Massachusetts Electric
A National Grid Company

u/A

27 June 2003

SCANNED

RECEIVED
JUL 2 2003

Massachusetts Department of Environmental Protection
Northeast Regional Office
One Winter Street
Boston, Massachusetts 02108

Attention: Site Management Branch

Subject: Phase III - Remedial Action Plan
Former Malden Manufactured Gas Plant (MGP) Site – Upland Portion
Malden, Massachusetts
RTN 3-0362 and Linked RTNs 3-3757, 3-11581, 3-12448,
3-13310, 3-13345, 3-13753, and 3-13754
Tier IB Permit Number 7378
100 COMMERCIAL ST

Dear Ladies and Gentlemen:

Massachusetts Electric Company (MEC) is pleased to submit this report entitled "Phase III – Remedial Action Plan, Former Manufactured Gas Plant (MGP) Site - Upland Portion, Malden, Massachusetts, RTN 3-0362, Tier IB Permit 7378," prepared by Haley & Aldrich, Inc. This report is designed to meet the Phase III requirements under the Massachusetts Contingency Plan (310 CMR 40.0000) for the upland portions of the former Malden MGP Site. The Malden River portion of the Site will be addressed separately, as discussed below.

As MEC discussed in a meeting with Massachusetts Department of Environmental Protection (MADEP) officials on April 3, 2003, MEC intends to address the sediments in the Malden River within the Site boundary as a separate operable unit. MGP-related impacts attributable to the former MGP Site were identified during the Phase II assessment in Malden River sediments from the Malden River culvert outfall to a point approximately 1,400 feet downstream (just north of the Medford Street bridge). The Mystic Valley Development Commission (MVDC), through the TeleCom City partnership, has formed a group of parties with interest in Malden River sediment remediation from the culvert outfall to the Amelia Earhart Dam. The Telecom City partnership formed due to the development of a telecommunications research and development park on 200 acres of land situated in Malden, Medford and Everett. This area is located along the Malden River downstream of the Site boundary. The MVDC has partnered with the Army Corps of Engineers to conduct a study of the nature and extent of sediment impacts and to identify potential remedial measures that may be undertaken in the area. It is also our understanding that MADEP is participating in this work. MEC is contributing technical and financial support to this project and intends to participate in this study, which has been designated the Malden River Ecosystem Restoration Study. MEC also intends to participate in discussions regarding the remediation and restoration of the Malden River. In light of these recent developments, remedial measures related to Malden River sediments associated with the MGP Site are best conducted in

55 Bearfoot Road
Northborough, MA 01532-1555
508.421.7000

conjunction with the efforts along the larger portion of the River to ensure consistency and coordination. Representatives of MADEP endorsed this approach at our April 3 meeting and during conversations thereafter.

An original signed copy of transmittal form BWSC-108 is submitted, unbound, along with this report. A copy of the signed form and this cover letter are provided in Appendix A of this report along with copies of Notification of Availability letters to appropriate Malden municipal officials.

Please contact me at 508-421-7564 with any questions or comments regarding this matter.

Sincerely,

Michele V. Leone (BAW)

Michele V. Leone
Senior Environmental Engineer

cc: Gregg Hunt, DEP (without enclosure)
Rick Standish, H&A
File

P. 1

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC-108

Q.K.

COMPREHENSIVE RESPONSE ACTION TRANSMITTAL FORM & PHASE I COMPLETION STATEMENT

Pursuant to 310 CMR 40.0484 (Subpart D) and 40.0800 (Subpart H)

Release Tracking Number: 3 - 362

A. SITE LOCATION:

Site Name: (optional) Former Malden MGP Site

Street: 100 Commercial Street

Location Aid: Commecial & Charles Streets

City/Town: Malden

ZIP Code: 02148-5510

Related Release Tracking Numbers that this Form Addresses: 3-3757, 3-11581, 3-12448, 3-13310, 3-13345, 3-13753, 3-13754

Tier Classification: (check one of the following) ☐ Tier IA ☑ Tier IB ☐ Tier IC ☐ Tier II ☐ Not Tier Classified

If a Tier I Permit has been issued, state the Permit Number: Permit No. 7378, effective date 12/28/1999

B. THIS FORM IS BEING USED TO: (check all that apply)

☐ Submit a **Phase I Completion Statement**, pursuant to 310 CMR 40.0484 (complete Sections A, B, C, G, H, I and J).

☐ Submit a **Phase II Scope of Work**, pursuant to 310 CMR 40.0834 (complete Sections A, B, C, G, H, I and J).

☐ Submit a final **Phase II Comprehensive Site Report and Completion Statement**, pursuant to 310 CMR 40.0836 (complete Sections A, B, C, D, G, H, I and J).

☑ Submit a **Phase III Remedial Action Plan and Completion Statement**, pursuant to 310 CMR 40.0862 (complete Sections A, B, C, G, H, I and J).

☐ Submit a **Phase IV Remedy Implementation Plan**, pursuant to 310 CMR 40.0874 (complete Sections A, B, C, G, H, I and J).

☐ Submit an **As-Built Construction Report**, pursuant to 310 CMR 40.0875 (complete Sections A, B, C, G, H, I and J).

☐ Submit a **Phase IV Final Inspection Report and Completion Statement**, pursuant to 310 CMR 40.0878 and 40.0879 (complete Sections A, B, C, E, G, H, I and J).

☐ Submit a periodic **Phase V Inspection & Monitoring Report**, pursuant to 310 CMR 40.0892 (complete Sections A, B, C, G, H, I and J).

☐ Submit a final **Phase V Inspection & Monitoring Report and Completion Statement**, pursuant to 310 CMR 40.0893 (complete Sections A, B, C, F, G, H, I and J).

RECEIVED
JUL 02 2003
DEP
NORTHEAST REGIONAL OFFICE

You must attach all supporting documentation required for each use of form indicated, including copies of any Legal Notices and Notices to Public Officials required by 310 CMR 40.1400.

C. RESPONSE ACTIONS:

☐ Check here if any response action(s) that serves as the basis for the Phase submittal(s) involves the use of Innovative Technologies. (DEP is interested in using this information to create an Innovative Technologies Clearinghouse.)

Describe Technologies: ______

D. PHASE II COMPLETION STATEMENT:

Specify the outcome of the Phase II Comprehensive Site Assessment:

☐ Additional Comprehensive Response Actions are necessary at this Site, based on the results of the Phase II Comprehensive Site Assessment.

☐ The requirements of a Class A Response Action Outcome have been met and a completed Response Action Outcome Statement (BWSC-104) will be submitted to DEP.

☐ The requirements of a Class B Response Action Outcome have been met and a completed Response Action Outcome Statement (BWSC-104) will be submitted to DEP.

☐ Rescoring of this Site using the Numerical Ranking System is necessary, based on the results of the final Phase II Report.

E. PHASE IV COMPLETION STATEMENT:

Specify the outcome of Phase IV activities:

☐ Phase V operation, maintenance or monitoring of the Comprehensive Response Action is necessary to achieve a Response Action Outcome. (This site will be subject to a Phase V Operation, Maintenance and Monitoring Annual Compliance Fee.)

☐ The requirements of a Class A Response Action Outcome have been met. No additional operation, maintenance or monitoring is necessary to ensure the integrity of the Response Action Outcome. A completed Response Action Outcome Statement (BWSC-104) will be submitted to DEP.

☐ The requirements of a Class C Response Action Outcome have been met. No additional operation, maintenance or monitoring is necessary to ensure the integrity of the Response Action Outcome. A completed Response Action Outcome Statement (BWSC-104) will be submitted to DEP.

SECTION E IS CONTINUED ON THE NEXT PAGE

COMPREHENSIVE RESPONSE ACTION TRANSMITTAL FORM & PHASE I COMPLETION STATEMENT

Pursuant to 310 CMR 40.0484 (Subpart D) and 40.0800 (Subpart H)

Release Tracking Number: 3 - 362

E. PHASE IV COMPLETION STATEMENT: (continued)

☐ The requirements of a Class C Response Action Outcome have been met. Further operation, maintenance or monitoring of the remedial action is necessary to ensure that conditions are maintained and that further progress is made toward a Permanent Solution. A completed Response Action Outcome Statement (BWSC-104) will be submitted to DEP.

Indicate whether the operation and maintenance will be Active or Passive. (Active Operation and Maintenance is defined at 310 CMR 40.0006.):

○ Active Operation and Maintenance ○ Passive Operation and Maintenance

(Active Operation and Maintenance makes the Site subject to a Post-RAO Class C Active Operation and Maintenance Annual Compliance Fee.)

F. PHASE V COMPLETION STATEMENT:

Specify the outcome of Phase V activities:

☐ The requirements of a Class A Response Action Outcome have been met and a completed Response Action Outcome Statement (BWSC-104) will be submitted to DEP.

☐ The requirements of a Class C Response Action Outcome have been met. No additional operation, maintenance or monitoring is necessary to ensure the integrity of the Response Action Outcome. A completed Response Action Outcome Statement (BWSC-104) will be submitted to DEP.

☐ The requirements of a Class C Response Action Outcome have been met. Further operation, maintenance or monitoring of the remedial action is necessary to ensure that conditions are maintained and that further progress is made toward a Permanent Solution. A completed Response Action Outcome Statement (BWSC-104) will be submitted to DEP.

Indicate whether the operation and maintenance will be Active or Passive. (Active Operation and Maintenance is defined at 310 CMR 40.0006.):

○ Active Operation and Maintenance ○ Passive Operation and Maintenance

(Active Operation and Maintenance makes the Site subject to a Post-RAO Class C Active Operation and Maintenance Annual Compliance Fee.)

G. LSP OPINION:

I attest under the pains and penalties of perjury that I have personally examined and am familiar with the information contained in this transmittal form, including any and all documents accompanying this submittal. In my professional opinion and judgment based upon application of (i) the standard of care in 309 CMR 4.02(1), (ii) the applicable provisions of 309 CMR 4.02(2) and (3), and (iii) the provisions of 309 CMR 4.03(5), to the best of my knowledge, information and belief,

> *if Section B indicates that a* ***Phase I, Phase II, Phase III, Phase IV or Phase V Completion Statement*** *is being submitted*, the response action(s) that is (are) the subject of this submittal (i) has (have) been developed and implemented in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, (ii) is (are) appropriate and reasonable to accomplish the purposes of such response action(s) as set forth in the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, and (iii) complies(y) with the identified provisions of all orders, permits, and approvals identified in this submittal;

> *if Section B indicates that a* ***Phase II Scope of Work*** *or a* ***Phase IV Remedy Implementation Plan*** *is being submitted*, the response action(s) that is (are) the subject of this submittal (i) has (have) been developed in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, (ii) is (are) appropriate and reasonable to accomplish the purposes of such response action(s) as set forth in the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, and (iii) complies(y) with the identified provisions of all orders, permits, and approvals identified in this submittal;

> *if Section B indicates that an* ***As-Built Construction Report*** *or a* ***Phase V Inspection and Monitoring Report*** *is being submitted*, the response action(s) that is (are) the subject of this submittal (i) is (are) being implemented in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, (ii) is (are) appropriate and reasonable to accomplish the purposes of such response action(s) as set forth in the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, and (iii) complies(y) with the identified provisions of all orders, permits, and approvals identified in this submittal.

I am aware that significant penalties may result, including, but not limited to, possible fines and imprisonment, if I submit information which I know to be false, inaccurate or materially incomplete.

☐ Check here if the Response Action(s) on which this opinion is based, if any, are (were) subject to any order(s), permit(s) and/or approval(s) issued by DEP or EPA. If the box is checked, you MUST attach a statement identifying the applicable provisions thereof.

LSP Name: Richard P. Standish LSP #: 2242 Stamp:

COMMONWEALTH OF MASSACHUSETTS
RICHARD P. STANDISH
No. 2242
REGISTERED
LICENSED SITE PROFESSIONAL

Telephone: 860-282-9400 Ext.: 3150

FAX: (optional) 860-282-9500

Signature: Richard P. Standish

Date: June 16, 2003

Massachusetts Department of Environmental Protection **BWSC-108**
Bureau of Waste Site Cleanup

COMPREHENSIVE RESPONSE ACTION TRANSMITTAL FORM & PHASE I COMPLETION STATEMENT
Pursuant to 310 CMR 40.0484 (Subpart D) and 40.0800 (Subpart H)

Release Tracking Number: 3 - 362

H. PERSON UNDERTAKING RESPONSE ACTION(S):

Name of Organization: Massachusetts Electric Company

Name of Contact: Michele V. Leone Title: Senior Environmental Engineer

Street: 55 Bearfoot Road

City/Town: Northborough State: MA ZIP Code: 01532-0000

Telephone: 508-421-7564 Ext.: FAX: (optional) 508-890-4706

☐ Check here if there has been a change in the person undertaking the Response Action.

I. RELATIONSHIP TO SITE OF PERSON UNDERTAKING RESPONSE ACTION(S): (check one)

☑ RP or PRP Specify: ◯ Owner ◯ Operator ◯ Generator ◯ Transporter Other RP or PRP: Party of Interest

☐ Fiduciary, Secured Lender or Municipality with Exempt Status (as defined by M.G.L. c. 21E, s. 2)

☐ Agency or Public Utility on a Right of Way (as defined by M.G.L. c. 21E, s. 5(j))

☐ Any Other Person Undertaking Response Action Specify Relationship:

J. CERTIFICATION OF PERSON UNDERTAKING RESPONSE ACTION(S):

I, Michele V. Leone, attest under the pains and penalties of perjury (i) that I have personally examined and am familiar with the information contained in this submittal, including any and all documents accompanying this transmittal form, (ii) that, based on my inquiry of those individuals immediately responsible for obtaining the information, the material information contained in this submittal is, to the best of my knowledge and belief, true, accurate and complete, and (iii) that I am fully authorized to make this attestation on behalf of the entity legally responsible for this submittal. I/the person or entity on whose behalf this submittal is made am/is aware that there are significant penalties, including, but not limited to, possible fines and imprisonment, for willfully submitting false, inaccurate, or incomplete information.

By: MVLeone Title: Senior Environmental Engineer
(signature)

For: Massachusetts Electric Company Date: 06/25/03
(print name of person or entity recorded in Section H)

Enter address of the person providing certification, if different from address recorded in Section H:

Street:

City/Town: State: ZIP Code:

Telephone: Ext.: FAX: (optional)

YOU MUST COMPLETE ALL RELEVANT SECTIONS OF THIS FORM OR DEP MAY RETURN THE DOCUMENT AS INCOMPLETE. IF YOU SUBMIT AN INCOMPLETE FORM, YOU MAY BE PENALIZED FOR MISSING A REQUIRED DEADLINE.

REPORT ON PHASE III REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE – UPLAND PORTION
MALDEN, MASSACHUSETTS
RTN 3-0362
TIER IB PERMIT 7378

VOLUME I OF III

by

Haley & Aldrich, Inc.
Boston, Massachusetts

for

Massachusetts Electric Company
Northborough, Massachusetts

File No. 06558-634
June 2003

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

LIST OF TABLES

LIST OF TABLES
(Continued)

HALEY & ALDRICH

LIST OF FIGURES

I. INTRODUCTION

This Remedial Action Plan (RAP) presents results of the Phase III – Identification, Evaluation and Selection of Comprehensive Remedial Action Alternatives (Phase III) for the upland portion of the Former Malden Manufactured Gas Plant (MGP) Site (the Site), in Malden, Massachusetts. The upland portion of the Site includes the terrestrial land parcels of the Site and excludes the Malden River downstream of the Malden River Culvert outfall to a point approximately 1,400 feet downstream (just north of the Medford Street Bridge). The Malden River portion of the Site will be addressed separately, as described below in Section 1.02. A Site Locus is presented on Figure 1. This report was prepared by Haley & Aldrich, Inc. (Haley & Aldrich), on behalf of Massachusetts Electric Company (MEC), in accordance with 310 CMR 40.0850.

1.01 Site Background Information

Portions of the former Malden MGP Site have been the subject of Massachusetts Contingency Plan (MCP) 310 CMR 40.0000 compliance activities since 1988 under various Massachusetts Department of Environmental Protection (MADEP) Release Tracking Numbers (RTNs). This Phase III report presents a Remedial Action Plan for those portions of the former Malden MGP which have not yet received a Response Action Outcome (RAO) or a Waiver Completion Statement, and are not subject to MCP investigations by others. The Phase II – Comprehensive Site Assessment (Phase II) for the Site identified Significant Risks to human health, public welfare and the environment. This Phase III Feasibility Study was completed to evaluate Remedial Action Alternatives to address the risks.

The former Malden and Melrose Gas Light Company (MMGLC) and its successor, the Mystic Valley Gas Company (MVGC), operated an MGP on approximately 16.4 acres of land in the vicinity of the intersection of Commercial and Charles Streets in Malden, Massachusetts from approximately the mid to late 1800s to the late 1960s/early 1970s. The former holdings occupied land currently referred to as Parcels A, B, C, D and E, as shown on Figure 2. Each of these properties was redeveloped following the decommissioning of the former MGP facilities in the 1970s, and is now owned and controlled by various parties. MEC does not own any of the Site parcels. As indicated above, this Phase III report addresses portions of the former MMGLC/MVGC holdings that have not been addressed by other parties, or that have not had a Waiver Completion Statement or RAO filed at MADEP. Therefore, Parcel C (RTN 3-2066), which has a Waiver Completion Statement dated 14 September 1990, and the portion of Parcel D (i.e., Callahan Park) subject to an existing Partial RAO (RTN -13310), are not included in this Phase III assessment.

1.02 Site Description and Location

The Former Malden MGP Site boundary and parcels of the MGP that are included in this Phase III are identified on Figure 3 and are described below:

- Parcel A: Parcel A is a rectangular shape parcel of approximately 2.8 acres, occupied by six buildings (51 through 109 Commercial Street) on five separate properties. The parcel is bounded by Commercial Street to the east, Charles Street to the south, a Massachusetts Bay Transit Authority (MBTA) Orange Line railroad right-of-way to the west, and Centre Street to the north. Current occupants of the buildings on Parcel A include: a dental office, a chiropractic office, a muffler shop, a retail liquor store, an automobile body shop, a rental car garage and office, a tanning/nail salon, and medical offices.

- Parcel B: Parcel B is a rectangular shape parcel of approximately 2 acres, bounded by Charles Street to the north, Commercial Street to the east, Adams Street to the south, and the MBTA Orange Line railroad right-of-way to the west. The single existing building on the parcel is located at 129 Commercial Street and is currently occupied by a commercial bakery.

- Parcel D: The portion of Parcel D that was not included in the Partial RAO (RTN-13310) includes an area associated with the former Governor House. The Governor House was an historic MGP facility that housed equipment used to regulate the flow of manufactured gas from gas holders on Parcel D into the gas distribution system located in the Charles Street right-of-way. Contamination associated with the former Governor House has been detected in soil in the eastern corner of the southern parking lot and in groundwater in monitoring wells located in the Charles Street right of way. This area includes approximately 3,670 square feet (sf), or 0.08 acres, of the southern Callahan Park parking lot, and a 267-ft length of Charles Street, covering an area of approximately 13,970 sf, or 0.32 acres. The Phase II Risk Characterization demonstrated a condition of No Significant Risk for this area. Furthermore, impacted soil in the Governor House area is not considered to be an ongoing source of contamination. Therefore, remedial alternatives are not developed or evaluated for the Governor House contamination in this Phase III RAP. The Governor House portion of the Site will be incorporated into the existing Grant of Environmental Restriction for Callahan Park, which specifies use restrictions (i.e., property use is maintained as a public park) and provides procedures and limitations for excavation of impacted soil. A Class B-1 RAO is anticipated for the Governor House portion of the Site.

- Parcel E: Parcel E is approximately 6.6 acres in size located at 100 Commercial Street, and is bounded by Commercial Street to the west, Charles Street to the south, Centre Street to the north, and the culverted Malden River to the east. The parcel is currently owned and occupied by the Boston Gas Company d/b/a KeySpan Energy Delivery New England (KeySpan) (formerly Boston Gas Company [BGC]), which actively uses the property as an Operations and Vehicle Maintenance Center.

- Malden River Sediments: Sediments in the reach of the Malden River between the Malden River Culvert outfall and a point approximately 1,400 ft downstream of the culvert outfall are also part of the Site, as outlined in the Phase II and is shown on Figure 3. The Malden River sediment portion of the Site will be excluded from this Phase III RAP for several reasons. As discussed with MADEP during a meeting held on 3 April 2003, MEC intends to address the sediments in the Malden River as a separate operable unit (OU). Additionally, the Mystic Valley Development

Commission (MVDC), through the TeleCom City partnership, has formed a group of parties with interest in Malden River sediment remediation. The Telecom City partnership formed due to the development of a state-of-the-art telecommunications research and development park on 200 acres of land situated in Malden, Medford and Everett. This area is located along the Malden River downstream of the Site boundary. The MVDC has partnered with the Army Corps of Engineers to conduct a study of the nature and extent of sediment impacts and to identify potential remedial measures that may be undertaken in the area. MEC is contributing technical and financial support to this project and intends to participate in this study, which has been designated the Malden River Ecosystem Restoration Study. MEC also intends to participate in discussions regarding the remediation and restoration of the Malden River. In light of these recent developments, remedial measures related to Malden River sediments associated with the former Malden MGP Site would be more efficient and cost-effective if conducted in conjunction with these efforts along the larger portion of the River.

The boundary of the Site was delineated in the Phase II Report, based on the areas where MGP residuals have come to be located and have not been addressed by other parties, or that have not had a Waiver Completion Statement or RAO filed at MADEP. The lateral limits of the disposal Site incorporate property lines where appropriate, and the extents of identified MGP-residuals where they extend beyond property lines. The boundaries of the former Malden MGP disposal Site are shown on Figure 3.

The Site is located within a designated Industrial Zone, and there are no institutions located within 500 ft. There are numerous residences within 0.5 miles of the Site and it is estimated that greater than 1,000 people live within 0.5 miles of the Site. The Site is not located within 3,000 ft of an Area of Critical Environmental Concern. Based on area groundwater use and recharge characteristics, the Site is not included within areas designated Zone I, Zone II, or Zone III. A MADEP Natural Resources Map for the Site is provided on Figure 4.

1.03 Phase III Purpose and RAP Overview

This Phase III evaluation assesses the feasibility of implementing various Remedial Action Alternatives for detected contamination at the Site. It considers those alternatives suited to the Site contaminants, affected media, and physical characteristics of the detected contaminants. The assessment is designed to select a Remedial Action Alternative that is a likely Permanent Solution, or to demonstrate that if a Permanent Solution is not feasible at this time, then implementation of a Temporary Solution is a more timely and cost-effective approach.

This RAP provides supporting information on the identification, evaluation, and selection of Remedial Action Alternatives for the Site. In order to develop and compare remedial alternatives for the Site, the Site is divided into Remedial Action Alternative Areas, based on property boundaries and types of contamination identified. For each Area, this Phase III provides a summary of Site conditions, remedial objectives, and presents results of an initial screening of remedial technologies, which is designed to select the most feasible technologies for further evaluation. Remedial alternatives, consisting of remedial technologies that were retained in the initial screening, are then developed. Remedial alternatives are evaluated in the detailed evaluation for each Area, and Remedial Action Alternatives are selected. Selected remedial alternatives are presented in Section X, and a schedule for Phase IV of the project – Implementation of the Selected Remedial Action Alternative (Phase IV), is presented in Section XI.

1.04 Summary of Disposal Site History and Regulatory Status

Contamination present at the Site is the result of over 100 years of MGP operations, and has impacted soil, groundwater, indoor air, sediments and surface water to varying degrees. Currently, a Release Abatement Measure (RAM) is ongoing to address the presence of benzene, toluene, ethylbenzene, xylene (BTEX), styrene and naphthalene contaminants in indoor air at the 129 Commercial Street property. An Immediate Response Action (IRA) is ongoing to address the migration of dense, non-aqueous phase liquid (DNAPL) phase coal tar into subsurface culverts that cross the Site. The Phase II for the Site was submitted to MADEP on 28 December 2001.

