration of compliance are in accordance with the substantive ARAR requirements for wetland, stream and pond areas. Appropriate lead-times will be required during both the design and construction-phases to interact with the various agencies involved and to reach agreement on the specifics of the remedies.

The sediment remedy at Richardson Pond will further require coordination between the remediation contractor, Boston & Maine Railroad (B&M) as well as the Massachusetts Bay Transportation Authority (MBTA). This will be required since AOC #8d will be the only area of concern north of the B&M/MBTA tracks and all site access points lie south of the tracks. At a minimum, remediation vehicles will need access to use the B&M/MBTA rail right-of-way.

Due to the relative locations of the Richardson Pond Group, East Middlesex Canal Group, and the Content Brook Group wetland AOCs, sediment remedies at AOCs #8c, 8d, and 8e and the surface water remedy at AOC #8e will need to be coordinated with the selected remedy at Operable Unit 2 of the Iron Horse Park CERCLA Site (*i.e.*, Shaffer Landfill). The OU2 remedy selected, and currently under construction, is capping of Shaffer Landfill along with construction of an upgraded landfill gas

flare station. As part of the remedy, there will be construction of access roads and stormwater detention basins at various points around the landfill perimeter.

An additional administrative issue will be to reach agreement between federal, state and local governmental entities on the specifics of implementing the monitored natural attenuation program. Under Alternative #48, this program will address residual sediment contamination and surface water at AOCs #8b, 8d, and 8e. Concurrence among the various governmental agencies will be required in defining the program (*e.g.*, number and type of monitoring locations, analytical/test parameters, frequency of testing, etc.) as well as interpretation of results and conclusions regarding the overall success of monitored natural attenuation.

**5.11.6.3 Availability of Services and Materials.** Evaluation of the availability of services and materials for Alternative #48 includes an assessment of three factors in accordance with EPA's feasibility study guidance: 1) the availability of treatment, storage capacity and disposal services, 2) the availability of necessary equipment and specialists, and 3) the availability of prospective technologies. These aspects are described in detail below:

Availability of TSDF Services. Since no remedial actions requiring off-site transport, storage or disposal are to be implemented as part of Alternative #48, the "Intensive Remedial Action B" alternative, there are no implementability constraints with regard to this issue for selection of this alternative.

Availability of Necessary Equipment and Specialists. A substantial quantity of heavy, earthmoving equipment as well as transport vehicles (both truck and rail variety) will be required for Alternative #48 during excavation of waste soils/waste fill from AOCs #3, 4, and 7, and construction of the caps at AOCs #1, 2, 5, and 6. The numbers of equipment and vehicles required will be proportional to the number of caps/excavations being conducted simultaneously in a given construction season.

Experienced pavement engineers and contractors will be required to install the single-barrier pavement-type cap at AOC #5. This remediation team will be require experience in pavement installations adjacent to multiple rail and spur lines.

The highest need for specialists related to soil and groundwater remediation in Alternative #48 will be for three areas: 1) specialized legal counsel/assistance for implementation of the institutional controls, 2) consultants experienced in monitored natural attenuation of surface water and sediment, and 3) engineers and contractors familiar with both civil sitework excavation

and asbestos abatement. Implementation of the institutional controls is expected to be a time-consuming process but should not pose significant implementability concerns that will prevent selection of this alternative as the final remedy. Legal specialists experienced in both CERCLA and non-CERCLA sites are available to facilitate this process. Similarly, monitored natural attenuation has been a technology employed at CERCLA sites in the last 10 years and there will be a substantial number of environmental consultants with familiarity in implementing such a program. Thus, availability of consultants familiar with monitored natural attenuation should not prevent selection of this alternative as the final remedy. Engineers and contractors familiar with both civil excavation/waste removal and asbestos abatement will be required for waste soil/waste fill removal from the Asbestos Lagoons with transfer to the Asbestos Landfill. An appropriate remediation team with experienced contractors of both types could be reasonably assembled to address this concern.

The sediment and surface water remedies for Alternative #48 will require specialists and some specialized equipment. The design/remediation contractor(s) will need to include a hydrology consultant on the team who will be familiar with the regional drainage patterns. This will be needed so that the sediment remedies do not impact overall site and area drainage. An experienced wetlands contractor will be an additional and necessary member of the team for restoration of wetland, stream and pond areas impacted by construction activities. The wetlands contractor will also be expected to provide appropriate guidance on diversion of water for sediment excavation at AOCs #8b and 8e. Specialized equipment will include tracked or other low-ground pressure vehicles which resist "bogging down"during work in wetland areas of concern.

Availability of Prospective Technologies. On-site groundwater treatment using phytoremediation is the only specialized technology implemented for Alternative #48. This technology requires only routine and commonly available construction materials and methods but requires ecological/engineering specialists familiar with the proper selection and installation of the environmental media. In addition, some of the environmental media (*e.g.*, wetlands plant types) may require specialized development and procurement.

Although this technology is not as "exotic" as many innovative technologies, it is still relatively uncommon and will require effort to identify and procure appropriate expertise, equipment and skilled personnel familiar with its design, construction and O&M. Therefore, this technology will be the limiting factor in the overall implementability with regard to "availability" for this alternative.

### 5.11.7 Cost for Alternative #48

Total estimated capital cost associated with this alternative is $75.1 million. This estimate assumes a contingency of 20%. The present value of all O&M costs would be $62.4 million. This estimate assumes an inflation rate of 3%, an interest rate of 7%, and a contingency of 15%. The maximum

duration of site remedial actions is assumed to be 30 years, in accordance with RI/FS guidance (U.S. EPA, 1988). Total present worth costs would therefore be $137.5 million. Detailed costs for this alternative are presented in Appendix D. The costs associated with each alternative selected for detailed evaluation are summarized in Table H-1 of Appendix H.

An analysis was performed to determine the cost savings associated with combining similar treatment processes used at different AOCs. The cost savings associated with the combination of treatment plants for on-site phytoremediation (groundwater and surface water) are approximately $8.2 million. This reduces the alternative's total costs to $129.3 million. This analysis is presented in Appendix H.

### 5.11.8 State Acceptance for Alternative #48

Acceptance of the selected, site-wide remedial alternative by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 5.11.9 Community Acceptance for Alternative #48

Acceptance of the selected, site-wide remedial alternative by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 5.12 ALTERNATIVE #51 - "FOCUSED TREATMENT AND REMEDIAL ACTION A"

Alternative #51 focuses intensive treatment technologies/process options on those AOCs with the highest human health risk while utilizing source control, in-situ and institutional action remedies on the remaining AOCs. This alternative results in a balance of good overall "Effectiveness" and "Implementability".

The overview of remedial action components for Alternative #51 is presented in Table 5-32 and Appendix F. Figure 5-11 details the remedial action site plan for this alternative. Alternative #51 includes the following remedial actions by media of concern and AOC:

Soil:

- Source control remedies consisting of horizontal containment (*i.e.*, caps) will be implemented at all disposal area AOCs [#1 - B&M Railroad Landfill, #2 - RSI Landfill (for groundwater source management), #5 - Contaminated Soils Area, #6 - Asbestos Landfill, #7 - Asbestos Lagoons] to address human health and ecological risk and/or meet ARAR requirements.
- Contaminated soil at AOC #3 (B&M Locomotive Shop Disposal Areas) and AOC #4 (Old B&M Oil/Sludge Recycling Area) will be excavated and relocated for ultimate disposal under one of the caps installed for AOCs#1, 2, 6, or 7. This remedy will also include institutional actions for monitoring to confirm appropriate source cleanup.

Groundwater:

- An on-site pump and treat remedy consisting of collection of contaminated groundwater (*e.g.*, extraction wells/subsurface drains) and treatment on-site using chemical and physical processes (coagulation / flocculation and precipitation, UV/chemical oxidation, adsorption technology) followed by discharge of treated water will be implemented at the highest human health risk-ranked AOC (#5 - Contaminated Soils Area). This remedy will also include institutional actions for groundwater monitoring.
- In-situ remedies consisting of monitored natural attenuation as well as institutional actions consisting of access restrictions (*e.g.*, institutional controls) and monitoring will be implemented at all remaining AOCs.

Surface Water and Sediment:

- Monitoring will be implemented at all three AOCs showing risk (#8b - Wetland 2 Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group). No remedial actions for surface water will be necessary at all remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) since contaminant concentrations are within acceptable human health and ecological risk levels. Sediment monitoring is included at these two AOCs as a provision if future toxicity testing results in ecological risk.

The detailed evaluation of Alternative #51 with respect to the nine FS criteria is presented in Sections 5.12.1 through 5.12.9.

### 5.12.1 Overall Protection of Human Health and the Environment for Alternative #51

Alternative #51 will provide some overall protection of human health and the environment by reducing some risks identified in the baseline risk assessment. For soil, overall protection of human health from implementation of Alternative #51 will result from the elimination of exposures to COCs in soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. In addition, the elimination of exposures to groundwater at AOCs #1 through 7 using institutional controls and monitored natural attenuation along with reduced COC concentrations from an on-site pump and treat remedy at the Contaminated Soils Area will provide overall protection of human health from groundwater exposures. Identified ecological risks from exposures to soil will be significantly reduced, and exposures to surface water will be gradually reduced. In sediment, however, only minor reductions of risk to ecological receptors will be expected. Therefore, Alternative #51 fails to meet all RAOs for the Site, as defined in Section 2.1, and only partially reduces risks to human health and the environment. The protection of human health and the environment are discussed in Sections 5.12.1.1 and 5.12.1.2, respectively.

**5.12.1.1 Human Health Protection.** Alternative #51 will provide overall protection of human health by eliminating risks identified in the baseline risk assessment. Current baseline risks to human health at the Contaminated Soils Area for female site workers of child-bearing age from exposure to lead in soil via indoor dust will be eliminated as a result of capping since windborne exposures to lead will be eliminated. For the current female site worker of child-bearing age at the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area, baseline risks to human health from exposure to lead in soil via indoor dust will be eliminated as a result of excavation and relocation for ultimate disposal under one of the caps installed for AOCs #1, 2, 6, or 7. For the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will be abated by capping, since windborne exposure to asbestos will be eliminated. However, since no

contaminant removal is performed with capping, the risk will return to baseline levels if the caps are not maintained.

The potential for future risks from ingestion of COCs in groundwater at the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons will be eliminated by restrictions on the future use of groundwater from these AOCs as a drinking water source. Significant reductions in groundwater concentrations for some organic COCs with negligible reductions in inorganic COC concentrations are expected to occur at the Contaminated Soils Area by the use of an on-site pump and treat remedy. Information in Section 5.12.5.3 and Appendix G documents times to achieve PRGs of from 2 years to >200 years for organic COCs in contrast to remedial times of >200 years for inorganic COCs at the Contaminated Soils Area using physical processes. Reductions in groundwater COC concentrations will also occur over time at AOCs #1, 2, 3, 4, 6 and 7 due to the removal of contaminated soil (at AOCs #3 and 4) and placement of caps (at AOCs #1, 2, 5, 6 and 7). Excavation and capping will lower groundwater COC concentrations by limiting the potential leaching of soil contaminants to groundwater. Natural degradative processes will also contribute to the lowering of groundwater COC concentrations over time. However, concentration reduction is expected to occur slowly for the most significant risk drivers (175 years to >200 years to achieve PRGs for arsenic and manganese; see Section 5.12.5.3 and Appendix G). Since there will be only partial containment of groundwater contamination with this alternative, risk to off-site receptors will be possible.

Additional short-term risks to workers will result from the excavation and/or capping of AOCs #1, 2, 3, 4, 5, 6 and 7, on-site groundwater treatment at the Contaminated Soils Area, and from soil and groundwater contact during monitoring. These risks will be mitigated by the use of appropriate personal protection equipment as needed. Specific long-term and short-term human health risks are discussed in Sections 5.12.3.1 and 5.12.5.1, respectively.

**5.12.1.2 Ecological Protection.** Alternative #51 will provide reductions in short-term and long-term risk to ecological receptors relative to baseline conditions for exposures to soil. Treatment of source

areas will reduce long-term risk of exposure to aquatic receptors from surface water contaminants. The reduction of risk to ecological receptors in sediments is expected to be minor.

Capping the B&M Railroad Landfill and excavating the B&M Locomotive Shop Disposal Areas will prevent future potential for exposure of terrestrial mammals to metal concentrations, resulting in a significant reduction in ecological risk from exposure to soils.

Adverse impacts on aquatic receptors from exposure to inorganics in surface waters will be reduced at the Wetland 2 Group, the Richardson Pond Group and the Content Brook Wetland Group. The removal or control of all the major source areas on site and treatment of groundwater at the Contaminated Soils Area will reduce the potential for discharge of metals in surface water runoff and gradually reduce concentration of contaminants discharged from groundwater. These mechanisms will reduce the concentration of metals contributing to risk to aquatic receptors in surface water over time. Resuspension of sediments, not treated by this alternative, still remains a potential source of metals in surface water. Impacts on benthic invertebrate populations from exposure to contaminants in sediment will not be reduced in the Wetland 2 Group, the Richardson Pond Group and Content Brook Wetland Group since the concentrations of contaminants in the sediments in these habitats will not be substantially reduced by this alternative.

The capping of B&M Railroad Landfill, RSI Landfill, Asbestos Lagoons, Asbestos Landfill, Contaminated Soils Area, and excavation of B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area will result in temporary, minor ecological impacts.

### 5.12.2 Compliance with ARARs for Alternative #51

Chemical-specific ARARs and TBCs for the Site are discussed at length in Section 2.3.1. A summary of the implications of each chemical-specific ARAR for this "Focused Treatment and Remedial Action A" alternative include:

- Safe Drinking Water Act and Massachusetts Drinking Water Regulations. Federal and Massachusetts MCLs are relevant and appropriate for site groundwater. This alternative sets attainment of Federal SDWA MCLs and MMCLs for inorganic and organic chemicals as groundwater remediation goals. Although levels of some organic compounds in groundwater are anticipated to be reduced, this alternative is not anticipated to be able to attain Federal SDWA MCLs or Massachusetts Maximum Contaminant Levels for inorganic chemicals in a reasonable time frame.

- Resource Conservation and Recovery Act Maximum Concentration Limits. RCRA groundwater corrective action requirements are relevant and appropriate requirements at the point of compliance at the limit of the waste management areas. The potential for contaminants to migrate from the area is reduced by this alternative. Monitoring will be conducted to track exposure-based limits at the point of compliance, and to verify a reduction in the migration of contaminants. Although levels of some organic compounds in groundwater are anticipated to be reduced, this alternative is not anticipated to be able to attain Federal RCRA MCLs for inorganic chemicals in a reasonable time frame.

- Federal Water Pollution Control Act, as Amended by the Clean Water Act, Ambient Water Quality Criteria (AWQC). Freshwater acute and chronic AWQC for the protection of aquatic life are considered appropriate and relevant for the site wetlands. Leachate outbreaks and surface water runoff are controlled under this alternative, thereby reducing the probability that AWQC may be exceeded.

- Clean Air Act and Massachusetts Air Pollution Control Regulations. Dust or other potential emissions that may result from excavation of waste materials are controlled under this alternative. There is no indication that ARARs for air will be exceeded by this alternative.

- Massachusetts Groundwater Quality Standards. Actions are taken under this alternative in an attempt to attain applicable "Class I" enforcement standards. Although levels of some organic

compounds in groundwater are anticipated to be reduced, this alternative is not anticipated to be able to attain groundwater standards for inorganic chemicals in a reasonable time frame.

- Massachusetts Surface Water Quality Standards. As part of the Shawsheen River Basin, site surface waters are classified as "Class B" habitat for fish, aquatic life and wildlife, and source of treated public water supplies. Surface water quality standards are considered applicable to site surface waters. Leachate outbreaks and surface water runoff are controlled under this alternative, thereby reducing the probability that surface water quality standards may be exceeded.

- Federal Criteria and Advisories To Be Considered. In addition to the ARARs listed above, there are other important issues and advisories which will require attention prior to and during remedial activities. These criteria and advisories to be considered include:
    - *Health Advisories*. Carcinogenic and non-carcinogenic risk levels due to consumption of contaminated drinking water will be exceeded.
    - *Federal Groundwater Protection Strategy of 1984*. Current, applicable "Class I" enforcement standards are not met under this alternative. Groundwater quality standards are exceeded.
    - *Threshold Limit Values (TLVs)*. There is no indication that these levels will be exceeded for site remediation workers under this alternative.

Location-specific ARARs and TBCs relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2), will not be met under this alternative. Although the minor impacts to wetlands and floodplains during cap construction will be mitigated, and no surface water discharges will occur, because the on-site wetlands will be allowed to remain in a degraded (contaminated) state, the "Focused Treatment and Remedial Action A" alternative for wetlands will not meet the intent of Executive Order 11990. This ARAR requires federal agencies to minimize wetland degradation and to preserve and enhance the beneficial uses of wetlands. This alternative will control the source of contamination and leave the wetlands and ecological habitats intact, but will also leave chemicals of concern in place.

Table 5-33 lists the action-specific ARARs for this alternative. The alternative attains all action-specific ARARs except those related to groundwater protection. Corrective actions must be completed within a "reasonable time period." Demonstrating that the action-specific ARAR detailed below can be attained will require long-term monitoring and evaluation. In the event that this ARAR cannot be attained within an agreed-upon, designated time period, then the groundwater remedy proposed for this alternative will need to be modified by means of a Technical Impracticability (TI) Waiver and/or Explanation of Significant Difference (ESD) to the Record of Decision.

- Hazardous/Solid Waste Management - Groundwater Protection, 310 CMR 30.660 - 30.675; 310 CMR 19.110 (AOCs #1, 2, 3, 6, and 7): A groundwater monitoring program will be implemented at the Site. Corrective measures consist of groundwater treatment at AOC #5 and monitored natural attenuation of groundwater at all remaining AOCs. Leachate generation from the landfill will be reduced but not eliminated. Monitoring will need to be conducted to determine attainment of this requirement.

Hazardous waste management landfill stabilization/solidification (310 CMR 30.632) regulations require that all wastes disposed of in a landfill are treated to the maximum extent practicable to minimize the potential for wastes migrating from the landfill site. This alternative includes excavation of materials from AOC #3 and subsequent on-site disposal. Currently, the alternative does not include stabilization/solidification of these wastes. If, however, after sampling the excavated material is shown to be a hazardous waste, further treatment may be warranted and this remedy revisited. This alternative includes sampling and analysis adequate to make this determination and, thus, attains this action-specific ARAR.

### 5.12.3 Long-Term Effectiveness and Permanence for Alternative #51

This alternative is evaluated below in terms of risk remaining at the Site after RAOs are addressed. This portion of the evaluation focuses on the extent and effectiveness of the controls required to manage the risk posed by treatment residuals and/or untreated contamination.

**5.12.3.1 Magnitude of Residual Risk: Human Health.** Alternative #51 implements controls to eliminate exposure of workers to soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. For groundwater, Alternative #51 implements access restrictions to prevent human contact with COCs at AOCs #1 through 7. In addition, the use of an on-site pump and treat remedy at the Contaminated Soils Area and the use of excavation and/or capping at AOCs #1, 2, 3, 4, 5, 6, and 7 are expected to partially reduce groundwater contamination at the Site. However, only partial containment of on-site groundwater contamination is expected. Under this alternative, the magnitude of residual risks will depend on the enforcement and reliability of institutional controls to prevent future human exposure to COCs in groundwater as well as the efficiency of the remedial measures at eliminating exposures to soil and groundwater COCs.

Under this alternative, exposure of female site workers of child-bearing age to lead in indoor dust from soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Contaminated Soils Area, which was estimated to result in a maternal blood level exceeding that protective of a 95$^{th}$ percentile fetal blood lead level of 10 µg/dl, will be eliminated by capping the Contaminated Soils Area, and eliminated through excavation and relocation of soils under capping for the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area. Likewise for the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will be eliminated by capping because fugitive dust generation will be prevented. Therefore, the use of capping at these AOCs will effectively eliminate the estimated risk for site workers to soils, unless the caps are not maintained.

Potential future residual human health risks to a resident from ingestion of COCs in groundwater from AOCs #1 through 7 will be eliminated by the implementation of groundwater access restrictions as long as long-term enforcement of the groundwater access restrictions is maintained. Should access restrictions not be maintained, the use of on-site groundwater treatment at the Contaminated Soils Area is expected to partially reduce groundwater residual risks by reducing the levels of some organic COCs (times to achieve PRGs of 2 years to >200 years). However, little reduction in the levels of inorganic COCs is expected. Contaminated groundwater will be partially contained with this alternative due to

the on-site treatment of groundwater at the Contaminated Soils Area. Therefore, potential risk to off-site receptors will be possible. As groundwater concentrations decline over time, there will be a partial lowering of residual risks to potential off-site receptors, and to on-site receptors should access restrictions not be maintained in the future. However, concentration reduction is expected to occur slowly for the most significant risk drivers (175 years to >200 years to achieve PRGs for arsenic and manganese; see Section 5.12.5.3 and Appendix G).

**5.12.3.2 Magnitude of Residual Risk: Ecological.** Alternative #51 will result in a quantifiable long-term reduction in risk to ecological receptors in soil and surface water, but not from sediments. The potential for exposure of small mammals to contaminants in soil will be removed at the B&M Railroad Landfill and the B&M Locomotive Shop Disposal Areas.

The removal or control of all the major source areas on site will reduce the potential for discharge of metals in surface water runoff and gradually reduce concentration of contaminants discharged from groundwater. The reduction of metals in groundwater will also be facilitated by collection and treatment of groundwater at the Contaminated Soils Area. In the long-term, these mechanisms will reduce the concentration of metals contributing to risk to aquatic receptors in surface water. The risk to aquatic receptors from exposure to metals in surface water will persist until substantial decreases in contaminant discharge are achieved. Resuspension of sediments, not treated by this alternative, still remains a potential source of metals in surface water. Therefore, residual risk to aquatic receptors will not be lowered substantially below baseline conditions for Alternative #51 in the short-term, but are expected to improve in the long-term.

Since no measures are taken in Alternative #51 to directly remove/reduce exposure from contaminants in sediments, the only effects on the concentration of contaminants will be dilution/dispersal through slow, natural processes and a minor reduction in the deposition of additional contamination from surface water over time. Consequently, the concentration of contaminants in sediments on site will not be substantially reduced under Alternative #51 and the risk to benthic invertebrates will not be reduced below baseline conditions.

### 5.12.4 Reduction of Toxicity, Mobility and Volume through Treatment for Alternative #51

Table 5-34 provides a summary of the treatment and process options selected, quantities of waste materials to be remediated, expected reductions in toxicity, mobility and volume, and residuals following treatment for Alternative #51. No human health or ecological risk was determined for soil at AOC #2 (RSI Landfill). Likewise, no risk was determined for surface water at AOC #8a (West Middlesex Canal Group) and AOC #8c (East Middlesex Canal Group). Therefore, reductions in toxicity, mobility and volume were not evaluated for these media at these AOCs. As a provision if future sediment toxicity testing results in ecological risk, actions are included in the alternative for AOCs #8a and #8c and evaluated below.

**5.12.4.1 Treatment/Recycling Processes to be Utilized.** Alternative #51 consists of source control remedies, including in-situ capping and excavation with on-site disposal, for soil, which are not considered treatment processes. Groundwater treatment processes to be utilized include on-site physical and chemical treatment, as well as monitored natural attenuation, with and without management of migration. Institutional actions to be implemented for surface water and sediment are not considered treatment processes. A more detailed description of the treatment/recycling processes to be utilized under Alternative #51 is provided in Section 5.12. Refer to Table 5-34 for specific treatment/recycling processes to be utilized at each AOC.

**5.12.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The following amounts of hazardous materials to be treated for Alternative #51 are provided below by media of concern and AOC. Values are only given if the remedial action will provide treatment. Monitored natural attenuation is considered a treatment process in this evaluation, since it typically results in reductions in contamination over time. Source control methods, including in-situ capping and excavation with on-site disposal, and institutional actions are not considered treatment processes.

<u>Groundwater (areal extent of source)</u>

- AOC #1 - B&M Railroad Landfill 12.4 acres
- AOC #2 - RSI Landfill 2.5 acres
- AOC #3 - B&M Locomotive Shop Disposal Areas 4.7 acres
- AOC #4 - Old B&M Oil/Sludge Recycling Area 7.0 acres

- AOC #5 - Contaminated Soils Area 6.7 acres
- AOC #6 - Asbestos Landfill 13.3 acres
- AOC #7 - Asbestos Lagoons 1.9 acres

**5.12.4.3 Degree of Expected Reductions in Toxicity, Mobility and Volume.** The degree of treatment and expected reductions for each treatment process under Alternative #51 are provided below by media of concern and AOC. Reductions expected from source control methods are not discussed, since these processes are not considered treatment. Reductions from monitored natural attenuation are provided for the U.S. EPA default time period, 30 years.

At all AOCs, no contaminated soil is treated under Alternative #51. Therefore, no reductions in toxicity, mobility and volume are expected for soil at all AOCs.

Monitored natural attenuation is expected to treat all of the contaminated groundwater at AOCs #1 through 4, 6, and 7. The amount of contaminated groundwater that will be collected and treated by physical and chemical process at AOC #5 is dependent on the density of the collection network. The following reductions in toxicity, mobility and volume are expected for groundwater:

Toxicity

- Monitored natural attenuation is expected to reduce the toxicity of the contaminated groundwater relative to a specific contaminant proportional to the volume reduction of that specific contaminant at AOCs #1 through 4, 6, and 7. Intermediate products that are more toxic than parent compounds may result if incomplete biodegradation of original contaminants occurs.
- At AOC #5, the toxicity of the contaminated groundwater relative to a specific contaminant will be reduced proportionally to the volume reduction of that specific contaminant through collection and treatment by physical and chemical processes.

Mobility

- Monitored natural attenuation will not provide reductions in mobility of COCs at all AOCs.
- The mobility reduction of the contaminants at AOC #5 will be dependent on the density of the groundwater collection network. If the extraction wells are positioned so as to capture the total amount of contaminated groundwater to be treated, the migration of contaminants outside of AOC #5 will be prevented.

Volume

- Monitored natural attenuation does not reduce the volume of the contaminated media at AOCs #1 through 4, 6, and 7.
- Organic COCs reductions in volume are expected to range from less than 15% to 100% across the Site. This broad range is due to differing physical and chemical properties on a compound by compound basis. Greater reductions of organics are possible due to biodegradation. Specific compounds used in the MODFLOW simulations, as well as BIOSCREEN results which additionally consider biodegradation rates, can be found in Appendix G. Table 5-34 provides estimated volume reductions for each AOC.
- Expected volume reductions from monitored natural attenuation for inorganic COCs vary from less than 15% to 17% across the Site. These low reductions may be attributed to adsorption of compounds to the soils within the aquifer. For specific compounds used the MODFLOW modeling, reference Appendix G. Inorganic volume reductions by AOC are provided in Table 5-34.
- Upon completion of the groundwater remedy, physical and chemical treatment processes are expected to reduce the volume of organic COCs by 96% to 98% (Hyman and Bagaasen, 1997) at AOC #5. Inorganic COCs are expected to exhibit a 92% to 99% (Amer, 1998, Ellis, 1997) volume reduction. Lesser values will result during the interim period prior to completion of the groundwater remedy.

There are no expected reductions in toxicity, mobility and volume in surface water and sediment at AOCs #8b, 8d, and 8e and sediment at AOCs #8a and 8c. Institutional actions will not confirm reductions or treatment of waste materials.

**5.12.4.4 Reversibility.** The reversibility of each treatment technology/process option type to be implemented under Alternative #51 is provided below by media of concern and AOC. Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. Since source control methods and institutional actions are not considered treatment processes, reversibility of treatment is not applicable to these processes.

Collection of contaminated groundwater and treatment by physical and chemical processes, to be implemented at AOC #5, is not considered a reversible process. Coagulation, flocculation, and precipitation processes remove aqueous phase contaminants from water through solidification and settling. Filtering and adsorption generally remove either organics or inorganics, dependent on the treatment media, through chemical and/or physical binding of contaminants to the media. The

UV/chemical oxidation process physically destroys organic contaminants by splitting them with ultraviolet light and an oxidizer.

Monitored natural attenuation, to be utilized to remediate groundwater at all remaining AOCs (#1 through 4, 6, and 7), is not considered reversible. Organic contaminants are degraded over time. Inorganic contaminants, on the other hand, may only be temporarily immobilized and later released.

**5.12.4.5 Type and Quantity of Residuals.** The types and quantities of contaminant residuals by media of concern and AOC expected after completion of the treatment technologies/process options implemented in Alternative #51 are summarized below. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are briefly discussed in Table 5-34.

The total amount of contaminated soil at all AOCs where horizontal containment is implemented (AOCs #1, 5, 6 and 7) will remain untreated but contained under the cap. Likewise, all of the contaminated soil to be excavated from AOCs #3 and 4 will remain untreated but contained, under an on-site cap.

At AOC #5, approximately 2% to 4% of organics and 1% to 8% of inorganics will remain in the groundwater following collection and physical/chemical treatment upon completion of the groundwater remedy. Greater amounts will be expected during the interim period prior to this endpoint. At all remaining AOCs (#1 through 4, 6, and 7), more toxic intermediate products may remain if incomplete degradation of original contaminants occurs through monitored natural attenuation. Residuals following treatment by monitored natural attenuation for a 30-year period, the U.S. EPA default time, are provided below. As stated above, the wide range in the reductions, and thus the residuals, is due to differing physical and chemical characteristics of compounds.

- It is expected that 0% to greater than 85% of the organic COCs and greater than 85% of the inorganic COCs will remain in the groundwater at AOC #1.
- The groundwater at AOC #2 is expected to contain 0% to 66% of the organic COCs and greater than 85% of the inorganic COCs after treatment.
- Approximately 4% of the organic COCs and greater than 85% of the inorganic COCs will remain at AOC #3 following treatment by monitored natural attenuation.

- At AOC #4, it is expected that 83% to greater than 85% of the inorganic COCs will remain in the groundwater after treatment. There are no organics exceeding PRGs at AOC #4. Therefore, organic reductions were not evaluated.
- An estimated 0% to 52% of the organic COCs and greater than 85% of the inorganic COCs will remain in the groundwater at AOC #6 following treatment.
- It is anticipated that 35% to greater than 85% of the organic COCs and greater than 85% of the inorganic COCs will remain in the groundwater at AOC #7.

Institutional actions will be implemented at all AOCs showing human health and ecological risk in surface water and sediment, as well as at AOCs #8a and 8c, where future sediment toxicity testing results may result in ecological risk. Since institutional actions do not involve treatment, the original amounts of contaminated surface water and sediment will be assumed to remain at all AOCs.

### 5.12.5 Short-Term Effectiveness for Alternative #51

This alternative is evaluated for effectiveness in protecting the community and local workers, site remediation workers, and the environment during the construction and implementation of the remedy.

**5.12.5.1 Protection of Community and Workers During Remedial Actions.** The construction and remediation measures proposed under this alternative include excavation and placement of soils from the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area beneath a cap, capping of the B&M Railroad Landfill, RSI Landfill, Contaminated Soils Area, Asbestos Landfill and Asbestos Lagoons, on-site groundwater treatment at the Contaminated Soils Area, and groundwater monitoring at AOCs #1 through 7.

The implementation of these construction/remedial measures will potentially result in additional short-term risk to the community from exposure to soil contaminants primarily associated with dust generation during soil disturbances at the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. Precautions will be implemented to prevent or limit fugitive dust generation during excavation/remedial activities. Worker exposure to COCs in soil during excavation/capping at AOCs #1, 2, 3, 4, 5, 6 and 7, in groundwater during on-site treatment at the Contaminated Soils Area, and in soil and groundwater during monitoring will also result in potential

health risk to workers. Use of personal protection equipment will be employed to reduce exposure if applicable OSHA standards are exceeded during these activities.

**5.12.5.2 Environmental Impacts.** The capping of B&M Railroad Landfill, RSI Landfill, Asbestos Landfill, Asbestos Lagoons, the Contaminated Soils Area and excavation of the B&M Locomotive Shop Disposal Areas and Old B&M Oil/Sludge Recycling Area will all require removal of vegetation. Wetlands are located around the border of a portion of each of these areas, with the exception of the Old B&M Oil/Sludge Recycling Area and Contaminated Soils Area. The extent of excavation or fill in wetland is estimated to be minimal for each alternative. Mitigation measures will include avoidance and minimization of temporary construction disturbance in adjacent wetlands during construction of landfill caps. Tree removal will be minimized, and proper construction and erosion control methods will be utilized. Mitigation will include restoration of upland habitat, and minimization of wetland impacts. Any unavoidable wetland loss will be mitigated by restoration or creation of wetlands on site. Changes in hydrology resulting from operation of the groundwater treatment system at the Contaminated Soils Area will be mitigated by properly maintaining flows of water close to existing conditions. Potential alterations in the hydrology and seasonal water levels in the adjacent wetlands will be minimized. Pumping rates and re-injection rates of water to wells will be implemented that are predicted, via modeling, to have minimal effects on water elevations in wetlands.

The alternative includes installation of monitoring wells throughout the Site. Mitigation measures will include avoidance and minimization of temporary construction disturbance in wetlands during construction of monitoring wells, and minimization of tree removal. Proper construction and erosion control methods will be utilized to minimize ecological impact to surrounding habitats.

The excavation of soil adjacent to the unnamed brook in B&M Locomotive Shop Disposal Area A may potentially cause disturbance to the stream bank. Mitigation measures will include avoidance and minimization of temporary construction disturbance in the stream channel and returning impacted areas to previous grades. Any unavoidable wetland loss from excavation will be mitigated by restoration or creation of wetlands on site.

**5.12.5.3 Time Until Remedial Action Objectives are Achieved.** Of the RAOs presented in Section 2, those for groundwater will take the longest to achieve. Through the use of groundwater flow modeling and contaminant retardation concepts (Appendix G), approximate times to achieve PRGs were calculated for the Site contaminants at each AOC. It should be noted that the mobility of inorganics is highly sensitive to site specific geochemistry. Other factors such as pH, dissolution, and colloidal transport could have significant impacts on mobility of inorganics. Therefore, these times should only be used for relative comparison and not for accurate representations of cleanup times.

Similar to Alternative #43, Alternative #51 includes monitored natural attenuation as a groundwater treatment process at all AOCs except AOC #5, the Contaminated Soils Area. Active groundwater collection will be used here prior to treatment and reinjection. Furthermore, site hydrology may be impacted by caps placed on AOCs #1, 2, 5, 6, and 7.

Modeling was performed to predict the reduction of contaminant concentrations over time due to natural processes, such as dispersion. However, additional contaminant reduction is expected to occur due to biodegradation. This aspect of monitored natural attenuation was evaluated using the BIOSCREEN natural attenuation decision support system (Appendix G). While improved cleanup times were estimated for a few compounds at the Site, these times were similar to those without biodegradation. Approximate cleanup times, assuming no biodegradation, for each AOC with contaminants above PRGs are presented below:

| Overburden | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | 55 | ND | >200 | >200 |
| AOC #2 - RSI Landfill | 87 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | 31 | ND | ND | >200 |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | 175 |
| AOC #5 - Contaminated Soils Area | 96 | >200 | >200 | >200 |
| AOC #6 - Asbestos Landfill | 63 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 46 | >200 | ND | >200 |

| Bedrock | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | >200 | >200 | ND | >200 |
| AOC #2 - RSI Landfill | 16 | ND | ND | >200 |

| | | | | |
|---|---|---|---|---|
| AOC #3 - B&M Locomotive Shop Disposal Areas | ND | ND | ND | ND |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | >200 |
| AOC #5 - Contaminated Soils Area | 182 | >200 | ND | >200 |
| AOC #6 - Asbestos Landfill | 24 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 186 | >200 | ND | >200 |

Notes: ND = Not detected at a concentration greater than PRGs at this AOC and flow zone

Some cleanup times reported above are high (i.e., greater than 200 years). This simply means that the compounds are essentially immobile. For example, arsenic and thallium have very high retardation coefficients and, ultimately, high cleanup times.

It should also be noted that the only SVOC detected above PRGs at all AOCs was bis(2-ethylhexyl)phthalate and the only pesticide was aldrin. The high retardation factors of these compounds increase the time of travel and source contaminant reduction. Evaluations assumed that the Contaminated Soils Area contained contaminants similar to the B&M Railroad Landfill, RSI Landfill, and the Asbestos Lagoons. The two compounds noted above are therefore assumed to be found at this AOC above PRGs. However, further evaluation may determine that this is not the case. Furthermore, the evaluations assumed that the maximum detections from the three nearby AOCs were also detected at the Contaminated Soils Area. Similarly, data from the RSI Landfill was used to characterize the Asbestos Landfill.

### 5.12.6 Implementability for Alternative #51

This section summarizes the technical and administrative feasibility of implementing Alternative #51, the "Focused Treatment and Remedial Action A" alternative, and the availability of various services and materials required for its implementation.

**5.12.6.1 Technical Feasibility.** Evaluation of the technical feasibility of Alternative #51 includes an assessment of three factors described in EPA's feasibility study guidance: 1) the ability to construct and operate the technologies, 2) the reliability of the technologies and 3) the ease of undertaking additional remedial actions, if necessary. These aspects are described in detail below:

Ability to Construct and Operate the Technologies. For Alternative #51, similar to Alternatives #8 through 48, the major implementability issue with regard to technical feasibility is the construction of caps at AOCs #1, 2, 5, 6, and 7 and the excavation and removal of waste soil/waste fill from AOCs #3 and 4 with relocation and regrading of these materials below one of the caps constructed at AOCs #1, 2, 6, or 7.

As discussed previously for Alternatives #8 through 48, the capping and excavation remedies for Alternative #51 at AOCs #1, 2, 3, 4, 6, and 7 will require a substantial civil engineering/earthwork component. The key implementability issue is the location of sensitive wetland areas or water bodies adjacent to every one of these AOCs. This will require comprehensive soil erosion, runoff and sedimentation control measures to minimize siltation impacts to wetland areas or water bodies. In addition, proper location and construction of temporary and permanent haul roads will be required to minimize impacts to wetland areas and water bodies. It is expected that the remediation contractor(s) will utilize the existing rail network to move equipment and materials to the largest degree possible. This rail network is closely situated to five of the six "earthwork" AOCs (*i.e.*, #1, 2, 3, 4, and 6). While the scope of the earthwork and transportation required for the capping and excavation activities is large, these are common problems faced and solved by experienced engineers and constructors. Maintenance of the capped and excavated areas is straightforward requiring only periodic inspections, vegetation control (*e.g.*, mowing) and filling of areas of settlement. As a result, no implementability constraints are expected with regard to construction and operation of the soil remedy for AOCs #1, 2, 3, 4, 6, and 7 in Alternative #51.

As discussed in prior alternatives, the primary implementability concern for placement of the single-barrier cap at AOC #5 is the limitation of conducting work within the Contaminated Soils Area while maintaining active use of the rail yard, rail spurs and roads that transect it. Placement of a single-barrier cap will require sitework adjacent to active railbeds and tracks. Therefore, Alternative #51 will require measures such as temporary structural supports, temporary use restrictions for tracks or roadways next to active work areas and temporary relocation of tracks and bedding material, if necessary. Implementing this remedy at AOC #5 will require close cooperation between rail yard users and the remediation engineer/contractor(s) and involve temporary disruptions to the rail yard operations. These are straightforward issues commonly faced and solved as part of construction efforts and are not sufficient to prevent consideration of this alternative as the selected remedy.

Construction, operation and maintenance of the on-site groundwater remedy at AOC #5 will need to address some key implementability issues. Drilling and installation of the groundwater extraction wells and installation of the horizontal trench and collection piping will require temporary disruptions and/or use restrictions within the active rail yard similar to the previously described for installation of the single-barrier cap. Successful operation and maintenance of the physical/chemical treatment plant will require consistent supervisory, operational and maintenance labor support similar to that provided for other wastewater/water treatment facilities. Additional, periodic engineering and manufacturer support will also be required to troubleshoot and solve process problems and repair and replace equipment, when required. Periodic cleaning of groundwater extraction and recharge well systems is also an expected task as

part of O&M. These activities are commonly solved by experienced remediation contractors and operators and should not be an implementability constraint for the groundwater remedy in this alternative.

Alternative #51 also includes the use of monitored natural attenuation to remediate contaminated groundwater at AOCs #1, 2, 3, 4, 6, and 7. Construction of this technology only requires installation of groundwater monitoring wells and "operation" only requires monitoring efforts to sample and analyze the groundwater. Therefore, there are no implementability constraints with regard to monitored natural attenuation.

Reliability of the Technologies. Reliability of the horizontal caps installed for AOCs #1, 2, 6, and 7 will be considered high if normal periodic maintenance of the cap is conducted. The high reliability will also apply to the excavation and removal of waste soils/waste fill from AOCs #3 and 4 with relocation and regrading of these materials below one of the caps constructed at AOCs #1, 2, 6, or 7. The reliability of the single-barrier cap installed for AOC #5 will be less than the landfill caps and much more sensitive to proper inspection and maintenance. Due to the heavy rail and truck loads and the complex pattern of drainage that will be required to address stormwater runoff, a more intensive O&M program of inspection, maintenance and repair will be required to ensure appropriate integrity of the single-barrier cap.

The reliability of on-site groundwater treatment using physical/chemical processes will be directly proportional to the degree of the operation and maintenance support provided to the facility. Given O&M support equivalent to facilities of this type at other successful wastewater, water and groundwater treatment plants, the reliability of on-site groundwater treatment for Alternative #51 will be high.

As stated previously under Alternatives #5 through 48, the reliability of monitored natural attenuation to remediate any residual contaminated groundwater at AOCs #1, 2, 3, 4, 6, and 7 should be considered "high" since there is no external equipment nor treatment systems that could breakdown. The reliability of the technology to meet PRGs, however, should not be confused with "implementability" but is more appropriately discussed under "effectiveness". The reader is directed to the "treatment efficiency" and the "time required to remediate" discussions in Sections 5.12.4, 5.12.5 and Appendix G.

As discussed previously for Alternatives #5 through 48, although the institutional controls which will be applied to AOCs #1 through 7 are not exactly technologies, their reliability will depend upon enforcement by the responsible agencies involved.

Ease of Undertaking Additional Remedial Actions. Applying additional remedial actions for contaminated soils contained by the horizontal caps installed at AOCs #1, 2, 5, 6, and 7 will be severely restricted since installation of the caps are largely permanent remediation technologies. This conclusion will also apply to the excavation and removal of waste soils/waste fill from AOCs #3 and 4 with relocation and regrading of these materials below one of the caps constructed at AOCs #1, 2, 6, or 7.

Additional remedial actions could be accommodated to a limited degree to modify on-site groundwater treatment using physical or chemical processes. Alternate types of coagulants or flocculants could be used to improve precipitation and removal of inorganics and metals contaminants. Alternate chemical oxidizing agents (peroxide, permanganate, ozone, etc.) could be tested in the UV/chemical oxidation system. In addition, different types or combinations of adsorbent media (activated carbon, activated alumina, etc.) could be used to improve the performance of the final, polishing adsorption step. If these modifications prove to be insufficient, then an alternate on-site treatment remedy could be constructed that could utilize the existing groundwater collection and recharge systems.

Additional remedial actions could be accommodated in place of monitored natural attenuation of groundwater. The only implementability limitation is that the new groundwater remediation technologies will need to accommodate the active, working area of the Contaminated Soils Area rail yard and not require installation within the confines of previously capped AOCs #1, 2, 6, and 7.

Additional remedial actions could be accommodated in place of routine monitoring of sediment at AOCs #8a through 8e and surface water at AOCs #8b, 8d, and 8e without any implementability concerns.

**5.12.6.2 Administrative Feasibility.** Evaluation of the administrative feasibility of Alternative #51 involves assessing the steps required to coordinate with other state, federal and local governmental entities. It should be noted that under Superfund, permits are not required for remediation activities, but compliance with substantive requirements is required.

The principal administrative feasibility issue with regard to Alternative #51, described previously for Alternatives #3 through 48, involves implementation of institutional controls in order to prohibit the use of groundwater. If proprietary controls are used, coordination with the individual property owners of the affected parcels, will be required. For example, implementation of a negative easement would require the property owner to convey to a third party (typically EPA) the right to limit how the landowner can use his or her property. Here the limitations would likely include prohibitions against the use of groundwater from wells on the property.

If governmental controls are used, coordination with federal, state and local government (the ATSDR, the Commonwealth of Massachusetts and/or the Town of Billerica) will be required. For example, implementation of land use restrictions may require the exercise of zoning authority by the Town of

Billerica to prohibit residential development in a contaminated area, or the adoption of a building permit ordinance in the Town of Billerica requiring anyone seeking a building permit for construction activities in a particular area to be notified of contamination in the area and of any relevant management standards - such an ordinance could also be used to prohibit types of construction that would result in unacceptable exposures (e.g., excavation in areas where subsurface contamination has not been fully removed). Implementation of groundwater use restrictions may require action by the Commonwealth of Massachusetts to prohibit or limit certain uses of groundwater in particular areas, or require closing or capping of wells. Implementation of advisories may also require action by the ATSDR or Commonwealth of Massachusetts to publically issue warnings that provide notice to potential users of land, surface water or groundwater of some existing or impending risk associated with their use.

An additional administrative issue is to reach agreement between federal, state and local governmental entities on the specifics of implementing the monitored natural attenuation program. Under Alternative #51, this program will address groundwater at AOCs #1, 2, 3, 4, 6, and 7. Concurrence among the various governmental entities will be required in defining the program (*e.g.*, number and type of monitoring locations, analytical/test parameters, frequency of testing) as well as interpretation of results and conclusions regarding the overall success of monitored natural attenuation.

**5.12.6.3 Availability of Services and Materials.** Evaluation of the availability of services and materials for Alternative #51 includes an assessment of three factors in accordance with EPA's feasibility study guidance: 1) the availability of treatment, storage capacity and disposal services, 2) the availability of necessary equipment and specialists, and 3) the availability of prospective technologies. These aspects are described in detail below:

Availability of TSDF Services. Since no remedial actions requiring off-site transport, storage or disposal are to be implemented as part of Alternative #51, the "Focused Treatment and Remedial Action A" alternative, there are no implementability constraints with regard to this issue for selection of this alternative.

Availability of Necessary Equipment and Specialists. A substantial quantity of heavy, earthmoving equipment as well as transport vehicles (both truck and rail variety) will be required for Alternative #18 during excavation of waste soils/waste fill from AOCs #3 and 4 and

construction of the caps at AOCs #1, 2, 5, 6, and 7. The numbers of equipment and vehicles required will be proportional to the number of caps and excavations being conducted simultaneously in a given construction season.

Experienced pavement engineers and contractors will be required to install the single-barrier pavement-type cap at AOC #5. This remediation team will require experience in pavement installations adjacent to multiple rail and spur lines.

The highest need for specialists in Alternative #51 is for two areas: 1) specialized legal counsel/assistance for implementation of the institutional controls and 2) consultants experienced in monitored natural attenuation of groundwater. Implementation of the institutional controls is expected to be a time-consuming process but should not pose significant implementability concerns that will prevent selection of this alternative as the final remedy. Legal specialists experienced in both CERCLA and non-CERCLA sites are available to facilitate this process. Similarly, monitored natural attenuation has been a technology employed at CERCLA sites in the last 10 years and there is a substantial number of environmental consultants with familiarity in implementing such a program. Thus, availability of consultants familiar with monitored natural attenuation should not prevent selection of this alternative as the final remedy.

Availability of Prospective Technologies. Alternative #51 will not require any specialized or innovative technologies. The remedial technologies required for the on-site groundwater treatment (*e.g.*, coagulation/flocculation & precipitation, UV/chemical oxidation, and adsorption) are all commonly used in treatment of water and wastewater. Manufacturer, supplier and vendor support are readily available for all of these technologies along with comprehensive literature evaluations documenting their performance. Therefore, there is no implementability limitation with regard to availability of prospective technologies for Alternative #51.

### 5.12.7 Cost for Alternative #51

Total estimated capital cost associated with this alternative is $35.9 million. This estimate assumes a contingency of 20%. The present value of all O&M costs would be $49.1 million. This estimate assumes an inflation rate of 3%, an interest rate of 7%, and a contingency of 15%. The maximum duration of site remedial actions is assumed to be 30 years, in accordance with RI/FS guidance (U.S. EPA, 1988). Total present worth costs would therefore be $85.0 million. Detailed costs for this alternative are presented in Appendix D. The costs associated with each alternative selected for detailed evaluation are summarized in Table H-1 of Appendix H.

### 5.12.8 State Acceptance for Alternative #51

Acceptance of the selected, site-wide remedial alternative by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 5.12.9 Community Acceptance for Alternative #51

Acceptance of the selected, site-wide remedial alternative by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 5.13 ALTERNATIVE #59 - "FOCUSED TREATMENT AND REMEDIAL ACTION B"

Alternative #59 is similar to Alternative #51 in that intensive treatment technologies/process options are focused on those AOCs with the highest human health risk while utilizing source control, in-situ and institutional action remedies on the remaining AOCs. Alternative #59 adds additional on-site treatment of soil to the remedy presented in Alternative #51. This results in a balance of good overall "Effectiveness" and "Implementability".

The overview of remedial action components for Alternative #59 is presented in Table 5-35 and Appendix F. Figure 5-12 details the remedial action site plan for this alternative. Alternative #59 includes the following remedial actions by media of concern and AOC:

Soil:

- Contaminated soil at AOCs #3 (B&M Locomotive Shop Disposal Areas), #4 (Old B&M Oil/Sludge Recycling Area), and #5 (Contaminated Soils Area) will be excavated and treated using chemical processes (solidification/stabilization). This remedy will also include monitoring to confirm appropriate source cleanup.
- Source control remedies consisting of horizontal containment (*e.g.*, caps) will be implemented at disposal area AOCs [#1-B&M Railroad Landfill, #2 - RSI Landfill (for groundwater source management), #6 - Asbestos Landfill, #7 - Asbestos Lagoons] to address human health and ecological risk and/or meet ARAR requirements.

Groundwater:

- An on-site pump and treat remedy consisting of collection of contaminated groundwater (*e.g.*, extraction wells/subsurface drains) and treatment on-site using biological processes (phytoremediation) followed by discharge will be applied to the highest human health risk-ranked AOC (#5-Contaminated Soils Area). This remedy will also include institutional actions for groundwater monitoring.
- In-situ remedies consisting of monitored natural attenuation as well as institutional actions consisting of access restrictions (*e.g.*, institutional controls) and monitoring will be implemented at all remaining AOCs.

Surface Water and Sediment:

- Monitoring will be implemented at all three AOCs showing risk (#8b - Wetland 2 Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group). No remedial actions for surface water will be necessary at all remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) since contaminant concentrations are within acceptable human health and ecological risk levels. Sediment monitoring is

included at these two AOCs as a provision if future toxicity testing results in ecological risk.

The detailed evaluation of Alternative #59 with respect to the nine FS criteria is presented in Sections 5.13.1 through 5.13.9.

### 5.13.1 Overall Protection of Human Health and the Environment for Alternative #59

Alternative #59 will provide some overall protection of human health and the environment by reducing some risks identified in the baseline risk assessment. For soil, overall protection of human health from implementation of Alternative #59 will result from a significant reduction or elimination of exposures to COCs in soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill and Asbestos Lagoons. In addition, the elimination of exposures to groundwater at AOCs #1 through 7 using institutional controls and monitored natural attenuation along with reduced COC concentrations from an on-site pump and treat remedy at the Contaminated Soils Area will provide overall protection of human health from groundwater exposures. Identified ecological risks from exposures to soil will be significantly reduced, and exposures to surface water will be gradually reduced. In sediment, however, only minor reductions of risk to ecological receptors will be expected. Therefore, Alternative #59 fails to meet all RAOs for the Site, as defined in Section 2.1, and only partially reduces risks to human health and the environment. The protection of human health and the environment are discussed in Sections 5.13.1.1 and 5.13.1.2, respectively.

**5.13.1.1 Human Health Protection.** Alternative #59 will provide overall protection of human health by eliminating risks identified in the baseline risk assessment. Current baseline risks to human health at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and the Contaminated Soils Area for female site workers of child-bearing age from exposure to lead in soil via indoor dust will be significantly reduced as a result of on-site solidification/stabilization since windborne exposures to lead will be diminished. Information in Section 5.13.4.3 documents an up to 99% decrease in the mobility of lead through the use of on-site solidification/stabilization. For the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial

asbestos will be abated by capping, since windborne exposure to asbestos will be eliminated. However, since no contaminant removal is performed with capping, the risk will return to baseline levels if the caps are not maintained.

The potential for future risks from ingestion of COCs in groundwater at the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons will be eliminated by restrictions on the future use of groundwater from these AOCs as a drinking water source. Significant reductions in groundwater concentrations for some organic COCs with negligible reductions in inorganic COC concentrations are expected to occur at the Contaminated Soils Area by the use of an on-site pump and treat remedy. Information in Section 5.13.5.3 and Appendix G documents times to achieve PRGs of from 2 years to >200 years for organic COCs in contrast to remedial times of >200 years for inorganic COCs using collection and treatment by phytoremediation at the Contaminated Soils Area. Reductions in groundwater COC concentrations will also occur over time at AOCs #1, 2, 3, 4, 6 and 7 due to the solidification/stabilization of contaminated soil (at AOCs #3, 4, and 5) and placement of caps (at AOCs #1, 2, 6, and 7). Solidification/stabilization and capping will lower groundwater COC concentrations by limiting the potential leaching of soil contaminants to groundwater. Natural degradative processes will also contribute to the lowering of groundwater COC concentrations over time. However, concentration reduction is expected to occur slowly for the most significant risk drivers (175 years to >200 years to achieve PRGs; see Section 5.13.5.3 and Appendix G). Since there will be only partial containment of groundwater contamination with this alternative, risk to off-site receptors will be possible.

Additional short-term risks to workers will result from exposures during soil solidification/ stabilization at AOCs #3, 4, and 5, the capping of AOCs #1, 2, 6 and 7, on-site groundwater treatment at the Contaminated Soils Area, and from soil and groundwater contact during monitoring. These risks will be mitigated by the use of appropriate personal protection equipment as needed. Specific long-term and short-term human health risks are discussed in Sections 5.13.3.1 and 5.13.5.1, respectively.

**5.13.1.2 Ecological Protection.** Alternative #59 will provide reductions in short-term and long-term risk to ecological receptors relative to baseline conditions for exposures to soil. Treatment of source areas will reduce long-term risk of exposure to aquatic receptors from surface water contaminants. The reduction of risk to ecological receptors in sediments is expected to be minor.

Capping the B&M Railroad Landfill and excavating/treating the B&M Locomotive Shop Disposal Areas will prevent future potential for exposure of terrestrial mammals to metal concentrations, resulting in a significant reduction in ecological risk from exposure to soils.

Adverse impacts on aquatic receptors from exposure to inorganics in surface waters will be reduced at the Wetland 2 Group, the Richardson Pond Group and the Content Brook Wetland Group. The removal or control of all the major source areas on-site and treatment of groundwater at the Contaminated Soils Area will reduce the potential for discharge of metals in surface water runoff and gradually reduce concentration of contaminants discharged from groundwater. These mechanisms will reduce the concentration of metals contributing to risk to aquatic receptors in surface water over time. Resuspension of sediments, not treated by this alternative, still remains a potential source of metals in surface water. Impacts on benthic invertebrate populations from exposure to contaminants in sediment will not be reduced in the Wetland 2 Group, the Richardson Pond Group and Content Brook Wetland Group since the concentrations of contaminants in the sediments in these habitats will not be substantially reduced by this alternative.

The capping of B&M Railroad Landfill, RSI Landfill, Asbestos Lagoons, Asbestos Landfill, and excavation of the Contaminated Soils Area, Old B&M Oil/Sludge Recycling Area, and B&M Locomotive Shop Disposal Areas will result in temporary, minor ecological impacts.

### 5.13.2 Compliance with ARARs for Alternative #59

Chemical-specific ARARs and TBCs for the Site are discussed at length in Section 2.3.1. A summary of the implications of each chemical-specific ARAR for this "Focused Treatment and Remedial Action B" alternative include:

- Safe Drinking Water Act and Massachusetts Drinking Water Regulations. Federal and Massachusetts MCLs are relevant and appropriate for site groundwater. This alternative sets attainment of Federal SDWA MCLs and MMCLs for inorganic and organic chemicals as groundwater remediation goals. Although levels of some organic compounds in groundwater are anticipated to be reduced, this alternative is not anticipated to be able to attain Federal SDWA MCLs or Massachusetts Maximum Contaminant Levels for inorganic chemicals in a reasonable time frame.

- Resource Conservation and Recovery Act Maximum Concentration Limits. RCRA groundwater corrective action requirements are relevant and appropriate requirements at the point of compliance at the limit of the waste management areas. The potential for contaminants to migrate from the area will be reduced by this alternative. Monitoring will be conducted to track exposure-based limits at the point of compliance, and to verify a reduction in the migration of contaminants. Although levels of some organic compounds in groundwater are anticipated to be reduced, this alternative is not anticipated to be able to attain Federal RCRA MCLs for inorganic chemicals in a reasonable time frame.

- Federal Water Pollution Control Act, as Amended by the Clean Water Act, Ambient Water Quality Criteria (AWQC). Freshwater acute and chronic AWQC for the protection of aquatic life are considered appropriate and relevant for the site wetlands. Leachate outbreaks and surface water runoff will be controlled under this alternative, thereby reducing the probability that AWQC may be exceeded.

- Clean Air Act and Massachusetts Air Pollution Control Regulations. Dust or other potential emissions that may result from excavation of waste materials will be controlled under this alternative. There is no indication that ARARs for air will be exceeded by this alternative.

- Massachusetts Groundwater Quality Standards. Actions are taken under this alternative in an attempt to attain applicable "Class I" enforcement standards. Although levels of some organic

compounds in groundwater are anticipated to be reduced, this alternative is not anticipated to be able to attain groundwater standards for inorganic chemicals in a reasonable time frame.

- Massachusetts Surface Water Quality Standards. As part of the Shawsheen River Basin, site surface waters are classified as "Class B" habitat for fish, aquatic life and wildlife, and source of treated public water supplies. Surface water quality standards are considered applicable to site surface waters. Leachate outbreaks and surface water runoff will be controlled under this alternative, thereby reducing the probability that surface water quality standards may be exceeded.

- Federal Criteria and Advisories To Be Considered. In addition to the ARARs listed above, there are other important issues and advisories which will require attention prior to and during remedial activities. These criteria and advisories to be considered include:
    - *Health Advisories.* Carcinogenic and non-carcinogenic risk levels due to consumption of contaminated drinking water will be exceeded.
    - *Federal Groundwater Protection Strategy of 1984.* Current, applicable "Class I" enforcement standards are not met under this alternative. Groundwater quality standards are exceeded.
    - *Threshold Limit Values (TLVs).* There is no indication that these levels will be exceeded for site remediation workers under this alternative.

Location-specific ARARs and TBCs relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2), will not be met under this alternative. Although the minor impacts to wetlands and floodplains during cap construction will be mitigated, and no surface water discharges will occur, because the on-site wetlands will be allowed to remain in a degraded (contaminated) state, the "Focused Treatment and Remedial Action B" alternative will not meet the intent of Executive Order 11990. This ARAR requires federal agencies to minimize wetland degradation and to preserve and enhance the beneficial uses of wetlands. This alternative will control the source of contamination and leave the wetlands and ecological habitats intact, but will also leave chemicals of concern in place.

Table 5-36 lists the action-specific ARARs for this alternative. The alternative attains all action-specific ARARs except those related to groundwater protection. Corrective actions must be completed within a "reasonable time period." Demonstrating that the action-specific ARAR detailed below can be attained will require long-term monitoring and evaluation. In the event that this ARAR cannot be attained within an agreed-upon, designated time period, then the groundwater remedy proposed for this alternative will need to be modified by means of a Technical Impracticability (TI) Waiver and/or Explanation of Significant Difference (ESD) to the Record of Decision.

- Hazardous/Solid Waste Management - Groundwater Protection, 310 CMR 30.660 - 30.675; 310 CMR 19.110 (AOCs #1, 2, 3, 6, and 7): A groundwater monitoring program will be implemented at the Site. Corrective measures consist of treatment at AOC #5 and monitored natural attenuation at all remaining AOCs. Leachate generation from the landfill will be reduced but not eliminated. Monitoring will need to be conducted to determine attainment of this requirement.

### 5.13.3 Long-Term Effectiveness and Permanence for Alternative #59

This alternative is evaluated below in terms of risk remaining at the Site after RAOs are addressed. This portion of the evaluation focuses on the extent and effectiveness of the controls required to manage the risk posed by treatment residuals and/or untreated contamination.

**5.13.3.1 Magnitude of Residual Risk: Human Health.** Alternative #59 implements controls to significantly reduce or eliminate exposure of workers to soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. For groundwater, Alternative #59 implements access restrictions to prevent human contact with COCs at AOCs #1 through 7. In addition, the use of an on-site pump and treat remedy at the Contaminated Soils Area and the use of soil solidification/stabilization at AOCs #3, 4, and 5 and capping at AOCs #1, 2, 6, and 7 are expected to partially reduce groundwater contamination at the Site. However, only partial containment of on-site groundwater contamination is expected. Under this alternative, the magnitude of residual risks will depend on the enforcement and reliability of

institutional controls to prevent future human exposure to COCs in groundwater as well as the efficiency of the remedial measures at eliminating exposures to soil and groundwater COCs.

Under this alternative, exposure of female site workers of child-bearing age to lead in indoor dust from soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Contaminated Soils Area, which was estimated to result in a maternal blood level exceeding that protective of a 95$^{th}$ percentile fetal blood lead level of 10 μg/dl, will be significantly reduced (up to 99%) through the use of on-site solidification/stabilization. For the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will be eliminated by capping because fugitive dust generation will be prevented. Therefore, the use of capping at these AOCs will effectively eliminate the estimated risk for site workers to soils, unless the caps are not maintained.

Potential future residual human health risks to a resident from ingestion of COCs in groundwater from AOCs #1 through 7 will be eliminated by the implementation of groundwater access restrictions as long as long-term enforcement of the groundwater access restrictions is maintained. Should access restrictions not be maintained, the use of on-site groundwater treatment at the Contaminated Soils Area is expected to partially reduce groundwater residual risks by reducing the levels of some organic COCs (times to achieve PRGs of from 2 years to >200 years). However, little reduction in the levels of inorganic COCs is expected. Contaminated groundwater will be partially contained with this alternative due to the on-site treatment of groundwater at the Contaminated Soils Area. However, risk to off-site receptors will be possible. As groundwater concentrations decline over time, there will be a partial lowering of residual risks to potential off-site receptors, and to on-site receptors should access restrictions not be maintained in the future. However, concentrations reduction is expected to occur slowly for the most significant risk drivers (175 years to >200 years to achieve PRGs for arsenic and manganese; see Section 5.13.5.3 and Appendix G).

**5.13.3.2 Magnitude of Residual Risk: Ecological.** Alternative #59 will result in a quantifiable long-term reduction in risk to ecological receptors in soil and surface water, but not from sediments. The

potential for exposure of small mammals to contaminants in soil will be removed at the B&M Railroad Landfill and the B&M Locomotive Shop Disposal Areas.

The removal or control of all the major source areas on-site will reduce the potential for discharge of metals in surface water runoff and gradually reduce concentration of contaminants discharged from groundwater. The reduction of metals in groundwater will also be facilitated by collection and treatment of groundwater at the Contaminated Soils Area. In the long-term, these mechanisms will reduce the concentration of metals contributing to risk to aquatic receptors in surface water. The risk to aquatic receptors from exposure to metals in surface water will persist until substantial decreases in contaminant discharge are achieved. Resuspension of sediments, not treated by this alternative, will still remain a potential source of metals in surface water. Therefore, residual risk to aquatic receptors will not be lowered substantially below baseline conditions for Alternative #59 in the short-term, but are expected to improve in the long-term.

Since no measures are taken in Alternative #59 to directly remove/reduce exposure from contaminants in sediments, the only effects on the concentration of contaminants will be dilution/dispersal through slow, natural processes and a minor reduction in the deposition of additional contamination from surface water over time. Consequently, the concentration of contaminants in on-site sediments will not be substantially reduced under Alternative #59 and the risk to benthic invertebrates will not be reduced below baseline conditions.

### 5.13.4 Reduction of Toxicity, Mobility and Volume through Treatment for Alternative #59

Table 5-37 provides a summary of the treatment and process options selected, quantities of waste materials to be remediated, expected reductions in toxicity, mobility and volume, and residuals following treatment for Alternative #59. No human health or ecological risk was determined for soil at AOC #2 (RSI Landfill). Likewise, no risk was determined for surface water at AOC #8a (West Middlesex Canal Group) and AOC #8c (East Middlesex Canal Group). Therefore, reductions in toxicity, mobility and volume were not evaluated for these media at these AOCs. As a provision if

future sediment toxicity testing results in ecological risk, actions are included in the alternative for AOCs #8a and #8c and evaluated below.

**5.13.4.1 Treatment/Recycling Processes to be Utilized.** Alternative #59 consists of in-situ capping as a source control remedy, and on-site solidification/stabilization processes for soil. In-situ capping is not considered a treatment process. Groundwater treatment processes to be utilized include collection and treatment by phytoremediation and monitored natural attenuation, as a stand-alone treatment, as well as in addition to management of migration. Institutional actions to be implemented for surface water and sediment are not considered treatment processes. A more detailed description of the treatment/recycling processes to be utilized under Alternative #59 is provided in Section 5.13. Refer to Table 5-37 for specific treatment/recycling processes to be utilized at each AOC.

**5.13.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The following amounts of hazardous materials to be treated for Alternative #59 are provided below by media of concern and AOC. Values are only given if the remedial action will provide treatment. Monitored natural attenuation is considered a treatment process in this evaluation, since it typically results in reductions in contamination over time. Source control methods and institutional actions are not considered treatment processes.

<u>Soil</u>

- AOC #3 - B&M Locomotive Shop Disposal Areas 150,800 $yd^3$
- AOC #4 - Old B&M Oil/Sludge Recycling Area 63,800 $yd^3$
- AOC #5 - Contaminated Soils Area 10,800 $yd^3$

<u>Groundwater (areal extent of source)</u>

- AOC #1 - B&M Railroad Landfill 12.4 acres
- AOC #2 - RSI Landfill 2.5 acres
- AOC #3 - B&M Locomotive Shop Disposal Areas 4.7 acres
- AOC #4 - Old B&M Oil/Sludge Recycling Area 7.0 acres
- AOC #5 - Contaminated Soils Area 6.7 acres
- AOC #6 - Asbestos Landfill 13.3 acres
- AOC #7 - Asbestos Lagoons 1.9 acres

**5.13.4.3 Degree of Expected Reductions in Toxicity, Mobility and Volume.** The degree of treatment and expected reductions for each treatment process under Alternative #59 are provided

below by media of concern and AOC. Reductions expected from source control methods and institutional actions are not discussed, since these processes are not considered treatment. Reductions from monitored natural attenuation are provided for the U.S. EPA default time period, 30 years.