A. MGP Processes Used at the Site

The three known methods of manufactured gas production are coal gasification (CG), carbureted water gasification (CWG), and oil gasification (OG). Although available information indicates that the former Malden MGP used all three production methods over the duration of its operational history, the primary method of gas production was the CWG method, in which gas was manufactured from coal, steam and oil. Gas produced using this method involved production of raw gas by forcing steam through a bed of hot, coked coal. This raw gas was enriched in a carburetor, where nozzles injected oil onto the hot bricks of the carburetor, causing the oil to volatilize and further enrich the gas. The enriched gas was then sent through the condensing process, during which tars and oils were removed from the gas through several cooling steps. Purification was the final polishing step in the gas production process, in which gaseous impurities such as volatile organic compounds (VOCs), hydrogen cyanide, and hydrogen sulfide were removed from the gas in purification boxes. The product gas was then stored in large holders until it was sent into a system of distribution pipes to be distributed to customers for use. The process of manufactured gas production resulted in the generation of several waste products, such as tars, oils, lime wastes, spent iron oxides and cyanide.

B. Land Use and History

Earliest available information indicates that the Malden and Melrose Gas Light Company (MMGLC) erected a gas manufacturing facility in 1855. The facility, which consisted of coal storage buildings, retort houses, a gas manufacturing building, a condenser house and limited purification facilities on Parcel A, reportedly began providing street lighting by gas on 1 November 1855. The locations of historic MGP facilities are shown on Figure 5. As the plant capacity was expanded, operations spread to Parcels B, D, and E. Parcel B was used primarily for gas purification operations, Parcel D was primarily used for storage and distribution of gas product, and Parcel E was the location of the second condenser house, a series of above-ground storage tanks, and various tar handling facilities. By 1920, a tar refinery, the American Tar Company, was built on the northern portion of Parcel A.

The MGP continued to operate as MMGLC through 1953. At that time, the MMGLC reorganized and became the Mystic Valley Gas Company (MVGC). Manufactured gas production continued through the early 1960s, at which time natural gas became available and quickly became the primary gas source for MVGC. By 1963, the gas manufacturing building, the retort house, and the tar storage tanks associated with the American Tar Company on Parcel A were removed. Although pipeline natural gas had become the predominant form of gas supplied to customers by the 1960s, limited production of manufactured gas continued to supplement natural gas supplies during peak demand periods until the early 1970s. In the mid-1970s, remaining MGP - affiliated structures were removed from Parcel A, and the Malden Redevelopment Authority (MRA) subdivided the parcel into four properties: 51 Commercial Street, 77 Commercial Street, 99-103 Commercial Street, and 105-109 Commercial Street. Development of Parcel A took place between 1973 and 1980. Gas purification operations on Parcel B ceased in the 1960s, and in the mid to late 1970s, previously existing structures were demolished and a two-story cinder block building, 129 Commercial Street, was constructed. Gas storage features remained on Parcel D until approximately 1975, when the gas holders, governor house and support facilities were dismantled. A partial RAO was submitted to MADEP on 10 January 1997 for the majority of Parcel D, and currently is the location of Callahan Park. The remaining portion of Parcel D (i.e., the governor house area) is addressed in this report. Parcel E remained as the primary operational property for MVGC. In the early 1960s gas manufacturing facilities on Parcel E were replaced by an office and storage building, which was constructed on Parcel E east of the control building. In the early 1970s, several structures associated with the gasification process were still present on the parcel. In the mid-1970s (approximately 1973-1975) remaining MGP-affiliated structures were razed except for the control building and the office and storage building. Following demolition of the former MGP structures in the mid-1970s, the office and storage building was expanded and extended north. This building is now known as the operations building. A maintenance garage was also constructed at this time. KeySpan Energy Delivery New England purchased the Boston Gas Company in 2000, and took ownership of Parcel E.

C. Historic Re-routing of Surface Water Bodies on the Site

The former Malden MGP was located in a marshy area, partially underlain by an organic peat deposit, and was transected by two meandering water bodies. The historic courses of the two surface water bodies on the Site, the Malden River and the West End Brook, are shown on Figure 5. Historically, the Malden River meandered through the Site, flowing generally from the north to south side of the Site, along the eastern Site boundary. The West End Brook, a tributary to the Malden River, flowed across the center of the Site from west to east before emptying into the Malden River. The West End Brook was straightened sometime in the mid 1900s, and in approximately 1970 – 1971, the Metropolitan District Commission (MDC) constructed a culvert to convey the West End Brook across the Parcel E portion of the Site. In 1977, the Malden River culvert was constructed. Both culverts are supported on wooden piles driven through the organic deposit to provide structural support, and are underlain by a layer of crushed stone, approximately 3 ft thick.

D. Current Regulatory Status

Investigations began at the Site in 1988, when the presence of coal tar contamination was first confirmed through subsurface borings. The Site was initially designated a Tier II Site under the MCP and assigned Release Tracking Number (RTN) 3-0362. In 1997, as part of a Tier II extension submittal, a series of RTNs, assigned due to releases or possible releases of contaminants associated with the former Malden MGP facility, were linked with RTN 3-0362. These include the following: RTN 3-3757 (Parcel B, 129 Commercial Street), RTN 3-13310 (portion of Parcel D (Callahan Park) not subject to RAO), and RTN 3-13345 (Charles Street Immediate Response Action Completion, linked with RTN 3-13310). Therefore, RTN 3-0362 is being used to manage MCP compliance activities for the former holdings of the Malden MGP facility that have not been addressed by other parties, or that have not had a Waiver Completion Statement or RAO filed at MADEP. Annual Tier II Extension Submittals were made from 1996 to 1999. In August 1999, a Tier Re-Classification/Tier IA Permit Application was submitted to MADEP, and Tier IB Permit 7378, with an effective date of 28 December 1999, was subsequently issued by MADEP. A Phase II Comprehensive Site Assessment was submitted to MADEP on 28 December 2001. Notice of delay letters for the Phase III Report were submitted to MADEP on 27 December 2001, 31 October 2002 and 27 February 2003, indicating that a Phase III Report for the Site would be submitted on or before 1 November 2002, 28 February 2003 and 27 June 2003 respectively. These extensions were requested to allow MEC more time to evaluate remedial options for this complicated Site and to discuss the recommended remedial action alternatives with City officials and impacted property owners.

Currently, two response actions are ongoing at the Site. One is a RAM, which was initiated in November 1998 to address the elevated concentrations of benzene, toluene, ethylbenzene, xylenes, styrene and naphthalene contaminants (BTEXSN) detected in indoor air at 129 Commercial Street. The RAM has involved continued indoor air testing, evaluation of options to mitigate the migration of VOCs from beneath the building floor slab to indoor air, pilot testing of floor sealing activities and the installation of a pilot scale, sub-slab ventilation system at 129 Commercial Street. Recent updates to the risk characterization for 129 Commercial Street incorporating the 2002 and 2003 indoor air data indicate a condition of No Significant Risk associated with indoor air contaminants under current use.

Another ongoing response action is an IRA, which was initiated in May 1996 in response to observations of an intermittent sheen on the surface of water flowing in the MR Culvert, which borders the Site. Specifically, the IRA has consisted of work to prevent migration of coal tar into the culverts including the sealing of expansion joints and weep holes in the culverts, and re-lining of catch basins and storm drain pipes that lead to the culverts. As part of the IRA, a pilot DNAPL extraction well designated RW-1 was installed adjacent to the WEB Culvert in the central portion of Parcel E in fall of 2001 to remove DNAPL from the Site subsurface and to reduce the potential for DNAPL migration into the culverts. Approximately 670 gallons of mobile DNAPL have been extracted from RW-1 between October 2001 and May 2003. In addition, joint sealing and drain line lining activities conducted between 1997 and 2002 have resulted in a significant reduction in observed sheens in the culvert. The 2003 annual culvert inspection activities conducted in June 2003 indicated no observed coal tar sources (i.e., leaking joints, drain line outfalls, etc.) to the culvert and no sheens on the water surface in the culvert. Based on these observations, IRA activities appear to have resulted in the mitigation of sheens to surface water in the culvert, and it is anticipated that an IRA Completion Report will be prepared and submitted to MADEP in the near future closing out the IRA.

II. DISPOSAL SITE CONDITIONS

The Phase II Comprehensive Site Assessment compiled and summarized data collected during Phase I and II investigations at the Site. This section presents a summary of the information presented in the Phase II, including a summary of the Site geology and hydrogeology, Site physical conditions, the nature and extent of contamination at the Site (including a summary of the conceptual Site model), and the extent of MCP Upper Concentration Limit (UCL) exceedences at the Site.

2.01 Summary of Site Geology and Hydrogeology

A. Subsurface Stratigraphy

The fate and transport of contaminants at the former Malden MGP Site is significantly influenced by subsurface geologic conditions. The following stratigraphic units have been identified (listed from surface downward), and are indicated on subsurface profiles in Figures 6A through 6G.

- Miscellaneous Urban Industrial Fill: Miscellaneous urban industrial fill at the Site typically contains fine sand and gravel with ash, cinders, slag, wood, steel, glass, plaster, asphalt, concrete and other urban debris. Fill thickness varies across the Site from approximately 2.5 to 17.5 ft.

- Organic Deposits: A layer of organic silt and peat underlies the urban fill in most of the northern portion of the Site. Where encountered, fibrous peat generally overlies and grades into organic silts. The top of the organic deposit, where present, is located approximately 4 to 17.5 ft below ground surface. This peat/organic silt zone is not continuous across the Site. It was not encountered in borings and test pit explorations on the southern portion of the Site, and the surface of the organic deposit is irregular in areas where it is encountered. The approximate extent of the organic deposit and a top of organic contour plan is shown on Figure 7. As can be seen in this figure, the organic deposit contains depressed areas, which generally coincide with the locations of former meandering stream channels associated with the location of the former West End Brook and Malden River, and the current location of the WEB and MR culverts. Additionally, some depressed areas coincide with historic MGP structures, indicating that a portion of the organic deposit may have been removed during construction of foundations for these structures. The organic deposit is believed to have been excavated from beneath the MBTA right-of way for geotechnical reasons during the construction of the railroad tracks in the early 1800s.

- Upper Sands: Medium to fine sand, coarse sandy gravel and gravelly sands generally lie below the organic deposits, ranging in thickness from approximately 2 to 6 ft. In areas where the organic deposits are not present, the sand deposits appear thicker, ranging from approximately 8 to 17 ft. Thin silty sand seams are sometimes found within the sand or sandy gravel zones.

- Silty Fine Sands: Silty fine sands typically underlie the upper sand unit across the Site, ranging in thickness from approximately 15 ft to greater than 50 ft. The silty sands appear to become finer with depth; the presence of silt and clay seams also increases with depth within the silty sand unit.

- Clay: Silty clay was observed sporadically in test borings and was not identified in a continuous layer at depth. The clay deposits were typically observed in seams at the bottom of the silty fine sand unit.

- Lower Sands: In isolated areas, a lower unit of coarse sandy material was observed beneath the silty fine sands and clay seams.

The alternation of sand units to silty fine sands to clay, then back to sands followed by finer gradations likely repeats and extends below the depth of penetration of explorations conducted by Haley & Aldrich to the top of bedrock. The stratigraphy is consistent with the interpretation of the Site location in the path of glacial meltwater streams emptying into an emergent shallow marine environment. Variations in meltwater stream energies likely account for silty seams within the sand units, sandy and clay seams within the silty sands, and sand seams within the clay units.

B. Hydrogeology

The former Malden MGP Site is located in a level, industrial setting. Two culverted surface water bodies, the WEB Culvert and the MR Culvert, flow across and adjacent to the Site. Shallow hydrogeologic conditions are primarily controlled by these culverted surface water bodies and the organic peat and silt deposits, which are present in the northern portion of the Site. The organic deposit represents the surface of an historic marsh; where encountered, the top of the organic deposit is located approximately 4 to 17.5 ft below the Site ground surface. The interpreted limits and elevation contour of the top of the organic deposit layer are presented on Figure 7. Low areas in the organic deposit are observed along historic river channels, and in areas in which the organic deposit was partially removed during construction activities, such as the vicinity of the former holder on Parcel A and along the culverts. The depth to groundwater ranges from approximately 4.5 to 12 ft below ground surface at the Site.

Water level measurements have been collected from Site monitoring wells to estimate the direction of shallow groundwater flow on the Site. Locations of Site monitoring wells, soil borings and test pits are shown on Figure 8. The shallow groundwater flow direction is significantly influenced by the organic deposit and the river channels on the Site. December 2000 water level measurements, which are representative of typical groundwater observations, are presented on Figure 9. As shown on this figure, the shallow groundwater flow direction varies across the Site, but generally is toward the south, parallel to flow in the Malden River. Ultimately, shallow groundwater is believed to flow into the Malden River, which drains the area in which the Site is located and discharges into the Mystic River. The water table is generally flat, although along the eastern boundary of the Site, hydraulic gradients are steeper, as groundwater drains into the channel of the Malden River. The WEB Culvert strongly influences groundwater flow near the center of the Site, as groundwater appears to drain into the WEB or the crushed stone backfill placed beneath the WEB culvert. Comparison of the groundwater levels in Figure 9 with the organic deposit elevations and contour on Figure 7 suggests that groundwater elevations are slightly elevated in areas of the Site that are underlain by high spots in the organic deposits. These areas are on Parcels E and A north of the WEB culvert (e.g., B1-OW, B6-OW, and B15-OW), and on Parcel E south of the WEB culvert (e.g., B112B-OW, B106-OW, and B104-OW). Shallow groundwater in these areas of the Site appears to be prevented from flowing downward into deeper formations. Rather, shallow groundwater appears to flow from high areas in the organic deposit to lower areas, such as the WEB and MR culverts.

Deep groundwater is separated to some degree from shallow groundwater in the northern portion of the Site by the organic deposit. Deep groundwater elevations based on August 2001 measurements are presented in Figure 10. As shown in Figure 10, deep groundwater flow at the Site is generally toward the south-southwest, parallel to the flow of the Malden River. Ultimately, deep groundwater most likely discharges into either the Malden or Mystic River, which drain the area in which the Site is located and discharge into Boston Harbor. However, the gradient is very slight, and the flow direction may vary with slight fluctuations in hydraulic head.

Measurements of shallow and deep groundwater elevations indicate that in some areas of the Site, strong downward gradients exist across the organic deposit. This may indicate a hydraulic separation in these areas between the upper and lower formations due to the presence of the organic deposit. Where it is present and has not been punctured (i.e., through construction, excavation, etc.), the organic deposit may prevent shallow recharge from flowing into the deeper formations. At three monitoring well locations along the WEB and MR culverts, either slightly upward or weak downward gradients are observed, indicating that the organic deposit may not be continuous near these wells. During construction for the culverts, the organic deposits may have been excavated and removed, or punctured by the wooden piles that were driven to support the culvert. As a result, shallow groundwater is allowed to flow into the deeper formations, relieving the vertical gradient at these locations.

2.02 Site Physical Conditions and Current Use

The Site is located in a developed, urban area, on land that has an industrial history that extends over the past 150 years. MGP facilities that previously existed on the Site were demolished between 1965 and 1980, and new buildings were built on the Site. Little is known about the demolition practices, however Site information presented in the Phase II suggests that contamination remains beneath some of the buildings on the Site.

A. Structures and Current Use

As mentioned above, the Site is located in a heavily developed, commercial/industrial area. As a result, there are nine major structures present at the Site, located on eight different properties. Buildings on the Site are shown on Figure 8. Table I lists the significant structures on the Site by Parcel.

TABLE I
SITE STRUCTURES AND CURRENT PROPERTY USE

Parcel Designation	Property Address	Structure Description	Current Property Use
Parcel A	51 Commercial St.	1-story building	Dentist Office/ Chiropractor Office
	65 Commercial St.	1-story building	Muffler Service Station
	77 Commercial St.	1-story building	Liquor Store
	89 Commercial St.	1-story building	Auto Body Service Station
	99-109 Commercial St.	99-103 Commercial Street; 2-story building	Auto Glass, Tanning Salon, and Print Shop
		105-109 Commercial Street; 2-story building	Medical Offices
Parcel B	129 Commercial St.	2-story commercial building with office space	Commercial Bakery and Frozen Storage
Parcel D	Callahan Park	None; Asphalt pavement	Parking
Parcel E	100 Commercial St.	1-story building; office and mechanical space	KeySpan Operations Facility
	100 Commercial St.	1-story Maintenance Garage	KeySpan Vehicle Maintenance Facility

B. Utilities

Utilities located on the Site include gas, water, electric, sewer, and drain pipes, located both beneath the city streets as well as on private property. Some of the more notable utilities include a 24-in. high-service Metropolitan Water Resources Authority (MWRA) water pipe that is located beneath Charles Street, as well as gas, electric, water and sewer utilities servicing buildings located on Parcels A, B and E. Additionally, the WEB Culvert transects the 100 Commercial Street property, and the MR Culvert lies along the eastern border of the 100 Commercial Street property. It is also expected that some historic, abandoned gas lines remain from the operational facilities of the historic MGP.

Characterization is located in Appendix B and the findings of the Risk Characterization are summarized in Section 2.05.

A. Results of Soil Sampling Conducted at 51 Commercial Street

The additional investigations conducted on the 51 Commercial Street property included the collection of three soil samples, which were collected from 0 to 3 ft below ground surface. Locations of the additional samples are shown on Figure 11, and analytical results are presented in Table II. The sample results indicate slightly elevated concentrations of PAHs and extractable petroleum hydrocarbon (EPH) aromatic compounds; however UCL exceedences were not observed, and the concentrations are generally lower than those observed in MGP-impacted soils on the Site. VOC, metals, and cyanide concentrations were below applicable MADEP standards. The concentrations observed in the three new samples were averaged together with the one previous sample result from 0 to 3 ft below ground surface to re-calculate the risk to the current landscaper on this property. Analytical data reports for the new samples are included in Appendix C.

B. Results of Supplemental Investigations at 129 Commercial Street

As was outlined in the Phase II and below in Section 2.04D, a source of BTEXSN compounds likely exists in soil beneath the two-story commercial building located at 129 Commercial Street. Additional investigations were conducted at the 129 Commercial Street Property to more closely estimate the location of the source of contamination as well as more closely define the nature and extent of contamination at the property. The additional investigations conducted on the property consisted of the installation of soil borings, monitoring wells and a temporary soil vapor monitoring point through the floor of the 129 Commercial Street building. Because the 129 Commercial Street building is the location of an operating commercial business, the investigation has been conducted in stages organized around the operating schedule of the business. Seven borings and 5 monitoring wells were installed in March 2002, and one additional boring with a soil vapor sampling point was installed in July 2002. Groundwater samples were collected from the five monitoring wells inside the building in March, May, and July/August 2002. Locations of new and previously existing borings and monitoring wells on the 129 Commercial Street property are shown on Figure 12, and analytical results obtained from the recent soil and groundwater samples are presented in Tables III and IV, respectively. Indoor air sampling was also conducted in October 2001, January 2002, April 2002, June 2002, October 2002, and January 2003 as part of the ongoing RAM at the 129 Commercial Street property. These data are presented in Table V. Boring logs, monitoring well installation records, and analytical data reports for soil, groundwater and indoor air are included in Appendix C.

In summary, the additional investigations conducted at the 129 Commercial Street property did not encounter a discrete source of contamination (such as a tank, drip pot, or other container) beneath the building. Rather, the results indicate the presence of BTEXSN contamination in soil and groundwater at several exploration locations.

Stained soil was observed in soil boring samples in a zone approximately 2 to 6 ft in thickness, located at or near the water table elevation. Visual observations and analytical results indicate the highest concentrations of BTEXSN in soil were located in borings 02B-B922, 02B-B923, and 02B-B924, located in the central portion of the building. The highest BTEXSN concentrations in groundwater were observed at monitoring location 02B-B918-OW, located downgradient of these locations in the southern portion of the building. The results of these investigations support the conceptual model presented in the Phase II, which contends that contaminated soil is located beneath the 129 Commercial Street building. As groundwater flows beneath the building, BTEXSN compounds are dissolved from the contaminated soil into and flow with groundwater. The elevated BTEXSN concentrations in soil and groundwater beneath the building appear to result in the elevated indoor air concentrations of these compounds.

Section 2.04D contains additional information concerning the nature and extent of contamination on the 129 Commercial Street property.

2.04 Nature and Extent of Contamination: Conceptual Site Model Summary

The former Malden MGP operated from the mid-1800s until the early 1970s. The types and levels of contaminants detected in soil, groundwater and sediment are consistent with this long industrial history. As described in Section 1.03, MGP operations at the former Malden MGP facility used coal, coke, and oils as raw feedstock for combustion in retorts and produced a number of residuals while processing the generated gas and separating impurities prior to gas distribution. MGP residuals included solid residue from the retorts, hydrocarbon/aqueous condensate from gas separator units (e.g., condensers, tar separators), and solid wastes from the purification process.

In general, the predominant classes of chemical compounds identified as the primary residuals from the processes used at the former Malden MGP include PAH, VOCs, and cyanide. The presence and ultimate form of the process residuals and associated chemicals currently present at the Site are a function of such factors as the extent and management of materials on-site during former MGP operations, the disposition of residuals, and the local subsurface or environmental conditions.

The former Malden MGP Site Conceptual Site Model (CSM), as presented in the Phase II, represents a synopsis of our understanding of the conditions present at the Site, including sources of contamination, affected media (i.e., soil, groundwater, etc.), potential exposure pathways and potential exposure points. The Phase II CSM identifies contaminant source areas, consistent with typical MADEP CSM terminology and based on observed contaminant distribution and the current understanding of historic MGP operations. For this Phase III RAP, seven types of contamination have been identified at the Site to facilitate the development and evaluation of remedial alternatives. For detailed information relating to Site characterization information, refer to the Phase II. The types of contamination observed at the Site are described below in a summary of the Conceptual Site Model for the Site.

has extracted approximately 670 gallons of mobile DNAPL from the central portion of Parcel E between October 2001 and May 2003. These results support the hypothesis that a portion of the coal tar beneath the Site is extractable DNAPL.

Two surface water bodies lie on or adjacent to the portion of the Site impacted by TSM and Shallow DNAPL. The WEB Culvert transects the TSM area, flowing from the western boundary of TSM impacts toward the east, where it discharges into the MR Culvert, which is located along the eastern Site boundary. South of Charles Street, the MR Culvert discharges and the Malden River flows as an open channel toward the Mystic River. TSM impacts have been observed in sediments within the WEB and MR culverts and in the Malden River downstream of the culvert outfall. An IRA was initiated to address the migration of DNAPL into the culverts. As part of the IRA, catch basins and storm drains in DNAPL -impacted areas of the Site were lined, and expansion joints and weep holes in the culverts in DNAPL-impacted areas have been sealed to prevent DNAPL infiltration. Annual inspections of the culvert have been conducted to confirm that these measures have achieved the desired result of reducing or eliminating DNAPL infiltration to the culverts. As discussed in Section 1.04, the 2003 annual culvert inspection activities conducted in June 2003 indicated no observed coal tar sources (i.e., leaking joints, drain line outfalls, etc.) to the culvert and no sheens on the water surface in the culvert. Based on these observations, IRA activities appear to have been successful, and it is anticipated that an IRA Completion Report will be prepared and submitted to MADEP in the near future closing out the IRA.

Culvert IRA activities have also included limited assessment of the crushed stone layer beneath the WEB Culvert, which have indicated that DNAPL is present at some locations beneath the WEB Culvert. In response to these observations, grout was injected beneath the MR Culvert at Station 7+30 in December 1998 to limit or eliminate the potential for DNAPL migration beneath the MR Culvert. Additionally, test holes drilled through the base of the MR Culvert into the crushed stone base near the MR Culvert outfall did not detect DNAPL.

C. Deep DNAPL

Coal tar residuals resulting from the production of manufactured gas at the former Malden MGP exists in the environment as a separate DNAPL phase, which tends to migrate vertically downward through soil and groundwater. A large portion of the former Malden MGP Site is underlain by a layer of organic deposits (the top of which ranges from 4 to 17.5 ft below ground surface), which impedes downward migration of coal tar DNAPL. In these areas, DNAPL tends to migrate horizontally along the upper surface of the organic deposit. As a result, DNAPL has not been detected in most deep wells on the Site. However, the organic deposit is absent in the southern portion of the Site, and in areas where it is present, it is discontinuous and has been penetrated or removed during various construction activities. These gaps in the organic deposit beneath the Site have likely allowed coal tar to migrate vertically as DNAPL into the deeper units below, resulting in both soil and groundwater impacts beneath the organic deposit.