All of the contaminated soil at AOCs #3, 4, and 5 will be treated by on-site solidification/stabilization under Alternative #59. On-site solidification/stabilization processes are expected to reduce the mobility of organic COCs by up to 93% (U.S. EPA, 1998a). Inorganic COCs are likely to exhibit up to 99% (U.S. EPA, 1998a) mobility reduction through on-site solidification/stabilization. The volume of the contaminated media may be increased by up to 100% through on-site solidification/stabilization processes. Organic and inorganic COCs will not be reduced in volume and the toxicity of the soils at AOCs #3, 4, and 5 will not be reduced through this process.

At AOC #5, the density of the collection network will determine the degree of treatment of contaminated groundwater by phytoremediation. Monitored natural attenuation is expected to treat all of the contaminated groundwater at AOCs #1 through 4, 6, and 7. The following reductions in toxicity, mobility and volume are expected for groundwater:

Toxicity

- Monitored natural attenuation is expected to reduce the toxicity of the contaminated groundwater relative to a specific contaminant proportional to the volume reduction of that specific contaminant at AOCs #1 through 4, 6, and 7. If incomplete biodegradation of original contaminants occurs, intermediate products that are more toxic than parent compounds may result.
- At AOC #5, the toxicity of the contaminated groundwater relative to a specific contaminant will be reduced proportionally to the volume reduction of that specific contaminant through collection and treatment by phytoremediation.

Mobility

- Monitored natural attenuation will not provide reductions in mobility of COCs at AOCs #1 through 4, 6, and 7.
- The mobility reduction of the contaminants at AOC #5 will be dependent on the density of the groundwater collection network. If the extraction wells are positioned so as to capture the total amount of contaminated groundwater to be treated, the migration of contaminants outside of AOC #5 will be prevented.

Volume

- Monitored natural attenuation will not reduce the volume of the contaminated media at AOCs #1 through 4, 6, and 7.

- Organic COCs reductions in volume are expected to range from less than 15% to 100% across the Site. This broad range is due to differing physical and chemical properties on a compound by compound basis. Greater reductions of organics are possible due to biodegradation. Specific compounds used in the MODFLOW simulations, as well as BIOSCREEN results which additionally consider biodegradation rates, can be found in Appendix G. Table 5-37 provides estimated volume reductions for each AOC.
- Expected volume reductions from monitored natural attenuation for inorganic COCs vary from less than 15% to 17% across the Site. These low reductions may be attributed to adsorption of compounds to the soils within the aquifer. For specific compounds used the MODFLOW modeling, reference Appendix G. Inorganic volume reductions by AOC are provided in Table 5-37.
- Phytoremediation processes are expected to reduce the volume of organic COCs by 90% to 95% (Gordon, 1998) at AOC #5. Inorganic COCs are expected to exhibit an 84% to 99% (FRTR, 1997) volume reduction. These reductions presented for phytoremediation represent upper bound limits upon completion of the groundwater remedy. Lesser values will result during the interim period prior to this endpoint.

There are no expected reductions in toxicity, mobility and volume in surface water and sediment at AOCs #8b, 8d, and 8e and sediment at AOCs #8a and 8c. Institutional actions will not confirm reductions or treatment of waste materials.

**5.13.4.4 Reversibility.** The reversibility of each treatment process to be implemented under Alternative #59 is provided below by media of concern and AOC. Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. Since source control methods and institutional actions are not considered treatment processes, reversibility of treatment is not applicable to these processes.

On-site solidification/stabilization processes to be utilized to treat the soils at AOCs #3, 4, and 5 are considered reversible. Weathering may affect the integrity of the solidified/stabilized material.

Collection of contaminated groundwater and treatment by phytoremediation, to be implemented at AOC #5, is not considered a reversible process. Contaminants taken up by plants are not readily released under normal conditions. Monitored natural attenuation, to be utilized at all remaining AOCs (#1 through 4, 6, and 7), is not considered reversible. Organic contaminants are degraded over time. Inorganic contaminants, on the other hand, may only be temporarily immobilized and later released.

**5.13.4.5 Type and Quantity of Residuals.** The types and quantities of contaminant residuals by media of concern and AOC expected after completion of the treatment technologies/process options implemented in Alternative #59 are summarized below. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are briefly discussed in Table 5-37.

At all AOCs where horizontal containment will be implemented (AOCs #1, 6, and 7), the total amount of contaminated soil at each respective AOC will remain untreated but contained under the cap. An estimated 150,800 $yd^3$ to 301,600 $yd^3$ of stabilized material will remain on-site from the solidification/stabilization treatment of AOC #3 soils. At AOC #4, approximately 63,800 $yd^3$ to 127,600 $yd^3$ of stabilized material will result from treatment. Similarly, AOC #5 residuals from the solidification/stabilization process will be approximately 10,800 $yd^3$ to 21,600 $yd^3$. In the stabilized material from AOCs #3, 4, and 5, greater than 7% of organic and 1% of inorganic contamination will have the potential to leach into lower-lying soils and groundwater.

At AOC #5, approximately 1% to 16% of organics and 5% to 10% of inorganics will remain in the groundwater following collection and treatment by phytoremediation upon completion of the groundwater remedy. Greater amounts will result during the interim period prior to this endpoint. At all remaining AOCs (#1 through 4, 6, and 7), more toxic intermediate products may remain if incomplete degradation of original contaminants occurs through monitored natural attenuation. Estimated residuals following monitored natural attenuation treatment for a 30 year period, the U.S. EPA default time, are provided below. As stated above, the high degree of variability in the reductions, and thus the residuals, is due to differing characteristics of compounds.

- It is expected that 0% to greater than 85% of the organic COCs and greater than 85% of the inorganic COCs will remain in the groundwater at AOC #1.
- The groundwater at AOC #2 is expected to contain 0% to 66% of the organic COCs and greater than 85% of the inorganic COCs after treatment.
- Approximately 4% of the organic COCs and greater than 85% of the inorganic COCs will remain at AOC #3 following treatment by monitored natural attenuation.
- At AOC #4, it is expected that 83% to greater than 85% of the inorganic COCs will remain in the groundwater after treatment. There are no organics exceeding PRGs at AOC #4. Therefore, organic reductions were not evaluated.

- An estimated 0% to 52% of the organic COCs and greater than 85% of the inorganic COCs will remain in the groundwater at AOC #6 following treatment.
- It is anticipated that 35% to greater than 85% of the organic COCs and greater than 85% of the inorganic COCs will remain in the groundwater at AOC #7.

Institutional actions will be implemented at all AOCs showing human health and ecological risk in surface water and sediment, as well as at AOCs #8a and 8c, where future sediment toxicity testing results may result in ecological risk. Since institutional actions will not involve treatment, the original amounts of contaminated surface water and sediment will be assumed to remain at all AOCs.

### 5.13.5 Short-Term Effectiveness for Alternative #59

This alternative is evaluated for effectiveness in protecting the community and local workers, site remediation workers, and the environment during the construction and implementation of the remedy.

**5.13.5.1 Protection of Community and Workers During Remedial Actions.** The construction and remediation measures proposed under this alternative include on-site solidification/stabilization of soils from the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Contaminated Soils Area, capping of the B&M Railroad Landfill, RSI Landfill, Asbestos Landfill and Asbestos Lagoons, on-site groundwater treatment at the Contaminated Soils Area, and groundwater monitoring at AOCs #1 through 7.

The implementation of these construction/remedial measures will potentially result in additional short-term risk to the community from exposure to soil contaminants primarily associated with dust generation during soil disturbances at the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. Precautions will be implemented to prevent or limit fugitive dust generation during excavation/remedial activities. Worker exposure to COCs in soil during disturbances at AOCs #1, 2, 3, 4, 5, 6, and 7, in groundwater during on-site treatment at the Contaminated Soils Area, and in soil and groundwater during monitoring will also result in potential health risk to workers. Use of personal protection equipment should be employed to reduce exposure if applicable OSHA standards are exceeded during these activities.

**5.13.5.2 Environmental Impacts.** The capping of B&M Railroad Landfill, RSI Landfill, Asbestos Landfill, Asbestos Lagoons, and excavation of B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Contaminated Soils Area will all require removal of vegetation. Wetlands are located around the border of a portion of each of these areas, with the exception of the Old B&M Oil/Sludge Recycling Area and Contaminated Soils Area. The extent of excavation or fill in wetland is estimated to be minimal for each alternative. Mitigation measures will include avoidance and minimization of temporary construction disturbance in adjacent wetlands during construction of landfill caps. Tree removal will be minimized, and proper construction and erosion control methods will be utilized. Mitigation will include restoration of upland habitat, and minimization of wetland impacts. Any unavoidable wetland loss will be mitigated by restoration or creation of on-site wetlands. Changes in hydrology resulting from operation of the groundwater treatment system at the Contaminated Soils Area will be mitigated by properly maintaining flows of water close to existing conditions. Potential alterations in the hydrology and seasonal water levels in the adjacent wetlands will be minimized. Pumping rates and re-injection rates of water to wells will be implemented that are predicted, via modeling, to have minimal effects on water elevations in wetlands.

The alternative includes installation of monitoring wells throughout the Site. Mitigation measures will include avoidance and minimization of temporary construction disturbance in wetlands during construction of monitoring wells, and minimization of tree removal. Proper construction and erosion control methods will be utilized to minimize ecological impact to surrounding habitats.

The excavation of soil adjacent to the unnamed brook in B&M Locomotive Shop Disposal Area A may potentially cause disturbance to the stream bank. Mitigation measures will include avoidance and minimization of temporary construction disturbance in the stream channel and returning impacted areas to previous grades. Any unavoidable wetland loss from excavation will be mitigated by restoration or creation of on-site wetlands.

**5.13.5.3 Time Until Remedial Action Objectives are Achieved.** Of the RAOs presented in Section 2, those for groundwater will take the longest to achieve. Through the use of groundwater flow modeling and contaminant retardation concepts (Appendix G), approximate times to achieve PRGs

were calculated for the Site contaminants at each AOC. It should be noted that the mobility of inorganics is highly sensitive to site specific geochemistry. Other factors such as pH, dissolution, and colloidal transport could have significant impacts on mobility of inorganics. Therefore, these times should only be used for relative comparison and not for accurate representations of cleanup times.

Similar to Alternatives #43 and #51, Alternative #59 includes monitored natural attenuation as a groundwater treatment process at all AOCs except AOC #5, the Contaminated Soils Area. Active groundwater collection will be used here prior to treatment and reinjection. Furthermore, site hydrology may be impacted by caps placed on AOCs #1, 2, 6, and 7.

Modeling was performed to predict the reduction of contaminant concentrations over time due to natural processes, such as dispersion. However, additional contaminant reduction is expected to occur due to biodegradation. This aspect of monitored natural attenuation was evaluated using the BIOSCREEN natural attenuation decision support system (Appendix G). While improved cleanup times were estimated for a few compounds at the Site, these times were similar to those without biodegradation. Approximate cleanup times, assuming no biodegradation, for each AOC with contaminants above PRGs are presented below:

| Overburden | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | 55 | ND | >200 | >200 |
| AOC #2 - RSI Landfill | 87 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | 31 | ND | ND | >200 |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | 175 |
| AOC #5 - Contaminated Soils Area | 96 | >200 | >200 | >200 |
| AOC #6 - Asbestos Landfill | 63 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 46 | >200 | ND | >200 |

| Bedrock | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | >200 | >200 | ND | >200 |
| AOC #2 - RSI Landfill | 16 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | ND | ND | ND | ND |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | >200 |
| AOC #5 - Contaminated Soils Area | 182 | >200 | ND | >200 |
| AOC #6 - Asbestos Landfill | 24 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 186 | >200 | ND | >200 |

Notes: ND = Not detected at a concentration greater than PRGs at this AOC and flow zone

Some cleanup times reported above are high (i.e., greater than 200 years). This simply means that the compounds are essentially immobile. For example, arsenic and thallium have very high retardation coefficients and, ultimately, high cleanup times.

It should also be noted that the only SVOC detected above PRGs at all AOCs was bis(2-ethylhexyl)phthalate and the only pesticide was aldrin. The high retardation factors of these compounds increase the time of travel and source contaminant reduction. Evaluations assumed that the Contaminated Soils Area contained contaminants similar to the B&M Railroad Landfill, RSI Landfill, and the Asbestos Lagoons. The two compounds noted above are therefore assumed to be found at this AOC above PRGs. However, further evaluation may determine that this is not the case. Furthermore, the evaluations assumed that the maximum detections from the three nearby AOCs were also detected at the Contaminated Soils Area. Similarly, data from the RSI Landfill was used to characterize the Asbestos Landfill.

### 5.13.6 Implementability for Alternative #59

This section summarizes the technical and administrative feasibility of implementing Alternative #59, the "Focused Treatment and Remedial Action B" alternative, and the availability of various services and materials required for its implementation.

**5.13.6.1 Technical Feasibility.** Evaluation of the technical feasibility of Alternative #59 includes an assessment of three factors described in EPA's feasibility study guidance: 1) the ability to construct and operate the technologies, 2) the reliability of the technologies and 3) the ease of undertaking additional remedial actions, if necessary. These aspects are described in detail below:

> Ability to Construct and Operate the Technologies. For Alternative #59, similar to Alternatives #8 through 51, a major implementability issue with regard to technical feasibility is the construction of landfill caps at AOCs #1, 2, 6, and 7.

As discussed previously for Alternatives #8 through 51, the capping remedies for Alternative #59 at AOCs #1, 2, 6, and 7 will require a substantial civil engineering/earthwork component. The key implementability issue is the location of sensitive wetland areas or water bodies adjacent to every one of these AOCs. This will require comprehensive soil erosion, runoff and sedimentation control measures to minimize siltation impacts to wetland areas or water bodies. In addition, proper location and construction of temporary and permanent haul roads will be required to minimize impacts to wetland areas and water bodies. It is expected that the remediation contractor(s) will utilize the existing rail network to move equipment and materials to the largest degree possible. This rail network is closely situated to three of the four "earthwork" AOCs (*i.e.*, #1, 2, and 6). While the scope of the earthwork and transportation required for the capping and excavation activities is large, these are common problems faced and solved by experienced engineers and contractors. Maintenance of the capped and excavated areas is straightforward requiring only periodic inspections, vegetation control (*e.g.*, mowing) and filling of areas of settlement. As a result, no implementability constraints are expected with regard to construction and operation of the soil remedy for AOCs #1, 2, 6, and 7 in Alternative #59.

The primary implementability concern for construction of on-site treatment of soils and waste fill for AOCs #3, 4, and 5 is the limitation of excavating and replacing materials within the Contaminated Soils Area while maintaining active use of the rail yard and the roads that transect it. Several measures may be required such as: temporary structural supports for tracks near the work zone, temporary use restrictions for tracks or roadways next to soil excavation or backfill areas, and temporary relocation of tracks and bedding material for treatment of soils beneath rail beds. No formal "operational" effort is required for the solidification/stabilization technology but maintenance inspections will be required on a period basis to confirm the integrity of the treated soil matrix.

Construction, operation, and maintenance of the on-site groundwater remedy at AOC #5 will need to address some key implementability issues. Drilling and installation of the groundwater extraction wells and installation of the horizontal trench and collection piping will require temporary disruptions and/or use restrictions within the active rail yard similar to those previously described for excavation of soils. Construction of the phytoremediation treatment plant (*i.e.*, engineered wetland) will require a large areal extent as well as careful attention to design elevations and hydraulics to ensure that gravity-driven flows through the wetland media are achieving the proper velocity to maximize removal efficiencies. Construction of the phytoremediation chamber should be completed by late spring to allow proper establishment of the environmental media during summer and fall. Since the phytoremediation technology is a biological system, "shock" loading conditions should be avoided as part of O&M. Shock loading conditions would include radical changes such as: rapid changes in groundwater flows, contaminant concentrations or temperatures, infestation or other plant or insect species or attack on the biological media by bacterial agents. Period "harvesting" or removal of the biological media (*e.g.*, plants, roots, soils) followed by proper disposal will be required as part of routine O&M when contaminant uptake has been maximized. Due to the nature of the phytoremediation technology, periodic cleaning of the groundwater recharge wells will be required as part of O&M prevent biofouling.

Alternative #59 also includes the use of monitored natural attenuation to remediate contaminated groundwater at AOCs #1, 2, 3, 4, 6, and 7. Construction of this technology only requires installation of groundwater monitoring wells and "operation" only requires monitoring efforts to sample and analyze the groundwater. Therefore, there are no implementability constraints with regard to monitored natural attenuation.

Reliability of the Technologies. Reliability of the horizontal caps installed for AOCs #1, 2, 6, and 7 will be considered high if normal periodic maintenance of the cap is conducted. For on-site solidification/stabilization of soils and waste fill at AOCs #3, 4, and 5, the design is expected to define the most appropriate solidification/stabilization matrix and reagents to reliably encapsulate the contaminants of concern. Once this is achieved, the reliability of the technology is directly dependent on two factors: 1) comprehensive pre-sorting of the soils/waste fill to be treated to remove inappropriate materials such as large boulders and large waste or debris items that could interfere with the matrix, and 2) the protection of the treated soil matrix from long-term damage from truck/rail loads and impacts.

The reliability of on-site groundwater treatment using phytoremediation will be directly dependent on proper operation and maintenance to avoid the "shock" loading conditions (*e.g.*, rapid changes in flow rate, temperature, and contaminant concentrations, infestation of hostile species of plants, insects of bacterial agents) that would reduce performance. In addition, since the wetlands media has a finite capacity to adsorb or absorb site contaminants, periodic removal and replacement as part of O&M is required to maintain system reliability.

As stated previously under Alternatives #5 through 51, the reliability of monitored natural attenuation to remediate any residual contaminated groundwater should be considered "high" since there is no external equipment nor treatment systems that could breakdown. The reliability of the technology to meet PRGs, however, should not be confused with "implementability" but is more appropriately discussed under "effectiveness". The reader is directed to the "treatment efficiency" and the "time required to remediate" discussions in Sections 5.13.4, 5.13.5 and Appendix G.

As discussed previously for Alternatives #5 through 51, although the institutional controls which will be applied to AOCs #1 through 7 are not exactly technologies, their reliability will depend upon enforcement by the responsible agencies involved.

Ease of Undertaking Additional Remedial Actions. Applying additional remedial actions for contaminated soils contained by the horizontal caps installed at AOCs #1, 2, 6, and 7 will be severely restricted since installation of the caps are largely permanent remediation technologies. This conclusion will also apply to the excavation and on-site solidification/stabilization treatment of waste soils/waste fill from AOCs #3, 4, and 5.

Additional remedial actions could be accommodated to a limited degree to modify on-site groundwater treatment using phytoremediation. Alternate combinations of wetlands media (*e.g.*, plant species, soil types) could be installed within the phytoremediation chamber in an attempt to improve system performance. If this proved to be insufficient, then an alternate on-site treatment

remedy (*e.g.*, physical-chemical) could be constructed that could utilize the existing groundwater collection and recharge systems.

Additional remedial actions could be accommodated in place of monitored natural attenuation of groundwater. The only implementability limitation is that the new groundwater remediation technologies will need to accommodate the active, working area of the Contaminated Soils Area rail yard, not require installation within the confines of previously capped AOCs #1, 2, 6, and 7 and not interfere with the stabilized/solidified soils in AOCs #3, 4, and 5.

Additional remedial actions could be accommodated in place of routine monitoring of sediment at AOCs #8a through 8e and surface water at AOCs #8b, 8d, and 8e without any implementability concerns.

**5.13.6.2 Administrative Feasibility.** Evaluation of the administrative feasibility of Alternative #59 involves assessing the steps required to coordinate with other state, federal and local governmental entities. It should be noted that under Superfund, permits are not required for remediation activities, but compliance with substantive requirements is required.

The principal administrative feasibility issue with regard to Alternative #59, described previously for Alternatives #3 through 51, involves implementation of institutional controls in order to prohibit the use of groundwater. If proprietary controls are used, coordination with the individual property owners of the affected parcels, will be required. For example, implementation of a negative easement would require the property owner to convey to a third party (typically EPA) the right to limit how the landowner can use his or her property. Here the limitations would likely include prohibitions against the use of groundwater from wells on the property.

If governmental controls are used, coordination with federal, state and local government (the ATSDR, the Commonwealth of Massachusetts and/or the Town of Billerica) will be required. For example, implementation of land use restrictions may require the exercise of zoning authority by the Town of Billerica to prohibit residential development in a contaminated area, or the adoption of a building permit ordinance in the Town of Billerica requiring anyone seeking a building permit for construction activities in a particular area to be notified of contamination in the area and of any relevant management standards - such an ordinance could also be used to prohibit types of construction that would result in unacceptable exposures (e.g., excavation in areas where subsurface contamination has

not been fully removed). Implementation of groundwater use restrictions may require action by the Commonwealth of Massachusetts to prohibit or limit certain uses of groundwater in particular areas, or require closing or capping of wells. Implementation of advisories may also require action by the ATSDR or Commonwealth of Massachusetts to publically issue warnings that provide notice to potential users of land, surface water or groundwater of some existing or impending risk associated with their use.

An additional administrative issue is to reach agreement between federal, state and local governmental entities on the specifics of implementing the monitored natural attenuation program. Under Alternative #59, this program will address groundwater at AOCs #1, 2, 3, 4, 6, and 7. Concurrence among the various governmental entities will be required in defining the program (*e.g.*, number and type of monitoring locations, analytical/test parameters, frequency of testing) as well as interpretation of results and conclusions regarding the overall success of monitored natural attenuation.

**5.13.6.3 Availability of Services and Materials.** Evaluation of the availability of services and materials for Alternative #59 includes an assessment of three factors in accordance with EPA's feasibility study guidance: 1) the availability of treatment, storage capacity and disposal services, 2) the availability of necessary equipment and specialists, and 3) the availability of prospective technologies. These aspects are described in detail below:

Availability of TSDF Services. Since no remedial actions requiring off-site transport, storage or disposal are to be implemented as part of Alternative #59, the "Focused Treatment and Remedial Action B" alternative, there are no implementability constraints with regard to this issue for selection of this alternative.

Availability of Necessary Equipment and Specialists. A substantial quantity of heavy, earthmoving equipment as well as transport vehicles (both truck and rail variety) will be required for Alternative #59 during construction of the caps at AOCs #1, 2, 6, and 7. The numbers of equipment and vehicles required will be proportional to the number of caps/excavations being conducted simultaneously in a given construction season.

The highest need for specialists in Alternative #59 is for two areas: 1) specialized legal counsel/assistance for implementation of the institutional controls and 2) consultants experienced in monitored natural attenuation of groundwater. Implementation of the institutional controls is expected to be a time-consuming process but should not pose significant implementability

concerns that will prevent selection of this alternative as the final remedy. Legal specialists experienced in both CERCLA and non-CERCLA sites are available to facilitate this process. Similarly, monitored natural attenuation has been a technology employed at CERCLA sites in the last 10 years and there is a substantial number of environmental consultants with familiarity in implementing such a program. Thus, availability of consultants familiar with monitored natural attenuation should not prevent selection of this alternative as the final remedy.

Availability of Prospective Technologies. On-site groundwater treatment using phytoremediation and on-site soil treatment using solidification/stabilization are the only specialized technologies implemented for Alternative #59. Phytoremediation technology requires only routine and commonly available construction materials and methods but requires ecological/engineering specialists familiar with the proper selection and installation of the environmental media. In addition, some of the environmental media (*e.g.*, wetlands plant types) may require specialized development and procurement. Solidification/ stabilization also uses commonly available construction materials but specialized methods, and more importantly, engineering/remedial specialists familiar with appropriate design and construction of this technology. Although these technologies are not as "exotic" as many innovative technologies, they will require effort to identify and procure appropriate expertise, equipment and skilled personnel. Therefore, availability of these technologies will be the limiting factor with regard to implementability of prospective technologies for Alternative #59.

### 5.13.7 Cost for Alternative #59

Total estimated capital cost associated with this alternative is $46.9 million. This estimate assumes a contingency of 20%. The present value of all O&M costs would be $72.5 million. This estimate assumes an inflation rate of 3%, an interest rate of 7%, and a contingency of 15%. The maximum duration of site remedial actions is assumed to be 30 years, in accordance with RI/FS guidance (U.S. EPA, 1988). Total present worth costs would therefore be $119.4 million. Detailed costs for this alternative are presented in Appendix D. The costs associated with each alternative selected for detailed evaluation are summarized in Table H-1 of Appendix H.

An analysis was performed to determine the cost savings associated with combining similar treatment processes used at different AOCs. The cost savings associated with the combination of treatment plants for on-site solidification/stabilization (soil) are approximately $3.7 million. This reduces the alternative's total costs to $115.6 million. This analysis is presented in Appendix H.

### 5.13.8 State Acceptance for Alternative #59

Acceptance of the selected, site-wide remedial alternative by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 5.13.9 Community Acceptance for Alternative #59

Acceptance of the selected, site-wide remedial alternative by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 5.14 ALTERNATIVE #67 - "FOCUSED TREATMENT AND REMEDIAL ACTION C"

Alternative #67 is similar to Alternative #59 in that intensive treatment technologies/process options are focused on those AOCs with the highest human health risk while utilizing source control, in-situ and institutional action remedies on the remaining AOCs. Alternative #67 uses an alternate on-site treatment approach to the remedy presented in Alternative #59. This results in a balance of good overall "Effectiveness" and "Implementability".

The overview of remedial action components for Alternative #67 is presented in Table 5-38 and Appendix F. Figure 5-13 details the remedial action site plan for this alternative. Alternative #67 includes the following remedial actions by media of concern and AOC:

Soil:

- Contaminated soil at AOCs #3 (B&M Locomotive Shop Disposal Areas), #4 (Old B&M Oil/Sludge Recycling Area) and #5 (Contaminated Soils Area) will be excavated and treated using chemical processes (chemical extraction, soil washing). This remedy will also include institutional actions for monitoring to confirm appropriate source cleanup.
- Source control remedies consisting of horizontal containment (e.g., caps) will be implemented at disposal area AOCs [#1 - B&M Railroad Landfill, #2 - RSI Landfill (for groundwater source managment), #6 - Asbestos Landfill, #7 - Asbestos Lagoons] to address human health and ecological risk and/or meet ARAR requirements.

Groundwater:

- An on-site pump and treat remedy consisting of collection of contaminated groundwater (*e.g.*, extraction wells/subsurface drains) and treatment on-site using chemical and physical processes (coagulation / flocculation and precipitation, UV/chemical oxidation, adsorption technology) followed by discharge of treated water will be applied to the highest human health risk-ranked AOC (#5 - Contaminated Soils Area). This remedy also includes institutional actions for groundwater monitoring.
- In-situ remedies consisting of monitored natural attenuation as well as institutional actions consisting of access restrictions (*e.g.*, institutional controls) and monitoring will be implemented at all remaining AOCs.

Surface Water and Sediment:

- Institutional actions consisting of monitoring are implemented at all three AOCs showing risk (#8b - Wetland 2 Group, #8d - Richardson Pond Group, #8e - Content Brook Wetland Group). No remedial actions for surface water will be necessary at all remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) since contaminant concentrations are within acceptable human health and ecological risk

levels. Sediment monitoring is included at these two AOCs as a provision if future toxicity testing results in ecological risk.

The detailed evaluation of Alternative #67 with respect to the nine FS criteria is presented in Sections 5.14.1 through 5.14.9.

### 5.14.1 Overall Protection of Human Health and the Environment for Alternative #67

Alternative #67 will provide some overall protection of human health and the environment by reducing some risks identified in the baseline risk assessment. For soil, overall protection of human health from implementation of Alternative #67 will result from a significant reduction or elimination of exposures to COCs in soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill and Asbestos Lagoons. In addition, the elimination of exposures to groundwater at AOCs #1 through 7 using institutional controls and monitored natural attenuation along with reduced COC concentrations from an on-site pump and treat remedy at the Contaminated Soils Area will provide overall protection of human health from groundwater exposures. Identified ecological risks from exposures to soil will be significantly reduced, and exposures to surface water will be gradually reduced. In sediment, however, only minor reductions of risk to ecological receptors will be expected. Therefore, Alternative #67 fails to meet all RAOs for the Site, as defined in Section 2.1, and only partially reduces risks to human health and the environment. The protection of human health and the environment are discussed in Sections 5.14.1.1 and 5.14.1.2, respectively.

**5.14.1.1 Human Health Protection.** Alternative #67 will provide overall protection of human health by eliminating risks identified in the baseline risk assessment. Current baseline risks to human health at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and the Contaminated Soils Area for female site workers of child-bearing age from exposure to lead in soil via indoor dust will be significantly reduced as a result of on-site soil washing and chemical extraction since windborne exposures to lead will be diminished. Information in Section 5.14.4.3 documents a removal efficiency of 94% for inorganics through the use of on-site soil washing and chemical extraction. For the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely

presence of surficial asbestos will be abated by capping, since windborne exposure to asbestos will be eliminated. However, since no contaminant removal is performed with capping, the risk will return to baseline levels if the caps are not maintained.

The potential for future risks from ingestion of COCs in groundwater at the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons will be eliminated by restrictions on the future use of groundwater from these AOCs as a drinking water source. Significant reductions in groundwater concentrations for organic COCs with negligible reductions in inorganic COC concentrations are expected to occur at the Contaminated Soils Area by the use of an on-site pump-and-treat remedy. Information in Section 5.14.5.3 and Appendix G documents times to achieve PRGs of from 2 years to >200 years for organic COCs in contrast to remedial times of >200 years for inorganic COCs using collection and treatment by physical and chemical processes (coagulation/flocculation and precipitation, UV/chemical oxidation, adsorption). Reductions in groundwater COC concentrations will also occur over time at AOCs #1, 2, 3, 4, 6, and 7 due to the washing and chemical extraction of contaminated soil (at AOCs #3, 4, and 5) and placement of caps (at AOCs #1, 2, 6, and 7). Soil washing with chemical extraction and capping will lower groundwater COC concentrations by limiting the potential leaching of soil contaminants to groundwater. Natural degradative processes will also contribute to the lowering of groundwater COC concentrations over time. However, concentration reduction is expected to occur slowly for the most significant risk drivers (175 to >200 years to achieve PRGs for arsenic and manganese; see Section 5.14.5.3 and Appendix G). Since there will be only partial containment of groundwater contamination with this alternative, risk to off-site receptors will be possible.

Additional short-term risks to workers will result from exposures during soil washing and chemical extraction at AOCs #3, 4, and 5, the capping of AOCs #1, 2, 6 and 7, on-site groundwater treatment at the Contaminated Soils Area, and from soil and groundwater contact during monitoring. These risks will be mitigated by the use of appropriate personal protection equipment as needed. Specific long-term and short-term human health risks are discussed in Sections 5.14.3.1 and 5.14.5.1, respectively.

**5.14.1.2 Ecological Protection.** Alternative #67 will provide reductions in short-term and long-term risk to ecological receptors relative to baseline conditions for exposures to soil. Treatment of source areas will reduce long-term risk of exposure to aquatic receptors from surface water contaminants. The reduction of risk to ecological receptors in sediments is expected to be minor.

Capping the B&M Railroad Landfill and excavating/treating the B&M Locomotive Shop Disposal Areas will prevent future potential for exposure of terrestrial mammals to metal concentrations, resulting in a significant reduction in ecological risk from exposure to soils.

Adverse impacts on aquatic receptors from exposure to inorganics in surface waters will be reduced at the Wetland 2 Group, the Richardson Pond Group and the Content Brook Wetland Group. The removal or control of all the major source areas on-site and treatment of groundwater at the Contaminated Soils Area will reduce the potential for discharge of metals in surface water runoff and gradually reduce concentration of contaminants discharged from groundwater. These mechanisms will reduce the concentration of metals contributing to risk to aquatic receptors in surface water over time. Resuspension of sediments, not treated by this alternative, still remains a potential source of metals in surface water. Impacts on benthic invertebrate populations from exposure to contaminants in sediment will not be reduced in the Wetland 2 Group, the Richardson Pond Group and Content Brook Wetland Group since the concentrations of contaminants in the sediments in these habitats will not be substantially reduced by this alternative.

The capping of B&M Railroad Landfill, RSI Landfill, Asbestos Lagoons, Asbestos Landfill, and remediation of Contaminated Soils Area, B&M Locomotive Shop Disposal Areas, and Old B&M Oil/Sludge Recycling Area will result in temporary, minor ecological impacts.

### 5.14.2 Compliance with ARARs for Alternative #67

Chemical-specific ARARs and TBCs for the Site are discussed at length in Section 2.3.1. A summary of the implications of each chemical-specific ARAR for this "Focused Treatment and Remedial Action C" alternative include:

- Safe Drinking Water Act and Massachusetts Drinking Water Regulations. Federal and Massachusetts MCLs are relevant and appropriate for site groundwater. This alternative sets attainment of Federal SDWA MCLs and Massachusetts Maximum Contaminant Levels for inorganic and organic chemicals as groundwater remediation goals. Although levels of some organic compounds in groundwater are anticipated to be reduced, this alternative is not anticipated to be able to attain Federal SDWA MCLs or Massachusetts Maximum Contaminant Levels for inorganic chemicals in a reasonable time frame.

- Resource Conservation and Recovery Act Maximum Concentration Limits. RCRA groundwater corrective action requirements are relevant and appropriate requirements at the point of compliance at the limit of the waste management areas. The potential for contaminants to migrate from the area is reduced by this alternative. Monitoring will be conducted to track exposure-based limits at the point of compliance, and to verify a reduction in the migration of contaminants. Although levels of some organic compounds in groundwater are anticipated to be reduced, this alternative is not anticipated to be able to attain Federal RCRA MCLs for inorganic chemicals in a reasonable time frame.

- Federal Water Pollution Control Act, as Amended by the Clean Water Act, Ambient Water Quality Criteria (AWQC). Freshwater acute and chronic AWQC for the protection of aquatic life are considered appropriate and relevant for the site wetlands. Leachate outbreaks and surface water runoff are controlled under this alternative, thereby reducing the probability that AWQC may be exceeded.

- Clean Air Act and Massachusetts Air Pollution Control Regulations. Dust or other potential emissions that may result from excavation of waste materials are controlled under this alternative. There is no indication that ARARs for air will be exceeded by this alternative.

- Massachusetts Groundwater Quality Standards. Actions are taken under this alternative in an attempt to attain applicable "Class I" enforcement standards. Although levels of some organic

compounds in groundwater are anticipated to be reduced, this alternative is not anticipated to be able to attain groundwater standards for inorganic chemicals in a reasonable time frame.

- Massachusetts Surface Water Quality Standards. As part of the Shawsheen River Basin, site surface waters are classified as "Class B" habitat for fish, aquatic life and wildlife, and source of treated public water supplies. Surface water quality standards are considered applicable to site surface waters. Leachate outbreaks and surface water runoff are controlled under this alternative, thereby reducing the probability that surface water quality standards may be exceeded.

- Federal Criteria and Advisories To Be Considered. In addition to the ARARs listed above, there are other important issues and advisories which will require attention prior to and during remedial activities. These criteria and advisories to be considered include:
    - *Health Advisories.* Carcinogenic and non-carcinogenic risk levels due to consumption of contaminated drinking water will be exceeded.
    - *Federal Groundwater Protection Strategy of 1984.* Current, applicable "Class I" enforcement standards are not met under this alternative. Groundwater quality standards are exceeded.
    - *Threshold Limit Values (TLVs).* There is no indication that these levels will be exceeded for site remediation workers under this alternative.

Location-specific ARARs and TBCs relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2), are not met under this alternative. Although the minor impacts to wetlands and floodplains during cap construction will be mitigated, and no surface water discharges will occur, because the on-site wetlands will be allowed to remain in a degraded (contaminated) state, this "Focused Treatment and Remedial Action C" alternative will not meet the intent of Executive Order 11990. This ARAR requires federal agencies to minimize wetland degradation and to preserve and enhance the beneficial uses of wetlands. This alternative controls the source of contamination and leaves the wetlands and ecological habitats intact, but also leaves chemicals of concern in place.

Table 5-39 lists the action-specific ARARs for this alternative. The alternative attains all action-specific ARARs except those related to groundwater protection. Corrective actions must be completed within a "reasonable time period." Demonstrating that the action-specific ARAR detailed below can be attained will require long-term monitoring and evaluation. In the event that this ARAR cannot be attained within an agreed-upon, designated time period, then the groundwater remedy proposed for this alternative will need to be modified by means of a Technical Impracticability (TI) Waiver and/or Explanation of Significant Difference (ESD) to the Record of Decision.

- Hazardous/Solid Waste Management - Groundwater Protection, 310 CMR 30.660 - 30.675; 310 CMR 19.110 (AOCs #1, 2, 3, 6, and 7: A groundwater monitoring program will be implemented at the Site. Corrective measures consist of treatment at AOC #5 and monitored natural attenuation at all remaining AOCs. Leachate generation from the landfill will be reduced but not eliminated. Monitoring will need to be conducted to determine attainment of this requirement.

### 5.14.3 Long-Term Effectiveness and Permanence for Alternative #67

This alternative is evaluated below in terms of risk remaining at the Site after RAOs are addressed. This portion of the evaluation focuses on the extent and effectiveness of the controls required to manage the risk posed by treatment residuals and/or untreated contamination.

**5.14.3.1 Magnitude of Residual Risk: Human Health.** Alternative #67 implements controls to significantly reduce or eliminate exposure of workers to soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. For groundwater, Alternative #67 implements access restrictions to prevent human contact with COCs at AOCs #1 through 7. In addition, the use of an on-site pump and treat remedy at the Contaminated Soils Area and the use of soil washing and chemical extraction at AOCs #3, 4, and 5 and capping at AOCs #1, 2, 6, and 7 are expected to partially reduce groundwater contamination at the Site. However, only partial containment of on-site groundwater contamination is expected. Under this alternative, the magnitude of residual risks will depend on the enforcement and reliability of institutional controls to prevent future human exposure to COCs in groundwater as well as the efficiency of the remedial measures at eliminating exposures to soil and groundwater COCs.

Under this alternative, exposure of female site workers of child-bearing age to lead in indoor dust from soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Contaminated Soils Area, which was estimated to result in a maternal blood level exceeding that protective of a 95$^{th}$ percentile fetal blood lead level of 10 µg/dl, will be significantly reduced (up to 94%) through the use of on-site soil washing and chemical extraction. For the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will be eliminated by capping because fugitive dust generation will be prevented. Therefore, the use of capping at these AOCs will effectively eliminate the estimated risk for site workers to soils, unless the caps are not maintained.

Potential future residual human health risks to a resident from ingestion of COCs in groundwater from AOCs #1 through 7 will be eliminated by the implementation of groundwater access restrictions as long as long-term enforcement of the groundwater access restrictions is maintained. Should access restrictions not be maintained, the use of on-site groundwater treatment at the Contaminated Soils Area is expected to partially reduce groundwater residual risks by reducing the levels of organic COCs (times to achieve PRGs of 2 years to >200 years). However, little reduction in the levels of inorganic COCs is expected. Contaminated groundwater will be partially contained with this alternative due to the on-site treatment of groundwater at the Contaminated Soils Area. Therefore, risk to off-site receptors will be possible. As groundwater concentrations decline over time, there will be a partial lowering of residual risks to potential off-site receptors, and to on-site receptors should access restrictions not be maintained in the future. However, concentration reduction is expected to occur slowly for the most significant risk drivers (175 to >200 years to achieve PRGs for arsenic and manganese; see Section 5.14.5.3 and Appendix G).

**5.14.3.2 Magnitude of Residual Risk: Ecological.** Alternative #67 will result in a quantifiable long-term reduction in risk to ecological receptors in soil and surface water, but not from sediments. The potential for exposure of small mammals to contaminants in soil will be removed at the B&M Railroad Landfill and the B&M Locomotive Shop Disposal Areas.

The removal or control of all the major source areas on-site will reduce the potential for discharge of metals in surface water runoff and gradually reduce concentration of contaminants discharged from groundwater. The reduction of metals in groundwater will also be facilitated by collection and treatment of groundwater at the Contaminated Soils Area. In the long-term, these mechanisms will reduce the concentration of metals contributing to risk to aquatic receptors in surface water. The risk to aquatic receptors from exposure to metals in surface water will persist until substantial decreases in contaminant discharge are achieved. Resuspension of sediments, not treated by this alternative, will still remain a potential source of metals in surface water. Therefore, residual risk to aquatic receptors will not be lowered substantially below baseline conditions for Alternative #67 in the short-term, but are expected to improve in the long-term.

Since no measures are taken in Alternative #67 to directly remove/reduce exposure from contaminants in sediments, the only effects on the concentration of contaminants will be dilution/dispersal through slow, natural processes and a minor reduction in the deposition of additional contamination from surface water over time. Consequently, the concentration of contaminants in on-site sediments will not be substantially reduced under Alternative #67 and the risk to benthic invertebrates will not be reduced below baseline conditions.

### 5.14.4 Reduction of Toxicity, Mobility and Volume through Treatment for Alternative #67

Table 5-40 provides a summary of the treatment and process options selected, quantities of waste materials to be remediated, expected reductions in toxicity, mobility and volume, and residuals following treatment for Alternative #67. No human health or ecological risk was determined for soil at AOC #2 (RSI Landfill). Likewise, no risk was determined for surface water at AOC #8a (West Middlesex Canal Group) and AOC #8c (East Middlesex Canal Group). Therefore, reductions in toxicity, mobility and volume were not evaluated for these media at these AOCs. As a provision if future sediment toxicity testing results in ecological risk, actions are included in the alternative for AOCs #8a and #8c and evaluated below.

**5.14.4.1 Treatment/Recycling Processes to be Utilized.** Alternative #67 consists of source control through horizontal containment, and on-site soil washing and chemical extraction processes for soil. Source control for soils is not considered a treatment process. Groundwater treatment processes to be utilized include on-site physical and chemical treatment, as well as monitored natural attenuation, with and without management of migration. Institutional actions to be implemented for surface water and sediment are not considered treatment processes. A more detailed description of the treatment/recycling processes to be utilized under Alternative #67 is provided in Section 5.14. Refer to Table 5-40 for specific treatment/recycling processes to be utilized at each AOC.

**5.14.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The following amounts of hazardous materials to be treated for Alternative #67 are provided below by media of concern and AOC. Values are only given if the remedial action will provide treatment. Monitored natural attenuation is considered a treatment process in this evaluation, since it typically results in reductions in contamination over time. Source control and institutional actions are not considered treatment processes.

<u>Soil</u>

- AOC #3 - B&M Locomotive Shop Disposal Areas 150,800 $yd^3$
- AOC #4 - Old B&M Oil/Sludge Recycling Area 63,800 $yd^3$
- AOC #5 - Contaminated Soils Area 10,800 $yd^3$

<u>Groundwater (areal extent of source)</u>

- AOC #1 - B&M Railroad Landfill 12.4 acres
- AOC #2 - RSI Landfill 2.5 acres
- AOC #3 - B&M Locomotive Shop Disposal Areas 4.7 acres
- AOC #4 - Old B&M Oil/Sludge Recycling Area 7.0 acres
- AOC #5 - Contaminated Soils Area 6.7 acres
- AOC #6 - Asbestos Landfill 13.3 acres
- AOC #7 - Asbestos Lagoons 1.9 acres

**5.14.4.3 Degree of Expected Reductions in Toxicity, Mobility and Volume.** The degree of treatment and expected reductions for each treatment process under Alternative #67 are provided below by media of concern and AOC. Reductions expected from source control methods and institutional actions are not discussed, since these processes are not considered treatment. Reductions from monitored natural attenuation are provided for the U.S. EPA default time period, 30 years.

All of the contaminated soil at AOCs #3, 4, and 5 will be treated by on-site soil washing and chemical extraction under Alternative #67. On-site soil washing and chemical extraction will reduce the volume of the contaminated soils from AOCs #3, 4, and 5 by 60% to 90% (Hyman and Bagaasen, 1997). The volume of organic contaminants is expected to be reduced by 90% to 99% (Hyman and Bagaasen, 1997, Khodadonst et al, 1999), while inorganics are expected to be reduced by approximately 94% (FRTR, 1997) by soil washing and chemical extraction. At these AOCs, on-site soil washing and chemical extraction processes will reduce the toxicity of contaminated soils relative to a specific contaminant proportional to the volume reduction of that specific contaminant. There is no expected contaminant mobility reduction in the contaminated soils of AOCs #3, 4, and 5 by the on-site soil washing and chemical extraction process.

Monitored natural attenuation is expected to treat all of the contaminated groundwater at AOCs #1 through 4, 6, and 7. The amount of contaminated groundwater that will be collected and treated by physical and chemical process at AOC #5 is dependent on the density of the collection network. The following reductions in toxicity, mobility and volume are expected for groundwater:

Toxicity

- Monitored natural attenuation is expected to reduce the toxicity of the contaminated groundwater relative to a specific contaminant proportionate to the volume reduction of that specific contaminant at AOCs #1 through 4, 6, and 7. Intermediate products that are more toxic than parent compounds may result if incomplete biodegradation of original contaminants occurs.
- The toxicity of the contaminated groundwater at AOC #5 is reduced proportional to the volume reduction through collection and treatment by physical and chemical processes.

Mobility

- Monitored natural attenuation will not provide reductions in the mobility of organic or inorganic contaminants at AOCs #1 through 4, 6, and 7.
- The mobility reduction of the contaminants at AOC #5 will be dependent on the density of the groundwater collection network. If the extraction wells are positioned so as to prevent the migration of contaminated groundwater beyond the network, contaminant mobility will be limited to AOC #5.

Volume

- Monitored natural attenuation will not reduce the volume of the contaminated media at AOCs #1 through 4, 6, and 7.
- Organic COCs reductions in volume are expected to range from less than 15% to 100% across the Site. This broad range is due to differing physical and chemical properties on

a compound by compound basis. Greater reductions of organics are possible due to biodegradation. Specific compounds used in the MODFLOW simulations, as well as BIOSCREEN results which additionally consider biodegradation rates, can be found in Appendix G. Table 5-40 provides estimated volume reductions for each AOC.

- Expected volume reductions from monitored natural attenuation for inorganic COCs vary from less than 15% to 17% across the Site. These low reductions may be attributed to adsorption of compounds to the soils within the aquifer. For specific compounds used the MODFLOW modeling, reference Appendix G. Inorganic volume reductions by AOC are provided in Table 5-40.
- Physical and chemical treatment processes are expected to reduce the volume of organic COCs by 96% to 98% (Hyman and Bagaasen, 1997) at AOC #5. Inorganic COCs are expected to exhibit a 92% to 99% (Amer, 1998, Ellis, 1997) volume reduction. These reductions presented represent upper bound limits upon completion of the groundwater remedy. Lesser values will result during the interim period prior to this endpoint.

There are no expected reductions in toxicity, mobility and volume in surface water and sediment at AOCs #8b, 8d, and 8e and sediment at AOCs #8a and 8c. Institutional actions will not confirm reductions or treatment of waste materials.

**5.14.4.4 Reversibility.** The reversibility of each treatment process to be implemented under Alternative #67 is provided below by media of concern and AOC. Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. Since source control methods and institutional actions are not considered treatment processes, reversibility of treatment is not applicable to these processes.

On-site soil washing and chemical extraction processes release contamination sorbed onto soil particles into wash water/solvents, thereby removing the contamination from the soil. These processes, to be utilized on the contaminated soils of AOCs #3, 4, and 5, are therefore not considered reversible.

Collection of contaminated groundwater and treatment by physical and chemical processes, to be implemented at AOC #5, is not considered a reversible process. Coagulation, flocculation, and precipitation processes remove aqueous phase contaminants from water through solidification and settling. Filtering and adsorption generally remove organics or inorganics, through chemical and/or

physical binding of contaminants to the media. UV/chemical oxidation processes physically destroy organic contaminants by splitting them with ultraviolet light and an oxidizer.

Monitored natural attenuation, to be utilized to address groundwater at all remaining AOCs (#1 through 4, 6, and 7), is not considered reversible. Organic contaminants are degraded over time. Inorganic contaminants, on the other hand, may only be temporarily immobilized and later released.

**5.14.4.5 Type and Quantity of Residuals.** The types and quantities of contaminant residuals by media of concern and AOC expected after completion of the treatment technologies/process options implemented in Alternative #67 are summarized below. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are discussed briefly in Table 5-40.

Approximately 1% to 10% of the organic COCs and 6% of the inorganic COCs will remain sorbed to the soil from AOCs #3, 4, and 5 following treatment by on-site soil washing and chemical extraction. At all AOCs where source control remedies will be implemented (AOCs #1, 6, and 7), the total amount of contaminated soil at each respective AOC will remain untreated but contained under an on-site cap.

Approximately 2% to 4% of organics and 1% to 8% of inorganics will remain in the groundwater collected at AOC #5 and treated by physical and chemical processes upon completion of the groundwater remedy. Greater amounts will result during the interim period prior to this endpoint. At all remaining AOCs (#1 through 4, 6, and 7), more toxic intermediate products may remain if incomplete degradation of original contaminants occurs through monitored natural attenuation. Estimated residuals following monitored natural attenuation treatment for a 30-year period, the U.S. EPA default time, are provided below. As stated above, the wide range in the reductions, and thus the residuals, is due to varying characteristics of compounds.

- It is expected that 0% to greater than 85% of the organic COCs and greater than 85% of the inorganic COCs will remain in the groundwater at AOC #1.
- The groundwater at AOC #2 is expected to contain 0% to 57% of the organic COCs and greater than 85% of the inorganic COCs after treatment.
- Approximately 3% of the organic COCs and greater than 85% of the inorganic COCs will remain at AOC #3 following treatment by monitored natural attenuation.

- At AOC #4, it is expected that 83% to greater than 85% of the inorganic COCs will remain in the groundwater after treatment. There are no organics exceeding PRGs at AOC #4. Therefore, organic reductions were not evaluated.
- An estimated 0% to 51% of the organic COCs and greater than 85% of the inorganic COCs will remain in the groundwater at AOC #6 following treatment.
- It is anticipated that 41% to greater than 85% of the organic COCs and greater than 85% of the inorganic COCs will remain in the groundwater at AOC #7.

Institutional actions are the process options that will be implemented at all AOCs showing risk in surface water and sediment, as well as at AOCs #8a and 8c, where future sediment toxicity testing results may result in ecological risk. Institutional actions will not confirm treatment and therefore, the original amounts of contaminated surface water and sediment will be assumed to remain at all AOCs.

### 5.14.5 Short-Term Effectiveness for Alternative #67

This alternative is evaluated for effectiveness in protecting the community and local workers, site remediation workers, and the environment during the construction and implementation of the remedy.

**5.14.5.1 Protection of Community and Workers During Remedial Actions.** The construction and remediation measures proposed under this alternative include on-site washing and chemical extraction of soils from the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Contaminated Soils Area, capping of the B&M Railroad Landfill, RSI Landfill, Asbestos Landfill and Asbestos Lagoons, on-site groundwater treatment at the Contaminated Soils Area, and groundwater monitoring at AOCs #1 through 7.

The implementation of these construction/remedial measures will potentially result in additional short-term risk to the community from exposure to soil contaminants primarily associated with dust generation during soil disturbances at the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. Precautions will be implemented to prevent or limit fugitive dust generation during excavation/remedial activities. Worker exposure to COCs in soil during disturbances at AOCs #1, 2, 3, 4, 5, 6, and 7, in groundwater during on-site treatment at the Contaminated Soils Area, and in soil and groundwater during monitoring will also result in potential

health risk to workers. Use of personal protection equipment will be employed to reduce exposure if applicable OSHA standards are exceeded during these activities.

**5.14.5.2 Environmental Impacts.** The capping of B&M Railroad Landfill, RSI Landfill, Asbestos Landfill, Asbestos Lagoons, and excavation of the Contaminated Soils Area, Old B&M Oil/Sludge Recycling Area, and B&M Locomotive Shop Disposal Areas will all require removal of vegetation. Wetlands are located around the border of a portion of each of these areas, with the exception of the Old B&M Oil/Sludge Recycling Area and Contaminated Soils Area. The extent of excavation or fill in wetland is estimated to be minimal for each alternative. Mitigation measures will include avoidance and minimization of temporary construction disturbance in adjacent wetlands during construction of landfill caps. Tree removal will be minimized, and proper construction and erosion control methods will be utilized. Mitigation will include restoration of upland habitat, and minimization of wetland impacts. Any unavoidable wetland loss will be mitigated by restoration or creation of on-site wetlands. Changes in hydrology resulting from operation of the groundwater treatment system at the Contaminated Soils Area will be mitigated by properly maintaining flows of water close to existing conditions. Potential alterations in the hydrology and seasonal water levels in the adjacent wetlands will be minimized. Pumping rates and re-injection rates of water to wells will be implemented that are predicted, via modeling, to have minimal effects on water elevations in wetlands.

The alternative includes installation of monitoring wells throughout the Site. Mitigation measures will include avoidance and minimization of temporary construction disturbance in wetlands during construction of monitoring wells, and minimization of tree removal. Proper construction and erosion control methods will be utilized to minimize ecological impact to surrounding habitats.

The excavation of soil adjacent to the unnamed brook in B&M Locomotive Shop Disposal Area A may potentially cause disturbance to the stream bank. Mitigation measures will include avoidance and minimization of temporary construction disturbance in the stream channel and returning impacted areas to previous grades. Any unavoidable wetland loss from excavation will be mitigated by restoration or creation of on-site wetlands.

**5.14.5.3 Time Until Remedial Action Objectives are Achieved.** Of the RAOs presented in Section 2, those for groundwater will take the longest to achieve. Through the use of groundwater flow modeling and contaminant retardation concepts (Appendix G), approximate times to achieve PRGs were calculated for the Site contaminants at each AOC. It should be noted that the mobility of inorganics is highly sensitive to site specific geochemistry. Other factors such as pH, dissolution, and colloidal transport could have significant impacts on mobility of inorganics. Therefore, these times should only be used for relative comparison and not for accurate representations of cleanup times.

Similar to Alternative #59, Alternative #67 includes monitored natural attenuation as a groundwater treatment process at all AOCs except AOC #5, the Contaminated Soils Area. Active groundwater collection will be used here prior to treatment and reinjection. Furthermore, site hydrology may be impacted by caps placed on AOCs #1, 2, 6, and 7, as well as groundwater injection of treated soil wash water from AOCs #3, 4, and 5.

Modeling was performed to predict the reduction of contaminant concentrations over time due to natural processes, such as dispersion. However, additional contaminant reduction is expected to occur due to biodegradation. This aspect of monitored natural attenuation was evaluated using the BIOSCREEN natural attenuation decision support system (Appendix G). While improved cleanup times were estimated for a few compounds at the Site, these times were similar to those without biodegradation. Approximate cleanup times, assuming no biodegradation, for each AOC with contaminants above PRGs are presented below:

| Overburden | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | 55 | ND | >200 | >200 |
| AOC #2 - RSI Landfill | 70 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | 31 | ND | ND | >200 |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | 175 |
| AOC #5 - Contaminated Soils Area | 105 | >200 | >200 | >200 |
| AOC #6 - Asbestos Landfill | 62 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 50 | >200 | ND | >200 |

| Bedrock | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | >200 | >200 | ND | >200 |
| AOC #2 - RSI Landfill | 27 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | ND | ND | ND | ND |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | >200 |
| AOC #5 - Contaminated Soils Area | 182 | >200 | ND | >200 |
| AOC #6 - Asbestos Landfill | 22 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 134 | >200 | ND | >200 |

Notes: ND = Not detected at a concentration greater than PRGs at this AOC and flow zone

Some cleanup times reported above are high (i.e., greater than 200 years). This simply means that the compounds are essentially immobile. For example, arsenic and thallium have very high retardation coefficients and, ultimately, high cleanup times.

It should also be noted that the only SVOC detected above PRGs at all AOCs was bis(2-ethylhexyl)phthalate and the only pesticide was aldrin. The high retardation factors of these compounds increase the time of travel and source contaminant reduction. Evaluations assumed that the Contaminated Soils Area contained contaminants similar to the B&M Railroad Landfill, RSI Landfill, and the Asbestos Lagoons. The two compounds noted above are therefore assumed to be found at this AOC above PRGs. However, further evaluation may determine that this is not the case. Furthermore, the evaluations assumed that the maximum detections from the three nearby AOCs were also detected at the Contaminated Soils Area. Similarly, data from the RSI Landfill was used to characterize the Asbestos Landfill.

### 5.14.6 Implementability for Alternative #67

This rail yard summarizes the technical and administrative feasibility of implementing Alternative #67, the "Focused Treatment and Remedial Action C" alternative, and the availability of various services and materials required for its implementation.

**5.14.6.1 Technical Feasibility.** Evaluation of the technical feasibility of Alternative #67 includes an assessment of three factors described in EPA's feasibility study guidance: 1) the ability to construct and operate the technologies, 2) the reliability of the technologies and 3) the ease of undertaking additional remedial actions, if necessary. These aspects are described in detail below:

Ability to Construct and Operate the Technologies. For Alternative #67, similar to Alternatives #8 thorough 59, a major implementability issue with regard to technical feasibility is the construction of landfill caps at AOCs #1, 2, 6, and 7.

As discussed previously for Alternatives #8 through 59, the capping and excavation remedies for Alternative #67 at AOCs #1, 2, 6, and 7 will require a substantial civil engineering/earthwork component. The key implementability issue is the location of sensitive wetland areas or water bodies adjacent to every one of these AOCs. This will require comprehensive soil erosion, runoff and sedimentation control measures to minimize siltation impacts to wetland areas or water bodies. In addition, proper location and construction of temporary and permanent haul roads will be required to minimize impacts to wetland areas and water bodies. It is expected that the remediation contractor(s) will utilize the existing rail network to move equipment and materials to the largest degree possible. This rail network is closely situated to three of the four "earthwork" AOCs (*e.g.*, #1, 2, and 6). While the scope of the earthwork and transportation required for the capping and excavation activities is large, these are common problems faced and solved by experienced engineers and constructors. Maintenance of the capped and excavated areas is straightforward requiring only periodic inspections, vegetation control (*e.g.*, mowing) and filling of areas of settlement. As a result, no implementability constraints are expected with regard to construction and operation of the soil remedy for AOCs #1, 2, 6, and 7 in Alternative #67.

The primary implementability concern for construction of on-site treatment using soil washing and chemical extraction for AOCs #3, 4, and 5 is the limitation of excavating and replacing materials within the Contaminated Soils Area while maintaining active use of the rail yard and roads that transect it. Several measures may be required such as: temporary structural supports for tracks or roadways next to soil excavation or backfill areas, and temporary structural supports for tracks near the work zone, temporary use restrictions for affected tracks or roadways, and temporary relocation of tracks and bedding material for treatment of soils beneath rail beds. "Operational" effort will require appropriate supervisory, labor support and equipment maintenance necessary to successfully process the excavated soils using soil washing/chemical extraction. No long-term maintenance will be necessary after treated soils achieve PRGs.

Construction, operation and maintenance of the on-site groundwater remedy at AOC #5 will need to address some key implementability issues. Drilling and installation of the groundwater extraction wells and installation of the horizontal trench and collection piping will require temporary disruptions and/or use restrictions within the active rail yard similar to those previously described for installation of the single-barrier cap. Successful operation and

maintenance of the physical/chemical treatment plant will require consistent supervisory, operational and maintenance labor support similar to that provided for other wastewater/water treatment facilities. Additional, periodic engineering and manufacturer support will also be required to troubleshoot and solve process problems and repair and replace equipment, when required. Periodic cleaning of groundwater extraction and recharge well systems is also an expected task as part of O&M. These activities are commonly solved by experienced remediation contractors and operators and should not be an implementability constraint for the groundwater remedy in this alternative.

Alternative #67 also includes the use of monitored natural attenuation to remediate contaminated groundwater at AOCs #1, 2, 3, 4, 6, and 7. Construction of this technology only requires installation of groundwater monitoring wells and "operation" only requires monitoring efforts to sample and analyze the groundwater. Therefore, there are no implementability constraints with regard to monitored natural attenuation.

Reliability of the Technologies. Reliability of the horizontal caps installed for AOCs #1, 2, 6, and 7 will be considered high if normal periodic maintenance of the cap is conducted. For on-site soil washing and chemical extraction of soils and waste fill at AOCs #3, 4, and 5, the design is expected to define the most appropriate wash solutions and/or chemical reagents to remove contaminants and meet PRGs. Once this is achieved, the reliability of the technology is directly dependent on three factors: 1) comprehensive pre-sorting of excavated soils/waste fill to remove inappropriate materials such as large boulders, metal, or other large debris that could interfere with the process train, 2) appropriate operational plant support, and 3) comprehensive program of analytical testing of treated soils with retreatment of those soils that fail to meet PRGs.

The reliability of on-site groundwater treatment using physical/chemical processes will be directly proportional to the degree of the operation and maintenance support provided to the facility. Given O&M support equivalent to facilities of this type at other successful wastewater, water and groundwater treatment plants, the reliability of on-site groundwater treatment for Alternative #67 will be high.

As stated previously under Alternatives #5 through 59, the reliability of monitored natural attenuation to remediate any residual contaminated groundwater should be considered "high" since there is no external equipment nor treatment systems that could breakdown. The reliability of the technology to meet PRGs, however, should not be confused with "implementability" but is more appropriately discussed under "effectiveness." The reader is directed to the "treatment efficiency" and the "time required to remediate" discussions in Sections 5.14.4, 5.14.5 and Appendix G.

As discussed previously for Alternatives #5 through 59, although the institutional controls which will be applied to AOCs #1 through 7 are not exactly technologies, their reliability will depend upon enforcement by the responsible agencies involved.

Ease of Undertaking Additional Remedial Actions. Applying additional remedial actions for contaminated soils contained by the horizontal caps installed at AOCs #1, 2, 6, and 7 will be severely restricted since installation of the caps are largely permanent remediation technologies. This conclusion will also apply to the excavation and on-site soil washing/chemical extraction treatment of waste soils/waste fill from AOCs #3, 4, and 5.

Additional remedial actions could be accommodated to a limited degree to modify on-site groundwater treatment using physical/chemical processes. Alternate types of coagulants or flocculants could be used to improve precipitation and removal of inorganic/metals contaminants. Alternate chemical oxidizing agents (peroxide, permanganate, ozone, etc.) could be tested in the UV/chemical oxidation system. In addition, different types or combinations of adsorbent media (activated carbon, activated alumina, etc.) could be used to improve the performance of the final, polishing adsorption step. If these modifications prove to be insufficient, then an alternate on-site treatment remedy could be constructed that could utilize the existing groundwater collection and recharge systems.

Additional remedial actions could be accommodated in place of monitored natural attenuation of groundwater. The only implementability limitation is that the new groundwater remediation technologies will need to accommodate the active, working area of the Contaminated Soils Area rail yard, and not require installation within the confines of previously capped AOCs #1, 2, 6, and 7.

Additional remedial actions could be accommodated in place of routine monitoring of sediment at AOCs #8a through 8e and surface water at AOCs #8b, 8d, and 8e without any implementability concerns.

**5.14.6.2 Administrative Feasibility.** Evaluation of the administrative feasibility of Alternative #67 involves assessing the steps required to coordinate with other state, federal and local governmental entities. It should be noted that under Superfund, permits are not required for remediation activities, but compliance with substantive requirements is required.

The principal administrative feasibility issue with regard to Alternative #67, described previously for Alternatives #3 through 59, involves implementation of institutional controls in order to prohibit the use of groundwater. If proprietary controls are used, coordination with the individual property owners of the affected parcels, will be required. For example, implementation of a negative easement would require the property owner to convey to a third party (typically EPA) the right to limit how the landowner can use his or her property. Here the limitations would likely include prohibitions against the use of groundwater from wells on the property.

If governmental controls are used, coordination with federal, state and local government (the ATSDR, the Commonwealth of Massachusetts and/or the Town of Billerica) will be required. For example, implementation of land use restrictions may require the exercise of zoning authority by the Town of Billerica to prohibit residential development in a contaminated area, or the adoption of a building permit ordinance in the Town of Billerica requiring anyone seeking a building permit for construction activities in a particular area to be notified of contamination in the area and of any relevant management standards - such an ordinance could also be used to prohibit types of construction that would result in unacceptable exposures (e.g., excavation in areas where subsurface contamination has not been fully removed). Implementation of groundwater use restrictions may require action by the Commonwealth of Massachusetts to prohibit or limit certain uses of groundwater in particular areas, or require closing or capping of wells. Implementation of advisories may also require action by the ATSDR or Commonwealth of Massachusetts to publically issue warnings that provide notice to potential users of land, surface water or groundwater of some existing or impending risk associated with their use.

An additional administrative issue is to reach agreement between federal, state and local governmental entities on the specifics of implementing the monitored natural attenuation program. Under Alternative #67, this program will address groundwater at AOCs #1, 2, 3, 4, 6, and 7. Concurrence among the various governmental entities will be required in defining the program (*e.g.*, number and type of monitoring locations, analytical/test parameters, frequency of testing, etc.) as well as interpretation of results and conclusions regarding the overall success of monitored natural attenuation.

**5.14.6.3 Availability of Services and Materials.** Evaluation of the availability of services and materials for Alternative #67 includes an assessment of three factors in accordance with EPA's feasibility study guidance: 1) the availability of treatment, storage capacity and disposal services, 2) the availability of necessary equipment and specialists, and 3) the availability of prospective technologies. These aspects are described in detail below:

Availability of TSDF Services. Since no remedial actions requiring off-site transport, storage or disposal are to be implemented as part of Alternative #67, the "Focused Treatment and Remedial

Action C" alternative, there are no implementability constraints with regard to this issue for selection of this alternative.

Availability of Necessary Equipment and Specialists. A substantial quantity of heavy, earthmoving equipment as well as transport vehicles (both truck and rail variety) will be required for Alternative #67 during construction of the caps at AOCs #1, 2, 6, and 7. The numbers of equipment and vehicles required will be proportional to the number of caps/excavations being conducted simultaneously in a given construction season.

The highest need for specialists in Alternative #67 is for two areas: 1) specialized legal counsel/assistance for implementation of the institutional controls and 2) consultants experienced in monitored natural attenuation of groundwater, sediments, and surface water. Implementation of the institutional controls is expected to be a time-consuming process but should not pose significant implementability concerns that will prevent selection of this alternative as the final remedy. Legal specialists experienced in both CERCLA and non-CERCLA sites are available to facilitate this process. Similarly, monitored natural attenuation has been a technology employed at CERCLA sites in the last 10 years and there is a substantial number of environmental consultants with familiarity in implementing such a program. Thus, availability of consultants familiar with monitored natural attenuation should not prevent selection of this alternative as the final remedy.

Availability of Prospective Technologies. On-site soil treatment using soil washing and chemical extraction is the only specialized technology implemented for Alternative #67. This technology may require some special chemical additives (*e.g.*, detergents) and/or chemical solvents and will require engineering/remediation specialists familiar with appropriate design and construction of this technology. Although soil washing/chemical extraction is not as "exotic" as many innovative technologies, it will still require effort to identify and procure appropriate expertise, equipment and skilled personnel. The remedial technologies required for the on-site groundwater treatment (*e.g.*, coagulation/flocculation and precipitation, UV/.chemical oxidation, and adsorption) are all commonly used in treatment of water and wastewater. Manufacturer, supplier and vendor support are readily available for all of these technologies along with comprehensive literature evaluations documenting their performance. Therefore, availability of on-site soil washing and chemical extraction technology will be the limiting factor with regard to implementability of prospective technologies for Alternative #67.