The quantity of DNAPL that exists in the deeper subsurface is difficult to estimate. Based on the deep exploration data collected at the Site, the extent of DNAPL in the subsurface beneath the organic deposit is limited. DNAPL has been detected in three of twelve deep wells on the Site, as reported in the Phase II and shown on Figure 13. In one of these three wells, B301L-OW, DNAPL was detected in past observations (1997 and 1998), however measurements made in July and August 2002 indicate less than 1/2 in. of DNAPL in the bottom of this well. In another of these three wells, B110A-OW, five measurements made between 1994 and 1999 observed a thickness of as much as 10 ft of DNAPL. Accumulated DNAPL was evacuated from B110A-OW using a vacuum truck in 1999. Subsequent DNAPL monitoring consisting of greater than 70 measurements between June 2000 and December 2001 indicated a thickness of less than 0.3 ft. The third of the deep monitoring wells on the Site that have been impacted by deep DNAPL, B108-OW, does contain a significant DNAPL thickness (77 measurements made between 1991 and 2001 detected an average DNAPL thickness of approximately 6.9 ft). However, observations made during installation of the test boring indicate that the source of the DNAPL in this well may be a section of soil 3.5 ft thick that is approximately 3 ft above the bottom of the well. Therefore, it is likely that DNAPL flow into the well from this zone may result in an accumulation of several ft of DNAPL in the well. Based on these observations, a limited quantity of deep DNAPL may require remediation.

D. LNAPL

LNAPL at the former Malden MGP Site is comprised of oils that represent the lighter fraction of MGP residuals, which are less dense than water. The approximate limits of observed LNAPL impacts are shown on Figure 13; LNAPL impacts have been observed across an area of approximately 21,000 sf on the southern portions of Parcels A and E, and a portion of Commercial Street. LNAPL has also been detected on the northern portion of Parcel E in monitoring well B1-OW; however LNAPL has not been observed during recent monitoring in this well. The presence of LNAPL has resulted in impacts to shallow soils and groundwater on the Site. Based on the estimated areal extent and an observed average thickness of approximately 0.35 ft over the impacted area, the estimated quantity of LNAPL present on the Site is approximately 9,400 gallons. However, estimation of LNAPL quantity based on thickness in monitoring wells is dependant upon several factors, including LNAPL characteristics, soil type, water table fluctuations, and other factors. Therefore, this estimate should be considered approximate. It is possible that the actual distribution of LNAPL in the subsurface is more sporadic over the LNAPL area, and the quantity of LNAPL that actually exists is significantly less than the amount estimated above. Observations over the duration of Phase II investigations indicate that the LNAPL area is stable, and that LNAPL is not migrating to new areas of the Site. LNAPL impacts also do not appear to be contributing significantly to groundwater impacts at the Site based on observed groundwater concentrations in areas downgradient of the LNAPL-impacted area.

During Phase II investigations at the site, several LNAPL removal methods were pilot-tested. These efforts included testing of "siphon without a pump" (SWAP) technology, which is a passive LNAPL removal system, use of absorbent pads for removal of LNAPL from monitoring wells, and vacuum extraction methods of LNAPL removal. The rate of LNAPL removal achieved by these methods is not anticipated to be applicable to removal of LNAPL on a site-wide basis.

E. BTEXSN in Soil and Groundwater

Parcel B was used by the MMGLC/MVGC for gas purification beginning from approximately 1900 to the early 1970s. As a result, BTEXSN compounds and cyanide are the primary contaminants that are observed in soil and groundwater on Parcel B.

Data collected during the Phase II and subsequent investigations indicate the presence of BTEXSN contamination in soil and groundwater beneath the 129 Commercial Street building. Maximum concentrations of total BTEXSN observed in groundwater samples collected from wells and borings on Parcel B are presented on Figure 14. Subsurface investigations to date have encountered moderately contaminated soil at and below the water table elevation. Based on VOC concentrations observed in groundwater, heavily impacted soil may be present beneath the building, located either above or below the water table elevation, in areas where investigation is not currently possible. Subsurface investigation has not been possible in some areas of the facility due to the presence of large, immovable features inside the building. Therefore, although heavily impacted soil has not been observed to date above the water table elevation, it is considered possible that it may exist in some areas beneath the building. As shown on Figure 14, BTEXSN concentrations in groundwater are very low on the north (upgradient) side of the building, and are elevated in groundwater samples collected from explorations underneath and downgradient of the building. From these investigations it appears that shallow groundwater (i.e., approximately 10 to 12 ft below ground surface) dissolves BTEXSN constituents as it flows through source material in soil beneath the building located below the water table elevation. Several historic features have been identified on historic plans, including the drip house, drip tank, the unlabelled subsurface tank, and the purifier boxes shown on Figure 14, however investigation activities have not located these features.

As mentioned in Section 2.02, a commercial bakery currently occupies the 129 Commercial Street building. Several large structures associated with production and storage are located inside the facility, including a blast freezer (approximately 3,870 sf), a storage freezer (approximately 9,450 sf), and large baking ovens. The presence of these facilities precludes further exploration to define the location of the source material beneath the building.

The recent subsurface investigations conducted during March through August 2002 investigated possible locations of source material beneath the building. Test borings were installed at the estimated locations of several of the historic features listed above. Investigation locations are presented on Figure 14. Stained soil was encountered at and below the water table elevation (approximately 11 to 16 ft below the building floor slab) in the central portion of the building. Borings installed at the estimated locations of historic MGP structures (an historic drip house, drip tank, and unlabelled subsurface tank) did not indicate that these locations were likely discrete sources of groundwater contamination. Based on visual observations and analytical data obtained during the recent investigation, the greatest degree of soil impact was observed in the central portion of the building, in borings 02B-B922-OW, 02B-B923-OW, and 02B-B924-OW. Further explorations within the building are precluded at this time due to the internal configuration and current use of the building. However, the results of recent investigations appear to indicate that the source of the groundwater contamination is likely beneath the central portion of the building. As shown on Figure 14, historic MMGLC purifier boxes were located in this general vicinity; the earliest available reference on which these appear is a plan dated 1912.

Because the cyanide contamination that is observed in groundwater samples from monitoring well 97B-B628-OW is upgradient of the observed VOC contamination, the source of the cyanide groundwater contamination on Parcel B is most likely different than the source of the VOC contamination. Furthermore, removal of cyanide at historic MGPs typically occurred in separate structures than those used for removal of VOC impurities. Because cyanide was not detected in soil samples from 97B-B628-OW, it is likely that the cyanide detected in groundwater at this monitoring location originates from upgradient of this location, either on Parcel B or in the Charles Street right-of-way. The Phase II Risk Characterization demonstrated a condition of No Significant Risk related to exposure to cyanide in soil and groundwater on Parcel B.

Impacted media on Parcel B include soil, groundwater, and indoor air. The most significant contamination has been detected in groundwater and indoor air. Based on our current understanding of subsurface conditions beneath the 129 Commercial Street building, indoor air impacts appear to result from volatilization of contaminants from impacted soil and groundwater. The presence of VOCs in groundwater is likely the result of dissolution of VOCs from source material (i.e., impacted soil) beneath the building. As a result, anticipated response actions at 129 Commercial Street will be linked to remediation of VOC impacts in soil and groundwater beneath the building. The area of impacted groundwater beneath the 129 Commercial Street building is indicated on Figure 14. Concentrations of total BTEXSN in groundwater samples collected from this area have been as high as approximately 295 mg/l. Additionally, contaminated soil has also been observed beneath the building in a portion of this area. The area of impacted soil is estimated to be approximately 21,000 sf. Assuming an average of a four-ft thick area of soil impact at the water table, as described above, the volume of impacted soil is approximately 3,100 cubic yards (cu yd).

F. Petroleum-impacted Soil

Petroleum-impacted soil associated with the former tank farm is located in the vicinity of the historic above-ground petroleum and coal tar tanks on the northern half of Parcel E, just north of the WEB culvert, as shown on Figure 13. The primary contamination observed in this area appears to be petroleum impacts associated with the historic fuel tanks. Generally, soils in this area are not saturated with coal tar, as is the case in the TSM-impacted areas on other portions of Parcel E. However, some soil samples in this area contained a mixture of tar-related compounds and petroleum compounds, indicating a mixture of contamination types in this area. This evidence is in agreement with historic MMGLC plans and with the CSM presented in this report, which indicate that the above-ground storage tanks were used for storage of both coal tar and petroleum during different periods of operation.

Based on the extent of petroleum impacts reported in the Phase II, the areal extent of the petroleum-impacted soil contamination is approximately 28,800 sf (3,200 square yards [sy]), and the vertical extent is variable. For the purposes of this Phase III RAP, the vertical extent is assumed to be approximately 12 ft below ground surface, the approximate depth of the upper surface of the organic deposit. Based on this assumption, the volume of petroleum-impacted soil is approximately 12,800 cu yd. As shown on Figure 13, a portion of this contamination is located beneath the KeySpan maintenance garage, which is located on the 100 Commercial Street property.

2.05 Risk Characterization Summary

A Method 3 Risk Characterization was conducted by AMEC Earth & Environmental (AMEC) of Westford, Massachusetts, in accordance with MCP requirements. The results of the Risk Characterization, which were presented in the Phase II Report, included a characterization of the risk to human health, public welfare and the environment attributable to the Former Malden MGP Site. Since submittal of the Phase II Report, AMEC has revised the Risk Characterization, based on new Site data described in Section 2.03. This work included a re-characterization of the risk to human health risk at the 51 and 129 Commercial Street properties, incorporating new Site information that was obtained during work associated with the Phase III evaluation, and a Substantial Hazard Evaluation for the Site. Documentation of the revised Risk Characterization results is included in Appendix B. A brief summary of the Site Risk Characterization (as revised) is presented in this section of the Phase III. As mentioned above, evaluation of remedial alternatives for the Malden River sediment portion of the Site is not included in this Phase III RAP. Therefore, results of the Risk Characterization pertaining to the Malden River have not been presented in this section.

A. General

The Site Risk Characterization involved evaluation of increased potential risk at the Site due to exposure to MGP residuals. Because land use was varied across the Site, different exposure pathways were evaluated at each property, based on current and anticipated future land use on each property. For the purposes of the Risk Characterization, each of these properties were treated as individual "sites" for which risks were calculated individually. The Charles Street parcel, which includes the section of Charles Street south of Callahan Park, is evaluated separate from the Governor House portion of the Site in the Risk Characterization. However, in this Phase III RAP, the Charles Street and the Former Governor House parcels are together referred to as the Governor House portion of the Site. See Figure 3 for the locations associated with the addresses listed below. The properties evaluated for risk are summarized in Table VI, below:

TABLE VI
SUMMARY OF PROPERTIES INCLUDED IN RISK CHARACTERIZATION

Property Address	Parcel on which Property is Located	Current Property Use
51 Commercial Street	Parcel A	Dentist Office and Chiropractor Office
65 Commercial Street	Parcel A	Muffler Service Station
77 Commercial Street	Parcel A	Liquor Store
89 Commercial Street	Parcel A	Auto Body Service Station
99 – 109 Commercial Street	Parcel A	Auto Glass, tanning Salon, printing shop, medical offices and other office space
100 Commercial Street	Parcel E	KeySpan operations and vehicle maintenance facility
129 Commercial Street	Parcel B	Commercial Bakery
Charles Street, between Commercial and Pearl Streets	N/A	City Street
Governor House	Parcel D	Parking lot for Callahan Park

B. Human Health Risk Characterization

1. Current Site Uses

The revised MCP Method 3 Human Health Risk Characterization (Appendix B) demonstrated a condition of No Significant Risk to Human Health for current Site uses on the terrestrial portion of the Site. Differences between the results of the Phase II Risk Characterization and the revised Risk Characterization presented in Appendix B are discussed below.

The original Phase II Risk Characterization did not demonstrate a condition of No Significant Risk to the current landscaper at 51 Commercial Street. However, this result was based on one sample collected from beneath a paved parking lot, which did not accurately represent the exposure point, and therefore, did not accurately characterize the risk to the landscaper. Additional soil samples were collected from the landscaped areas of the property, and the revised Risk Characterization was conducted using this data and the previously collected data point. The revised Risk Characterization demonstrated a condition of No Significant Risk to the current landscaper at 51 Commercial Street.

The original Phase II Risk Characterization for the 129 Commercial Street Property could not demonstrate a condition of No Significant Risk to the current commercial worker via inhalation of indoor air. This result was based on indoor air data collected between September 1999 and October 2001. However, the revised Risk Characterization, which was based on indoor air data collected between September 1999 and October 2002, demonstrated a condition of No Significant Risk to the current commercial worker via the indoor air pathway. This change is likely due to the lower VOC concentrations that have been observed during recent indoor air sampling events inside the facility undertaken as part of the ongoing RAM.

2. Potential Future Site Uses

The Risk Characterization for the Site was conducted based on the assumption that current use of land on the Site is continued into the future. Therefore, potential exposure pathways that were evaluated for future use in the Risk Characterization include those that may associated with the future commercial/industrial use of the Site (i.e., commercial/industrial workers, construction workers, and utility workers). In the event that a change in the use of a property is proposed (e.g., conversion of commercial or industrial properties to residential use), the remedial approach to that property would be re-evaluated in the context of the proposed use.

As previously discussed, the Phase II Risk Characterization demonstrated a condition of No Significant Risk at the Governor House portion of the Site and for the Charles Street public right-of-way. The Risk Characterization could not demonstrate a condition of No Significant Risk to Human Health for some potential future exposure pathways, as summarized in Table VII below:

TABLE VII
SUMMARY OF HUMAN HEALTH RISK CHARACTERIZATION
FUTURE EXPOSURE PATHWAYS

Receptor	Location	Pathway[1]	Compound(s) of Concern
Future Construction Worker	100 Commercial Street	Ambient Inhalation from excavation	Naphthalene
Future Construction Worker	100 Commercial Street (Hot Spot 3)	Ambient Inhalation from excavation	Naphthalene, Benzene, C_9-C_{10} Aromatics, Methylnaphthalene
Future on-site Commercial/Industrial worker	100 Commercial Street	Soil Ingestion	PAHs, arsenic
Future Construction Worker	99-109 Commercial Street	Ambient Inhalation from excavation	Naphthalene, Benzene, Aromatics
Future Construction Worker	99-109 Commercial Street (Hot Spot 2)	Ambient Inhalation from excavation	Naphthalene, Benzene, C_9-C_{10} Aromatics, Trimethylbenzene, Methylnaphthalene
Future On-site Commercial/Industrial Worker	99-109 Commercial Street	Soil ingestion	PAHs
Future Construction Worker	89 Commercial Street 77 Commercial Street	Ambient Inhalation from excavation	Naphthalene, Methylnaphthalene
Future On-site Commercial/Industrial Worker	89 Commercial Street 77 Commercial Street 65 Commercial Street 51 Commercial Street	Soil ingestion	PAHs
Future Construction Worker	65 Commercial Street	Ambient Inhalation from excavation	Naphthalene, Methylnaphthalene, C_9-C_{10} Aromatics, C_{11}-C_{12} Aromatics
Future Construction Worker	51 Commercial Street	Ambient Inhalation from excavation	Naphthalene, Methylnaphthalene, Trimethylbenzene

Notes:
1. Explanation of Exposure Pathway terms:
   Ambient Inhalation from excavation: Inhalation of ambient (i.e., outdoor) air containing VOCs volatilized from soil exposed during excavation

HALEY & ALDRICH

C. Risk to Public Welfare

Risk to pubic welfare was also calculated in the Risk Characterization. As specified in the MCP, the risk to public welfare is based on the following: (1) a comparison of property-wide and hotspot average soil and groundwater concentrations to the UCLs; (2) comparison of indoor air and ambient vapor concentrations to odor thresholds; (3) the presence of NAPL having a thickness equal to or greater than ½ in.; and (4) comparison of estimated airborne vapor concentrations to odor thresholds. A condition of No Significant Risk to Public Welfare was demonstrated for 129 Commercial Street, 77 Commercial Street, Charles Street right-of-way, and the former Governor House.

A condition of No Significant Risk to Public Welfare was not demonstrated for 100 Commercial Street, 99-109 Commercial Street, 89 Commercial Street, 65 Commercial Street, and 51 Commercial Street based on exceedences of UCLs. NAPL greater than ½ in. has been identified in monitoring wells located at 100 Commercial Street, 99-109 Commercial Street, 89 Commercial Street, 65 Commercial Street, and 51 Commercial Street. In addition, site-wide soil concentrations for one or more constituents exceeded their respective UCLs in these areas.

Table VIII lists the properties at which a condition of No Significant Risk to Public Welfare could not be satisfied, based on the Risk Characterization.

TABLE VIII
SUMMARY OF PUBLIC WELFARE RISK CHARACTERIZATION RESULTS

Location	Compound(s) of Concern
100 Commercial Street	>0.5 in. of NAPL; concentrations of compounds > UCL
99-109 Commercial Street	>0.5 in. of NAPL; concentrations of compounds > UCL
89 Commercial Street	>0.5 in. of NAPL; concentrations of compounds > UCL
65 Commercial Street	>0.5 in. of NAPL; concentrations of compounds > UCL
51 Commercial Street	>0.5 in. of NAPL; concentrations of compounds > UCL

D. Environmental Risk

Aside from the Malden River section of the Site, which has been excluded from this Phase III RAP, environmental resource areas have not been identified at the Site. Therefore, a condition of No Significant Risk to the environment was demonstrated for the terrestrial portion of the Site.

E. Substantial Hazard Evaluation

An evaluation of the Substantial Hazards that exist on the Site is required for Sites at which a condition of No Significant Risk could not be satisfied for current exposure pathways, and for Sites at which a Temporary Solution may be appropriate.

Achievement of a Temporary Solution (i.e., a Class C RAO) requires elimination of substantial hazards that have been identified on the Site. AMEC conducted a Substantial Hazard Evaluation (SHE) for the terrestrial portion of the Site. A copy of the AMEC Substantial Hazard Evaluation is part of the revised Risk Characterization included in Appendix B.

The purpose of the SHE is to evaluate the level of potential risk that is present at the Site under current Site use. The SHE is comprised of two components: human health and ecological evaluation. For the human health portion, the SHE evaluates potential risk in a manner similar to the Risk Characterization, except the SHE evaluates potential risk posed over a reduced exposure period. The exposure period considered for the SHE is equal to the period of time elapsed between notification to MADEP of the presence of hazardous materials at the Site and the date that the SHE is conducted, plus an additional five years. The results of the SHE are compared to the same thresholds as the standard Risk Characterization; as a result, a risk that is considered a Substantial Hazard indicates a greater degree of risk to the exposed population than failure to demonstrate a condition of No Significant Risk. The Human Health SHE indicated a result of No Substantial Hazard for the terrestrial portion of the Site.

The ecological portion of the SHE is not as quantitative as the human health portion. The criteria listed in the MCP are listed in the AMEC report in Appendix B, and include the following:

- Evidence of stressed biota
- Visible presence of oil or hazardous materials (OHM) within 3 ft of the ground surface over two acres
- Continued discharge of contaminated groundwater to surface water where concentrations of Site-related OHM in surface water and/or sediment exceed Massachusetts surface water standards
- Continued discharge of contaminated groundwater to surface water where concentrations of Site-related OHM in surface water and/or sediment already pose a significant risk
- Migration of OHM to additional environmental media or resource area where exposures would potentially pose a significant risk of harm in the future, and
- Ecological risk or harm such that recovery would be substantially more difficult or would require more time if the Site was not remediated for even a short period of time

The ecological receptor associated with the Former Malden MGP Site is the Malden River. The Malden River itself has been excluded from this Phase III RAP and will be evaluated in the future in the context of the ongoing MRA and the Army Corps of Engineers Malden River Ecosystem Restoration Feasibility Study. However, the terrestrial portion of the Site that is evaluated in this Phase III RAP does include the MR Culvert, which conveys the Malden River along the eastern Site boundary, and the WEB Culvert, which empties into the MR Culvert. As described in Section 2.04A, TSM impacts have been observed within the WEB and MR Culverts, and coal tar DNAPL has been detected in the crushed stone bedding beneath the WEB Culvert.

Several remedial measures have been undertaken in response to these observations. An ongoing IRA was initiated in response to the observation of an intermittent sheen on the water surface in the MR Culvert. This response action has included the sealing of expansion joints and weep holes in the culverts, and re-lining of drain pipes that empty into the culverts. In addition, grout was injected beneath the MR Culvert at a location just downstream of the confluence with the WEB Culvert to prevent DNAPL migration in the crushed stone bedding. Annual inspections of the culverts have been conducted to check the integrity of these seals. The 2003 annual culvert inspection activities conducted in June 2003 indicated no observed coal tar sources (i.e., leaking joints, drain line outfalls, etc.) to the culvert and no sheen on the water surface in the culvert. These observations indicate that the response actions have successfully addressed the IRA conditions and it is anticipated that an IRA Completion Report will be prepared and submitted to MADEP in the near future closing out the IRA.

Because steps have been and continue to be taken to address the potential for Site contaminants to impact the WEB and MR Culverts and the Malden River, the SHE concludes that a condition of No Substantial Hazard exists at the Site, in accordance with the MCP.

F. Conclusions Based on Risk Characterization Results

Based on the results of the revised Risk Characterization, a condition of No Significant Risk could not be satisfied for future potential exposure pathways at 51, 65, 77, 89, 99-109, and 100 Commercial Street. A condition of No Substantial Hazard was satisfied for the Site.

In Section III of this report, remedial objectives are outlined for achievement of a Permanent or Temporary Solution at the Site. The remedial objectives were developed based on the results of the revised Risk Characterization summarized in this section, with the goal of eliminating or mitigating potential risks caused by potential exposure to Site contamination.

The revised Risk Characterization for the Site demonstrated a condition of No Significant Risk to Human Health for the 129 Commercial Street property. However, the Risk Characterization for the indoor air inhalation pathway at this property was based on data that were collected during the operation of a pilot-scale mechanical sub-slab venting system, which was installed for the purpose of mitigating the migration of VOCs into indoor air, thereby reducing VOC concentrations in indoor air. This system was installed as a temporary measure and, as such, this Phase III RAP includes an evaluation of remedial alternatives for reducing concentrations of VOCs in indoor air.

2.06 Remedial Action Alternative Areas

In order to facilitate the evaluation of potential remedial technologies and alternatives, the Site has been divided into five Remedial Action Alternative Areas (referred to herein as "Areas") based on property boundaries, characteristics, and type of contamination present. A summary of the five Areas, including a brief description and lists of the types of contamination and impacted media is presented below in Table IX.

TABLE IX
SUMMARY OF REMEDIAL ACTION ALTERNATIVE AREAS AND ASSOCIATED IMPACTED MEDIA

Site Area	Area Description	Properties Located Within The Area	Types Of Contamination Identified Within The Area	Impacted Media Contributing To Risk
AREA 1	Northern Portion of Parcel E	100 Commercial Street	TSM Shallow DNAPL Deep DNAPL LNAPL Petroleum-impacted Soil	DNAPL LNAPL Soil
AREA 2	Southern Portion of Parcel E (includes WEB Culvert)	100 Commercial Street	TSM Shallow DNAPL Deep DNAPL LNAPL	DNAPL LNAPL Soil
AREA 3	Northern portion of Parcel A	51 Commercial Street 65 Commercial Street 77 Commercial Street 89 Commercial Street	TSM Shallow DNAPL	DNAPL and Soil
AREA 4	Southern portion of Parcel A	99-109 Commercial Street	TSM LNAPL	LNAPL Soil
AREA 5	Parcel B	129 Commercial Street	BTEXSN in soil and groundwater	Soil Groundwater Indoor Air

The boundaries of the five Remedial Action Alternative Areas, along with the Site boundary, are shown on Figure 15. As can be seen on Figure 15, public rights of way, such as Commercial Street, Charles Street and Centre Street have not been included in the Remedial Action Alternative Areas. MGP impacts are believed to be less beneath the roadways than on gas manufacturing areas. These roadways existed at the time the MGP was in operation, and therefore it is considered unlikely that MGP waste is contained in shallow soils beneath the roadways. It is likely that mobile contaminants, such as LNAPL and shallow DNAPL, exist beneath the roadways due to flow from adjacent properties. These impacts would be located near the water table or the top surface of the organic deposit, and would likely be located below the depth of most utilities. To the extent practical, remedial measures on properties adjacent to these areas will be designed to reduce contamination in these areas, such as design of DNAPL and LNAPL systems with radii of influence that extend beneath the adjacent roadways. Aside from these efforts, implementation of remedial measures in these areas would be difficult and are considered infeasible at this time due to the presence of numerous utilities and heavy vehicular use. Furthermore, this Phase III RAP does not include an evaluation of AULs to restrict exposures to contaminants located beneath public rights-of-way, as AULs are not required by the MCP, per 310 CMR 40.1012(3).