### 5.14.7 Cost for Alternative #67

Total estimated capital cost associated with this alternative is $48.7 million. This estimate assumes a contingency of 20%. The present value of all O&M costs would be $95.7 million. This estimate assumes an inflation rate of 3%, an interest rate of 7%, and a contingency of 15%. The maximum duration of site remedial actions is assumed to be 30 years, in accordance with RI/FS guidance (U.S.

EPA, 1988). Total present worth costs would therefore be $144.4 million. Detailed costs for this alternative are presented in Appendix D. The costs associated with each alternative selected for detailed evaluation are summarized in Table H-1 of Appendix H.

An analysis was performed to determine the cost savings associated with combining similar treatment processes used at different AOCs. The cost savings associated with the combination of treatment plants for on-site physical/chemical treatment (groundwater/soil wash water) and on-site soil washing/chemical extraction (soil) are approximately $7.3 million. This reduces the alternative's total costs to $137.2 million. This analysis is presented in Appendix H.

### 5.14.8 State Acceptance for Alternative #67

Acceptance of the selected, site-wide remedial alternative by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 5.14.9 Community Acceptance for Alternative #67

Acceptance of the selected, site-wide remedial alternative by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 5.15 ALTERNATIVE #72 - "MAXIMUM REMEDIAL ACTION"

Alternative #72 represents the remedy with the highest overall "Effectiveness" and "Implementability" and offers the most extensive combination of remedial technologies and process options.

The overview of remedial action components for Alternative #72 is presented in Table 5-41 and Appendix F. Figure 5-14 details the remedial action site plan for this alternative. Alternative #72 includes the following remedial actions by media of concern and AOC:

Soil:

- Source control remedies consisting of horizontal containment (*e.g.*, caps) will be implemented at disposal area AOCs [#1 - B&M Railroad Landfill, #2 - RSI Landfill (for groundwater source management), #6 - Asbestos Landfill] to address human health and ecological risk or meet ARAR requirements.
- Contaminated soil will be treated on-site using chemical processes (*e.g.*, chemical extraction/soil washing) at AOCs #3 (B&M Locomotive Shop Disposal Areas), #4 (Old B&M Oil/Sludge Recycling Area), and #5 (Contaminated Soils Area). This remedy includes monitoring to confirm achievement of soil PRGs.
- Contaminated soil at AOC #7 (Asbestos Lagoons) will be excavated and relocated for ultimate disposal under the cap installed for AOC #6. This remedy also includes monitoring to confirm appropriate source cleanup.

Groundwater:

- An on-site pump and treat remedy consisting of collection of contaminated groundwater (*e.g.*, extraction wells/subsurface drains) and treatment on-site using chemical and physical processes (coagulation/flocculation and precipitation, UV/chemical oxidation, adsorption technology) followed by discharge of treated water will be implemented at all AOCs. Vertical containment will be used where necessary to prevent wetland dewatering during groundwater collection. This remedy will also include institutional actions for groundwater monitoring.

Surface Water:

- An on-site collection and treatment remedy consisting of collection of contaminated surface water (*e.g.*, pumps, diversion weirs/channels) and treatment on-site using biological processes (suspended growth aerobic processes) and chemical/physical processes (sedimentation, coagulation/flocculation and precipitation, adsorption technology) followed by discharge will be applied to AOCs #8b (Wetland 2 Group) and #8e (Content Brook Wetland Group). This remedy will also include institutional actions for surface water monitoring.
- In-situ remedies consisting of monitored natural attenuation will be implemented at AOC #8d (Richardson Pond Group).

Sediment:

- Source control remedies consisting of dredging/dry excavation of "hot spot" locations and on-site treatment using chemical processes (chemical extraction, soil washing) will be applied to contaminated sediments in AOCs #8b (Wetland 2 Group) and #8e (Content Brook Wetland Group). Remaining lesser contaminated sediments will be mitigated through in-situ means via monitored natural attenuation.
- Source control remedies consisting of dredging/dry excavation of "hot spot" locations will be applied to contaminated sediments in AOC #8d (Richardson Pond Group). Excavated sediments are disposed of on-site via relocation under one of the caps installed for AOCs #1, 2, or 6. Remaining lesser contaminated sediments will be mitigated through in-situ means via monitored natural attenuation. Similarly, the same actions are included at the remaining AOCs (#8a - West Middlesex Canal Group and #8c - East Middlesex Canal Group) as a provision if future toxicity testing results in ecological risk.

The detailed evaluation of Alternative #72 with respect to the nine FS criteria is presented in Sections 5.15.1 through 5.15.9.

### 5.15.1 Overall Protection of Human Health and the Environment for Alternative #72

Alternative #72 will provide some overall protection of human health and the environment by reducing some risks identified in the baseline risk assessment. For soil, overall protection of human health from implementation of Alternative #72 will result from a significant reduction or elimination of exposures to COCs in soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. In addition, the elimination of exposures to groundwater at AOCs #1 through 7 using institutional controls along with reduced COC concentrations using on-site pump and treat remedies at AOCs #1 through 7 will provide overall protection of human health from groundwater exposures. Identified ecological risks from exposures to soil will be removed. Long-term reduction in exposure of aquatic receptors to surface water will be achieved, and the exposure of benthic organisms to sediment contaminants will be significantly reduced. Therefore, Alternative #72 meets all RAOs for the Site, as defined in Section 2.1, and significantly reduces risks to human health and the environment. The protection of human health and the environment are discussed in Sections 5.15.1.1 and 5.15.1.2, respectively.

**5.15.1.1 Human Health Protection.** Alternative #72 will provide overall protection of human health by eliminating risks identified in the baseline risk assessment. Current baseline risks to human health at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and the Contaminated Soils Area for female site workers of child-bearing age from exposure to lead in soil via indoor dust will be significantly reduced as a result of on-site soil washing and chemical extraction since windborne exposures to lead will be diminished. Information in Section 5.15.4.3 documents a removal efficiency of 94% for inorganics through the use of on-site soil washing and chemical extraction. For the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will be abated by excavation and/or capping, since windborne exposure to asbestos will be eliminated. However, since no contaminant removal is performed with capping, the risk will return to baseline levels if the caps are not maintained.

The potential for future risks from ingestion of COCs in groundwater at the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons will be eliminated by restrictions on the future use of groundwater from these AOCs as a drinking water source. Significant reductions in groundwater concentrations for organic COCs, with negligible reductions in inorganic COCs are expected by the use of an on-site pump and treat remedy at AOCs #1 through 7. Information in Section 5.15.5.3 and Appendix G documents times to achieve PRGs of from <1 year to >200 years for organic COCs in contrast to remedial times of 35 years to >200 years for inorganic COCs using collection and treatment by physical and chemical processes (coagulation/flocculation and precipitation, UV/chemical oxidation, adsorption). Reductions in groundwater COC concentrations will occur over time due to the washing and chemical extraction of contaminated soil (at AOCs #3, 4, and 5) and excavation/capping (at AOCs #1, 2, 6, and 7). Soil washing with chemical extraction and excavation/capping will lower groundwater COC concentrations by limiting the potential leaching of soil contaminants to groundwater. Natural processes will also contribute to the lowering of groundwater COC concentrations over time. However, contaminant reduction is expected to occur slowly for the most significant risk drivers (35 years to >200 years for to achieve PRGs for arsenic and manganese; see Section 5.15.5.3 and Appendix G). Since there will be significant containment of

contaminated groundwater on-site with this alternative, potential risk to off-site receptors will be minimal.

Additional short-term risks to workers will result from exposures during soil washing and chemical extraction at AOCs #3, 4, and 5, the excavation/capping of AOCs #1, 2, 6, and 7, on-site groundwater treatment at AOCs #1 through 7, and from soil and/or groundwater contact during monitoring. These risks will be mitigated by the use of appropriate personal protection equipment as needed. Specific long-term and short-term human health risks are discussed in Sections 5.15.3.1 and 5.15.5.1, respectively.

**5.15.1.2 Ecological Protection.** Alternative #72 will provide reductions in short-term and long-term risk to ecological receptors relative to baseline conditions for exposures to soil, surface water and sediment. Capping the B&M Railroad Landfill and excavating/soil washing at the B&M Locomotive Shop Disposal Areas will prevent future potential for exposure of terrestrial mammals to metal concentrations, resulting in a significant reduction in ecological risk from exposure to soils.

The ecological risks identified for on-site surface water and sediment will also be reduced by this alternative. Adverse impacts on aquatic receptors from exposure to inorganics in surface waters will be reduced at the Wetland 2 Group, Richardson Pond Group and Content Brook Wetland Group. Direct collection and treatment of surface water will reduce metals concentrations in Wetland 2 Group and Content Brook Wetland Group. In addition, capping or treatment of the major source areas on site is likely to reduce the potential future discharge of contaminants from surface runoff and from groundwater. Dredging/excavation of the sediments will reduce the potential for resuspension of metals from sediments in the long term. Impacts on benthic invertebrate populations from exposure to contaminants in sediment will be reduced for Wetland 2 Group, the Richardson Pond Group and Content Brook Wetland Group. Specific long-term and short-term reductions in ecological risks are discussed in Section 5.15.3.2.

The capping of B&M Railroad Landfill, RSI Landfill, Asbestos Landfill, and excavation of the Asbestos Lagoons, the Contaminated Soils Area, Old B&M Oil/Sludge Recycling Area, and the B&M

Locomotive Shop Disposal Areas will result in temporary, minor ecological impacts. Construction of groundwater extraction and injection systems and on-site water treatment systems will also result in temporary, minor ecological impacts. Dredging and excavation of portions of AOCs #8a through 8e will result in temporary and permanent loss of wetland habitats. These impacts will be mitigated by restoration or creation of on-site wetlands.

### 5.15.2 Compliance with ARARs for Alternative #72

Chemical-specific ARARs and TBCs for the Site are discussed at length in Section 2.3.1. A summary of the implications of each chemical-specific ARAR for this "Maximum Remedial Action" alternative include:

- Safe Drinking Water Act and Massachusetts Drinking Water Regulations. Federal and Massachusetts MCLs are relevant and appropriate for site groundwater. This alternative sets attainment of Federal SDWA MCLs and Massachusetts Maximum Contaminant Levels for inorganic and organic chemicals as groundwater remediation goals. Although levels of some organic compounds in groundwater are anticipated to be reduced, this alternative is not anticipated to be able to attain Federal SDWA MCLs or Massachusetts Maximum Contaminant Levels for inorganic chemicals in a reasonable time frame.

- Resource Conservation and Recovery Act Maximum Concentration Limits. RCRA groundwater corrective action requirements are relevant and appropriate requirements at the point of compliance at the limit of the waste management areas. The potential for contaminants to migrate from the area is reduced by this alternative. Monitoring will be conducted to track exposure-based limits at the point of compliance, and to verify a reduction in the migration of contaminants. Although levels of some organic compounds in groundwater are anticipated to be reduced, this alternative is not anticipated to be able to attain Federal RCRA MCLs for inorganic chemicals in a reasonable time frame.

- Federal Water Pollution Control Act, as Amended by the Clean Water Act, Ambient Water Quality Criteria (AWQC). Freshwater acute and chronic AWQC for the protection of aquatic life are considered appropriate and relevant for the Site wetlands. Leachate outbreaks and surface water runoff are controlled under this alternative, thereby reducing the probability that AWQC may be exceeded.

- Clean Air Act and Massachusetts Air Pollution Control Regulations. Dust or other potential emissions that may result from excavation of waste materials are controlled under this alternative. There is no indication that ARARs for air will be exceeded by this alternative.

- Massachusetts Groundwater Quality Standards. Actions are taken under this alternative in an attempt to attain applicable "Class I" enforcement standards. Although levels of some organic compounds in groundwater are anticipated to be reduced, this alternative is not anticipated to be able to attain groundwater standards for inorganic chemicals in a reasonable time frame.

- Massachusetts Surface Water Quality Standards. As part of the Shawsheen River Basin, site surface waters are classified as "Class B" habitat for fish, aquatic life and wildlife, and source of treated public water supplies. Surface water quality standards are considered applicable to site surface waters. Leachate outbreaks and surface water runoff are controlled under this alternative, thereby reducing the probability that surface water quality standards may be exceeded.

- Federal Criteria and Advisories To Be Considered. In addition to the ARARs listed above, there are other important issues and advisories which will require attention prior to and during remedial activities. These criteria and advisories to be considered include:
    - *Health Advisories.* Carcinogenic and non-carcinogenic risk levels due to consumption of contaminated drinking water will be exceeded.
    - *Federal Groundwater Protection Strategy of 1984.* Current, applicable "Class I" enforcement standards are not met under this alternative. Groundwater quality standards are exceeded.

- *Threshold Limit Values (TLVs).* There is no indication that these levels will be exceeded for site remediation workers under this alternative.

In terms of wetland remediation under this alternative, excavation of contaminated sediments at the Richardson Pond Group and Content Brook is supplemented with monitored natural attenuation. To mitigate unavoidable wetland impacts, a site restoration plan will need to be developed. Included within this plan will be specifications for restoration of areas impacted by the remedial action, revegetation standards, and wetlands monitoring for at least three growing seasons after remediation is completed.

Location-specific ARARs and TBCs relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2) are met under this alternative as long as monitoring provides support that no further remedial actions are necessary to meet the intent of Executive Order 11990, and as long as mitigation of excavated wetlands is completed.

Table 5-41 lists the action-specific ARARs for this alternative. This alternative is designed to attain all action-specific ARARs. The alternative attains all action-specific ARARs except those related to groundwater protection. Corrective actions must be completed within a "reasonable time period." Demonstrating that the action-specific ARAR detailed below can be attained will require long-term monitoring and evaluation. In the event that this ARAR cannot be attained within an agreed upon, designated time period, the groundwater remedy proposed for this alternative will need to be modified by means of a Technical Impracticability (TI) Waiver and/or Explanation of Significant Difference (ESD) to the Record of Decision. Although corrective measures under this alternative includes groundwater treatment , attainment of remedial action objectives for inorganic chemicals may be difficult to achieve in a reasonable time frame. This would affect attainment of the following ARAR:

- Hazardous/Solid Waste Management - Groundwater Protection, 310 CMR 30.660 - 30.675; 310 CMR 19.110 (AOCs #1, 2, 3, 6, and 7).

### 5.15.3 Long-Term Effectiveness and Permanence for Alternative #72

This alternative is evaluated below in terms of risk remaining at the Site after RAOs are addressed. This portion of the evaluation focuses on the extent and effectiveness of the controls required to manage the risk posed by treatment residuals and/or untreated contamination.

**5.15.3.1 Magnitude of Residual Risk: Human Health.** Alternative #72 implements controls to significantly reduce or eliminate exposure of workers to soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. For groundwater, Alternative #72 implements access restrictions to prevent human contact with COCs at AOCs #1 through 7. In addition, the use of an on-site pump and treat remedy at AOCs #1 through 7, soil washing and chemical extraction at AOCs #3, 4, and 5, and excavation and/or capping at AOCs #1, 2, 6, and 7 are expected to partially reduce groundwater contamination at the Site. Significant containment of groundwater contamination is expected. Under this alternative, the magnitude of residual risks will depend on the enforcement and reliability of institutional controls to prevent human exposures to COCs in groundwater as well as the efficiency of the remedial measures at eliminating exposures to soil and groundwater COCs.

Under this alternative, exposure of female site workers of child-bearing age to lead in indoor dust from soil at the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Contaminated Soils Area, which was estimated to result in a maternal blood level exceeding that protective of a 95$^{th}$ percentile fetal blood lead level of 10 μg/dl, will be significantly reduced (up to 94%) through the use of on-site soil washing and chemical extraction. For the Asbestos Landfill and Asbestos Lagoons, potential risks associated with the likely presence of surficial asbestos will be eliminated by excavation and/or capping because fugitive dust generation will be prevented. Therefore, the use of excavation and/or capping at these AOCs will effectively eliminate the estimated risk for site workers to soils, unless the caps are not maintained.

Potential future residual human health risks to a resident from ingestion of COCs in groundwater from AOCs #1 through 7 will be eliminated by the implementation of groundwater access restrictions as

long as long-term enforcement of the groundwater access restrictions is maintained. Should access restrictions not be maintained, the use of on-site groundwater treatment at AOCs #1 through 7 is expected to partially reduce groundwater residual risks by reducing the levels of organic COCs (times to achieve PRGs of from <1 year to >200 years; see Section 5.15.5.3). However, little reduction in the levels of inorganic COCs is expected. Contaminated groundwater will be largely contained with this alternative due to the use of an on-site pump and treat remedy for groundwater at AOCs #1 through 7. Therefore, potential risk to off-site receptors will be minimal. As groundwater concentrations decline over time, there will be a partial lowering of residual risks to potential off-site receptors, and to on-site receptors should access restrictions not be maintained in the future. However, concentration reduction is expected to occur slowly for the most significant risk drivers (35 years to >200 years to achieve PRGs for arsenic and manganese; see Section 5.15.5.3 and Appendix G).

**5.15.3.2 Magnitude of Residual Risk: Ecological.** Alternative #72 will result in a quantifiable long-term reduction in risk to ecological receptors in soil, surface water and from sediments. The potential for exposure of small mammals to contaminants in soil will be removed at the B&M Railroad Landfill and the B&M Locomotive Shop Disposal Areas.

The removal or control of all the major source areas on-site will reduce the potential for discharge of metals in surface water runoff and gradually reduce concentration of contaminants discharged from groundwater. In addition, a portion of the surface water at the Wetland 2 Group and Content Brook Wetland Group will be collected and treated. Based on estimates of treatment efficiencies for metals in surface water for Alternative #72 (Table 5-43), the toxicity of metals in treated surface water will be reduced up to 90%, but only a small portion of the water will be collected and treated. Surface water treatment, combined with source reduction, will reduce risk to aquatic receptors from exposure to metals in surface water. Resuspension of sediments still remains a potential source of metals in surface water. However, dredging of sediment in open water areas of Wetland 2 Group and Content Brook Wetland Group will further reduce the potential for resuspension or release of metals to surface water, thereby further reducing ecological risk to aquatic receptors. Short-term, temporary increases in concentration of contaminants in surface water are possible during dredging in Wetland 2 Group, spot excavation in Richardson Pond Group, East Middlesex Canal Group, and West Middlesex Canal

Group, and dredging of sediment in open water areas of Content Brook Wetland Group. The residual risk to aquatic receptors will be lowered substantially below baseline conditions for Alternative #72, and are expected to continue to improve in the long-term after both soil, groundwater and sediment source controls are effective. These measures will result in quantifiable reduction of risk to aquatic receptors.

Since direct measures are taken in Alternative #72 to remove/reduce exposure from contaminants in sediments, this alternative will result in a substantial reduction of risk to benthic invertebrates. The open water areas of the Wetland 2 Group, including the unnamed brook, the associated pond west of the B&M Wastewater Lagoons (OU1), and the B&M Pond, will be dredged. The dredging will result in the reduction of mobility of total PAHs, 4,4'-DDD, antimony, copper and lead from contaminated sediments in the treated areas. The RAO for protection of exposure of benthic invertebrates from contaminants will be achieved in these areas. Spot excavation in adjacent emergent wetlands will further reduce risk to benthic invertebrates. If spot excavation in adjacent wetlands is unable to remove all sediments that exceed PRGs, it is possible that small areas will remain with residual risk to benthic invertebrates. The overall reduction of risk to benthic invertebrates will be substantial; the amount of remaining risk is unknown since the extent of area that will continue to exceed PRGs is unknown, but expected to be minor.

Spot excavation of isolated areas of sediment with high concentrations of PAHs in Richardson Pond will substantially reduce risk to benthic invertebrates. Exposure of benthic invertebrates to PAH will be eliminated in the areas of excavation. Residual risk will remain in any areas in which concentrations of PAHs in sediments exceeding the PRG of 4.5 mg/kg are not excavated. It is assumed that the majority of the sediments of the pond with total PAH concentrations above the PRG will be removed and the ecological RAO will be attained for Richardson Pond.

Removing the contaminated sediments from open water and "hot spot" areas in Content Brook Wetland Group will result in achieving the RAO for protection of exposure of benthic invertebrates in these areas. However, there will be residual risk to benthic invertebrates inhabiting adjacent emergent wetlands, where arsenic may continue to exceed PRGs. The reduction of risk to benthic invertebrates

will be substantial. However, the amount of remaining risk is unknown since the extent of area that will continue to exceed PRGs is unknown.

The only effects on the concentration of contaminants in areas outside of dredging and capping activities will be dilution/dispersal through slow, natural processes and a minor reduction in the deposition of additional contamination from surface water over time. Consequently, the concentration of contaminants in sediments outside of open water areas on-site will continue to pose a risk to benthic invertebrates under Alternative #72. However, the overall risk to benthic invertebrates site-wide will be substantially reduced below baseline conditions under this Alternative.

### 5.15.4 Reduction of Toxicity, Mobility and Volume through Treatment for Alternative #72

Table 5-43 provides a summary of the treatment and process options selected, quantities of waste materials to be remediated, expected reductions in toxicity, mobility and volume, and residuals following treatment for Alternative #72. No human health or ecological risk was determined for soil at AOC #2 (RSI Landfill). Likewise, no risk was determined for surface water at AOC #8a (West Middlesex Canal Group) and AOC #8c (East Middlesex Canal Group). Therefore, reductions in toxicity, mobility and volume were not evaluated for these media at these AOCs. As a provision if future sediment toxicity testing results in ecological risk, actions are included in the alternative for AOCs #8a and #8c and evaluated below.

**5.15.4.1 Treatment/Recycling Processes to be Utilized.** Alternative #72 applies source control remedies consisting of horizontal containment and excavation with on-site disposal, as well as on-site treatment including soil washing and chemical extraction processes for soil. Source control methods are not considered treatment processes. Groundwater treatment processes to be utilized include on-site physical and chemical treatment, both with and without management of migration. Surface water mitigation measures will include collection and treatment of a portion of surface waters through biological, physical and chemical treatment, and monitored natural attenuation of remaining surface waters. Dry excavation/dredging followed by on-site soil washing and chemical extraction will be utilized in addition to spot excavations and on-site disposal of contaminated sediments in the wetlands.

Spot excavations and on-site disposal are source control remedies that are not considered treatment processes. Sediments not excavated and/or treated by soil washing and chemical extraction will be remediated through monitored natural attenuation. A more detailed description of the treatment/recycling processes to be utilized under Alternative #72 is provided in Section 5.15. Refer to Table 5-43 for specific treatment/recycling processes to be utilized at each AOC.

**5.15.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The following amounts of hazardous materials to be treated for Alternative #72 are provided below by media of concern and AOC. Values are only given if the remedial action will provide treatment. Monitored natural attenuation is considered a treatment process in this evaluation, since it typically results in contaminant reduction over time. Source control remedies and institutional actions are not considered treatment processes. Limited sediment sampling was conducted in the wetland areas, AOCs #8a, 8b, 8c, 8d and 8e, to determine the extent of contamination. Approximate amounts resulting from this determination are provided below.

<u>Soil</u>

- AOC #3 - B&M Locomotive Shop Disposal Areas 150,800 $yd^3$
- AOC #4 - Old B&M Oil/Sludge Recycling Area 63,800 $yd^3$
- AOC #5 - Contaminated Soils Area 10,800 $yd^3$

<u>Groundwater (areal extent of source)</u>

- AOC #1 - B&M Railroad Landfill 12.4 acres
- AOC #2 - RSI Landfill 2.5 acres
- AOC #3 - B&M Locomotive Shop Disposal Areas 4.7 acres
- AOC #4 - Old B&M Oil/Sludge Recycling Area 7.0 acres
- AOC #5 - Contaminated Soils Area 6.7 acres
- AOC #6 - Asbestos Landfill 13.3 acres
- AOC #7 - Asbestos Lagoons 1.9 acres

<u>Sediment</u>

- AOC #8a - West Middlesex Canal Group non-excavated sediments
- AOC #8b - Wetland Group 2 all contaminated sediments
- AOC #8c - East Middlesex Canal Group non-excavated sediments
- AOC #8d - Richardson Pond Group non-excavated sediments
- AOC #8e - Content Brook Wetland Group all contaminated sediments

Surface Water

- AOC #8b - Wetland Group 2 — 7.6 acres
- AOC #8d - Richardson Pond Group — 107 acres
- AOC #8e - Content Brook Wetland Group — 1.4 acres

**5.15.4.3 Degree of Expected Reductions in Toxicity, Mobility and Volume.** The degree of treatment and expected reductions for each treatment process under Alternative #72 are provided below by media of concern and AOC. Reductions expected from source control methods are not discussed, since these processes are not considered treatment. Reductions from monitored natural attenuation are provided for the U.S. EPA default time period, 30 years. For monitored natural attenuation of surface water and sediment, reductions are provided in general terms. Intensive transport modeling required to provide quantifiable reductions is beyond the scope of this FS. Only limited case studies, which can not provide a comprehensive, quantitative estimate, are available in technical literature.

All of the contaminated soil at AOCs #3, 4, and 5 will be treated by on-site soil washing and chemical extraction under Alternative #67. On-site soil washing and chemical extraction will reduce the volume of the contaminated soils from AOCs #3, 4, and 5 by 60% to 90% (Hyman and Bagaasen, 1997). The volume of organic contaminants is expected to be reduced by 90% to 99% (Hyman and Bagaasen, 1997, Khodadonst et al, 1999), while inorganics are expected to be reduced by approximately 94% (FRTR, 1997) by soil washing and chemical extraction. At these AOCs, on-site soil washing and chemical extraction processes will reduce the toxicity of contaminated soils relative to a specific contaminant proportionate to the volume reduction of that specific contaminant. There is no expected contaminant mobility reduction in the contaminated soils of AOCs #3, 4, and 5 by the on-site soil washing and chemical extraction process.

Groundwater at all AOCs will be collected and treated by physical and chemical processes, either with or without management of migration. Although management of migration is not treatment, it is beneficial to consider it in the evaluation of the amount of contaminated groundwater treated by a pump and treat system. For groundwater collection processes, management of migration typically consists of both horizontal containment through capping to reduce further source contamination to

groundwater and vertical containment through slurry walls downgradient of the extraction wells. At AOC #7, management of migration will consist only of vertical slurry walls. Although vertical slurry walls will primarily serve to minimize pumping impacts to the neighboring wetlands, they will also provide vertical containment of overburden contaminated groundwater. Therefore, at the AOCs where vertical slurry walls will be utilized in addition to collection and treatment by physical and chemical processes (AOCs #1, 2, 6, and 7), all of the overburden groundwater is expected to be treated. Vertical slurry walls will be keyed into the top of bedrock, and will not extend through the bedrock. Therefore, bedrock groundwater will not be contained by slurry walls and the degree of treatment of the bedrock groundwater at AOCs #1, 2, 6, and 7 will be dependent on the density of the collection network. At the AOCs where collection and treatment by physical and chemical processes will be utilized in the absence of management of migration (AOCs #3, 4, and 5), the amount of both overburden and bedrock groundwaters that will be collected for treatment by physical and chemical processes is dependent on the density of the collection network.

At all AOCs, the toxicity of the contaminated groundwater relative to a specific contaminant is expected to be reduced proportionally to the volume reduction of that specific contaminant provided by physical and chemical treatment. At AOCs #1, 2, 6, and 7, contaminant mobility in the overburden groundwater will be limited to each respective AOC by vertical slurry walls. In bedrock groundwater at AOCs #1, 2, 6, and 7, the mobility of organic and inorganic COCs will be dependent on the density of the groundwater collection network. Likewise, at the AOCs which will utilize collection and treatment by physical and chemical processes without management of migration (AOCs #3, 4, and 5), contaminant mobility in both overburden and bedrock groundwaters will be dependent on the density of the collection network. Physical and chemical treatment processes are expected to reduce the volume of organic COCs by 96% to 98% (Hyman and Bagaasen, 1997) and inorganic COCs by 92% to 99% (Amer, 1998, Ellis, 1997) at all AOCs upon completion of the groundwater remedy. Lesser values will result during the interim period prior to this endpoint.

Only a small portion of the surface waters at AOCs #8b and 8e are expected to be collected for treatment by biological, physical and chemical processes. Remaining surface waters at these AOCs and all of the surface water at AOC #8d will be treated by monitored natural attenuation. Both

treatment methods, monitored natural attenuation and biological, physical and chemical processes, will reduce the toxicity of the contaminated surface water relative to a specific contaminant proportional to the volume reduction of that specific contaminant. The mobility of contaminants at AOCs #8b and 8e will be reduced proportional to the amount collected for treatment. Monitored natural attenuation will provide no contaminant mobility reduction in the surface water at AOC #8d. In the portion of surface waters to be collected from AOCs #8b and 8e, biological, physical and chemical treatment processes are expected to reduce the volume of organic COCs by 96% to 98% (Hyman and Bagaasen, 1997) and inorganic COCs by 92% to 99% (Amer, 1998, Ellis, 1997). The volume of contaminants in remaining surface water at AOCs #8b and 8e, as well as all of the surface water at AOC #8d, is expected to be reduced over time by monitored natural attenuation.

All of the contaminated sediments at AOCs #8b and 8e will be treated under Alternative #72. Dry excavated/dredged open water sediments within these AOCs will be treated by on-site soil washing and chemical extraction. Treatment by on-site soil washing and chemical extraction of the contaminated sediments to be excavated from AOCs #8b and 8e is expected to reduce the volume of contaminated media by 60% to 90% (Hyman and Bagaasen, 1997). Both organic and inorganic COCs in the sediment excavated from AOCs #8b and 8e are expected to be reduced in volume by up to 90% (U.S. EPA, 1998b). The toxicity of the excavated open water sediments relative to a specific contaminant is expected to be reduced proportionally to the volume reduction of that specific contaminant provided by on-site soil washing and chemical extraction. The mobility of contaminants in the sediments will not be reduced and some sediments may be resuspended during dry excavation/dredging.

All non-open water sediments at AOCs #8b and 8e, as well as all non-excavated sediments at AOCs #8a, 8c, and 8d, will be remediated through monitored natural attenuation. These lesser contaminated sediments will not be reduced in volume through mitigation by monitored natural attenuation, however, the volume of organic and inorganic COCs will be reduced at all AOCs over time. Monitored natural attenuation will reduce the toxicity of the remaining sediments relative to a specific contaminant proportional to the volume reduction of that specific contaminant at each respective AOC.

There will be no mobility reduction of COCs in the lesser contaminated sediments remediated through monitored natural attenuation at all AOCs.

**5.15.4.4 Reversibility.** The reversibility of each treatment process to be implemented under Alternative #72 is provided below by media of concern and AOC. Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. Since source control methods are not considered treatment, reversibility of treatment is not applicable to these processes.

On-site soil washing and chemical extraction processes release contamination sorbed onto soil particles into wash water/solvents, thereby removing the contamination from the soil. These processes, to be utilized on the contaminated soils of AOCs #3, 4, and 5, are therefore not considered reversible.

Collection of contaminated groundwater and treatment by physical and chemical processes, to be implemented at all AOCs, is not considered a reversible process. Coagulation, flocculation, and precipitation processes remove aqueous phase contaminants from water through solidification and settling. Filtering and adsorption generally remove organics or inorganics, through chemical and/or physical binding of contaminants to the media. UV/chemical oxidation processes physically destroy organic contaminants by splitting them with ultraviolet light and an oxidizer.

Treatment by biological, physical and chemical processes for the surface water to be collected from AOCs #8b and 8e is not considered reversible. The same treatment train will be utilized for treatment of surface water as with groundwater, except biological treatment will be included for surface water. Biological treatment removes floating algae or other organic matter from the influent surface water prior to subsequent treatment processes. Monitored natural attenuation of uncollected surface waters from AOCs #8b and 8e, as well as the total amount of surface water from AOC #8d, is not considered reversible. Contaminants are dispersed and degraded over time.

On-site soil washing and chemical extraction processes to be utilized on the excavated sediments from AOCs #8b and 8e are not considered reversible. Soil washing and chemical extraction processes remove contaminants sorbed to sediments by transfer to wash water/solvents. Monitored natural attenuation of remaining, lesser contaminated sediments to be implemented at all AOCs is not considered reversible, as contaminants are degraded over time.

**5.15.4.5 Type and Quantity of Residuals.** The types and quantities of contaminant residuals by media of concern and AOC expected after completion of the treatment technologies/process options implemented in Alternative #72 are summarized below. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are discussed briefly in Table 5-43.

Approximately 1% to 10% of the organic COCs and 6% of the inorganic COCs will remain sorbed to the soil from AOCs #3, 4, and 5 following treatment by on-site soil washing and chemical extraction. At all AOCs where source control remedies will be implemented (AOCs #1, 6, and 7), the total amount of contaminated soil at each respective AOC will remain untreated but contained under an on-site cap.

Approximately 2% to 4% of organics and 1% to 8% of inorganics will remain in the groundwater collected at all AOCs and treated by physical and chemical processes upon completion of the groundwater remedy. Greater amounts will result during the interim period prior to this endpoint.

Residuals remaining in the surface water to be collected at AOCs #8b and 8e after treatment by biological, physical and chemical processes will include 2% to 4% of organic COCs and 1% to 8% of inorganic COCs. In the uncollected portion at these AOCs, as well as in the total amount of surface water at AOC #8d, the amounts of residual contaminants following treatment by monitored natural attenuation were not determined due to lack of a comprehensive, quantitative reduction estimate.

Greater than 10% of organics and 10% of inorganics will remain sorbed to the sediment to be excavated from AOCs #8b and 8e and treated by on-site soil washing and chemical extraction. All of the contaminated sediment to be excavated from AOCs #8a, 8c, and 8d will remain untreated but

contained under an on-site cap. The residuals from monitored natural attenuation processes at all AOCs were not quantified, due to lack of contaminant volume reductions.

### 5.15.5 Short-Term Effectiveness for Alternative #72

This alternative is evaluated for effectiveness in protecting the community and local workers, site remediation workers, and the environment during the construction and implementation of the remedy.

**5.15.5.1 Protection of Community and Workers During Remedial Actions.** The construction and remediation measures proposed under this alternative include on-site washing and chemical extraction of soils from the B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Contaminated Soils Area, excavation and/or capping of the B&M Railroad Landfill, RSI Landfill, Asbestos Landfill and Asbestos Lagoons, on-site groundwater treatment at AOCs #1 through 7, and soil and/or groundwater monitoring at AOCs #1 through 7.

The implementation of these construction/remedial measures will potentially result in additional short-term risk to the community from exposure to soil contaminants primarily associated with dust generation during soil disturbances at the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, Asbestos Landfill, and Asbestos Lagoons. Precautions will be implemented to prevent or limit fugitive dust generation during excavation/remedial activities. Worker exposure to COCs in soil during disturbances at AOCs #1, 2, 3, 4, 5, 6 and 7, in groundwater during on-site treatment at AOCs #1 through 7, and in soil and groundwater during monitoring will also result in potential health risk to workers. Use of personal protection equipment will be employed to reduce exposure if applicable OSHA standards are exceeded during these activities.

**5.15.5.2 Environmental Impacts.** The capping of B&M Railroad Landfill, RSI Landfill, Asbestos Landfill and excavation of B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, Contaminated Soils Area, and Asbestos Lagoons will all require removal of vegetation. Vertical containment walls will also be constructed between the edge of the landfill and the wetlands at B&M

Railroad Landfill, RSI Landfill, the Asbestos Landfill, and the Asbestos Lagoons. Wetlands are located around the border of a portion of each of these areas, with the exception of Old B&M Oil/Sludge Recycling Area. The extent of excavation or fill in wetland is estimated to be minimal for installation of the caps and walls. Mitigation measures will include avoidance and minimization of temporary construction disturbance in adjacent wetlands during construction of landfill caps or treatment walls. Tree removal will be minimized, and proper construction and erosion control methods will be utilized. Mitigation will include restoration of upland habitat, and minimization of wetland impacts. Any unavoidable wetland loss will be mitigated by restoration or creation of on-site wetlands. Changes in hydrology resulting from construction of landfill caps and groundwater treatment systems will be mitigated by properly designed stormwater retention systems and maintenance of flows of water close to existing conditions. Potential alterations in the hydrology and seasonal water levels in the adjacent wetlands will be minimized. Pumping rates and re-injection rates of water to wells will be implemented that are predicted, via modeling, to have minimal effects on water elevations in wetlands.

The alternative includes installation of monitoring wells throughout the Site. Mitigation measures will include avoidance and minimization of temporary construction disturbance in adjacent wetlands during construction of monitoring wells, and minimization of tree removal. Proper construction and erosion control methods will be utilized to minimize ecological impact to surrounding habitats.

Sediment removal at Wetland 2 will also result in temporary wetland impacts for access roads and significant wetland impacts resulting from dredging of approximately 1 ft. of sediment from open water areas. Mitigation will include minimization of wetland impacts and restoration of access roads by returning impacted areas to previous grades and restoring wetland vegetation. Any unavoidable wetland loss from dredging will be mitigated by restoration or creation of on-site wetlands. The majority of the dredged areas will be restored to grade after dredging by backfilling with suitable material to replace the substrate. The size and location of wetland mitigation areas will be determined during design based on the estimated wetland loss (approximately 2.5 acres). The majority of the dredged areas will be restored to grade after dredging by backfilling with suitable material to replace

the substrate. Appropriate erosion control techniques will be implemented to prevent impacts to adjacent wetland areas during dredging, and prevent downstream discharge of sediment.

Spot excavation and on-site disposal of sediments in Richardson Pond Group, East Middlesex Canal Group, and West Middlesex Canal Group will also result in temporary wetland impacts for access roads and additional areas of wetland impacts resulting from dredging of wetland sediments. Mitigation will include minimization of wetland impacts and restoration of access roads by returning impacted areas to previous grades and restoring wetland vegetation. Any unavoidable wetland loss from dredging will be mitigated by restoration or creation of on-site wetlands. The size and location of wetland mitigation areas will be determined during design based on the estimated wetland loss. The majority of the dredged areas will be restored to grade after dredging by backfilling with suitable material to replace the substrate. Appropriate erosion control techniques will be implemented to prevent impacts to adjacent wetland areas during dredging, and prevent downstream discharge of sediment.

Excavation and on-site disposal of sediments from open channel areas in Content Brook Wetland Group will also result in wetland impacts. Mitigation will include minimization of wetland impacts and restoration of impacted areas to previous grades and restoring wetland vegetation. Any unavoidable wetland loss from dredging will be mitigated by restoration or creation of on-site wetlands. The size and location of wetland mitigation areas will be determined during design based on the estimated wetland loss (approximately 1.5 acres). The majority of the dredged areas will be restored to grade after dredging by backfilling with suitable material to replace the substrate. Appropriate erosion control techniques will be implemented to prevent impacts to adjacent wetland areas during dredging, and prevent downstream discharge of sediment.

**5.15.5.3 Time Until Remedial Action Objectives are Achieved.** Of the RAOs presented in Section 2, those for groundwater will take the longest to achieve. Through the use of groundwater flow modeling and contaminant retardation concepts (Appendix G), approximate times to achieve PRGs were calculated for the Site contaminants at each AOC. It should be noted that the mobility of inorganics is highly sensitive to site specific geochemistry. Other factors such as pH, dissolution, and

colloidal transport could have significant impacts on mobility of inorganics. Therefore, these times should only be used for relative comparison and not for accurate representations of cleanup times.

Similar to Alternative #48, Alternative #72 utilizes active groundwater collection at all AOCs, followed by treatment and reinjection. To minimize wetland impacts from groundwater pumping, slurry walls are located at the edge of AOCs #1, 2, 6, and 7. Furthermore, site hydrology may be impacted by caps placed on AOCs #1, 2, and 6. Additional hydrology impacts may be realized from groundwater injection of treated surface water from AOCs #8b and 8e, as well as groundwater injection of treated soil/sediment wash water from AOCs #3, 4, 5, 8b, and 8e.

Modeling was performed to predict the reduction of contaminant concentrations over time due to natural processes, such as dispersion. Approximate cleanup times, assuming no biodegradation, for each AOC with contaminants above PRGs are presented below:

| Overburden | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | 10 | ND | >200 | 138 |
| AOC #2 - RSI Landfill | 37 | ND | ND | >200 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | 12 | ND | ND | >200 |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | 200 |
| AOC #5 - Contaminated Soils Area | 98 | >200 | >200 | >200 |
| AOC #6 - Asbestos Landfill | 10 | ND | ND | >200 |
| AOC #7 - Asbestos Lagoons | 9 | 78 | ND | 132 |

| Bedrock | Years | | | |
|---|---|---|---|---|
| | VOCs | SVOCs | Pesticides | Inorganics |
| AOC #1 - B&M Railroad Landfill | 25 | 18 | ND | 35 |
| AOC #2 - RSI Landfill | 3 | ND | ND | 183 |
| AOC #3 - B&M Locomotive Shop Disposal Areas | ND | ND | ND | ND |
| AOC #4 - Old B&M Oil/Sludge Recycling Area | ND | ND | ND | 88 |
| AOC #5 - Contaminated Soils Area | >200 | >200 | ND | >200 |
| AOC #6 - Asbestos Landfill | 2 | ND | ND | 87 |
| AOC #7 - Asbestos Lagoons | 29 | >200 | ND | >200 |

Notes: ND = Not detected at a concentration greater than PRGs at this AOC and flow zone

Some cleanup times reported above are high (i.e., greater than 200 years). This simply means that the compounds are essentially immobile. For example, arsenic and thallium have very high retardation coefficients and, ultimately, high cleanup times.

It should also be noted that the only SVOC detected above PRGs at all AOCs was bis(2-ethylhexyl)phthalate and the only pesticide was aldrin. The high retardation factors of these compounds increase the time of travel and source contaminant reduction. Evaluations assumed that the Contaminated Soils Area contained contaminants similar to the B&M Railroad Landfill, RSI Landfill, and the Asbestos Lagoons. The two compounds noted above are therefore assumed to be found at this AOC above PRGs. However, further evaluation may determine that this is not the case. Furthermore, the evaluations assumed that the maximum detections from the three nearby AOCs were also detected at the Contaminated Soils Area. Similarly, data from the RSI Landfill was used to characterize the Asbestos Landfill.

### 5.15.6 Implementability for Alternative #72

This section summarizes the technical and administrative feasibility of implementing Alternative #72, the "Maximum Remedial Action" alternative, and the availability of various services and materials required for its implementation.

**5.15.6.1 Technical Feasibility.** Evaluation of the technical feasibility of Alternative #72 includes an assessment of three factors described in EPA's feasibility study guidance: 1) the ability to construct and operate the technologies, 2) the reliability of the technologies and 3) the ease of undertaking additional remedial actions, if necessary. These aspects are described in detail below:

> Ability to Construct and Operate the Technologies. For Alternative #72, similar to Alternatives #8 through 67, a major implementability issue with regard to technical feasibility is the construction of landfill caps at AOCs #1, 2, and 6 and the excavation and removal of waste soil/waste fill from AOC #7 with relocation and regrading of these materials below the cap constructed at AOC # 6.
>
> As discussed previously for Alternatives #8 through 67, the capping and excavation remedies for Alternative #72 at AOCs #1, 2, 6, and 7 will require a substantial civil engineering/earthwork

component. The key implementability issue is the location of sensitive wetland areas or water bodies adjacent to every one of these AOCs. This will require comprehensive soil erosion, runoff and sedimentation control measures to minimize siltation impacts to wetland areas or water bodies. In addition, proper location and construction of temporary and permanent haul roads will be required to minimize impacts to wetland areas and water bodies. It is expected that the remediation contractor(s) will utilize the existing rail network to move equipment and materials to the largest degree possible. This rail network is closely situated to three of these AOCs (#1, 2, and 6). While the scope of the earthwork and transportation required for the capping and excavation activities is large, these are common problems faced and solved by experienced engineers and constructors. Maintenance of the capped and excavated areas is straightforward requiring only periodic inspections, vegetation control (*e.g.*, mowing) and filling of areas of settlement. As a result, no implementability constraints are expected with regard to construction and operation of the soil remedy for AOCs #1, 2, and 6 in Alternative #72.

The primary implementability concern for construction of on-site treatment using soil washing & chemical extraction for soils from AOCs #3, 4, and 5 and sediments from AOCs #8b and 8e is the limitation of excavating and replacing materials in a manner minimizing the invasive nature of the activity. At AOC #5, several measures may be required to maintain active use of the rail yard such as: temporary structural supports for tracks or roadways next to soil excavation or backfill areas, and temporary structural supports for tracks near the work zone, temporary use restrictions for affected tracks or roadways, and temporary relocation of tracks and bedding material for treatment of soils beneath rail beds. "Operational" effort will require appropriate supervisory, labor support and equipment maintenance necessary to successfully process the excavated soils using soil washing/chemical extraction. No long-term maintenance will be necessary after treated soils achieve PRGs.

Construction, operation and maintenance of the on-site groundwater remedies at AOCs #1 through 7 will need to address some key implementability issues. Drilling and installation of the groundwater extraction wells and installation of the horizontal trenches and collection piping will require careful construction coordination at AOCs #1, 2, 6, and 7. At these AOCs, well installation must occur within a narrow strip between cap installation or waste fill excavation and bordering wetlands and/or the area for installation of vertical containment (*e.g.*, slurry walls). Drilling and installation at AOCs #3, 4, and 5 must accommodate on-going on-site soil excavation and treatment activities as well as the active rail yard operations within the Contaminated Soils Area. As described above, working within AOC #5 will require temporary construction measures and cause temporary disruptions to rail yard operations. Successful operation and maintenance of the on-site physical/chemical groundwater treatment for AOCs #1 through 7 will require consistent supervisory, operational and maintenance labor support similar to that provided for other wastewater/water treatment facilities. Additional, periodic engineering and manufacturer support will also be required to troubleshoot and solve process problems and repair and replace equipment, when required. Periodic cleaning of groundwater extraction and recharge well systems is also an expected task as part of O&M. These activities are commonly solved by experienced remediation contractors and operators and should not be an implementability constraint for the groundwater remedy in this alternative.

The spot sediment excavation and stream dredging activities at AOCs #8a through 8e will need to address the following construction implementability issues: 1) installation of temporary access roads, 2) minimization of downstream siltation, 3) work limitations to seasonal low-flow periods, and 4) wetlands, streambed and pond restoration. In addition, the sediment mitigation activities at AOCs #8b and 8e will require temporary diversion of Content Brook to allow efficient "dry" sediment excavation from source areas rather than dredging. Access roads will need to be constructed along the banks adjacent to the work areas to allow transport of materials, access for construction equipment, and access for remediation personnel. Temporary silt control measures will be required to prevent downstream impacts during excavation activities. Work within the wetland, stream, and pond areas will be limited to low-flow seasonal periods (late summer/early fall). Periodic, heavy storms will require suspension of work and temporary stabilization measures if construction efforts are still in-progress. At the close of construction activities, wetlands, streambank, streambed and pond restoration activities will be required for those areas impacted by construction. The goal of the restoration will be to return these areas to the same water elevations, flow capacity and overall drainage hydrology as existed before.

On-site treatment of contaminated surface water using physical/chemical treatment will have the same implementability issues with regard to construction, operation and maintenance as discussed previously for groundwater treatment. An exception to this will be collection of surface water which will occur by direct diversion from the surface water body.

There are no implementability concerns with respect to construction or operation of monitored natural attenuation for the residual contaminated sediments at AOCs #8a through 8e and surface water at AOCs #8b, 8d, and 8e. No structures are required for construction and "operation" only requires periodic field testing, sampling and analysis.

Reliability of the Technologies. Reliability of the horizontal caps installed for AOCs #1, 2, and 6 will be considered high if normal periodic maintenance of the cap is conducted.

For on-site soil washing & chemical extraction of soils and waste fill at AOCs #3, 4, and 5, and sediments at AOCs #8b and 8e, the design is expected to define the most appropriate wash solutions and/or chemical reagents to remove contaminants and meet PRGs. Once this is achieved, the reliability of the technology is directly dependent on three factors: 1) comprehensive pre-sorting of excavated soils/waste fill sediments to remove inappropriate materials such as large boulders, metal, roots or other large debris that could interface with the process train, and 2) appropriate operational plant support, and 3) comprehensive program of analytical testing of treated materials with re-treatment of those materials that fail to meet PRGs.

The reliability of on-site groundwater and surface water treatment using physical/chemical processes will be directly proportional to the degree of the operation and maintenance support provided to the facility. Given O&M support equivalent to facilities of this type at other successful wastewater, water and groundwater treatment plants, the reliability of on-site groundwater and surface water treatment for Alternative #72 will be high.

As discussed previously for Alternatives #5 through 67, although the institutional controls which will be applied to AOCs #1 through 7 are not exactly technologies, their reliability will depend upon enforcement by the responsible agencies involved.

The reliability of monitored natural attenuation to remediate any residual sediment at AOCs #8a through 8e or surface water contamination at AOCs #8b, 8d, and 8e should be considered "high" since there is no external equipment nor treatment systems that could break down. The reliability of the technology to meet PRGs, however, should not be confused with "implementability" but is more appropriately discussed under "effectiveness." The reader is directed to the "treatment efficiency" and the "time required to remediate" discussions in Sections 5.15.4 and 5.15.5.

Ease of Undertaking Additional Remedial Actions. Applying additional remedial actions for contaminated soils contained by the caps installed at AOCs #1, 2, and 6 will be severely restricted since installation of the caps are largely permanent remediation technologies. This conclusion will also apply to excavation and removal of soils/waste fill from AOC #7 with relocation and regrading of these materials below the cap constructed for AOC #6. On-site treatment of soils from AOCs #3, 4, and 5 and sediments from AOCs #8b and 8e using soil washing/chemical extraction will also be "irreversible" remediation technologies. However, if previously treated soils and sediments did not meet PRGs, then additional on-site treatment could be applied to these media.

Additional remedial actions could be accommodated to a limited degree to modify on-site groundwater and surface water treatment using physical/chemical processes. Alternate types of coagulants or flocculants could be used to improve precipitation and removal of inorganic/metals contaminants. Alternate chemical oxidizing agents (peroxide, permanganate, ozone, etc.) could be tested in the UV/chemical oxidation system. In addition, different types or combinations of adsorbent media (activated carbon, activated alumina, etc.) could be used to improve the performance of the final, polishing adsorption step. If these modifications prove to be insufficient, then an alternate on-site treatment remedy could be constructed that could utilize the existing groundwater and surface water collection and recharge systems. The only implementability limitation is that the new groundwater remediation technologies will need to accommodate the active, working area of the Contaminated Soils Area rail yard and not require installation within the confines of previously capped AOCs #1, 2, and 6.

Additional technologies could be used in place of monitored natural attenuation of remaining contaminated sediments at AOCs #8a through 8e or surface water at AOCs #8b, 8d, and 8e without any major implementability concerns.

**5.15.6.2 Administrative Feasibility.** Evaluation of the administrative feasibility of Alternative #72 involves assessing the steps required to coordinate with other state, federal and local governmental entities. It should be noted that under Superfund, permits are not required for remediation activities, but compliance with substantive requirements is required.

The principal administrative feasibility issue with regard to Alternative #72, described previously for Alternatives #3 through 67, involves implementation of institutional controls in order to prohibit the use of groundwater. If proprietary controls are used, coordination with the individual property owners of the affected parcels, will be required. For example, implementation of a negative easement would require the property owner to convey to a third party (typically EPA) the right to limit how the landowner can use his or her property. Here the limitations would likely include prohibitions against the use of groundwater from wells on the property.

If governmental controls are used, coordination with federal, state and local government (the ATSDR, the Commonwealth of Massachusetts and/or the Town of Billerica) will be required. For example, implementation of land use restrictions may require the exercise of zoning authority by the Town of Billerica to prohibit residential development in a contaminated area, or the adoption of a building permit ordinance in the Town of Billerica requiring anyone seeking a building permit for construction activities in a particular area to be notified of contamination in the area and of any relevant management standards - such an ordinance could also be used to prohibit types of construction that would result in unacceptable exposures (e.g., excavation in areas where subsurface contamination has not been fully removed). Implementation of groundwater use restrictions may require action by the Commonwealth of Massachusetts to prohibit or limit certain uses of groundwater in particular areas, or require closing or capping of wells. Implementation of advisories may also require action by the ATSDR or Commonwealth of Massachusetts to publically issue warnings that provide notice to potential users of land, surface water or groundwater of some existing or impending risk associated with their use.

Another administrative feasibility issue for Alternative #72 involves the sediment and surface water remedies. The sediment remedies (*e.g.*, dredging, excavation and on-site treatment or disposal) conducted at AOCs #8a through 8e and the surface water remedies (collection, on-site treatment, discharge) conducted at AOCs #8b, and 8e will all require a substantial administrative component to ensure that the design, construction, and long-term maintenance are in accordance with the substantive ARAR requirements for wetland, stream, and pond areas. Appropriate lead-times will be required

during both the design and construction-phases to interact with the various agencies involved and to reach agreement on the specifics of the remedies.

The sediment remedy at Richardson Pond will further require coordination between the remediation contractor, Boston & Maine Railroad (B&M) as well as the Massachusetts Bay Transportation Authority (MBTA). This will be required since AOC #8d will be the only area of concern north of the B&M/MBTA tracks and all site access points lie south of the tracks. At a minimum, remediation vehicles will need access to use the B&M/MBTA rail right-of-way.

Due to the relative locations of the Richardson Pond Group, East Middlesex Canal Group, and the Content Brook Group, sediment remedies at AOCs #8c, 8d, and 8e and the surface water remedy at AOC #8e will need to be coordinated with the selected remedy at Operable Unit 2 of the Iron Horse Park CERCLA Site (*e.g.*, Shaffer Landfill). The OU2 remedy selected, and currently under construction, is capping of Shaffer Landfill along with construction of an upgraded landfill gas flare station. As part of the remedy, there will be construction of access roads and stormwater detention basins at various points around the landfill perimeter.

An additional administrative issue will be to reach agreement between federal, state and local agencies on the specifics of implementing the monitored natural attenuation program. Under Alternative #72, this program will address residual sediment contamination at AOCs #8a through 8e and surface water at AOCs #8b, 8d, and 8e. Concurrence among the various agencies will be required in defining the program (*e.g.*, number and type of monitoring locations, analytical/test parameters, frequency of testing, etc.) as well as interpretation of results and conclusions regarding the overall success of monitored natural attenuation.

**5.15.6.3 Availability of Services and Materials.** Evaluation of the availability of services and materials for Alternative #72 includes an assessment of three factors in accordance with EPA's feasibility study guidance: 1) the availability of treatment, storage capacity and disposal services, 2) the availability of necessary equipment and specialists, and 3) the availability of prospective technologies. These aspects are described in detail below:

Availability of TSDF Services. Since no remedial actions requiring off-site transport, storage or disposal are to be implemented as part of Alternative #72, the "Maximum Remedial Action" alternative, there are no implementability constraints with regard to this issue for selection of this alternative.

Availability of Necessary Equipment and Specialists. A substantial quantity of heavy, earthmoving equipment as well as transport vehicles (both truck and rail variety) will be required for Alternative #72 during excavation of waste soils/waste fill from AOC #7 and construction of the caps at AOCs #1, 2, and 6. The numbers of equipment and vehicles required will be proportional to the number of caps/excavations being conducted simultaneously in a given construction season.

The highest need for specialists related to soil and groundwater remediation in Alternative #72 will be for three areas: 1) specialized legal counsel/assistance for implementation of the institutional controls, 2) consultants experienced in monitored natural attenuation of surface water and sediment, and 3) engineers and contractors familiar with both civil sitework excavation and asbestos abatement. Implementation of the institutional controls is expected to be a time-consuming process but should not pose significant implementability concerns that will prevent selection of this alternative as the final remedy. Legal specialists experienced in both CERCLA and non-CERCLA sites are available to facilitate this process. Similarly, monitored natural attenuation has been a technology employed at CERCLA sites in the last 10 years and there will be a substantial number of environmental consultants with familiarity in implementing such a program. Thus, availability of consultants familiar with monitored natural attenuation should not prevent selection of this alternative as the final remedy. Engineers and contractors familiar with both civil excavation/waste removal and asbestos abatement will be required for waste soil/waste fill removal from the Asbestos Lagoons with transfer to the Asbestos Landfill. An appropriate remediation team with experienced contractors of both types could be reasonably assembled to address this concern.

The sediment and surface water remedies for Alternative #72 will require specialists and some specialized equipment. The design/remediation contractor(s) will need to include a hydrology consultant on the team who will be familiar with the regional drainage patterns. This will be needed so that the sediment and surface water remedies do not impact overall site and area drainage. An experienced wetlands contractor will be an additional and necessary member of the team for restoration of wetland, stream and pond areas impacted by construction activities. The wetlands contractor will also be expected to provide appropriate guidance on diversion of water for sediment excavation at AOCs #8b and 8e. Specialized equipment will include tracked or other low-ground pressure vehicles which resist "bogging down"during work in wetland areas of concern.

Availability of Prospective Technologies. On-site soil and sediment treatment using soil washing and chemical extraction is the only specialized technology implemented for Alternative #72. This technology may require some special chemical additives (*e.g.*, detergents) and/or chemical solvents and will require engineering/remediation specialists familiar with appropriate design and construction of this technology. Although soil washing/chemical

extraction is not as "exotic" as many innovative technologies, it will still require effort to identify and procure appropriate expertise, equipment and skilled personnel. The remedial technologies required for the on-site groundwater and surface water treatment (*e.g.*, coagulation/flocculation & precipitation, UV/chemical oxidation, and adsorption) are all commonly used in treatment of water and wastewater. Manufacturer, supplier and vendor support are readily available for all of these technologies along with comprehensive literature evaluations documenting their performance. Therefore, availability of on-site soil washing & chemical extraction technology will be the limiting factor with regard to implementability of Alternative #72.

### 5.15.7 Cost for Alternative #72

Total estimated capital cost associated with this alternative is $104.9 million. This estimate assumes a contingency of 20%. The present value of all O&M costs would be $165.0 million. This estimate assumes an inflation rate of 3%, an interest rate of 7%, and a contingency of 15%. The maximum duration of site remedial actions is assumed to be 30 years, in accordance with RI/FS guidance (U.S. EPA, 1988). Total present worth costs would therefore be $270.0 million. Detailed costs for this alternative are presented in Appendix D. The costs associated with each alternative selected for detailed evaluation are summarized in Table H-1 of Appendix H.

An analysis was performed to determine the cost savings associated with combining similar treatment processes used at different AOCs. The cost savings associated with the combination of treatment plants for on-site physical/chemical treatment (groundwater/soil and sediment wash water), on-site biological/physical/chemical treatment (surface water), and on-site soil washing/chemical extraction (soil and sediment) are approximately $79.8 million. This reduces the alternative's total costs to $190.2 million. This analysis is presented in Appendix H.

### 5.15.8 State Acceptance for Alternative #72

Acceptance of the selected, site-wide remedial alternative by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 5.15.9 Community Acceptance for Alternative #72

Acceptance of the selected, site-wide remedial alternative by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

# SECTION 6.0

# COMPARATIVE ANALYSIS OF THE REMEDIAL ALTERNATIVES

This section presents the comparative analysis of the fifteen alternatives for which detailed evaluations were completed. The comparative analysis evaluates the relative performance of each of the alternatives presented in Section 5.0 versus the nine feasibility study criteria. Advantages and disadvantages of each alternative versus the others are described in detail in the sections 6.1 through 6.9. Table 6-1 presents a summary of the comparative analysis of the fifteen alternatives for each of the nine feasibility study criteria.

Overall protection of human health and the environment and compliance with ARARs will serve as the threshold criteria that must be met by any alternative in order for it to be selected as the proposed remedy. The next five FS criteria (*e.g.*, long-term effectiveness and permanence, reduction of toxicity, mobility and volume through treatment, short-term effectiveness, implementability and cost) will differentiate between the remaining alternatives that meet the threshold criteria.

State and community acceptance are criteria that will be addressed in the ROD once formal comments on the FS report and the proposed plan have been received.

## 6.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Overall protection of human health and the environment, within the limits of the remedial action objectives defined for this feasibility study, is a key threshold criterion that must be attained by an alternative to be eligible for selection in the ROD. This section describes the overall assessment of whether each alternative achieves adequate protection of human health and the environment.

Referring to Table 6-1, Alternatives #1, 3 and 5 will not provide for the protection of either human health or the environment, while Alternatives #27, 48 and 72 will attain adequate protection of both human health and the environment. Alternatives #8, 15, 18, 31, 43, 46, 51, 59 and 67 will attain adequate protection of human health, but only approach attainment of adequate protection of the

environment, since none of these alternatives implement measures to directly remove/reduce exposure to contaminants in sediments.

### 6.1.1 Protection of Human Health

Alternatives #1, 3, and 5 will not be protective of human health, and therefore, will not meet this criterion. These alternatives will not significantly reduce or eliminate the potential for exposure of human receptors to soil (at AOCs # 3, 4, 5, 6, and 7) and groundwater (at AOCs #1 through 7) relative to baseline conditions. Alternative #1 (the "No Action" alternative) will provide for no protection of human health from either soil or groundwater exposures. Alternative #3 will partially protect human receptors from groundwater exposures through the use of institutional controls at AOCs #2, 5 and 6, while Alternative #5 will protect human receptors from groundwater exposures through the use of institutional controls at AOCs #1 through 7. Monitored natural attenuation at AOCs #1 through 7 is also a component of the groundwater remedy for Alternative #5. However, modeling conducted for this FS indicates that monitored natural attenuation will be largely ineffective for the most significant risk drivers (*i.e.*, arsenic and manganese). Since Alternatives #3 and 5 will not implement measures to contain contaminated groundwater on-site, institutional controls will only be effective at eliminating groundwater ingestion risk if placed on impacted groundwater areas in on-site as well as potentially impacted off-site locations. Neither Alternative #3 nor 5 will protect human receptors sufficiently from soil exposures at AOCs #3, 4, 5, 6, and 7. Overall risks to human health at the Site will be greatest for Alternative #1, but will remain at unacceptable levels for Alternatives #3 (due to soil and groundwater exposures) and 5 (due to soil exposures).

Alternatives #8, 15, 18, 27, 31, 43, 51, 59 and 67 will provide for overall protection of human health by significantly reducing or eliminating the potential for human exposures to soil and groundwater. For these alternatives, soil exposures at AOCs # 3, 4, 5, 6 and 7 will be effectively reduced or eliminated either through soil excavation and/or capping, or through the use of remedial technologies that efficiently prevent fugitive dust generation (solidification/stabilization, soil washing/chemical extraction, or soil flushing/enhanced biodegradation). Should the caps not be maintained, soil risk will return to baseline levels for Alternatives #18, 27, 43 and 51 which provide for excavation/capping

only. Soil risk will be slightly less for Alternatives #8, 15, 31, 59 and 67 should the caps not be maintained since the soil remedy provides for effective treatment or off-site disposal of soils for some AOCs and capping of the remaining AOCs.

These nine alternatives will also provide for the protection of human health due to on-site exposure to groundwater, primarily through the use of institutional controls. Monitored natural attenuation is a component of the groundwater remedy for these alternatives as well. However, modeling conducted for this FS indicates that monitored natural attenuation will be largely ineffective for the most significant risk drivers (*i.e.*, arsenic and manganese). Despite the fact that some of these alternatives (Alternatives #27, 43, 51, 59 and 67) provide for limited groundwater treatment as well as institutional controls, groundwater risk will return to unacceptable levels under these alternatives if the proposed institutional controls are not effectively implemented or maintained. The groundwater treatment technologies proposed for these alternatives are either not effective for all COCs present in all aquifers or are applied to groundwater at only one AOC (*e.g.*, the Contaminated Soils Area) or a limited number of AOCs. In addition, groundwater will not be adequately contained on-site under these nine alternatives. Therefore, there will be a potential risk of exposure to groundwater contaminants for off-site receptors.

The remaining alternatives (#46, 48, and 72) will also provide for overall protection of human health by significantly reducing or eliminating the potential for human exposures to soil and groundwater. For these alternatives, soil exposures at AOCs #3, 4, 5, 6 and 7 will be effectively reduced or eliminated either through soil excavation and/or capping, or through the use of on-site soil washing with chemical extraction that efficiently prevents fugitive dust generation. Should the caps not be maintained, soil risk will return to baseline levels for Alternatives #46 and 48 which provide for excavation/capping only. Soil risk will be less for Alternative #72, should the caps not be maintained, since the soil remedy provides for effective treatment of AOCs #3 and 5 and capping of AOCs #6 and 7. At AOCs #1 through 7, these three alternatives will provide the same level of protection from groundwater exposures through the use of remedial technologies which target groundwater. Groundwater risk will return to unacceptable levels under these alternatives if the proposed institutional controls are not effectively implemented or maintained since the groundwater treatment

technologies proposed for these alternatives will not be effective for all COCs present in groundwater. However, groundwater will be adequately contained on-site under these three alternatives. Therefore, the risk of exposure to groundwater contaminants for off-site receptors will be minimal.

### 6.1.2 Protection of the Environment

The "No Action" alternative (Alternative #1), Alternative #3, and Alternative #5 will not be protective of the environment, and therefore, do not meet this criterion. These alternatives will not reduce or eliminate the potential for exposure of ecological receptors relative to baseline conditions. These alternatives will not remove or reduce risk to small mammals from exposure to soils. Since the only source area to be treated is the Contaminated Soils Area in Alternative #5, the reduction in concentrations of metals in surface water are assumed to be minimal for each alternative, and therefore, there will be no reduction in risk to aquatic receptors. None of these alternatives will result in reduction of risk of exposure of benthic invertebrates to sediments since there will be no direct measures to reduce the contaminants in sediments.

Nine of the alternatives (#8, 15, 18, 31, 43, 46, 51, 59 and 67) will be partially protective of the environment, but will not fully meet RAOs and PRGs and therefore do not meet this criterion. In all nine of these alternatives, the potential for exposure of small mammals to contaminants in soil will be removed at the B&M Railroad Landfill and the B&M Railroad Locomotive Shop Disposal Areas. These alternatives will also achieve long-term reduction in exposure of aquatic receptors to surface water, but the risk to benthic invertebrates will persist.

In all nine of these alternatives, the majority of the potential source areas for metal contamination of surface water and ground water will be controlled or removed. Some of these alternatives employ treatment strategies that will allow relatively faster or more effective reduction of metals in surface water. However, since the relative amount of metal contamination in surface water that is contributed by groundwater discharge, surface water run-off, resuspension of sediments, or other sources under baseline conditions is unknown, it is not possible to distinguish the relative effectiveness of the treatment alternatives in achieving RAOs and PRGs in surface water. Therefore, all of these

alternatives are assessed as achieving long-term reduction in exposure of aquatic receptors to surface water, but the relative effectiveness of each of these alternatives is not distinguishable.

None of these nine alternatives implement measures to directly remove/reduce exposure to contaminants in sediments. The only effects on the concentration of contaminants in sediments will be dilution/dispersal through slow, natural processes and a minor reduction in the deposition of additional contamination from surface water over time. Consequently, the concentration of contaminants in sediments on-site will not be substantially reduced under these alternatives, and the risk to benthic invertebrates will persist under these nine alternatives. For exposure of benthic invertebrates, these nine alternatives do not meet this criterion.