Based on Site monitoring data collected to date the potential for exposure to LNAPL and DNAPL beneath the streets is limited based on the probable location of these media. LNAPL has been detected in monitoring wells located along Commercial and Charles Streets (97A-B601-OW, 99A-B816-OW and B109A-OW) at depths ranging from approximately 5.3 to 9.9 ft bgs, and shallow DNAPL has been detected in wells located adjacent to Commercial Street (B502-OW, 99E-B822-OW, and 00A-B914-OW) at depths ranging from approximately 11.2 to 14.5 ft bgs. Based on these observations, it is considered unlikely that LNAPL or DNAPL would be encountered during routine utility work beneath the public right-of way portions of the Site.

It is also noteworthy that, as shown in Table IX above, although groundwater contains elevated concentrations of contaminants, remediation of groundwater on Areas 1 through 4 is not required to achieve a condition of No Significant Risk. Groundwater is not used on these Areas as a resource (i.e., for drinking water or industrial use), and based on groundwater sampling data obtained during the Phase II investigation, plumes of groundwater contamination do not appear to be leaving the Site. Additionally, it is anticipated that remedial approaches to remediate LNAPL, DNAPL and soil will have a beneficial effect on groundwater quality. Therefore, Remedial Action Alternatives developed for Areas 1 through 4 will not include an evaluation of remedial components for groundwater. A groundwater monitoring program will be conducted during implementation of the selected remedy.

The boundaries, current use, characteristics and known extent of contamination on the five Remedial Action Alternative Areas, referred to herein as "Areas", are briefly described below. An evaluation of remedial alternatives is presented for each Area in Sections V through X.

A. Area 1, Northern Portion of Parcel E

Area 1 is the northern portion of 100 Commercial Street, the property currently owned by KeySpan. Area 1 is bounded by Commercial Street to the west, Centre Street to the North, the MR Culvert to the east and Area 2 to the south. Area 1 is approximately 2.3 acres, consisting of a maintenance garage (approximately 3,200 sf), parking areas, storage space for KeySpan and minimal landscaped space. Service trucks and other vehicles use Area 1; as a result there is relatively high truck traffic volume on the Area. KeySpan operations currently require use of the parking and storage areas and the maintenance garage on Area 1. However, KeySpan has indicated that use of Area 1 facilities may be discontinued to allow remedial actions to take place. Therefore, KeySpan business activities are not considered in the evaluation of the feasibility of remedial alternatives on Area 1.

1. Area 1 Characteristics

Area 1 is underlain by a relatively impermeable organic peat and silt deposit, ranging from approximately 4 to 17.5 ft below ground surface. The organic deposit separates shallow groundwater flow from deeper groundwater beneath the organic deposit, and controls the migration of shallow DNAPL. Shallow DNAPL flow is interpreted to be controlled by pressure head and gravity (i.e., shape of the organic deposit). Groundwater flow above the organic deposit is separated from deeper groundwater flow by the organic deposit. An historic river channel (the Malden River, before it was channeled into the MR Culvert) is located on the northern half of this Area. The river channel, which is now filled, is located beneath the parking area on the northern portion of the Area. Water in the channel historically flowed from the alignment of the existing Malden River channel at the eastern end of Area 1 to the western Area boundary. It then flowed onto Parcel A (Area 3), where the channel meandered around to the southeast, at which point it merged with the alignment of the existing WEB culvert.

Historic MGP facilities on Area 1 include the Parcel E Tank Farm, which was located on the southern portion of Area 1, just north of the alignment of the existing WEB culvert. Known historic features on Area 1 include six above-ground storage tanks and the Hood Garage (unrelated to the MGP), located at the northwestern corner of Area 1.

2. Area 1 Conceptual Site Model

The types of contamination that have been identified on Area 1 include TSM, shallow DNAPL, deep DNAPL, LNAPL, and petroleum-impacted soil. Impacted media include soil and groundwater. Shallow DNAPL has been observed in the former river channel along the top surface of the organic deposit, and appears to have collected at depressions in the deposit. Deep DNAPL has been identified in one deep monitoring well on the northern portion of Area 1, along the alignment of the historic river channel. DNAPL has not been detected in this well during recent measurements. LNAPL was observed once in 1995 in one monitoring well in the historic river channel on the northern portion of Area 1; however LNAPL has not been observed during subsequent monitoring at this location. TSM and petroleum-impacted soils have been identified on Area 1, and are intermixed in some areas. Elevated PAH, TPH, VOC compounds, and cyanide have also been detected in soil. Based on sampling results in previous investigations, TSM is assumed to contain concentrations of PAHs or VOCs that exceed UCLs, and one soil sample collected from within the Parcel E Tank Farm Area exceeded UCLs for TPH. Observed groundwater impacts include VOCs, PAHs, TPH and cyanide, and appear to be limited in severity and extent. Based on groundwater elevation measurements, the crushed stone layer beneath the culverts drains groundwater in the vicinity of the culverts.

3. Summary of Risk Characterization Results Relevant to Area 1

The Risk Characterization, as it relates to Area 1, satisfied a condition of No Significant Risk to Human Health under current conditions. A condition of

E. Area 5, Parcel B

Area 5 is the 129 Commercial Street Property, bounded by Commercial Street to the east, Charles Street to the north, the MBTA rail tracks to the west, and Adams Street to the south. Area 5 is approximately 2 acres in size and consists of an approximately 42,000 sf building, parking areas, and landscaped space along Commercial and Adams Streets. The 129 Commercial Street building is currently occupied by a commercial bakery with active operations and limited unused, available space inside or outside of the facility. Facility operations include regular manufacturing 6 days per week, with 2 shifts per day, with additional production during high demand periods, and large freezing facilities. Outside the facility are located employee parking areas and a large turn-around space to accommodate delivery trucks.

1. Area 5 Site Characteristics

Historically, Area 5 was the location of MGP gas purification operations. It is possible that historic MGP features, such as drip pots or a drip tank, are located beneath the building. However, such facilities have not been identified by the 10 borings conducted to date beneath the building. Further exploration beneath the building is precluded due to the presence of several large, immovable features located inside the facility. These features include baking ovens, a storage freezer and a blast freezer, and occupy approximately ¼ of the facility space.

Impacts in this Area consist of elevated concentrations of VOCs, specifically BTEXSN compounds and cyanide in soil and groundwater beneath the building. Elevated concentrations of some VOCs have been detected in indoor air inside the building. A RAM remains ongoing to reduce concentrations of VOCs in indoor air at the 129 Commercial Street property. Actions undertaken as part of the RAM have included the installation of a pilot-scale sub-slab ventilation system along a portion of the eastern side of the building, and the sealing of parts of the floor to prevent vapor migration through the floor slab. The results of periodic indoor air sampling conducted during the RAM have indicated a decrease in VOC concentrations in indoor air, resulting in a condition of No Significant Risk with the system operating.

2. Area 5 Conceptual Site Model

The contamination observed at the property consists of elevated BTEXSN compounds, which have been observed in soil, groundwater, and indoor air, and cyanide in soil and groundwater. Cyanide concentrations are highest at the northeastern corner of the property, beneath the parking lot north of the building. The highest BTEXSN concentrations have been observed in soil and groundwater beneath the central portion of the building. According to the current conceptual model for Area 5, dissolution of contaminants occurs as groundwater flows through contaminated soil that exists beneath the building. Subsurface investigations to date have encountered moderately contaminated future exposure pathways at the Site; however, the Risk Characterization did satisfy a condition of No Substantial Hazard. The selection and implementation of a remedial action alternative must result in conditions that will satisfy the MCP requirements for a Response Action Outcome (RAO), namely:

- For a Class A RAO, all sources of contamination that are resulting in or likely to result in increased concentrations in environmental media are eliminated or controlled, and all exposure pathways for which a condition of No Significant Risk could not be satisfied in the Site Risk Characterization are mitigated or eliminated.
- For a Class B RAO, no remedial actions are necessary at a Site because results of assessment actions have determined that a level of No Significant Risk exists.
- For a Class C RAO, all Substantial Hazards are eliminated.

Achievement of a Class A RAO would require removal or control of sources of contamination that result in future exposure pathways for which a condition of No Significant Risk could not be satisfied. With the exception of the Governor House portion of the Site, a Class B RAO is not appropriate for this Site, because the Risk Characterization was unable to satisfy a condition of No Significant Risk to future receptors at the Site. In the event that a Class A or B RAO cannot be achieved due to Site conditions, a Temporary Solution, or Class C RAO, is a potential response action outcome given that a condition of No Substantial Hazard was satisfied for the Terrestrial portion of the Site.

The specific requirements of Class A, B and C RAOs for the terrestrial portion of the Site are discussed in the following sections. The requirements outlined in this section will be used during evaluation of remedial alternatives at the Site, and for the evaluation of the practicality and feasibility of achieving a Permanent or Temporary Solution for the Site.

3.02 Remedial Objectives to Achieve a Permanent Solution

Achievement of a Permanent Solution at the Site requires elimination of exposures that result in potential current and future human health and environmental risk, and elimination of UCL exceedences in Site media. Based on the potential risks identified in the Risk Characterization (presented in Section 2.06 above) and distribution of UCL exceedences, the following remedial objectives must be met to achieve a Permanent Solution.

A. Elimination of Potential Exposure to Contaminated Soil

A Permanent Solution for the Site would require elimination of potential exposure to soil by the following receptors through soil remediation, placement of a cap, or AULs, as appropriate. A summary of soil exposure pathways requiring remediation or mitigation in order to achieve a Permanent Solution is provided below in Table X.

TABLE X
SUMMARY OF SOIL EXPOSURE PATHWAYS REQUIRING REMEDIATION

Receptor	Exposure Pathway	Types of Contamination	Affected Properties
Future commercial/industrial site worker	Ingestion of soil	TSM; Shallow DNAPL	100 Commercial Street 99-109 Commercial Street 51, 65, 77, 89 Commercial Street
Future commercial/industrial site worker	Ingestion of soil	LNAPL	99-109 Commercial Street 100 Commercial Street
Future commercial/industrial site worker	Ingestion of soil	Petroleum-impacted soil	100 Commercial Street
Future construction worker	Inhalation of VOCs volatilized from soil	TSM; Shallow DNAPL	100 Commercial Street 99-109 Commercial Street 51, 65, 77, 89 Commercial Street
Future construction worker	Inhalation of VOCs volatilized from soil	LNAPL	99-109 Commercial Street 100 Commercial Street
Future construction worker	Inhalation of VOCs volatilized from soil	Petroleum-impacted soil	100 Commercial Street

B. Elimination of Potential Exposure to Indoor Air

Elevated VOC concentrations were detected in indoor air at 129 Commercial Street during Phase II investigations. A Release Abatement Measure was initiated in response to these elevated concentrations, and a pilot-scale sub-slab venting system was installed beneath the floor of the 129 Commercial Street building to reduce VOC concentrations in indoor air. The data evaluated in the Human Health Risk Characterization were collected as part of the RAM, to monitor the effectiveness of the system. Therefore, the indoor air data used in the Risk Characterization were collected while the system was running, and may be lower than those that would be observed in the absence of the system. In order to achieve a Permanent Solution, this Phase III RAP will include an evaluation of remedial alternatives for the long-term mitigation of the indoor air inhalation pathway. Based on the current conceptual Site model, elevated VOC concentrations in indoor air at the 129 Commercial Street building are likely due to volatilization of BTEXSN compounds from groundwater or soil beneath the building.

C. Elimination of soil UCL Exceedences.

In order to achieve a Permanent Solution, UCL soil exceedences must be eliminated through remediation or installation of an engineered barrier. Based on the results of the Phase II, TSM contains concentrations of PAHs and/or VOCs that exceed UCLs. The limits of the observed extent of TSM, which include a significant portion of

3.04 Remedial Objectives for Area 1

Area 1 is the northern portion of Parcel E, the 100 Commercial Street Property. As described above, Area 1 contains impacts from TSM, shallow DNAPL, deep DNAPL, LNAPL, and petroleum-impacted soil. However, deep DNAPL and LNAPL have not been observed in monitoring wells on Area 1 during recent measurements. Therefore, LNAPL and deep DNAPL monitoring will be conducted, and in the event that they are detected consistently on the Area, remedial systems will be installed for their removal. Impacted media requiring remediation include DNAPL and soil. The estimated volume of shallow DNAPL on Area 1 is approximately 3,[illegible]00 gallons, the estimated areal extent of TSM is approximately 1,900 square yards (sy), and the estimated areal extent of petroleum-impacted soils is approximately 3,200 sy. Remedial objectives were developed to mitigate risk related to current use of Area 1. Remedial objectives are listed below:

<u>NAPL:</u>

- Reduce thickness of DNAPL to less than ½ in.

<u>Soil:</u>

- Reduce soil contaminant concentrations to less than the UCLs.
- Prevent exposure to soil within 15 ft of the ground surface to address potential risk to future on-site industrial/commercial workers, and construction workers.

3.05 Remedial Objectives for Area 2

Area 2 is the southern portion of Parcel E, the 100 Commercial Street Property. As described above, Area 2 contains impacts from TSM, shallow DNAPL, deep DNAPL and LNAPL. The estimated volume of NAPL in the subsurface includes approximately 11,500 gallons of shallow DNAPL and 3,800 gallons of LNAPL. The areal extent of TSM-impacted soils is estimated to be approximately 10,800 sy, and the areal extent of LNAPL-impacted soils is estimated to be approximately 400 sy. Remedial objectives are listed below:

<u>NAPL:</u>

- Reduce thickness of DNAPL and LNAPL in monitoring wells to less than ½ in.

<u>Soil:</u>

- Reduce soil contaminant concentrations to less than the UCLs.
- Prevent exposure to soil within 15 ft of the ground surface to address potential risk to future on-site industrial/commercial workers, and construction workers.

<u>Other:</u>

- Allow for continued operation of the on-site business.

3.06 Remedial Objectives for Area 3

Area 3 is the northern portion of Parcel A, including the 55 through 89 Commercial Street properties. As described above, Area 3 contains impacts from TSM and shallow DNAPL. The volume of shallow DNAPL in the subsurface on Area 3 is estimated to be approximately

3,700 gallons, and the areal extent of TSM-impacted soils is estimated as 8,400 sy. Remedial objectives are listed below:

NAPL:

- Reduce thickness of DNAPL in monitoring wells to less than ½ in.

Soil:

- Reduce soil contaminant concentrations to less than the UCLs.
- Prevent exposure to soil within 15 ft of the ground surface to address potential risk to future on-site industrial/commercial workers and construction workers.

Other:

- Allow for continued operation of the on-site businesses.

3.07 Remedial Objectives for Area 4

Area 4 is the southern portion of Parcel A, including the 99-105 and 105-109 Commercial Street buildings. As described above, Area 4 contains impacts from TSM and LNAPL. The estimated volume of LNAPL on Area 4 is approximately 5,600 gallons of LNAPL, and the areal extent of TSM and LNAPL - impacted soils is approximately 560 sy and 640 sy, respectively. Remedial objectives are listed below:

NAPL:

- Reduce thickness of LNAPL in monitoring wells to less than ½ in.

Soil:

- Reduce soil contaminant concentrations to less than the UCLs.
- Prevent exposure to soil within 15 ft of the ground surface to address potential risk to future on-site industrial/commercial workers and construction workers.

Other:

- Allow for continued operation of the on-site businesses.

3.08 Remedial Objectives for Area 5

Area 5 consists of the 129 Commercial Street Property. As described above, contamination on Area 5 requiring remediation consists of BTEXSN in soil, groundwater and indoor air. Remedial objectives are listed below:

Soil:

- Reduce soil contamination such that groundwater concentrations are below MCP S-2/GW-2 standards.

Groundwater:

- Reduce VOC concentrations to below GW-2 to mitigate the source of indoor air contamination.

Indoor Air:

- Reduce concentrations of VOCs in indoor air that exceed MADEP risk thresholds.

Other:

- Allow the on-site business to continue to operate with as little disruption as possible during implementation of remedial action alternatives.

IV. REMEDIAL ACTION ALTERNATIVE EVALUATION PROCESS

As described in Section 2.06, in order to facilitate evaluation of remedial alternatives for the Site, the Site has been divided into five Remedial Action Alternative Areas based on property boundaries, characteristics, and type of contamination present. Sections V through X present a summary of each Area's conditions and remedial objectives, and the development and evaluation of Remedial Action Alternatives for each of the five Areas. Sections V through IX include an Initial Screening of potentially applicable remedial technologies, development of Remedial Action Alternatives, and a Detailed Evaluation of Remedial Action Alternatives. Because the format of Sections V through IX for the five Areas is similar, a brief description of the individual components and definitions of terms used in the evaluation process is provided below.

4.01 Initial Screening Process

A. Initial Screening

An initial screening of remedial technologies is conducted for each Area to identify technologies that are reasonably likely to be feasible, based on contaminants present in the Area, contaminated media, and specific Area characteristics. Per 310 CMR 40.0856, remedial technologies are reasonably likely to be feasible if they are reasonably likely to achieve a Permanent or Temporary Solution, and if individuals with the necessary expertise to implement the technology are available.

Remedial technologies were screened for the contaminated media that contribute to exposure pathways for which a condition of No Significant Risk could not be satisfied for current or future receptors on properties located within each Area. The results of the initial screening are presented in a table, which includes a brief description of the technology and the rationale for retaining or eliminating the technology. A brief list of the remedial technologies that meet the initial screening criteria is provided in the Initial Screening text of the report.

B. Elimination of Remedial Technologies Based on Site Characteristics

As discussed above, the Initial Screening criteria are a basic set of criteria intended to identify remedial technologies that may be applicable based on the general conditions at the Site. However, the specific characteristics of each Area (as listed above in Section 2.06) limit the feasibility of some remedial technologies. Therefore, those technologies that are not likely to be feasible for a specific Area are eliminated before Remedial Action Alternatives are developed. Remedial technologies that are eliminated based on Site characteristics are listed in this Section, either in bullet or tabular form, along with the rationale for elimination.

4.02 Development of Remedial Action Alternatives

A Remedial Action Alternative, as used in this Phase III RAP, is defined as a combination of remedial technologies that is reasonably likely to meet the remedial objectives for the Area. Remedial Action Alternatives include components that remove, remediate, or mitigate exposure to contaminated media that result in exposure pathways for which a condition of No Significant Risk could not be satisfied for the Area. Remedial Action Alternatives are developed from the technologies that met the initial screening criteria and were not eliminated based on characteristics of the individual Area above.

4.03 Detailed Evaluation Process

In this Section, Remedial Action Alternatives that were developed for the Area are compared based on their potential to achieve the Area remedial objectives, and to meet the specific Area characteristics listed in Section 2.06. The Remedial Action Alternatives are compared using the eight criteria that are specified in the MCP, which include effectiveness, short and long term reliability, implementability, capital and long-term costs, risks, benefits, timeliness, and effect on non-pecuniary interests. These criteria are defined below. The detailed evaluation, which is summarized in a table for each Site Area, results in the selection of a Remedial Action Alternative for the Area, which is judged to be the most appropriate for the Site, based on known conditions in the Area and the evaluation criteria listed below.

A. Evaluation Criteria

The alternatives were evaluated with respect to the following eight criteria as defined in 310 CMR 40.0858:

Effectiveness: This criterion addresses a remedial alternative's ability to achieve a Permanent or Temporary Solution; its effectiveness in reusing, recycling, destroying, detoxifying, or treating the hazardous materials; and its effectiveness in reducing levels of untreated hazardous material to concentrations that achieve or approach background.

Short-term and Long-term Reliability: This criterion is used to assess the degree of certainty that an alternative will be successful and the effectiveness of measures required to manage residues, remaining wastes, and control discharges to the environment. This criterion includes assessment of both the probability of success of risk reduction and/or contaminant mass reduction in the near term, as well as the probability that the alternative will be successful in achieving the long-term remedial goals.

Implementability: The Implementability criterion addresses the technical complexity of the alternative; integration with existing facility operations; integration with other remedial operations; maintenance and monitoring requirements; Site access requirements; availability of necessary services and materials; availability of off-site treatment, storage and disposal facilities; and whether the alternative meets regulatory requirements for permits required by local, state or federal agencies.

Cost: Costs considered include design, construction, equipment, Site preparation, labor, permits, disposal, operation, energy requirements, maintenance, monitoring, environmental restoration and damages to natural resources. Costs are provided for comparison and feasibility purposes only, and are considered accurate to approximately +50/-30 percent.

The Net Present Value (NPV) is presented for alternatives that include ongoing activities, such as operation, maintenance and/or monitoring. An annual discount rate of 6 percent was used based on long-term typical United States public debt instruments. NPV estimates are provided for comparison only, and are considered accurate to approximately +50/-30 percent.

Risks: Short-term on-site and off-site risks during implementation are considered under this criterion. The Risk criterion also addresses on-site and off-site risks posed over the period of time required for the alternative to attain the remedial goal, and the long-term potential risk posed by hazardous material remaining at the Site after the completion of remedial activities.

Benefits: This criterion addresses the benefit of restoring natural resources; providing for productive Site reuse; avoided costs of relocating people; and avoided lost value of the Site.

Timeliness: The timeliness of eliminating uncontrolled sources or achieving a level of No Significant Risk or No Substantial Hazard is evaluated under this criterion.

Effect on Non-pecuniary Interests: This criterion addresses the effect of the alternative on non-monetary aspects, such as aesthetic values. It also includes impact of the installation of remedial measures on the use of properties not owned by MEC.

B. Weighting of the Evaluation Criteria

In accordance with 40.0861(2)(b), the approach to the evaluation of Remedial Action Alternatives and the weighting of the criteria listed above is provided herein. The weighting of the Detailed Evaluation criteria varies slightly by Area; however the following general approach is taken in evaluation of the Remedial Alternatives according to the criteria listed above. The criterion that is given the greatest weight in this Phase III is implementability. Properties on the Site have features such as buildings and operating commercial businesses that limit the implementability of some remedial measures. The next tier of criteria includes effectiveness, cost and non-pecuniary interests. Remedial Alternatives that would result in a cost-effective Permanent Solution for the Site are considered more desirable than alternatives that may not result in a Permanent Solution, or may represent a higher cost burden to achieve a similar result (i.e., a Permanent or Temporary Solution). The non-pecuniary interest criterion is used in this evaluation to consider the potential for negative impacts on the businesses operating on the properties located within the Site limits, and the effect that the implementation of the remedy may have on the surrounding area. These potential impacts are important because the Site is located in an urban area near Malden Center, and disruption to the area could have far-reaching financial implications to the businesses in the area and the community of Malden itself. The reliability, benefits and risk criteria are also given due consideration, as these are important factors in the selection of a remedial solution that will meet the remedial goals. Because a condition of No Substantial Hazard exists for the terrestrial portion of the Site, and a condition of No Significant Risk to Human Health and the Environment exists for current site conditions, the Timeliness criterion is given the least weight in this evaluation.

4.04 Selected Remedial Action Alternatives for the Site

Selected Remedial Action Alternatives and conceptual details regarding their implementation (such as time requirements and order of implementation) are described at the conclusion of the Detailed Evaluations for each Site Area. A summary of the selected overall Remedy for the Site, which will be a combination of the selected remedies for each Site Area, is then presented at the conclusion of this Phase III RAP, in Section X.

V. EVALUATION OF REMEDIAL ALTERNATIVES FOR AREA 1

5.01 Introduction

In this section, Remedial Action Alternatives to address contamination identified in Area 1 are developed and evaluated. A brief summary of the existing conditions and remedial objectives for Area 1 is provided below. Based on these conditions and objectives, an initial screening of remedial technologies is presented in Section 5.04 to identify technologies that may be reasonably likely to be feasible to address contamination identified on Area 1. Remedial technologies that meet the initial screening criteria but are not applicable on Area 1 due to specific site characteristics are eliminated from further consideration in Section 5.04 E. Remedial Action Alternatives are then developed in Section 5.05 by combining the remaining remedial technologies based on knowledge of Site conditions and engineering judgement. A detailed evaluation of the Remedial Action Alternatives is then conducted in Section 5.06, and the recommended Remedial Alternative is presented in Section 5.07.

5.02 Summary of Area 1 Conditions

Area 1 is the northern portion of the 100 Commercial Street property, which is currently used as part of the KeySpan Energy Delivery Operations Center. Area 1 is bounded by Centre and Commercial Streets and the MR and WEB culverts, and includes the portion of the MR Culvert that abuts it. Types of contamination that have been identified in Area 1 include TSM, shallow DNAPL, deep DNAPL, LNAPL and petroleum-impacted soil. The estimated volume of shallow DNAPL on Area 1 is approximately 3,200 gallons, the estimated areal extent of TSM is approximately 1,900 square yards (sy), and the estimated areal extent of petroleum-impacted soils is approximately 3,200 sy. As described in Section 2.06, deep DNAPL and LNAPL have not been identified in Area 1 monitoring wells during recent monitoring events.

5.03 Summary of Area 1 Remedial Objectives

Remedial objectives were developed to mitigate risk related to future commercial use of Area 1. Remedial objectives are listed below:

<u>NAPL:</u>

- Reduce thickness of DNAPL to less than ½ in.

<u>Soil:</u>

- Reduce soil contaminant concentrations to less than the UCLs.
- Prevent exposure to soil within 15 ft of the ground surface to address potential risk to future on-site industrial/commercial workers, and construction workers.

Because LNAPL and deep DNAPL have not been detected during recent monitoring events, remedial measures for their removal from the subsurface will not be evaluated. Monitoring of wells in which LNAPL and deep DNAPL have been detected will be conducted during implementation of the remedy. In the event that LNAPL or deep DNAPL are detected consistently in a monitoring well, removal methods will be evaluated.

5.04 Initial Screening of Remedial Technologies for Area 1

An initial screening of remedial technologies was conducted to identify technologies that are reasonably likely to be feasible at the Site, based on Site contaminants, contaminated media, and specific Site characteristics. Per 310 CMR 40.0856, remedial technologies are reasonably likely to be feasible if they are reasonably likely to achieve a Permanent or Temporary Solution, and if individuals with the necessary expertise to implement the technology are available.

Remedial technologies were screened for the contamination that contributes to exposure pathways for which a condition of No Significant Risk could not be satisfied for foreseeable future receptors on Area 1. A summary of the initial screening for Area 1 is presented in Table XI, including a brief description of the remedial technologies, and a rationale for retaining or eliminating the technology. Remedial technologies that meet the initial screening criteria are listed and briefly described below.

A. Shallow DNAPL

- **DNAPL extraction using recovery wells:** Installation of large (8-in.) diameter recovery wells, equipped with a submersible pump to extract DNAPL from the subsurface. Extracted DNAPL would be pumped from wells to small buildings on Site, in which it would be stored until it is transported off-site for disposal. A DNAPL extraction well has been operating on the southern portion of the 100 Commercial Street property (Area 2) since October 2001, and has collected approximately 670 gallons of DNAPL to date.

- **DNAPL extraction/migration control using trenches:** Excavation of trenches that are keyed into the low-permeability organic deposit, and backfilled with gravel to collect DNAPL. A recovery well would be installed in the backfilled trench, equipped with a submersible pump to extract and collect DNAPL. Trenches could used to control shallow DNAPL migration from one portion of the Site to another through placement along property or area boundaries. Extracted DNAPL would be stored in small buildings on Site, and transported off-site for disposal or incineration.

- **Vertical subsurface barrier for DNAPL migration control:** Installation of a vertical barrier to DNAPL flow. Need depends on sequencing of DNAPL remediation on adjacent properties or areas. The type of barrier would depend on Phase IV design; potential options include a slurry wall, sheet piling, or a Waterloo™ Barrier.

- **Disposal or incineration:** Off-site transport of extracted NAPL to an appropriate receiving facility for disposal or incineration.

B. Soil

- **Excavation and off-site treatment:** Excavate and remove contaminated soil to an average depth of approximately 12 ft, along with DNAPL and LNAPL where present, and transport impacted soils off-site for treatment. Suitable excavated soils may be re-used as backfill on site. Implementation of this action would require support of excavations and building foundations during excavation, and may require demolition of on-site buildings if contamination is located beneath buildings. Implementation would also require an enclosure for control of vapors and odors.

- **Installation of an Engineered Barrier:** RCRA-type Engineered Barrier consistent with 310 CMR 40.0000, to be installed over soil containing contaminant concentrations in excess of the UCL. Installation of an Engineered Barrier would require excavation of approximately 3 ft of soil, followed by placement of an HDPE impermeable membrane, which would be covered by approximately 1 ft of clean sand and a geo-composite drainage layer. The drainage layer would be covered by a marker fabric, and either pavement or a vegetated surface. Implementation of this alternative would require demolition of buildings, if present in areas of contamination.

- **Installation/Maintenance of a Direct Contact Barrier:** Installation and/or maintenance of a surface barrier (i.e., 3 ft of soil, asphalt or concrete pavement), to prevent direct contact with surface soils.

- **Incineration:** Off-site transport of excavated soil to an appropriate receiving facility for incineration

- **Ex-situ thermal descrption:** Treatment of excavated soil material using thermal desorption with an afterburner. May be performed on or off-site; however on-site thermal desorption is not likely implementable due to the urban location and active use of the Area.

- **In-situ chemical oxidation:** Injection of hydrogen peroxide, Fenton's Reagent, or other oxidant into soil using temporary injection wells to chemically break down contaminants to innocuous compounds. This remedial method is not feasible when a significant amount of free-phase product (i.e., LNAPL or DNAPL) exists in the subsurface, as uncontrollable reactions can result.

- **Activity and Use Limitations (AULs):** Place restrictions on future property use and activities to prevent potential exposure through a pathway for which a condition of No Significant Risk could not be satisfied.

C. Elimination of Remedial Technologies Based on Site Characteristics

Remedial technologies passed the initial screening portion of the evaluation process if the technology is reasonably likely to achieve a Permanent or Temporary Solution, and if experts are available to implement the technology. However, some technologies are not considered feasible in Area 1 due to specific site characteristics in Area 1. Therefore, the remedial technologies listed in Table XII below are not considered reasonably feasible in Area 1 and will not be incorporated into Remedial Action Alternatives for Area 1.

TABLE XII
REMEDIAL TECHNOLOGIES ELIMINATED BASED ON SITE CHARACTERISTICS
AREA 1

Remedial Technology	Technology Type	Target Media	Reason For Elimination
Extraction using trenches	Extraction	Shallow DNAPL	Significantly more disruptive and difficult to implement than extraction wells, which have been demonstrated to be effective on Area 2 for extraction of DNAPL.
DNAPL migration control using trenches	DNAPL migration control	Shallow DNAPL	Significantly more disruptive and difficult to implement than vertical subsurface barriers, which would likely be effective for DNAPL migration control.

5.05 Development of Remedial Action Alternatives for Area 1

Remedial Action Alternatives for Area 1 are presented below. The Remedial Action Alternatives were developed using engineering judgement from the remedial technologies that passed the initial screening and were not eliminated based on specific Site characteristics. Approximate locations of the components of the Remedial Alternatives for Area 1 are shown on Figure 16.

- **Alternative 1-1**: Excavation of TSM, and shallow DNAPL, and petroleum-impacted soil, provisional shallow DNAPL migration control, and an AUL.

  This alternative involves the excavation of the TSM and shallow DNAPL contamination on the northern portion of Area 1 and excavation of the petroleum-impacted soil on the southern portion of Area 1. Excavation of the petroleum-impacted soil would also require demolition of the KeySpan maintenance garage. Approximate locations of proposed remedial components for Area 1 are shown on Figure 16. In addition to the removal of contaminated soil and DNAPL, excavation of TSM located within the Area is intended to remove the source of shallow DNAPL in the Area. If needed, DNAPL migration onto Area 1 would be prevented using a vertical subsurface barrier, such as sheet piling or a Waterloo™ Barrier. It is anticipated that DNAPL migration control may be necessary in the event that the estimated DNAPL volume of approximately 3,200 gallons beneath Area 1, and a net extraction rate of 35 gallons per month for the 5 extraction wells, it is estimated that approximately 5 to 7 years will be required to reach the DNAPL remedial goals on Area 1. Therefore, the estimated total time requirement to reach a Permanent Solution in Alternative 1-3 is approximately 6 to 9 years. However, the long-term rate of DNAPL recovery is difficult to estimate and may decrease with time. A vertical subsurface barrier would be installed to prevent the migration of shallow DNAPL from adjacent areas onto Area 1, if necessary. An AUL would be required to maintain the Engineered Barrier.

Implementation of this alternative would involve closing off the majority of the Area during excavation and installation of the Engineered Barrier, and therefore would result in significant disruption to facility operations. Additionally, an estimated 240 truckloads would be required to transport the excavated soil off-site. Use of the Area by the owner would likely be limited or completely discontinued during implementation of the remedy.

- **Alternative 1-4**: Shallow DNAPL recovery, provisional shallow DNAPL migration control, in-situ chemical oxidation of TSM area and petroleum-impacted soil, and an AUL

Alternative 1-4 would involve the installation of five shallow DNAPL recovery wells (as above in Alternative 1-3), and monitoring of deep monitoring wells for DNAPL and shallow wells for LNAPL. A small storage building would be required on Area 1 to store recovered DNAPL prior to off-site disposal. If necessary, the migration of shallow DNAPL from adjacent areas onto Area 1 would be prevented using a vertical subsurface barrier, and TSM and petroleum-impacted soil would be treated through injection of oxidants to promote in-situ chemical oxidation reactions. Chemical oxidation treatment of impacted soil in this alternative would be conducted as the treatment becomes feasible. In the case of TSM soils, chemical oxidation of soil would not be feasible until DNAPL has been reduced to the extent practicable. In the case of petroleum-impacted soils, LNAPL and DNAPL have not been identified; therefore the feasibility of the treatment of soil is dependent on the current owner's operational needs. As described above, it is estimated that approximately 5 to 7 years will be required to reach the DNAPL remedial goals. For the purposes of estimation, Alternative 1-4 includes implementation of chemical oxidation as one integrated program for the TSM and petroleum-impacted soils once the DNAPL remedial goals have been met. The chemical oxidation program is assumed to involve the installation of approximately 150 temporary injection wells (assuming 20-ft spacing between the wells), and three oxidant injections. Assuming chemical oxidation requires approximately 1 to 2 years to implement, the time requirement to reach a Permanent Solution in Alternative 1-4 is estimated to be approximately 6 to 9 years from the date of implementation of DNAPL extraction. AULs may be required to mitigate risk through future soil exposure pathways.

Disruption to facility operations during DNAPL extraction would involve temporary disruption during installation of extraction wells and a storage building, plus regular (weekly or monthly) maintenance activities performed on wells and at the storage building and transport of extracted DNAPL off-site. Disruption to Area operations during chemical oxidation would involve limitations on use of the Area for three periods of approximately one month during installation of temporary injection wells and injection of oxidant.

- **Alternative 1-5**: Shallow DNAPL recovery, Monitoring of LNAPL and deep DNAPL, provisional shallow DNAPL migration control and AUL

  Alternative 1-5 is a less intrusive remedial option than Alternatives 1-1 through 1-4 to address the presence of MGP contamination on Area 1. This alternative involves the installation of five shallow DNAPL recovery wells, monitoring of deep monitoring wells for the presence of DNAPL, and monitoring for the presence of LNAPL in monitoring wells. If shallow DNAPL migration control is required, vertical subsurface barriers may be installed to prevent migration of DNAPL onto Area 1 from adjacent properties. As described above, it is estimated that five DNAPL extraction wells would accomplish the DNAPL remedial goals in approximately 5 to 7 years. However, because this alternative does not include remediation of soil, a Permanent Solution is not achieved in Alternative 1-5. An AUL will be required to mitigate risk through future soil exposure pathways.

  Disruption to facility operations during DNAPL extraction would involve temporary disruption during installation of extraction wells and a storage building, plus regular (weekly or monthly) maintenance activities performed on wells and at the storage building and transport of extracted DNAPL off-site.

- **Alternative 1-6**: NAPL Monitoring and AUL

  This alternative involves continued monitoring of LNAPL and DNAPL to ensure that NAPL located in the subsurface on Area 1 does not migrate off-site. Because this alternative does not involve removal of NAPL from the subsurface, it would not require a subsurface barrier to shallow DNAPL migration. This alternative involves minimal disruption to Area use during implementation of the remedy.

5.06 Detailed Evaluation of Remedial Action Alternatives for Area 1

This section presents a Detailed Evaluation of the Remedial Action Alternatives presented above, based on the criteria listed in Section 4.03. As with the other Areas, this evaluation is based on the current property conditions and use, as described in Section 2.06 and summarized in Section 5.02. A summary of the detailed evaluation of the six remedial action alternatives developed for Area 1 is presented in Table XIII. Table XIII presents a summary of the likely effectiveness, reliability, implementability, cost (net present value, or NPV), risks, benefits, timeliness, and potential effect on non- pecuniary interests of each alternative. A comparison of the six remedial alternatives based on these criteria is presented below.

As indicated in Table XIII, each of the six remedial action alternatives (with the exception of Alternative 1-1) provisional shallow DNAPL migration control and an AUL. Achievement of a Permanent Solution on Area 1 will require accomplishment of the NAPL reduction remedial goals. On Area 1, this goal is expected to be reasonably attainable with respect to deep DNAPL and LNAPL, as these contaminants have not been observed on Area 1 during recent monitoring events. Provisional shallow DNAPL migration control is intended to be a method of preventing the migration of shallow DNAPL from adjacent areas onto Area 1 once remediation on Area 1 has been completed. Because these remedial components are common to nearly all the remedial action alternatives proposed for Area 1, they do not have a significant impact on the comparison of the alternatives and are not included in the evaluation presented below. An AUL may be used to mandate specific land use requirements, such as a requirement that commercial/industrial use of the property be maintained, eliminating residential exposure pathways from consideration.

- **Effectiveness:** As shown on Figure 16, two distinct areas of contamination exist within Area 1: the contamination associated with TSM on the northern portion of the Area, and the petroleum-impacted soils on the southern portion of Area 1. Because they involve excavation of the contamination associated with TSM, Alternatives 1-1 and 1-2 are considered the most effective of the proposed alternatives. Alternative 1-3 (Engineered Barrier installation) is less effective than Alternatives 1-1 and 1-2, because although Alternative 1-3 eliminates the potential for exposure to contaminated soil through the installation of an Engineered Barrier, DNAPL extraction is likely to be a less effective means of DNAPL removal than excavation. Alternative 1-4 would likely have a similar level of effectiveness in the long term as Alternative 1-3, as both of these alternatives rely on DNAPL extraction wells to remove shallow DNAPL, and both would eliminate potential for exposure to soil containing UCL exceedences. A difference in effectiveness between Alternative 1-3 and 1-4 is that the Engineered Barrier proposed in Alternative 1-3 provides more rapid elimination of UCLs in the short term, however in-situ chemical oxidation proposed in Alternative 1-4 would likely result in a reduction in contaminant concentrations, a more effective solution in the long term. Alternative 1-5 is less effective than Alternatives 1-1, 1-2, 1-3, and 1-4, because it would not include measures (i.e., excavation or chemical oxidation) to reduce concentrations of contaminants in soil to less than the UCLs. Alternative 1-6, a "monitoring only" alternative, is the least effective of the six that were evaluated, because it would not include shallow DNAPL extraction or measures to reduce concentrations of contaminants to less than the UCLs. Alternatives 1-1, 1-2, 1-3, and 1-4 are likely Permanent Solutions for Area 1, although 1-3 and 1-4 would require a significantly longer time to reach a Permanent Solution than Alternatives 1-1 and 1-2 (refer to timeliness below). Alternatives 1-5 and 1-6 represent Temporary Solutions.

- **Short and Long-term Reliability:** In general, the alternatives that involve excavation of the contamination associated with TSM on the northern portion of Area 1 (i.e., Alternatives 1-1 and 1-2) are considered the most reliable remedial alternatives. Alternative 1-1 is considered the most reliable alternative, both in the short and long term, of the six evaluated alternatives because it involves excavation of both the contamination associated with TSM and the petroleum-impacted soil. Alternative 1-2, which involves excavation of the TSM contamination and in-situ chemical oxidation of petroleum-impacted soil, is also highly reliable; chemical oxidation has been used at other MGP and petroleum contamination sites to reduce concentrations of PAHs and VOCs. Alternative 1-3 is ranked as moderately reliable, less reliable than Alternatives 1-1 and 1-2 in the short and long term. Alternative 1-3 provides relatively reliable elimination of the exposure pathway to UCLs in soil through installation of an Engineered Barrier. However, DNAPL extraction wells are a less certain method of DNAPL removal compared to excavation, and are likely to require a longer time period to accomplish the DNAPL remedial goals than excavation. Based on the successful operation of a DNAPL extraction well on Area 2, it is likely that DNAPL extraction wells placed in proper locations on Area 1 will effectively remove DNAPL from the subsurface. However, it is less certain that the DNAPL remedial goals will be reached using DNAPL extraction wells than would be the case if the contamination were excavated. Alternative 1-4, which also relies upon DNAPL extraction wells to remove DNAPL and uses in-situ chemical oxidation to reduce concentrations of contaminants in soil, is also ranked as moderately reliable in the short and long term. Alternative 1-4 is considered more reliable than Alternative 1-3 in the long term, because the in-situ chemical oxidation component of Alternative 1-4 would likely result in a reduction in contaminant concentrations. Alternative 1-5 is considered moderately reliable in the short term, as DNAPL extraction wells are likely to function reliably once installed. However, over the long term Alternative 1-5 is ranked as a low reliability alternative, because it does not include a method to reduce contaminant concentrations in soil, which would be required for a Permanent Solution. Reliability of Alternative 1-6 is low, as remedial systems are not installed in this Alternative.

- **Implementability:** Implementability is an important criterion in the selection of a remedial alternative for Area 1. Alternatives 1-1 and 1-2 would be difficult to implement, due to the large volume of highly impacted soil that would be excavated and transported off-site in these Alternatives. Nuisance odors and high truck traffic would be very disruptive to the surrounding area of Malden Center, which has a relatively high volume of public pedestrian and vehicular traffic. A temporary enclosure would likely be required to contain potentially hazardous vapors, and workers inside the enclosure would require Level B respiratory protection (i.e., supplied air). Excavation support, dewatering, and water treatment would also be required. The KeySpan maintenance garage would need to be removed in order to excavate petroleum-impacted soils in Alternative 1-1, and to install the Engineered Barrier in Alternative 1-3. Demolition of the maintenance garage would not be required in Alternatives 1-2 or 1-4, as oxidants may be delivered through the floor slab of the garage, assuming proper ventilation of sub-slab soil can be provided. Demolition of the Maintenance Garage also would not be required for Alternatives 1-5 and 1-6.

  The alternatives that do not involve excavation of the TSM and shallow DNAPL are generally considered to be more implementable than Alternatives 1-1 and 1-2. Alternative 1-3 is considered moderately difficult to implement, due to the relatively large volume of shallow soil that would be excavated to install an engineered barrier. However, Alternative 1-3 would be considerably less disruptive than Alternatives 1-1 and 1-2, because shallow soils (i.e., 0 to 3 ft bgs) in Area 1 are less contaminated than deeper soils near the organic deposit. Alternative 1-3 would also not involve excavation dewatering. Alternatives 1-4 and 1-5 are considered readily implementable, because few difficulties are anticipated with the installation of DNAPL extraction wells, and chemical oxidation of TSM and petroleum-impacted soils after NAPL removal (included in Alternative 1-4) is expected to be relatively straightforward. Alternative 1-6 is considered readily implementable, as it includes only monitoring and does not call for the installation of remedial measures.

- **Cost:** As listed in Table XIII, Alternatives 1-1 and 1-2 are the most expensive, with estimated 30-year NPV of approximately $4,900,000 (4.9M) and $2.3M, respectively. The costs of Alternatives 1-1 and 1-2 are driven by the need for an enclosed structure for excavation and off-site transportation and disposal of contaminated soil and NAPL. The estimated 30-year NPV for Alternative 1-3, which involves the installation of an Engineered Barrier and shallow DNAPL extraction wells, is approximately $2.1M. It is noteworthy that the estimated 30-year NPV for Alternatives 1-2 and 1-3 are within 10%, indicating that installation of an engineered barrier may not be a cost-effective solution on Area 1 due to the presence of shallow DNAPL. The estimated 30-year NPV for Alternatives 1-4, 1-5, and 1-6 are approximately $1.1M, $540K, and $110K, respectively. At approximately $1.1M, Alternative 1-4 is currently the most cost-effective potential Permanent Solution for Area 1.

- **Risks:** The highest level of risk for the evaluated alternatives for Area 1 is associated with Alternatives 1-1 and 1-2, which have been given a "high" risk level for this evaluation. These risks include risk of inhalation of vapors by workers and passersby during excavation of TSM and contaminated soils. Mitigation of these risks would require an enclosure and Level B respiratory protection during excavation. In Level B excavation work inside an enclosure, workers would be subject to higher risks of injury due to limited fields of vision and fatigue, as well as exhaustion and dehydration. Additional risks to workers are involved with the handling and injection of chemical oxidants in Alternative 1-2; these risks include hazards associated with handling caustic reagents, and the potential for vapor, pressure and heat buildup beneath pavement and structures during in-situ chemical oxidation. Risk associated with the installation of an Engineered Barrier in Alternative 1-3 is considered to be relatively low, because although this alternative involves excavation of shallow soils, shallow soils on Area 1 are less impacted than deeper soils near the upper surface of the organic deposit. A moderate level of risk is associated with Alternative 1-4; risks associated with this alternative include the risks mentioned above for chemical oxidation. Risk associated with Alternative 1-5 is scored as low, as this alternative does not include excavation or chemical oxidation of TSM/soils. The lowest risk level is associated with Alternative 1-6, which is a "monitoring only" alternative, and involves very little potential for exposure to hazardous materials.

  Long-term risks due to contamination left in-place are greatest in Alternative 1-6, which does not remove DNAPL or contaminated soil. These risks are less for Alternative 1-5, which removes DNAPL over the long term but leaves TSM in place.

Long-term risk for Alternatives 1-4 and 1-3 are less than those associated with Alternative 1-5 and similar to each other, as both remove DNAPL and eliminate the potential for exposure to UCLs in soil. Alternatives 1-2 and 1-1 present the lowest long-term risk, as they include removal or in-situ treatment of contamination.

- **Benefits:** Alternatives 1-1 and 1-2 provide the greatest benefit, as they provide the greatest reduction in contaminant mass (i.e., removal/treatment of DNAPL, LNAPL [if present] TSM, and impacted soil) on Area 1 in the shortest possible time frame. Benefits of Alternative 1-3 include elimination of the potential for exposure to TSM and contaminated soil in the short term, and removal of DNAPL, over time. Alternative 1-4 would result in removal of DNAPL and reduction of soil contaminant concentrations, both over the long term. Alternative 1-5 provides the benefit of the removal of DNAPL from Area 1, but does not reduce soil contaminant concentrations. Alternative 1-6 provides little benefit in terms of contaminant reduction.

- **Timeliness:** There is significant variation in the timeliness of the evaluated alternatives for Area 1. Alternatives 1-1 and 1-2 are the timeliest alternatives under consideration for Area 1. Implementation of these alternatives is expected to result in a Permanent Solution within approximately 1 to 3 and 2 to 4 years, respectively. The other alternatives are less timely. Alternative 1-3 would eliminate the potential for exposure to soil containing contaminant concentrations greater than the UCLs (through the installation of an Engineered Barrier) within 1 to 2 years; however attainment of the DNAPL remedial goals (and therefore a Permanent Solution) is anticipated to require approximately 5 to 7 years. Therefore, the time required to attain a Permanent Solution for Alternative 1-3 is approximately 6 to 9 years. The estimated time requirement to attain a Permanent Solution in Alternative 1-4 is the same as Alternative 1-3, approximately 6 to 9 years. Alternative 1-5 would require approximately 5 to 7 years to reach the DNAPL remedial goals, but does not reach a Permanent Solution because it does not include measures to reduce contaminant concentrations in soil to below UCLs. Alternative 1-6 also would not reach a Permanent Solution because it does not include measures to remove NAPL or to reduce contaminant concentrations to less than UCLs.