The remaining three alternatives, Alternatives #27, 48, and 72, will be protective of the environment, since each includes controls to remove exposures to contaminants in soils, surface water and sediments. These alternatives will remove the potential for exposure of small mammals to contaminants in soil at the B&M Railroad Landfill and the B&M Locomotive Shop Disposal Areas. Similar to the nine alternatives discussed previously, the potential source areas for metal contamination of surface water and ground water will be controlled or removed by Alternatives #27, 48, and 72. These alternatives are assessed as achieving long-term reduction in exposure of aquatic receptors to surface water. In addition, more rapid reductions in surface water contaminants will be achieved by Alternatives #48 and 72, since collection and treatment of surface water will be implemented for these alternatives. Each of these three alternatives will also significantly reduce the exposure of benthic organisms to sediment contaminants by capping (Alternative #27) or dredging (Alternatives #48 and 72) open water areas of the wetlands in the three major wetland habitats.

The remedial technologies utilized by the 15 alternatives differ in the magnitude of the potential impacts on natural habitats. There will be no short-term environmental impacts from the implementation of Alternative #1. Alternatives #3 and 5 will result in temporary and minor impacts resulting from installation of fencing and monitoring wells. The impacts on natural habits will be greater for the nine "intermediate" alternatives (#8, 15, 18, 31, 43, 46, 51, 59 and 67). All of these involve construction of caps, installation of groundwater removal systems/walls, and/or excavation of

contaminated soils, in addition to monitoring wells, and in some cases, fencing. These potential impacts will be mitigated. The most significant impacts on wetland habitats will occur for Alternatives #27, 48 and 72. Each of these alternatives includes capping and/or dredging wetland sediments. The potential impacts are highest for Alternative #27, since capping in B&M Pond will result in the most extensive loss of wetland habitat and require the largest amount of mitigation.

## 6.2 COMPLIANCE WITH ARARS

Three alternatives do not attain ARARs: Alternative #1 – No Action, Alternative #3 – Limited Action, and Alternative #5 – Institutional Controls.

There are numerous federal and state regulatory requirements that may be ARAR due to the specific compounds at the Site or due to site characteristics. A summary of the chemical-specific ARARs and guidance to be considered for the Site include:

- Safe Drinking Water Act and Massachusetts Drinking Water Regulations. Federal and Massachusetts MCLs are relevant and appropriate for site groundwater. Attainment of Federal SDWA MCLs and MMCLs for inorganic and organic chemicals are set as groundwater remediation goals. Alternatives #15, 27, 31, 46, 48, 51, 59, 67, and 72 implement active groundwater remedial actions intended to attain those goals. Although the intent of these alternatives is to meet these ARARs, long-term monitoring will be necessary to determine attainment of the remediation goals. Although levels of some organic compounds in groundwater are anticipated to be reduced within a reasonable time frame, these alternatives are not anticipated to be able to attain Federal SDWA MCLs or Massachusetts Maximum Contaminant Levels for inorganic chemicals in a reasonable time frame (see the discussion on "Time to Remediate"). Remaining alternatives (#1, 3, 5, 8, and 18) do not make any advancements toward meeting this ARAR.

- Resource Conservation and Recovery Act Maximum Concentration Limits. RCRA groundwater corrective action requirements are relevant and appropriate requirements at the

point of compliance at the limit of the waste management areas. The potential for contaminants to migrate from the Site is reduced by Alternatives #15, 27, 31, 46, 48, 51, 59, 67, and 72 . Although the intent of these alternatives is to meet this ARAR, long-term monitoring will be necessary to determine attainment of the remediation goals, and it is suspected that these goals will not be met for inorganic contaminants (see the discussion on "Time to Remediate"). Monitoring will be conducted to track exposure-based limits at the point of compliance, and to verify a reduction in the migration of contaminants. Remaining alternatives do not make any advancements toward meeting this ARAR.

- Federal Water Pollution Control Act, as Amended by the Clean Water Act, Ambient Water Quality Criteria (AWQC). Freshwater acute and chronic AWQC for the protection of aquatic life are considered appropriate and relevant for site wetlands. Leachate outbreaks and surface water run-off are controlled under all alternatives except for Alternatives #1, 3, and 5. These controls will reduce the probability that AWQC may be exceeded. This ARAR is met for Alternatives #8, 15, 18, 27, 31, 43, 46, 48, 51, 59, 67, and 72.

- Clean Air Act and Massachusetts Air Pollution Control Regulations. Dust or other potential emissions that may result from excavation of waste materials are controlled under all alternatives. Because of the use of controls, there is no indication that ARARs for air would be exceeded by any of the alternatives.

- Massachusetts Groundwater Quality Standards. Actions are taken under Alternatives #15, 27, 31, 46, 48, 51, 59, 67, and 72 to attain applicable "Class I" enforcement standards. These alternatives implement remedial actions intended to attain those standards. Although the intent of these alternatives is to meet this ARAR, long-term monitoring will be necessary to determine attainment of the remediation goals, and it is suspected that these goals will not be met for inorganic contaminants (see the discussion on "Time to Remediate"). Remaining alternatives do not provide a mechanism for attaining these standards.

- Massachusetts Surface Water Quality Standards. As part of the Shawsheen River Basin, site surface waters are classified as "Class B" habitat for fish, aquatic life and wildlife, and source of treated public water supplies. Surface water quality standards are considered applicable to site surface waters. Leachate outbreaks and surface water run-off are controlled under all alternatives except for Alternatives #1, 3, and 5. These controls will reduce the probability that AWQC may be exceeded. Advances are made toward meeting this ARAR for Alternatives #8, 15, 18, 27, 31, 43, 46, 48, 51, 59, 67, and 72; monitoring of the surface waters will determine actual compliance.

- Federal Criteria and Advisories To Be Considered. In addition to the ARARs listed above, there are other important issues and advisories that will require attention prior to and during remedial activities. These criteria and advisories to be considered include:
  - *Health Advisories.* Carcinogenic and non-carcinogenic risk levels due to consumption of contaminated drinking water will be exceeded.
  - *Threshold Limit Values (TLVs).* Due to the availability of monitoring devices and controls, there is no indication that these levels would be exceeded for site remediation workers under any alternatives.

Requirements relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2) are the primary location-specific ARARs for this Site. Of the 14 alternatives with some degree of remedial action, three attain all wetlands ARARs, and another nine partially attain wetlands ARARs. The three that attain are: Alternative #27 – "Sediment Source Control", Alternative #48 – Intensive Remedial Action B", and Alternative #72 – "Maximum Remedial Action". Alternatives #8, 15, 18, 31, 43, 46, 51, 59, and 67 only partially attain Executive Order 11990, Protection of Wetlands because sediments would be allowed to remain in a degraded (contaminated) state. Although these alternatives control the source by reducing leachate outbreaks and surface water run-off, since they leave chemicals of concern in place, the location-specific ARAR would not be met. Alternatives #1, 3, and 5 do not attain any location-specific ARARs.

In addition to the chemical- and location-specific ARARs, there are over 55 federal or state regulatory requirements that may be ARAR depending on remedial actions taken at the Site. Many of these action-specific ARARs can be addressed through engineering or other controls to be taken at the Site during remediation. Alternatives #1, 3, and 5 do not attain most action-specific ARARs.

Alternatives #8,15, 18, and 31 attain all action-specific ARARs except those related to groundwater protection and corrective action. Alternatives #27, 43, 46, 48, 51, 59, 67, and 72 attain all action-specific ARARs except those related to groundwater protection. Corrective actions must be completed within a "reasonable time period." Demonstrating that the action-specific ARARs detailed below can be attained will require long-term monitoring and evaluation. In the event that these ARARs cannot be attained within an agreed-upon, designated time period, then the groundwater remedy proposed for this alternative will need to be modified by means of a Technical Impracticability (TI) Waiver and/or Explanation of Significant Difference (ESD) to the Record of Decision.

- Hazardous/Solid Waste Management – Groundwater Protection, 310 CMR 30.660-675/310 CMR 19.110 and
- Groundwater Quality Standard, 314 CMR 6.00.

The attainment of groundwater protection standards for Alternatives #8, 15, and 31, which include monitored natural attenuation at some or all AOCs, is questionable. Monitored natural attenuation is to be implemented for these alternatives through increased monitoring of site groundwater. Demonstration of this approach will need to be performed at the Site. It remains to be demonstrated if RCRA – Subpart F, Groundwater Protection Standards, Hazardous/Solid Waste Management – Groundwater Protection, and Massachusetts Groundwater Quality Standards would be attained by these alternatives.

There are three major groups of action-specific ARARs for this alternative that may not be met for every alternative. Attainment of the requirements of these three action-specific ARARs are discussed below for each alternative. Remaining action-specific ARARs not discussed are assumed to be able to be met for any alternative.

- Massachusetts Hazardous/Solid Waste Management (Applicable for AOCs #1, 2, 3, 6, and 7).

  - *Closure.* Attained by Alternatives #8, 15, 18, 27, 31, 43, 46, 48, 51, 59, 67, and 72; not attained by Alternatives #1, 3, or 5.
  - *Post-Closure.* Attained by Alternatives #8, 15, 18, 27, 31, 43, 46, 48, 51, 59, 67, and 72; not attained by Alternatives #1, 3, or 5.
  - *Groundwater Protection.* Partially attained by Alternatives #27, 43, 46, 48, 51, 59, 67, and 72; not attained by Alternatives #1, 3, 5, 8, 15, 18, or 31.
  - *Landfills.* Attained by Alternatives #8, 15, 18, 27, 31, 43, 46, 48, 51, 59, 67, and 72; not attained by Alternatives #1, 3, or 5.

## 6.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

This section summarizes the evaluation for risks remaining at the Site after RAOs have been met, and risk from management of residuals.

### 6.3.1 Magnitude of Residual Risk: Human Health

Alternative #1 will provide no long-term effectiveness and permanence and will not protect against the human health risks identified in the baseline human health risk assessment. Exposure pathways which exceed risk management criteria include inhalation of soil COCs in indoor dust by female workers and groundwater ingestion exposures at the Site.

Alternatives #3 and 5 will provide for only minimal reductions in baseline human health risks for both soil (at AOCs # 3, 5, 6 and 7) and groundwater (at AOCs #1 through 7) relative to baseline conditions. Alternative #3 will partially reduce groundwater risk through the use of institutional controls at AOCs #2, 5 and 6, while Alternative #5 will eliminate groundwater risk through the use of institutional controls at AOCs #1 through 7. However, since contaminant concentrations for the most significant risk drivers will not be substantially reduced in a reasonable time period (>200 years to achieve PRGs for arsenic and manganese) and contaminated groundwater will not be adequately contained on-site, institutional controls will only be effective at eliminating groundwater ingestion risk if maintained for long time periods (>200 years) and placed on impacted groundwater areas in on-site as well as

potentially impacted off-site locations. Residual soil risk for Alternatives #3 and 5 will continue to exceed EPA risk management criteria since significant fugitive dust emissions from one or more AOCs will continue to occur. Therefore, overall residual risks will remain at unacceptable levels for Alternatives #3 and 5.

Alternatives #8, 15, 18, 27, 31, 43, 51, 59 and 67 will provide for overall residual risks below EPA risk management criteria by significantly reducing or eliminating the potential for human exposures to soil and groundwater. For these alternatives, soil exposures at AOCs # 3, 5, 6 and 7 will be effectively reduced or eliminated either through soil excavation and/or capping, or through the use of remedial technologies that efficiently prevent fugitive dust generation (solidification/stabilization, soil washing/chemical extraction, or soil flushing/enhanced biodegradation). Should the caps not be maintained, residual risk will return to baseline levels for Alternatives #18, 27, 43 and 51 which provide for excavation/capping only. Soil residual risk will be slightly less for Alternatives #8, 15, 31, 59 and 67 should the caps not be maintained since the soil remedy provides for effective treatment or off-site disposal of soils for some AOCs and capping of the remaining AOCs.

Residual groundwater risks for these nine alternatives will be below EPA risk management criteria due to the use of institutional controls at AOCs #1 through 7. Monitored natural attenuation, selected as a component of the remedy for these nine alternatives, and additional groundwater treatment technologies applied for Alternatives #27, 43, 51, 59, and 67 will not effectively reduce COC concentrations to the levels of the PRGs within a 30-year time frame. Since contaminant concentrations for the most significant risk drivers will not be substantially reduced in a reasonable time period (>200 years to achieve PRGs for arsenic and manganese) and contaminated groundwater will not be adequately contained on-site, institutional controls will only be effective at eliminating groundwater ingestion risk if maintained for long time periods (>200 years) and placed on impacted groundwater areas in on-site as well as potentially impacted off-site locations. Therefore, there will be a potential risk of exposure to groundwater contaminants for off-site receptors.

Alternatives #46, 48, and 72 will also provide for overall residual risks below EPA risk management criteria by significantly reducing or eliminating the potential for human exposures to soil and groundwater. For these alternatives, soil exposures at AOCs #3, 4, 5, 6, and 7 will be effectively reduced or eliminated either through soil excavation and/or capping, or through the use of on-site soil washing with chemical extraction that efficiently prevents fugitive dust generation. Should the caps not be maintained, residual risk will return to baseline levels for Alternatives #46 and 48 which provide for excavation/capping only. Soil residual risk will be less for Alternative #72, should the caps not be maintained, since the soil remedy provides for effective treatment of AOCs #3, 4, and 5 and capping of AOCs #6 and 7.

Residual groundwater risks for these three alternatives will be below EPA risk management criteria due to the use of institutional controls at AOCs #1 through 7. Since the groundwater treatment technologies applied for these alternatives will not effectively reduce COC concentrations to the levels of the PRGs within a thirty-year timeframe, institutional controls will only be effective at eliminating groundwater ingestion risk if maintained for long time periods (>200 years). Residual risks will return to baseline levels if the proposed institutional controls are not effectively implemented or maintained. However, since contaminated groundwater will be largely contained on-site, residual risks to off-site receptors will be minimal.

### 6.3.2 Magnitude of Residual Risk: Ecological

Alternatives #1, 3 and 5 will not result in a quantifiable long-term reduction of risk to ecological receptors. These alternatives will not remove or reduce risk to small mammals from exposure to soils. The metals in soils are relatively immobile. Leaching will not result in a substantial reduction in total concentrations of metals in soil over time. Therefore, there will not be a significant reduction in risk to small mammal receptors at the B&M Railroad Landfill and the B&M Locomotive Shop Disposal Areas for these alternatives.

Since the only technology utilized in these alternatives is in-situ solidification/stabilization of the Contaminated Soils Area in Alternative #5, the reduction in concentrations of metals in surface water are assumed to be minimal for each alternative. Therefore, there will be no reduction in risk to aquatic receptors from exposure to metal concentrations in surface water, since there are no mechanisms employed that will reduce the source of metals relative to background conditions.

None of these three alternatives (#1, 3 or 5) will result in reduction of risk of exposure of benthic invertebrates to sediments since there will be no direct measures to reduce the contaminants in sediments. Natural processes will tend to degrade organic contaminants (PAHs, pesticides) in sediments, and disperse all the contaminants (metals, PAHs, pesticides) through resuspension of sediments, transport downstream, deposition of new material, and vertical mixing by organisms in sediment. However, these processes are slow, and the source of contaminants for additional accumulation in sediment will not be substantially reduced over time. Consequently, the reduction in concentration of contaminants resulting from natural processes will not be substantial, and the documented adverse impacts on the aquatic receptors and benthic communities will not be removed under these alternatives.

For nine of the alternatives (#8, 15, 18, 31, 43, 46, 51, 59, and 67) the risk from exposure of mammals to soils will be virtually eliminated. The risk to aquatic receptors will also be substantially reduced, however, the risk to benthic invertebrate communities in the wetlands will not be decreased measurably below baseline conditions.

In all nine of these alternatives, the potential for exposure of small mammals to contaminants in soil will be removed at the B&M Railroad Landfill and the B&M Locomotive Shop Disposal Areas. Also, in all nine of these alternatives, the majority of the potential source areas for metal contamination of surface water and ground water will be controlled or removed. Some of these alternatives employ treatment strategies that will allow relatively faster or more effective reduction of metals in surface water. However, since the relative amount of metal contamination in surface water that is contributed by groundwater discharge, surface water run-off, resuspension of sediments, or other sources under

baseline conditions is unknown, it is not possible to distinguish the relative effectiveness of the treatment alternatives in reducing concentrations of metals in surface water. Therefore, all of these alternatives are assessed as achieving long-term reduction in exposure of aquatic receptors to metals in surface water, but the relative effectiveness of each of these alternatives is not distinguishable.

None of these nine alternatives implement measures to directly remove/reduce exposure to contaminants in sediments. The only effects on the concentration of contaminants in sediments will be dilution/dispersal through slow, natural processes and a minor reduction in the deposition of additional contamination from surface water over time. Natural processes will tend to degrade organic contaminants (PAHs, pesticides) in sediments, and disperse all the contaminants (metals, PAHs, pesticides) through resuspension of sediments, transport downstream, deposition of new material, and vertical mixing by organisms in sediment. Consequently, the concentration of contaminants in sediments on site will not be substantially reduced under these alternatives, and the risk to benthic invertebrates will persist under these alternatives in Wetland Group 2, Richardson Pond Wetland Group, and Content Brook Wetland Group.

Alternatives #27, 48, and 72 employ technologies to reduce the concentration of contaminants in surface water and sediments that are not utilized by the other 12 alternatives. The long-term risks to ecological receptors from exposure to contaminants in soils will be essentially eliminated, and risks to aquatic and benthic receptors from exposure to contaminants in sediments will be substantially reduced in these three alternatives.

The mechanisms and amount of reduction in risk for these alternatives for soils will be similar to the preceding nine alternatives. These three alternatives will also remove the potential for exposure of small mammals to contaminants in soil at the B&M Railroad Landfill and the B&M Locomotive Shop Disposal Areas.

Similar to the nine alternatives discussed previously, the potential source areas for metal contamination of surface water and ground water will be controlled or removed by Alternatives #27,

48 and 72. These alternatives are assessed as achieving long-term reduction in exposure of aquatic receptors to contaminants in surface water. In addition, more rapid reductions in surface water contaminants will be achieved by Alternatives #48 and 72, since collection and treatment of surface water will be implemented for these alternatives at the Wetland 2 Group and Content Brook Wetland Group. For the portion of the surface water that will be treated for Alternatives #48 and 72, the toxicity of metals in surface water will be reduced proportional to the contaminant volume reduction (80-90%), but only a small the portion of the water will be collected and treated. Therefore, Alternatives #48 and 72 will result in a reduction of risk of aquatic receptor exposure to metals in surface water in a shorter period of time than Alternative #27, which does not employ surface water treatment.

Each of these three alternatives will also significantly reduce the exposure of benthic organisms to sediment contaminants by capping and dredging (Alternative #27), or only dredging (Alternatives #48 and 72) open water and "hot spot" areas of the wetlands in the three major wetland habitats. The open water and "hot spot" areas of the Wetland 2 Group, including the Unnamed Stream, the Fire Pond, and the B&M Pond, will be dredged or capped. The dredging or capping will result in the reduction of mobility of total PAHs, 4,4'-DDD, antimony, copper, and lead from contaminated sediments in the treated areas. The elimination of exposure of benthic invertebrates to contaminants will be achieved in these areas. However, there will be residual risk to benthic invertebrates inhabiting adjacent emergent wetlands, where concentrations of analytes will not be reduced. The overall reduction of risk to benthic invertebrates will be substantial; the amount of remaining risk is unknown since the extent of area of sediments that will continue to exceed PRGs is unknown.

Spot excavation of isolated areas of sediment with high concentrations of PAHs in Richardson Pond in each of these three alternatives, will substantially reduce risk to benthic invertebrates. Exposure of benthic invertebrates to PAHs will be eliminated in the areas of excavation. Residual risk will remain in any areas in which sediments with concentrations of PAHs exceeding the PRG of 4.5 mg/kg are not excavated. It is assumed that the majority of the sediments of the pond with total PAH concentrations

above the PRG will be removed and the exposure to PAHs will be substantially below baseline conditions for Richardson Pond.

Removing the contaminated sediments from open water and "hot spot" areas in Content Brook Wetland Group will result in elimination of exposure of benthic invertebrates in these areas. However, similar to Wetland 2 Group, there will be residual risk to benthic invertebrates inhabiting adjacent emergent wetlands, where arsenic will continue to exceed PRGs. The reduction of risk to benthic invertebrates will be substantial for all three alternatives in Content Brook Wetland.

## 6.4 REDUCTION OF TOXICITY, MOBILITY AND VOLUME THROUGH TREATMENT

This section provides a comparison of the treatment and process options selected, quantities of waste materials to be remediated, expected reductions in toxicity, mobility and volume, and residuals following treatment among all 15 alternatives. No human health or ecological risk was determined for soil at AOC #2 (RSI Landfill). Likewise, no risk was determined for surface water at AOC #8a (West Middlesex Canal Group) and AOC #8c (East Middlesex Canal Group). Therefore, reductions in toxicity, mobility and volume were not evaluated for these media at these AOCs. Whenever all AOCs are referenced within an alternative, the above mentioned AOCs (#2 for soil and #8a and 8c for surface water) are not included.

### 6.4.1 Treatment/Recycling Processes Utilized

The treatment processes to be utilized in mitigating all media range from relatively simple in-situ processes to more complex on-site treatment. Alternative #1 is the "No Action" alternative, and therefore will utilize no treatment processes.

For soil, institutional actions to be implemented at all AOCs for Alternative #3 and at AOC #7 for Alternative #5 are not considered treatment processes. Source control remedies, consisting of excavation and/or capping, will be utilized at all AOCs in Alternatives #18, 27, 43, 46, 48, and 51.

Other alternatives which will implement source control remedies at one or more AOCs include Alternatives #8, 15, 31, 59, 67, and 72. Source control remedies are not considered treatment processes. Monitored natural attenuation of soils, considered a less complex treatment, will be implemented at AOCs #1, 3, 4, and 6 for Alternative #5. More active measures, such as in-situ solidification/stabilization, enhanced biodegradation and soil flushing, and excavation with off-site treatment/disposal, will be used to mitigate soils at the highest risk-ranked AOC (#5) through Alternatives #5, 8, 15, and 31. For the purposes of this FS, it is assumed that excavation with off site treatment/disposal will include treatment of contaminated soils. Remaining soil treatment technologies to be utilized at the Site include on-site remedies consisting of solidification/stabilization and soil washing/chemical extraction processes at AOCs #3, 4, and 5 in Alternatives #59, 67, and 72.

For groundwater, institutional actions to be implemented at all AOCs under Alternative #3 are not considered treatment processes. Treatment through monitored natural attenuation will be implemented at all AOCs for Alternatives #5 and 18 and at AOC #5 for Alternative #27. Alternatives #8, 31, 43, 51, 59, and 67 will also utilize monitored natural attenuation at all AOCs except AOC #5 (#1 through 4, 6, and 7). More active remedial measures, including in-situ chemical oxidation with monitored natural attenuation and collection and treatment by either phytoremediation or physical and chemical processes, will mitigate contaminated groundwater at AOC #5 under these alternatives. In-situ chemical oxidation with monitored natural attenuation will be implemented under Alternative #15 to mitigate groundwater at AOCs #3 and 5, as well as at AOC #3 for Alternative #27. At all disposal site AOCs where contaminated groundwater can be feasibly contained (AOCs #1, 2, 4, 6, and 7), passive/reactive treatment walls and in-situ enhanced biodegradation will be expected to remediate contaminated groundwater in Alternatives #15 and 27. Groundwater at all AOCs will be collected and treated by on-site phytoremediation for Alternatives #46 and 48. Collection and treatment of groundwater at all AOCs by on-site physical and chemical processes will be implemented under Alternative #72.

Institutional actions, to be implemented at all AOCs showing ecological risk in surface water (AOCs #8b, 8d, and 8e) through Alternatives #3, 8, 18, 31, 43, 51, 59, and 67, are not considered treatment

processes. There will be no actions taken in Alternative #5 for surface water. Monitored natural attenuation will be implemented as a stand-alone treatment process at all AOCs for Alternatives #15, 27, and 46, as well as at AOC #8d for Alternatives #48 and 72. More vigorous mitigation will be implemented at both AOCs #8b and 8e under Alternatives #48 and 72, which includes collection of a portion of surface water and treatment by phytoremediation or biological, physical, and chemical processes, respectively. Monitored natural attenuation will be utilized to treat remaining surface water at AOCs #8b and 8e for Alternatives #48 and 72.

At all AOCs showing ecological risk in sediment (AOCs #8b, 8d, and 8e), as well as AOCs #8a and 8c, where future sediment toxicity testing results may result in ecological risk, institutional actions, which are not considered treatment processes, will be implemented for Alternatives #3, 8, 18, 31, 43, 51, 59, and 67. Monitored natural attenuation, which will not employ active remediation, will be implemented at AOCs #8a through 8e under Alternatives #15 and 46. Alternatives #27 and 48 will utilize source control measures consisting of excavation and/or capping of most contaminated sediments and mitigation of remaining sediments through monitored natural attenuation at all AOCs. Source control, through spot excavation and on-site disposal, with monitored natural attenuation will also be implemented at AOC #8a, 8c, and 8d under Alternative #72. Source control remedies are not considered treatment processes. The most active mitigation measures to be utilized for contaminated sediment include dry excavation/dredging with subsequent on-site soil washing and chemical extraction processes, and monitored natural attenuation of remaining sediments. These processes will be utilized to remediate contaminated sediments at AOCs #8b and 8e in Alternative #72.

### 6.4.2 Amount of Hazardous Materials to be Treated or Recycled

The amounts of waste materials to be treated or recycled is discussed below as a comparison among alternatives to evaluate whether the treatment processes within each alternative will remediate the total quantity of known contaminated media. For specific quantities of contaminated media to be treated, refer to Section 5 text and tables. As stated in Section 6.4.1, no action and institutional actions are to be utilized for all media in Alternatives #1 and 3, respectively, and various media in other alternatives.

These are not considered treatment processes and, therefore, will not be expected to treat any amount of hazardous materials. Source control remedies, such as in-situ capping and excavation with on-site disposal, are utilized to differing degrees within most alternatives. Source control remedies are not considered treatment processes.

All of the treatment processes to be implemented for mitigation of soils through all alternatives are expected to treat the total quantity of contaminated soils at each respective AOC. Soil treatment processes include monitored natural attenuation, in-situ solidification/stabilization, in-situ enhanced biodegradation and soil flushing, excavation with off-site treatment/disposal, and on-site soil washing and chemical extraction.

For groundwater, all of the contaminated groundwater (*i.e.*, overburden and bedrock) at all AOCs is expected to be treated through Alternatives #5 and 18 by monitored natural attenuation processes. Likewise, monitored natural attenuation will treat the total quantity of groundwater to be remediated at all AOCs except AOC #5 though Alternatives #8, 31, 43, 51, 59, and 67. These alternatives will employ more active measures for AOC #5. Under Alternatives #8 and 31, the amount of groundwater to be treated by in-situ chemical oxidation will be dependent on the density of the injection network. Alternatives #43, 51, 59, and 67 will implement collection and on-site treatment by either phytoremediation or physical and chemical processes for groundwater at AOC #5. The amount of groundwater collected for treatment by these on-site processes will be dependent on the use of vertical containment and the density of the collection network. Collection and treatment by phytoremediation will be utilized to treat contaminated groundwater at all AOCs in Alternatives #46 and 48. Physical and chemical processes will treat the collected groundwater under Alternative #72. The amount of overburden groundwater to be collected for treatment by either process is dependent on whether management of migration will be utilized in addition to the process. If management of migration is included in the treatment, as it will be at AOCs #1, 2, 6, and 7, slurry walls will provide vertical containment, allowing virtually all of the contaminated overburden groundwater to be captured. For Alternatives #46, 48, and 72, the amount of bedrock groundwater, as well as both overburden and bedrock groundwater at AOCs where management of migration is not utilized (AOCs #3, 4, and 5), to

be collected is dependent on the density of the groundwater collection network. Passive/reactive treatment walls will be expected to treat the total quantity of contaminated overburden groundwater at AOCs #1, 2, 4, 6, and 7 in Alternatives #15 and 27. The amount of bedrock groundwater to be treated by in-situ enhanced biodegradation at these AOCs under Alternatives #15 and 27 will be dependent on the density of the injection network. The degree of treatment of contaminated groundwater through in-situ chemical oxidation, to be implemented at AOCs #3 and 5 under Alternative #15 and AOC #3 for Alternative #27, will also be dependent on the density of the injection network. Monitored natural attenuation will be used to treat the total quantity of groundwater at AOC #5 in Alternative #27.

The total amount of surface water at all AOCs showing human health and ecological risk is expected to be treated, either by monitored natural attenuation utilized as a stand-alone process, or in conjunction with collection and active treatment, for all alternatives which include treatment processes. For Alternatives #48 and 72, at AOCs where active treatment will be utilized to mitigate a portion of the contaminated surface water, monitored natural attenuation will be utilized to remediate the remaining portions.

For all alternatives which include on-site soil washing and chemical extraction with monitored natural attenuation of lesser contaminated sediments (Alternative #72) or monitored natural attenuation as a stand-alone process (Alternatives #15 and 46), all of the contaminated sediment is expected to be remediated at all AOCs where these processes will be implemented. For Alternatives #27, 48, and 72, only non-excavated and non-open water (capped) sediments will be treated at AOCs where monitored natural attenuation will be implemented to mitigate lesser contaminated sediments. Under these alternatives the most contaminated sediments will be addressed through source control remedies.

### 6.4.3 Degree of Expected Reductions in Toxicity, Mobility or Volume

A detailed discussion of the reductions in toxicity, mobility and volume to be expected through each alternative is provided below. For the purposes of this FS in making comparisons between options, the toxicity of the contaminated media relative to a specific contaminant is assumed to be reduced

proportionally to the reduction in volume of that specific toxic contaminant provided by a given treatment technology. Therefore, this discussion will be concentrated more on volume reductions than toxicity reductions. Reductions upon completion of the remedy for all treatment processes, except monitored natural attenuation, are considered in the comparison. For the expected time until completion, refer to the Time Until Remedial Action Objectives are Achieved text in Section 5. Monitored natural attenuation reductions are provided for the 30-year default remediation time period.

Alternative #72 is expected to provide the greatest degree of reductions in toxicity, mobility, and/or volume. At AOCs #3, 4, and 5, an expected 90% to 99% of contaminants will be removed from the contaminated soils by on-site soil washing and chemical extraction processes. Soils at remaining AOCs (#1, 6, and 7) will be contained either in-situ or under an on-site cap, source control remedies that provide no treatment and thus no reductions. Groundwater at all AOCs will be collected and treated by physical and chemical processes, thereby removing and destroying approximately 92% to 99% of COCs upon completion of the groundwater remedy. Groundwater clean-up to PRGs may take substantially longer than the 30-year default remediation time period. Adsorption of contaminants to soils within the aquifer is expected to result in the inability of the groundwater collection system to capture all contaminants within the 30-year period. Management of migration methods (*e.g.*, slurry walls), to be utilized in conjunction with collection and treatment of groundwater, will limit contaminant migration outside of the AOCs where implemented.

Under Alternative #72, surface water at all AOCs will be treated by monitored natural attenuation, which will provide reductions in toxicity and volume of contaminants over time. Portions of surface water at AOCs #8b and 8e will be collected and treated by biological, physical and chemical processes, with resulting contaminant mass reductions expected to be 92% to 99%. Alternative #72 is the only alternative which includes more active treatment processes than monitored natural attenuation for contaminated sediment. Sediments excavated from AOCs #8b and 8e will be treated on-site by soil washing and chemical extraction, with expected contaminant reductions up to 90%. Monitored natural attenuation will treat remaining sediments at the Site under Alternative #72.

Alternatives #15, 46, and 48 are expected to provide substantial reductions in the toxicity, mobility and/or volume of the contaminated groundwater across the Site, and some reductions for surface water and sediment, as well. Soils will be treated by in-situ enhanced biodegradation and soil flushing at AOC #5 under Alternative #15. Resulting contaminant reductions are expected to be substantial, in the range of 70% to 100%. However, a contaminant mobility increase is expected, as soil flushing transfers contaminants from soil to groundwater. Soils at remaining AOCs (#1 through 4, 6, and 7) under Alternative #15 and all AOCs under Alternatives #46 and 48 will be addressed through source control remedies, which provide no reductions through treatment.

Collection of contaminated groundwater and treatment by phytoremediation will be utilized at all AOCs and management of migration at three AOCs by Alternatives #46 and 48. Phytoremediation is expected to remove 84% to 99% of the COCs from the groundwater upon completion of the groundwater remedy. As stated above, the capture of COCs in order to meet RAOs may not be complete within a 30-year time period. Management of migration (*e.g.*, slurry walls), to be utilized in addition to collection and treatment of groundwater, will prevent contaminant migration outside of the AOCs where implemented. Under Alternative #15, groundwater at five of the seven AOCs (#1, 2, 4, 6, and 7) will be treated in-situ by passive/reactive treatment walls and enhanced biodegradation. Contaminant reductions at these AOCs are expected to be 87% to 99% in the overburden groundwater. Organic COCs will likely be reduced by 87% to 93% in the bedrock groundwater upon completion of the groundwater remedy. At these five AOCs, contaminant mobility in the overburden groundwater will be limited to each respective AOC by treatment walls. Groundwater at remaining AOCs (#3 and 5) under Alternative #15 will be treated through in-situ chemical oxidation and monitored natural attenuation. Organic contaminant volume reductions are likely to be 94% to 99% through in-situ chemical oxidation. Inorganic contaminant volume reductions from treatment by monitored natural attenuation at AOCs #3 and 5 have been estimated at less than 16%.

Source control remedies for sediment, including excavation of open water and "hot spot" areas at all AOCs with on-site disposal to be implemented under Alternative #48 will not provide any reductions through treatment. Remaining sediments in Alternative #48, as well as all contaminated sediments in

Alternatives #15 and 46, will be mitigated though monitored natural attenuation. Surface water will be treated under Alternatives #15, 46, and 48. However, expected reductions are unknown since monitored natural attenuation will treat most of the surface waters under Alternatives #15, 46, and 48. Only a portion of the surface waters at AOCs #8b and 8e will be actively treated by phytoremediation in Alternative #48 with resulting COC volume reductions expected to be 84% to 99%.

Alternative #27 is expected to provide reductions in toxicity, mobility and/or volume similar to those of Alternatives #46 and 48. Source control remedies, to be implemented for soil at all AOCs under Alternative #27, will not provide reductions through treatment. Groundwater at five of the seven AOCs (#1, 2, 4, 6, and 7) will be treated in-situ by passive/reactive treatment walls and enhanced biodegradation. Contaminant reductions at these AOCs are expected to be 87% to 99% in the overburden groundwater. Organic COCs will likely be reduced by 87% to 93% in the bedrock groundwater upon completion of the groundwater remedy. At these five AOCs, contaminant mobility in the overburden groundwater will be limited to each respective AOC by treatment walls. Contaminated groundwater at AOC #3 will be treated through in-situ chemical oxidation and monitored natural atttenuation. Organic contaminant volume reductions are likely to be 94% to 99% through in-situ chemical oxidation. Monitored natural attenuation will provide treatment of contaminated groundwater at the remaining AOC (#5) under Alternative #27. Contaminant volume reductions resulting from monitored natural attenuation will be varied and dependent on the specific COC.

Surface water treatment will include monitored natural attenuation at all AOCs for Alternative #27. Reductions in toxicity and contaminant mass will likely result from monitored natural attenuation over time. Under Alternative #27, monitored natural attenuation will provide reductions in the volume of contaminants in non-excavated and non-open water sediments at all AOCs.

Overall, Alternatives #8, 31, 59, and 67 are expected to provide moderate reductions in toxicity, mobility and/or volume. Alternative #31 includes the most effective treatment for soil at AOC #5, excavation and disposal/treatment off-site. Removing the contaminated soil from the Site eliminates

the toxicity, mobility and volume of contaminants at the Site. Alternative #67 will implement one of the most active processes to remove contaminants from soil, on-site soil washing and chemical extraction, at three AOCs. On-site soil washing and chemical extraction processes are expected to reduce contaminant volumes by 90% to 99%. Alternative #59 will utilize on-site solidification/stabilization technologies to significantly reduce the mobility of contaminants, by 93% to 99%, at AOCs #3, 4, and 5. However, the volume of contaminated media is expected to increase by up to 100% through in-situ solidification/stabilization, and it is assumed that the volume increase from on-site processes will be similar. In-situ enhanced biodegradation and soil flushing will be utilized to treat soils at AOC #5 under Alternative #8. It is expected that enhanced biodegradation and soil flushing will remove a significant volume of contaminants. However, soil flushing increases the mobility of contaminants through transfer of contaminants from soil to groundwater.

Under Alternatives #59 and 67, groundwater at one AOC (#5) will be collected for treatment by phytoremediation and physical and chemical processes, respectively. Significant contaminant volume reductions are likely to result from both phytoremediation (84% to 99%) and physical and chemical processes (92% to 99%). However, contaminant retardation will limit the amount of contaminants removed during collection. Consideration should be given to the length of time required to achieve RAOs (Section 6.5.3). Groundwater at AOC #5 under Alternatives #8 and 31 will be treated by in-situ chemical oxidation and monitored natural attenuation. Organic contaminant volume reductions are likely to be 94% to 99% through in-situ chemical oxidation. Inorganic contaminant volume reductions from treatment by monitored natural attenuation at AOCs #3 and 5 have been estimated at less than 15%. Groundwater at the remaining AOCs will undergo monitored natural attenuation processes in Alternatives #8, 31, 59, and 67. Contaminant volume reductions resulting from monitored natural attenuation will be varied and dependent on the specific COC.

Alternatives #8, 31, 59, and 67 do not include any treatment technologies for mitigation of surface water and sediment and therefore, reductions in toxicity, mobility, and volume will not be expected.

There are very little reductions in toxicity, mobility, and/or volume expected through the implementation of Alternative #5, 43, and 51. Only one active treatment will be used at one AOC for one media under these alternatives. In-situ solidification/stabilization will be used to mitigate risks from contaminated soils at AOC #5 under Alternative #5. Substantial contaminant mobility reductions, approximately 85% to 99%, will likely result from in-situ solidification/stabilization. However, the volume of contaminated media will increase up to 100%. Monitored natural attenuation of soils will be implemented at AOCs #1, 3, and 4, and is expected to result in small reductions in toxicity and volume over a 30-year period. Institutional actions, to be implemented at AOCs #6 and 7, will not provide reductions in toxicity, mobility and volume under Alternative #5. Source control remedies, to be implemented at all AOCs under Alternatives #43 and 51, will not provide reductions through treatment.

Active groundwater treatment processes will be implemented at AOC #5 under Alternatives #43 and 51. Under Alternative #43, treatment by phytoremediation will likely result in contaminant volume reductions of 84% to 99%. Treatment by physical and chemical processes is expected to result in contaminant volume reductions of 92% to 99% under Alternative #51. However, contaminant retardation will limit the amount of contaminants removed during collection. Consideration should be given to the length of time required to achieve RAOs (Section 6.5.3). Groundwater at all AOCs under Alternative #5 and all remaining AOCs (#1 through 4, 6 and 7) under Alternatives #43 and 51 will be mitigated through monitored natural attenuation. Contaminant volume reductions resulting from monitored natural attenuation will be varied and dependent on the specific COC. No reductions will result from the implementation of institutional actions at all AOCs for surface water and sediment.

Alternative #18 will provide the smallest reductions of toxicity, mobility, and/or volume of all the alternatives which utilize treatment processes. Source control remedies, to be implemented at all AOCs to address contaminated soils, will not provide reductions through treatment. Monitored natural attenuation will treat groundwater at all AOCs and is not likely to provide considerable reductions. No treatment processes will be utilized to remediate surface water and sediment. Therefore, no reductions are expected nor will be confirmed for surface water and sediment under Alternative #18.

No treatment processes will be utilized in Alternative #1, the "No Action" alternative, and Alternative #3, the "Institutional Actions" alternative. Therefore, reductions in toxicity, mobility, and volume will not be expected or confirmed for all media under Alternatives #1 and 3.

### 6.4.4 Reversibility

Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment process. In general, active treatments (*e.g.*, soil washing and chemical extraction of soils, physical and chemical treatment of groundwater) either destroy, degrade, or remove contaminants from the media of concern, and therefore, are not reversible. Reversibility is only evaluated if the remedy to be implemented provides treatment. Therefore, reversibility is not applicable to no action, institutional actions, and source control remedies. Only two alternatives (#5 and 59) will implement treatment processes that are considered reversible.

Alternative #59 is the most reversible alternative, since it utilizes a reversible process for the treatment of contaminated soils at three AOCs (#3, 4, and 5). On-site solidification/stabilization of these soils will result in a stabilized mass that is assumed to remain on-site after treatment. This mass has the potential to weather and leach contaminants over time. Groundwater treatment processes to be implemented under Alternative #59 include monitored natural attenuation and phytoremediation, which are not considered reversible. Through monitored natural attenuation, organic contaminants are degraded over time and inorganic contaminants may only be temporarily immobilized. Phytoremediation is the uptake of contaminants by plants, a process that is not considered reversible.

Alternative #5 will implement a reversible treatment process at one AOC. In-situ solidification/ stabilization processes, to be implemented at AOC #5, are reversible, since the integrity of the stabilized material may be affected by weathering. Monitored natural attenuation, to be utilized to mitigate contaminated soils at the two remaining AOCs, as well as groundwater at all AOCs, is not considered reversible.

All other alternatives will implement treatment processes that are not considered reversible. Refer to Section 5 for further discussion on the reversibility of specific treatment processes under each alternative.

### 6.4.5 Type and Quantity of Residuals

A comparison of types and quantities of contaminant residuals expected after completion of the treatment technologies/process options for all alternatives is provided below. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are discussed briefly in the Section 5 tables titled "Quantities and Types of Hazardous Materials to be Treated and Process Residuals" and in Table 6-1, "Comparative Analysis of the Remedial Alternatives".

The least amount of contaminant residuals will result from the implementation of Alternative #72, since this alternative will utilize the most active treatment processes. Contaminant residuals in soils at AOCs #3, 4, and 5 are expected to contain only 1% to 9% of the original amount of contaminants following treatment by on-site soil washing and chemical extraction processes. Soils at the remaining AOCs (#1, 6, and 7) will remain untreated but contained either in-situ or under an on-site cap. Approximately 1% to 8% of contaminants are expected to remain in the treated groundwater from all AOCs upon completion of the groundwater remedy by collection and treatment by physical and chemical processes. Residuals are expected to be greater than 1% to 8% at the end of the 30-year default remediation time period.

For Alternative #72, expected surface water residuals from monitored natural attenuation were not quantified. However, contaminant residuals in the portion of surface water to be collected from AOCs #8b and 8e and treated by biological, physical and chemical processes will likely be 1% to 8%. Residuals in sediments excavated from AOCs #8b and 8e and treated by on-site soil washing and chemical extraction will be greater than 10% of the original contaminants. Excavated sediments from AOCs #8a, 8c, and 8d will remain untreated, but contained under an on-site cap. Significant

contaminant residuals are expected from monitored natural attenuation of non-open water and non-excavated sediments, since reductions of contaminant volumes in the sediment are expected to be low.

Overall contaminant residual amounts from the implementation of Alternatives #15, 27, 31, 46, 48, and 67 are similar, although these alternatives will not employ all of the same treatment processes, and more/less residuals may result among alternatives for a particular media. There are no soil residuals at the highest-risk ranked AOC (#5) under Alternative #31 following excavation and off-site disposal/treatment. For Alternative #67, soil contaminant residuals are expected to be minimal (1% to 9%) in the treated soils from AOCs #3, 4, and 5. Soil residuals at AOC #5 following treatment by in-situ enhanced biodegradation and soil flushing will be up to 30% of the original contaminants for Alternative #15. Inorganics will likely be transferred from soil to groundwater through soil flushing. Original soils for remaining AOCs under Alternatives #15, 31 and 67, as well as at all AOCs for Alternatives #27, 46, and 48 will remain untreated but contained under a cap.

Groundwater at all AOCs under Alternatives #46 and 48 will be collected and treated by phytoremediation. Groundwater at six of the seven AOCs will be treated in-situ by either chemical oxidation and monitored natural attenuation or passive/reactive treatment walls in Alternatives #15 and 27. Groundwater residuals from these active mitigation measures under Alternatives #27, 46, and 48 are expected to be approximately 1% to 15% upon completion of the groundwater remedy. Greater amounts will result during the interim period prior to groundwater clean-up. Groundwater residuals expected for Alternatives #31 and 67 are more significant. Residuals following monitored natural attenuation, which will mitigate groundwater at six of the seven AOCs under both alternatives, are expected to be highly variable, but in most cases, greater than 50% of the original contaminants are expected to remain after a period of 30 years. AOC #5 groundwater will undergo in-situ chemical oxidation/monitored natural attenuation for Alternatives #15 and 31. Organic residuals are expected to be 1% to 6%, while greater than 85% of inorganics will likely remain at AOC #5 for Alternatives #15 and 31. For Alternative #67, approximately 1% to 8% of all contaminants are expected to remain in the treated AOC #5 groundwater after treatment by physical and chemical processes upon completion

of the groundwater remedy. At the end of the 30-year time period, residuals for Alternative #67 are expected to be present in greater amounts than the above range.

The amount of residuals to be expected after treatment by monitored natural attenuation of surface water is unknown for Alternatives #15, 27, 46, and 48. Some surface water will be treated at AOCs #8b and 8e under Alternative #48, with expected contaminant residuals of 1% to 8%. The original contamination is expected to remain in the surface water at all AOCs for Alternatives #31 and 67, as institutional actions do not confirm contaminant reduction. Sediments at all AOCs will remain on-site, untreated and contained under a cap for Alternatives #27 and 48. Expected residuals resulting from monitored natural attenuation of sediments at all AOCs under Alternatives #15 and 46 and remaining sediments under Alternatives #27 and 48 were not quantified. For Alternatives #31 and 67, institutional actions will not provide reductions, and therefore, the original contamination in the sediment is expected to remain unchanged.

Alternatives #18, 43, and 51 are expected to result in substantial amounts of residuals for all media. Soils at all AOCs remain untreated but contained under an on-site cap for all three alternatives. Groundwater contaminant residuals at all AOCs under Alternative #18 and at six of the seven AOCs under Alternatives #43 and 51 are expected to be significant, with greater than 50% of the original volume of COCs persisting after 30 years of treatment. Groundwater at the remaining AOC, #5, will be collected for treatment by either phytoremediation or physical and chemical processes under Alternatives #43 and 51. Expected residuals upon completion of the groundwater remedy by phytoremediation and physical and chemical treatment will be in the range of 1% to 16%. Greater amounts will result during the interim period prior to this endpoint.

Institutional actions will be implemented at all AOCs for surface water and sediment under Alternatives #18, 43, and 51. Since institutional actions will not incorporate treatment processes, reductions are not anticipated and the original contamination is expected to remain at all AOCs.

Alternatives #8 and 59, which will employ very few active treatment techniques, are likely to result in sizeable residuals. Soils from five AOCs for Alternative #8 and three AOCs for Alternative #59 will remain untreated but contained under an on-site cap. In Alternative #8, AOC #5 soil residuals following treatment by in-situ enhanced biodegradation and soil flushing will include up to 30% of the original contaminants. Inorganics will be transferred to groundwater through the soil flushing process under Alternative #8. The amount of contaminated media will be increased by up to 100% following treatment by on-site solidification/stabilization processes of soils from AOCs #3, 4, and 5 under Alternative #59. Greater than 7% of organic and 1% of inorganic contaminants in these stabilized soils will have the potential to leach into the groundwater. Under both Alternatives #8 and 59, groundwater at six of the seven AOCs will be mitigated through monitored natural attenuation. Residuals at these AOCs are expected to be varied, but will generally be greater than 50% of the original contaminants. Residuals at AOC #5 following treatment by in-situ chemical oxidation and monitored natural attenuation are expected to be 1% to 6% for organic COCs and greater than 90% for inorganic COCs under Alternative #8. Approximately 1% to 16% of contaminants are expected to remain in the groundwater upon completion of the groundwater remedy at AOC #5 in Alternative #59. Greater amounts are expected to remain at the end of the 30-year remediation period.

Alternatives #8 and 59 will implement institutional actions, which do not confirm reductions, for surface water and sediment at all AOCs. Therefore, the original surface water and sediment contamination is expected to remain at all AOCs.

Alternative #5 is expected to result in the most residuals of all the alternatives which will utilize at least one treatment process. In-situ solidification/stabilization, the only active treatment process to be utilized under Alternative #5, will result in up to double the amount of contaminated media at AOC #5. Within the stabilized mass, 1% to 15% of the contaminants will have the potential to leach into groundwater. At AOCs #1, 3, and 4, most of the contaminants will remain sorbed to the soil following treatment by monitored natural attenuation. The original soil contamination is expected to remain at AOCs #6 and 7, as only institutional actions will be implemented at these AOCs under Alternative #5. Groundwater residuals resulting from monitored natural attenuation will vary. Institutional actions

will not provide contaminant reductions in surface water and sediment at all AOCs, and therefore, the original contamination is expected to remain unchanged at AOCs #8b and 8e.

No treatment processes will be utilized in Alternative #1, the "No Action" alternative, and Alternative #3, the "Institutional Actions" alternative. Therefore, the original contamination at the Site is expected to remain unchanged under these alternatives.

## 6.5 SHORT-TERM EFFECTIVENESS

The effectiveness of each remedial alternative during construction and implementation are compared to one another in the following paragraphs.

### 6.5.1 Protection of Community and Workers During Remedial Actions

Short-term risks include any additional risks to the community or workers at the Site from exposures to soil or groundwater COCs as a result of construction measures and implementation of remedial activities. There will be no additional short-term risks from exposures under Alternative #1, since this alternative involves no action at the Site.

Alternatives #3 and 5 will have nominal increases of short-term risks to the community and workers due to the installation of fencing and the requirement to perform soil and groundwater monitoring. Short-term risks will be slightly greater for Alternative #5 than Alternative #3 due to the treatment of soil at the Contaminated Soils Area by in-situ solidification/stabilization instead of fencing. Air sampling and monitoring will be used to evaluate any potential risks to the community from inhalation exposures, and engineering controls will be used to reduce any potential inhalation risks from invasive activities. Dust control measures will be used to mitigate potential soil inhalation exposures. Concentrations of COCs are expected to be greatest on-site. Therefore, workers at the Site will use appropriate PPE to mitigate any potential risks from exposures to soil or groundwater COCs.

The remaining alternatives (#8, 15, 18, 27, 31, 43, 46, 48, 51, 59, 67 and 72) will have the greatest short-term risks to the community and workers due to the inclusion of excavation and/or capping for soils as well as groundwater treatment and/or monitoring. Short-term risks may be slightly lower for Alternatives #8, 15, 18, 27, and 31 since the groundwater technology either consists of monitored natural attenuation or in-situ treatments during which worker exposures will be less than those associated with the groundwater extraction technologies included as part of the remedies for Alternatives #43, 46, 48, 51, 59, 67 and 72. Short-term soil and groundwater risks will be mitigated by a variety of measures. Air sampling and monitoring will be used to evaluate any potential risks to the community associated with invasive soil activities. Engineering controls will also be used to minimize the degree of invasive work and to mitigate potential risks from this exposure pathway. Workers will wear appropriate PPE to mitigate potential risks from increased exposures to COCs in soil and groundwater at the Site.

### 6.5.2 Environmental Impacts

The remedial technologies utilized by the 15 alternatives differ in the magnitude of the potential impacts to natural habitats. There will be no short-term habitat impacts due to remedial activities from the implementation of Alternative #1. Alternatives #3 and 5 will result in temporary and minor impacts resulting from installation of fencing and monitoring wells. The impacts to natural habits will be greater for the nine "intermediate" alternatives (#8, 15, 18, 31, 43, 46, 51, 59, and 67). All of these involve construction of caps, installation of groundwater removal systems/walls, and/or excavation of contaminated soils, in addition to monitoring wells, and in some cases, fencing. These activities will temporarily displace some resident organisms and some mortality of animals will occur during capping operations. The potential impacts to adjacent wetlands from disturbance during construction will be mitigated. Alternatives #15, 43, and 46 will also include groundwater treatment systems that could potentially affect seasonal water levels in the adjacent wetlands. Pumping rates and re-injection rates of water to wells will be implemented that are predicted, via modeling, to have minimal effects on water elevations in wetlands.

The most significant impacts to wetland habitats will occur for Alternatives #27, 48, and 72. In addition to the construction impacts for the nine alternatives discussed above, each of these alternatives include capping and/or dredging wetland sediments. The potential impacts will be highest for Alternative #27, since capping in B&M Pond will require the most extensive loss of wetland habitat and require the largest amount of mitigation (approximately 10 acres). The other two alternatives, #48 and #72, require lesser amounts of mitigation (approximately 4 acres).

### 6.5.3 Time Until Remedial Action Objectives are Achieved

Of the RAOs presented in Section 2, those for groundwater will take the longest to achieve. Within the 15 alternatives, groundwater remedial actions include monitored natural attenuation, horizontal barriers (caps), vertical barriers, treatment walls, in-situ enhanced bioremediation, in-situ chemical oxidation, and pump-and-treat technologies. Each of these actions influences the time to achieve PRGs, sometimes improving times in one AOC while increasing times in another AOC. For example, in-situ chemical oxidation may improve the time to achieve organic PRGs in one AOC, but can also change the site hydrology (due to oxidant injection) such that contaminants will not disperse as quickly at another AOC.

A summary of the estimated times until PRGs are achieved based on the groundwater modeling results described in Appendix G is presented in Table 6-1 for both overburden and bedrock. It should be noted that the only SVOC detected at the Site was bis(2-ethylhexyl) phthalate and the only pesticide was aldrin. The high retardation factors (*e.g.*, migration limiting parameters) of these compounds increase the time of travel and reduce source concentrations. Similarly, the site inorganics (manganese, arsenic, and thallium) also have high retardation factors. None of the inorganics, SVOCs (overburden only), and pesticides reach PRGs in less than the 30-year U.S. EPA default time period for remediation. It should most importantly be noted that the mobility of inorganics is highly sensitive to site-specific geochemistry. Other factors such as pH, dissolution, and colloidal transport could have significant impacts on mobility of inorganics. Therefore, these times should only be used for relative comparison and not for accurate representations of cleanup times.

From the results presented in Table 6-1, it is apparent that even in the alternatives which result in the most extensive reductions (Alternatives #46, 48, and 72), there are site COCs which will not be removed in a "reasonable" amount of time. Aldrin will persist in the overburden at the B&M Railroad Landfill. Bis(2-ethylhexyl)phthalate was detected in both flow zones at the Asbestos Lagoons and in the bedrock at the B&M Railroad Landfill. Evaluations assumed that the Contaminated Soils Area contained contaminants similar to the B&M Railroad Landfill, RSI Landfill, and the Asbestos Lagoons. The two compounds mentioned above are therefore assumed to be found at this AOC above PRGs. However, further evaluation may determine that this is not the case. Furthermore, the evaluations assumed that the maximum detections from the three nearby AOCs were also detected at the Contaminated Soils Area. This resulted in the Contaminated Soils Area never meeting PRGs in less than 30 years for any of the groupings presented above.

## 6.6 IMPLEMENTABILITY

The alternative with the highest degree of implementability would have the following characteristics from EPA's FS guidance (U.S. EPA, 1988):

- require the lowest effort to construct, operate and maintain the technologies.
- include or consist only of the highest or most reliable technologies.
- require the lowest effort to undertake additional remedial actions, if necessary.
- include the fewest administrative hurdles for obtaining necessary permits, approvals and agreements.
- rely only minimally on off-site treatment, storage and disposal facility services (TSDFs)
- require the least amount or quantity of necessary specialized equipment and/or personnel specialists.
- utilize commonly available technologies to the largest degree.

Conversely, alternatives with lesser degrees of implementability will have lesser degrees of the characteristics discussed above. The first three bullets define the "technical feasibility" with regard to implementability of the alternative, the fourth bullet defines "administrative feasibility," and the

remaining three bullets define the "availability of services and materials" with respect to the alternative. These three factors combine to provide the overall degree of implementability of the alternative. After evaluating all fifteen alternatives and combining the technical feasibility, administrative feasibility and availability of services and materials evaluations, the overall implementability comparison is as follows:

- Alternative #1 has the highest degree of overall implementability.
- Alternatives #3 and 5 are comparable in their overall high degree of implementability or high relative ease to implement.
- Alternatives #8, 18, 31, 43, 51, 59, and 67 are comparable in their overall moderate degree of implementability.
- Alternatives #15, 27, 46, 48, and 72 are comparable in their overall degree of lesser implementability or relative difficulty in implementing; of these alternatives, Alternative #72 will have the lowest degree of implementability.

In general, the more complex the remedial alternative (with respect to numbers of AOCs and contaminated media addressed), the more difficult it will be to implement, and the lesser degree of overall implementability it will have in comparison to other, less complex, alternatives. As a result, Alternative #1, the "No Action" alternative, is the most implementable and Alternative #72, the "Maximum Remedial Action" alternative, is the least implementable.

Sections 6.6.1, 6.6.2, and 6.6.3 present more detailed evaluations of the comparison of implementability characteristics of the remedial alternatives for which this analysis was performed.

### 6.6.1 Technical Feasibility

Implementability with regard to the technical feasibility of an alternative includes an evaluation of three factors: 1) ability to construct, operate and maintain the technologies, 2) the reliability of the technologies, and 3) the ease of undertaking additional remedial actions, if warranted by site conditions determined after implementation of the remedy. Each of these three factors are described for the fifteen alternatives.

The ability to construct, operate and maintain the technologies associated with each remedial alternative is proportional to the degree or intensity of each remedy. Alternatives that address all the media of concern, and more AOCs while using more intensive remedial technologies such as containment and in-situ or on-site treatments will have the greatest difficulty in implementing construction and O&M. Conversely, alternatives which address fewer media of concern, fewer AOCs, and utilize less intensive technologies such as institutional actions will be easier to implement. As a result, Alternatives #1, 3, and 5 will be the easiest to construct, operate, and maintain due to their use of either no action (Alternative #1) or use of limited actions and institutional controls. Alternatives #8, 18, 31, 43, 51, 59, and 67 will be comparable for their moderate effort required to construct, operate and maintain. These alternatives involve a mixture of focused, intensive remedial actions focused on a few AOCs or media (soil, groundwater) with the use of institutional actions or no actions at AOCs and media of lesser risk. Alternatives #15, 27, 46, 48, and 72 will be comparable in requiring higher efforts necessary to construct, operate, and maintain. This is primarily due to the addition of more remedies associated with sediments and surface water combined with a greater reliance of more intensive technologies such as in-situ and on-site treatment for contaminated soils and groundwater.

All fifteen alternatives contain remedial technologies that can be considered "reliable" in terms of relying or counting on the day-to-day functioning of the remedy as intended. This assessment is dependant on the assumption that proper construction techniques and O&M efforts are provided as appropriate to the level of the technology. Clearly, maintaining proper function of a groundwater treatment plant will require a substantial degree more effort than maintaining a site security fence. Therefore, from the point-of-view of maintaining day-to-day function, the lesser alternatives will be easier to implement and the more intensive alternatives, more difficult to implement.

In terms of achieving the remedial action objectives, however, the reliability of an alternative is proportional to the greater intensity of the remedial actions contained in the alternative. Thus, the lowest reliabilities may be expected in Alternatives #1, 3, and 5 since there is either no action occurring or there is a much greater reliance on institutional actions such as institutional controls and monitoring and in-situ remedies such as monitored natural attenuation. Alternatives #8, 18, 31, 43,

and 51 will be comparable in providing a moderate-to-high level of reliability that the remedial action objectives can be achieved. This is due to the greater usage of more intensive technologies for soil and groundwater at selected, higher risk, AOCs. Alternatives #15, 27, 46, 48, 59, 67, and 72 will offer the highest reliability due to having the highest intensity of remedial technologies and addressing the greatest number of site AOCs and media-of-concern.

The ease of undertaking additional remedial actions, if warranted by future site conditions or requirements, is also proportional to the degree or intensity of each remedy. Alternatives that address all the media of concern, and more AOCs while using more intensive remedial technologies such as containment, in-situ or on-site treatment remedies will have the greatest difficulty in undertaking and implementing additional remedial actions. Conversely, alternatives which address fewer media of concern, fewer AOCs, and utilize less intensive technologies such as institutional actions can more easily implement additional remedial actions. As a result, Alternatives #1, 3, and 5 will be the easiest to implement additional remedial actions, if necessary, due to their use of either no action (Alternative #1) or use of limited actions and institutional controls. Alternatives #8, 18, 31, 43, 51, 59, and 67 will be comparable for their moderate effort needed to implement additional, future remedial actions. These alternatives involve a mixture of intensive remedial actions focused on a few AOCs or media (soil, groundwater) but the use of institutional actions or no actions at other AOCs and media of lesser risk, at which it would be easy to implement additional remedial actions. Alternatives #15, 27, 46, 48, and 72 will be comparable in requiring higher efforts to implement additional remedial actions, if required, after the remedy has been implemented. This is due to the addition of more remedies associated with sediments and surface water combined with a greater reliance of more intensive technologies such as in-situ and on-site treatment for contaminated soils and groundwater.

### 6.6.2 Administrative Feasibility

Alternative #1, as the "No Action" alternative, has the fewest administrative hurdles to address and only requires agreement among the regulatory agencies (local, state and federal) that no remedial actions are warranted at the site. Therefore, Alternative #1 has the highest degree of administrative

feasibility. Alternatives #3, 5, 8, 15, 18, 31, 43, 46, 51, 59, and 67 have comparable, moderate degrees of administrative feasibility. All of these alternatives incorporate the use of institutional actions in the form of institutional controls prohibiting soil disturbance and/or groundwater use as well as monitoring. In addition, all of these alternatives except for Alternative #3 incorporate the use of monitored natural attenuation as part of their remedial actions. The primary administrative burdens for these alternatives will be negotiation, development, and execution of the institutional controls and regulatory agency concurrence on the particulars of the monitored natural attenuation programs.

Alternatives #27, 48, and 72 will be the most difficult to implement from an administrative feasibility point-of-view due to the higher administrative burdens associated with these remedies: 1) incorporation of institutional actions in the form of institutional controls as well as monitoring, 2) incorporation of monitored natural attenuation of sediments and surface water, and 3) the application of active sediment and/or surface water remedies that create short-term impacts to wetlands, streams, and surface water areas. The application of active remedies associated with sediments and surface water for Alternatives #27, 48, and 72 nearly doubles the administrative requirements for permits, approvals, and agreements when compared with Alternatives #3, 5, 8, 18, 31, 43, 51, 59, and 67.

### 6.6.3 Availability of Services and Materials

Implementability with regard to the availability of services and materials includes an evaluation of three factors: 1) availability or usage of off-site transport, storage, and disposal facilities (TSDFs), 2) availability of necessary or specialized equipment or specialist personnel needed to implement the alternative, and 3) availability of prospective technologies required by the alternative. Each of these three factors are described for the fifteen alternatives.

Alternatives #1, 3, 5, 8, 15, 18, 27, 43, 46, 48, 51, 59, 67, and 72 are similar in that use of off-site TSDF services are not required to treat or dispose of contaminated media-of-concern. These alternatives, therefore, will be easier to implement since reliance on an outside disposal contractor will

not be required. Alternative #31 requires the use of an off-site TSDF to treat and dispose of contaminated soils so it will have lesser implementability than the other alternatives described above.

Alternative #1 does not require any necessary, or specialized equipment nor require specialized personnel so it will have the easiest implementability. Alternatives #3, 8, 18, 31, 43, 51, 59, and 67 will all be comparable for only requiring low-to-moderate specialized and/or necessary equipment needs and specialist personnel. These relate to the following requirements: installation of fencing and security measures, procurement of specialists for implementing and evaluating monitored natural attenuation and implementing institutional controls, and heavy earthmoving equipment and expertise for civil/sitework capping and soil or waste fill excavation. Alternatives #5, 15, 27, 46, 48, and 72 will be comparable for requiring moderate-to-high levels of specialized or necessary equipment needs and/or specialist personnel. These relate to the same requirements as the low-to-moderate alternatives plus the need for engineers and contractors familiar with asbestos abatement and waste relocation, the need for hydrology consultants and wetlands restoration experts for the sediment and surface water remedies, and the use of specialized heavy equipment for the sediments and surface water remedies.

Alternatives #1, 3, 5, 8, 31, 51, and 67 will only require commonly available or typical remedial technologies and would therefore have the highest implementability. Alternatives #15, 27, 43, 46, 48, 59, and 72 would require some more unusual or innovative technologies related to innovative soil treatment technologies such as in-situ and on-site solidification/stabilization, groundwater treatment such as in-situ chemical oxidation and on-site treatment using phytoremediation, excavation and disposal or treatment of sediments and collection and treatment of surface water. As a result, these alternatives would have lesser degrees of implementability due to their greater reliance on less commonly used or innovative technologies.

## 6.7 COST

The total net present worth cost (capital plus O&M over the duration of the remedial action) for the 14 alternatives with action ranges from $38 million to $270 million. Costs for each alternative are summarized below, with further details presented in Table H-1 of Appendix H.

- Alternative #1 - total capital - $0; total O&M - $0
- Alternative #3 - total capital - $1.3 million; total O&M - $36.7 million
- Alternative #5 - total capital - $2.0 million; total O&M - $35.1 million
- Alternative #8 - total capital - $35.1 million; total O&M - $55.0 million
- Alternative #15 - total capital - $85.9 million; total O&M - $106.1 million
- Alternative #18 - total capital - $33.3 million; total O&M - $42.8 million
- Alternative #27 - total capital - $89.2 million; total O&M - $94.1 million
- Alternative #31 - total capital - $40.2 million; total O&M - $46.7 million
- Alternative #43 - total capital - $34.7 million; total O&M - $42.6 million
- Alternative #46 - total capital - $66.9 million; total O&M - $49.4 million
- Alternative #48 - total capital - $75.1 million; total O&M - $62.4 million
- Alternative #51 - total capital - $35.9 million; total O&M - $49.1 million
- Alternative #59 - total capital - $46.8 million; total O&M - $72.5 million
- Alternative #67 - total capital - $48.7 million; total O&M - $95.8 million
- Alternative #72 - total capital - $104.9 million; total O&M - $165.0 million

Alternative #72 has the highest capital and O&M costs of all evaluated alternatives. Alternatives #27 and 15 have the next highest capital costs and high O&M costs due to in-situ treatment walls.

The costs presented provide order-of-magnitude estimates which may be used to compare the relative expense of each alternative. Contingencies of 20% on capital costs and 15% on O&M costs are utilized to account for any inaccuracy of the costs. Based on the degree of accuracy of the estimates, the cost differences between some of the alternatives may not be significant. To provide a better analysis of the differences, cost sensitivities were provided as described below.

Key cost variables were tested to determine the cost sensitivity of each of the alternatives. The results of this sensitivity analysis are shown in Table H-2 of Appendix H. The variables tested include: interest rate (for net present worth estimation), inflation rate, total capital costs, and total annual (*e.g.* O&M) costs.

Variation of the interest rate was evaluated at 5 and 9%. These values are estimated to be reasonable lower and upper bounds, respectively, for long-term financial performance and reflect values above the rate of inflation. Similarly, variation of the inflation rate was evaluated at 2 and 6%.

Total capital and annual costs were varied from the base case by a +50% increase and -30% decrease. This range was selected based upon the minimum accuracy of the costs required per EPA's RI/FS guidance (U.S. EPA, 1988).

In Table H-1, "Overall" costs reflect the highest and lowest total cost of each alternative for any of the variables evaluated. Based on this, the potential sensitivity range of costs for action alternatives varies from a low case of $26.5 million (for Alternative #5) to a high value of $352.5 million (for Alternative #72).

## 6.8 STATE ACCEPTANCE

Acceptance of the selected, site-wide remedial alternative by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

## 6.9 COMMUNITY ACCEPTANCE

Acceptance of the selected, site-wide remedial alternative by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

# SECTION 7.0

# COMPARATIVE ANALYSIS OF THE REMEDIAL TECHNOLOGIES BY AOC

During detailed evaluation of alternatives, groundwater modeling was performed to determine relative times to achieve remedial action objectives (RAOs) for groundwater cleanup. The large size of the Site and the presence of multiple source areas created a complex situation to model; however, the number of monitoring wells was considered sufficient to adequately define the extent of groundwater contamination and to support development of a groundwater model. The modeling indicated that, in most cases, the times to achieve RAOs were much greater than the EPA default evaluation time period of 30 years. In many cases, the predicted remediation times were significantly greater than 200 years due to persistent contaminants which do not degrade easily or at all (*e.g.*, inorganics). As a result of these conclusions from the modeling, EPA has decided to address potential groundwater cleanup by initially performing source control measures, then monitoring groundwater and evaluating trends in the contaminant concentrations that result from those actions.

In the sections of the report that follow the modeling discussion (Section 7.1), only actions that address media other than groundwater are evaluated. A comparative analysis of the technology/process options proposed at each individual AOC is presented. The comparative analysis evaluates the relative performance of each of the technologies presented in Section 3.0 versus the nine feasibility study criteria. Advantages and disadvantages of each technology are described in detail.

Overall protection of human health and the environment and compliance with ARARs are the two threshold criteria that must be met by any technology/process option in order for it to be selected in a proposed remedy. The next five FS criteria (*i.e.*, long-term effectiveness and permanence, reduction of toxicity, mobility and volume through treatment, short-term effectiveness, implementability and cost) are used to differentiate among the remaining technologies that meet the threshold criteria. The final two criteria, State and community

acceptance, are addressed in the ROD once formal comments on the proposed plan have been received.

## 7.1 SITE GROUNDWATER MODELING DISCUSSION

As part of the detailed evaluation of alternatives, groundwater modeling was performed to evaluate relative times to reach RAOs for each remedial alternative at each AOC. The approach to the groundwater modeling was to first perform flow modeling to simulate groundwater movement through the AOCs. A particle tracking model was then applied to track the flowpath and velocity of each "particle" of contaminated groundwater as it migrated through the subsurface via advective flow. Retardation of the contaminant "particles" was accounted for by applying a pore volume flushing equation to determine the number of pore volume flushes necessary, under a particular groundwater remedial action, to reduce contaminant levels to the PRGs. A different approach was also used as a confirmation of the pore flushing results for organic contaminants under remediation scenarios with no engineered components. Natural attenuation of organic compounds was simulated using a screening level model (BIOSCREEN). This model incorporates both biodegradation and retardation and was used, for the monitored natural attenuation alternatives, to verify the relative times to reach RAOs that resulted from the pore flush calculations.

This approach of applying a groundwater flow model, a particle tracking model, a pore flushing solution, and a screening-level natural attenuation model was considered more appropriate at this step of the remediation process than applying a contaminant transport model. The effort and amount of data that would be required to develop, calibrate, and apply a contaminant transport model were judged to be too great and unnecessary to meet the goals of a feasibility study. The goal of the modeling effort was to be able to compare times to reach RAOs (estimated remediation times) at each AOC for the different proposed groundwater remedial actions, varying from monitored natural attenuation to vertical flow barriers and pump-and-treat systems. The goal was not to try to predict actual remediation times of each alternative. This latter level of

effort and detail is more appropriate for the remedial design phase, a later step in the remedial action development process.

### 7.1.1 Model Development and Use

Model development, calibration, and simulations are discussed in detail in Appendix G. To summarize, the groundwater flow model was developed using information available from the remedial investigation including boring logs, slug tests, water levels from monitoring wells and staff gauges, and stream seepage tests. The model boundaries extend beyond the boundaries of the Site, since groundwater conditions within the Site depend on the hydrogeologic characteristics of the surrounding area. The resolution of the model is greatest within the AOCs, where most of the site characterization data exists and where the most accurate simulation results are needed. Major hydrologic features such as the Middlesex Canal, the unnamed stream, and several ponds and wetlands were accounted for by using groundwater/surface water interaction modules of the model.

The model has four layers to represent the different lithological and hydrological characteristics of the glacial outwash, till, and bedrock that underlie the Site. Horizontal conductivities from field testing were applied to each layer. In general, transmissivities of the model layers were very low due to the low hydraulic conductivities and the minimal saturated thicknesses. The model was calibrated by matching model-predicted water levels to measured water levels. Model parameters, such as hydraulic conductivities of the four layers, streambed conductances, and recharge, were adjusted based on professional judgment until a suitable match with field-measured conditions was achieved. Calibration was essentially a verification step to ensure the predictive capability of the model was suitable for the intended purpose.

The calibrated model was used to perform simulations of groundwater flow at the Site under varying stresses created by the remedial actions at each of the AOCs (*i.e.*, extraction wells, injection wells, horizontal barriers, French drains, and/or capping). The groundwater flow simulations provided a groundwater flow field at each AOC. Using a separate particle-tracking

model, contaminant particles were then introduced into these flow fields at the upgradient edge of each AOC and were tracked to determine the time needed for the particles to flow through the AOC. This value is essentially the time to flush one pore volume of water through the particular AOC.

A pore volume flushing equation was then used to determine how many pore volumes would be necessary to flush through the AOC to reduce each contaminant concentration to its PRG. The number of pore volumes, multiplied by the time it takes to flush one pore volume, was considered to be the time to achieve RAOs at each AOC. This analysis assumes that there are no sources of contaminants left in the groundwater; it was assumed that the sources would be eliminated by source control measures. The pore volume flushing equation accounts for the retardation of the contaminant that would occur due to sorption to soil particles. It is considered conservative because other mechanisms such as biodegradation and dispersion, which would further attenuate the contaminant, are not simulated.

Literature values of the distribution coefficient, $K_d$, which represents adsorption to soil particles, were used for each contaminant with a PRG. Adsorption is most applicable to organic compounds, such as VOCs, SVOCs, and pesticides, because the process is primarily a function of affinity of these compounds for organic matter and, only to a lesser extent, a function of other geochemical parameters. With regard to inorganic compounds, adsorption and attenuation are very sensitive to site geochemistry (*i.e.*, pH, dissolved oxygen, oxidation/reduction potential) and cannot be modeled accurately. Therefore, the calculated remediation times for inorganic contaminants should be considered very approximate, although they are probably reasonable order-of-magnitude estimates since the inorganic compounds of concern at this Site (*i.e.*, arsenic, thallium, manganese) will likely be strongly sorbed to soil particles, based on literature values of $K_d$. Due to the assumptions/limitations discussed above, the results of pore volume flushing should only be used for the comparison of remediation times and not as actual values of remediation times, even in the case of the organic compounds.

The evaluation of monitored natural attenuation employed a screening level model, which incorporates attenuation by adsorption and biodegradation. The natural attenuation simulations were only used for relative comparison and screening purposes because 1) only a screening level model was used and 2) literature values of the decay constants that simulate biodegradation were used. Actual biodegradation rates may be highly variable in the field, based on site geochemistry and other variables such as the availability of microbes and nutrients.

### 7.1.2 Modeling Results

Using the modeling approach described above, the time to reach RAOs (remediation time) was calculated for each alternative, at each AOC, for each AOC contaminant with an associated PRG. The modeling results are presented in Table G-4 of Appendix G. The results show that the contaminants at the Site are generally very persistent. As expected, the lowest remediation times were for VOCs such as trichloroethylene (TCE), 1,2-dichloroethane, 1,1-dichloroethylene, benzene, and 1,1,2,2-tetrachloroethane. The highest remediation times were for SVOCs such as bis(2-ethylhexyl)phthalate, pesticides such as aldrin, and inorganics such as manganese, arsenic, and thallium. VOCs are typically more soluble and not as strongly adsorbed as SVOCs, pesticides, and inorganic compounds. In particular, pesticides and metals can be very strongly adsorbed to soil particles.

To illustrate the difference in adsorption of various contaminants, the relative values of the retardation factors (R) for the pore volume flushing model (which is the factor that indicates how much slower dissolved contaminants travel than groundwater, due to adsorption) can be considered. For example, the R for TCE is approximately 1.7, whereas the R for arsenic is approximately 232. This means that the attenuation of arsenic by adsorption is about 137 times greater than TCE (*i.e.*, the travel time of TCE is 137 times greater than arsenic). This also means that TCE and arsenic will travel 1.7 times and 232 times slower than groundwater, respectively. The highest R calculated for the site contaminants are for aldrin (571) and thallium (11,877). These compounds will be essentially immobile in the environment.

Most of the remediation times for SVOCs, pesticides, and inorganics are over 200 years, which is reflective of how strongly sorbed these compounds can be in the environment. The remediation times for VOCs are also quite high, but in that case the duration is due more to the low hydraulic conductivities of the soils and bedrock at the Site. The lowest remediation times were for VOCs in scenarios involving active remediation (*e.g.*, alternatives using groundwater injection and extraction to increase gradients and thereby reduce pore volume flushing times). The results of monitored natural attenuation simulations also indicated that the times to reach RAOs would be quite long, even though some degree of natural attenuation would be occurring.

The overall conclusion from the modeling is that even with active remediation, groundwater remediation to PRGs will generally require many (>30) years at each AOC. While there may be some marginal benefit to applying active remediation to remove select contaminants at certain AOCs, other compounds will persist for very long periods of time, making complete groundwater remediation in these areas impracticable within the time frame that EPA considers reasonable (about 30 years). This result, when considered with the other feasibility study evaluation results presented in Section 6, led to the decision to pursue source control measures only rather than also applying active groundwater remediation measures. The benefit of source control measures is that they could have a more immediate positive effect on groundwater by limiting or preventing the future contribution of contaminants, thus potentially limiting future contaminant migration. Unless evaluation of monitoring data shows the need, active groundwater remediation is not anticipated to be utilized.

## 7.2 B&M RAILROAD LANDFILL

Table 7-1 presents a summary of the primary evaluation factors and a comparative assessment of the technologies/process options evaluated for AOC #1, B&M Railroad Landfill. The only media of concern was soil. These technologies/process options for remediation of soil include:

- No Action;

- Inst. Action - Institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures) as well as monitoring;
- InSitu-1 - In-situ remedy of monitored natural attenuation and institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures) as well as monitoring;
- SC-1 - Source control remedy consisting of horizontal containment (*i.e.*, double-barrier cap).

It must be noted that the use of monitored natural attenuation as a remedy for contaminated soils without source containment is not recommended.

### 7.2.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment, within the limits of the remedial action objectives defined for this feasibility study, is a key threshold criterion that must be attained by an option to be eligible for selection in the ROD. This section describes the overall assessment of whether each option achieves adequate protection of human health and the environment.

**7.2.1.1 Human Health Protection.** As noted in Section 2.0, there are no human health risks due to soil at this AOC. Therefore, all actions achieve this criteria.

**7.2.1.2 Ecological Protection.** As noted in Section 2.0, there is ecological risk at this AOC due to inorganics. Of the technologies/process options evaluated, only source control through capping would be protective of the environment. The other options will not reduce or eliminate the potential for exposure of ecological receptors relative to baseline conditions because they do not remove or reduce risk to small mammals from exposure to soils.

With regard to potential impacts of remedial technologies on natural habitats, there will be no short-term environmental impacts for the No Action option. Institutional actions and monitored natural attenuation (Inst. Action and InSitu-1) will result in temporary and minor impacts resulting from installation of fencing and monitoring wells. The impacts on natural habitats will be greater for the source control option (SC-1). This involves construction of a cap in addition to monitoring wells and fencing. However, these potential impacts will be mitigated.

### 7.2.2 Compliance With ARARs

There are numerous federal and state regulatory requirements that are ARAR due to the specific compounds at the Site or due to site characteristics. Table 7-2 presents a summary of the ARARs associated with this AOC.

Primary location-specific ARARs for this AOC include requirements relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2), as well as requirements relating to historic landmarks, such as the Middlesex Canal. While this AOC is not a wetland area, these ARARs must be followed during remedial actions which may impact wetlands or are near the Middlesex Canal. Of the remedial options presented for this AOC which have some degree of remedial action, only one (SC-1) performs significant activities in neighboring wetland areas. All planned remedial actions will limit/mitigate any wetland disturbances.

For this AOC, action-specific ARARs include requirements for landfill closure and post closure (Massachusetts Hazardous Waste Management). Of the four options presented for this AOC, only one (SC-1) meets the requirements of these regulations. The remaining three options (No Action, Inst. Action, and InSitu-1) do not take steps towards landfill closure, and therefore do not attain ARARs.

### 7.2.3 Long-Term Effectiveness and Permanence

This section summarizes the evaluation for risks remaining at the Site after RAOs have been met, and for risks from management of residuals.

**7.2.3.1 Magnitude of Residual Risk: Human Health.** As noted in Section 2.0, there are no human health risks due to soil at this AOC. Therefore, there will be no residual risk remaining following the use of any noted remedial option.

**7.2.3.2 Magnitude of Residual Risk: Ecological.** Of the technologies/process options evaluated, the No Action, Inst. Action, and InSitu-1 options will not result in a quantifiable long-term reduction of risk to ecological receptors. These options will not remove or reduce risk to small mammals from exposure to soils. The metals in soils are relatively immobile. Leaching will not result in a substantial reduction in total concentrations of metals in soil over time. Therefore, there will not be a significant reduction in risk to small mammal receptors at the B&M Railroad Landfill. For the remaining capping option, SC-1, the risk from exposure of mammals to soils will be virtually eliminated.

### 7.2.4 Reduction of Toxicity, Mobility and Volume Through Treatment

This section provides a comparison of the treatment and process options selected; quantities of waste materials to be remediated; expected reductions in toxicity, mobility and volume; and residuals following treatment options.

**7.2.4.1 Treatment/Recycling Processes Utilized.** The only treatment process evaluated for mitigation of soil at AOC #1 is a relatively simple in-situ process. The No Action, Inst. Action, and SC-1 options are not considered treatment processes. Monitored natural attenuation of soils (InSitu-1), considered a less complex treatment, is evaluated below.

**7.2.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The amounts of waste materials to be treated or recycled are discussed below as an evaluation of whether the treatment processes will remediate the total quantity of known contaminated media. For specific quantities of contaminated media to be treated, refer to Section 5 text and tables.

Monitored natural attenuation implemented for mitigation of soils is expected to treat the total quantity of contaminated soils at AOC #1.

**7.2.4.3 Degree of Expected Reductions in Toxicity, Mobility or Volume.** A detailed discussion of the reductions in toxicity, mobility and volume to be expected after completion of

the treatment technologies/process options is provided below. For the purposes of this FS in making comparisons between options, the toxicity of the contaminated media relative to a specific contaminant is assumed to be reduced proportionally to the reduction in volume of that specific toxic contaminant provided by a given treatment technology. Therefore, this discussion will be concentrated more on volume reductions than toxicity reductions. Reductions upon completion of the remedy, except for monitored natural attenuation, are considered in the evaluation. Monitored natural attenuation reductions are provided for the 30-year default remediation time period.

Monitored natural attenuation of soils implemented at AOC #1 is expected to result in small reductions in toxicity and volume over a 30-year period. No treatment processes will be utilized for the No Action, Inst. Action, and SC-1 options. Therefore, reductions in toxicity, mobility, and volume will not be expected or confirmed for these options.

**7.2.4.4 Reversibility.** Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. In general, active treatments (*e.g.*, soil washing and chemical extraction of soils) either destroy, degrade, or remove contaminants from the media of concern, and therefore, are not *reversible.*

Monitored natural attenuation, the only treatment option evaluated for mitigation of contaminated soils at AOC #1, is not considered reversible, as organic contaminants are degraded over time and eventually inorganics are likely to be dispersed, although they may be temporarily immobilized.

**7.2.4.5 Type and Quantity of Residuals.** A comparison of types and quantities of residuals expected after completion of the treatment technologies/process options is provided below. The following discussion concentrates on contaminant residuals resulting from treatment. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are also discussed briefly

below, as well as in the Section 5 tables titled "Quantities and Types of Hazardous Materials to be Treated and Process Residuals." Treatment/process residuals are the basis for the comparison of the treatment technology residuals in Table 7-1.

At AOC #1, most of the contaminants will remain sorbed to the soil following treatment by monitored natural attenuation. The only treatment/process residuals expected to be produced by monitored natural attenuation are investigation-derived wastes.

No treatment processes will be utilized in the other options. Therefore, the original contamination at the AOC is expected to remain unchanged under these options.

### 7.2.5 Short-Term Effectiveness

The effectiveness of each remedial option during construction and implementation are compared to one another in the following paragraphs.

**7.2.5.1 Protection of Community and Workers During Remedial Actions.** Short-term risks include any additional risks to the community or workers at the Site from exposures to soil COCs as a result of construction measures and implementation of remedial activities. There will be no additional short-term risks from exposures under the No Action option.

The Inst. Action and InSitu-1 options will have nominal increases of short-term risks to the community and workers due to the installation of fencing and the requirement to perform soil monitoring. Air sampling and monitoring will be used to evaluate any potential risks to the community from inhalation exposures, and engineering controls will be used to reduce any potential inhalation risks from invasive activities. Dust control measures will be used to mitigate potential soil inhalation exposures. Concentrations of COCs are expected to be greatest on-site. Therefore, workers at the Site will use appropriate PPE to mitigate any potential risks from exposures to soil COCs.

The remaining option, SC-1, will have the greatest short-term risks to the community and workers due to the inclusion of capping for soils. Short-term soil risks will be mitigated by a variety of measures. Air sampling and monitoring will be used to evaluate any potential risks to the community associated with invasive soil activities. Engineering controls will also be used to minimize the degree of invasive work and to mitigate potential risks from this exposure pathway. Workers will wear appropriate PPE to mitigate potential risks from increased exposures to COCs in soil at the Site.

**7.2.5.2 Environmental Impacts.** The remedial technologies evaluated at this AOC differ in the magnitude of the potential impacts to natural habitats. There will be no short-term habitat impacts resulting from the No Action option. The Inst. Action and InSitu-1 options will result in temporary and minor impacts resulting from installation of fencing and monitoring wells. The impacts to natural habitats will be greater for the SC-1 option. This involves construction of a cap and installation of fencing. These activities will temporarily displace some resident organisms and some mortality of animals will occur during capping operations. The potential impacts to adjacent wetlands from disturbance during construction are expected to be minor and will be mitigated.

**7.2.5.3 Time Until Remedial Action Objectives are Achieved.** Of the options evaluated for this AOC, only SC-1 is expected to achieve RAOs quickly. Installation of a cap (approximately 2 years) protects ecological receptors from inorganic COC exposure. Monitored natural attenuation, as part of InSitu-1, is not expected to reduce inorganic contaminant concentrations to PRGs in less than 30 years, the EPA default evaluation time period. Similarly, the No Action and Inst. Action options perform no actions which would be expected to achieve RAOs in less than 30 years.

### 7.2.6 Implementability

The options with the highest degree of implementability would have the following characteristics from EPA's FS guidance (U.S. EPA, 1988):

- require the lowest effort to construct, operate and maintain the technologies.
- include or consist only of the highest or most reliable technologies.
- require the lowest effort to undertake additional remedial actions, if necessary.
- include the fewest administrative hurdles for obtaining necessary permits, approvals and agreements.
- rely only minimally on off-site treatment, storage and disposal facility services (TSDFs)
- require the least amount or quantity of necessary specialized equipment and/or personnel specialists.
- utilize commonly available technologies to the largest degree.

Conversely, options with lesser degrees of implementability will have lesser degrees of the characteristics discussed above. The first three bullets define the "technical feasibility" with regard to implementability of the option, the fourth bullet defines "administrative feasibility," and the remaining three bullets define the "availability of services and materials" with respect to the option. These three factors combine to provide the overall degree of implementability of the option. After evaluating all options and combining the technical feasibility, administrative feasibility and availability of services and materials evaluations, the overall implementability comparison is as follows:

- The No Action option has the highest degree of overall implementability.
- The Inst. Action and InSitu-1 options are comparable in their overall high degree of implementability or high relative ease to implement.
- The SC-1 option has an overall moderate degree of implementability.

In general, more complex remedial technologies are more difficult to implement and will have lesser degrees of overall implementability compared to other, less complex, options. As a result, the No Action option is the most implementable, and the SC-1 option, capping, is the least implementable.

Sections 7.2.6.1, 7.2.6.2, and 7.2.6.3 present more detailed evaluations of the comparison of implementability characteristics of the remedial options for which this analysis was performed.

**7.2.6.1 Technical Feasibility.** Implementability with regard to the technical feasibility of an option includes an evaluation of three factors: 1) ability to construct, operate and maintain the technologies, 2) the reliability of the technologies, and 3) the ease of undertaking additional remedial actions, if warranted by site conditions determined after implementation of the remedy. Each of these three factors is described for the options at this AOC.

The ability to construct, operate and maintain the technologies associated with each remedial option is proportional to the degree or intensity of each remedy. Options which use more intensive remedial technologies such as containment and in-situ or on-site treatments will have the greatest difficulty in implementing construction and O&M. Conversely, options which utilize less intensive technologies, such as institutional actions, will be easier to implement. As a result, the No Action, Inst. Action, and InSitu-1 options will be the easiest to construct, operate, and maintain due to their use of either no action or use of limited actions and institutional controls. The SC-1 option requires a moderate effort to construct, operate and maintain.

All options contain remedial technologies that can be considered "reliable" in terms of relying or counting on the day-to-day functioning of the remedy as intended. This assessment is dependent on the assumption that proper construction techniques and O&M efforts are provided as appropriate to the level of the technology. Clearly, maintaining a landfill cap will require a higher degree of effort than maintaining a site security fence. Therefore, from the point-of-view of maintaining day-to-day function, the lesser options (No Action, Inst. Action, and InSitu-1) will be easier to implement, and the more intensive option, SC-1, more difficult to implement.

In terms of achieving the remedial action objectives, however, the reliability of an option is proportional to the greater intensity of the remedial actions contained in the option. Thus, the lowest reliabilities may be expected in the No Action, Inst. Action, and InSitu-1 options, since

there is either no action occurring or there is a much greater reliance on institutional controls, monitoring, and in-situ remedies such as monitored natural attenuation. The SC-1 option provides a high level of reliability that the remedial action objectives can be achieved.

The ease of undertaking additional remedial actions, if warranted by future site conditions or requirements, is also proportional to the degree or intensity of each remedy. Options that use more intensive remedial technologies such as containment, in-situ or on-site treatment remedies will have the greatest difficulty in undertaking and implementing additional remedial actions. Conversely, options which utilize less intensive technologies such as institutional actions can more easily implement additional remedial actions. As a result, the No Action, Inst. Action, and InSitu-1 options will be the easiest to implement additional remedial actions, if necessary, due to their use of either no action or use of limited actions and institutional controls. The SC-1 option will require a moderate effort to implement additional, future remedial actions.

**7.2.6.2 Administrative Feasibility.** The No Action option has the fewest administrative issues to address and only requires agreement among the regulatory agencies (local, state and federal) that no remedial actions are warranted at the AOC. Therefore, this option has the highest degree of administrative feasibility. The Inst. Action, InSitu-1, and SC-1 options have comparable, moderate degrees of administrative feasibility. All of these options incorporate the use of institutional actions in the form of institutional controls prohibiting soil disturbance as well as monitoring. The primary administrative burdens for these options will be negotiation, development, and execution of institutional controls.

**7.2.6.3 Availability of Services and Materials.** Implementability with regard to the availability of services and materials includes an evaluation of three factors: 1) availability or usage of off-site treatment, storage, and disposal facilities (TSDFs), 2) availability of necessary or specialized equipment or specialist personnel needed to implement the option, and 3) availability of prospective technologies required by the option. Each of these three factors is described for the options at this AOC.

All options are similar in that use of off-site TSDF services are not required to treat or dispose of contaminated media-of-concern. These options, therefore, will be easy to implement since reliance on an outside disposal contractor will not be required.

The No Action option does not require any specialized equipment or specialized personnel, so it will have the easiest implementability. The remaining options will all be comparable for only requiring low-to-moderate specialized and/or necessary equipment needs and specialist personnel. These relate to the following requirements: installation of fencing and security measures, procurement of specialists for implementing and evaluating monitored natural attenuation and implementing institutional actions/institutional controls, and heavy earthmoving equipment and expertise for civil/sitework capping and soil or waste fill excavation.

### 7.2.7 Cost

The total net present worth costs (capital plus O&M over the duration of the remedial action) for the three options with action range from $0.28 million to $9.04 million. Costs for each option are summarized below, with further details presented in Appendix *D*.

- No Action - capital = $0; O&M = $0; total = $0
- Inst. Action - capital = $0.16 million; O&M = $0.12 million; total = $0.28 million
- InSitu-1 - capital = $0.16 million; O&M = $0.19 million; total = $0.35 million
- SC-1 - capital = $8.87 million; O&M = $0.17 million; total = $9.04 million

The costs presented provide order-of-magnitude estimates which may be used to compare the relative expense of each option. Contingencies of 20% on capital costs and 15% on O&M costs are utilized to account for any inaccuracy of the costs. Based on the degree of accuracy of the estimates, the cost differences between some of the options may not be significant.

To evaluate the impact of the soil remedial actions on groundwater quality, monitoring of groundwater will be performed for five years. The five-year timeframe should allow enough time for sufficient data collection to support a data trend evaluation and also coincides with a 5-

year review, which is required under CERCLA. Additional costs (net present worth) related to this action are summarized below, with further details presented in Appendix D.

- Groundwater Monitoring - capital = $0.06 million; O&M = $0.56 million

### 7.2.8 State Acceptance

Acceptance of the selected option for this AOC by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 7.2.9 Community Acceptance

Acceptance of the selected option for this AOC by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 7.3 RSI LANDFILL

Table 7-3 presents a summary of the primary evaluation factors and a comparative assessment of the technologies/process options evaluated for AOC #2, RSI Landfill. Risk limits were not exceeded at this AOC for soil. However, single-barrier capping (SC-1) as part of source control for groundwater has been established as a technology/process option for remediation in this area, along with the No Action option.

### 7.3.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment, within the limits of the remedial action objectives defined for this feasibility study, is a key threshold criterion that must be attained by a remedial action to be eligible for selection in the ROD. This section describes the overall

assessment of whether each process option achieves adequate protection of human health and the environment.

**7.3.1.1 Human Health Protection.** As noted in Section 2.0, there are no human health risks due to soil at this AOC. Therefore, all actions achieve this criteria.

**7.3.1.2 Ecological Protection.** As noted in Section 2.0, there are no ecological risks at this AOC due to soil. Therefore, all actions achieve this criteria.

With regard to potential impacts of remedial technologies on natural habitats, there will be no short-term environmental impacts for the No Action option. The impacts on natural habitats will be greater for the source control option (SC-1). This involves construction of a cap in addition to monitoring wells and fencing. However, these potential impacts will be mitigated.

### 7.3.2 Compliance With ARARs

There are numerous federal and state regulatory requirements that are ARAR due to the specific compounds at the Site or due to site characteristics. Table 7-4 presents a summary of the ARARs associated with this AOC.

Primary location-specific ARARs for this AOC include requirements relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2), as well as requirements relating to historic landmarks, such as the Middlesex Canal. While this AOC is not a wetland area, these ARARs must be followed for remedial actions which may impact wetlands or are near the Middlesex Canal. Of the remedial options presented for this AOC which have some degree of remedial action, only one (SC-1) performs significant activities in neighboring wetland areas. All planned remedial actions will limit/mitigate any wetland disturbances.

For this AOC, action-specific ARARs include requirements for landfill closure and post closure (Massachusetts Solid Waste Management). Of the two options presented for this AOC, only one (SC-1) meets the requirements of these regulations. The remaining option (No Action) does not take steps towards landfill closure, and therefore does not attain ARARs.

### 7.3.3 Long-Term Effectiveness and Permanence

This section summarizes the evaluation for risks remaining at the Site after RAOs have been met, and for risks from management of residuals.

**7.3.3.1 Magnitude of Residual Risk: Human Health.** As noted in Section 2.0, there are no human health risks due to soil at this AOC. Therefore, there will be no residual risk remaining following the use of any noted remedial option.

**7.3.3.2 Magnitude of Residual Risk: Ecological.** As noted in Section 2.0, there are no ecological risks due to soil at this AOC. Therefore, there will be no residual risk remaining following the use of any noted remedial option.

### 7.3.4 Reduction of Toxicity, Mobility and Volume Through Treatment

This section provides a comparison of the treatment and process options selected; quantities of waste materials to be remediated; expected reductions in toxicity, mobility and volume; and residuals following treatment options. Of the two remedial options noted for this AOC, No Action and SC-1 (capping as part of source control), neither are considered treatment processes.

**7.3.4.1 Treatment/Recycling Processes Utilized.** No treatment/recycling processes are utilized under the No Action and SC-1 options.

**7.3.4.2 Amount of Hazardous Materials to be Treated or Recycled.** No amount of hazardous materials are treated or recycled at this AOC through the No Action and SC-1 options.

**7.3.4.3 Degree of Expected Reductions in Toxicity, Mobility or Volume.** Reductions in toxicity, mobility or volume are not applicable, since the No Action and SC-1 options provide no treatment.

**7.3.4.4 Reversibility.** Reversibility of treatment is not applicable to the No Action and SC-1 options.

**7.3.4.5 Type and Quantity of Residuals.** The original contamination at this AOC is expected to remain unchanged under the No Action and SC-1 options, since no soil treatment processes will be implemented.

### 7.3.5 Short-Term Effectiveness

The effectiveness of each remedial option during construction and implementation are compared to one another in the following paragraphs.

**7.3.5.1 Protection of Community and Workers During Remedial Actions.** Short-term risks include any additional risks to the community or workers at the Site from exposures to soil COCs as a result of construction measures and implementation of remedial activities. There will be no additional short-term risks from exposures under the No Action option.

The remaining option, SC-1, will have the greatest short-term risks to the community and workers due to the inclusion of capping for soils. Short-term soil risks will be mitigated by a variety of measures. Air sampling and monitoring will be used to evaluate any potential risks to the community associated with invasive soil activities. Engineering controls will also be used to minimize the degree of invasive work and to mitigate potential risks from this exposure pathway.

Workers will wear appropriate PPE to mitigate potential risks from increased exposures to COCs in soil at the Site.

**7.3.5.2 Environmental Impacts.** The remedial technologies evaluated at this AOC differ in the magnitude of the potential impacts to natural habitats. There will be no short-term habitat impacts resulting from the No Action option. The impacts to natural habitats will be greater for the SC-1 option. This involves construction of a cap and installation of fencing. These activities will temporarily displace some resident organisms and some mortality of animals may occur during capping operations. The potential impacts to adjacent wetlands from disturbance during construction is expected to be minor and will be mitigated.

**7.3.5.3 Time Until Remedial Action Objectives are Achieved.** There are no RAOs for soil at this AOC. However, as part of source control for groundwater protection, installation of a cap is anticipated to take approximately 2 years.

### 7.3.6 Implementability

The options with the highest degree of implementability would have the following characteristics from EPA's FS guidance (U.S. EPA, 1988):

- require the lowest effort to construct, operate and maintain the technologies.
- include or consist only of the highest or most reliable technologies.
- require the lowest effort to undertake additional remedial actions, if necessary.
- include the fewest administrative hurdles for obtaining necessary permits, approvals and agreements.
- rely only minimally on off-site treatment, storage and disposal facility services (TSDFs)
- require the least amount or quantity of necessary specialized equipment and/or personnel specialists.
- utilize commonly available technologies to the largest degree.

Conversely, options with lesser degrees of implementability will have lesser degrees of the characteristics discussed above. The first three bullets define the "technical feasibility" with

regard to implementability of the option, the fourth bullet defines "administrative feasibility," and the remaining three bullets define the "availability of services and materials" with respect to the option. These three factors combine to provide the overall degree of implementability of the option. After evaluating all options and combining the technical feasibility, administrative feasibility and availability of services and materials evaluations, the overall implementability comparison is as follows:

- The No Action option has the highest degree of overall implementability.
- The SC-1 option has an overall moderate degree of implementability.

In general, more complex remedial technologies are more difficult to implement and will have lesser degrees of overall implementability compared to other, less complex, options. As a result, the No Action option is the most implementable, and the SC-1 option, capping, is the least implementable.

Sections 7.3.6.1, 7.3.6.2, and 7.3.6.3 present more detailed evaluations of the comparison of implementability characteristics of the remedial options for which this analysis was performed.

**7.3.6.1 Technical Feasibility.** Implementability with regard to the technical feasibility of an option includes an evaluation of three factors: 1) ability to construct, operate and maintain the technologies, 2) the reliability of the technologies, and 3) the ease of undertaking additional remedial actions, if warranted by site conditions determined after implementation of the remedy. Each of these three factors is described for the options at this AOC.

The ability to construct, operate and maintain the technologies associated with each remedial option is proportional to the degree or intensity of each remedy. Options which use more intensive remedial technologies such as containment and in-situ or on-site treatments will have the greatest difficulty in implementing construction and O&M. Conversely, options which utilize less intensive technologies, such as institutional actions, will be easier to implement. As a

result, the No Action option will be the easiest to construct, operate, and maintain. The SC-1 option requires a moderate effort to construct, operate, and maintain.

Both options contain remedial technologies that can be considered "reliable" in terms of relying or counting on the day-to-day functioning of the remedy as intended. This assessment is dependent on the assumption that proper construction techniques and O&M efforts are provided as appropriate to the level of the technology. Clearly, maintaining a landfill cap will require a higher degree of effort than performing no actions. Therefore, from the point-of-view of maintaining day-to-day function, the lesser option (No Action) will be easier to implement, and the more intensive option, SC-1, more difficult to implement.

In terms of achieving the remedial action objectives (source control for groundwater), however, the reliability of an option is proportional to the greater intensity of the remedial actions contained in the option. Thus, the lowest reliability may be expected in the No Action option. The SC-1 option provides a high level of reliability that the remedial action objectives can be achieved. There are no remedial action objectives for soil at this AOC.

The ease of undertaking additional remedial actions, if warranted by future site conditions or requirements, is also proportional to the degree or intensity of each remedy. Options that use more intensive remedial technologies such as containment, in-situ or on-site treatment remedies will have the greatest difficulty in undertaking and implementing additional remedial actions. Conversely, options which utilize less intensive technologies such as institutional actions can more easily implement additional remedial actions. As a result, the No Action option will be the easiest to implement additional remedial actions, if necessary. The SC-1 option will require a moderate effort to implement additional, future remedial actions.

**7.3.6.2 Administrative Feasibility.** The No Action option has the fewest administrative issues to address and only requires agreement among the regulatory agencies (local, state and federal) that no remedial actions are warranted at the AOC. Therefore, this option has the highest degree

of administrative feasibility. The SC-1 option has a moderate degree of administrative feasibility.

**7.3.6.3 Availability of Services and Materials.** Implementability with regard to the availability of services and materials includes an evaluation of three factors: 1) availability or usage of off-site treatment, storage, and disposal facilities (TSDFs), 2) availability of necessary or specialized equipment or specialist personnel needed to implement the option, and 3) availability of prospective technologies required by the option. Each of these three factors is described for the options at this AOC.

Both options are similar in that use of off-site TSDF services are not required to treat or dispose of contaminated soil. These options, therefore, will be easy to implement since reliance on an outside disposal contractor will not be required.

The No Action option does not require any specialized equipment or specialized personnel, so it will have the easiest implementability. The remaining option will only require low-to-moderate specialized and/or necessary equipment needs and specialist personnel. These relate to the following requirements: heavy earthmoving equipment and expertise for civil/sitework capping.

### 7.3.7 Cost

The total net present worth costs (capital plus O&M over the duration of the remedial action) for the source control option is $1.87 million. Costs for each option are summarized below, with further details presented in Appendix D.

- No Action - capital = $0; O&M = $0; total = $0
- SC-1 - capital = $1.84 million; O&M = $0.03 million; total = $1.87 million

The costs presented provide order-of-magnitude estimates which may be used to compare the relative expense of each option. Contingencies of 20% on capital costs and 15% on O&M costs

are utilized to account for any inaccuracy of the costs. Based on the degree of accuracy of the estimates, the cost differences between some of the options may not be significant.

To evaluate the impact of the soil remedial actions on groundwater quality, monitoring of groundwater will be performed for five years. The five-year timeframe should allow enough time for sufficient data collection to support a data trend evaluation and also coincides with a 5-year review, which is required under CERCLA. Additional costs (net present worth) related to this action are summarized below, with further details presented in Appendix D.

- Groundwater Monitoring - capital = $0.03 million; O&M = $0.59 million

### 7.3.8 State Acceptance

Acceptance of the selected option for this AOC by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 7.3.9 Community Acceptance

Acceptance of the selected option for this AOC by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 7.4 B&M LOCOMOTIVE SHOP DISPOSAL AREAS

Table 7-5 presents a summary of the primary evaluation factors and a comparative assessment of the technologies/process options evaluated for AOC #3, B&M Locomotive Shop Disposal Areas. The only media of concern was soil. These technologies/process options for remediation of soil include:

- No Action;
- Inst. Action - Institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures) as well as monitoring;
- InSitu-1 - In-situ remedy of monitored natural attenuation and institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures) as well as monitoring;
- SC-1 - Source control remedy consisting of horizontal containment (*i.e.*, single-barrier cap).
- SC-2 - Source control remedy consisting of soil/waste excavation and placement under caps at other on-site AOCs;
- OnSite-1 - Remedy consisting of soil/waste excavation and on-site treatment via solidification/stabilization;
- OnSite-2 - Remedy consisting of soil/waste excavation and on-site treatment via soil washing/chemical extraction.

It must be noted that the use of monitored natural attenuation as a remedy for contaminated soils without source containment is not recommended.

### 7.4.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment, within the limits of the remedial action objectives defined for this feasibility study, is a key threshold criterion that must be attained by a remedial action to be eligible for selection in the ROD. This section describes the overall assessment of whether each process option achieves adequate protection of human health and the environment.

**7.4.1.1 Human Health Protection.** As noted in Section 2.0, there is human health risk at this AOC due to lead in soil. The No Action, Inst. Action, and InSitu-1 options will not be protective of human health, and therefore, will not meet this criterion. These options will not significantly reduce or eliminate the potential for exposure of human receptors to soil (via fugitive dust) relative to baseline conditions. The No Action option will provide for no protection of human health from soil exposures.

The SC-1, SC-2, OnSite-1, and OnSite-2 options will provide for overall protection of human health by significantly reducing or eliminating the potential for human exposures to soil. For these options, soil exposures will be effectively reduced or eliminated either through soil excavation and capping, or through the use of remedial technologies that efficiently prevent fugitive dust generation (solidification/stabilization or soil washing/chemical extraction). For the SC-1 and SC-2 options, if the caps are not maintained, soil risk will return to baseline levels.

**7.4.1.2 Ecological Protection.** As noted in Section 2.0, there is ecological risk at this AOC due to inorganics. The No Action, Inst. Action, and InSitu-1 options will not be protective of the environment, and therefore, do not meet this criterion. These options will not reduce or eliminate the potential for exposure of ecological receptors relative to baseline conditions. These options will not remove or reduce risk to small mammals from exposure to soils. For the SC-1, SC-2, OnSite-1, and OnSite-2 options, the potential for exposure of small mammals to contaminants in soil will be removed.

With regard to potential impacts of remedial technologies on natural habitats, there will be no short-term environmental impacts for the No Action option. Institutional actions and monitored natural attenuation (Inst. Action and InSitu-1) will result in temporary and minor impacts resulting from installation of fencing. The impacts on natural habitats will be greater for the source control options (SC-1 and SC-2) and the two on-site treatment options (OnSite-1 and OnSite-2). These options involve either capping or excavation of the areas prior to either disposal or treatment. However, these potential impacts will be mitigated.

### 7.4.2 Compliance With ARARs

There are numerous federal and state regulatory requirements that are ARAR due to the specific compounds at the Site or due to site characteristics. Table 7-6 presents a summary of the ARARs associated with this AOC.

Primary location-specific ARARs for this AOC include requirements relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2). These requirements must be considered when conducting remedial actions. Of the remedial options presented for this AOC which have some degree of remedial action, four (SC-1, SC-2, OnSite-1, and OnSite-2) could potentially perform significant activities in neighboring wetland areas. All planned remedial actions will limit/mitigate any wetland disturbances.

For this AOC, action-specific ARARs include requirements for landfill closure and post closure (Massachusetts Solid Waste Management). Of the seven options presented for this AOC, four (SC-1, SC-2, OnSite-1, and OnSite-2) meet the requirements of these regulations. The remaining three options (No Action, Inst. Action, and InSitu-1) do not take steps towards landfill closure, and therefore do not attain ARARs. Additionally, requirements relating to the discharge of soil washing water (OnSite-2), to either groundwater or surface water, will be met.

### 7.4.3 Long-Term Effectiveness and Permanence

This section summarizes the evaluation for risks remaining at the Site after RAOs have been met, and for risks from management of residuals.

**7.4.3.1 Magnitude of Residual Risk: Human Health.** The No Action option will provide no long-term effectiveness and permanence and will not protect against the human health risks identified in the baseline human health risk assessment. The exposure pathway which exceeds risk management criteria is inhalation of soil COCs in indoor dust by female workers.

The Inst. Action and InSitu-1 options will provide for only minimal reductions in baseline human health risks for soil at this AOC relative to baseline conditions. Residual soil risk will continue to exceed EPA risk management criteria since significant fugitive dust emissions will continue to occur. Therefore, overall residual risks will remain at unacceptable levels.

The SC-1, SC-2, OnSite-1, and OnSite-2 options will provide for overall residual risks below EPA risk management criteria by significantly reducing or eliminating the potential for human exposures to soil. For these options, soil exposures will be effectively reduced or eliminated either through capping, soil excavation and capping, or through the use of remedial technologies that efficiently prevent fugitive dust generation (solidification/stabilization or soil washing/chemical extraction). For the SC-1 and SC-2 options, the caps must be maintained or residual risk will return to baseline levels.

**7.4.3.2 Magnitude of Residual Risk: Ecological.** Of the technologies/process options evaluated, the No Action, Inst. Action, and InSitu-1 options will not result in a quantifiable long-term reduction of risk to ecological receptors. These options will not remove or reduce risk to small mammals from exposure to soils. The metals in soils are relatively immobile. Leaching will not result in a substantial reduction in total concentrations of metals in soil over time. Therefore, there will not be a significant reduction in risk to small mammal receptors at the B&M Locomotive Shop Disposal Areas. For the remaining options (SC-1, SC-2, OnSite-1, and OnSite-2), the risk from exposure of mammals to soils will be virtually eliminated.

### 7.4.4 Reduction of Toxicity, Mobility and Volume Through Treatment

This section provides a comparison of the treatment and process options selected; quantities of waste materials to be remediated; expected reductions in toxicity, mobility and volume; and residuals following treatment options.

**7.4.4.1 Treatment/Recycling Processes Utilized.** Treatment processes evaluated for mitigation of soil at AOC #3 include monitored natural attenuation (InSitu-1), solidification/stabilization (OnSite-1), and soil washing/chemical extraction (OnSite-2). The No Action , Inst. Action, SC-1, and SC-2 options are not considered treatment processes.

**7.4.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The amounts of waste materials to be treated or recycled are discussed below as an evaluation of whether the treatment processes will remediate the total quantity of known contaminated media. For specific quantities of contaminated media to be treated, refer to Section 5 text and tables.

Monitored natural attenuation (InSitu-1), solidification/stabilization (OnSite-1), and soil washing/chemical extraction (OnSite-2) to be implemented for mitigation of soils are expected to treat the total quantity of contaminated soils at AOC #3.

**7.4.4.3 Degree of Expected Reductions in Toxicity, Mobility or Volume.** A detailed discussion of the reductions in toxicity, mobility and volume to be expected from treatment options is provided below. For the purposes of this FS in making comparisons between options, the toxicity of the contaminated media relative to a specific contaminant is assumed to be reduced proportionally to the reduction in volume of that specific toxic contaminant provided by a given treatment technology. Therefore, this discussion will be concentrated more on volume reductions than toxicity reductions. Reductions upon completion of the remedy, except for monitored natural attenuation, are considered in the evaluation. Monitored natural attenuation reductions are provided for the 30-year default remediation time period.

Soil washing/chemical extraction processes (OnSite-2) are expected to provide the greatest degree of reductions in toxicity, mobility, and/or volume of the treatment processes to be implemented to mitigate the contaminated soils at AOC #3. The volume of contaminants is expected to be reduced by 90% to 99% through the implementation of OnSite-2. There is no expected contaminant mobility decrease through on-site soil washing/chemical extraction processes.

Excavation and on-site solidification/stabilization (OnSite-1) is expected to reduce the mobility of contaminants by 93% to 99%. However, the volume of contaminants and the toxicity of the

contaminated media will not be reduced and the volume of contaminated media may be increased by up to 100% through implementation of OnSite-1.

Monitored natural attenuation (InSitu-1) of soils implemented at AOC #3 is expected to result in small reductions in toxicity and volume over a 30-year period.

No treatment processes will be utilized for the No Action, Inst. Action, SC-1, and SC-2 options. Therefore, reductions in toxicity, mobility, and volume will not be expected or confirmed for these options.

**7.4.4.4 Reversibility.** Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. In general, active treatments (*e.g.*, soil washing and chemical extraction of soils) either destroy, degrade, or remove contaminants from the media of concern, and therefore, are not reversible.

Solidification/stabilization processes (OnSite-1) are considered reversible. These processes result in a stabilized mass that has the potential to weather and leach contaminants over time. As stated above, soil washing/chemical extraction processes (OnSite-2) are not considered reversible, since contaminants are removed from the soil. Monitored natural attenuation (InSitu-1) is also not considered reversible, as organic contaminants are degraded over time and eventually inorganics are likely to be dispersed, although they may be temporarily immobilized.

**7.4.4.5 Type and Quantity of Residuals.** A comparison of types and quantities of residuals expected after completion of the treatment technologies/process options is provided below. The following discussion concentrates on contaminant residuals resulting from treatment. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are also discussed briefly below, as well as in the Section 5 tables titled "Quantities and Types of Hazardous Materials to

be Treated and Process Residuals." Treatment/process residuals are the basis for the comparison of the treatment technology residuals in Table 7-5.

Of the soil treatment processes to be implemented at AOC #3, soil washing/chemical extraction processes (OnSite-2) will likely result in the least amount of contaminant residuals, however, treatment/process residuals, including spent washing/extraction solvent, will be generated. Only 1% to 9% of the original volume of contaminants are expected to remain in the treated soils. Significant contaminant residuals are likely to result from monitored natural attenuation (InSitu-1), since reductions of contaminant volumes in the soil are expected to be low. The only treatment/process residuals expected to be produced by monitored natural attenuation are investigation-derived wastes. The greatest amount of residuals are expected to result from solidification/stabilization processes (OnSite-1). Through OnSite-1, the amount of contaminated media may increase up to 100%. All of the original contaminants will remain in the stabilized mass, with greater than 7% of organic and 1% of inorganic contaminants in these stabilized soils having the potential to leach into groundwater.

No treatment processes will be utilized in the No Action, Inst. Action, SC-1, and SC-2 options. Therefore, the original contamination at the AOC is expected to remain unchanged at AOC #3 under these options.

### 7.4.5 Short-Term Effectiveness

The effectiveness of each remedial option during construction and implementation are compared to one another in the following paragraphs.

**7.4.5.1 Protection of Community and Workers During Remedial Actions.** Short-term risks include any additional risks to the community or workers at the Site from exposures to soil COCs as a result of construction measures and implementation of remedial activities. There will be no additional short-term risks from exposures under the No Action option.

The Inst. Action and InSitu-1 options will have nominal increases of short-term risks to the community and workers due to the installation of fencing and the requirement to perform soil monitoring. Air sampling and monitoring will be used to evaluate any potential risks to the community from inhalation exposures, and engineering controls will be used to reduce any potential inhalation risks from invasive activities. Dust control measures will be used to mitigate potential soil inhalation exposures. Concentrations of COCs are expected to be greatest on-site. Therefore, workers at the Site will use appropriate PPE to mitigate any potential risks from exposures to soil COCs.

The remaining options, SC-1, SC-2, OnSite-1, and OnSite-2, will have the greatest short-term risks to the community and workers due to the inclusion of either capping or the excavation of soils, followed by either capping or treatment. Short-term soil risks will be mitigated by a variety of measures. Air sampling and monitoring will be used to evaluate any potential risks to the community associated with invasive soil activities. Engineering controls will also be used to minimize the degree of invasive work and to mitigate potential risks from this exposure pathway. Workers will wear appropriate PPE to mitigate potential risks from increased exposures to COCs in soil at the Site.

**7.4.5.2 Environmental Impacts.** The remedial technologies evaluated at this AOC differ in the magnitude of the potential impacts to natural habitats. There will be no short-term habitat impacts resulting from the No Action option. The Inst. Action and InSitu-1 options will result in temporary and minor impacts resulting from installation of fencing. The impacts to natural habitats will be greater for the SC-1, SC-2, OnSite-1, and OnSite-2 options. These involve excavation of the disposal areas and will temporarily displace some resident organisms, thereby potentially causing some mortality of animals during operations. The potential impacts to adjacent wetlands from disturbance during construction are expected to be moderate and will be mitigated.

**7.4.5.3 Time Until Remedial Action Objectives are Achieved.** Of the options evaluated for this AOC, SC-1, SC-2, OnSite-1, and OnSite-2 are expected to achieve RAOs quickly when compared to No Action, Inst. Action, and InSitu-1. Either capping or excavation followed by either capping or treatment is expected to take 2 to 3 years. Monitored natural attenuation, as part of InSitu-1, is not expected to reduce inorganic contaminant concentrations to PRGs in less than 30 years, the EPA default evaluation time period. Similarly, the No Action and Inst. Action options perform no actions which would be expected to achieve RAOs in less than 30 years.

### 7.4.6 Implementability

The options with the highest degree of implementability would have the following characteristics from EPA's FS guidance (U.S. EPA, 1988):

- require the lowest effort to construct, operate and maintain the technologies.
- include or consist only of the highest or most reliable technologies.
- require the lowest effort to undertake additional remedial actions, if necessary.
- include the fewest administrative hurdles for obtaining necessary permits, approvals and agreements.
- rely only minimally on off-site treatment, storage and disposal facility services (TSDFs)
- require the least amount or quantity of necessary specialized equipment and/or personnel specialists.
- utilize commonly available technologies to the largest degree.

Conversely, options with lesser degrees of implementability will have lesser degrees of the characteristics discussed above. The first three bullets define the "technical feasibility" with regard to implementability of the option, the fourth bullet defines "administrative feasibility," and the remaining three bullets define the "availability of services and materials" with respect to the option. These three factors combine to provide the overall degree of implementability of the option. After evaluating all options and combining the technical feasibility, administrative feasibility and availability of services and materials evaluations, the overall implementability comparison is as follows:

- The No Action option has the highest degree of overall implementability.
- The Inst. Action and InSitu-1 options are comparable in their overall high degree of implementability or high relative ease to implement.
- The SC-1 and SC-2 options have an overall moderate degree of implementability.
- The OnSite-1 and OnSite-2 options are comparable in their overall degree of lesser implementability or relative difficulty in implementing.

In general, more complex remedial technologies are more difficult to implement and will have lesser degrees of overall implementability compared to other, less complex, options. As a result, the No Action option is the most implementable, and the OnSite-1 and OnSite-2 options, are the least implementable.

Sections 7.4.6.1, 7.4.6.2, and 7.4.6.3 present more detailed evaluations of the comparison of implementability characteristics of the remedial options for which this analysis was performed.

**7.4.6.1 Technical Feasibility.** Implementability with regard to the technical feasibility of an option includes an evaluation of three factors: 1) ability to construct, operate and maintain the technologies, 2) the reliability of the technologies, and 3) the ease of undertaking additional remedial actions, if warranted by site conditions determined after implementation of the remedy. Each of these three factors is described for the options at this AOC.

The ability to construct, operate and maintain the technologies associated with each remedial option is proportional to the degree or intensity of each remedy. Options which use more intensive remedial technologies such as containment and in-situ or on-site treatments will have the greatest difficulty in implementing construction and O&M. Conversely, options which utilize less intensive technologies, such as institutional actions, will be easier to implement. As a result, the No Action, Inst. Action, and InSitu-1 options will be the easiest to construct, operate, and maintain due to their use of either no action or use of limited actions and institutional controls. The SC-1 and SC-2 options require a moderate effort to construct, operate and maintain, while the OnSite-1 and OnSite-2 options require the highest effort. This is primarily due to the addition of and greater reliance on more intensive technologies such as on-site treatment for contaminated soils.

All options contain remedial technologies that can be considered "reliable" in terms of relying or counting on the day-to-day functioning of the remedy as intended. This assessment is dependent on the assumption that proper construction techniques and O&M efforts are provided as appropriate to the level of the technology. Clearly, maintaining a landfill cap or treatment system will require a higher degree of effort than maintaining a site security fence. Therefore, from the point-of-view of maintaining day-to-day function, the lesser options (No Action, Inst. Action, and InSitu-1) will be easier to implement, and the more intensive options, SC-1, SC-2, OnSite-1, and OnSite-1, more difficult to implement.

In terms of achieving the remedial action objectives, however, the reliability of an option is proportional to the greater intensity of the remedial actions contained in the option. Thus, the lowest reliabilities may be expected in the No Action, Inst. Action, and InSitu-1 options, since there is either no action occurring or there is a much greater reliance on institutional controls, monitoring, and in-situ remedies such as monitored natural attenuation. The SC-1, SC-2, OnSite-1, and OnSite-2 options provide a high level of reliability that the remedial action objectives can be achieved.

The ease of undertaking additional remedial actions, if warranted by future site conditions or requirements, is also proportional to the degree or intensity of each remedy. Options that use more intensive remedial technologies such as containment, in-situ or on-site treatment remedies will have the greatest difficulty in undertaking and implementing additional remedial actions. Conversely, options which utilize less intensive technologies such as institutional actions can more easily implement additional remedial actions. As a result, the No Action, Inst. Action, and InSitu-1 options will be the easiest to implement additional remedial actions, if necessary, due to their use of either no action or use of limited actions and institutional controls. The SC-1, SC-2, OnSite-1, and OnSite-2 options will require a moderate effort to implement additional, future remedial actions.

**7.4.6.2 Administrative Feasibility.** The No Action option has the fewest administrative issues to address and only requires agreement among the regulatory agencies (local, state and federal) that no remedial actions are warranted at the AOC. Therefore, this option has the highest degree of administrative feasibility. The Inst. Action, InSitu-1, SC-1, SC-2, OnSite-1, and OnSite-2 options have comparable, moderate degrees of administrative feasibility. All of these options incorporate the use of institutional actions in the form of either monitoring or institutional controls prohibiting soil disturbance. The primary administrative burdens for these options will be negotiation, development, and execution of institutional controls.

**7.4.6.3 Availability of Services and Materials.** Implementability with regard to the availability of services and materials includes an evaluation of three factors: 1) availability or usage of off-site treatment, storage, and disposal facilities (TSDFs), 2) availability of necessary or specialized equipment or specialist personnel needed to implement the option, and 3) availability of prospective technologies required by the option. Each of these three factors is described for the options at this AOC.

All options are similar in that use of off-site TSDF services are not required to treat or dispose of contaminated media-of-concern. These options, therefore, will be easy to implement since reliance on an outside disposal contractor will not be required.

The No Action option does not require any specialized equipment or specialized personnel, so it will have the easiest implementability. Inst. Action, InSitu-1, SC-1, and SC-2 will all be comparable for only requiring low-to-moderate specialized and/or necessary equipment needs and specialist personnel. These relate to the following requirements: installation of fencing and security measures, procurement of specialists for implementing and evaluating monitored natural attenuation and implementing institutional actions/institutional controls, and heavy earthmoving equipment and expertise for civil/sitework capping and soil or waste fill excavation. The OnSite-1 and OnSite-2 options would require use of some less-typical technologies related to soil treatment such as on-site solidification/stabilization and soil washing/chemical extraction. As a

result, these options would have lesser degrees of implementability due to their greater reliance on less commonly used or innovative technologies.

### 7.4.7 Cost

The total net present worth costs (capital plus O&M over the duration of the remedial action) for the five options with action range from $0.24 million to $42.06 million. Costs for each option are summarized below, with further details presented in Appendix D.

- No Action - capital = $0; O&M = $0; total = $0
- Inst. Action - capital = $0.13 million; O&M = $0.11 million; total = $0.24 million
- InSitu-1 - capital = $0.13 million; O&M = $0.17 million; total = $0.30 million
- SC-1 - capital = $1.96 million; O&M = $0.12 million; total = $2.08 million
- SC-2 - capital = $8.15 million; O&M = $0; total = $8.15 million
- OnSite-1 - capital = $33.63 million; O&M = $0; total = $33.63 million
- OnSite-2 - capital = $42.06 million; O&M = $0; total = $42.06 million

The costs presented provide order-of-magnitude estimates which may be used to compare the relative expense of each option. Contingencies of 20% on capital costs and 15% on O&M costs are utilized to account for any inaccuracy of the costs. Based on the degree of accuracy of the estimates, the cost differences between some of the options may not be significant.

To evaluate the impact of the soil remedial actions on groundwater quality, monitoring of groundwater will be performed for five years. The five-year timeframe should allow enough time for sufficient data collection to support a data trend evaluation and also coincides with a 5-year review, which is required under CERCLA. Additional costs (net present worth) related to this action are summarized below, with further details presented in Appendix D.

- Groundwater Monitoring - capital = $0.05 million; O&M = $0.48 million

### 7.4.8 State Acceptance

Acceptance of the selected option for this AOC by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 7.4.9 Community Acceptance

Acceptance of the selected option for this AOC by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 7.5 OLD B&M OIL/SLUDGE RECYCLING AREA

Table 7-7 presents a summary of the primary evaluation factors and a comparative assessment of the technologies/process options evaluated for AOC #4, Old B&M Oil/Sludge Recycling Area. The only media of concern was soil. These technologies/process options for remediation of soil include:

- No Action;
- Inst. Action - Institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures) as well as monitoring;
- InSitu-1 - In-situ remedy of monitored natural attenuation and institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures) as well as monitoring;
- SC-1 - Source control remedy consisting of horizontal containment (*i.e.*, single-barrier cap).
- SC-2 - Source control remedy consisting of soil excavation and placement under caps at other on-site AOCs;
- OnSite-1 - Remedy consisting of soil excavation and on-site treatment via solidification/stabilization;
- OnSite-2 - Remedy consisting of soil excavation and on-site treatment via soil washing/chemical extraction.

It must be noted that the use of monitored natural attenuation as a remedy for contaminated soils without source containment is not recommended.

### 7.5.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment, within the limits of the remedial action objectives defined for this feasibility study, is a key threshold criterion that must be attained by an option to be eligible for selection in the ROD. This section describes the overall assessment of whether each option achieves adequate protection of human health and the environment.

**7.5.1.1 Human Health Protection.** As noted in Section 2.0, there is human health risk at this AOC due to lead in soil. The No Action, Inst. Action, and InSitu-1 options will not be protective of human health, and therefore, will not meet this criterion. These options will not significantly reduce or eliminate the potential for exposure of human receptors to soil (via fugitive dust) relative to baseline conditions. The No Action option will provide for no protection of human health from soil exposures.

The SC-1, SC-2, OnSite-1, and OnSite-2 options will provide for overall protection of human health by significantly reducing or eliminating the potential for human exposures to soil, including inhalation of fugitive dust. For these options, soil exposures will be effectively reduced or eliminated either through soil excavation and/or capping, or through the use of remedial technologies that efficiently prevent fugitive dust generation (solidification/stabilization or soil washing/chemical extraction). For the SC-1 and SC-2 options, if the caps are not maintained, soil risk will return to baseline levels.

**7.5.1.2 Ecological Protection.** As noted in Section 2.0, there are no ecological risks due to soil at this AOC. Therefore, all actions achieve this criteria.

With regard to potential impacts of remedial technologies on natural habitats, there will be no short-term environmental impacts for the No Action option. Institutional actions and monitored natural attenuation (Inst. Action and InSitu-1) will result in temporary and minor impacts resulting from installation of fencing. The impacts on natural habitats will be greater for the source control options (SC-1 and SC-2) and the two on-site treatment options (OnSite-1 and OnSite-2). These options involve excavation or significant disturbance of the areas prior to capping, disposal, or treatment. However, these potential impacts will be mitigated.

### 7.5.2 Compliance With ARARs

There are numerous federal and state regulatory requirements that are ARAR due to the specific compounds at the Site or due to site characteristics. Table 7-8 presents a summary of the ARARs associated with this AOC.

For this AOC, action-specific ARARs include requirements for closure and post closure (Massachusetts Solid Waste Management). Of the seven options presented for this AOC, four (SC-1, SC-2, OnSite-1, and OnSite-2) meet the requirements of these regulations. The remaining three options (No Action, Inst. Action, and InSitu-1) do not take steps towards closure, and therefore do not attain ARARs. Requirements relating to the discharge of soil washing water, to either groundwater or surface water, will be met (OnSite-2).

### 7.5.3 Long-Term Effectiveness and Permanence

This section summarizes the evaluation for risks remaining at the Site after RAOs have been met, and for risks from management of residuals.

**7.5.3.1 Magnitude of Residual Risk: Human Health.** The No Action option will provide no long-term effectiveness and permanence and will not protect against the human health risks

identified in the baseline human health risk assessment. The exposure pathway which exceeds risk management criteria is inhalation of soil COCs in indoor dust by female workers.

The Inst. Action and InSitu-1 options will provide for only minimal reductions in baseline human health risks for soil at this AOC relative to baseline conditions. Residual soil risk will continue to exceed EPA risk management criteria since significant fugitive dust emissions will continue to occur. Therefore, overall residual risks will remain at unacceptable levels.

The SC-1, SC-2, OnSite-1, and OnSite-2 options will provide for overall residual risks below EPA risk management criteria by significantly reducing or eliminating the potential for human exposures to soil. For these options, soil exposures will be effectively reduced or eliminated either through soil excavation and/or capping, or through the use of remedial technologies that efficiently prevent fugitive dust generation (solidification/stabilization or soil washing/chemical extraction). If the soil is capped in-place (SC-1) or placed below on-site caps (SC-2), the caps must be maintained or residual risk will return to baseline levels.

**7.5.3.2 Magnitude of Residual Risk: Ecological.** As noted in Section 2.0, there are no ecological risks due to soil at this AOC. Therefore, there will be no residual risk remaining following the use of any noted remedial option.

#### 7.5.4 Reduction of Toxicity, Mobility and Volume Through Treatment

This section provides a comparison of the treatment and process options selected; quantities of waste materials to be remediated; expected reductions in toxicity, mobility and volume; and residuals following treatment options.

**7.5.4.1 Treatment/Recycling Processes Utilized.** Treatment processes evaluated for mitigation of soil at AOC #4 include monitored natural attenuation (InSitu-1), solidification/stabilization

(OnSite-1), and soil washing/chemical extraction (OnSite-2). The No Action , Inst. Action, SC-1, and SC-2 options are not considered treatment processes.

**7.5.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The amounts of waste materials to be treated or recycled are discussed below as an evaluation of whether the treatment processes will remediate the total quantity of known contaminated media. For specific quantities of contaminated media to be treated, refer to Section 5 text and tables.

Monitored natural attenuation (InSitu-1), solidification/stabilization (OnSite-1), and soil washing/chemical extraction (OnSite-2) to be implemented for mitigation of soils are expected to treat the total quantity of contaminated soils at AOC #4.

**7.5.4.3 Degree of Expected Reductions in Toxicity, Mobility or Volume.** A detailed discussion of the reductions in toxicity, mobility and volume to be expected from treatment options is provided below. For the purposes of this FS in making comparisons between options, the toxicity of the contaminated media relative to a specific contaminant is assumed to be reduced proportionally to the reduction in volume of that specific toxic contaminant provided by a given treatment technology. Therefore, this discussion will be concentrated more on volume reductions than toxicity reductions. Reductions upon completion of the remedy, except for monitored natural attenuation, are considered in the evaluation. Monitored natural attenuation reductions are provided for the 30-year default remediation time period.

Soil washing/chemical extraction processes (OnSite-2) are expected to provide the greatest degree of reductions in toxicity, mobility, and/or volume of the treatment processes to be implemented to mitigate the contaminated soils at AOC #4. The volume of contaminants is expected to be reduced by 90% to 99% through the implementation of OnSite-2. There is no expected contaminant mobility decrease through on-site soil washing/chemical extraction processes.

Excavation and on-site solidification/stabilization (OnSite-1) is expected to reduce the mobility of contaminants by 93% to 99%. However, the volume of contaminants and the toxicity of the contaminated media will not be reduced and the volume of contaminated media may be increased by up to 100% through implementation of OnSite-1.

Monitored natural attenuation (InSitu-1) of soils implemented at AOC #4 is expected to result in small reductions in toxicity and volume over a 30-year period.

No treatment processes will be utilized for the No Action, Inst. Action, SC-1, and SC-2 options. Therefore, reductions in toxicity, mobility, and volume will not be expected or confirmed for these options.

**7.5.4.4 Reversibility.** Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. In general, active treatments (*e.g.*, soil washing and chemical extraction of soils) either destroy, degrade, or remove contaminants from the media of concern, and therefore, are not reversible.

Solidification/stabilization processes (OnSite-1) are considered reversible. These processes result in a stabilized mass that has the potential to weather and leach contaminants over time. As stated above, soil washing/chemical extraction processes (OnSite-2) are not considered reversible, since contaminants are removed from the soil. Monitored natural attenuation (InSitu-1) is also not considered reversible, as organic contaminants are degraded over time and eventually inorganics are likely to be dispersed, although they may be temporarily immobilized.

**7.5.4.5 Type and Quantity of Residuals.** A comparison of types and quantities of residuals expected after completion of the treatment technologies/process options is provided below. The following discussion concentrates on contaminant residuals resulting from treatment. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are also discussed briefly

below, as well as in the Section 5 tables titled "Quantities and Types of Hazardous Materials to be Treated and Process Residuals." Treatment/process residuals are the basis for the comparison of the treatment technology residuals in Table 7-7.