- **Effect on Non-pecuniary Interests:** Implementation of Alternatives 1-1 and 1-2 would have a significant impact on the use of Area 1 and on the surrounding area of Malden Center during excavation work. Excavation of TSM soil, because it contains high concentrations of volatile and semivolatile compounds such as benzene and naphthalene, would be conducted inside an enclosure to contain potentially harmful vapors. Despite this precaution, nuisance odors are likely during the excavation process. Additionally, transport of the anticipated volume of TSM soil (approximately 3,725 cu yd), which is included in both Alternatives 1-1 and 1-2, would require a minimum of approximately 150 truckloads (assuming approximately 25 cu yd per truck) to transport the soil to an off-site treatment facility. Transport of the petroleum-impacted soil (approximately 12,800 cu yd), excavation of which is included in Alternative 1-1, would require approximately 500 additional truckloads. Importation of clean fill would likely require a similar number of truck trips, resulting in approximate total numbers of 1,300 truck trips for Alternative 1-1, and approximately 300 truck trips for Alternative 1-2. This volume of truck traffic, over a period of approximately six months to one year of excavation work, would have a significant impact on the local area. The impact of Alternative 1-3 on the local area would be less than Alternatives 1-1 and 1-2, due to the smaller anticipated excavation volume and because contaminant concentrations are generally lower in shallow soils. However, the excavation and Engineered Barrier construction work would still require a significant amount of construction traffic and would likely be very disruptive to the area. Additionally, construction of an Engineered Barrier would limit options for future development on the Area. Implementation of Alternatives 1-4 and 1-5 would be significantly less disruptive to property use and to the local area than Alternatives 1-1, 1-2 and 1-3, because Alternatives 1-4 and 1-5 do not involve excavation of contaminated soil.

5.07 Selected Remedial Action Alternative for Area 1

In summary, Alternatives 1-1 and 1-2, which involve excavation of the contamination related to TSM on the northern portion of the property, are likely the most effective, reliable, and timely alternatives and provide the most benefit in terms of reducing contaminant concentrations in the subsurface. However, these alternatives are also the most difficult to implement, have the greatest associated short-term risk, are the most costly to implement, and would have significant negative impacts on the community surrounding the Area during implementation. Alternative 1-3 provides effective, reliable elimination of potential exposure to UCLs at the site in a timely manner, but requires a lengthy period of time (i.e., approximately 6 to 9 years) to reach a Permanent Solution due to reliance on DNAPL extraction to reach DNAPL goals. Further, Alternative 1-3 limits future Area use options through the installation of an Engineered Barrier. Alternative 1-4 would reach a Permanent Solution in a similar timeframe as Alternative 1-3, and is easier and less costly to implement. Additionally, because Alternative 1-4 does not include excavation, it would have significantly less impact on the surrounding area than Alternative 1-3. Because Alternative 1-4 is a likely effective, reliable, and implementable Permanent Solution, it would be preferable over Alternatives 1-5 and 1-6, which are not likely Permanent Solutions, and Alternative 1-4 is the selected Remedial Action Alternative for Area 1. Alternative 1-4 involves the following components:

- Shallow DNAPL extraction using wells equipped with submersible pumps;
- Chemical oxidation of soil (when feasible),
- Control of shallow DNAPL migration onto the property (if necessary) and
- An AUL to maintain commercial/industrial land use on the property.

Approximately five 8-in. diameter, shallow DNAPL extraction wells are anticipated to extract DNAPL from the historic river channel on the northern portion of the property. Because LNAPL and deep DNAPL have not been observed recently, monitoring will be conducted to evaluate whether extraction of deep DNAPL and LNAPL is appropriate. Installation of DNAPL extraction wells can begin once when facility operations allow the installation of extraction wells and a NAPL storage facility on the property. In-situ chemical oxidation of petroleum-impacted soil may be implemented as appropriate, given the requirements of the current property use. In-situ chemical oxidation of TSM soil, which is anticipated to require approximately 1 to 2 years to implement, cannot be conducted until such time as the thickness of DNAPL has been reduced to the extent practicable on the Site. This is anticipated to require an estimated 5 to 7 years, based on the estimated quantity of DNAPL beneath Area 1 and observed DNAPL extraction rates in RW-1, a DNAPL extraction well located on Area 2. Therefore the time requirement to attain a Permanent Solution on Area 1 is approximately 6 to 9 years. Shallow DNAPL migration control may be implemented to prevent the flow of DNAPL from adjacent properties (i.e., Area 3) onto Area 1, which may prolong the time required to achieve the remedial goals on Area 1. The projected Net Present Value of this alternative is estimated to be approximately $1.1M.

VI. EVALUATION OF REMEDIAL ALTERNATIVES FOR AREA 2

6.01 Introduction

In this section, Remedial Action Alternatives to address contamination identified in Area 2, the southern portion of the 100 Commercial Street property, are developed and evaluated. A brief summary of the existing conditions and remedial objectives for Area 2 are provided below. Based on these conditions and objectives, an initial screening of remedial technologies is presented in Section 6.04 to identify technologies that may be applicable to address contamination identified on Area 2. Remedial technologies that meet the initial screening criteria but are not applicable on Area 2 due to specific site characteristics are eliminated from further consideration in Section 6.04 D. Remedial Action Alternatives are then developed in Section 6.05 by combining the remaining remedial technologies based on knowledge of site conditions and engineering judgement. A detailed evaluation of the Remedial Action Alternatives is then conducted in Section 6.06, and the recommended Remedial Alternative is presented in Section 6.07.

6.02 Summary of Area 2 Conditions

Area 2 is the southern portion of the 100 Commercial Street property currently owned by KeySpan, as shown in Figure 15. Area 2 is bounded by Charles and Commercial Streets, Area 1, and the MR Culvert. Area 2 includes a portion of the WEB Culvert, which transects the northern portion of Area 2, and the section of the MR Culvert that abuts it to the east. Area 2 was the location of several historic MGP features, including the historic condenser house, a relief holder, a tar filter and tar spray pond. Types of contamination that have been identified on Area 2 include TSM and shallow DNAPL, deep DNAPL, and LNAPL. The estimated volume of NAPL in the subsurface includes approximately 11,500 gallons of shallow DNAPL and 3,800 gallons of LNAPL. Based on the results of the Phase II investigations, recoverable deep DNAPL is likely present on Area 2 in the vicinity of B108-OW (refer to Figure 13). However, the volume is difficult to reliably estimate due to the sporadic nature of the detections and the geology at depth. The areal extent of TSM-impacted soils is estimated to be approximately 10,800 sy, and the areal extent of LNAPL-impacted soils is estimated to be approximately 400 sy. These estimates include DNAPL and impacted soil that likely exists beneath the 100 Commercial Street building. A DNAPL extraction well (RW-1) has been operating successfully on Area 2 since October 2001; to date approximately 670 gallons of DNAPL have been extracted from the subsurface using this well.

6.03 Summary of Area 2 Remedial Objectives

Impacted media contributing to risk include DNAPL (shallow and deep), LNAPL, and soil. Remedial objectives are listed below:

<u>NAPL:</u>

- Reduce thickness of DNAPL and LNAPL in monitoring wells to less than ½ in.

Soil:

- Reduce soil contaminant concentrations to less than the UCLs.
- Prevent exposure to soil within 15 ft of the ground surface to address potential risk to future on-site industrial/commercial workers, construction workers, and residents.

Other:

- Allow for continued operation of the on-site businesses.

6.04 Initial Screening of Remedial Technologies for Area 2

An initial screening of remedial technologies was conducted to identify technologies that are reasonably likely to be feasible for Area 2, based on the type of contamination observed within the Area, contaminated media present, and specific Area characteristics. Per 310 CMR 40.0856, remedial technologies are reasonably likely to be feasible if they are reasonably likely to achieve a Permanent or Temporary Solution, and if individuals with the necessary expertise to implement the technology are available to implement the technology.

Remedial technologies were screened for the contaminated media that contribute to exposure pathways for which a condition of No Significant Risk could not be satisfied for foreseeable future receptors on Area 2. A summary of the initial screening for Area 2 is presented in Table XIV, including a brief description of the remedial technologies, and a rationale for retaining or eliminating the technology. Remedial technologies that meet the initial screening criteria are listed and briefly described below.

A. DNAPL

- **DNAPL extraction using recovery wells:** Installation of large (8-in.) diameter recovery wells, equipped with a submersible pump to extract DNAPL from the subsurface. Extracted DNAPL would be pumped to small buildings on Site, stored and transported off-site for disposal or incineration. A DNAPL extraction well has been operating on the northern portion of this Area since October 2001, and has collected approximately 670 gallons of DNAPL to date.

- **DNAPL extraction/DNAPL migration control using trenches:** Excavation of trenches that are keyed into the low-permeability organic deposit, and backfilled with gravel to collect DNAPL. A recovery well would be installed in the backfilled trench, equipped with a submersible pump to extract and collect DNAPL. Trenches may be installed along Area boundary to cut off DNAPL flow and prevent migration of DNAPL onto the Area from adjacent Areas. Extracted DNAPL would be stored in small buildings on Site, and transported off-site for disposal or incineration.

- **Vertical subsurface barrier for DNAPL migration control:** Installation of a barrier to DNAPL flow. The type of barrier would depend on the results of a feasibility assessment; potential options include a slurry wall, sheet piling, or a Waterloo™ Barrier. The barrier for Area 2 would also involve injection of grout through the base of the WEB Culvert to prevent DNAPL migration through the crushed stone bedding beneath the culvert.

- **Disposal or incineration:** Off-site transport of extracted NAPL to an appropriate receiving facility for disposal or incineration.

B. LNAPL

- **Multi-phase Extraction (MPE):** Extraction of groundwater, soil vapor and LNAPL through the application of a vacuum to specially designed extraction wells. Requires separation of NAPL from water and ex-situ treatment of both groundwater and soil vapor.

- **Belt-skimmer:** Extraction of LNAPL using belt-skimmers, which consist of two pulleys that drive a hydrophobic belt through the groundwater surface in a monitoring well and to the top of the well, bringing the LNAPL to the surface and skim the oil into a collection container. The belt-skimmer system is driven by an electrical motor.

- **Disposal or Incineration:** Off-site transport of extracted NAPL to an appropriate receiving facility for disposal or incineration

C. **Soil**

- **Excavation and off-site treatment:** Excavate and remove contaminated soil to an average depth of approximately 12 ft, along with DNAPL and LNAPL where present, and transport impacted soils off-site for treatment. Suitable excavated soils may be re-used as backfill on site. Implementation of this action would require support of excavations and building foundations during excavation, and may require demolition of on-site buildings if contamination is located beneath buildings. Implementation would also require an enclosure for control of vapors and odors.

- **Installation of an Engineered Barrier:** RCRA-type Engineered Barrier consistent with 310 CMR 40.0000, to be installed over soil containing contaminant concentrations in excess of the UCL. Installation of an Engineered Barrier would require excavation of approximately 3 ft of soil, followed by placement of an HDPE impermeable membrane, which would be covered by approximately 1 ft of clean sand and a geo-composite drainage layer. The drainage layer would be covered by a marker fabric, and either pavement or a vegetated surface. Implementation of this alternative would require demolition of buildings, if present in areas of contamination. Would require deeper excavation and construction of a clean utility corridor at locations with subsurface utilities.

- **Installation/Maintenance of a Direct Contact Barrier:** Installation and/or maintenance of a surface barrier (i.e., 3 ft of soil, asphalt or concrete pavement), to prevent direct contact with surface soils.

- **Incineration:** Off-site transport of excavated soil to an appropriate receiving facility for incineration

- **Ex-situ thermal desorption:** Treatment of excavated soil material using thermal desorption with an afterburner. May be performed on or off-site; however on-site thermal desorption is not likely implementable due to the urban location and active use of the Area.

- **In-situ chemical oxidation:** Injection of hydrogen peroxide, Fenton's Reagent, or other oxidant into soil using temporary injection wells to chemically break down contaminants to innocuous compounds. This remedial method is not feasible when a significant amount of free-phase product (i.e., LNAPL or DNAPL) exists in the subsurface, as uncontrollable reactions can result.

- **Activity and Use Limitations (AULs):** Place restrictions on future property uses and activities to prevent potential exposure through a pathway for which a condition of No Significant Risk could not be satisfied.

D. Elimination of Remedial Technologies Based on Site Characteristics

Area 2 represents a portion of the KeySpan Operations Center and consists of a large (37,000 sf) commercial building and a parking lot used to store a fleet of service vehicles. Remedial Action Alternatives for Area 2 are developed based on the assumptions that current use continues into the future (i.e., the existing building remains on site, and that the commercial business is not re-located for the installation of remedial components on the Area). Area 2 is located in a public, urban area, and experiences high traffic volume in its current use. Excavation of soil on Area 2 to achieve the remedial objectives is not considered reasonably feasible at this time due to the presence of the large building on the Area. Based on this reasoning, six remedial technologies that met Initial Screening criteria are not reasonably feasible on Area 2 and will not be incorporated into Remedial Action Alternatives for Area 2. These technologies are summarized below in Table XV:

TABLE XV
REMEDIAL TECHNOLOGIES ELIMINATED BASED ON SITE CHARACTERISTICS
AREA 2

Remedial Technology	Technology Type	Target Media	Reason For Elimination
Extraction using trenches	Extraction	Shallow DNAPL	Significantly more disruptive and difficult to implement than extraction wells, which have been demonstrated to be effective on Area 2 for extraction of DNAPL.
DNAPL migration control using trenches	DNAPL migration control	Shallow DNAPL	Significantly more disruptive and difficult to implement than vertical subsurface barriers, which would likely be effective for DNAPL migration control.
Excavation and off-site treatment	Physical Removal	Soil/TSM	Excavation beneath the building is infeasible; therefore this remedial method cannot achieve a Permanent Solution for the Site.
Incineration	*Ex-situ* treatment	Soil/TSM	Not necessary if soil is not excavated.
Thermal desorption	*Ex-situ* treatment	Soil/TSM	Not necessary if soil is not excavated.
Engineered Barrier	Barrier	Soil/TSM	Installation of an Engineered Barrier would not result in a Permanent Solution for the Area due to the presence of a building on the Area; contamination is located beneath the building and the existing building cannot serve as a barrier to potential exposure.

6.05 Development of Remedial Action Alternatives for Area 2

Three Remedial Action Alternatives that are reasonably likely to meet the remedial objectives have been developed for Area 2 and are described below. Approximate locations of the components of the Remedial Alternatives for Area 2 are shown on Figure 17.

- **Alternative 2-1**: Shallow and deep DNAPL recovery, LNAPL recovery using MPE, provisional shallow DNAPL migration control, in-situ chemical oxidation of TSM and LNAPL-impacted soil, and AUL

  Alternative 2-1 involves the installation of shallow and deep DNAPL extraction wells equipped with submersible pumps, MPE wells for the extraction of LNAPL, provisional shallow DNAPL migration control using vertical subsurface barriers, in-situ chemical oxidation of TSM soil, and AULs to ensure that current industrial/commercial property conditions are maintained on the property. In this alternative, approximately 13 DNAPL extraction wells would be installed in locations on Area 2 where DNAPL is known to exist based on subsurface investigations to date, and where low spots are known or inferred to exist in the organic peat and silt deposit. Based on the estimated DNAPL volume of approximately 11,500 gallons and on observed recovery rates observed in RW-1, it is estimated that attainment of the DNAPL remedial goals will require approximately 7 to 10 years.

Alternative 2-1 also includes the installation of approximately 12 MPE wells. Because it applies a very high vacuum in the vicinity of the extraction wells, MPE typically results in rapid LNAPL extraction rates and is included as an aggressive approach to remove LNAPL from the subsurface. It is estimated that MPE would require approximately 2 years to reach the LNAPL remedial goals on Area 2.

In-situ chemical oxidation is proposed in Alternative 2-1 to reduce concentrations of contaminants in accessible soil once the free-phase product is removed. In-situ chemical oxidation would be implemented using a network of approximately 245 temporary injection wells (assuming a 20-ft radius of influence), and is anticipated to require approximately 2 to 3 years to implement. It is assumed that chemical oxidation is not reasonably feasible beneath the 100 Commercial Street building or beneath the WEB Culvert due to the disruption this would cause to the commercial business located in the building, and the potential for the build-up of heat and vapors beneath the building and the culvert. Therefore, in-situ chemical oxidation would be conducted in accessible soils only. Chemical oxidation of TSM and LNAPL-impacted soils is not feasible until DNAPL and LNAPL have been removed, to the extent practicable; therefore it would not be implemented until the NAPL remedial goals have been reached on the Area. Implementation of chemical oxidation on Area 2 would require significant reductions in use of the Area surrounding the 100 Commercial Street building during installation of temporary injection wells and injection of oxidants.

Vertical subsurface barriers to shallow DNAPL flow may be installed to prevent migration of shallow DNAPL onto Area 2 from adjacent areas. This may be desired in the event that remedial goals are met and a Permanent Solution is reached on Area 2 before they are reached on adjacent areas. The vertical barrier for Area 2 would involve driven sheet piling or a Waterloo™ Barrier, as shown on Figure 17, and grout injected through the base of the WEB Culvert to prevent potential DNAPL migration in the crushed stone beneath the culvert.

Alternative 2-1 is anticipated to require approximately 9 to 13 years to complete. However, contaminants (TSM and shallow DNAPL) would likely remain beneath the 100 Commercial Street building following implementation of Alternative 2-1, necessitating an AUL. Because TSM (i.e., UCL exceedences in soil) and shallow DNAPL would likely remain beneath the building in this alternative, Alternative 2-1 would not achieve a Permanent Solution and therefore represents a Temporary Solution.

- **Alternative 2-2**: Shallow and deep DNAPL recovery, LNAPL recovery using belt-skimmers, provisional shallow DNAPL migration control, and AUL

Alternative 2-2 involves the installation of 13 shallow and deep DNAPL extraction wells, 6 LNAPL extraction wells equipped with belt-skimmers, provisional shallow

DNAPL migration control using vertical subsurface barriers, and AULs to ensure that current property conditions are maintained on the Area. It is anticipated that the LNAPL remedial goals may be met in approximately 4 to 6 years, and the DNAPL remedial goals may be met in approximately 7 to 10 years. However, because DNAPL likely exists beneath the 100 Commercial Street building, it is possible that the DNAPL remedial goals may not be achievable on Area 2 under current conditions and use. TSM would also remain on the Area in Alternative 2-2. Therefore, Alternative 2-2 also represents a Temporary Solution.

- **Alternative 2-3**: LNAPL and shallow and deep DNAPL monitoring and AUL

  Alternative 2-3 is a monitoring alternative. Based on Site data collected to date, the LNAPL and DNAPL plume dimensions appear stable; this alternative proposes monitoring to ensure that the extents of LNAPL and DNAPL impacts do not expand.

6.06 Detailed Evaluation of Remedial Action Alternatives for Area 2

This section presents a Detailed Evaluation of the three Remedial Action Alternatives presented above, based on the criteria listed in Section 4.03. As with the other Areas, this evaluation is based on the current property conditions and use, as described in Section 2.06 and summarized in Section 6.02. A summary of the detailed evaluation of the three Remedial Action Alternatives developed for Area 2 is presented in Table XVI. Table XVI presents a summary of the likely effectiveness, reliability, implementability, cost (net present value, NPV), risks, benefits, timeliness, and potential effect on non- pecuniary interests of each alternative. The presence of the existing KeySpan operations building currently located on Area 2 limits the implementability and effectiveness of some remedial alternatives on Area 2. Because it is likely that DNAPL and TSM soil containing contaminant concentrations greater than UCLs are located beneath the building, a Permanent Solution is not proposed for Area 2; the remedial alternatives evaluated below represent Temporary Solutions. A comparison of the three remedial alternatives based on these criteria is presented below.

- Effectiveness: Because Alternative 2-1 includes LNAPL extraction using MPE, Alternative 2-1 is likely to provide more effective and more rapid LNAPL removal than Alternative 2-2. MPE is generally more effective in low-permeability soils; the effectiveness of MPE on Area 2 will therefore depend on the permeability of soils within the LNAPL area. However, the same method of DNAPL extraction is proposed in Alternatives 2-1 and 2-2; therefore DNAPL extraction would occur at the same rate in both of these alternatives. It is unlikely that either Alternatives 2-1 or 2-2 would reach the DNAPL remedial goals, because DNAPL would likely remain beneath the 100 Commercial Street building; however, they would likely be effective at removing significant DNAPL mass from the subsurface in this Area. Additionally, it is likely that TSM exists beneath the building, and would also remain beneath the building under these alternatives. Therefore, neither Alternative 2-1 nor 2-2 would reach a Permanent Solution. Both Alternatives 2-1 and 2-2 are ranked with a "moderate" level of effectiveness, because although they do not reach a Permanent Solution, they will reduce the volume of DNAPL and LNAPL present on the Area. Alternative 2-3 also would not provide a Permanent Solution, as it is a monitoring-only alternative, and is given a "low" effectiveness ranking, because it does not reduce the volume of NAPL on Area 2. Each of the evaluated alternatives represents a Temporary Solution for Area 2.

- Short and Long Term Reliability: The technologies proposed in Alternatives 2-1 (DNAPL extraction wells, MPE, and in-situ chemical oxidation) and 2-2 (DNAPL extraction wells and belt-skimmers) are considered reliable remedial technologies. Both alternatives are considered moderately reliable in the short and long term, although MPE is considered a slightly more reliable method of LNAPL extraction than belt-skimmers. The reliability criterion is not relevant for Alternative 2-3, as a remedial system is not proposed in this Alternative.

- Implementability: Alternative 2-1 is considered somewhat difficult to implement, because the proposed MPE system would require extraction equipment and a groundwater and vapor treatment system on Area 2 and the chemical oxidation component would require approximately 245 injection points. Injection of oxidants beneath the buildings on Area 2 is not considered reasonably feasible due to the disruption this would cause to the commercial businesses located in the buildings, and the potential for the build-up of heat and vapors beneath the buildings. Therefore it is assumed that chemical oxidation would not be conducted beneath the buildings on Area 3. These technologies could present significant logistical problems for the Area facility operations. Alternative 2-2 is readily implementable; the belt-skimmers included in Alternative 2-2 would involve considerably less intrusion than MPE into the commercial operations on the Area, as significantly less space and equipment are required to implement this remedial component. Additionally, Alternative 2-2 does not include in-situ chemical oxidation, which is not fully implementable due to the presence of the building on Area 2. Alternative 2-3, which includes monitoring of LNAPL and DNAPL on Area 2, is readily implementable.

- Cost: Alternative 2-1, which is the most aggressive remedial alternative, is also the most costly alternative, with an estimated NPV of approximately $2.4M. The estimated NPV for Alternative 2-2 is approximately $1.3M. The estimated NPV for Alternative 2-3, which is a monitoring alternative, is approximately $110K.

- Risks: Low to moderate risk is associated with the three alternatives evaluated for Area 2. Moderate risks associated with Alternative 2-1 include those associated with handling of extracted LNAPL and DNAPL, and handling the caustic oxidants during in-situ chemical oxidation. Low risk is associated with implementation of Alternative 2-2, including the handling of extracted LNAPL and DNAPL. Risks associated with Alternative 2-2 are somewhat less than those associated with Alternative 2-1, as Alternative 2-2 does not involve the handling of caustic oxidants. Alternative 2-3 involves few risks of exposure to hazardous chemicals.

  Long-term risks due to potential exposure to contamination left in place are higher in Alternatives 2-2 and 2-3, because these alternatives do not include measures to reduce contaminant concentrations in soil. This long-term risk is reduced somewhat in

Alternative 2-1, which includes in-situ chemical oxidation to reduce contaminant concentrations in accessible soils.