Of the soil treatment processes to be implemented at AOC #4, soil washing/chemical extraction processes (OnSite-2) will likely result in the least amount of contaminant residuals. Only 1% to 9% of the original volume of contaminants are expected to remain in the treated soils. However, treatment/process residuals, including spent washing/extraction solvent, will be generated by soil washing and chemical extraction processes. Significant contaminant residuals are likely to result from monitored natural attenuation (InSitu-1), since reductions of contaminant volumes in the soil are expected to be low. The only treatment/process residuals expected to be produced by monitored natural attenuation are investigation-derived wastes. The greatest amount of residuals are expected to result from solidification/stabilization processes (OnSite-1). Through OnSite-1, the amount of contaminated media may increase up to 100%. All of the original contaminants will remain in the stabilized mass, with greater than 7% of organic and 1% of inorganic contaminants in these stabilized soils having the potential to leach into groundwater.

No treatment processes will be utilized in the No Action , Inst. Action, SC-1, and SC-2 options. Therefore, the original contamination at the AOC is expected to remain unchanged at AOC #4 under these options.

### 7.5.5 Short-Term Effectiveness

The effectiveness of each remedial option during construction and implementation are compared to one another in the following paragraphs.

**7.5.5.1 Protection of Community and Workers During Remedial Actions.** Short-term risks include any additional risks to the community or workers at the Site from exposures to soil COCs

as a result of construction measures and implementation of remedial activities. There will be no additional short-term risks from exposures under the No Action option.

The Inst. Action and InSitu-1 options will have nominal increases of short-term risks to the community and workers due to the installation of fencing and the requirement to perform soil monitoring. Air sampling and monitoring will be used to evaluate any potential risks to the community from inhalation exposures, and engineering controls will be used to reduce any potential inhalation risks from invasive activities. Dust control measures will be used to mitigate potential soil inhalation exposures. Concentrations of COCs are expected to be greatest on-site. Therefore, workers at the Site will use appropriate PPE to mitigate any potential risks from exposures to soil COCs.

The remaining options, SC-1, SC-2, OnSite-1, and OnSite-2, will have the greatest short-term risks to the community and workers due to the inclusion of significant disturbance or excavation of soils, followed by either capping or treatment. Short-term soil risks will be mitigated by a variety of measures. Air sampling and monitoring will be used to evaluate any potential risks to the community associated with invasive soil activities. Engineering controls will also be used to minimize the degree of invasive work and to mitigate potential risks from this exposure pathway. Workers will wear appropriate PPE to mitigate potential risks from increased exposures to COCs in soil at the Site.

**7.5.5.2 Environmental Impacts.** The remedial technologies evaluated at this AOC differ in the magnitude of the potential impacts to natural habitats. There will be no short-term habitat impacts resulting from the No Action option. The Inst. Action and InSitu-1 options will result in temporary and minor impacts resulting from installation of fencing. The impacts to natural habitats will be greater for the SC-1, SC-2, OnSite-1, and OnSite-2 options. These involve excavation and/or capping of the AOC and will temporarily displace some resident organisms, thereby potentially causing some mortality of animals during operations.

**7.5.5.3 Time Until Remedial Action Objectives are Achieved.** Of the options evaluated for this AOC, SC-1, SC-2, OnSite-1, and OnSite-2 are expected to achieve RAOs quickly when compared to No Action, Inst. Action, and InSitu-1. Capping in-place or excavation followed by either capping or treatment is expected to take 2 to 3 years. Monitored natural attenuation, as part of InSitu-1, is not expected to reduce inorganic contaminant concentrations to PRGs in less than 30 years, the EPA default evaluation time period. Similarly, the No Action and Inst. Action options perform no actions which would be expected to achieve RAOs in less than 30 years.

### 7.5.6 Implementability

The options with the highest degree of implementability would have the following characteristics from EPA's FS guidance (U.S. EPA, 1988):

- require the lowest effort to construct, operate and maintain the technologies.
- include or consist only of the highest or most reliable technologies.
- require the lowest effort to undertake additional remedial actions, if necessary.
- include the fewest administrative hurdles for obtaining necessary permits, approvals and agreements.
- rely only minimally on off-site treatment, storage and disposal facility services (TSDFs)
- require the least amount or quantity of necessary specialized equipment and/or personnel specialists.
- utilize commonly available technologies to the largest degree.

Conversely, options with lesser degrees of implementability will have lesser degrees of the characteristics discussed above. The first three bullets define the "technical feasibility" with regard to implementability of the option, the fourth bullet defines "administrative feasibility," and the remaining three bullets define the "availability of services and materials" with respect to the option. These three factors combine to provide the overall degree of implementability of the option. After evaluating all options and combining the technical feasibility, administrative feasibility and availability of services and materials evaluations, the overall implementability comparison is as follows:

- The No Action option has the highest degree of overall implementability.
- The Inst. Action and InSitu-1 options are comparable in their overall high degree of implementability or high relative ease to implement.
- The SC-1 and SC-2 options have an overall moderate degree of implementability.
- The OnSite-1 and OnSite-2 options are comparable in their overall degree of lesser implementability or relative difficulty in implementing.

In general, more complex remedial technologies are more difficult to implement and will have lesser degrees of overall implementability compared to other, less complex, options. As a result, the No Action option is the most implementable, and the OnSite-1 and OnSite-2 options, are the least implementable.

Sections 7.5.6.1, 7.5.6.2, and 7.5.6.3 present more detailed evaluations of the comparison of implementability characteristics of the remedial options for which this analysis was performed.

**7.5.6.1 Technical Feasibility.** Implementability with regard to the technical feasibility of an option includes an evaluation of three factors: 1) ability to construct, operate and maintain the technologies, 2) the reliability of the technologies, and 3) the ease of undertaking additional remedial actions, if warranted by site conditions determined after implementation of the remedy. Each of these three factors is described for the options at this AOC.

The ability to construct, operate and maintain the technologies associated with each remedial option is proportional to the degree or intensity of each remedy. Options which use more intensive remedial technologies such as containment and in-situ or on-site treatments will have the greatest difficulty in implementing construction and O&M. Conversely, options which utilize less intensive technologies, such as institutional actions, will be easier to implement. As a result, the No Action, Inst. Action, and InSitu-1 options will be the easiest to construct, operate, and maintain due to their use of either no action or use of limited actions and institutional controls. The SC-1 and SC-2 options require a moderate effort to construct, operate and maintain, while the OnSite-1 and OnSite-2 options require the highest effort. This is primarily due to the addition of a greater reliance of more intensive technologies such as on-site treatment for contaminated soils.

All options contain remedial technologies that can be considered "reliable" in terms of relying or counting on the day-to-day functioning of the remedy as intended. This assessment is dependent on the assumption that proper construction techniques and O&M efforts are provided as appropriate to the level of the technology. Clearly, maintaining a landfill cap will require a higher degree of effort than maintaining a site security fence. Therefore, from the point-of-view of maintaining day-to-day function, the lesser options (No Action, Inst. Action, and InSitu-1) will be easier to implement, and the more intensive options, SC-1, SC-2, OnSite-1, and OnSite-1, more difficult to implement.

In terms of achieving the remedial action objectives, however, the reliability of an option is proportional to the greater intensity of the remedial actions contained in the option. Thus, the lowest reliabilities may be expected in the No Action, Inst. Action, and InSitu-1 options, since there is either no action occurring or there is a much greater reliance on institutional controls, monitoring, and in-situ remedies such as monitored natural attenuation. The SC-1, SC-2, OnSite-1, and OnSite-2 options provide a high level of reliability that the remedial action objectives can be achieved.

The ease of undertaking additional remedial actions, if warranted by future site conditions or requirements, is also proportional to the degree or intensity of each remedy. Options that use more intensive remedial technologies such as containment, in-situ or on-site treatment remedies will have the greatest difficulty in undertaking and implementing additional remedial actions. Conversely, options which utilize less intensive technologies such as institutional actions can more easily implement additional remedial actions. As a result, the No Action, Inst. Action, and InSitu-1 options will be the easiest to implement additional remedial actions, if necessary, due to their use of either no action or use of limited actions and institutional controls. The SC-1, SC-2, OnSite-1, and OnSite-2 options will require a moderate effort to implement additional, future remedial actions.

**7.5.6.2 Administrative Feasibility.** The No Action option has the fewest administrative issues to address and only requires agreement among the regulatory agencies (local, state and federal) that no remedial actions are warranted at the AOC. Therefore, this option has the highest degree of administrative feasibility. The Inst. Action, InSitu-1, SC-1, SC-2, OnSite-1, and OnSite-2 options have comparable, moderate degrees of administrative feasibility. All of these options incorporate the use of institutional actions in the form of either monitoring or institutional controls prohibiting soil disturbance. The primary administrative burdens for these options will be negotiation, development, and execution of institutional controls.

**7.5.6.3 Availability of Services and Materials.** Implementability with regard to the availability of services and materials includes an evaluation of three factors: 1) availability or usage of off-site treatment, storage, and disposal facilities (TSDFs), 2) availability of necessary or specialized equipment or specialist personnel needed to implement the option, and 3) availability of prospective technologies required by the option. Each of these three factors is described for the options at this AOC.

All options are similar in that use of off-site TSDF services are not required to treat or dispose of contaminated media-of-concern. These options, therefore, will be easy to implement since reliance on an outside disposal contractor will not be required.

The No Action option does not require any specialized equipment or specialized personnel, so it will have the easiest implementability. Inst. Action, InSitu-1, SC-1, and SC-2 will all be comparable for only requiring low-to-moderate specialized and/or necessary equipment needs and specialist personnel. These relate to the following requirements: installation of fencing and security measures, procurement of specialists for implementing and evaluating monitored natural attenuation and implementing institutional actions/institutional controls, and heavy earthmoving equipment and expertise for civil/sitework capping and soil or waste fill excavation. The OnSite-1 and OnSite-2 options would require use of some less-typical technologies related to soil treatment such as on-site solidification/stabilization and soil washing/chemical extraction. As a

result, these options would have lesser degrees of implementability due to their greater reliance on less commonly used or innovative technologies.

### 7.5.7 Cost

The total net present worth costs (capital plus O&M over the duration of the remedial action) for the five options with action range from $0.23 million to $20.56 million. Costs for each option are summarized below, with further details presented in Appendix D.

- No Action - capital = $0; O&M = $0; total = $0
- Inst. Action - capital = $0.12 million; O&M = $0.11 million; total = $0.23 million
- InSitu-1 - capital = $0.12 million; O&M = $0.16 million; total = $0.28 million
- SC-1 - capital = $1.16 million; O&M = $0.33 million; total = $1.49 million
- SC-2 - capital = $4.99 million; O&M = $0; total = $4.99 million
- OnSite-1 - capital = $15.60 million; O&M = $0; total = $15.60 million
- OnSite-2 - capital = $20.56 million; O&M = $0; total = $20.56 million

The costs presented provide order-of-magnitude estimates which may be used to compare the relative expense of each option. Contingencies of 20% on capital costs and 15% on O&M costs are utilized to account for any inaccuracy of the costs. Based on the degree of accuracy of the estimates, the cost differences between some of the options may not be significant.

To evaluate the impact of the soil remedial actions on groundwater quality, monitoring of groundwater will be performed for five years. The five-year timeframe should allow enough time for sufficient data collection to support a data trend evaluation and also coincides with a 5-year review, which is required under CERCLA. Additional costs (net present worth) related to this action are summarized below, with further details presented in Appendix D.

- Groundwater Monitoring - capital = $0.06 million; O&M = $0.56 million

### .5.8 State Acceptance

Acceptance of the selected option for this AOC by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 7.5.9 Community Acceptance

Acceptance of the selected option for this AOC by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 7.6 CONTAMINATED SOILS AREA

Table 7-9 presents a summary of the primary evaluation factors and a comparative assessment of the technologies/process options evaluated for AOC #5, Contaminated Soils Area. The only media of concern was soil. These technologies/process options for remediation of soil include:

- No Action;
- Inst. Action - Institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures) as well as monitoring;
- InSitu-1 - In-situ remedy of monitored natural attenuation and institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures);
- InSitu-2 - In-situ remedy consisting of solidification/stabilization and access restrictions (*i.e.*, institutional controls) as well as monitoring;
- InSitu-3 - In-situ remedy consisting of soil flushing, enhanced biodegradation, and access restrictions (*i.e.*, institutional controls) as well as monitoring;
- SC-1 - Source control remedy consisting of horizontal containment (*i.e.*, single-barrier cap).
- Off Site - Remedy consisting of soil excavation and off site treatment/disposal;
- OnSite-1 - Remedy consisting of soil excavation and on-site treatment via solidification/stabilization;
- OnSite-2 - Remedy consisting of soil excavation and on-site treatment via soil washing/chemical extraction.

It must be noted that the use of monitored natural attenuation as a remedy for contaminated soils without source containment is not recommended.

### 7.6.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment, within the limits of the remedial action objectives defined for this feasibility study, is a key threshold criterion that must be attained by an option to be eligible for selection in the ROD. This section describes the overall assessment of whether each option achieves adequate protection of human health and the environment.

**7.6.1.1 Human Health Protection.** As noted in Section 2.0, there is human health risk at this AOC due to lead in soil. The No Action, Inst. Action, and InSitu-1 options will not be protective of human health, and therefore, will not meet this criterion. These options will not significantly reduce or eliminate the potential for exposure of human receptors to soil (via fugitive dust) relative to baseline conditions. The No Action option will provide for no protection of human health from soil exposures.

The remaining options, InSitu-2, InSitu-3, SC-1, Off Site, OnSite-1, and OnSite-2, will provide for overall protection of human health by significantly reducing or eliminating the potential for human exposures to soil. For these options, soil exposures will be effectively reduced or eliminated either through soil excavation and/or capping, or through the use of remedial technologies that efficiently prevent fugitive dust generation (solidification/stabilization, soil washing/chemical extraction, or soil flushing/enhanced biodegradation). Should any caps utilized not be maintained, soil risk will return to baseline levels.

**7.6.1.2 Ecological Protection.** As noted in Section 2.0, there are no ecological risks due to soil at this AOC. Therefore, all actions achieve this criteria.

With regard to potential impacts of remedial technologies on natural habitats, there will be no short-term environmental impacts for the No Action option. Institutional actions and two of the three in-situ options (Inst. Action, InSitu-1, and InSitu-3) will result in temporary and minor impacts resulting from installation of fencing. The impacts on natural habitats will be greater for the remaining in-situ option (InSitu-2 - solidification/stabilization), the source control option (SC-1), the Off Site option, and the two on-site treatment options (OnSite-1 and OnSite-2). These options involve excavation or significant disturbance of the areas prior to capping, disposal, or treatment. However, these potential impacts will be mitigated.

### 7.6.2 Compliance With ARARs

There are numerous federal and state regulatory requirements that are ARAR due to the specific compounds at the Site or due to site characteristics. Table 7-10 presents a summary of the ARARs associated with this AOC.

For this AOC, action-specific ARARs include requirements for closure and post closure (Massachusetts Solid Waste Management). Of the nine options presented for this AOC, six (InSitu-2, InSitu-3, SC-1, Off Site, OnSite-1, and OnSite-2) meet the requirements of these regulations. The remaining three options (No Action, Inst. Action, and InSitu-1) do not take steps towards closure, and therefore do not attain ARARs. Requirements relating to the discharge of soil washing water, to either groundwater or surface water, will be met (OnSite-2).

### 7.6.3 Long-Term Effectiveness and Permanence

This section summarizes the evaluation for risks remaining at the Site after RAOs have been met, and for risks from management of residuals.

**7.6.3.1 Magnitude of Residual Risk: Human Health.** The No Action option will provide no long-term effectiveness and permanence and will not protect against the human health risks

identified in the baseline human health risk assessment. The exposure pathway which exceeds risk management criteria is inhalation of soil COCs in indoor dust by female workers.

The Inst. Action and InSitu-1 options will provide for only minimal reductions in baseline human health risks for soil at this AOC relative to baseline conditions. Residual soil risk will continue to exceed EPA risk management criteria since significant fugitive dust emissions will continue to occur. Therefore, overall residual risks will remain at unacceptable levels.

The remaining options, InSitu-2, InSitu-3, SC-1, Off Site, OnSite-1, and OnSite-2, will provide for overall residual risks below EPA risk management criteria by significantly reducing or eliminating the potential for human exposures to soil. For these options, soil exposures will be effectively reduced or eliminated either through soil excavation and/or capping, or through the use of remedial technologies that efficiently prevent fugitive dust generation (solidification/stabilization, soil washing/chemical extraction, or soil flushing/enhanced bioremediation). If the SC-1 option is used, the cap must be maintained or residual risk will return to baseline levels.

**7.6.3.2 Magnitude of Residual Risk: Ecological.** As noted in Section 2.0, there are no ecological risks due to soil at this AOC. Therefore, there will be no residual risk remaining following the use of any noted remedial option.

### 7.6.4 Reduction of Toxicity, Mobility and Volume Through Treatment

This section provides a comparison of the treatment and process options selected; quantities of waste materials to be remediated; expected reductions in toxicity, mobility and volume; and residuals following treatment options.

**7.6.4.1 Treatment/Recycling Processes Utilized.** Treatment processes evaluated for mitigation of soil at AOC #5 include monitored natural attenuation (InSitu-1), in-situ

solidification/stabilization (InSitu-2), soil flushing/enhanced biodegradation (InSitu-3), excavation and off site treatment/disposal (Off Site), ex-situ solidification/stabilization (OnSite-1), and soil washing/chemical extraction (OnSite-2). For the purposes of this FS, it is assumed that excavation with off site treatment/disposal will include treatment of contaminated soils. The No Action , Inst. Action, and SC-1 options are not considered treatment processes.

**7.6.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The amounts of waste materials to be treated or recycled are discussed below as an evaluation of whether the treatment processes will remediate the total quantity of known contaminated media. For specific quantities of contaminated media to be treated, refer to Section 5 text and tables.

All treatment processes to be implemented for mitigation of soils are expected to treat the total quantity of contaminated soils at AOC #5. Treatment processes include monitored natural attenuation (InSitu-1), in-situ solidification/stabilization (InSitu-2), soil flushing/enhanced biodegradation (InSitu-3), excavation and off-site treatment/disposal (Off Site), ex-situ solidification/stabilization (OnSite-1), and soil washing/chemical extraction (OnSite-2).

**7.6.4.3 Degree of Expected Reductions in Toxicity, Mobility or Volume.** A detailed discussion of the reductions in toxicity, mobility and volume to be expected from treatment options is provided below. For the purposes of this FS in making comparisons between options, the toxicity of the contaminated media relative to a specific contaminant is assumed to be reduced proportionally to the reduction in volume of that specific toxic contaminant provided by a given treatment technology. Therefore, this discussion will be concentrated more on volume reductions than toxicity reductions. Reductions upon completion of the remedy, except for monitored natural attenuation, are considered in the evaluation. Monitored natural attenuation reductions are provided for the 30-year default remediation time period.

Excavation and offsite treatment/disposal (Off Site) provides the most effective treatment of the AOC #5 soils. Removing the contaminated soil from the Site eliminates the toxicity, mobility, and volume of contaminants at the Site.

Soil washing/chemical extraction processes (OnSite-2) are expected to provide substantial reductions in the volume of contaminants. The volume of contaminants is expected to be reduced by 90% to 99% through the implementation of OnSite-2. There is no expected contaminant mobility decrease through on-site soil washing/chemical extraction processes.

In-situ soil flushing and enhanced biodegradation (InSitu-3) is expected to significantly reduce the volume of contaminants (70% to 100%) in the soils at AOC #5. However, soil flushing increases the mobility of contaminants through transfer from soil to groundwater.

Excavation and on-site solidification/stabilization (OnSite-1) is expected to reduce the mobility of contaminants by 93% to 99%. Similar reductions in the mobility of contaminants (85% to 99%) is expected through in-situ solidification/stabilization (InSitu-2). However, the volume of contaminants and the toxicity of the contaminated media will not be reduced, and the volume of contaminated media may be increased by up to 100% through implementation of both InSitu-2 and OnSite-1.

Monitored natural attenuation (InSitu-1) of soils implemented at AOC #5 is expected to result in small reductions in toxicity and volume over a 30-year period.

No treatment processes will be utilized for the No Action, Inst. Action, and SC-1 options. Therefore, reductions in toxicity, mobility, and volume will not be expected or confirmed for these options.

**7.6.4.4 Reversibility.** Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process

option. In general, active treatments (*e.g.*, soil washing and chemical extraction of soils) either destroy, degrade, or remove contaminants from the media of concern, and therefore, are not reversible.

Solidification/stabilization processes (InSitu-2 and OnSite-1) are considered reversible. These processes result in a stabilized mass that has the potential to weather and leach contaminants over time.

All other treatment processes to be implemented at AOC #5, including monitored natural attenuation (InSitu-1), soil flushing and enhanced biodegradation (InSitu-3), and soil washing/chemical extraction (OnSite-2), are not considered reversible. These processes remove and/or degrade contaminants.

**7.6.4.5 Type and Quantity of Residuals.** A comparison of types and quantities of residuals expected after completion of the treatment technologies/process options is provided below. The following discussion concentrates on contaminant residuals resulting from treatment. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are also discussed briefly below, as well as in the Section 5 tables titled "Quantities and Types of Hazardous Materials to be Treated and Process Residuals." Treatment/process residuals are the basis for the comparison of the treatment technology residuals in Table 7-9.

Excavation and off site treatment/disposal (Off Site) results in no residuals remaining on-site. Of the soil treatment processes to be implemented at AOC #3 where contaminant residuals are to remain on-site, soil washing/chemical extraction processes (OnSite-2) will likely result in the least amount of contaminant residuals. Only 1% to 9% of the original volume of contaminants are expected to remain in the treated soils. However, treatment/process residuals, including spent washing/extraction solvent, will be generated by soil washing and chemical extraction processes.

Soil flushing and enhanced biodegradation (InSitu-3) will result in some contaminant residuals. Up to 8% of organics and 5% to 30% of inorganics are likely to remain in the AOC #5 soils after implementation of InSitu-3. Contaminants that are not degraded are transferred to the groundwater. There are no treatment/process residuals expected from soil flushing and enhanced biodegradation.

Significant residuals are likely to result following treatment by monitored natural attenuation (InSitu-1), since reductions of contaminant volumes in the soil are expected to be low. The only treatment/process residuals expected to be produced by monitored natural attenuation are investigation-derived wastes.

The greatest amount of residuals are likely to remain from solidification/stabilization processes (InSitu-2 and OnSite-1). Through InSitu-2 and OnSite-1, the amount of contaminated media may increase up to 100% and all of the original contaminants will remain in the stabilized mass. For on-site solidification/stabilization, greater than 7% of organic and 1% of inorganic contaminants in these stabilized soils will have the potential to leach into groundwater. The amount of inorganics that have the potential to leach is the same for in-situ solidification/ stabilization, while organic contaminants are more likely to leach (15%) with in-situ processes.

No treatment processes will be utilized in the No Action, Inst. Action, and SC-1 options. Therefore, the original contamination at the AOC is expected to remain unchanged under these options.

### 7.6.5 Short-Term Effectiveness

The effectiveness of each remedial option during construction and implementation are compared to one another in the following paragraphs.

**7.6.5.1 Protection of Community and Workers During Remedial Actions.** Short-term risks include any additional risks to the community or workers at the Site from exposures to soil COCs as a result of construction measures and implementation of remedial activities. There will be no additional short-term risks from exposures under the No Action option.

The Inst. Action, InSitu-1, and InSitu-3 options will have nominal increases of short-term risks to the community and workers due to the installation of fencing and the requirement to perform soil monitoring. Air sampling and monitoring will be used to evaluate any potential risks to the community from inhalation exposures, and engineering controls will be used to reduce any potential inhalation risks from invasive activities. Dust control measures will be used to mitigate potential soil inhalation exposures. Concentrations of COCs are expected to be greatest on-site. Therefore, workers at the Site will use appropriate PPE to mitigate any potential risks from exposures to soil COCs.

The remaining options, InSitu-2, SC-1, Off Site, OnSite-1, and OnSite-2, will have the greatest short-term risks to the community and workers due to the inclusion of excavation or significant disturbance of soils, followed by either capping or treatment. Short-term soil risks will be mitigated by a variety of measures. Air sampling and monitoring will be used to evaluate any potential risks to the community associated with invasive soil activities. Engineering controls will also be used to minimize the degree of invasive work and to mitigate potential risks from this exposure pathway. Workers will wear appropriate PPE to mitigate potential risks from increased exposures to COCs in soil at the Site.

**7.6.5.2 Environmental Impacts.** The remedial technologies evaluated at this AOC differ in the magnitude of the potential impacts to natural habitats. There will be no short-term habitat impacts resulting from the No Action option. The Inst. Action and InSitu-1 options will result in temporary and minor impacts resulting from installation of fencing. The impacts to natural habitats will be greater for the remaining options (InSitu-2, InSitu-3, SC-1, Off Site, OnSite-1, and OnSite-2). These can involve soil flushing (InSitu-3), excavation, capping, or significant

disturbance of the AOC and will temporarily displace some resident organisms, thereby potentially causing some mortality of animals during operations.

**7.6.5.3 Time Until Remedial Action Objectives are Achieved.** Of the options evaluated for this AOC, InSitu-2, InSitu-3, SC-1, Off Site, OnSite-1, and OnSite-2 are expected to achieve RAOs quickly when compared to No Action, Inst. Action, and InSitu-1. In-situ treatment, capping, or excavation followed by either treatment/disposal is expected to take 2 to 3 years. Monitored natural attenuation, as part of InSitu-1, is not expected to reduce inorganic contaminant concentrations to PRGs in less than 30 years, the EPA default evaluation time period. Similarly, the No Action and Inst. Action options perform no actions which would be expected to achieve RAOs in less than 30 years.

### 7.6.6 Implementability

The options with the highest degree of implementability would have the following characteristics from EPA's FS guidance (U.S. EPA, 1988):

- require the lowest effort to construct, operate and maintain the technologies.
- include or consist only of the highest or most reliable technologies.
- require the lowest effort to undertake additional remedial actions, if necessary.
- include the fewest administrative hurdles for obtaining necessary permits, approvals and agreements.
- rely only minimally on off-site treatment, storage and disposal facility services (TSDFs)
- require the least amount or quantity of necessary specialized equipment and/or personnel specialists.
- utilize commonly available technologies to the largest degree.

Conversely, options with lesser degrees of implementability will have lesser degrees of the characteristics discussed above. The first three bullets define the "technical feasibility" with regard to implementability of the option, the fourth bullet defines "administrative feasibility," and the remaining three bullets define the "availability of services and materials" with respect to the option. These three factors combine to provide the overall degree of implementability of the

option. After evaluating all options and combining the technical feasibility, administrative feasibility and availability of services and materials evaluations, the overall implementability comparison is as follows:

- The No Action option has the highest degree of overall implementability.
- The Inst. Action and InSitu-1 options are comparable in their overall high degree of implementability or high relative ease to implement.
- The InSitu-2, InSitu-3, SC-1,and Off Site options have an overall moderate degree of implementability.
- The OnSite-1 and OnSite-2 options are comparable in their overall degree of lesser implementability or relative difficulty in implementing.

In general, more complex remedial technologies are more difficult to implement and will have lesser degrees of overall implementability compared to other, less complex, options. As a result, the No Action option is the most implementable, and the OnSite-1 and OnSite-2 options, are the least implementable.

Sections 7.6.6.1, 7.6.6.2, and 7.6.6.3 present more detailed evaluations of the comparison of implementability characteristics of the remedial options for which this analysis was performed.

**7.6.6.1 Technical Feasibility.** Implementability with regard to the technical feasibility of an option includes an evaluation of three factors: 1) ability to construct, operate and maintain the technologies, 2) the reliability of the technologies, and 3) the ease of undertaking additional remedial actions, if warranted by site conditions determined after implementation of the remedy. Each of these three factors is described for the options at this AOC.

The ability to construct, operate and maintain the technologies associated with each remedial option is proportional to the degree or intensity of each remedy. Options which use more intensive remedial technologies such as containment and in-situ or on-site treatments will have the greatest difficulty in implementing construction and O&M. Conversely, options which utilize less intensive technologies, such as institutional actions, will be easier to implement. As a result, the No Action, Inst. Action, and InSitu-1 options will be the easiest to construct, operate,

and maintain due to their use of either no action or use of limited actions and institutional controls. The InSitu-2, InSitu-3, SC-1, and Off Site options require a moderate effort to construct, operate and maintain, while the OnSite-1 and OnSite-2 options require the highest effort. This is primarily due to the addition of a greater reliance of more intensive technologies such as on-site treatment for contaminated soils.

All options contain remedial technologies that can be considered "reliable" in terms of relying or counting on the day-to-day functioning of the remedy as intended. This assessment is dependent on the assumption that proper construction techniques and O&M efforts are provided as appropriate to the level of the technology. Clearly, maintaining a landfill cap will require a higher degree of effort than maintaining a site security fence. Therefore, from the point-of-view of maintaining day-to-day function, the lesser options (No Action, Inst. Action, and InSitu-1) will be easier to implement, and the more intensive options, InSitu-2, InSitu-3, SC-1, Off Site, OnSite-1, and OnSite-1, more difficult to implement.

In terms of achieving the remedial action objectives, however, the reliability of an option is proportional to the greater intensity of the remedial actions contained in the option. Thus, the lowest reliabilities may be expected in the No Action, Inst. Action, and InSitu-1 options, since there is either no action occurring or there is a much greater reliance on institutional controls, monitoring, and in-situ remedies such as monitored natural attenuation. The remaining options (InSitu-2, InSitu-3, SC-1, Off Site, OnSite-1, and OnSite-1) provide a high level of reliability that the remedial action objectives can be achieved.

The ease of undertaking additional remedial actions, if warranted by future site conditions or requirements, is also proportional to the degree or intensity of each remedy. Options that use more intensive remedial technologies such as containment, in-situ or on-site treatment remedies will have the greatest difficulty in undertaking and implementing additional remedial actions. Conversely, options which utilize less intensive technologies such as institutional actions can more easily implement additional remedial actions. As a result, the No Action, Inst. Action, and

InSitu-1 options will be the easiest to implement additional remedial actions, if necessary, due to their use of either no action or use of limited actions and institutional controls. The remaining options (InSitu-2, InSitu-3, SC-1, Off Site, OnSite-1, and OnSite-1) will require a moderate effort to implement additional, future remedial actions.

**7.6.6.2 Administrative Feasibility.** The No Action option has the fewest administrative issues to address and only requires agreement among the regulatory agencies (local, state and federal) that no remedial actions are warranted at the AOC. Therefore, this option has the highest degree of administrative feasibility. The Inst. Action, InSitu-1, InSitu-2, InSitu-3, SC-1, Off Site, OnSite-1, and OnSite-1 options have comparable, moderate degrees of administrative feasibility. Most of these options incorporate the use of institutional actions in the form of either monitoring or institutional controls prohibiting soil disturbance. The primary administrative burdens for these options will be negotiation, development, and execution of institutional controls.

**7.6.6.3 Availability of Services and Materials.** Implementability with regard to the availability of services and materials includes an evaluation of three factors: 1) availability or usage of off-site treatment, storage, and disposal facilities (TSDFs), 2) availability of necessary or specialized equipment or specialist personnel needed to implement the option, and 3) availability of prospective technologies required by the option. Each of these three factors is described for the options at this AOC.

All options except Off Site are similar in that use of off-site TSDF services are not required to treat or dispose of contaminated media-of-concern. These options, therefore, will be easy to implement since reliance on an outside disposal contractor will not be required. The Off Site option requires the use of an off-site TSDF to treat and dispose of contaminated soils, so it will have lesser implementability than the other options described above.

The No Action option does not require any specialized equipment or specialized personnel, so it will have the easiest implementability. Inst. Action, InSitu-1, SC-1, and Off Site will all be

comparable for only requiring low-to-moderate specialized and/or necessary equipment needs and specialist personnel. These relate to the following requirements: installation of fencing and security measures, procurement of specialists for implementing and evaluating monitored natural attenuation and implementing institutional actions/institutional controls, and heavy earthmoving equipment and expertise for civil/sitework capping and soil excavation. The OnSite-1 and OnSite-2 options would require use of some less-typical technologies related to soil treatment such as on-site solidification/stabilization and soil washing/chemical extraction. Similarly, the InSitu-2 and InSitu-3 options would require use of soil treatment technologies such as in-situ solidification/stabilization and soil flushing/enhanced biodegradation. As a result, these options would have lesser degrees of implementability due to their greater reliance on less commonly used or innovative technologies.

### 7.6.7 Cost

The total net present worth costs (capital plus O&M over the duration of the remedial action) for the eight options with action range from $0.35 million to $10.40 million. Costs for each option are summarized below, with further details presented in Appendix D.

- No Action - capital = $0; O&M = $0; total = $0
- Inst. Action - capital = $0.15 million; O&M = $0.20 million; total = $0.35 million
- InSitu-1 - capital = $0.15 million; O&M = $0.24 million; total = $0.39 million
- InSitu-2 - capital = $1.06 million; O&M = $0; total = $1.06 million
- InSitu-3 - capital = $9.04 million; O&M = $0; total = $9.04 million
- SC-1 - capital = $0.89 million; O&M = $0.32 million; total = $1.21 million
- Off Site - capital = $6.64 million; O&M = $0; total = $6.64 million
- OnSite-1 - capital = $7.01 million; O&M = $0; total = $7.01 million
- OnSite-2 - capital = $10.4 million; O&M = $0; total = $10.40 million

The costs presented provide order-of-magnitude estimates which may be used to compare the relative expense of each option. Contingencies of 20% on capital costs and 15% on O&M costs are utilized to account for any inaccuracy of the costs. Based on the degree of accuracy of the estimates, the cost differences between some of the options may not be significant.

To evaluate the impact of the soil remedial actions on groundwater quality, monitoring of groundwater will be performed for five years. The five-year timeframe should allow enough time for sufficient data collection to support a data trend evaluation and also coincides with a 5-year review, which is required under CERCLA. Additional costs (net present worth) related to this action are summarized below, with further details presented in Appendix D.

- Groundwater Monitoring - capital = $0.06 million; O&M = $1.13 million

### 7.6.8 State Acceptance

Acceptance of the selected option for this AOC by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 7.6.9 Community Acceptance

Acceptance of the selected option for this AOC by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 7.7 ASBESTOS LANDFILL

Table 7-11 presents a summary of the primary evaluation factors and a comparative assessment of the technologies/process options evaluated for AOC #6, Asbestos Landfill. The only media of concern was soil. Previous sections of this report provided the option of capping this AOC under the assumption that the existing cap may not be adequately protective. However, recent Site visits have determined that the existing cap is protective if maintained properly. Therefore, the technologies/process options for remediation of soil include:

- No Action;

- Inst. Action - Institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures) as well as monitoring and maintenance of the existing cap

### 7.7.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment, within the limits of the remedial action objectives defined for this feasibility study, is a key threshold criterion that must be attained by an option to be eligible for selection in the ROD. This section describes the overall assessment of whether each option achieves adequate protection of human health and the environment.

**7.7.1.1 Human Health Protection.** As long as the existing cap is maintained, the No Action and Inst. Action options will be protective of human health by significantly reducing or eliminating the potential for human exposures to soil. Therefore, all actions achieve this criteria.

**7.7.1.2 Ecological Protection.** As noted in Section 2.0, there are no ecological risks due to soil at this AOC. Therefore, all actions achieve this criteria.

With regard to potential impacts of remedial technologies on natural habitats, there will be no short-term environmental impacts for the No Action option. Institutional actions (Inst. Action) will result in temporary and minor impacts resulting from installation of fencing.

### 7.7.2 Compliance With ARARs

There are numerous federal and state regulatory requirements that are ARAR due to the specific compounds at the Site or due to site characteristics. Table 7-12 presents a summary of the ARARs associated with this AOC.

Primary location-specific ARARs for this AOC include requirements relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2). While this AOC is not a wetland area, these ARARs must be followed during remedial actions which may impact wetlands. Of the remedial options presented for this AOC which have some degree of remedial action, only

one (Inst. Action) performs minor activities in neighboring wetland areas. All planned remedial actions will limit/mitigate any wetland disturbances.

For this AOC, action-specific ARARs include requirements for disturbance of asbestos-containing materials (Massachusetts Air Pollution Control). Any work performed as part of the Inst. Action will comply with the requirements of these regulations.

### 7.7.3 Long-Term Effectiveness and Permanence

This section summarizes the evaluation for risks remaining at the Site after RAOs have been met, and for risks from management of residuals.

**7.7.3.1 Magnitude of Residual Risk: Human Health.** For the two options, there are no human health risks as long as the existing cap is maintained. Without maintenance, residual risk will return to levels which exist without a cap.

**7.7.3.2 Magnitude of Residual Risk: Ecological.** As noted in Section 2.0, there are no ecological risks due to soil at this AOC. Therefore, there will be no residual risk remaining following the use of any noted remedial option.

### 7.7.4 Reduction of Toxicity, Mobility and Volume Through Treatment

This section provides a comparison of the treatment and process options selected; quantities of waste materials to be remediated; expected reductions in toxicity, mobility and volume; and residuals following treatment options. Of the remedial options noted for this AOC, none are considered treatment processes.

**7.7.4.1 Treatment/Recycling Processes Utilized.** No treatment/recycling processes are utilized under the No Action and Inst. Actions options.

**7.7.4.2 Amount of Hazardous Materials to be Treated or Recycled.** No amount of hazardous materials are treated or recycled at this AOC through the No Action and Inst. Actions options.

**7.7.4.3 Degree of Expected Reductions in Toxicity, Mobility or Volume.** Reductions in toxicity, mobility or volume are not applicable, since the No Action and Inst. Actions options provide no treatment.

**7.7.4.4 Reversibility.** Reversibility of treatment is not applicable to the No Action and Inst. Actions options.

**7.7.4.5 Type and Quantity of Residuals.** The original contamination at this AOC is expected to remain unchanged under the No Action and Inst. Actions options, since no soil treatment processes will be implemented.

### 7.7.5 Short-Term Effectiveness

The effectiveness of each remedial option during construction and implementation are compared to one another in the following paragraphs.

**7.7.5.1 Protection of Community and Workers During Remedial Actions.** Short-term risks include any additional risks to the community or workers at the Site from exposures to soil COCs as a result of construction measures and implementation of remedial activities. There will be no additional short-term risks from exposures under the No Action option.

The Inst. Action option will have a nominal increase of short-term risks to the community and workers due to the installation of fencing and the requirement to perform soil monitoring. Air sampling and monitoring will be used to evaluate any potential risks to the community from inhalation exposures, and engineering controls will be used to reduce any potential inhalation risks from invasive activities. Dust control measures will be used to mitigate potential soil

inhalation exposures. Concentrations of COCs are expected to be greatest on-site. Therefore, workers at the Site will use appropriate PPE to mitigate any potential risks from exposures to soil COCs.

**7.7.5.2 Environmental Impacts.** The remedial technologies evaluated at this AOC differ in the magnitude of the potential impacts to natural habitats. There will be no short-term habitat impacts resulting from the No Action option. The Inst. Action option will result in temporary and minor impacts resulting from installation of fencing. The potential impacts to adjacent wetlands from disturbance during construction are expected to be minor and will be mitigated.

**7.7.5.3 Time Until Remedial Action Objectives are Achieved.** As the existing cap is considered protective, the RAOs have already been achieved for this AOC.

### 7.7.6 Implementability

The options with the highest degree of implementability would have the following characteristics from EPA's FS guidance (U.S. EPA, 1988):

- require the lowest effort to construct, operate and maintain the technologies.
- include or consist only of the highest or most reliable technologies.
- require the lowest effort to undertake additional remedial actions, if necessary.
- include the fewest administrative hurdles for obtaining necessary permits, approvals and agreements.
- rely only minimally on off-site treatment, storage and disposal facility services (TSDFs)
- require the least amount or quantity of necessary specialized equipment and/or personnel specialists.
- utilize commonly available technologies to the largest degree.

Conversely, options with lesser degrees of implementability will have lesser degrees of the characteristics discussed above. The first three bullets define the "technical feasibility" with regard to implementability of the option, the fourth bullet defines "administrative feasibility," and the remaining three bullets define the "availability of services and materials" with respect to

the option. These three factors combine to provide the overall degree of implementability of the option. After evaluating all options and combining the technical feasibility, administrative feasibility and availability of services and materials evaluations, the overall implementability comparison is as follows:

- The No Action option has the highest degree of overall implementability.
- The Inst. Action option has an overall high degree of implementability.

In general, more complex remedial technologies are more difficult to implement and will have lesser degrees of overall implementability compared to other, less complex, options. As a result, the No Action option is the most implementable, and the Inst. Actions option, is the least implementable, although both are similar in degree.

Sections 7.7.6.1, 7.7.6.2, and 7.7.6.3 present more detailed evaluations of the comparison of implementability characteristics of the remedial options for which this analysis was performed.

**7.7.6.1 Technical Feasibility.** Implementability with regard to the technical feasibility of an option includes an evaluation of three factors: 1) ability to construct, operate and maintain the technologies, 2) the reliability of the technologies, and 3) the ease of undertaking additional remedial actions, if warranted by site conditions determined after implementation of the remedy. Each of these three factors is described for the options at this AOC.

The ability to construct, operate and maintain the technologies associated with each remedial option is proportional to the degree or intensity of each remedy. Options which use more intensive remedial technologies such as containment and in-situ or on-site treatments will have the greatest difficulty in implementing construction and O&M. Conversely, options which utilize less intensive technologies, such as institutional actions, will be easier to implement. As a result, the No Action and Inst. Action options will be relatively easy to construct, operate, and maintain due to their use of either no action or use of limited actions and institutional controls.

All options contain remedial technologies that can be considered "reliable" in terms of relying or counting on the day-to-day functioning of the remedy as intended. This assessment is dependent on the assumption that proper construction techniques and O&M efforts are provided as appropriate to the level of the technology. Clearly, maintaining a site security fence will require a higher degree of effort than performing no action. Therefore, from the point-of-view of maintaining day-to-day function, the lesser option (No Action) will be easier to implement, and the more intensive option, Inst. Actions, more difficult to implement.

In terms of achieving the remedial action objectives, based on continuing maintenance of the existing cap, both options meet RAOs and are considered to provide a high level of reliability.

The ease of undertaking additional remedial actions, if warranted by future site conditions or requirements, is also proportional to the degree or intensity of each remedy. Options that use more intensive remedial technologies such as containment, in-situ or on-site treatment remedies will have the greatest difficulty in undertaking and implementing additional remedial actions. Conversely, options which utilize less intensive technologies such as institutional actions can more easily implement additional remedial actions. As a result, the No Action and Inst. Action options will be relatively easy to implement additional remedial actions, if necessary, due to their use of either no action or use of limited actions and institutional controls..

**7.7.6.2 Administrative Feasibility.** The No Action option has the fewest administrative issues to address and only requires agreement among the regulatory agencies (local, state and federal) that no remedial actions are warranted at the AOC. Therefore, this option has the highest degree of administrative feasibility. The Inst. Action option has a moderate degrees of administrative feasibility. The primary administrative burdens for the Inst. Action option will be negotiation, development, and execution of institutional controls.

**7.7.6.3 Availability of Services and Materials.** Implementability with regard to the availability of services and materials includes an evaluation of three factors: 1) availability or usage of off-

site treatment, storage, and disposal facilities (TSDFs), 2) availability of necessary or specialized equipment or specialist personnel needed to implement the option, and 3) availability of prospective technologies required by the option. Each of these three factors is described for the options at this AOC.

All options are similar in that use of off-site TSDF services are not required to treat or dispose of contaminated media-of-concern. These options, therefore, will be easy to implement since reliance on an outside disposal contractor will not be required.

The No Action option does not require any specialized equipment or specialized personnel, so it will have the easiest implementability. The Inst. Actions option will only require low-to-moderate specialized and/or necessary equipment needs and specialist personnel. These relate to the following requirements: installation of fencing and security measures and implementing institutional actions/institutional controls.

### 7.7.7 Cost

The total net present worth costs (capital plus O&M over the duration of the remedial action) for the Institutional Action option is $0.4 million. Costs for each option are summarized below, with further details presented in Appendix D.

- No Action - capital = $0; O&M = $0; total = $0
- Inst. Action - capital = $0.20 million; O&M = $0.20 million; total = $0.40 million

The costs presented provide order-of-magnitude estimates which may be used to compare the relative expense of each option. Contingencies of 20% on capital costs and 15% on O&M costs are utilized to account for any inaccuracy of the costs. Based on the degree of accuracy of the estimates, the cost differences between some of the options may not be significant.

To evaluate the impact of the soil remedial actions on groundwater quality, monitoring of groundwater will be performed for five years. The five-year timeframe should allow enough

time for sufficient data collection to support a data trend evaluation and also coincides with a 5-year review, which is required under CERCLA. Additional costs (net present worth) related to this action are summarized below, with further details presented in Appendix D.

- Groundwater Monitoring - capital = $0.08 million; O&M = $0.83 million

### 7.7.8 State Acceptance

Acceptance of the selected option for this AOC by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 7.7.9 Community Acceptance

Acceptance of the selected option for this AOC by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 7.8 ASBESTOS LAGOONS

Table 7-13 presents a summary of the primary evaluation factors and a comparative assessment of the technologies/process options evaluated for AOC #7, Asbestos Lagoons. The only media of concern was soil. These technologies/process options for remediation of soil include:

- No Action;
- Inst. Action - Institutional actions consisting of access restrictions (*i.e.*, institutional controls, fencing and security measures) as well as monitoring;
- SC-1 - Source control remedy consisting of horizontal containment (*i.e.*, single-barrier cap);
- SC-2 - Source control remedy consisting of soil excavation and placement under caps at other on-site AOCs.

### 7.8.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment, within the limits of the remedial action objectives defined for this feasibility study, is a key threshold criterion that must be attained by an option to be eligible for selection in the ROD. This section describes the overall assessment of whether each option achieves adequate protection of human health and the environment.

**7.8.1.1 Human Health Protection.** As noted in Section 2.0, there is the potential for human health risks due to asbestos in soil at this AOC. The No Action and Inst. Action options will not be protective of human health, and therefore, will not meet this criterion. These options will not significantly reduce or eliminate the potential for exposure of human receptors to soil relative to baseline conditions. The No Action option will provide for no protection of human health from soil exposures.

The SC-1 and SC-2 options will provide for overall protection of human health by significantly reducing or eliminating the potential for human exposures to soil. For this option, soil exposures will be effectively reduced or eliminated through capping (both in-place or via placement under another AOC's cap). If the cap the soil is under is not maintained, soil risk will return to baseline levels.

**7.8.1.2 Ecological Protection.** As noted in Section 2.0, there are no ecological risks due to soil at this AOC. Therefore, all actions achieve this criteria.

With regard to potential impacts of remedial technologies on natural habitats, there will be no short-term environmental impacts for the No Action option. Institutional actions (Inst. Action) will result in temporary and minor impacts resulting from installation of fencing. The impacts on natural habitats will be greater for the source control options (SC-1 and SC-2). These option involve either placing a cap over the area or excavating the soil and placing it under another AOC's cap. However, these potential impacts will be mitigated.

### 7.8.2 Compliance With ARARs

There are numerous federal and state regulatory requirements that are ARAR due to the specific compounds at the Site or due to site characteristics. Table 7-14 presents a summary of the ARARs associated with this AOC.

Primary location-specific ARARs for this AOC include requirements relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2). While this AOC is not a wetland area, these ARARs must be followed during remedial actions which may impact wetlands. Of the remedial options presented for this AOC which have some degree of remedial action, two (SC-1 and SC-2) perform significant activities in neighboring wetland areas. All planned remedial actions will limit/mitigate any wetland disturbances.

For this AOC, action-specific ARARs include requirements related to disturbance of asbestos-containing materials. Of the four options presented for this AOC, only two (SC-1 and SC-2) fully attain these ARARs. The remaining two options (No Action and Inst. Action) do not attain ARARs.

### 7.8.3 Long-Term Effectiveness and Permanence

This section summarizes the evaluation for risks remaining at the Site after RAOs have been met, and for risks from management of residuals.

**7.8.3.1 Magnitude of Residual Risk: Human Health.** The No Action option will provide no long-term effectiveness and permanence and will not protect against the human health risks identified in the baseline human health risk assessment (asbestos).

The Inst. Action option will provide for only minimal reductions in baseline human health risks for soil at this AOC relative to baseline conditions. Therefore, overall residual risks will remain at unacceptable levels.

The SC-1 and SC-2 options will provide for overall residual risks below EPA risk management criteria by significantly reducing or eliminating the potential for human exposures to soil. For these options, soil exposures will be effectively reduced or eliminated through capping. The cap must be maintained or residual risk will return to baseline levels.

**7.8.3.2 Magnitude of Residual Risk: Ecological.** As noted in Section 2.0, there are no ecological risks due to soil at this AOC. Therefore, there will be no residual risk remaining following the use of any noted remedial option.

### 7.8.4 Reduction of Toxicity, Mobility and Volume Through Treatment

This section provides a comparison of the treatment and process options selected; quantities of waste materials to be remediated; expected reductions in toxicity, mobility and volume; and residuals following treatment options. Of the four remedial options noted for this AOC, none are considered treatment processes.

**7.8.4.1 Treatment/Recycling Processes Utilized.** No treatment/recycling processes are utilized under the No Action, Inst. Actions, SC-1 and SC-2 options.

**7.8.4.2 Amount of Hazardous Materials to be Treated or Recycled.** No amount of hazardous materials are treated or recycled at this AOC through the No Action, Inst. Actions, SC-1 and SC-2 options.

**7.8.4.3 Degree of Expected Reductions in Toxicity, Mobility or Volume.** Reductions in toxicity, mobility or volume are not applicable, since the No Action, Inst. Actions, SC-1 and SC-2 options provide no treatment.

**7.8.4.4 Reversibility.** Reversibility of treatment is not applicable to the No Action, Inst. Actions, SC-1 and SC-2 options.

**7.8.4.5 Type and Quantity of Residuals.** The original contamination at this AOC is expected to remain unchanged under the No Action, Inst. Actions, SC-1 and SC-2 options, since no soil treatment processes will be implemented.

### 7.8.5 Short-Term Effectiveness

The effectiveness of each remedial option during construction and implementation are compared to one another in the following paragraphs.

**7.8.5.1 Protection of Community and Workers During Remedial Actions.** Short-term risks include any additional risks to the community or workers at the Site from exposures to soil COCs as a result of construction measures and implementation of remedial activities. There will be no additional short-term risks from exposures under the No Action option.

The Inst. Action option will have a nominal increase of short-term risks to the community and workers due to the installation of fencing and the requirement to perform soil monitoring. Air sampling and monitoring will be used to evaluate any potential risks to the community from inhalation exposures, and engineering controls will be used to reduce any potential inhalation risks from invasive activities. Dust control measures will be used to mitigate potential soil inhalation exposures. Concentrations of COCs are expected to be greatest on-site. Therefore, workers at the Site will use appropriate PPE to mitigate any potential risks from exposures to soil COCs.

The remaining options, SC-1 and SC-2, will have the greatest short-term risks to the community and workers due to the inclusion of capping (or excavation followed by capping) for soils. Short-term soil risks will be mitigated by a variety of measures. Air sampling and monitoring will be used to evaluate any potential risks to the community associated with invasive soil activities. Engineering controls will also be used to minimize the degree of invasive work and to mitigate potential risks from this exposure pathway. Workers will wear appropriate PPE to mitigate potential risks from increased exposures to COCs in soil at the Site.

**7.8.5.2 Environmental Impacts.** The remedial technologies evaluated at this AOC differ in the magnitude of the potential impacts to natural habitats. There will be no short-term habitat impacts resulting from the No Action option. The Inst. Action option will result in temporary and minor impacts resulting from installation of fencing. The impacts to natural habitats will be greater for the SC-1 and SC-2 options. These involve either excavation or construction of a cap and installation of fencing. These activities will temporarily displace some resident organisms and some mortality of animals may occur during operations. The potential impacts to adjacent wetlands from disturbance during construction are expected to be minor and will be mitigated.

**7.8.5.3 Time Until Remedial Action Objectives are Achieved.** Of the options evaluated for this AOC, only SC-1 and SC-2 are expected to achieve RAOs quickly. Excavation or installation of a cap (approximately 2 years) protects human receptors from asbestos. The No Action and Inst. Action options perform no actions which would be expected to achieve RAOs in less than 30 years.

### 7.8.6 Implementability

The options with the highest degree of implementability would have the following characteristics from EPA's FS guidance (U.S. EPA, 1988):

- require the lowest effort to construct, operate and maintain the technologies.
- include or consist only of the highest or most reliable technologies.

- require the lowest effort to undertake additional remedial actions, if necessary.
- include the fewest administrative hurdles for obtaining necessary permits, approvals and agreements.
- rely only minimally on off-site treatment, storage and disposal facility services (TSDFs)
- require the least amount or quantity of necessary specialized equipment and/or personnel specialists.
- utilize commonly available technologies to the largest degree.

Conversely, options with lesser degrees of implementability will have lesser degrees of the characteristics discussed above. The first three bullets define the "technical feasibility" with regard to implementability of the option, the fourth bullet defines "administrative feasibility," and the remaining three bullets define the "availability of services and materials" with respect to the option. These three factors combine to provide the overall degree of implementability of the option. After evaluating all options and combining the technical feasibility, administrative feasibility and availability of services and materials evaluations, the overall implementability comparison is as follows:

- The No Action option has the highest degree of overall implementability.
- The Inst. Action option has an overall high degree of implementability.
- The SC-1 and SC-2 options have an overall moderate degree of implementability.

In general, more complex remedial technologies are more difficult to implement and will have lesser degrees of overall implementability compared to other, less complex, options. As a result, the No Action option is the most implementable, and the SC-1 option, capping, is the least implementable.

Sections 7.8.6.1, 7.8.6.2, and 7.8.6.3 present more detailed evaluations of the comparison of implementability characteristics of the remedial options for which this analysis was performed.

**7.8.6.1 Technical Feasibility.** Implementability with regard to the technical feasibility of an option includes an evaluation of three factors: 1) ability to construct, operate and maintain the technologies, 2) the reliability of the technologies, and 3) the ease of undertaking additional

remedial actions, if warranted by site conditions determined after implementation of the remedy. Each of these three factors is described for the options at this AOC.

The ability to construct, operate and maintain the technologies associated with each remedial option is proportional to the degree or intensity of each remedy. Options which use more intensive remedial technologies such as containment and in-situ or on-site treatments will have the greatest difficulty in implementing construction and O&M. Conversely, options which utilize less intensive technologies, such as institutional actions, will be easier to implement. As a result, the No Action and Inst. Action options will be the easiest to construct, operate, and maintain due to their use of either no action or use of limited actions and institutional controls. The SC-1 and SC-2 options require a moderate effort to construct, operate and maintain.

All options contain remedial technologies that can be considered "reliable" in terms of relying or counting on the day-to-day functioning of the remedy as intended. This assessment is dependent on the assumption that proper construction techniques and O&M efforts are provided as appropriate to the level of the technology. Clearly, maintaining a landfill cap will require a higher degree of effort than maintaining a site security fence. Therefore, from the point-of-view of maintaining day-to-day function, the lesser options (No Action and Inst. Action) will be easier to implement, and the more intensive options, SC-1 and SC-2, more difficult to implement.

In terms of achieving the remedial action objectives, however, the reliability of an option is proportional to the greater intensity of the remedial actions contained in the option. Thus, the lowest reliabilities may be expected in the No Action and Inst. Action options, since there is either no action occurring or there is a much greater reliance on institutional controls and monitoring. The SC-1 and SC-2 options provide a high level of reliability that the remedial action objectives can be achieved.

The ease of undertaking additional remedial actions, if warranted by future site conditions or requirements, is also proportional to the degree or intensity of each remedy. Options that use

more intensive remedial technologies such as containment, in-situ or on-site treatment remedies will have the greatest difficulty in undertaking and implementing additional remedial actions. Conversely, options which utilize less intensive technologies such as institutional actions can more easily implement additional remedial actions. As a result, the No Action and Inst. Action options will be the easiest to implement additional remedial actions, if necessary, due to their use of either no action or use of limited actions and institutional controls. The SC-1 and SC-2 options will require a moderate effort to implement additional, future remedial actions.

**7.8.6.2 Administrative Feasibility.** The No Action option has the fewest administrative issues to address and only requires agreement among the regulatory agencies (local, state and federal) that no remedial actions are warranted at the AOC. Therefore, this option has the highest degree of administrative feasibility. The Inst. Action, SC-1, and SC-2 options have comparable, moderate degrees of administrative feasibility. The primary administrative burdens for the Inst. Action option will be negotiation, development, and execution of institutional controls.

**7.8.6.3 Availability of Services and Materials.** Implementability with regard to the availability of services and materials includes an evaluation of three factors: 1) availability or usage of off-site treatment, storage, and disposal facilities (TSDFs), 2) availability of necessary or specialized equipment or specialist personnel needed to implement the option, and 3) availability of prospective technologies required by the option. Each of these three factors is described for the options at this AOC.

All options are similar in that use of off-site TSDF services are not required to treat or dispose of contaminated media-of-concern. These options, therefore, will be easy to implement since reliance on an outside disposal contractor will not be required.

The No Action option does not require any specialized equipment or specialized personnel, so it will have the easiest implementability. The remaining options will all be comparable for only requiring low-to-moderate specialized and/or necessary equipment needs and specialist

personnel. These relate to the following requirements: installation of fencing and security measures, implementing institutional actions/institutional controls, and heavy earthmoving equipment and expertise for civil/sitework capping.

### 7.8.7 Cost

The total net present worth costs (capital plus O&M over the duration of the remedial action) for the three options with action range from $0.21 million to $2.26 million. Costs for each option are summarized below, with further details presented in Appendix D.

- No Action - capital = $0; O&M = $0; total = $0
- Inst. Action - capital = $0.08 million; O&M = $0.13 million; total = $0.21 million
- SC-1 - capital = $2.15 million; O&M = $0.11 million; total = $2.26 million
- SC-2 - capital = $1.33 million; O&M = $0; total = $1.33 million

The costs presented provide order-of-magnitude estimates which may be used to compare the relative expense of each option. Contingencies of 20% on capital costs and 15% on O&M costs are utilized to account for any inaccuracy of the costs. Based on the degree of accuracy of the estimates, the cost differences between some of the options may not be significant.

To evaluate the impact of the soil remedial actions on groundwater quality, monitoring of groundwater will be performed for five years. The five-year timeframe should allow enough time for sufficient data collection to support a data trend evaluation and also coincides with a 5-year review, which is required under CERCLA. Additional costs (net present worth) related to this action are summarized below, with further details presented in Appendix D.

- Groundwater Monitoring - capital = $0.06 million; O&M = $0.58 million

### 7.8.8 State Acceptance

Acceptance of the selected option for this AOC by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 7.8.9 Community Acceptance

Acceptance of the selected option for this AOC by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 7.9 WEST MIDDLESEX CANAL GROUP

Table 7-15 presents a summary of the primary evaluation factors and a comparative assessment of the technologies/process options evaluated for AOC #8a, West Middlesex Canal Group. The only media of concern was sediment. These technologies/process options for remediation of sediment include:

- No Action;
- Inst. Action - Institutional actions consisting of monitoring;
- InSitu - In-situ remedy of monitored natural attenuation;
- SC-2 - Source control remedy consisting of sediment excavation and placement under caps at other on-site AOCs along with monitored natural attenuation of remaining sediments.

### 7.9.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment, within the limits of the remedial action objectives defined for this feasibility study, is a key threshold criterion that must be attained by an option to be eligible for selection in the ROD. This section describes the overall assessment of whether each option achieves adequate protection of human health and the environment.

**7.9.1.1 Human Health Protection.** As noted in Section 2.0, there are no human health risks due to sediment at this AOC. Therefore, all actions achieve this criteria.

**7.9.1.2 Ecological Protection.** As noted in Section 2.0, the extent and level of exceedences of sediment benchmarks did not clearly indicate risk to benthic invertebrate communities at this AOC. However, further toxicity testing at some stations has been proposed to confirm the potential biological effects of the sediment contaminants. If the future toxicity testing determines ecological risk in portions of this AOC, only one of the technologies/process options evaluated, source control through excavation (SC-2), would be protective of the environment. Of the three remaining options (No Action, Inst. Action, and InSitu), none implement measures to directly remove/reduce exposure to contaminants in sediments. The only effects on the concentration of contaminants in sediments will be dilution/dispersal through slow, natural processes. Consequently, the concentration of contaminants in sediments on-site will not be substantially reduced under these options, and the exposure of benthic invertebrates to sediment contaminants will persist at or near existing levels. For exposure of benthic invertebrates in areas of confirmed toxicity, these three options do not meet this criterion.

### 7.9.2 Compliance With ARARs

There are numerous federal and state regulatory requirements that are ARAR due to the specific compounds at the Site or due to site characteristics. Table 7-16 presents a summary of the ARARs associated with this AOC.

Primary location-specific ARARs for this AOC include requirements relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2), as well as requirements relating to historic landmarks, such as the Middlesex Canal. These requirements must be considered when conducting remedial actions. All planned remedial actions will mitigate any wetland disturbances.

For this AOC, action-specific ARARs include requirements for transportation of potentially hazardous excavated material (SC-2). Of the four options presented for this AOC, only one (SC-2) meets the requirements of all ARARs. Two options, Inst. Action and InSitu-1, are not expected to attain wetland ARARs in a reasonable amount of time, and therefore only partially meet ARARs. The remaining option, No Action, does not meet ARARs.

### 7.9.3 Long-Term Effectiveness and Permanence

This section summarizes the evaluation for risks remaining at the Site after RAOs have been met, and for risks from management of residuals.

**7.9.3.1 Magnitude of Residual Risk: Human Health.** As noted in Section 2.0, there are no human health risks due to sediment at this AOC. Therefore, there will be no residual risk remaining following the use of any noted remedial option.

**7.9.3.2 Magnitude of Residual Risk: Ecological.** Of the technologies/process options evaluated, the No Action, Inst. Action, and InSitu options will not result in a quantifiable long-term reduction of risk to ecological receptors. These options will not remove or reduce risk to benthic invertebrates from exposure to sediments. Natural processes will tend to degrade organic contaminants (PAHs, pesticides) in sediments, and disperse all the contaminants (metals, PAHs, pesticides) through resuspension of sediments, transport downstream, deposition of new material, and vertical mixing by organisms in sediment. However, these processes are slow, and the source of contaminants for additional accumulation in sediment will not be substantially reduced

over time. Consequently, the reduction in concentration of contaminants resulting from natural processes will not be substantial, and the potential adverse impacts on the benthic communities will not be removed under these options.

The SC-2 option includes spot excavation of isolated areas of sediment with high concentrations of COCs. Exposure of benthic invertebrates to COCs will be eliminated in the areas of excavation. Residual risk will remain in any areas in which sediments with concentrations of COCs exceeding any PRGs for this AOC are not excavated. It is assumed that the majority of the sediments with COCs above PRGs will be removed and the exposure to COCs will be substantially below baseline conditions.

### 7.9.4 Reduction of Toxicity, Mobility and Volume Through Treatment

This section provides a comparison of the treatment and process options selected; quantities of waste materials to be remediated; expected reductions in toxicity, mobility and volume; and residuals following treatment options.

**7.9.4.1 Treatment/Recycling Processes Utilized.** The only treatment process evaluated for mitigation of sediment at AOC #8a is a relatively simple in-situ process. The No Action option, Inst. Action option, and excavation with on-site capping portion of SC-2 are not considered treatment processes. Monitored natural attenuation of sediments (InSitu and as part of SC-2), considered a less complex treatment, is evaluated below.

**7.9.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The amounts of waste materials to be treated or recycled are discussed below as an evaluation of whether the treatment processes will remediate the total quantity of known contaminated media. For specific quantities of contaminated media to be treated, refer to Section 5 text and tables.

Monitored natural attenuation when implemented as a stand-alone process (InSitu) is expected to treat the total quantity of contaminated sediments at AOC #8a. When implemented as part of SC-2, monitored natural attenuation will treat all non-excavated sediments. Contaminated sediments that will be excavated and placed under an on-site cap under SC-2 will not be treated.

**7.9.4.3 Degree of Expected Reductions in Toxicity, Mobility or Volume.** A detailed discussion of the reductions in toxicity, mobility and volume to be expected from treatment options is provided below. For the purposes of this FS in making comparisons between options, the toxicity of the contaminated media relative to a specific contaminant is assumed to be reduced proportionally to the reduction in volume of that specific toxic contaminant provided by a given treatment technology. Therefore, this discussion will be concentrated more on volume reductions than toxicity reductions. Reductions upon completion of the remedy, except for monitored natural attenuation, are considered in the evaluation. Monitored natural attenuation reductions are provided for the 30-year default remediation time period.

Monitored natural attenuation of sediments implemented at AOC #8a is expected to result in small reductions in toxicity and volume over a 30-year period. No treatment processes will be utilized for the No Action, Inst. Action, and SC-2 options. Therefore, reductions in toxicity, mobility, and volume will not be expected or confirmed for these options.

**7.9.4.4 Reversibility.** Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. In general, active treatments (*e.g.*, sediment washing and chemical extraction of sediments) either destroy, degrade, or remove contaminants from the media of concern, and therefore, are not reversible.

Monitored natural attenuation, the only treatment option evaluated for mitigation of contaminated sediments at AOC #8a, is not considered reversible. Organic contaminants are

degraded over time. Although inorganic contaminants may be temporarily immobilized, they will likely be dispersed over time.

**7.9.4.5 Type and Quantity of Residuals.** A comparison of types and quantities of residuals expected after completion of the treatment technologies/process options is provided below. The following discussion concentrates on contaminant residuals resulting from treatment. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are also discussed briefly below, as well as in the Section 5 tables titled "Quantities and Types of Hazardous Materials to be Treated and Process Residuals." Treatment/process residuals are the basis for the comparison of the treatment technology residuals in Table 7-15.

At AOC #8a, most of the contaminants will remain sorbed to the sediment following treatment by monitored natural attenuation. The only treatment/process residuals expected to be produced by monitored natural attenuation are investigation-derived wastes.

No treatment processes will be utilized in the No Action, Inst. Actions and SC-2 options. Therefore, the original contamination at the AOC is expected to remain unchanged under these options.

### 7.9.5 Short-Term Effectiveness

The effectiveness of each remedial option during construction and implementation are compared to one another in the following paragraphs.

**7.9.5.1 Protection of Community and Workers During Remedial Actions.** Short-term risks include any additional risks to the community or workers at the Site from exposures to sediment COCs as a result of construction measures and implementation of remedial activities. There will be no additional short-term risks from exposures under the No Action option.

The Inst. Action and InSitu options will have nominal increases of short-term risks to the community and workers due to the requirement of performing sediment monitoring. Concentrations of COCs are expected to be greatest on-site. Therefore, workers at the Site will use appropriate PPE to mitigate any potential risks from exposures to sediment COCs.

The remaining option, SC-2, will have the greatest short-term risks to the community and workers due to the inclusion of excavation for sediments. Short-term risks will be mitigated by a variety of measures. Air sampling and monitoring will be used to evaluate any potential risks to the community associated with invasive sediment activities. Engineering controls will also be used to minimize the degree of invasive work and to mitigate potential risks from this exposure pathway. Workers will wear appropriate PPE to mitigate potential risks from increased exposures to COCs in sediment at the Site.

**7.9.5.2 Environmental Impacts.** The remedial technologies evaluated at this AOC differ in the magnitude of the potential impacts to natural habitats. There will be no short-term habitat impacts resulting from the No Action option. The Inst. Action and InSitu options will result in temporary and minor impacts resulting from sediment monitoring. The impacts to natural habitats will be greater for the SC-2 option. This involves excavation of wetland sediments and will temporarily displace some resident organisms. The potential impacts to wetlands from disturbance during construction are expected to be major and will be mitigated. It is estimated that wetlands replacement will be performed over one acre for the SC-2 option.

**7.9.5.3 Time Until Remedial Action Objectives are Achieved.** Of the options evaluated for this AOC, only SC-2 is expected to achieve RAOs quickly. Sediment excavation (approximately 1 to 2 years) protects ecological receptors from COC exposure. Monitored natural attenuation, as part of InSitu, is not expected to reduce contaminant concentrations to PRGs in less than 30 years, the EPA default evaluation time period. Similarly, the No Action and Inst. Action options perform no actions which would be expected to achieve RAOs in less than 30 years.

### 7.9.6 Implementability

The options with the highest degree of implementability would have the following characteristics from EPA's FS guidance (U.S. EPA, 1988):

- require the lowest effort to construct, operate and maintain the technologies.
- include or consist only of the highest or most reliable technologies.
- require the lowest effort to undertake additional remedial actions, if necessary.
- include the fewest administrative hurdles for obtaining necessary permits, approvals and agreements.
- rely only minimally on off-site treatment, storage and disposal facility services (TSDFs)
- require the least amount or quantity of necessary specialized equipment and/or personnel specialists.
- utilize commonly available technologies to the largest degree.

Conversely, options with lesser degrees of implementability will have lesser degrees of the characteristics discussed above. The first three bullets define the "technical feasibility" with regard to implementability of the option, the fourth bullet defines "administrative feasibility," and the remaining three bullets define the "availability of services and materials" with respect to the option. These three factors combine to provide the overall degree of implementability of the option. After evaluating all options and combining the technical feasibility, administrative feasibility and availability of services and materials evaluations, the overall implementability comparison is as follows:

- The No Action option has the highest degree of overall implementability.
- The Inst. Action and InSitu options are comparable in their overall high degree of implementability or high relative ease to implement.
- The SC-2 option has an overall moderate degree of implementability.

In general, more complex remedial technologies are more difficult to implement and will have lesser degrees of overall implementability compared to other, less complex, options. As a result, the No Action option is the most implementable, and the SC-2 option, excavation, is the least implementable.

Sections 7.9.6.1, 7.9.6.2, and 7.9.6.3 present more detailed evaluations of the comparison of implementability characteristics of the remedial options for which this analysis was performed.

**7.9.6.1 Technical Feasibility.** Implementability with regard to the technical feasibility of an option includes an evaluation of three factors: 1) ability to construct, operate and maintain the technologies, 2) the reliability of the technologies, and 3) the ease of undertaking additional remedial actions, if warranted by site conditions determined after implementation of the remedy. Each of these three factors is described for the options at this AOC.

The ability to construct, operate and maintain the technologies associated with each remedial option is proportional to the degree or intensity of each remedy. Options which use more intensive remedial technologies such as containment and in-situ or on-site treatments will have the greatest difficulty in implementing construction and O&M. Conversely, options which utilize less intensive technologies, such as institutional actions, will be easier to implement. As a result, the No Action, Inst. Action, and InSitu options will be the easiest to construct, operate, and maintain due to their use of either no action or use of limited actions. The SC-2 option requires a moderate effort to construct, operate and maintain.

All options contain remedial technologies that can be considered "reliable" in terms of relying or counting on the day-to-day functioning of the remedy as intended. This assessment is dependent on the assumption that proper construction techniques and O&M efforts are provided as appropriate to the level of the technology. Clearly, maintaining a landfill cap will require a higher degree of effort than maintaining a site security fence. Therefore, from the point-of-view of maintaining day-to-day function, the lesser options (No Action, Inst. Action, and InSitu) will be easier to implement, and the more intensive option, SC-2, more difficult to implement.

In terms of achieving the remedial action objectives, however, the reliability of an option is proportional to the greater intensity of the remedial actions contained in the option. Thus, the lowest reliabilities may be expected in the No Action, Inst. Action, and InSitu options, since

there is either no action occurring or there is a much greater reliance on monitoring and in-situ remedies, such as monitored natural attenuation. The SC-2 option provides a high level of reliability that the remedial action objectives can be achieved.

The ease of undertaking additional remedial actions, if warranted by future site conditions or requirements, is also proportional to the degree or intensity of each remedy. Options that use more intensive remedial technologies such as containment, in-situ or on-site treatment remedies will have the greatest difficulty in undertaking and implementing additional remedial actions. Conversely, options which utilize less intensive technologies such as institutional actions can more easily implement additional remedial actions. As a result, the No Action, Inst. Action, and InSitu options will be the easiest to implement additional remedial actions, if necessary, due to their use of either no action or use of limited actions. The SC-2 option will require a moderate effort to implement additional, future remedial actions.

**7.9.6.2 Administrative Feasibility.** The No Action option has the fewest administrative issues to address and only requires agreement among the regulatory agencies (local, state and federal) that no remedial actions are warranted at the AOC. Therefore, this option has the highest degree of administrative feasibility. Similarly, the Inst. Action option only requires agreement regarding monitoring locations and frequencies. The InSitu option has a moderate degree of administrative feasibility. The primary administrative burden will be regulatory agency concurrence on the particulars of the monitored natural attenuation programs. The SC-2 option will also encounter the administrative burden associated with a monitored natural attenuation program. Additionally, the SC-2 option has a higher administrative burden associated with short-term impacts to wetlands. The application of an active remedy associated with sediments nearly doubles the administrative requirements for permits, approvals, and agreements when compared with other options.

**7.9.6.3 Availability of Services and Materials.** Implementability with regard to the availability of services and materials includes an evaluation of three factors: 1) availability or usage of off-

site treatment, storage, and disposal facilities (TSDFs), 2) availability of necessary or specialized equipment or specialist personnel needed to implement the option, and 3) availability of prospective technologies required by the option. Each of these three factors is described for the options at this AOC.

All options are similar in that use of off-site TSDF services are not required to treat or dispose of contaminated media-of-concern. These options, therefore, will be easy to implement since reliance on an outside disposal contractor will not be required.

The No Action option does not require any specialized equipment or specialized personnel, so it will have the easiest implementability. The remaining options will all be comparable for only requiring low-to-moderate specialized and/or necessary equipment needs and specialist personnel. These relate to the following requirements: procurement of specialists for implementing and evaluating monitored natural attenuation, and heavy earthmoving equipment and expertise for civil/sitework and sediment excavation. As the SC-2 option requires more equipment than the other options, it is considered to be slightly less implementable.

### 7.9.7 Cost

The total net present worth costs (capital plus O&M over the duration of the remedial action) for the three options with action range from $1.53 million to $2.00 million. Costs for each option are summarized below, with further details presented in Appendix D. For the Institutional Action, Insitu, and SC-2 options, pre-design sediment sampling with toxicity testing costs have been included in the total capital cost estimate.

- No Action - capital = $0; O&M = $0; total = $0
- Inst. Action - capital = $0.12 million; O&M = $1.41 million; total = $1.53 million
- InSitu - capital = $0.12 million; O&M = $1.57 million; total = $1.69 million
- SC-2 - capital = $0.43 million; O&M = $1.57 million; total = $2.00 million

The costs presented provide order-of-magnitude estimates which may be used to compare the relative expense of each option. Contingencies of 20% on capital costs and 15% on O&M costs

are utilized to account for any inaccuracy of the costs. Based on the degree of accuracy of the estimates, the cost differences between some of the options may not be significant.

### 7.9.8 State Acceptance

Acceptance of the selected option for this AOC by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 7.9.9 Community Acceptance

Acceptance of the selected option for this AOC by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 7.10 WETLAND 2 GROUP - SEDIMENTS

Table 7-17 presents a summary of the primary evaluation factors and a comparative assessment of the technologies/process options evaluated for sediments at AOC #8b, Wetland 2 Group. These technologies/process options for remediation of sediment include:

- No Action;
- Inst. Action - Institutional actions consisting of monitoring;
- InSitu - In-situ remedy of monitored natural attenuation;
- SC-1 - Source control remedy consisting of horizontal containment (*e.g.*, natural or engineered cap) along with monitored natural attenuation of remaining sediments;
- SC-2 - Source control remedy consisting of sediment excavation and placement under caps at other on-site AOCs along with monitored natural attenuation of remaining sediments;
- SC/Off Site - Remedy consisting of sediment excavation and off site treatment/disposal along with monitored natural attenuation of remaining sediments;
- SC/OnSite-1 - Remedy consisting of sediment excavation and on-site treatment via solidification/stabilization along with monitored natural attenuation of remaining sediments;

- SC/OnSite-2 - Remedy consisting of sediment excavation and on-site treatment via sediment washing/chemical extraction along with monitored natural attenuation of remaining sediments.

### 7.10.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment, within the limits of the remedial action objectives defined for this feasibility study, is a key threshold criterion that must be attained by an option to be eligible for selection in the ROD. This section describes the overall assessment of whether each option achieves adequate protection of human health and the environment.

**7.10.1.1 Human Health Protection.** As noted in Section 2.0, there are no human health risks due to sediment at this AOC. Therefore, all actions achieve this criteria.

**7.10.1.2 Ecological Protection.** As noted in Section 2.0, there is ecological risk at this AOC due to organic and inorganic COCs. Of the technologies/process options evaluated, the five source control options (SC-1, SC-2, SC/Off Site, SC/OnSite-1, and SC/OnSite-2) would be protective of the environment. Each of these five options will significantly reduce the exposure of benthic organisms to sediment contaminants by capping (SC-1) or excavation/dredging (SC-2, SC/Off Site, SC/OnSite-1, and SC/OnSite-2) open water areas of the wetlands. Of the three remaining options (No Action, Inst. Action, and InSitu), none implement measures to directly remove/reduce exposure to contaminants in sediments. The only effects on the concentration of contaminants in sediments will be dilution/dispersal through slow, natural processes. Consequently, the concentration of contaminants in sediments on-site will not be substantially reduced under these options, and the risk to benthic invertebrates will persist. For exposure of benthic invertebrates, these three options do not meet this criterion.

The remedial technologies utilized by the eight options differ in the magnitude of the potential impacts on natural habitats. There will be no short-term environmental impacts from the implementation of the No Action, Inst. Action, and InSitu options. The most significant impacts

on wetland habitats will occur for the remaining options (SC-1, SC-2, SC/Off Site, SC/OnSite-1, and SC/OnSite-2). Each of these include either capping or dredging of wetland sediments. The potential impacts are highest for SC-1, since capping in B&M Pond will result in the most extensive loss of wetland habitat and require the largest amount of mitigation.

### 7.10.2 Compliance With ARARs

There are numerous federal and state regulatory requirements that are ARAR due to the specific compounds at the Site or due to site characteristics. Table 7-18 presents a summary of the ARARs associated with this AOC.

Primary location-specific ARARs for this AOC include requirements relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2), as well as requirements relating to historic landmarks, such as the Middlesex Canal. These requirements must be considered when conducting remedial actions. All planned remedial actions will limit/mitigate any wetland disturbances.

For this AOC, action-specific ARARs include requirements for transportation of potentially hazardous excavated material (SC/Off Site). Additionally, requirements relating to the discharge of soil washing water, to either groundwater or surface water, will be met (SC/OnSite-2). Of the eight options presented for this AOC, five (SC-1, SC-2, SC/Off Site, SC/OnSite-1, and SC/OnSite -2) meet the requirements of all ARARs. Two options, Inst. Action and InSitu-1, are not expected to attain wetland ARARs in a reasonable amount of time, and therefore only partially meet ARARs. The remaining option, No Action, does not meet ARARs.

### 7.10.3 Long-Term Effectiveness and Permanence

This section summarizes the evaluation for risks remaining at the Site after RAOs have been met, and for risks from management of residuals.

**7.10.3.1 Magnitude of Residual Risk: Human Health.** As noted in Section 2.0, there are no human health risks due to sediment at this AOC. Therefore, there will be no residual risk remaining following the use of any noted remedial option.

**7.10.3.2 Magnitude of Residual Risk: Ecological.** Of the technologies/process options evaluated, the No Action, Inst. Action, and InSitu options will not result in a quantifiable long-term reduction of risk to ecological receptors. These options will not remove or reduce risk to benthic invertebrates from exposure to sediments. Natural processes will tend to degrade organic contaminants (PAHs, pesticides) in sediments, and disperse all the contaminants (metals, PAHs, pesticides) through resuspension of sediments, transport downstream, deposition of new material, and vertical mixing by organisms in sediment. However, these processes are slow, and the source(s) of contaminants for additional accumulation in sediment (e.g., groundwater discharge and overland runoff from upland AOCs) will not be substantially reduced over time. Consequently, the reduction in concentration of contaminants resulting from natural processes will not be substantial, and the documented adverse impacts on the benthic communities will not be removed under these options.

The source control options will significantly reduce the exposure of benthic organisms to sediment contaminants by capping or dredging open water and "hot spot" areas of Wetland 2 Group, including the Unnamed Stream, the Fire Pond, and the B&M Pond. The dredging or capping will result in the reduction of mobility of total PAHs, 4,4'-DDD, antimony, copper, and lead from contaminated sediments in the treated areas. The elimination of exposure of benthic invertebrates to contaminants will be achieved in these areas. However, there will be residual risk to benthic invertebrates inhabiting adjacent emergent wetlands, where concentrations of analytes will not be reduced. The overall reduction of risk to benthic invertebrates will be substantial; the amount of remaining risk is unknown since the extent of area of sediments that will continue to exceed PRGs is unknown.

### 7.10.4 Reduction of Toxicity, Mobility and Volume Through Treatment

This section provides a comparison of the treatment and process options selected; quantities of waste materials to be remediated; expected reductions in toxicity, mobility and volume; and residuals following treatment options.

**7.10.4.1 Treatment/Recycling Processes Utilized.** The only treatment processes evaluated for mitigation of sediment at AOC #8b are monitored natural attenuation (InSitu), excavation with offsite treatment/disposal (as part of SC/Off Site), ex-situ solidification/stabilization (as part of SC/OnSite-1), and ex-situ soil washing/chemical extraction (as part of SC/OnSite-2). For the purposes of this FS, it is assumed that excavation with off site treatment/disposal will include treatment of contaminated sediments. The No Action option, Inst. Action option, and capping or excavation with capping portion of SC-1 and SC-2 are not considered treatment processes.

**7.10.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The amounts of waste materials to be treated or recycled are discussed below as an evaluation of whether the treatment processes will remediate the total quantity of known contaminated media. For specific quantities of contaminated media to be treated, refer to Section 5 text and tables.

For all treatment technologies/process options that use a combination of source control through active treatment and monitored natural attenuation (SC/Off Site, SC/OnSite-1, and SC/OnSite-2), the total quantity of contaminated sediments will be treated. Monitored natural attenuation when implemented as a stand-alone process (InSitu) is also expected to treat the total quantity of contaminated sediments at AOC #8b. Monitored natural attenuation, when implemented as part of SC-1 and SC-2, will treat all non-open water sediments. Contaminated sediments that will be capped in-place under SC-1 or excavated and placed under an on-site cap under SC-2 will not be treated.

**7.10.4.3 Degree of Expected Reductions in Toxicity, Mobility or Volume.** A detailed discussion of the reductions in toxicity, mobility and volume to be expected from treatment options is provided below. For the purposes of this FS in making comparisons between options, the toxicity of the contaminated media relative to a specific contaminant is assumed to be reduced proportionally to the reduction in volume of that specific toxic contaminant provided by a given treatment technology. Therefore, this discussion will be concentrated more on volume reductions than toxicity reductions. Reductions upon completion of the remedy, except for monitored natural attenuation, are considered in the evaluation. Monitored natural attenuation reductions are provided for the 30-year default remediation time period.

Excavation and off site treatment/disposal of open-water sediments (as part of SC/Off Site) provides the most effective treatment of the AOC #8b sediments. Removing the contaminated sediments from the Site eliminates the toxicity, mobility, and volume of contaminants at the Site.

Soil washing/chemical extraction processes of excavated open-water sediments (as part of SC/OnSite-2) are expected to provide substantial reductions in the volume of contaminants. The volume of contaminants is expected to be reduced by up to 90% through soil washing/chemical extraction processes. There is no expected contaminant mobility decrease through on-site soil washing/chemical extraction processes.

Excavation and on-site solidification/stabilization of open-water sediments (as part of SC/OnSite-1) is expected to reduce the mobility of contaminants similar to the mobility reduction resulting from on-site solidification/stabilization of soils, 93% to 99%. However, the volume of contaminants and the toxicity of the contaminated media will not be reduced, and the volume of contaminated media may be increased by up to 100% through implementation of SC/OnSite-1.

Monitored natural attenuation of all contaminated sediments at AOC #8b (InSitu) and non-open water sediments (as part of SC/Off Site, SC/OnSite-1 and SC/OnSite-2) is expected to result in small reductions in toxicity and volume over a 30-year period.

No treatment processes will be utilized for the No Action, Inst. Action, SC-1 and SC-2 options. Therefore, reductions in toxicity, mobility, and volume will not be expected or confirmed for these options.

**7.10.4.4 Reversibility.** Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. In general, active treatments (*e.g.*, sediment washing and chemical extraction of sediments) either destroy, degrade, or remove contaminants from the media of concern, and therefore, are not reversible.

Solidification/stabilization processes (as part of SC/OnSite-1) are considered reversible. These processes result in a stabilized mass that has the potential to weather and leach contaminants over time.

All other treatment processes to be implemented at AOC #8b, including monitored natural attenuation (InSitu) and soil washing/chemical extraction (as part of SC/OnSite-2), are not considered reversible. These processes remove and/or degrade contaminants.

**7.10.4.5 Type and Quantity of Residuals.** A comparison of types and quantities of residuals expected after completion of the treatment technologies/process options is provided below. The following discussion concentrates on contaminant residuals resulting from treatment. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are also discussed briefly below, as well as in the Section 5 tables titled "Quantities and Types of Hazardous Materials to be Treated and Process Residuals." Treatment/process residuals are the basis for the comparison of the treatment technology residuals in Table 7-17.

Excavation and off site treatment/disposal (as part of SC/Off Site) results in no residuals remaining on-site. Of the sediment treatment processes to be implemented at AOC #8b where contaminant residuals are to remain on-site, soil washing/chemical extraction processes (as part of SC/OnSite-2) will likely result in the least amount of contaminant residuals. Approximately 10% of the original volume of contaminants are expected to remain in the treated sediments. However, treatment/process residuals, including spent washing/extraction solvent, will be generated through soil washing/chemical extraction processes.

Significant residuals are likely to result following treatment by monitored natural attenuation (InSitu-1), since reductions of contaminant volumes in the sediment are expected to be low. The only treatment/process residuals expected to be produced by monitored natural attenuation are investigation-derived wastes.

The greatest amount of residuals are likely to remain from solidification/stabilization processes (as part of SC/OnSite-1). Through solidification/stabilization, the amount of contaminated media may increase up to 100% and all of the original contaminants will remain in the stabilized mass. For on-site solidification/stabilization, greater than 7% of organic and 1% of inorganic contaminants in these stabilized soils will have the potential to leach into groundwater. The amount of inorganics that have the potential to leach is the same for in-situ solidification/stabilization, while organic contaminants are more likely to leach (15%) with in-situ processes.

No treatment processes will be utilized in the No Action, Inst. Action, SC-1 and SC-2 options. Therefore, the original contamination at the AOC is expected to remain unchanged under these options.

### 7.10.5 Short-Term Effectiveness

The effectiveness of each remedial option during construction and implementation are compared to one another in the following paragraphs.

**7.10.5.1 Protection of Community and Workers During Remedial Actions.** Short-term risks include any additional risks to the community or workers at the Site from exposures to sediment COCs as a result of construction measures and implementation of remedial activities. There will be no additional short-term risks from exposures under the No Action option.

The Inst. Action and InSitu options will have nominal increases of short-term risks to the community and workers due to the requirement of performing sediment monitoring. Concentrations of COCs are expected to be greatest on-site. Therefore, workers at the Site will use appropriate PPE to mitigate any potential risks from exposures to sediment COCs.

The remaining source control options, SC-1, SC-2, SC/Off Site, SC/OnSite-1, and SC/OnSite-2, will have the greatest short-term risks to the community and workers due to the inclusion of excavation for sediments. Short-term risks will be mitigated by a variety of measures. Air sampling and monitoring will be used to evaluate any potential risks to the community associated with invasive sediment activities. Engineering controls will also be used to minimize the degree of invasive work and to mitigate potential risks from this exposure pathway. Workers will wear appropriate PPE to mitigate potential risks from increased exposures to COCs in sediment at the Site.

**7.10.5.2 Environmental Impacts.** The remedial technologies evaluated at this AOC differ in the magnitude of the potential impacts to natural habitats. There will be no short-term habitat impacts resulting from the No Action option. The Inst. Action and InSitu options will result in temporary and minor impacts resulting from sediment monitoring. The impacts to natural habitats will be greater for the source control options. Each of these options include capping or

dredging wetland sediments. The potential impacts will be highest for SC-1, since capping in B&M Pond will require the most extensive loss of wetland habitat and require the largest amount of mitigation. It is estimated that wetlands replacement would be performed over 9.7 acres for SC-1 and 2.6 acres for SC-2, SC/Off Site, SC/OnSite-1, and SC/OnSite-2.

**7.10.5.3 Time Until Remedial Action Objectives are Achieved.** Of the options evaluated for this AOC, only the source control options, SC-1, SC-2, SC/Off Site, SC/OnSite-1, and SC/OnSite-2, are expected to achieve RAOs quickly. Sediment excavation and capping (approximately 1 to 2 years) protects ecological receptors from COC exposure. Monitored natural attenuation, as part of InSitu, is not expected to reduce contaminant concentrations to PRGs in less than 30 years, the EPA default evaluation time period. Similarly, the No Action and Inst. Action options perform no actions which would be expected to achieve RAOs in less than 30 years.

### 7.10.6 Implementability

The options with the highest degree of implementability would have the following characteristics from EPA's FS guidance (U.S. EPA, 1988):

- require the lowest effort to construct, operate and maintain the technologies.
- include or consist only of the highest or most reliable technologies.
- require the lowest effort to undertake additional remedial actions, if necessary.
- include the fewest administrative hurdles for obtaining necessary permits, approvals and agreements.
- rely only minimally on off-site treatment, storage and disposal facility services (TSDFs)
- require the least amount or quantity of necessary specialized equipment and/or personnel specialists.
- utilize commonly available technologies to the largest degree.

Conversely, options with lesser degrees of implementability will have lesser degrees of the characteristics discussed above. The first three bullets define the "technical feasibility" with regard to implementability of the option, the fourth bullet defines "administrative feasibility,"

and the remaining three bullets define the "availability of services and materials" with respect to the option. These three factors combine to provide the overall degree of implementability of the option. After evaluating all options and combining the technical feasibility, administrative feasibility and availability of services and materials evaluations, the overall implementability comparison is as follows:

- The No Action option has the highest degree of overall implementability.
- The Inst. Action and InSitu options are comparable in their overall high degree of implementability or high relative ease to implement.
- The SC-1, SC-2, SC/Off Site, SC/OnSite-1, and SC/OnSite-2 options are comparable in their overall degree of lesser implementability or relative difficulty in implementing.

In general, more complex remedial technologies are more difficult to implement and will have lesser degrees of overall implementability compared to other, less complex, options. As a result, the No Action option is the most implementable, and the source control options are the least implementable.

Sections 7.10.6.1, 7.10.6.2, and 7.10.6.3 present more detailed evaluations of the comparison of implementability characteristics of the remedial options for which this analysis was performed.

**7.10.6.1 Technical Feasibility.** Implementability with regard to the technical feasibility of an option includes an evaluation of three factors: 1) ability to construct, operate and maintain the technologies, 2) the reliability of the technologies, and 3) the ease of undertaking additional remedial actions, if warranted by site conditions determined after implementation of the remedy. Each of these three factors is described for the options at this AOC.

The ability to construct, operate and maintain the technologies associated with each remedial option is proportional to the degree or intensity of each remedy. Options which use more intensive remedial technologies such as containment and in-situ or on-site treatments will have the greatest difficulty in implementing construction and O&M. Conversely, options which utilize less intensive technologies, such as institutional actions, will be easier to implement. As a

result, the No Action, Inst. Action, and InSitu options will be the easiest to construct, operate, and maintain due to their use of either no action or use of limited actions and monitoring. The source control options require a moderate-to-high effort to construct, operate and maintain.

All options contain remedial technologies that can be considered "reliable" in terms of relying or counting on the day-to-day functioning of the remedy as intended. This assessment is dependent on the assumption that proper construction techniques and O&M efforts are provided as appropriate to the level of the technology. Clearly, maintaining a treatment system will require a higher degree of effort than performing monitoring. Therefore, from the point-of-view of maintaining day-to-day function, the lesser options (No Action, Inst. Action, and InSitu) will be easier to implement, and the most intensive option, SC/OnSite-2, more difficult to implement.

In terms of achieving the remedial action objectives, however, the reliability of an option is proportional to the greater intensity of the remedial actions contained in the option. Thus, the lowest reliabilities may be expected in the No Action, Inst. Action, and InSitu options, since there is either no action occurring or there is a much greater reliance on monitoring and in-situ remedies, such as monitored natural attenuation. The source control options provide a high level of reliability that the remedial action objectives can be achieved.

The ease of undertaking additional remedial actions, if warranted by future site conditions or requirements, is also proportional to the degree or intensity of each remedy. Options that use more intensive remedial technologies such as containment, in-situ or on-site treatment remedies will have the greatest difficulty in undertaking and implementing additional remedial actions. Conversely, options which utilize less intensive technologies such as institutional actions can more easily implement additional remedial actions. As a result, the No Action, Inst. Action, and InSitu options will be the easiest to implement additional remedial actions, if necessary, due to their use of either no action or use of limited actions and institutional controls. The source control options will require a moderate effort to implement additional, future remedial actions.

**7.10.6.2 Administrative Feasibility.** The No Action option has the fewest administrative issues to address and only requires agreement among the regulatory agencies (local, state and federal) that no remedial actions are warranted at the AOC. Therefore, this option has the highest degree of administrative feasibility. Similarly, the Inst. Action option only requires agreement regarding monitoring locations and frequencies. The InSitu option has a moderate degree of administrative feasibility. The primary administrative burden will be regulatory agency concurrence on the particulars of the monitored natural attenuation programs. The source control options will also encounter the administrative burden associated with a monitored natural attenuation program. Additionally, the source control options have a higher administrative burden associated with short-term impacts to wetlands. The application of an active remedy associated with sediments nearly doubles the administrative requirements for permits, approvals, and agreements when compared with other options.

**7.10.6.3 Availability of Services and Materials.** Implementability with regard to the availability of services and materials includes an evaluation of three factors: 1) availability or usage of off-site treatment, storage, and disposal facilities (TSDFs), 2) availability of necessary or specialized equipment or specialist personnel needed to implement the option, and 3) availability of prospective technologies required by the option. Each of these three factors is described for the options at this AOC.

All options, except SC/Off Site, are similar in that use of off-site TSDF services are not required to treat or dispose of contaminated media-of-concern. These options, therefore, will be easy to implement since reliance on an outside disposal contractor will not be required. The SC/Off Site option requires the use of an off-site TSDF to treat and dispose of contaminated sediment, so it will have lesser implementability than the other options.

The No Action option does not require any specialized equipment or specialized personnel, so it will have the easiest implementability. Except for the off-site treatment/disposal (SC/Off Site), the SC-1, SC-2, and SC/Off Site options will all be comparable for only requiring low-to-

moderate specialized and/or necessary equipment needs and specialist personnel. These relate to the following requirements: procurement of specialists for implementing and evaluating monitored natural attenuation, and heavy earthmoving equipment and expertise for civil/sitework and sediment excavation. The SC/OnSite-1 and SC/OnSite-2 options will be comparable for requiring moderate-to-high specialized and/or necessary equipment needs and specialist personnel. These two options are similar to the other source control options with regards to monitored natural attenuation and sediment excavation. Additionally, these require specialists and equipment for on-site treatment of the sediments either by solidification/stabilization or soil washing/chemical extraction.

### 7.10.7 Cost

The total net present worth costs (capital plus O&M over the duration of the remedial action) for the seven options with action range from $2.09 million to $11.95 million. Costs for each option are summarized below, with further details presented in Appendix D.

- No Action - capital = $0; O&M = $0; total = $0
- Inst. Action - capital = $0.01 million; O&M = $2.08 million; total = $2.09 million
- InSitu - capital = $0.01 million; O&M = $2.34 million; total = $2.35 million
- SC-1 - capital = $4.48 million; O&M = $2.49 million; total = $6.97 million
- SC-2 - capital = $4.15 million; O&M = $2.34 million; total = $6.49 million
- SC/Off Site - capital = $6.89 million; O&M = $2.34 million; total = $9.23 million
- SC/OnSite-1 - capital = $6.98 million; O&M = $2.34 million; total = $9.32 million
- SC/OnSite-2 - capital = $9.61 million; O&M = $2.34 million; total = $11.95 million

The costs presented provide order-of-magnitude estimates which may be used to compare the relative expense of each option. Contingencies of 20% on capital costs and 15% on O&M costs are utilized to account for any inaccuracy of the costs. Based on the degree of accuracy of the estimates, the cost differences between some of the options may not be significant.

### 7.10.8 State Acceptance

Acceptance of the selected option for this AOC by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 7.10.9 Community Acceptance

Acceptance of the selected option for this AOC by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 7.11 WETLAND 2 GROUP - SURFACE WATER

Table 7-19 presents a summary of the primary evaluation factors and a comparative assessment of the technologies/process options evaluated for surface water at AOC #8b, Wetland 2 Group. These technologies/process options for remediation of surface water include:

- No Action;
- Inst. Action - Institutional actions consisting of monitoring;
- InSitu - In-situ remedy of monitored natural attenuation;
- OnSite-1 - Remedy consisting of surface water collection and treatment via phytoremediation, along with monitored natural attenuation of remaining surface water;
- OnSite-2 - Remedy consisting of surface water collection and treatment via biological/physical/chemical methods, along with monitored natural attenuation of remaining surface water.

### 7.11.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment, within the limits of the remedial action objectives defined for this feasibility study, is a key threshold criterion that must be attained by

an option to be eligible for selection in the ROD. This section describes the overall assessment of whether each option achieves adequate protection of human health and the environment.

**7.11.1.1 Human Health Protection.** As noted in Section 2.0, there are no human health risks due to surface water at this AOC. Therefore, all actions achieve this criteria.

**7.11.1.2 Ecological Protection.** As noted in Section 2.0, there is ecological risk at this AOC due to inorganics in surface water. However, since the relative amount of metal contamination in surface water that is contributed by groundwater discharge, surface water run-off, resuspension of sediments, or other sources under baseline conditions is unknown, it is not possible to distinguish the relative effectiveness of the treatment options presented in achieving RAOs and PRGs in surface water. Therefore, all of these options are assessed as achieving long-term reduction in exposure of aquatic receptors to surface water, but the relative effectiveness of each of these alternatives is not distinguishable. The InSitu option confirms reductions in surface water contaminants through monitored natural attenuation. More rapid reductions in surface water contaminants will be achieved by the OnSite-1 and OnSite-2 options, since collection and treatment of some surface water will be implemented. Treatment strategies will be employed in these two options that will allow relatively faster or more effective reduction of metals in surface water. However, surface water not collected will be subject to the long-term processes noted for monitored natural attenuation.

With regard to potential impacts of remedial technologies on natural habitats, there will be no short-term environmental impacts for the No Action option. Institutional actions and monitored natural attenuation (Inst. Action and InSitu) will result in temporary and minor impacts resulting from monitoring. The impacts on natural habitats will be greater for the collection and treatment options (OnSite-1 and OnSite-2). These options involve installation of collection pipes and pump stations. However, these potential impacts will be mitigated.

### 7.11.2 Compliance With ARARs

There are numerous federal and state regulatory requirements that are ARAR due to the specific compounds at the Site or due to site characteristics. A summary of the chemical-specific ARARs and guidance to be considered for actions at this AOC include:

- Federal Clean Water Act Ambient Water Quality Criteria. Remedial actions which include treatment of contaminated surface water will comply with these requirements.

Primary location-specific ARARs for this Site include requirements relating to federal and state stream, wetland, fish and wildlife, and floodplain regulations (see Section 2.3.2), as well as requirements relating to historic landmarks, such as the Middlesex Canal. These requirements must be considered when conducting remedial actions.

For any of the remedial options at this AOC, the ability of the surface water to meet water quality standards, over the long-term, is dependent upon source control remediation being completed (upland source AOCs and treatment of sediments). Therefore, in the short-term, the five options presented for this AOC (No Action, Inst. Action, InSitu, OnSite-1, and OnSite-2) only partially attain ARARs.

### 7.11.3 Long-Term Effectiveness and Permanence

This section summarizes the evaluation for risks remaining at the Site after RAOs have been met, and for risks from management of residuals.

**7.11.3.1 Magnitude of Residual Risk: Human Health.** As noted in Section 2.0, there are no human health risks due to surface water at this AOC. Therefore, there will be no residual risk remaining following the use of any noted remedial option.

**7.11.3.2 Magnitude of Residual Risk: Ecological.** Since the relative amount of metal contamination in surface water that is contributed by groundwater discharge, surface water run-off, resuspension of sediments, or other sources under baseline conditions is unknown, it is not possible to distinguish the relative effectiveness of the treatment options in reducing concentrations of metals in surface water. Therefore, all of these options are assessed as achieving long-term reduction in exposure of aquatic receptors to surface water, but the relative effectiveness of each of these alternatives is not distinguishable. The InSitu option confirms reductions in surface water contaminants through monitored natural attenuation. More rapid reductions in surface water contaminants will be achieved by the OnSite-1 and OnSite-2 options, since collection and treatment of some surface water will be implemented. Treatment strategies will be employed in these two options that will allow relatively faster or more effective reduction of metals in surface water. However, surface water not collected will be subject to the long-term processes noted for monitored natural attenuation. For the portion of the surface water that will be collected and treated, the toxicity of metals in surface water will be reduced proportional to the contaminant volume reduction (80-90%), but only a small portion of the water will be collected and treated. Therefore, the OnSite-1 and OnSite-2 options will result in a reduction of risk of aquatic receptor exposure to metals in surface water in a shorter period of time than the other options, which do not employ surface water treatment.

### 7.11.4 Reduction of Toxicity, Mobility and Volume Through Treatment

This section provides a comparison of the treatment and process options selected; quantities of waste materials to be remediated; expected reductions in toxicity, mobility and volume; and residuals following treatment options.

**7.11.4.1 Treatment/Recycling Processes Utilized.** Treatment processes evaluated for mitigation of surface water at AOC #8b include monitored natural attenuation, phytoremediation, and on-site biological/physical/chemical treatment. The No Action and Inst. Action options are not considered treatment processes.

**7.11.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The amounts of waste materials to be treated or recycled are discussed below as an evaluation of whether the treatment processes will remediate the total quantity of known contaminated media. For specific quantities of contaminated media to be treated, refer to Section 5 text and tables.

All treatment processes to be implemented for mitigation of surface water are expected to treat the total quantity of contaminated surface water at AOC #8b. Treatment processes include monitored natural attenuation (InSitu-1), and collection and treatment by either phytoremediation (OnSite-1) or biological/physical/chemical processes (OnSite-2) with monitored natural attenuation of remaining surface waters.

**7.11.4.3 Degree of Expected Reductions in Toxicity, Mobility or Volume.** A detailed discussion of the reductions in toxicity, mobility and volume to be expected from treatment options is provided below. For the purposes of this FS in making comparisons between options, the toxicity of the contaminated media relative to a specific contaminant is assumed to be reduced proportionally to the reduction in volume of that specific toxic contaminant provided by a given treatment technology. Therefore, this discussion will be concentrated more on volume reductions than toxicity reductions. Reductions upon completion of the remedy, except for monitored natural attenuation, are considered in the evaluation. Monitored natural attenuation reductions are provided for the 30-year default remediation time period.

The greatest degree of reductions in toxicity, mobility and/or volume are likely to result from OnSite-2, collection of a portion of surface waters and treatment by biological/physical/chemical processes and monitored natural attenuation of remaining surface waters. In the portion that is collected for treatment, organic contaminant volume reductions are expected to be 96% to 98%, while inorganics are likely to be reduced by 92% to 99% in volume. The mobility of contaminants will be proportional to the amount collected.

Very substantial reductions are also anticipated for the portion of surface water collected and treated by phytoremediation through OnSite-1. Volume reductions through phytoremediation are approximated at 90% to 95% for organic contaminants and 84% to 99% for inorganic contaminants.

Small reductions in toxicity and volume over a 30-year period are expected to result from monitored natural attenuation of remaining surface waters, as well as when monitored natural attenuation will be implemented as a stand-alone process (InSitu).

No treatment processes will be utilized for the No Action and Inst. Action options. Therefore, reductions in toxicity, mobility, and volume will not be expected or confirmed for these options.

**7.11.4.4 Reversibility.** Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. In general, active treatments (*e.g.*, surface water washing and chemical extraction of surface waters) either destroy, degrade, or remove contaminants from the media of concern, and therefore, are not reversible.

All treatment processes to be implemented for mitigation of contaminated surface waters at AOC #8b are not considered reversible. Through monitored natural attenuation, contaminants are either degraded or dispersed. Contaminants are removed from collected water by phytoremediation and biological/physical/chemical treatments.

**7.11.4.5 Type and Quantity of Residuals.** A comparison of types and quantities of residuals expected after completion of the treatment technologies/process options is provided below. The following discussion concentrates on contaminant residuals resulting from treatment. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are also discussed briefly below, as well as in the Section 5 tables titled "Quantities and Types of Hazardous Materials to

be Treated and Process Residuals." Treatment/process residuals are the basis for the comparison of the treatment technology residuals in Table 7-19.

The least amount of contaminant residuals, only 2% to 4% of organics and 1% to 8% of inorganics, will remain in the surface water after treatment by biological/physical/chemical processes (as part of OnSite-2). Slightly more contaminant residuals are expected to remain after treatment by phytoremediation (as part of OnSite-1). Approximately 5% to 10% of organics and 1% to 16% of inorganics will remain in the surface water collected and treated by phytoremediation. However, biological/physical/chemical processes will generate substantial quantities of process sludges and spent filter media/absorbent. Moderate quantities of treatment/process residuals are expected from treatment by phytoremediation. Phytoremediation treatment/process residuals include harvested plants and process media.

Following treatment by monitored natural attenuation, the remaining surface waters, as well as the total quantity of surface waters when monitored natural attenuation will be implemented as a stand-alone process, most of the contaminants will remain in the surface water. The only treatment/process residuals expected to be produced by monitored natural attenuation are investigation-derived wastes.

No treatment processes will be utilized in the other options. Therefore, the original contamination at the AOC is expected to remain unchanged under these options.

### 7.11.5 Short-Term Effectiveness

The effectiveness of each remedial option during construction and implementation are compared to one another in the following paragraphs.

**7.11.5.1 Protection of Community and Workers During Remedial Actions.** Short-term risks include any additional risks to the community or workers at the Site from exposures to surface

water COCs as a result of construction measures and implementation of remedial activities. There will be no additional short-term risks from exposures under the No Action option.

The Inst. Action and InSitu options will have nominal increases of short-term risks to the community and workers due to surface water monitoring. Concentrations of COCs are expected to be greatest on-site. Therefore, workers at the Site will use appropriate PPE to mitigate any potential risks from exposures to surface water COCs.

The remaining options, OnSite-1 and OnSite-2, will have the greatest short-term risks to the community and workers due to the inclusion of surface water collection (installation of piping and pump stations) and treatment. Short-term surface water risks will be mitigated by a variety of measures. Engineering controls will also be used to minimize the degree of invasive sediment work and to mitigate potential risks from this exposure pathway. Workers will wear appropriate PPE to mitigate potential risks from increased exposures to COCs in surface water at the Site.

**7.11.5.2 Environmental Impacts.** The remedial technologies evaluated at this AOC differ in the magnitude of the potential impacts to natural habitats. There will be no short-term habitat impacts resulting from the No Action, Inst. Action, and InSitu options. The impacts to natural habitats will be greater for the surface water collection and treatment options, OnSite-1 and OnSite-2. Each of these options include installation of piping and pumping stations. This involves excavation of wetland sediments and will temporarily displace some resident organisms. The potential impacts to wetlands from disturbance during construction are expected to be moderate and will be mitigated.

**7.11.5.3 Time Until Remedial Action Objectives are Achieved.** Since the relative amount of metal contamination in surface water that is contributed by groundwater discharge, surface water run-off, resuspension of sediments, or other sources under baseline conditions is unknown, it is not possible to distinguish the relative effectiveness of the treatment options presented in achieving RAOs and PRGs in surface water. Therefore, all of these options are assessed as

achieving long-term reduction in exposure of aquatic receptors to surface water, but the relative effectiveness of each of these alternatives is not distinguishable. More rapid reductions in surface water contaminants will be achieved by the OnSite-1 and OnSite-2 options, since collection and treatment of some surface water will be implemented. Treatment strategies will be employed in these two options that will allow relatively faster or more effective reduction of metals in surface water. However, surface water not collected will be subject to the long-term processes noted for monitored natural attenuation.

### 7.11.6 Implementability

The options with the highest degree of implementability would have the following characteristics from EPA's FS guidance (U.S. EPA, 1988):

- require the lowest effort to construct, operate and maintain the technologies.
- include or consist only of the highest or most reliable technologies.
- require the lowest effort to undertake additional remedial actions, if necessary.
- include the fewest administrative hurdles for obtaining necessary permits, approvals and agreements.
- rely only minimally on off-site treatment, storage and disposal facility services (TSDFs)
- require the least amount or quantity of necessary specialized equipment and/or personnel specialists.
- utilize commonly available technologies to the largest degree.

Conversely, options with lesser degrees of implementability will have lesser degrees of the characteristics discussed above. The first three bullets define the "technical feasibility" with regard to implementability of the option, the fourth bullet defines "administrative feasibility," and the remaining three bullets define the "availability of services and materials" with respect to the option. These three factors combine to provide the overall degree of implementability of the option. After evaluating all options and combining the technical feasibility, administrative feasibility and availability of services and materials evaluations, the overall implementability comparison is as follows:

- The No Action option has the highest degree of overall implementability.
- The Inst. Action and InSitu options are comparable in their overall high degree of implementability or high relative ease to implement.
- The OnSite-1 and OnSite-2 options are comparable in their overall low-to-moderate degree of implementability.

In general, more complex remedial technologies are more difficult to implement and will have lesser degrees of overall implementability compared to other, less complex, options. As a result, the No Action option is the most implementable, and the OnSite-1 option, collection followed by biological/physical/chemical treatment, is the least implementable.

Sections 7.11.6.1, 7.11.6.2, and 7.11.6.3 present more detailed evaluations of the comparison of implementability characteristics of the remedial options for which this analysis was performed.

**7.11.6.1 Technical Feasibility.** Implementability with regard to the technical feasibility of an option includes an evaluation of three factors: 1) ability to construct, operate and maintain the technologies, 2) the reliability of the technologies, and 3) the ease of undertaking additional remedial actions, if warranted by site conditions determined after implementation of the remedy. Each of these three factors is described for the options at this AOC.

The ability to construct, operate and maintain the technologies associated with each remedial option is proportional to the degree or intensity of each remedy. Options which use more intensive remedial technologies such as containment and in-situ or on-site treatments will have the greatest difficulty in implementing construction and O&M. Conversely, options which utilize less intensive technologies, such as institutional actions, will be easier to implement. As a result, the No Action, Inst. Action, and InSitu options will be the easiest to construct, operate, and maintain due to their use of either no action or use of limited actions. The OnSite-1 and OnSite-2 option requires a moderate-to-high effort to construct, operate and maintain.

All options contain remedial technologies that can be considered "reliable" in terms of relying or counting on the day-to-day functioning of the remedy as intended. This assessment is dependent

on the assumption that proper construction techniques and O&M efforts are provided as appropriate to the level of the technology. Clearly, maintaining a treatment system will require a higher degree of effort than performing monitoring. Therefore, from the point-of-view of maintaining day-to-day function, the lesser options (No Action, Inst. Action, and InSitu) will be easier to implement, and the more intensive options, OnSite-1 and OnSite-2, more difficult to implement.

In terms of achieving the remedial action objectives, however, the reliability of an option is proportional to the greater intensity of the remedial actions contained in the option. Thus, the lowest reliabilities may be expected in the No Action, Inst. Action, and InSitu options, since there is either no action occurring or there is a much greater reliance on monitoring and in-situ remedies, such as monitored natural attenuation. The OnSite-1 and OnSite-2 options provides a high level of reliability that the remedial action objectives can be achieved.

The ease of undertaking additional remedial actions, if warranted by future site conditions or requirements, is also proportional to the degree or intensity of each remedy. Options that use more intensive remedial technologies such as containment, in-situ or on-site treatment remedies will have the greatest difficulty in undertaking and implementing additional remedial actions. Conversely, options which utilize less intensive technologies such as institutional actions can more easily implement additional remedial actions. As a result, the No Action, Inst. Action, and InSitu options will be the easiest to implement additional remedial actions, if necessary, due to their use of either no action or use of limited actions and monitoring. The OnSite-1 and OnSite-2 options will require a moderate effort to implement additional, future remedial actions.

**7.11.6.2 Administrative Feasibility.** The No Action option has the fewest administrative issues to address and only requires agreement among the regulatory agencies (local, state and federal) that no remedial actions are warranted at the AOC. Therefore, this option has the highest degree of administrative feasibility. Similarly, the Inst. Action option only requires agreement regarding monitoring locations and frequencies. The InSitu option has a moderate degree of administrative

feasibility. The primary administrative burden will be regulatory agency concurrence on the particulars of the monitored natural attenuation programs. The remaining options (OnSite-1 and OnSite-2) will also encounter the administrative burden associated with a monitored natural attenuation program. Additionally, these options have a higher administrative burden associated with short-term impacts to wetlands. The application of an active remedy associated with surface water nearly doubles the administrative requirements for permits, approvals, and agreements when compared with other options.

**7.11.6.3 Availability of Services and Materials.** Implementability with regard to the availability of services and materials includes an evaluation of three factors: 1) availability or usage of off-site treatment, storage, and disposal facilities (TSDFs), 2) availability of necessary or specialized equipment or specialist personnel needed to implement the option, and 3) availability of prospective technologies required by the option. Each of these three factors is described for the options at this AOC.

All options are similar in that use of off-site TSDF services are not required to treat or dispose of contaminated media-of-concern. These options, therefore, will be easy to implement since reliance on an outside disposal contractor will not be required.

The No Action option does not require any specialized equipment or specialized personnel, so it will have the easiest implementability. The Inst. Action option will also only require personnel for monitoring and will be easy to implement. The InSitu option will only require low-to-moderate specialized and/or necessary equipment needs and specialist personnel. These relate to procurement of specialists for implementing and evaluating monitored natural attenuation. The OnSite-1 and OnSite-2 options will be comparable for requiring moderate-to-high specialized and/or necessary equipment needs and specialist personnel. These two options are similar to the InSitu option with regards to monitored natural attenuation. Additionally, these require specialists and equipment for collection and on-site treatment of the surface water either by

phytoremediation or biological/physical/chemical methods. As phytoremediation is less common than other methods, it is considered to be slightly less implementable.

### 7.11.7 Cost

The total net present worth costs (capital plus O&M over the duration of the remedial action) for the four options with action range from $1.93 million to $16.66 million. Costs for each option are summarized below, with further details presented in Appendix D.

- No Action - capital = $0; O&M = $0; total = $0
- Inst. Action - capital = $0.01 million; O&M = $1.92 million; total = $1.93 million
- InSitu - capital = $0.01 million; O&M = $3.25 million; total = $3.26 million
- OnSite-1 - capital = $2.00 million; O&M = $9.07 million; total = $11.07 million
- OnSite-2 - capital = $4.26 million; O&M = $12.40 million; total = $16.66 million

The costs presented provide order-of-magnitude estimates which may be used to compare the relative expense of each option. Contingencies of 20% on capital costs and 15% on O&M costs are utilized to account for any inaccuracy of the costs. Based on the degree of accuracy of the estimates, the cost differences between some of the options may not be significant.

### 7.11.8 State Acceptance

Acceptance of the selected option for this AOC by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 7.11.9 Community Acceptance

Acceptance of the selected option for this AOC by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 7.12 EAST MIDDLESEX CANAL GROUP

Table 7-20 presents a summary of the primary evaluation factors and a comparative assessment of the technologies/process options evaluated for AOC #8c, East Middlesex Canal Group. The only media of concern was sediment. These technologies/process options for remediation of sediment include:

- No Action;
- Inst. Action - Institutional actions consisting of monitoring;
- InSitu - In-situ remedy of monitored natural attenuation;
- SC-2 - Source control remedy consisting of sediment excavation and placement under caps at other on-site AOCs along with monitored natural attenuation of remaining sediments.

### 7.12.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment, within the limits of the remedial action objectives defined for this feasibility study, is a key threshold criterion that must be attained by an option to be eligible for selection in the ROD. This section describes the overall assessment of whether each option achieves adequate protection of human health and the environment.

**7.12.1.1 Human Health Protection.** As noted in Section 2.0, there are no human health risks due to sediment at this AOC. Therefore, all actions achieve this criteria.

**7.12.1.2 Ecological Protection.** As noted in Section 2.0, the extent and level of exceedences of sediment benchmarks did not clearly indicate risk to benthic invertebrate communities at this AOC. However, further toxicity testing at some stations has been proposed to confirm the potential biological effects of the sediment contaminants. If the future toxicity testing determines ecological risk in portions of this AOC, only one of the technologies/process options evaluated, source control through excavation (SC-2), would be protective of the environment. Of the three remaining options (No Action, Inst. Action, and InSitu), none implement measures to directly

remove/reduce exposure to contaminants in sediments. The only effects on the concentration of contaminants in sediments will be dilution/dispersal through slow, natural processes. Consequently, the concentration of contaminants in sediments on-site will not be substantially reduced under these options, and the exposure of benthic invertebrates to sediment contaminants will persist at or near existing levels. For exposure of benthic invertebrates in areas of confirmed toxicity, these three options do not meet this criterion.

### 7.12.2 Compliance With ARARs

There are numerous federal and state regulatory requirements that are ARAR due to the specific compounds at the Site or due to site characteristics. Table 7-21 presents a summary of the ARARs associated with this AOC.

Primary location-specific ARARs for this AOC include requirements relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2), as well as requirements relating to historic landmarks, such as the Middlesex Canal. These requirements must be considered when conducting remedial actions. All planned remedial actions will mitigate any wetland disturbances.

For this AOC, action-specific ARARs include requirements for transportation of potentially hazardous excavated material (SC-2). Of the four options presented for this AOC, only one (SC-2) meets the requirements of all ARARs. Two options, Inst. Action and InSitu-1, are not expected to attain wetland ARARs in a reasonable amount of time, and therefore only partially meet ARARs. The remaining option, No Action, does not meet ARARs.

### 7.12.3 Long-Term Effectiveness and Permanence

This section summarizes the evaluation for risks remaining at the Site after RAOs have been met, and for risks from management of residuals.

**7.12.3.1 Magnitude of Residual Risk: Human Health.** As noted in Section 2.0, there are no human health risks due to sediment at this AOC. Therefore, there will be no residual risk remaining following the use of any noted remedial option.

**7.12.3.2 Magnitude of Residual Risk: Ecological.** Of the technologies/process options evaluated, the No Action, Inst. Action, and InSitu options will not result in a quantifiable long-term reduction of risk to ecological receptors. These options will not remove or reduce risk to benthic invertebrates from exposure to sediments. Natural processes will tend to degrade organic contaminants (PAHs, pesticides) in sediments, and disperse all the contaminants (metals, PAHs, pesticides) through resuspension of sediments, transport downstream, deposition of new material, and vertical mixing by organisms in sediment. However, these processes are slow, and the source of contaminants for additional accumulation in sediment will not be substantially reduced over time. Consequently, the reduction in concentration of contaminants resulting from natural processes will not be substantial, and the potential adverse impacts on the benthic communities will not be removed under these options.

The SC-2 option includes spot excavation of isolated areas of sediment with high concentrations of COCs. Exposure of benthic invertebrates to COCs will be eliminated in the areas of excavation. Residual risk will remain in any areas in which sediments with concentrations of COCs exceeding any PRGs for this AOC are not excavated. It is assumed that the majority of the sediments with COCs above PRGs will be removed and the exposure to COCs will be substantially below baseline conditions.

### 7.12.4 Reduction of Toxicity, Mobility and Volume Through Treatment

This section provides a comparison of the treatment and process options selected; quantities of waste materials to be remediated; expected reductions in toxicity, mobility and volume; and residuals following treatment options.

**7.12.4.1 Treatment/Recycling Processes Utilized.** The only treatment process evaluated for mitigation of sediment at AOC #8c is a relatively simple in-situ process. The No Action , Inst. Action, and SC-2 options are not considered treatment processes. Monitored natural attenuation of sediments (InSitu), considered a less complex treatment, is evaluated below.

**7.12.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The amounts of waste materials to be treated or recycled are discussed below as an evaluation of whether the treatment processes will remediate the total quantity of known contaminated media. For specific quantities of contaminated media to be treated, refer to Section 5 text and tables.

Monitored natural attenuation when implemented as a stand-alone process (InSitu) is expected to treat the total quantity of contaminated sediments at AOC #8c. When implemented as part of SC-2, monitored natural attenuation will treat all non-excavated sediments. Contaminated sediments that will be excavated and placed under an on-site cap under SC-2 will not be treated.

**7.12.4.3 Degree of Expected Reductions in Toxicity, Mobility or Volume.** A detailed discussion of the reductions in toxicity, mobility and volume to be expected from treatment options is provided below. For the purposes of this FS in making comparisons between options, the toxicity of the contaminated media relative to a specific contaminant is assumed to be reduced proportionally to the reduction in volume of that specific toxic contaminant provided by a given treatment technology. Therefore, this discussion will be concentrated more on volume reductions than toxicity reductions. Reductions upon completion of the remedy, except for monitored natural attenuation, are considered in the evaluation. Monitored natural attenuation reductions are provided for the 30-year default remediation time period.

Monitored natural attenuation of sediments implemented at AOC #8c is expected to result in small reductions in toxicity and volume over a 30-year period. No treatment processes will be utilized for the No Action, Inst. Action, and SC-2 options. Therefore, reductions in toxicity, mobility, and volume will not be expected or confirmed for these options.

**7.12.4.4 Reversibility.** Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. In general, active treatments (*e.g.*, sediment washing and chemical extraction of sediments) either destroy, degrade, or remove contaminants from the media of concern, and therefore, are not reversible.

Monitored natural attenuation, the only treatment option evaluated for mitigation of contaminated sediments at AOC #8c, is not considered reversible. Organic contaminants are degraded over time. Although inorganic contaminants may be temporarily immobilized, they will likely be dispersed over time.

**7.12.4.5 Type and Quantity of Residuals.** A comparison of types and quantities of residuals expected after completion of the treatment technologies/process options is provided below. The following discussion concentrates on contaminant residuals resulting from treatment. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are also discussed briefly below, as well as in the Section 5 tables titled "Quantities and Types of Hazardous Materials to be Treated and Process Residuals." Treatment/process residuals are the basis for the comparison of the treatment technology residuals in Table 7-20.

At AOC #8c, most of the contaminants will remain sorbed to the sediment following treatment by monitored natural attenuation. The only treatment/process residuals expected to be produced by monitored natural attenuation are investigation-derived wastes.

No treatment processes will be utilized in the other options. Therefore, the original contamination at the AOC is expected to remain unchanged under these options.

### 7.12.5 Short-Term Effectiveness

The effectiveness of each remedial option during construction and implementation are compared to one another in the following paragraphs.

**7.12.5.1 Protection of Community and Workers During Remedial Actions.** Short-term risks include any additional risks to the community or workers at the Site from exposures to sediment COCs as a result of construction measures and implementation of remedial activities. There will be no additional short-term risks from exposures under the No Action option.

The Inst. Action and InSitu options will have nominal increases of short-term risks to the community and workers due to the requirement of performing sediment monitoring. Concentrations of COCs are expected to be greatest on-site. Therefore, workers at the Site will use appropriate PPE to mitigate any potential risks from exposures to sediment COCs.

The remaining option, SC-2, will have the greatest short-term risks to the community and workers due to the inclusion of excavation for sediments. Short-term risks will be mitigated by a variety of measures. Air sampling and monitoring will be used to evaluate any potential risks to the community associated with invasive sediment activities. Engineering controls will also be used to minimize the degree of invasive work and to mitigate potential risks from this exposure pathway. Workers will wear appropriate PPE to mitigate potential risks from increased exposures to COCs in sediment at the Site.

**7.12.5.2 Environmental Impacts.** The remedial technologies evaluated at this AOC differ in the magnitude of the potential impacts to natural habitats. There will be no short-term habitat impacts resulting from the No Action option. The Inst. Action and InSitu options will result in temporary and minor impacts resulting from sediment monitoring. The impacts to natural habitats will be greater for the SC-2 option. This involves excavation of wetland sediments and will temporarily displace some resident organisms. The potential impacts to wetlands from

disturbance during construction are expected to be major and will be mitigated. It is estimated that wetlands replacement will be performed over one acre for the SC-2 option.

**7.12.5.3 Time Until Remedial Action Objectives are Achieved.** Of the options evaluated for this AOC, only SC-2 is expected to achieve RAOs quickly. Sediment excavation (approximately 1 to 2 years) protects ecological receptors from COC exposure. Monitored natural attenuation, as part of InSitu, is not expected to reduce contaminant concentrations to PRGs in less than 30 years, the EPA default evaluation time period. Similarly, the No Action and Inst. Action options perform no actions which would be expected to achieve RAOs in less than 30 years.

### 7.12.6 Implementability

The options with the highest degree of implementability would have the following characteristics from EPA's FS guidance (U.S. EPA, 1988):

- require the lowest effort to construct, operate and maintain the technologies.
- include or consist only of the highest or most reliable technologies.
- require the lowest effort to undertake additional remedial actions, if necessary.
- include the fewest administrative hurdles for obtaining necessary permits, approvals and agreements.
- rely only minimally on off-site treatment, storage and disposal facility services (TSDFs)
- require the least amount or quantity of necessary specialized equipment and/or personnel specialists.
- utilize commonly available technologies to the largest degree.

Conversely, options with lesser degrees of implementability will have lesser degrees of the characteristics discussed above. The first three bullets define the "technical feasibility" with regard to implementability of the option, the fourth bullet defines "administrative feasibility,"

and the remaining three bullets define the "availability of services and materials" with respect to the option. These three factors combine to provide the overall degree of implementability of the option. After evaluating all options and combining the technical feasibility, administrative feasibility and availability of services and materials evaluations, the overall implementability comparison is as follows:

- The No Action option has the highest degree of overall implementability.
- The Inst. Action and InSitu options are comparable in their overall high degree of implementability or high relative ease to implement.
- The SC-2 option has an overall moderate degree of implementability.

In general, more complex remedial technologies are more difficult to implement and will have lesser degrees of overall implementability compared to other, less complex, options. As a result, the No Action option is the most implementable, and the SC-2 option, excavation, is the least implementable.

Sections 7.12.6.1, 7.12.6.2, and 7.12.6.3 present more detailed evaluations of the comparison of implementability characteristics of the remedial options for which this analysis was performed.

**7.12.6.1 Technical Feasibility.** Implementability with regard to the technical feasibility of an option includes an evaluation of three factors: 1) ability to construct, operate and maintain the technologies, 2) the reliability of the technologies, and 3) the ease of undertaking additional remedial actions, if warranted by site conditions determined after implementation of the remedy. Each of these three factors is described for the options at this AOC.

The ability to construct, operate and maintain the technologies associated with each remedial option is proportional to the degree or intensity of each remedy. Options which use more intensive remedial technologies such as containment and in-situ or on-site treatments will have the greatest difficulty in implementing construction and O&M. Conversely, options which utilize less intensive technologies, such as institutional actions, will be easier to implement. As a

result, the No Action, Inst. Action, and InSitu options will be the easiest to construct, operate, and maintain due to their use of either no action or use of limited actions. The SC-2 option requires a moderate effort to construct, operate and maintain.

All options contain remedial technologies that can be considered "reliable" in terms of relying or counting on the day-to-day functioning of the remedy as intended. This assessment is dependent on the assumption that proper construction techniques and O&M efforts are provided as appropriate to the level of the technology. Clearly, maintaining a landfill cap will require a higher degree of effort than maintaining a site security fence. Therefore, from the point-of-view of maintaining day-to-day function, the lesser options (No Action, Inst. Action, and InSitu) will be easier to implement, and the more intensive option, SC-2, more difficult to implement.

In terms of achieving the remedial action objectives, however, the reliability of an option is proportional to the greater intensity of the remedial actions contained in the option. Thus, the lowest reliabilities may be expected in the No Action, Inst. Action, and InSitu options, since there is either no action occurring or there is a much greater reliance on monitoring and in-situ remedies, such as monitored natural attenuation. The SC-2 option provides a high level of reliability that the remedial action objectives can be achieved.

The ease of undertaking additional remedial actions, if warranted by future site conditions or requirements, is also proportional to the degree or intensity of each remedy. Options that use more intensive remedial technologies such as containment, in-situ or on-site treatment remedies will have the greatest difficulty in undertaking and implementing additional remedial actions. Conversely, options which utilize less intensive technologies such as institutional actions can more easily implement additional remedial actions. As a result, the No Action, Inst. Action, and InSitu options will be the easiest to implement additional remedial actions, if necessary, due to their use of either no action or use of limited actions. The SC-2 option will require a moderate effort to implement additional, future remedial actions.

**7.12.6.2 Administrative Feasibility.** The No Action option has the fewest administrative issues to address and only requires agreement among the regulatory agencies (local, state and federal) that no remedial actions are warranted at the AOC. Therefore, this option has the highest degree of administrative feasibility. Similarly, the Inst. Action option only requires agreement regarding monitoring locations and frequencies. The InSitu option has a moderate degree of administrative feasibility. The primary administrative burden will be regulatory agency concurrence on the particulars of the monitored natural attenuation programs. The SC-2 option will also encounter the administrative burden associated with a monitored natural attenuation program. Additionally, the SC-2 option has a higher administrative burden associated with short-term impacts to wetlands. The application of an active remedy associated with sediments nearly doubles the administrative requirements for permits, approvals, and agreements when compared with other options.

**7.12.6.3 Availability of Services and Materials.** Implementability with regard to the availability of services and materials includes an evaluation of three factors: 1) availability or usage of off-site treatment, storage, and disposal facilities (TSDFs), 2) availability of necessary or specialized equipment or specialist personnel needed to implement the option, and 3) availability of prospective technologies required by the option. Each of these three factors is described for the options at this AOC.

All options are similar in that use of off-site TSDF services are not required to treat or dispose of contaminated media-of-concern. These options, therefore, will be easy to implement since reliance on an outside disposal contractor will not be required.

The No Action option does not require any specialized equipment or specialized personnel, so it will have the easiest implementability. The remaining options will all be comparable for only requiring low-to-moderate specialized and/or necessary equipment needs and specialist personnel. These relate to the following requirements: procurement of specialists for implementing and evaluating monitored natural attenuation, and heavy earthmoving equipment

and expertise for civil/sitework and sediment excavation. As the SC-2 option requires more equipment than the other options, it is considered to be slightly less implementable.

### 7.12.7 Cost

The total net present worth costs (capital plus O&M over the duration of the remedial action) for the three options with action range from $1.55 million to $2.02 million. Costs for each option are summarized below, with further details presented in Appendix D. For the Institutional Action, Insitu, and SC-2 options, pre-design sediment sampling with toxicity testing costs have been included in the total capital cost estimate.

- No Action - capital = $0; O&M = $0; total = $0
- Inst. Action - capital = $0.08 million; O&M = $1.47 million; total = $1.55 million
- InSitu - capital = $0.08 million; O&M = $1.64 million; total = $1.72 million
- SC-2 - capital = $0.38 million; O&M = $1.64 million; total = $2.02 million

The costs presented provide order-of-magnitude estimates which may be used to compare the relative expense of each option. Contingencies of 20% on capital costs and 15% on O&M costs are utilized to account for any inaccuracy of the costs. Based on the degree of accuracy of the estimates, the cost differences between some of the options may not be significant.

### 7.12.8 State Acceptance

Acceptance of the selected option for this AOC by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 7.12.9 Community Acceptance

Acceptance of the selected option for this AOC by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 7.13 RICHARDSON POND GROUP - SEDIMENTS

Table 7-22 presents a summary of the primary evaluation factors and a comparative assessment of the technologies/process options evaluated for sediments at AOC #8d, Richardson Pond Group. These technologies/process options for remediation of sediment include:

- No Action;
- Inst. Action - Institutional actions consisting of monitoring;
- InSitu - In-situ remedy of monitored natural attenuation;
- SC-2 - Source control remedy consisting of sediment excavation and placement under caps at other on-site AOCs along with monitored natural attenuation of remaining sediments.

### 7.13.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment, within the limits of the remedial action objectives defined for this feasibility study, is a key threshold criterion that must be attained by an alternative to be eligible for selection in the ROD. This section describes the overall assessment of whether each alternative achieves adequate protection of human health and the environment.

**7.13.1.1 Human Health Protection.** As noted in Section 2.0, there are no human health risks due to sediment at this AOC. Therefore, all actions achieve this criteria.

**7.13.1.2 Ecological Protection.** As noted in Section 2.0, there is ecological risk at this AOC due to PAHs in sediment. Of the technologies/process options evaluated, only source control through excavation (SC-2) would be protective of the environment. Of the three remaining options (No Action, Inst. Action, and InSitu), none implement measures to directly remove/reduce exposure to contaminants in sediments. The only effects on the concentration of contaminants in sediments will be dilution/dispersal through slow, natural processes. Consequently, the concentration of contaminants in sediments on-site will not be substantially

reduced under these options, and the risk to benthic invertebrates will persist. For exposure of benthic invertebrates, these three options do not meet this criterion.

The remedial technologies utilized by the four options differ in the magnitude of the potential impacts on natural habitats. There will be no short-term environmental impacts from the implementation of the No Action, Inst. Action, and InSitu options. The most significant impacts on wetland habitats will occur for the SC-2 option since it includes excavation of wetland sediments. However, these potential impacts will be mitigated.

### 7.13.2 Compliance With ARARs

There are numerous federal and state regulatory requirements that are ARAR due to the specific compounds at the Site or due to site characteristics. Table 7-23 presents a summary of the ARARs associated with this AOC.

Primary location-specific ARARs for this AOC include requirements relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2), as well as requirements relating to historic landmarks, such as the Middlesex Canal. These requirements should be considered when conducting remedial actions. All planned remedial actions will mitigate any wetland disturbances.