- Benefits: Alternatives 2-1 and 2-2 both provide the benefit of reducing the quantity of LNAPL and DNAPL in the subsurface. The completeness of the removal of DNAPL is dependent on the ability of DNAPL extraction wells surrounding the 100 Commercial Street building to remove DNAPL from beneath the building. Alternative 2-1 includes some additional benefit due to the in-situ chemical oxidation component, which would reduce contaminant concentrations in accessible soil. However, soil beneath the building would not be accessible for chemical oxidation treatment. Alternative 2-3 produces no significant beneficial reduction of contaminants, as it includes neither NAPL extraction nor soil remediation.

- Timeliness: LNAPL removal using MPE in Alternative 2-1 is likely to require approximately 2 years, which would be more rapid than removal using belt-skimmers in Alternative 2-2, which is anticipated to require approximately 4 to 6 years. The method and therefore the rate of DNAPL extraction is the same in both Alternatives 2-1 and 2-2; DNAPL extraction is expected to continue for approximately 7 to 10 years on Area 2. It is unlikely that the DNAPL extraction wells proposed in Alternatives 2-1 and 2-2 will accomplish the DNAPL remedial goals, as a portion of the DNAPL on Area 2 is located beneath the 100 Commercial Street building. Chemical oxidation of TSM and LNAPL-impacted soil, which is proposed as a remedial component in Alternative 2-1, would not be implementable until LNAPL and DNAPL have been reduced to the extent practicable. In-situ chemical oxidation is anticipated to require approximately 2 to 3 years to reach the soil remedial goals; however soils beneath the 100 Commercial Street building are not accessible for chemical oxidation treatment. Therefore the remedial goals will not be met for soils beneath the building. Alternative 2-3 could be implemented immediately and would continue for the foreseeable future, until a Permanent Solution can be implemented.

- Effect on Non-pecuniary Interests: Alternative 2-1 results in more adverse effects on non-pecuniary interests, because the MPE system and chemical oxidation injection proposed in this alternative would require more equipment and would have a greater impact on property use than Alternative 2-2. Both Alternatives 2-1 and 2-2 would require the construction of a small NAPL storage building on the Area, which is not expected to have a significant effect on the aesthetics or use of the Area. The requirement for a small DNAPL storage building may be satisfied through modifications to the existing building located on the northern side of the KeySpan Operations building, which was constructed in association with the installation of the existing DNAPL recovery well. Alternative 2-3 would have very little effect on use of the Area or aesthetics.

6.07 Selected Remedial Action Alternative for Area 2

In summary, although Alternative 2-1 may be slightly more effective and reliable and provide marginal additional benefit over Alternative 2-2, neither alternative would provide a

Permanent Solution for Area 2. Implementation of Alternative 2-1 would likely provide slightly more effective, reliable, and rapid LNAPL removal than Alternative 2-2, and would reduce the quantity of DNAPL on the Area. Alternative 2-1 would also provide additional benefit of reduced contaminant concentrations in accessible soil. However, Alternative 2-1 would not reach a Permanent Solution because DNAPL and TSM would likely remain beneath the 100 Commercial Street building. The belt-skimmers proposed for LNAPL extraction in Alternative 2-2 are considered to be a relatively reliable technology, and would provide effective LNAPL extraction over time. Implementation of Alternative 2-2 would also provide for effective reduction in the quantity of DNAPL in accessible areas, and like Alternative 2-1, Alternative 2-2 would not result in a Permanent Solution. Alternative 2-3, which involves monitoring of LNAPL and DNAPL, also would not result in a Permanent Solution. Based on the successful operation of a DNAPL extraction well on Area 2, DNAPL extraction is feasible on the property and therefore Alternative 2-3, which does not include DNAPL extraction, is not considered a viable alternative. Both Alternatives 2-1 and 2-2 would have the same result (i.e., would result in a Temporary Solution due to the contamination that would remain beneath the 100 Commercial Street building). Therefore, because of the implementation difficulties, impact on use, and higher cost of Alternative 2-1, Alternative 2-2 is the selected remedy for Area 2.

Implementation of Alternative 2-2 would involve the installation of approximately 13 DNAPL recovery wells, placed in locations of likely DNAPL accumulation, as shown on Figure 17. Approximately 6 belt-skimmer wells would be installed on the southwestern corner of the Area to remove LNAPL, as shown on Figure 17. A vertical barrier to DNAPL migration may also be installed, if necessary. The anticipated time requirement to reach the DNAPL remedial goals is approximately 7 to 10 years, based on assumed DNAPL extraction rates. However, it is likely that DNAPL will remain beneath the 100 Commercial Street building on Area 2.

VII. EVALUATION OF REMEDIAL ALTERNATIVES FOR AREA 3

7.01 Introduction

In this section, Remedial Action Alternatives to address contamination identified in Area 3, the northern portion of Parcel A. Area 3 is bounded by Centre Street to the north, the MBTA Orange line to the west, Area 4 to the south, and Commercial Street to the east. Area 3 is comprised of four separately owned properties, including 51 Commercial Street, 65 Commercial Street, 77 Commercial Street, and 89 Commercial Street. Use of these properties is currently commercial, and involves a high degree of public access. The WEB Culvert crosses Area 3 between the 77 Commercial Street and the 89 Commercial Street properties. A brief summary of the existing conditions and remedial objectives for Area 3 are provided below. Based on these conditions and objectives, an initial screening of remedial technologies is presented in Section 7.04 to identify technologies that may be applicable to address contamination identified on Area 3. Remedial technologies that meet the initial screening criteria but are not applicable on Area 3 due to specific site characteristics are eliminated from further consideration in Section 7.04. Remedial Action Alternatives are then developed in Section 7.05 by combining the remaining remedial technologies based on knowledge of site conditions and engineering judgement. A detailed evaluation of the Remedial Action Alternatives is then conducted in Section 7.06, and the recommended Remedial Alternative is presented in Section 7.07.

7.02 Summary of Area 3 Conditions

TSM and shallow DNAPL contamination has been identified on Area 3. This contamination is likely residual from historic MGP operations and the operation of the American Tar Company, which operated on the northern portion of Area 3 and land to the north of Area 3, which is now Centre Street. The historic location of the American Tar Company is shown on Figure 5. According to the conceptual model for the Site, DNAPL flow beneath Area 3 is by gravity along the upper surface of the organic deposit. The majority of the DNAPL in the subsurface on Area 3 is believed to be located in the historic Malden River channel, which is a low area in the organic deposit and is shown on Figure 7. The volume of shallow DNAPL in the subsurface on Area 3 is estimated to be approximately 3,700 gallons, and the areal extent of TSM-impacted soils is estimated as 8,400 sy. These estimates include DNAPL and impacted soil that likely exist beneath the buildings located on Area 3.

7.03 Summary of Area 3 Remedial Objectives

Impacted media on Area 3 include shallow DNAPL and soil. Remedial objectives are listed below:

<u>NAPL:</u>

- Reduce thickness of DNAPL in monitoring wells to less than ½ in.

<u>Soil:</u>

- Reduce soil contaminant concentrations to less than the UCLs.

- Prevent exposure to soil within 15 ft of the ground surface to address potential risk to future on-site industrial/commercial workers and construction workers.

Other:

- Allow for continued operation of the on-site businesses.

7.04 Initial Screening of Remedial Technologies for Area 3

An initial screening of remedial technologies was conducted to identify technologies that are reasonably likely to be feasible for Area 3, based on the type of contamination observed within the Area, contamination present, and specific Area characteristics. Per 310 CMR 40.0856, remedial technologies are reasonably likely to be feasible if they are reasonably likely to achieve a Permanent or Temporary Solution, and if individuals with the necessary expertise to implement the technology are available to implement the technology.

Remedial technologies were screened for the contaminated media that contribute to exposure pathways for which a condition of No Significant Risk could not be satisfied for future receptors on Area 3. A summary of the initial screening for Area 3 is presented in Table XVII, including a brief description of the remedial technologies, and a rationale for retaining or eliminating the technology. Remedial technologies that meet the initial screening criteria are listed and briefly described below by the medium they address.

A. DNAPL

- **DNAPL extraction using recovery wells:** Installation of large (8-in.) diameter recovery wells, equipped with a submersible pump to extract DNAPL from the subsurface. Extracted DNAPL would be pumped to small buildings on Site, stored and transported off-site for disposal or incineration. A DNAPL extraction well has been operating on the northern portion of Area 2 since October 2001, and has collected approximately 670 gallons of DNAPL to date.

- **DNAPL extraction/DNAPL migration control using trenches:** Excavation of trenches that are keyed into the low-permeability organic deposit, and backfilled with gravel to collect DNAPL. A recovery well would be installed in the backfilled trench, equipped with a submersible pump to extract and collect DNAPL. Trenches may be installed along Area boundary to cut off DNAPL flow and prevent migration of DNAPL onto the Area from adjacent Areas. Extracted DNAPL would be stored in small buildings on Site, and transported off-site for disposal or incineration.

- **Vertical subsurface barrier for DNAPL migration control:** Installation of a barrier to DNAPL flow. The type of barrier would depend on the results of a feasibility assessment; potential options include a slurry wall, sheet piling, or a Waterloo™ Barrier. The barrier for Area 3 could also include injection of grout through the base of the WEB Culvert to prevent DNAPL migration through the crushed stone bedding beneath the culvert.

C. Elimination of Remedial Technologies Based on Site Characteristics

As described above, Area 3 is comprised of four individually owned properties with five operating commercial businesses. Each property consists of a small building a parking lot, and minimal landscaped space. Area 3 is located in a public, urban area, with a high degree of public access in its current use. Therefore, remedial technologies that result in significant disruption to business operations or public nuisance are considered infeasible. Likewise, DNAPL extraction or remediation of TSM or soil beneath buildings to achieve the remedial objectives is not considered feasible. Based on this reasoning, six remedial technologies are not reasonably feasible on Area 3 and will not be incorporated into Remedial Action Alternatives for Area 3. These remedial technologies are summarized below in Table XVIII:

TABLE XVIII
REMEDIAL TECHNOLOGIES ELIMINATED BASED ON SITE CHARACTERISTICS
AREA 3

Remedial Technology	Technology Type	Target Media	Reason For Elimination
Extraction using trenches	Extraction	Shallow DNAPL	Significantly more disruptive and difficult to implement than extraction wells, which have been demonstrated to be effective on Area 3 for extraction of DNAPL.
DNAPL migration control using trenches	DNAPL migration control	Shallow DNAPL	Significantly more disruptive and difficult to implement than vertical subsurface barriers, which would likely be effective for DNAPL migration control.
Excavation and off-site Disposal	Physical Removal	Soil/TSM	Excavation beneath the building is infeasible; therefore this remedial method cannot achieve a Permanent Solution for the Site.
Incineration	*Ex-situ* treatment	Soil/TSM	Not necessary if soil is not excavated.
Thermal desorption	*Ex-situ* treatment	Soil/TSM	Not necessary if soil is not excavated.
Engineered Barrier	Barrier	Soil/TSM	Installation of an Engineered Barrier would not result in a Permanent Solution for the Area due to the presence of four buildings on the Area; contamination is likely located beneath the existing buildings and the buildings cannot serve as barriers to potential exposure.

7.05 Development of Remedial Action Alternatives for Area 3

Three Remedial Action Alternatives developed to meet the remedial goals for Area 3 are discussed below. Approximate locations of the components of the Remedial Alternatives for Area 3 are shown on Figure 18.

- **Alternative 3-1**: Shallow DNAPL recovery, provisional shallow DNAPL migration control, in-situ chemical oxidation of TSM and soil, and AUL

  Alternative 3-1 would involve the installation of approximately 12 shallow DNAPL recovery wells, and construction of a small storage building to store recovered DNAPL prior to off-site disposal. Based on the estimated volume of DNAPL on Area 3 (approximately 3,700 gallons) and observed recovery rates for DNAPL recovery RW-1 on Area 2, it is estimated that the DNAPL remedial goals may be attained in approximately 3 to 5 years. However, because of the presence of the four buildings on Area 3, DNAPL may remain in the subsurface, preventing the attainment of a Permanent Solution for the Area. The migration of shallow DNAPL from adjacent areas onto Area 3 could be prevented using a vertical subsurface barrier, which would consist of driven sheeting as indicated on Figure 18. The vertical barrier could also involve injection of grout through the base of the WEB Culvert to prevent DNAPL migration through the crushed stone base beneath the culvert. The locations of the vertical barriers coincide with the historic river channels that previously flowed from east to west in the northern portion of Area 3, then meandered to the south and back to the west at the approximate location of the current WEB culvert. Given the variations in the historic river bottom, as expressed by the depressed area of the organic deposit, it is not possible to make a direct correlation between the former flow direction of the river and the migration direction of shallow DNAPL.

  Following completion of DNAPL recovery, TSM soil would be treated in-situ through injection of oxidants in accessible soils, using a network of approximately 180 injection wells (assuming 20-ft radius of influence) to promote chemical oxidation reactions. It is assumed that chemical oxidation will not be conducted beneath buildings on Area 3 or beneath the WEB Culvert, due to the possibility for the build-up of heat and vapors beneath these structures. It is anticipated to require three oxidant injections over a period of approximately 2 to 3 years. During implementation of chemical oxidation on Area 3, use of the parking areas surrounding the buildings on the Area would be significantly reduced, due to temporary well installation and oxidant injection activities. AULs may be required to mitigate risk through future soil exposure pathways.

- **Alternative 3-2**: Shallow DNAPL recovery, provisional shallow DNAPL migration control and AUL

  Alternative 3-2 is a less intrusive remedial option to address the presence of TSM and shallow DNAPL contamination on Area 3. This alternative involves the installation of approximately 12 shallow DNAPL recovery wells to recover DNAPL from the subsurface, as proposed in Alternative 3-1. If shallow DNAPL migration control is required, vertical subsurface barriers may be installed to prevent migration of DNAPL onto Area 3 from adjacent properties. This alternative does not include a remedial component to address residual soil TSM contamination and will not achieve a Permanent Solution. An AUL may be required to mitigate risk through future soil exposure pathways.

- **Alternative 3-3**: Shallow DNAPL monitoring and AUL

  Alternative 3-3 is a monitoring alternative. Based on Site data collected to date, the DNAPL plume dimensions appear stable; this alternative proposes monitoring to ensure that the extent of DNAPL impact does not expand.

7.06 Detailed Evaluation of Remedial Action Alternatives for Area 3

This section presents a Detailed Evaluation of the three Remedial Action Alternatives presented above, based on the criteria listed in Section 4.03. As with the other Areas, this evaluation is based on the current property conditions and use, as described in Section 2.06 and summarized in Section 7.02. A summary of the detailed evaluation of the three Remedial Action Alternatives developed for Area 3 is presented in Table XIX. Table XIX presents a summary of the likely effectiveness, reliability, implementability, cost (net present value, or NPV), risks, benefits, timeliness, and potential effect on non- pecuniary interests of each alternative. The presence of the existing buildings currently located on Area 3 limits the implementability of Alternatives 3-1 and 3-2. Because it is likely that DNAPL and soil containing contaminant concentrations greater than UCLs are located beneath these buildings, a Permanent Solution is not proposed for Area 3; the remedial alternatives evaluated below represent Temporary Solutions. A comparison of the three remedial alternatives based on these criteria is presented below.

- Effectiveness: It is unlikely that Alternatives 3-1 or 3-2, both of which include DNAPL extraction using extraction wells, would reach the DNAPL remedial goals, because DNAPL would likely remain beneath the buildings located on Area 3. Additionally, it is likely that TSM exists beneath the buildings, and would also remain beneath the building under Alternatives 3-1 and 3-2. Therefore, although Alternatives 3-1 and 3-2 would reduce the quantity of DNAPL on Area 3, neither would reach a Permanent Solution. Both Alternatives 3-1 and 3-2 are ranked with a "moderate" effectiveness. Alternative 3-3 also would not provide a Permanent Solution, as it is a monitoring-only alternative, and does not reduce the quantity of DNAPL. Therefore Alternative 3-3 is ranked as "low" under the effectiveness category. Each of the three evaluated alternatives represents a Temporary Solution for Area 3.

- Short and Long Term Reliability: The technologies proposed in Alternatives 3-1 (DNAPL extraction wells and in-situ chemical oxidation of soil) and 3-2 (DNAPL extraction wells) are considered reliable remedial technologies. Both alternatives 3-1 and 3-2 are considered moderately reliable in the short and long term. Reliability is not considered relevant to Alternative 3-3, as a remedial system is not installed under this Alternative.

- Implementability: The DNAPL extraction components of Alternatives 3-1 and 3-2 are readily implementable, although implementability of a DNAPL extraction system would be contingent upon agreements with property owners to construct a small DNAPL storage building on one of the properties on Area 3. Additionally, installation of 180 chemical oxidation wells on Area 3, as proposed in Alternative 3-1, would likely cause significant disruption to the operating businesses on the Area. As component in Alternative 3-1, would not be implementable until the quantity of DNAPL has been reduced to the extent practicable using DNAPL extraction wells. Once it is implementable, in-situ chemical oxidation is anticipated to require approximately 2 to 3 years to reach the soil remedial goals; however soils beneath the buildings on Area 3 are not accessible for chemical oxidation treatment. Therefore the remedial goals would not likely be met for soils beneath the building. Alternative 3-3 could be implemented immediately and would continue for the foreseeable future, until a Permanent Solution can be implemented.

- Effect on Non-pecuniary Interests: Alternatives 3-1 and 3-2 would both have a moderate impact on property use and aesthetics. Both of these alternatives would require the construction of a small NAPL storage building on a property within the Area. Alternative 3-1 would have additional impact on property use, as this alternative would involve three injections of chemical oxidant into soil beneath the Area. These injections may not be acceptable to the property owners, due to the public nature of the businesses operating on these properties. Alternative 3-3 would have very little effect on use of the Area or aesthetics.

7.07 Selected Remedial Action Alternative for Area 3

Implementation of either Alternatives 3-1 and 3-2 would result in effective, reliable reduction in the quantity of DNAPL in accessible portions of Area 3. Neither alternative would result in timely achievement of the DNAPL remedial goals; this is anticipated to require approximately 3 to 5 years for both of these alternatives. The in-situ chemical oxidation component included in Alternative 3-1 would provide additional benefit of reduction in contaminant concentrations; however this remedial component cannot be implemented until the quantity of DNAPL has been reduced to the extent practicable. Neither Alternative 3-1 nor 3-2 would reach a Permanent Solution because DNAPL and TSM would likely remain beneath the buildings located on Area 3. Alternative 3-3, which involves monitoring of DNAPL, also would not result in a Permanent Solution. Based on the successful operation of a DNAPL extraction well on Area 2, DNAPL extraction is feasible on the Site. Therefore, DNAPL extraction should be included in the selected remedy for Area 3 and Alternative 3-3 is not considered a viable alternative. Both Alternatives 3-1 and 3-2 would have the same outcome (i.e., would result in a Temporary Solution due to the contamination that would remain beneath the buildings). Therefore, because of the implementation difficulties, impact on use, and higher cost of Alternative 3-1, Alternative 3-2 is the selected remedy for Area 3.

Alternative 3-2 involves the installation of approximately 12 shallow DNAPL extraction wells, which would be installed in locations at which the top of the organic deposit is relatively low. Proposed locations for DNAPL extraction wells are shown on Figure 18; DNAPL extraction well locations are proposed along the historic Malden River channel, in order to maximize the effectiveness of this alternative.

VIII. EVALUATION OF REMEDIAL ALTERNATIVES FOR AREA 4

8.01 Introduction

In this section, Remedial Action Alternatives are developed to address contamination identified in Area 4, which is the southern portion of Parcel A, as shown on Figure 19. Area 4 is bounded by Charles Street to the south, the MBTA Orange line to the west, Area 3 to the north, and Commercial Street to the east. Area 4 is comprised of one property on which two buildings are located, containing medical offices and other businesses involving a high degree of public use. A brief summary of the existing conditions and remedial objectives for Area 4 are provided below. Based on these conditions and objectives, an initial screening of remedial technologies is presented in Section 8.04 to identify technologies that may be applicable to address contamination identified on Area 4. Remedial technologies that meet the initial screening criteria but are not applicable on Area 4 due to specific site characteristics are eliminated from further consideration in Section 8.04. Remedial Action Alternatives are then developed in Section 8.05 by combining the remaining remedial technologies based on knowledge of site conditions and engineering judgement. A detailed evaluation of the Remedial Action Alternatives is then conducted in Section 8.06, and the recommended Remedial Alternative is presented in Section 8.07.

8.02 Summary of Area 4 Conditions

LNAPL has been identified in one monitoring well on the southwestern portion of Area 4, and in a monitoring well located in the Commercial Street ROW, just east of Area 4. A small area of TSM contamination has been identified in the southern portion of Area 4, as well as along the northern boundary of Area 4 with Area 3. This contamination is likely residual from historic MGP operations; historic MGP features that have been located on Area 4 include gas production buildings, condensers, tar filters, gas holders and purification facilities. The historic location of MGP features is shown on Figure 5. The volume of LNAPL in the subsurface on Area 4 is estimated to be approximately 5,600 gallons. The areal extent of TSM-impacted soil is estimated as approximately 560 sy, and the volume of LNAPL-impacted soils is estimated as approximately 640 sy. These estimates do not include contaminated soils that may be located beneath the buildings located on Area 4.

8.03 Summary of Area 4 Remedial Objectives

Area 4 contains impacts from TSM and LNAPL. Remedial objectives are listed below:

<u>NAPL:</u>

- Reduce thickness of LNAPL in monitoring wells to less than ½ in.

<u>Soil:</u>

- Reduce soil contaminant concentrations to less than the UCLs.
- Prevent exposure to soil within 15 ft of the ground surface to address potential risk to future on-site industrial/commercial workers and construction workers.

Other:

- Allow for continued operation of the on-site businesses.

8.04 Initial Screening of Remedial Technologies for Area 4

An initial screening of remedial technologies was conducted to identify technologies that are reasonably likely to be feasible for Area 4, based on the type of contamination observed within the Area, contamination present, and specific Area characteristics. Per 310 CMR 40.0856, remedial technologies are reasonably likely to be feasible if they are reasonably likely to achieve a Permanent or Temporary Solution, and if individuals with the necessary expertise to implement the technology are available to implement the technology.

Remedial technologies were screened for the contaminated media that contribute to exposure pathways for which a condition of No Significant Risk could not be satisfied for current or future receptors on Area 4. A summary of the initial screening for Area 4 is presented in Table XX, including a brief description of the remedial technologies, and a rationale for retaining or eliminating the technology. Remedial technologies that meet the initial screening criteria are listed and briefly described below by the medium they address.

A. LNAPL

- **Multi-phase Extraction (MPE):** Extraction of groundwater, soil vapor and LNAPL through the application of a vacuum to specially designed extraction wells. Requires separation of NAPL from water and ex-situ treatment of both groundwater and soil vapor.

- **Belt-skimmer:** Extraction of LNAPL using belt-skimmers, which consist of two pulleys that drive a hydrophobic belt through the groundwater surface in a monitoring well and to the top of the well, bringing the LNAPL to the surface and skim the oil into a collection container. The belt-skimmer system is driven by an electrical motor.

- **Disposal or Incineration:** Off-site transport of extracted NAPL to an appropriate receiving facility for disposal or incineration.

B. Soil

- **Excavation and off-site treatment:** Excavate and remove contaminated soil to an average depth of approximately 12 ft, along with LNAPL where present, and transport impacted soils off-site for treatment. Suitable excavated soils may be re-used as backfill on site. Implementation of this action would require support of excavations and building foundations during excavation, and may require demolition of on-site buildings if contamination is located beneath buildings. Implementation would also require an enclosure for control of vapors and odors.

- **Installation of an Engineered Barrier:** RCRA-type Engineered Barrier consistent with 310 CMR 40.0000, to be installed over soil containing contaminant concentrations in excess of the UCL. Installation of an Engineered Barrier would require excavation of approximately 3 ft of soil, followed by placement of an HDPE impermeable membrane, which would be covered by approximately 1 ft of clean sand and a geo-composite drainage layer. The drainage layer would be covered by a marker fabric, and either pavement or a vegetated surface. Implementation of this alternative would require demolition of buildings, if present in areas of contamination. Would require deeper excavation and construction of a clean utility corridor at locations with subsurface utilities.

- **Installation/Maintenance of a Direct Contact Barrier:** Installation and/or maintenance of a surface barrier (i.e., 3 ft of soil, asphalt or concrete pavement), to prevent direct contact with surface soils.