For this AOC, action-specific ARARs include requirements for transportation of potentially hazardous excavated material (SC-2). Of the four options presented for this AOC, only one (SC-2) meets the requirements of all ARARs. Two options, Inst. Action and InSitu-1, are not expected to attain wetland ARARs in a reasonable amount of time, and therefore only partially meet ARARs. The remaining option, No Action, does not meet ARARs.

### 7.13.3 Long-Term Effectiveness and Permanence

This section summarizes the evaluation for risks remaining at the Site after RAOs have been met, and for risks from management of residuals.

**7.13.3.1 Magnitude of Residual Risk: Human Health.** As noted in Section 2.0, there are no human health risks due to sediment at this AOC. Therefore, there will be no residual risk remaining following the use of any noted remedial option.

**7.13.3.2 Magnitude of Residual Risk: Ecological.** Of the technologies/process options evaluated, the No Action, Inst. Action, and InSitu options will not result in a quantifiable long-term reduction of risk to ecological receptors. These options will not remove or reduce risk to benthic invertebrates from exposure to sediments. Natural processes will tend to degrade organic contaminants in sediments, and disperse all the contaminants through resuspension of sediments, transport downstream, deposition of new material, and vertical mixing by organisms in sediment. However, these processes are slow, and the source of contaminants for additional accumulation in sediment will not be substantially reduced over time. Consequently, the reduction in concentration of contaminants resulting from natural processes will not be substantial, and the documented adverse impacts on the benthic communities will not be removed under these options.

The SC-2 option includes spot excavation of isolated areas of sediment with high concentrations of COCs. Exposure of benthic invertebrates to COCs will be eliminated in the areas of excavation. Residual risk will remain in any areas in which sediments with concentrations of COCs exceeding any PRGs for this AOC are not excavated. It is assumed that the majority of the sediments with COCs above PRGs will be removed and the exposure to COCs will be substantially below baseline conditions.

### 7.13.4 Reduction of Toxicity, Mobility and Volume Through Treatment

This section provides a comparison of the treatment and process options selected; quantities of waste materials to be remediated; expected reductions in toxicity, mobility and volume; and residuals following treatment options.

**7.13.4.1 Treatment/Recycling Processes Utilized.** The only treatment process evaluated for mitigation of sediment at AOC #8d is a relatively simple in-situ process. The No Action , Inst. Action, and SC-2 options are not considered treatment processes. Monitored natural attenuation of sediments (InSitu), considered a less complex treatment, is evaluated below.

**7.13.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The amounts of waste materials to be treated or recycled are discussed below as an evaluation of whether the treatment processes will remediate the total quantity of known contaminated media. For specific quantities of contaminated media to be treated, refer to Section 5 text and tables.

Monitored natural attenuation when implemented as a stand-alone process (InSitu) is expected to treat the total quantity of contaminated sediments at AOC #8d. When implemented as part of SC-2, monitored natural attenuation will treat all non-excavated sediments. Contaminated sediments that will be excavated and placed under an on-site cap under SC-2 will not be treated.

**7.13.4.3 Degree of Expected Reductions in Toxicity, Mobility or Volume.** A detailed discussion of the reductions in toxicity, mobility and volume to be expected from treatment options is provided below. For the purposes of this FS in making comparisons between options, the toxicity of the contaminated media relative to a specific contaminant is assumed to be reduced proportionally to the reduction in volume of that specific toxic contaminant provided by a given treatment technology. Therefore, this discussion will be concentrated more on volume reductions than toxicity reductions. Reductions upon completion of the remedy, except for

monitored natural attenuation, are considered in the evaluation. Monitored natural attenuation reductions are provided for the 30-year default remediation time period.

Monitored natural attenuation of sediments implemented at AOC #8d is expected to result in small reductions in toxicity and volume over a 30-year period. No treatment processes will be utilized for the No Action, Inst. Action, and SC-2 options. Therefore, reductions in toxicity, mobility, and volume will not be expected or confirmed for these options.

**7.13.4.4 Reversibility.** Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. In general, active treatments (*e.g.*, sediment washing and chemical extraction of sediments) either destroy, degrade, or remove contaminants from the media of concern, and therefore, are not reversible.

Monitored natural attenuation, the only treatment option evaluated for mitigation of contaminated sediments at AOC #8d, is not considered reversible. Organic contaminants are degraded over time. Although inorganic contaminants may be temporarily immobilized, they will likely be dispersed over time.

**7.13.4.5 Type and Quantity of Residuals.** A comparison of types and quantities of residuals expected after completion of the treatment technologies/process options is provided below. The following discussion concentrates on contaminant residuals resulting from treatment. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are also discussed briefly below, as well as in the Section 5 tables titled "Quantities and Types of Hazardous Materials to be Treated and Process Residuals." Treatment/process residuals are the basis for the comparison of the treatment technology residuals in Table 7-22.

At AOC #8d, most of the contaminants will remain sorbed to the sediment following treatment by monitored natural attenuation. The only treatment/process residuals expected to be produced by monitored natural attenuation are investigation-derived wastes.

No treatment processes will be utilized in the other options. Therefore, the original contamination at the AOC is expected to remain unchanged under these options.

### 7.13.5 Short-Term Effectiveness

The effectiveness of each remedial option during construction and implementation are compared to one another in the following paragraphs.

**7.13.5.1 Protection of Community and Workers During Remedial Actions.** Short-term risks include any additional risks to the community or workers at the Site from exposures to sediment COCs as a result of construction measures and implementation of remedial activities. There will be no additional short-term risks from exposures under the No Action option.

The Inst. Action and InSitu options will have nominal increases of short-term risks to the community and workers due to the requirement of performing sediment monitoring. Concentrations of COCs are expected to be greatest on-site. Therefore, workers at the Site will use appropriate PPE to mitigate any potential risks from exposures to sediment COCs.

The remaining option, SC-2, will have the greatest short-term risks to the community and workers due to the inclusion of excavation for sediments. Short-term risks will be mitigated by a variety of measures. Air sampling and monitoring will be used to evaluate any potential risks to the community associated with invasive sediment activities. Engineering controls will also be used to minimize the degree of invasive work and to mitigate potential risks from this exposure pathway. Workers will wear appropriate PPE to mitigate potential risks from increased exposures to COCs in sediment at the Site.

**7.13.5.2 Environmental Impacts.** The remedial technologies evaluated at this AOC differ in the magnitude of the potential impacts to natural habitats. There will be no short-term habitat impacts resulting from the No Action option. The Inst. Action and InSitu options will result in temporary and minor impacts resulting from sediment monitoring. The impacts to natural habitats will be greater for the SC-2 option. This involves excavation of wetland sediments and will temporarily displace some resident organisms. The potential impacts to wetlands from disturbance during construction are expected to be major and will be mitigated. It is estimated that wetlands replacement will be performed over one acre for the SC-2 option.

**7.13.5.3 Time Until Remedial Action Objectives are Achieved.** Of the options evaluated for this AOC, only SC-2 is expected to achieve RAOs quickly. Sediment excavation (approximately 1 to 2 years) protects ecological receptors from COC exposure. Monitored natural attenuation, as part of InSitu, is not expected to reduce contaminant concentrations to PRGs in less than 30 years, the EPA default evaluation time period. Similarly, the No Action and Inst. Action options perform no actions which would be expected to achieve RAOs in less than 30 years.

### 7.13.6 Implementability

The options with the highest degree of implementability would have the following characteristics from EPA's FS guidance (U.S. EPA, 1988):

- require the lowest effort to construct, operate and maintain the technologies.
- include or consist only of the highest or most reliable technologies.
- require the lowest effort to undertake additional remedial actions, if necessary.
- include the fewest administrative hurdles for obtaining necessary permits, approvals and agreements.
- rely only minimally on off-site treatment, storage and disposal facility services (TSDFs)
- require the least amount or quantity of necessary specialized equipment and/or personnel specialists.
- utilize commonly available technologies to the largest degree.

Conversely, options with lesser degrees of implementability will have lesser degrees of the characteristics discussed above. The first three bullets define the "technical feasibility" with regard to implementability of the option, the fourth bullet defines "administrative feasibility," and the remaining three bullets define the "availability of services and materials" with respect to the option. These three factors combine to provide the overall degree of implementability of the option. After evaluating all options and combining the technical feasibility, administrative feasibility and availability of services and materials evaluations, the overall implementability comparison is as follows:

- The No Action option has the highest degree of overall implementability.
- The Inst. Action and InSitu options are comparable in their overall high degree of implementability or high relative ease to implement.
- The SC-2 option has an overall moderate degree of implementability.

In general, more complex remedial technologies are more difficult to implement and will have lesser degrees of overall implementability compared to other, less complex, options. As a result, the No Action option is the most implementable, and the SC-2 option, excavation, is the least implementable.

Sections 7.13.6.1, 7.13.6.2, and 7.13.6.3 present more detailed evaluations of the comparison of implementability characteristics of the remedial options for which this analysis was performed.

**7.13.6.1 Technical Feasibility.** Implementability with regard to the technical feasibility of an option includes an evaluation of three factors: 1) ability to construct, operate and maintain the technologies, 2) the reliability of the technologies, and 3) the ease of undertaking additional remedial actions, if warranted by site conditions determined after implementation of the remedy. Each of these three factors is described for the options at this AOC.

The ability to construct, operate and maintain the technologies associated with each remedial option is proportional to the degree or intensity of each remedy. Options which use more

intensive remedial technologies such as containment and in-situ or on-site treatments will have the greatest difficulty in implementing construction and O&M. Conversely, options which utilize less intensive technologies, such as institutional actions, will be easier to implement. As a result, the No Action, Inst. Action, and InSitu options will be the easiest to construct, operate, and maintain due to their use of either no action or use of limited actions. The SC-2 option requires a moderate effort to construct, operate and maintain.

All options contain remedial technologies that can be considered "reliable" in terms of relying or counting on the day-to-day functioning of the remedy as intended. This assessment is dependent on the assumption that proper construction techniques and O&M efforts are provided as appropriate to the level of the technology. Clearly, maintaining a landfill cap will require a higher degree of effort than maintaining a site security fence. Therefore, from the point-of-view of maintaining day-to-day function, the lesser options (No Action, Inst. Action, and InSitu) will be easier to implement, and the more intensive option, SC-2, more difficult to implement.

In terms of achieving the remedial action objectives, however, the reliability of an option is proportional to the greater intensity of the remedial actions contained in the option. Thus, the lowest reliabilities may be expected in the No Action, Inst. Action, and InSitu options, since there is either no action occurring or there is a much greater reliance on monitoring and in-situ remedies, such as monitored natural attenuation. The SC-2 option provides a high level of reliability that the remedial action objectives can be achieved.

The ease of undertaking additional remedial actions, if warranted by future site conditions or requirements, is also proportional to the degree or intensity of each remedy. Options that use more intensive remedial technologies such as containment, in-situ or on-site treatment remedies will have the greatest difficulty in undertaking and implementing additional remedial actions. Conversely, options which utilize less intensive technologies such as institutional actions can more easily implement additional remedial actions. As a result, the No Action, Inst. Action, and InSitu options will be the easiest to implement additional remedial actions, if necessary, due to

their use of either no action or use of limited actions. The SC-2 option will require a moderate effort to implement additional, future remedial actions.

**7.13.6.2 Administrative Feasibility.** The No Action option has the fewest administrative issues to address and only requires agreement among the regulatory agencies (local, state and federal) that no remedial actions are warranted at the AOC. Therefore, this option has the highest degree of administrative feasibility. Similarly, the Inst. Action option only requires agreement regarding monitoring locations and frequencies. The InSitu option has a moderate degree of administrative feasibility. The primary administrative burden will be regulatory agency concurrence on the particulars of the monitored natural attenuation programs. The SC-2 option will also encounter the administrative burden associated with a monitored natural attenuation program. Additionally, the SC-2 option has a higher administrative burden associated with short-term impacts to wetlands. The application of an active remedy associated with sediments nearly doubles the administrative requirements for permits, approvals, and agreements when compared with other options.

**7.13.6.3 Availability of Services and Materials.** Implementability with regard to the availability of services and materials includes an evaluation of three factors: 1) availability or usage of off-site treatment, storage, and disposal facilities (TSDFs), 2) availability of necessary or specialized equipment or specialist personnel needed to implement the option, and 3) availability of prospective technologies required by the option. Each of these three factors is described for the options at this AOC.

All options are similar in that use of off-site TSDF services are not required to treat or dispose of contaminated media-of-concern. These options, therefore, will be easy to implement since reliance on an outside disposal contractor will not be required.

The No Action option does not require any specialized equipment or specialized personnel, so it will have the easiest implementability. The remaining options will all be comparable for only

requiring low-to-moderate specialized and/or necessary equipment needs and specialist personnel. These relate to the following requirements: procurement of specialists for implementing and evaluating monitored natural attenuation, and heavy earthmoving equipment and expertise for civil/sitework and sediment excavation. As the SC-2 option requires more equipment than the other options, it is considered to be slightly less implementable.

### 7.13.7 Cost

The total net present worth costs (capital plus O&M over the duration of the remedial action) for the three options with action range from $1.50 million to $1.98 million. Costs for each option are summarized below, with further details presented in Appendix D.

- No Action - capital = $0; O&M = $0; total = $0
- Inst. Action - capital = $0.01 million; O&M = $1.49 million; total = $1.50 million
- InSitu - capital = $0.01 million; O&M = $1.67 million; total = $1.68 million
- SC-2 - capital = $0.31 million; O&M = $1.67 million; total = $1.98 million

The costs presented provide order-of-magnitude estimates which may be used to compare the relative expense of each option. Contingencies of 20% on capital costs and 15% on O&M costs are utilized to account for any inaccuracy of the costs. Based on the degree of accuracy of the estimates, the cost differences between some of the options may not be significant.

### 7.13.8 State Acceptance

Acceptance of the selected option for this AOC by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 7.13.9 Community Acceptance

Acceptance of the selected option for this AOC by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 7.14 RICHARDSON POND GROUP - SURFACE WATER

Table 7-24 presents a summary of the primary evaluation factors and a comparative assessment of the technologies/process options evaluated for surface water at AOC #8d, Richardson Pond Group. These technologies/process options for remediation of surface water include:

- No Action;
- Inst. Action - Institutional actions consisting of monitoring;
- InSitu - In-situ remedy of monitored natural attenuation;

### 7.14.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment, within the limits of the remedial action objectives defined for this feasibility study, is a key threshold criterion that must be attained by an alternative to be eligible for selection in the ROD. This section describes the overall assessment of whether each alternative achieves adequate protection of human health and the environment.

**7.14.1.1 Human Health Protection.** As noted in Section 2.0, there are no human health risks due to surface water at this AOC. Therefore, all actions achieve this criteria.

**7.14.1.2 Ecological Protection.** As noted in Section 2.0, there is ecological risk at this AOC due to inorganics in surface water. However, since the relative amount of metal contamination in surface water that is contributed by groundwater discharge, surface water run-off, resuspension of sediments, or other sources under baseline conditions is unknown, it is not possible to distinguish the relative effectiveness of the treatment options presented in achieving RAOs and PRGs in surface water. Therefore, all of these options are assessed as achieving long-term reduction in exposure of aquatic receptors to surface water, but the relative effectiveness of each of these alternatives is not distinguishable. However, the InSitu option confirms reductions in surface water contaminants through monitored natural attenuation.

With regard to potential impacts of remedial technologies on natural habitats, there will be no short-term environmental impacts for the No Action option. Institutional actions and monitored natural attenuation (Inst. Action and InSitu) will result in temporary and minor impacts resulting from monitoring.

### 7.14.2 Compliance With ARARs

There are numerous federal and state regulatory requirements that are ARAR due to the specific compounds at the Site or due to site characteristics. A summary of the chemical-specific ARARs and guidance to be considered for actions at this AOC include:

- Federal Clean Water Act Ambient Water Quality Criteria. Remedial actions which include treatment of contaminated surface water will comply with these requirements.

Primary location-specific ARARs for this AOC include requirements relating to federal and state stream, wetland, fish and wildlife, and floodplain regulations (see Section 2.3.2), as well as requirements relating to historic landmarks, such as the Middlesex Canal. These requirements must be considered when conducting remedial actions.

For any of the remedial options at this AOC, the ability of the surface water to meet water quality standards, over the long-term, is dependent upon source control remediation being completed (upland source AOCs and treatment of sediments). Therefore, in the short-term, the three options presented for this AOC (No Action, Inst. Action, and InSitu) only partially attain ARARs.

### 7.14.3 Long-Term Effectiveness and Permanence

This section summarizes the evaluation for risks remaining at the Site after RAOs have been met, and for risks from management of residuals.

**7.14.3.1 Magnitude of Residual Risk: Human Health.** As noted in Section 2.0, there are no human health risks due to surface water at this AOC. Therefore, there will be no residual risk remaining following the use of any noted remedial option.

**7.14.3.2 Magnitude of Residual Risk: Ecological.** Since the relative amount of contamination in surface water that is contributed by groundwater discharge, surface water run-off, resuspension of sediments, or other sources under baseline conditions is unknown, it is not possible to distinguish the relative effectiveness of the treatment options in reducing COC concentrations in surface water. Therefore, all of these options are assessed as achieving long-term reduction in exposure of aquatic receptors to surface water, but the relative effectiveness of each of these alternatives is not distinguishable. However, the InSitu option confirms reductions in surface water contaminants through monitored natural attenuation.

### 7.14.4 Reduction of Toxicity, Mobility and Volume Through Treatment

This section provides a comparison of the treatment and process options selected; quantities of waste materials to be remediated; expected reductions in toxicity, mobility and volume; and residuals following treatment options.

**7.14.4.1 Treatment/Recycling Processes Utilized.** The only treatment processes evaluated for mitigation of surface water at AOC #8d is monitored natural attenuation. The No Action and Inst. Action options are not considered treatment processes.

**7.14.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The amounts of waste materials to be treated or recycled are discussed below as an evaluation of whether the treatment processes will remediate the total quantity of known contaminated media. For specific quantities of contaminated media to be treated, refer to Section 5 text and tables.

Monitored natural attenuation implemented for mitigation of surface waters is expected to treat the total quantity of contaminated surface waters at AOC #8d.

**7.14.4.3 Degree of Expected Reductions in Toxicity, Mobility or Volume.** A detailed discussion of the reductions in toxicity, mobility and volume to be expected from treatment options is provided below. For the purposes of this FS in making comparisons between options, the toxicity of the contaminated media relative to a specific contaminant is assumed to be reduced proportionally to the reduction in volume of that specific toxic contaminant provided by a given treatment technology. Therefore, this discussion will be concentrated more on volume reductions than toxicity reductions. Reductions upon completion of the remedy, except for monitored natural attenuation, are considered in the evaluation. Monitored natural attenuation reductions are provided for the 30-year default remediation time period.

Monitored natural attenuation of surface waters implemented at AOC #8d is expected to result in small reductions in toxicity and volume over a 30-year period. No treatment processes will be utilized for the No Action and Inst. Action options. Therefore, reductions in toxicity, mobility, and volume will not be expected or confirmed for these options.

**7.14.4.4 Reversibility.** Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. In general, active treatments (*e.g.*, surface water washing and chemical extraction of surface waters) either destroy, degrade, or remove contaminants from the media of concern, and therefore, are not reversible.

Monitored natural attenuation, the only treatment option evaluated for mitigation of contaminated surface waters at AOC #8d, is not considered reversible. Contaminants are degraded and dispersed over time.

**7.14.4.5 Type and Quantity of Residuals.** A comparison of types and quantities of residuals expected after completion of the treatment technologies/process options is provided below. The following discussion concentrates on contaminant residuals resulting from treatment. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are also discussed briefly below, as well as in the Section 5 tables titled "Quantities and Types of Hazardous Materials to be Treated and Process Residuals." Treatment/process residuals are the basis for the comparison of the treatment technology residuals in Table 7-24.

At AOC #8d, most of the contaminants will remain within the surface water following treatment by monitored natural attenuation. The only treatment/process residuals expected to be produced by monitored natural attenuation are investigation-derived wastes.

No treatment processes will be utilized in the other options. Therefore, the original contamination at the AOC is expected to remain unchanged under these options.

### 7.14.5 Short-Term Effectiveness

The effectiveness of each remedial option during construction and implementation are compared to one another in the following paragraphs.

**7.14.5.1 *Protection of Community and Workers During Remedial Actions.*** Short-term risks include any additional risks to the community or workers at the Site from exposures to surface water COCs as a result of construction measures and implementation of remedial activities. There will be no additional short-term risks from exposures under the No Action option.

The Inst. Action and InSitu options will have nominal increases of short-term risks to the community and workers due to surface water monitoring. Concentrations of COCs are expected to be greatest on-site. Therefore, workers at the Site will use appropriate PPE to mitigate any potential risks from exposures to surface water COCs.

**7.14.5.2 Environmental Impacts.** The remedial technologies evaluated at this AOC are equal in the magnitude of the potential impacts to natural habitats. There will be no short-term habitat impacts resulting from the No Action, Inst. Action, and InSitu options.

**7.14.5.3 Time Until Remedial Action Objectives are Achieved.** Since the relative amount of COC contamination in surface water that is contributed by groundwater discharge, surface water run-off, resuspension of sediments, or other sources under baseline conditions is unknown, it is not possible to distinguish the relative effectiveness of the treatment options presented in achieving RAOs and PRGs in surface water. Therefore, all of these options are assessed as achieving long-term reduction in exposure of aquatic receptors to surface water, but the relative effectiveness of each of these alternatives is not distinguishable.

### 7.14.6 Implementability

The options with the highest degree of implementability would have the following characteristics from EPA's FS guidance (U.S. EPA, 1988):

- require the lowest effort to construct, operate and maintain the technologies.
- include or consist only of the highest or most reliable technologies.
- require the lowest effort to undertake additional remedial actions, if necessary.
- include the fewest administrative hurdles for obtaining necessary permits, approvals and agreements.
- rely only minimally on off-site treatment, storage and disposal facility services (TSDFs)
- require the least amount or quantity of necessary specialized equipment and/or personnel specialists.
- utilize commonly available technologies to the largest degree.

Conversely, options with lesser degrees of implementability will have lesser degrees of the characteristics discussed above. The first three bullets define the "technical feasibility" with regard to implementability of the option, the fourth bullet defines "administrative feasibility," and the remaining three bullets define the "availability of services and materials" with respect to the option. These three factors combine to provide the overall degree of implementability of the

option. After evaluating all options and combining the technical feasibility, administrative feasibility and availability of services and materials evaluations, the overall implementability comparison is as follows:

- The No Action option has the highest degree of overall implementability.
- The Inst. Action and InSitu options are comparable in their overall high degree of implementability or high relative ease to implement.

In general, more complex remedial technologies are more difficult to implement and will have lesser degrees of overall implementability compared to other, less complex, options. As a result, the No Action option is the most implementable, and the InSitu option, monitored natural attenuation, is the least implementable.

Sections 7.14.6.1, 7.14.6.2, and 7.14.6.3 present more detailed evaluations of the comparison of implementability characteristics of the remedial options for which this analysis was performed.

**7.14.6.1 Technical Feasibility.** Implementability with regard to the technical feasibility of an option includes an evaluation of three factors: 1) ability to construct, operate and maintain the technologies, 2) the reliability of the technologies, and 3) the ease of undertaking additional remedial actions, if warranted by site conditions determined after implementation of the remedy. Each of these three factors is described for the options at this AOC.

The ability to construct, operate and maintain the technologies associated with each remedial option is proportional to the degree or intensity of each remedy. Options which use more intensive remedial technologies such as containment and in-situ or on-site treatments will have the greatest difficulty in implementing construction and O&M. Conversely, options which utilize less intensive technologies, such as institutional actions, will be easier to implement. As a result, the No Action, Inst. Action, and InSitu options will be the relatively equal in ease to construct, operate, and maintain due to their use of either no action or use of limited actions.

All options contain remedial technologies that can be considered "reliable" in terms of relying or counting on the day-to-day functioning of the remedy as intended. This assessment is dependent on the assumption that proper construction techniques and O&M efforts are provided as appropriate to the level of the technology. Clearly, maintaining a treatment system will require a higher degree of effort than performing monitoring. Therefore, from the point-of-view of maintaining day-to-day function, the three options presented (No Action, Inst. Action, and InSitu) will be equally easy to implement.

In terms of achieving the remedial action objectives, however, the reliability of an option is proportional to the greater intensity of the remedial actions contained in the option. Thus, the lowest reliabilities may be expected in the No Action and Inst. Action options, since there is either no action occurring or there is a much greater reliance on monitoring. The InSitu option (monitored natural attenuation) provides a slightly higher level of reliability than the other two options that the remedial action objectives can be achieved.

The ease of undertaking additional remedial actions, if warranted by future site conditions or requirements, is also proportional to the degree or intensity of each remedy. Options that use more intensive remedial technologies such as containment, in-situ or on-site treatment remedies will have the greatest difficulty in undertaking and implementing additional remedial actions. Conversely, options which utilize less intensive technologies such as institutional actions can more easily implement additional remedial actions. As a result, the No Action, Inst. Action, and InSitu options will be the comparably easy to implement additional remedial actions, if necessary, due to their use of either no action or use of monitoring and/or monitored natural attenuation.

**7.14.6.2 Administrative Feasibility.** The No Action option has the fewest administrative issues to address and only requires agreement among the regulatory agencies (local, state and federal) that no remedial actions are warranted at the AOC. Therefore, this option has the highest degree of administrative feasibility. Similarly, the Inst. Action option only requires agreement regarding

monitoring locations and frequencies. The InSitu option has a moderate degree of administrative feasibility. The primary administrative burden will be regulatory agency concurrence on the particulars of the monitored natural attenuation programs.

**7.14.6.3 Availability of Services and Materials.** Implementability with regard to the availability of services and materials includes an evaluation of three factors: 1) availability or usage of off-site treatment, storage, and disposal facilities (TSDFs), 2) availability of necessary or specialized equipment or specialist personnel needed to implement the option, and 3) availability of prospective technologies required by the option. Each of these three factors is described for the options at this AOC.

All options are similar in that use of off-site TSDF services are not required to treat or dispose of contaminated media-of-concern. These options, therefore, will be easy to implement since reliance on an outside disposal contractor will not be required.

The No Action option does not require any specialized equipment or specialized personnel, so it will have the easiest implementability. The Inst. Action option will also only require personnel for monitoring and will be easy to implement. The InSitu option will only require low-to-moderate specialized and/or necessary equipment needs and specialist personnel. These relate to procurement of specialists for implementing and evaluating monitored natural attenuation.

### 7.14.7 Cost

The total net present worth costs (capital plus O&M over the duration of the remedial action) for the two options with action range from $1.33 million to $2.23 million. Costs for each option are summarized below, with further details presented in Appendix D.

- No Action - capital = $0; O&M = $0; total = $0
- Inst. Action - capital = $0.01 million; O&M = $1.32 million; total = $1.33 million
- InSitu - capital = $0.01 million; O&M = $2.22 million; total = $2.23 million

The costs presented provide order-of-magnitude estimates which may be used to compare the relative expense of each option. Contingencies of 20% on capital costs and 15% on O&M costs are utilized to account for any inaccuracy of the costs. Based on the degree of accuracy of the estimates, the cost differences between some of the options may not be significant.

### 7.14.8 State Acceptance

Acceptance of the selected option for this AOC by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 7.14.9 Community Acceptance

Acceptance of the selected option for this AOC by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 7.15 CONTENT BROOK WETLAND GROUP - SEDIMENTS

Table 7-25 presents a summary of the primary evaluation factors and a comparative assessment of the technologies/process options evaluated for sediments at AOC #8e, Content Brook Wetland Group. These technologies/process options for remediation of sediment include:

- No Action;
- Inst. Action - Institutional actions consisting of monitoring;
- InSitu - In-situ remedy of monitored natural attenuation;
- SC-2 - Source control remedy consisting of sediment excavation and placement under caps at other on-site AOCs along with monitored natural attenuation of remaining sediments;
- SC/Off Site - Remedy consisting of sediment excavation and off site treatment/disposal along with monitored natural attenuation of remaining sediments;

- SC/OnSite-1 - Remedy consisting of sediment excavation and on-site treatment via solidification/stabilization along with monitored natural attenuation of remaining sediments;
- SC/OnSite-2 - Remedy consisting of sediment excavation and on-site treatment via soil washing/chemical extraction along with monitored natural attenuation of remaining sediments.

### 7.15.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment, within the limits of the remedial action objectives defined for this feasibility study, is a key threshold criterion that must be attained by an option to be eligible for selection in the ROD. This section describes the overall assessment of whether each option achieves adequate protection of human health and the environment.

**7.15.1.1 Human Health Protection.** As noted in Section 2.0, there are no human health risks due to sediment at this AOC. Therefore, all actions achieve this criteria.

**7.15.1.2 Ecological Protection.** As noted in Section 2.0, there is ecological risk at this AOC due to inorganic COCs. Of the technologies/process options evaluated, the four source control options (SC-2, SC/Off Site, SC/OnSite-1, and SC/OnSite-2) would be protective of the environment. Each of these four options will significantly reduce the exposure of benthic organisms to sediment contaminants by excavation/dredging (SC-2, SC/Off Site, SC/OnSite-1, and SC/OnSite-2) open water areas of the wetlands. Of the three remaining options (No Action, Inst. Action, and InSitu), none implement measures to directly remove/reduce exposure to contaminants in sediments. The only effects on the concentration of contaminants in sediments will be dilution/dispersal through slow, natural processes. Consequently, the concentration of contaminants in sediments on-site will not be substantially reduced under these options, and the risk to benthic invertebrates will persist. For exposure of benthic invertebrates, these three options do not meet this criterion.

The remedial technologies utilized by the seven options differ in the magnitude of the potential impacts on natural habitats. There will be no short-term environmental impacts from the implementation of the No Action, Inst. Action, and InSitu options. The most significant impacts on wetland habitats will occur for the remaining options (SC-2, SC/Off Site, SC/OnSite-1, and SC/OnSite-2). Each of these include excavation/dredging of wetland sediments. Wetland mitigation will be performed to offset these impacts.

### 7.15.2 Compliance With ARARs

There are numerous federal and state regulatory requirements that are ARAR due to the specific compounds at the Site or due to site characteristics. Table 7-26 presents a summary of the ARARs associated with this AOC.

Primary location-specific ARARs for this AOC include requirements relating to federal and state stream, wetland, and floodplain regulations (see Section 2.3.2). These requirements should be considered when conducting remedial actions. All planned remedial actions will limit/mitigate any wetland disturbances.

For this AOC, action-specific ARARs include requirements for transportation of potentially hazardous excavated material (SC-2, SC/Off Site, SC/OnSite-1, and SC/OnSite-2). Additionally, requirements relating to the discharge of soil washing water, to either groundwater or surface water, will be met (SC/OnSite-2). Of the seven options presented for this AOC, four (SC-2, SC/Off Site, SC/OnSite-1, and SC/OnSite -2) meet the requirements of all ARARs. Two options, Inst. Action and InSitu-1, are not expected to attain wetland ARARs in a reasonable amount of time, and therefore only partially meet ARARs. The remaining option, No Action, does not meet ARARs.

### 7.15.3 Long-Term Effectiveness and Permanence

This section summarizes the evaluation for risks remaining at the Site after RAOs have been met, and for risks from management of residuals.

**7.15.3.1 Magnitude of Residual Risk: Human Health.** As noted in Section 2.0, there are no human health risks due to sediment at this AOC. Therefore, there will be no residual risk remaining following the use of any noted remedial option.

**7.15.3.2 Magnitude of Residual Risk: Ecological.** Of the technologies/process options evaluated, the No Action, Inst. Action, and InSitu options will not result in a quantifiable long-term reduction of risk to ecological receptors. These options will not remove or reduce risk to benthic invertebrates from exposure to sediments. Natural processes will tend to degrade organic contaminants in sediments, and disperse all the contaminants (including inorganics) through resuspension of sediments, transport downstream, deposition of new material, and vertical mixing by organisms in sediment. However, these processes are slow, and the source of contaminants for additional accumulation in sediment will not be substantially reduced over time. Consequently, the reduction in concentration of contaminants resulting from natural processes will not be substantial, and the documented adverse impacts on the benthic communities will not be removed under these options.

Removing the contaminated sediments from open water and "hot spot" areas in Content Brook Wetland Group will result in elimination of exposure of benthic invertebrates in these areas. However, there will be residual risk to benthic invertebrates inhabiting adjacent emergent wetlands, if arsenic exceeding PRGs remains in areas which may be inaccessible due to remedial actions at Shaffer Landfill. The reduction of risk to benthic invertebrates will be substantial for all source control options in Content Brook Wetland Group.

### 7.15.4 Reduction of Toxicity, Mobility and Volume Through Treatment

This section provides a comparison of the treatment and process options selected; quantities of waste materials to be remediated; expected reductions in toxicity, mobility and volume; and residuals following treatment options.

**7.15.4.1 Treatment/Recycling Processes Utilized.** The only treatment processes evaluated for mitigation of sediment at AOC #8e are monitored natural attenuation (InSitu), excavation with offsite treatment/disposal (as part of SC/Off Site), ex-situ solidification/stabilization (as part of SC/OnSite-1), and ex-situ soil washing/chemical extraction (as part of SC/OnSite-2). For the purposes of this FS, it is assumed that excavation with off site treatment/disposal will include treatment of contaminated sediments. The No Action , Inst. Action, and SC-2 options are not considered treatment processes.

**7.15.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The amounts of waste materials to be treated or recycled are discussed below as an evaluation of whether the treatment processes will remediate the total quantity of known contaminated media. For specific quantities of contaminated media to be treated, refer to Section 5 text and tables.

For all treatment technologies/process options that use a combination of source control through active treatment and monitored natural attenuation (SC/Off Site, SC/OnSite-1, and SC/OnSite-2), the total quantity of contaminated sediments will be treated. Monitored natural attenuation when implemented as a stand-alone process (InSitu) is also expected to treat the total quantity of contaminated sediments at AOC #8e. Monitored natural attenuation, when implemented as part of SC-2, will treat all non-open water sediments. Contaminated sediments that will be excavated and placed under an on-site cap under SC-2 will not be treated.

**7.15.4.3 Degree of Expected Reductions in Toxicity, Mobility or Volume.** A detailed discussion of the reductions in toxicity, mobility and volume to be expected from treatment

options is provided below. For the purposes of this FS in making comparisons between options, the toxicity of the contaminated media relative to a specific contaminant is assumed to be reduced proportionally to the reduction in volume of that specific toxic contaminant provided by a given treatment technology. Therefore, this discussion will be concentrated more on volume reductions than toxicity reductions. Reductions upon completion of the remedy, except for monitored natural attenuation, are considered in the evaluation. Monitored natural attenuation reductions are provided for the 30-year default remediation time period.

Excavation and off site treatment/disposal of open-water sediments (as part of SC/Off Site) provides the most effective treatment of the AOC #8e sediments. Removing the contaminated sediments from the Site eliminates the toxicity, mobility, and volume of contaminants at the Site.

Soil washing/chemical extraction processes of excavated open-water sediments (as part of SC/OnSite-2) are expected to provide substantial reductions in the volume of contaminants. The volume of contaminants is expected to be reduced by up to 90% through soil washing/chemical extraction processes. There is no expected contaminant mobility decrease through on-site soil washing/chemical extraction processes.

Excavation and on-site solidification/stabilization of open-water sediments (as part of SC/OnSite-1) is expected to reduce the mobility of contaminants similar to the mobility reduction resulting from on-site solidification/stabilization of soils, 93% to 99%. However, the volume of contaminants and the toxicity of the contaminated media will not be reduced, and the volume of contaminated media may be increased by up to 100% through implementation of SC/OnSite-1.

Monitored natural attenuation of all contaminated sediments at AOC #8e (InSitu) and non-open water sediments (as part of SC/Off Site, SC/OnSite-1 and SC/OnSite-2) is expected to result in small reductions in toxicity and volume over a 30-year period.

No treatment processes will be utilized for the No Action, Inst. Action, and SC-2 options. Therefore, reductions in toxicity, mobility, and volume will not be expected or confirmed for these options.

**7.15.4.4 Reversibility.** Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. In general, active treatments (*e.g.*, sediment washing and chemical extraction of sediments) either destroy, degrade, or remove contaminants from the media of concern, and therefore, are not reversible.

Solidification/stabilization processes (as part of SC/OnSite-1) are considered reversible. These processes result in a stabilized mass that has the potential to weather and leach contaminants over time.

All other treatment processes to be implemented at AOC #8b, including monitored natural attenuation (InSitu) and soil washing/chemical extraction (as part of SC/OnSite-2), are not considered reversible. These processes remove and/or degrade contaminants.

**7.15.4.5 Type and Quantity of Residuals.** A comparison of types and quantities of residuals expected after completion of the treatment technologies/process options is provided below. The following discussion concentrates on contaminant residuals resulting from treatment. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are also discussed briefly below, as well as in the Section 5 tables titled "Quantities and Types of Hazardous Materials to be Treated and Process Residuals." Treatment/process residuals are the basis for the comparison of the treatment technology residuals in Table 7-25.

Excavation and off site treatment/disposal (as part of SC/Off Site) results in no residuals remaining on-site. Of the sediment treatment processes to be implemented at AOC #8e where contaminant residuals are to remain on-site, soil washing/chemical extraction processes (as part

of SC/OnSite-2) will likely result in the least amount of contaminant residuals. Approximately 10% of the original volume of contaminants are expected to remain in the treated sediments. However, treatment/ process residuals, including spent washing/extraction solvent, will be generated from soil washing/chemical extraction processes.

Significant contaminant residuals are likely to result following treatment by monitored natural attenuation (InSitu-1), since reductions of contaminant volumes in the sediment are expected to be low. The only treatment/process residuals expected to be produced by monitored natural attenuation are investigation-derived wastes.

The greatest amount of residuals are likely to remain from solidification/stabilization processes (as part of SC/OnSite-1). Through solidification/stabilization, the amount of contaminated media may increase up to 100% and all of the original contaminants will remain in the stabilized mass. For on-site solidification/stabilization, greater than 7% of organic and 1% of inorganic contaminants in these stabilized soils will have the potential to leach into groundwater. The amount of inorganics that have the potential to leach is the same for in-situ solidification/ stabilization, while organic contaminants are more likely to leach (15%) with in-situ processes.

No treatment processes will be utilized in the No Action, Inst. Action and SC-2 options. Therefore, the original contamination at the AOC is expected to remain unchanged under these options.

### 7.15.5 Short-Term Effectiveness

The effectiveness of each remedial option during construction and implementation are compared to one another in the following paragraphs.

**7.15.5.1 Protection of Community and Workers During Remedial Actions.** Short-term risks include any additional risks to the community or workers at the Site from exposures to sediment

COCs as a result of construction measures and implementation of remedial activities. There will be no additional short-term risks from exposures under the No Action option.

The Inst. Action and InSitu options will have nominal increases of short-term risks to the community and workers due to the requirement of performing sediment monitoring. Concentrations of COCs are expected to be greatest on-site. Therefore, workers at the Site will use appropriate PPE to mitigate any potential risks from exposures to sediment COCs.

The remaining source control options, SC-2, SC/Off Site, SC/OnSite-1, and SC/OnSite-2, will have the greatest short-term risks to the community and workers due to the inclusion of excavation for sediments. Short-term risks will be mitigated by a variety of measures. Air sampling and monitoring will be used to evaluate any potential risks to the community associated with invasive sediment activities. Engineering controls will also be used to minimize the degree of invasive work and to mitigate potential risks from this exposure pathway. Workers will wear appropriate PPE to mitigate potential risks from increased exposures to COCs in sediment at the Site.

**7.15.5.2 Environmental Impacts.** The remedial technologies evaluated at this AOC differ in the magnitude of the potential impacts to natural habitats. There will be no short-term habitat impacts resulting from the No Action option. The Inst. Action and InSitu options will result in temporary and minor impacts resulting from sediment monitoring. The impacts to natural habitats will be greater for the source control options. Each of these options include excavation or dredging wetland sediments. Wetland mitigation will be performed to offset these impacts. It is estimated that wetlands replacement would be performed over 1.5 acres for each source control option.

**7.15.5.3 Time Until Remedial Action Objectives are Achieved.** Of the options evaluated for this AOC, only the source control options, SC-2, SC/Off Site, SC/OnSite-1, and SC/OnSite-2, are expected to achieve RAOs quickly. Sediment excavation (approximately 1 to 2 years)

protects ecological receptors from COC exposure. Monitored natural attenuation, as part of InSitu, is not expected to reduce contaminant concentrations to PRGs in less than 30 years, the EPA default evaluation time period. Similarly, the No Action and Inst. Action options perform no actions which would be expected to achieve RAOs in less than 30 years.

### 7.15.6 Implementability

The options with the highest degree of implementability would have the following characteristics from EPA's FS guidance (U.S. EPA, 1988):

- require the lowest effort to construct, operate and maintain the technologies.
- include or consist only of the highest or most reliable technologies.
- require the lowest effort to undertake additional remedial actions, if necessary.
- include the fewest administrative hurdles for obtaining necessary permits, approvals and agreements.
- rely only minimally on off-site treatment, storage and disposal facility services (TSDFs)
- require the least amount or quantity of necessary specialized equipment and/or personnel specialists.
- utilize commonly available technologies to the largest degree.

Conversely, options with lesser degrees of implementability will have lesser degrees of the characteristics discussed above. The first three bullets define the "technical feasibility" with regard to implementability of the option, the fourth bullet defines "administrative feasibility," and the remaining three bullets define the "availability of services and materials" with respect to the option. These three factors combine to provide the overall degree of implementability of the option. After evaluating all options and combining the technical feasibility, administrative feasibility and availability of services and materials evaluations, the overall implementability comparison is as follows:

- The No Action option has the highest degree of overall implementability.
- The Inst. Action and InSitu options are comparable in their overall high degree of implementability or high relative ease to implement.

- The SC-2, SC/Off Site, SC/OnSite-1, and SC/OnSite-2 options are comparable in their overall degree of lesser implementability or relative difficulty in implementing.

In general, more complex remedial technologies are more difficult to implement and will have lesser degrees of overall implementability compared to other, less complex, options. As a result, the No Action option is the most implementable, and the source control options are the least implementable.

Sections 7.15.6.1, 7.15.6.2, and 7.15.6.3 present more detailed evaluations of the comparison of implementability characteristics of the remedial options for which this analysis was performed.

**7.15.6.1 Technical Feasibility.** Implementability with regard to the technical feasibility of an option includes an evaluation of three factors: 1) ability to construct, operate and maintain the technologies, 2) the reliability of the technologies, and 3) the ease of undertaking additional remedial actions, if warranted by site conditions determined after implementation of the remedy. Each of these three factors is described for the options at this AOC.

The ability to construct, operate and maintain the technologies associated with each remedial option is proportional to the degree or intensity of each remedy. Options which use more intensive remedial technologies such as containment and in-situ or on-site treatments will have the greatest difficulty in implementing construction and O&M. Conversely, options which utilize less intensive technologies, such as institutional actions, will be easier to implement. As a result, the No Action, Inst. Action, and InSitu options will be the easiest to construct, operate, and maintain due to their use of either no action or use of limited actions and monitoring. The source control options require a moderate-to-high effort to construct, operate and maintain.

All options contain remedial technologies that can be considered "reliable" in terms of relying or counting on the day-to-day functioning of the remedy as intended. This assessment is dependent on the assumption that proper construction techniques and O&M efforts are provided as appropriate to the level of the technology. Clearly, maintaining a treatment system will require a

higher degree of effort than performing monitoring. Therefore, from the point-of-view of maintaining day-to-day function, the lesser options (No Action, Inst. Action, and InSitu) will be easier to implement, and the most intensive option, SC/OnSite-2, more difficult to implement.

In terms of achieving the remedial action objectives, however, the reliability of an option is proportional to the greater intensity of the remedial actions contained in the option. Thus, the lowest reliabilities may be expected in the No Action, Inst. Action, and InSitu options, since there is either no action occurring or there is a much greater reliance on monitoring and in-situ remedies, such as monitored natural attenuation. The source control options provide a high level of reliability that the remedial action objectives can be achieved.

The ease of undertaking additional remedial actions, if warranted by future site conditions or requirements, is also proportional to the degree or intensity of each remedy. Options that use more intensive remedial technologies such as containment, in-situ or on-site treatment remedies will have the greatest difficulty in undertaking and implementing additional remedial actions. Conversely, options which utilize less intensive technologies such as institutional actions can more easily implement additional remedial actions. As a result, the No Action, Inst. Action, and InSitu options will be the easiest to implement additional remedial actions, if necessary, due to their use of either no action or use of limited actions and institutional controls. The source control options will require a moderate effort to implement additional, future remedial actions.

**7.15.6.2 Administrative Feasibility.** The No Action option has the fewest administrative issues to address and only requires agreement among the regulatory agencies (local, state and federal) that no remedial actions are warranted at the AOC. Therefore, this option has the highest degree of administrative feasibility. Similarly, the Inst. Action option only requires agreement regarding monitoring locations and frequencies. The InSitu option has a moderate degree of administrative feasibility. The primary administrative burden will be regulatory agency concurrence on the particulars of the monitored natural attenuation programs. The source control options will also encounter the administrative burden associated with a monitored natural attenuation program.

Additionally, the source control options have a higher administrative burden associated with short-term impacts to wetlands. The application of an active remedy associated with sediments nearly doubles the administrative requirements for permits, approvals, and agreements when compared with other options.

**7.15.6.3 Availability of Services and Materials.** Implementability with regard to the availability of services and materials includes an evaluation of three factors: 1) availability or usage of off-site treatment, storage, and disposal facilities (TSDFs), 2) availability of necessary or specialized equipment or specialist personnel needed to implement the option, and 3) availability of prospective technologies required by the option. Each of these three factors is described for the options at this AOC.

All options, except SC/Off Site, are similar in that use of off-site TSDF services are not required to treat or dispose of contaminated media-of-concern. These options, therefore, will be easy to implement since reliance on an outside disposal contractor will not be required. The SC/Off Site option requires the use of an off-site TSDF to treat and dispose of contaminated sediment, so it will have lesser implementability than the other options.

The No Action option does not require any specialized equipment or specialized personnel, so it will have the easiest implementability. Except for the off-site treatment/disposal (SC/Off Site), the SC-2 and SC/Off Site options will be comparable for only requiring low-to-moderate specialized and/or necessary equipment needs and specialist personnel. These relate to the following requirements: procurement of specialists for implementing and evaluating monitored natural attenuation, and heavy earthmoving equipment and expertise for civil/sitework and sediment excavation. The SC/OnSite-1 and SC/OnSite-2 options will be comparable for requiring moderate-to-high specialized and/or necessary equipment needs and specialist personnel. These two options are similar to the other source control options with regards to monitored natural attenuation and sediment excavation. Additionally, these require specialists

and equipment for on-site treatment of the sediments either by solidification/stabilization or soil washing/chemical extraction.

### 7.15.7 Cost

The total net present worth costs (capital plus O&M over the duration of the remedial action) for the six options with action range from $1.43 million to $6.97 million. Costs for each option are summarized below, with further details presented in Appendix D.

- No Action - capital = $0; O&M = $0; total = $0
- Inst. Action - capital = $0.01 million; O&M = $1.42 million; total = $1.43 million
- InSitu - capital = $0.01 million; O&M = $1.59 million; total = $1.60 million
- SC-2 - capital = $1.54 million; O&M = $1.59 million; total = $3.13 million
- SC/Off Site - capital = $1.98 million; O&M = $1.59 million; total = $3.57 million
- SC/OnSite-1 - capital = $2.64 million; O&M = $1.59 million; total = $4.23 million
- SC/OnSite-2 - capital = $5.38 million; O&M = $1.59 million; total = $6.97 million

The costs presented provide order-of-magnitude estimates which may be used to compare the relative expense of each option. Contingencies of 20% on capital costs and 15% on O&M costs are utilized to account for any inaccuracy of the costs. Based on the degree of accuracy of the estimates, the cost differences between some of the options may not be significant.

### 7.15.8 State Acceptance

Acceptance of the selected option for this AOC by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 7.15.9 Community Acceptance

Acceptance of the selected option for this AOC by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## 7.16 CONTENT BROOK WETLAND GROUP - SURFACE WATER

Table 7-27 presents a summary of the primary evaluation factors and a comparative assessment of the technologies/process options evaluated for surface water at AOC #8e, Content Brook Wetland Group. These technologies/process options for remediation of surface water include:

- No Action;
- Inst. Action - Institutional actions consisting of monitoring;
- InSitu - In-situ remedy of monitored natural attenuation;
- OnSite-1 - Remedy consisting of surface water collection and treatment via phytoremediation, along with monitored natural attenuation of remaining surface water;
- OnSite-2 - Remedy consisting of surface water collection and treatment via biological/physical/chemical methods, along with monitored natural attenuation of remaining surface water.

### 7.16.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment, within the limits of the remedial action objectives defined for this feasibility study, is a key threshold criterion that must be attained by an option to be eligible for selection in the ROD. This section describes the overall assessment of whether each option achieves adequate protection of human health and the environment.

**7.16.1.1 Human Health Protection.** As noted in Section 2.0, there are no human health risks due to surface water at this AOC. Therefore, all actions achieve this criteria.

**7.16.1.2 Ecological Protection.** As noted in Section 2.0, there is ecological risk at this AOC due to inorganics in surface water. However, since the relative amount of metal contamination in surface water that is contributed by groundwater discharge, surface water run-off, resuspension of sediments, or other sources under baseline conditions is unknown, it is not possible to distinguish the relative effectiveness of the treatment options presented in achieving RAOs and PRGs in surface water. Therefore, all of these options are assessed as achieving long-term reduction in

exposure of aquatic receptors to surface water, but the relative effectiveness of each of these alternatives is not distinguishable. The InSitu option confirms reductions in surface water contaminants through monitored natural attenuation. More rapid reductions in surface water contaminants will be achieved by the OnSite-1 and OnSite-2 options, since collection and treatment of some surface water will be implemented. Treatment strategies will be employed in these two options that will allow relatively faster or more effective reduction of metals in surface water. However, surface water not collected will be subject to the long-term processes noted for monitored natural attenuation.

With regard to potential impacts of remedial technologies on natural habitats, there will be no short-term environmental impacts for the No Action option. Institutional actions and monitored natural attenuation (Inst. Action and InSitu) will result in temporary and minor impacts resulting from monitoring. The impacts on natural habitats will be greater for the collection and treatment options (OnSite-1 and OnSite-2). These options involve installation of collection pipes and pump stations. However, these potential impacts will be mitigated.

### 7.16.2 Compliance With ARARs

There are numerous federal and state regulatory requirements that are ARAR due to the specific compounds at the Site or due to site characteristics. A summary of the chemical-specific ARARs and guidance to be considered for actions at this AOC include:

- Federal Clean Water Act Ambient Water Quality Criteria. Remedial actions which include treatment of contaminated surface water will comply with these requirements.

Primary location-specific ARARs for this Site include requirements relating to federal and state stream, wetland, fish and wildlife, and floodplain regulations (see Section 2.3.2). These requirements must be considered when conducting remedial actions.

For any of the remedial options at this AOC, the ability of the surface water to meet water quality standards, over the long-term, is dependent upon source control remediation being completed (upland source AOCs and treatment of sediments). Therefore, in the short-term, the five options presented for this AOC (No Action, Inst. Action, InSitu, OnSite-1, and OnSite-2) only partially attain ARARs.

### 7.16.3 Long-Term Effectiveness and Permanence

This section summarizes the evaluation for risks remaining at the Site after RAOs have been met, and for risks from management of residuals.

**7.16.3.1 Magnitude of Residual Risk: Human Health.** As noted in Section 2.0, there are no human health risks due to surface water at this AOC. Therefore, there will be no residual risk remaining following the use of any noted remedial option.

**7.16.3.2 Magnitude of Residual Risk: Ecological.** Since the relative amount of metal contamination in surface water that is contributed by groundwater discharge, surface water run-off, resuspension of sediments, or other sources under baseline conditions is unknown, it is not possible to distinguish the relative effectiveness of the treatment options in reducing concentrations of metals in surface water. Therefore, all of these options are assessed as achieving long-term reduction in exposure of aquatic receptors to surface water, but the relative effectiveness of each of these alternatives is not distinguishable. The InSitu option confirms reductions in surface water contaminants through monitored natural attenuation. More rapid reductions in surface water contaminants will be achieved by the OnSite-1 and OnSite-2 options, since collection and treatment of some surface water will be implemented. Treatment strategies will be employed in these two options that will allow relatively faster or more effective reduction of metals in surface water. However, surface water not collected will be subject to the long-term processes noted for monitored natural attenuation. For the portion of the surface water that will be collected and treated, the toxicity of metals in surface water will be reduced proportional to

the contaminant volume reduction (80-90%), but only a small portion of the water will be collected and treated. Therefore, the OnSite-1 and OnSite-2 options will result in a reduction of risk of aquatic receptor exposure to metals in surface water in a shorter period of time than the other options, which do not employ surface water treatment.

### 7.16.4 Reduction of Toxicity, Mobility and Volume Through Treatment

This section provides a comparison of the treatment and process options selected; quantities of waste materials to be remediated; expected reductions in toxicity, mobility and volume; and residuals following treatment options.

**7.16.4.1 Treatment/Recycling Processes Utilized.** The only treatment processes evaluated for mitigation of surface water at AOC #8e are monitored natural attenuation, phytoremediation, and on-site biological/physical/chemical treatment. The No Action and Inst. Action options are not considered treatment processes.

**7.16.4.2 Amount of Hazardous Materials to be Treated or Recycled.** The amounts of waste materials to be treated or recycled are discussed below as an evaluation of whether the treatment processes will remediate the total quantity of known contaminated media. For specific quantities of contaminated media to be treated, refer to Section 5 text and tables.

All treatment processes to be implemented for mitigation of surface water are expected to treat the total quantity of contaminated surface water at AOC #8e. Treatment processes include monitored natural attenuation (InSitu-1), and collection and treatment by either phytoremediation (OnSite-1) or biological/physical/chemical processes (OnSite-2) with monitored natural attenuation of remaining surface waters.

**7.16.4.3 Degree of Expected Reductions in Toxicity, Mobility or Volume.** A detailed discussion of the reductions in toxicity, mobility and volume to be expected from treatment

options is provided below. For the purposes of this FS in making comparisons between options, the toxicity of the contaminated media relative to a specific contaminant is assumed to be reduced proportionally to the reduction in volume of that specific toxic contaminant provided by a given treatment technology. Therefore, this discussion will be concentrated more on volume reductions than toxicity reductions. Reductions upon completion of the remedy, except for monitored natural attenuation, are considered in the evaluation. Monitored natural attenuation reductions are provided for the 30-year default remediation time period.

The greatest degree of reductions in toxicity, mobility and volume are likely to result from OnSite-2, collection of a portion of surface waters and treatment by biological/physical/chemical processes and monitored natural attenuation of remaining surface waters. In the portion that is collected for treatment, organic contaminant volume reductions are expected to be 96% to 98%, while inorganics are likely to be reduced by 92% to 99% in volume. The mobility of contaminants will be proportional to the amount collected.

Very substantial reductions are also anticipated for the portion of surface water collected and treated by phytoremediation through OnSite-1. Volume reductions through phytoremediation are approximated at 90% to 95% for organic contaminants and 84% to 99% for inorganic contaminants.

Small reductions in toxicity and volume over a 30-year period are expected to result from monitored natural attenuation of remaining surface waters, as well as when monitored natural attenuation will be implemented as a stand-alone process (InSitu).

No treatment processes will be utilized for the No Action and Inst. Action options. Therefore, reductions in toxicity, mobility, and volume will not be expected or confirmed for these options.

**7.16.4.4 Reversibility.** Reversibility evaluates the likelihood of a return to original contaminant conditions in the event of the discontinuance or elimination of the treatment technology/process option. In general, active treatments (*e.g.*, surface water washing and chemical extraction of surface waters) either destroy, degrade, or remove contaminants from the media of concern, and therefore, are not reversible.

All treatment processes to be implemented for mitigation of contaminated surface waters at AOC #8e are not considered reversible. Through monitored natural attenuation, contaminants are either degraded or dispersed. Contaminants are removed from collected water by phytoremediation and biological/physical/chemical treatments.

**7.16.4.5 Type and Quantity of Residuals.** A comparison of types and quantities of residuals expected after completion of the treatment technologies/process options is provided below. The following discussion concentrates on contaminant residuals resulting from treatment. Treatment/process residuals (*e.g.*, spent adsorption media and sludges) are also discussed briefly below, as well as in the Section 5 tables titled "Quantities and Types of Hazardous Materials to be Treated and Process Residuals." Treatment/process residuals are the basis for the comparison of the treatment technology residuals in Table 7-27.

The least amount of contaminant residuals, only 2% to 4% of organics and 1% to 8% of inorganics, will remain in the surface water after treatment by biological/physical/chemical processes (as part of OnSite-2). Slightly more contaminant residuals are expected to remain after treatment by phytoremediation (as part of OnSite-1). Approximately 5% to 10% of organics and 1% to 16% of inorganics will remain in the surface water collected and treated by phytoremediation. However, biological/physical/chemical processes will generate substantial quantities of process sludges and spent filter media/absorbent. Moderate quantities of treatment/process residuals are expected from treatment by phytoremediation. Phytoremediation treatment/process residuals include harvested plants and process media.

Following treatment by monitored natural attenuation, the remaining surface waters, as well as the total quantity of surface waters when monitored natural attenuation will be implemented as a stand-alone process, most of the contaminants will remain in the surface water. The only treatment/process residuals expected to be produced by monitored natural attenuation are investigation-derived wastes.

No treatment processes will be utilized in the other options. Therefore, the original contamination at the AOC is expected to remain unchanged under these options.

### 7.16.5 Short-Term Effectiveness

The effectiveness of each remedial option during construction and implementation are compared to one another in the following paragraphs.

**7.16.5.1 Protection of Community and Workers During Remedial Actions.** Short-term risks include any additional risks to the community or workers at the Site from exposures to surface water COCs as a result of construction measures and implementation of remedial activities. There will be no additional short-term risks from exposures under the No Action option.

The Inst. Action and InSitu options will have nominal increases of short-term risks to the community and workers due to surface water monitoring. Concentrations of COCs are expected to be greatest on-site. Therefore, workers at the Site will use appropriate PPE to mitigate any potential risks from exposures to surface water COCs.

The remaining options, OnSite-1 and OnSite-2, will have the greatest short-term risks to the community and workers due to the inclusion of surface water collection (installation of piping and pump stations) and treatment. Short-term surface water risks will be mitigated by a variety of measures. Engineering controls will also be used to minimize the degree of invasive sediment

work and to mitigate potential risks from this exposure pathway. Workers will wear appropriate PPE to mitigate potential risks from increased exposures to COCs in surface water at the Site.

**7.16.5.2 Environmental Impacts.** The remedial technologies evaluated at this AOC differ in the magnitude of the potential impacts to natural habitats. There will be no short-term habitat impacts resulting from the No Action, Inst. Action, and InSitu options. The impacts to natural habitats will be greater for the surface water collection and treatment options, OnSite-1 and OnSite-2. Each of these options include installation of piping and pumping stations. This involves excavation of wetland sediments and will temporarily displace some resident organisms. The potential impacts to wetlands from disturbance during construction are expected to be moderate and will be mitigated.

**7.16.5.3 Time Until Remedial Action Objectives are Achieved.** Since the relative amount of metal contamination in surface water that is contributed by groundwater discharge, surface water run-off, resuspension of sediments, or other sources under baseline conditions is unknown, it is not possible to distinguish the relative effectiveness of the treatment options presented in achieving RAOs and PRGs in surface water. Therefore, all of these options are assessed as achieving long-term reduction in exposure of aquatic receptors to surface water, but the relative effectiveness of each of these alternatives is not distinguishable. More rapid reductions in surface water contaminants will be achieved by the OnSite-1 and OnSite-2 options, since collection and treatment of some surface water will be implemented. Treatment strategies will be employed in these two options that will allow relatively faster or more effective reduction of metals in surface water. However, surface water not collected will be subject to the long-term processes noted for monitored natural attenuation.

### 7.16.6 Implementability

The options with the highest degree of implementability would have the following characteristics from EPA's FS guidance (U.S. EPA, 1988):

- require the lowest effort to construct, operate and maintain the technologies.
- include or consist only of the highest or most reliable technologies.
- require the lowest effort to undertake additional remedial actions, if necessary.
- include the fewest administrative hurdles for obtaining necessary permits, approvals and agreements.
- rely only minimally on off-site treatment, storage and disposal facility services (TSDFs)
- require the least amount or quantity of necessary specialized equipment and/or personnel specialists.
- utilize commonly available technologies to the largest degree.

Conversely, options with lesser degrees of implementability will have lesser degrees of the characteristics discussed above. The first three bullets define the "technical feasibility" with regard to implementability of the option, the fourth bullet defines "administrative feasibility," and the remaining three bullets define the "availability of services and materials" with respect to the option. These three factors combine to provide the overall degree of implementability of the option. After evaluating all options and combining the technical feasibility, administrative feasibility and availability of services and materials evaluations, the overall implementability comparison is as follows:

- The No Action option has the highest degree of overall implementability.
- The Inst. Action and InSitu options are comparable in their overall high degree of implementability or high relative ease to implement.
- The OnSite-1 and OnSite-2 options are comparable in their overall low-to-moderate degree of implementability.

In general, more complex remedial technologies are more difficult to implement and will have lesser degrees of overall implementability compared to other, less complex, options. As a result, the No Action option is the most implementable, and the OnSite-2 option, collection followed by biological/physical/chemical treatment, is the least implementable.

Sections 7.16.6.1, 7.16.6.2, and 7.16.6.3 present more detailed evaluations of the comparison of implementability characteristics of the remedial options for which this analysis was performed.

**7.16.6.1 Technical Feasibility.** Implementability with regard to the technical feasibility of an option includes an evaluation of three factors: 1) ability to construct, operate and maintain the technologies, 2) the reliability of the technologies, and 3) the ease of undertaking additional remedial actions, if warranted by site conditions determined after implementation of the remedy. Each of these three factors is described for the options at this AOC.

The ability to construct, operate and maintain the technologies associated with each remedial option is proportional to the degree or intensity of each remedy. Options which use more intensive remedial technologies such as containment and in-situ or on-site treatments will have the greatest difficulty in implementing construction and O&M. Conversely, options which utilize less intensive technologies, such as institutional actions, will be easier to implement. As a result, the No Action, Inst. Action, and InSitu options will be the easiest to construct, operate, and maintain due to their use of either no action or use of limited actions. The OnSite-1 and OnSite-2 option requires a moderate-to-high effort to construct, operate and maintain.

All options contain remedial technologies that can be considered "reliable" in terms of relying or counting on the day-to-day functioning of the remedy as intended. This assessment is dependent on the assumption that proper construction techniques and O&M efforts are provided as appropriate to the level of the technology. Clearly, maintaining a treatment system will require a higher degree of effort than performing monitoring. Therefore, from the point-of-view of maintaining day-to-day function, the lesser options (No Action, Inst. Action, and InSitu) will be easier to implement, and the more intensive options, OnSite-1 and OnSite-2, more difficult to implement.

In terms of achieving the remedial action objectives, however, the reliability of an option is proportional to the greater intensity of the remedial actions contained in the option. Thus, the lowest reliabilities may be expected in the No Action, Inst. Action, and InSitu options, since there is either no action occurring or there is a much greater reliance on monitoring and in-situ

remedies, such as monitored natural attenuation. The OnSite-1 and OnSite-2 options provides a high level of reliability that the remedial action objectives can be achieved.

The ease of undertaking additional remedial actions, if warranted by future site conditions or requirements, is also proportional to the degree or intensity of each remedy. Options that use more intensive remedial technologies such as containment, in-situ or on-site treatment remedies will have the greatest difficulty in undertaking and implementing additional remedial actions. Conversely, options which utilize less intensive technologies such as institutional actions can more easily implement additional remedial actions. As a result, the No Action, Inst. Action, and InSitu options will be the easiest to implement additional remedial actions, if necessary, due to their use of either no action or use of limited actions and monitoring. The OnSite-1 and OnSite-2 options will require a moderate effort to implement additional, future remedial actions.

**7.16.6.2 Administrative Feasibility.** The No Action option has the fewest administrative issues to address and only requires agreement among the regulatory agencies (local, state and federal) that no remedial actions are warranted at the AOC. Therefore, this option has the highest degree of administrative feasibility. Similarly, the Inst. Action option only requires agreement regarding monitoring locations and frequencies. The InSitu option has a moderate degree of administrative feasibility. The primary administrative burden will be regulatory agency concurrence on the particulars of the monitored natural attenuation programs. The remaining options (OnSite-1 and OnSite-2) will also encounter the administrative burden associated with a monitored natural attenuation program. Additionally, these options have a higher administrative burden associated with short-term impacts to wetlands. The application of an active remedy associated with surface water nearly doubles the administrative requirements for permits, approvals, and agreements when compared with other options.

**7.16.6.3 Availability of Services and Materials.** Implementability with regard to the availability of services and materials includes an evaluation of three factors: 1) availability or usage of off-site treatment, storage, and disposal facilities (TSDFs), 2) availability of necessary

or specialized equipment or specialist personnel needed to implement the option, and 3) availability of prospective technologies required by the option. Each of these three factors is described for the options at this AOC.

All options are similar in that use of off-site TSDF services are not required to treat or dispose of contaminated media-of-concern. These options, therefore, will be easy to implement since reliance on an outside disposal contractor will not be required.

The No Action option does not require any specialized equipment or specialized personnel, so it will have the easiest implementability. The Inst. Action option will also only require personnel for monitoring and will be easy to implement. The InSitu option will only require low-to-moderate specialized and/or necessary equipment needs and specialist personnel. These relate to procurement of specialists for implementing and evaluating monitored natural attenuation. The OnSite-1 and OnSite-2 options will be comparable for requiring moderate-to-high specialized and/or necessary equipment needs and specialist personnel. These two options are similar to the InSitu option with regards to monitored natural attenuation. Additionally, these require specialists and equipment for collection and on-site treatment of the surface water either by phytoremediation or biological/physical/chemical methods. As phytoremediation is less common than other methods, it is considered to be slightly less implementable.

### 7.16.7 Cost

The total net present worth costs (capital plus O&M over the duration of the remedial action) for the four options with action range from $1.26 million to $16.18 million. Costs for each option are summarized below, with further details presented in Appendix D.

- No Action - capital = $0; O&M = $0; total = $0
- Inst. Action - capital = $0.01 million; O&M = $1.25 million; total = $1.26 million
- InSitu - capital = $0.01 million; O&M = $2.09 million; total = $2.10 million
- OnSite-1 - capital = $2.36 million; O&M = $9.23 million; total = $11.59 million
- OnSite-2 - capital = $4.73 million; O&M = $11.45 million; total = $16.18 million

The costs presented provide order-of-magnitude estimates which may be used to compare the relative expense of each option. Contingencies of 20% on capital costs and 15% on O&M costs are utilized to account for any inaccuracy of the costs. Based on the degree of accuracy of the estimates, the cost differences between some of the options may not be significant.

### 7.16.8 State Acceptance

Acceptance of the selected option for this AOC by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

### 7.16.9 Community Acceptance

Acceptance of the selected option for this AOC by the Town of Billerica will be determined during the public review and comment period for the Proposed Plan.

## SECTION 8.0

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