- **Incineration:** Off-site transport of excavated soil to an appropriate receiving facility for incineration

- **Ex-situ thermal desorption:** Treatment of excavated soil material using thermal desorption with an afterburner. May be performed on or off-site; however on-site thermal desorption is not likely implementable due to the urban location and active use of the Area.

- **In-situ chemical oxidation:** Injection of hydrogen peroxide, Fenton's Reagent, or other oxidant into soil using temporary injection wells to chemically break down contaminants to innocuous compounds. This remedial method is not feasible when a significant amount of free-phase product (i.e., LNAPL) exists in the subsurface, as uncontrollable reactions can result.

- **Activity and Use Limitations (AULs):** Place restrictions on future property uses and activities to prevent potential exposure through a pathway for which a condition of No Significant Risk could not be satisfied.

C. Elimination of Remedial Technologies Based on Site Characteristics

As described above, Area 4 consists of a privately owned property, on which two buildings are located with operating commercial businesses. The property consists of two small buildings, parking space, and minimal landscaped space. Area 4 is located in a relatively public, urban area, with a high degree of public access in its current use. Therefore, remedial technologies that result in significant disruption to business operations or public nuisance are considered infeasible. Likewise, LNAPL extraction or remediation of TSM or soil beneath buildings to achieve the remedial objectives is not considered feasible due to the presence of the two buildings on the Area. Based on this reasoning, four remedial technologies are not reasonably feasible on Area 4 and will not be incorporated into Remedial Action Alternatives for Area 4. These technologies are listed below in Table XXI:

TABLE XXI
REMEDIAL TECHNOLOGIES ELIMINATED BASED ON SITE CHARACTERISTICS
AREA 4

Remedial Technology	Technology Type	Target Media	Reason For Elimination
Excavation and off-site Disposal	Physical Removal	Soil/TSM	Excavation beneath the building is infeasible; therefore this remedial method cannot achieve a Permanent Solution for the Site.
Incineration	*Ex-situ* treatment	Soil/TSM	Not necessary if soil is not excavated.
Thermal desorption	*Ex-situ* treatment	Soil/TSM	Not necessary if soil is not excavated.
Engineered Barrier	Barrier	Soil/TSM	Installation of an Engineered Barrier would not result in a Permanent Solution for the Area due to the presence of two buildings on the Area; contamination is likely located beneath the buildings and the existing buildings cannot serve as barriers to potential exposure.

8.05 Development of Remedial Action Alternatives for Area 4

Three Remedial Action Alternatives that are reasonably likely to meet the remedial objectives have been developed for Area 4 and are described below. Approximate locations of the components of the Remedial Alternatives for Area 4 are shown on Figure 19.

- **Alternative 4-1**: LNAPL recovery using MPE, in-situ chemical oxidation of TSM and LNAPL-impacted soil, and AUL

  Alternative 4-1 involves the installation of MPE wells for the extraction of LNAPL, in-situ chemical oxidation of TSM and LNAPL-impacted soils, and AULs to ensure that current conditions are maintained on the Area. Implementation of MPE on Area 4 would involve the installation of approximately 20 MPE wells. Because it applies a high vacuum, MPE results in rapid LNAPL extraction rates and is included as an aggressive approach to remove LNAPL from the subsurface. It is anticipated that approximately 2 years would be required to reach the LNAPL remedial goals in Alternative 4-1. Chemical oxidation of LNAPL-impacted soils is not feasible until LNAPL has been removed, to the extent practicable; therefore it would not be implemented in areas impacted by LNAPL until the LNAPL remedial goals have been reached for the Area. Further, it is assumed that chemical oxidation of LNAPL-impacted soils would not be conducted beneath the buildings on Area 4. Chemical oxidation of TSM-impacted soils on the northern portion of Area 4 may be implemented once access has been obtained, as NAPL has not been observed in this portion of the Area. Chemical oxidation of the TSM and LNAPL-impacted soils on Area 4 is anticipated to require approximately 1 to 2 years.

- **Alternative 4-2**: LNAPL recovery using belt-skimmers and AUL

  Alternative 4-2 involves the installation of approximately 13 LNAPL extraction wells equipped with belt-skimmers and an AUL to ensure that current property conditions are maintained on the Area. Based on the estimated volume of LNAPL on Area 4 and anticipated rates of LNAPL recovery, it is estimated that the LNAPL remedial goals may be attained in approximately 3 to 5 years. However, it is considered likely that LNAPL may exist beneath the southern building on Area 2; therefore attainment of the LNAPL remedial goals may not be attainable on Area 4. This alternative does not include in-situ chemical oxidation, as this technology is not likely to be feasible beneath the buildings on the Area.

- **Alternative 4-3**: LNAPL monitoring and AUL

  Alternative 4-3 is a monitoring alternative; this alternative proposes monitoring to ensure that the extent of LNAPL impacts does not expand.

8.06 Detailed Evaluation of Remedial Action Alternatives for Area 4

This section presents a Detailed Evaluation of the three Remedial Action Alternatives presented above, based on the criteria listed in Section 4.03. As with the other Areas, this evaluation is based on the current property conditions and use, as described in Section 2.06 and summarized in Section 8.02. A summary of the detailed evaluation of the three Remedial Action Alternatives developed for Area 4 are presented in Table XXII. Table XXII presents a summary of the likely effectiveness, reliability, implementability, cost (net present value, or NPV), risks, benefits, timeliness, and potential effect on non- pecuniary interests of each alternative. The presence of the existing buildings currently located on Area 4 limits the implementability and effectiveness of some remedial alternatives for Area 4. Because it is likely that LNAPL and soil containing contaminant concentrations greater than UCLs are located beneath buildings, a Permanent Solution is not proposed for Area 4; the remedial alternatives evaluated below represent Temporary Solutions. A comparison of the three remedial alternatives based on these criteria is presented below.

- Effectiveness: Because Alternative 4-1 includes LNAPL extraction using MPE, Alternative 4-1 is likely to provide more effective and more rapid LNAPL removal than Alternative 4-2. MPE is generally more effective in low-permeability soils; the effectiveness of MPE on Area 4 will therefore depend on the permeability of soils within the LNAPL area. However, it is unlikely that either Alternatives 4-1 or 4-2 would reach the LNAPL remedial goals, because LNAPL would likely remain beneath the buildings located on Area 4. Additionally, it is likely that contaminated soil, potentially containing soil contamination in excess of UCLs, exists beneath the buildings on Area 4, and would also remain beneath the building under these alternatives. Therefore, neither Alternative 4-1 nor 4-2 would reach a Permanent Solution. Because Alternatives 4-1 and 4-2 would reduce the volume of LNAPL on Area 4 but would only achieve a Temporary Solution, both are ranked with a "moderate" level of effectiveness. Alternative 4-3 also would not provide a Permanent Solution, as it is a monitoring-only alternative, but would not reduce the volume of TSM or LNAPL on the Area. Therefore Alternative 4-3 is given a "low" effectiveness ranking. Each of the evaluated alternatives represents a Temporary Solution for Area 4.

- Short and Long Term Reliability: The technologies proposed in Alternatives 4-1 (MPE and in-situ chemical oxidation) and 4-2 (belt-skimmers) are considered reliable remedial technologies. Both alternatives are considered moderately reliable in the short and long term, although MPE is considered a slightly more reliable method of LNAPL extraction than belt-skimmers because MPE is a more aggressive system and has been used successfully at other sites for LNAPL removal. The reliability criterion is not relevant for Alternative 4-3, as a remedial system is not proposed in this Alternative.

- Implementability: Alternative 4-1 is considered moderately difficult to implement, because the proposed MPE system would require approximately 20 MPE wells, extraction equipment and a groundwater and vapor treatment system on Area 4. Additionally, 35 chemical oxidation wells would be required in Alternative 4-1. Remedial facilities such as these would disrupt the current use of the Area. Alternative 4-2 is readily implementable; the belt-skimmers included in Alternative 4-2 would involve considerably less intrusion than MPE into the commercial operations on the Area, as significantly less space and equipment are required to implement this remedial component. Additionally, Alternative 4-2 does not include in-situ chemical oxidation, which is not fully implementable due to the presence of the building on Area 4. Alternative 4-3, which includes monitoring of LNAPL on Area 4, is readily implementable.

- Cost: The estimated NPV for Alternative 4-1, which includes MPE and chemical oxidation of TSM and LNAPL-impacted soils is approximately \$1.3M. The NPV for Alternative 4-2 is significantly lower, \$510K, as it includes a less aggressive approach to the removal of LNAPL (i.e., belt-skimmers) and does not include chemical oxidation of TSM and LNAPL-impacted soils. The estimated NPV for the monitoring alternative 4-3 is approximately \$100K.

- Risks: Moderate to low risks are associated with the three alternatives evaluated for Area 4. Moderate risks associated with Alternative 4-1 include those associated with handling of extracted LNAPL, and handling the caustic oxidants during in-situ chemical oxidation. Risk associated with implementation of Alternative 4-2 is somewhat lower than in Alternative 4-1, and includes the handling of extracted LNAPL only. For alternatives 4-1 and 4-2, in which LNAPL extraction is proposed, measures would be required to ensure that people on the property (including employees, medical patients or other visitors) do not come into contact with extraction equipment or extracted LNAPL. Alternative 4-3 involves few risks of exposure to hazardous chemicals.

  Long-term risks associated with contamination left in place are highest for Alternatives 3-2 and 3-3; Alternative 3-3 does not include removal of LNAPL from the subsurface, and neither Alternative 3-2 nor Alternative 3-3 includes measures to reduce concentrations of contaminants in soil. Long-term risks are lowest in Alternative 3-1, which includes in-situ chemical oxidation to reduce contaminant concentrations in accessible soils.

- Benefits: Alternatives 4-1 and 4-2 both provide the benefit of reducing the quantity of LNAPL on the Area. The completeness of the removal of LNAPL is dependent on the ability of LNAPL extraction wells adjacent to the building to remove DNAPL from beneath the building. As mentioned above under "Effectiveness", MPE (proposed in Alternative 4-1) may be more effective at reducing the quantity of LNAPL beneath the buildings on Area 4. Alternative 4-1 also includes some additional benefit due to the in-situ chemical oxidation component, which would reduce contaminant concentrations in accessible soil. However, soil beneath the building would not be accessible for chemical oxidation treatment. Alternative 4-3 produces little beneficial reduction of contaminants, as it includes neither LNAPL extraction nor soil remediation.

- Timeliness: LNAPL removal using MPE in Alternative 4-1 is likely to require approximately 2 years, which would be more rapid than removal using belt-skimmers in Alternative 4-2, which is anticipated to require approximately 3 to 5 years. However, it is unlikely that the LNAPL extraction wells proposed in Alternatives 2-1 and 2-2 will accomplish the LNAPL remedial goals, as it is believed that a portion of the LNAPL on Area 4 is located beneath the buildings on Area 4. Chemical oxidation of TSM and LNAPL-impacted soil, which is proposed as a remedial component in Alternative 4-1, would not be implementable until LNAPL quantity has been reduced to the extent practicable. In-situ chemical oxidation is anticipated to require approximately 2 years to reach the soil remedial goals; however soils beneath the buildings are not accessible for chemical oxidation treatment. Therefore the remedial goals will not be met for soils beneath the building. Alternative 4-3 could be implemented immediately and would continue for the foreseeable future, until a Permanent Solution can be implemented.

- Effect on Non-pecuniary Interests: Alternative 4-1 is likely to have greater adverse effects on non-pecuniary interests, because the MPE system and chemical oxidation injection proposed in this alternative would require more equipment and would have a greater impact on property use than Alternative 4-2. Both Alternatives 4-1 and 4-2 would require the construction of a small NAPL storage building on the Area. It is not known whether the construction of this building on Area 4 would be acceptable to the property owner. Alternative 4-3 would have very little effect on use of the Area or aesthetics.

8.07 Selected Remedial Action Alternative for Area 4

In summary, although Alternative 4-1 may be slightly more effective and reliable and provide marginal additional benefit over Alternative 4-2, neither alternative would provide a likely Permanent Solution for Area 4. Implementation of Alternative 4-1 would likely provide slightly more effective, reliable, and rapid LNAPL removal than Alternative 4-2, and would also provide additional benefit of reduced contaminant concentrations in accessible soil.

However, Alternative 4-1 would not reach a Permanent Solution because LNAPL and contaminated soil would likely remain beneath the buildings located on Area 4. The belt-skimmers proposed for LNAPL extraction in Alternative 4-2 are considered to be a relatively reliable technology, and would provide effective LNAPL extraction over time. Like Alternative 4-1, Alternative 4-2 would not result in a Permanent Solution. Alternative 4-3, which involves monitoring of LNAPL and no contaminant removal or reduction, also would not result in a Permanent Solution. Therefore Alternative 4-3, which does not include an LNAPL extraction component, is not a recommended alternative. Both Alternatives 4-1 and 4-2 would result in a Temporary Solution due to the contamination that may remain beneath the buildings on the Area. Therefore, because of the implementation difficulties, impact on use and higher cost of Alternative 4-1, Alternative 4-2 is the selected remedy for Area 4.

IX. EVALUATION OF REMEDIAL ALTERNATIVES FOR AREA 5

9.01 Introduction

Brown and Caldwell conducted a focused evaluation of remedial alternatives for Area 5. This section presents a summary of Brown and Caldwell's Phase III RAP for Area 5. The Brown and Caldwell evaluation, which is included in Appendix E of this Report, includes a statement of Remedial Action Objectives, an Identification and Initial Screening of Technologies and Development of Remedial Alternatives, a Detailed Evaluation of Remedial Action Alternatives, and Selection of a Remedial Action Alternative for Area 5.

9.02 Remedial Action Objectives

A. Risk Characterization Summary

The Human Health Risk Characterization satisfied a condition of No Significant Risk for current and future exposure pathways on Area 5. A condition of No Significant Risk to Public Welfare and the environment was also satisfied.

Although a condition of No Significant Risk has been satisfied for the indoor air inhalation pathway, the level of potential risk presented by the elevated levels of VOCs is approximately equivalent to the MADEP criteria at which a condition of No Significant Risk cannot be satisfied. Additionally, the data used in the Risk Characterization were collected during operation of a pilot-scale sub-slab ventilation system. Therefore, an evaluation of remedial alternatives to address indoor air was conducted.

B. Remedial Action Objectives

Remedial alternatives were developed to mitigate potential risk due to volatilization of benzene and naphthalene into indoor air. This may be accomplished through reduction of contaminant concentrations in groundwater and/or controlling vapor migration. MEC is conducting an evaluation of the HVAC system inside the building to assess the feasibility of making modifications to the existing system. The evaluation is being conducted to assess whether implementation of modifications to the existing system or installation of a new system is a feasible measure to control the infiltration of vapors from the subgrade. Therefore, the Brown and Caldwell evaluation did not include remedial alternatives for the HVAC system.

9.03 Identification, Initial Screening, and Development of Remedial Action Alternatives

A. Identification and Screening of Technologies

The Brown and Caldwell evaluation recommends the use of horizontal directional drilling (HDD) technology to install remedial measures on Area 5. HDD would involve installation of horizontal wells or vapor extraction systems beneath the building. The evaluation states that a thorough utility location effort would be required prior to HDD installation and information regarding the building foundation system would be necessary. If this information is not available, a field investigation is recommended. The evaluation also states that if historic MGP structures shown on historic maps are encountered during drilling operations, the well installation layout may have to be revised. Brown and Caldwell stated that it may be possible to drill through the former MGP structures, depending on the condition and types of material used for construction. Finally, the Brown and Caldwell evaluation stated that the presence of the structures may provide preferential pathways for air or oxidants, and may reduce treatment efficiencies.

Remedial measures evaluated in the Brown and Caldwell evaluation would be installed using HDD methods. The remedial technologies that met the initial screening criteria include the following:

- Air Sparging: Injection of air into groundwater at relatively high flow rates to promote volatilization and biodegradation of VOCs in groundwater.
- Biosparging: Injection of air or oxygen into groundwater at relatively low flow rates to promote biodegradation of VOCs in groundwater.
- Chemical Oxidation using Ozone: Chemical conversion of hazardous constituents to less toxic compounds that are more stable, less mobile or inert. Ozone would be generated on-site and may be sparged or dissolved in water and injected into the subsurface.

B. Development of Remedial Action Alternatives

Each of the technologies listed above were identified by Brown and Caldwell as potential remedial alternatives for the treatment of groundwater on Area 5. It was assumed that a SVE system would be installed in each remedial alternative as a vapor management system to control vapor migration into the facility. The following are the remedial action alternatives evaluated by Brown and Caldwell:

- Alt-1: No Further Action
  This alternative would include no further remedial measures to address groundwater and soil vapor impacts on Area 5. This alternative includes groundwater monitoring at Area 5.

- Alt-2: Air Sparging with SVE
  This alternative would include horizontal air sparging wells spaced at 30-ft intervals beneath the building and an SVE system to control migration of vapors. The estimated air sparge flow rate would be 750 scfm; the SVE system is described below.

- Alt-3: Biosparging with SVE

This alternative would include biosparging wells spaced at 30-ft intervals beneath the building and an SVE system to control migration of vapors. The estimated biosparge rate would be 375 scfm.

- Alt-4: Chemical Oxidation using Ozone with SVE
  This alternative would include application of ozone similar to an air sparging system or a biosparging system, with an SVE system to control migration of vapors.

- SVE Component: An SVE system would be installed using horizontal wells in the unsaturated zone in Alt-2, Alt-3, and Alt-4 to capture vapors that may be migrating into indoor air. SVE extraction systems generally have extraction rates 1.25 to 5 times greater than the biosparging rate.

9.04 Detailed Evaluation of Remedial Alternatives

The following is a summary of the detailed evaluation of the remedial alternatives presented by Brown and Caldwell.

- Effectiveness: Alt-1 would not achieve a Permanent Solution. Alt-2, Alt-3, and Alt-4 would effectively treat the contaminants and achieve a Permanent Solution, however the timeframe in which this would be accomplished is uncertain because areas of elevated concentrations are not well defined and cannot be directly assessed.

- Reliability: Alt-1 would not successfully achieve the remedial action objectives. For the remaining alternatives, Brown and Caldwell stated that the reliability of the treatment mechanisms has been shown to be effective for many sites with the types of contaminants on Area 5. For this application, the reliability of the alternatives would be more dependent on the ability of the horizontal well injection system to deliver the air, nutrients or ozone to the treatment area.

- Difficulty in Implementation: The horizontal well system would have to be designed to not interfere with subgrade utilities, the foundation structure of the building and possibly historic MGP structures. Field testing prior to the design would be necessary in order to determine well spacing. Monitoring would also be required to assess the effectiveness of the alternative. There is sufficient availability of services, materials, equipment and specialists for implementation of the alternatives, and operation of the alternatives could be integrated with existing facility operations and conditions. The horizontal well system in Alt-2, Alt-3, and Alt-4 would have to be designed to not interfere with subgrade utilities and the foundation structure of the building, and well spacing would need to be calculated based on field studies.

- Costs: Capital installation costs for the alternatives are as follows: Alt-1, $0; Alt-2, $900,000; Alt-3, $840,000; Alt-4, $1,100,000. The estimated total present net worth of monitoring costs for the alternatives are as follows: Alt-1, $440,000; Alt-2, $100,000; Alt-3, $130,000; Alt-4, $100,000.

- Risks: Alt-1 does not have short-term risks associated with implementation, however long-term risks are associated with leaving contamination in place. Short-term risks in Alt-2, Alt-3, and Alt-4 would be the limited potential exposures to soils from cuttings during well installation. For Alt-4, there is the potential for exposures to ozone gas, should leakage occur.

- Benefits: Alt-1 does not reduce concentrations in a reasonable timeframe. Alt-2, Alt-3, and Alt-4 would lower the concentrations of contaminants in groundwater and therefore would enhance the restoration of Area 5. Implementation of the alternatives would not affect facility operations because equipment could be located in a non-obtrusive location.

- Timeliness: Alt-1 would require the longest time frame to achieve the remedial objectives. Alt-2 (air sparging) and Alt-4 (chemical oxidation with ozone) would likely require the shortest time frame, approximately 3 years. Alt-3 (biosparging) would likely require approximately 5 years.

- Non-pecuniary interests: Alt-1 would not have any effect on non-pecuniary interests, The remaining alternatives would require installation of horizontal wells and an equipment building to house equipment. Monitoring activities would be required as well.

9.05 Selection of a Remedial Action Alternative

The following is a summary of Brown and Caldwell's comparison of the alternatives evaluated in the detailed evaluation, feasibility evaluation and the recommended alternative to address groundwater and soil impacts on Area 5.

A. Comparison of Alternatives

Alt-1 was rated the least favorable alternative and not considered a viable alternative. The remaining alternatives were rated favorably for this application. Costs are comparable, and implementation of any of the alternatives would probably result in successful reduction of COCs. Alt-4 (chemical oxidation) requires more intense training and higher level field personnel due to the complexity of the equipment involved. Alt-2 (air sparging) may accomplish volatilization of benzene, but volatilization of naphthalene may not be easy to accomplish. Alt-2 also involves higher operational costs, and has a higher potential for migration of VOCs into the facility. Therefore, Alt-3 was favored over the other alternatives.

B. *Feasibility of Implementing a Permanent Solution*

The recommended remedial alternative is intended to reduce constituents in indoor air. However, Brown and Caldwell stated that since areas of elevated concentrations in the soil that are most likely contributing to groundwater and indoor air contamination has not been identified, there is uncertainty as to the timeframe that would be required to reduce the concentrations to a level where No Significant Risk could be demonstrated.

C. Feasibility of Achieving or Approaching Background

The Brown and Caldwell evaluation states that because areas of elevated concentrations in soil that are most likely contributing to groundwater contamination have not been definitively located, reduction of groundwater and soil concentrations to background cannot be expected and is not probable.

D. Feasibility of Reducing Concentrations in Soil to Below UCLs

Phase II Investigations for Area 5 did not detect UCLs in soil. However, the areas of elevated concentrations that may be contributing to groundwater contamination has not been definitively located, and further investigation is not feasible. It is possible that constituents are present at concentrations above UCLs. However, without knowing the location of the elevated concentrations, the feasibility of reducing the concentrations of to below UCLs is not predictable.

E. Selection of Alternatives

Brown and Caldwell selected remedial alternative Alt-3, biosparging with SVE, installed in horizontal wells beneath the building using HDD techniques. The conceptual design includes three horizontal delivery wells for biosparging, connected to a manifold and blower station located on the southwest corner of the property. The SVE system would include installation of four horizontal SVE wells and six vertical extraction wells located in front of the building. The SVE blower and vapor treatment system would be located in a shed on-site. The SVE system should operate at an air flow rate approximately four times greater than the air flow rate of the biosparging system. Groundwater monitoring would be conducted on a quarterly basis at the site for an estimated five years. Implementation and accomplishment of the remedial goals is anticipated to require approximately six to seven years.

Field tests would be required to obtain specific site information to determine the horizontal well spacing. Additionally, Brown and Caldwell stated that while the HDD drilling assembly can be steered to predetermined points in both the vertical and horizontal plane, it should be noted that a thorough utility location effort is required and also, information regarding the foundation system is necessary. If this information is not available, a field investigation to obtain as much site information as possible would be beneficial.

As previously mentioned in Section 9.02B, MEC is conducting an evaluation of the HVAC system for the 129 Commercial Street facililty, and therefore an evaluation of the installation of a new HVAC system or modifications to the existing system were not included in the Brown and Caldwell evaluation. If, however, site conditions or other parameters interfere with the successful installation of a horizontal well system that would meet the design requirements of the selected remedial alternative, then further effort will be directed toward the consideration of the implementation of an HVAC system for the 129 Commercial Street facility that would minimize the infiltration of vapors from the subgrade.

X. SUMMARY OF SELECTED REMEDIAL ACTION ALTERNATIVES

10.01 Phase III RAP Overview

This Phase III RAP has presented an evaluation of remedial alternatives for the former Malden MGP Site. As required by 310 CMR 40.0859(1), a Site-wide remedial action alternative that addresses the various impacted media at the Site has been selected based on the detailed evaluation criteria listed in 310 CMR 40.0858. This alternative is described below in Section 10.03. Based on the evaluation contained in this Phase III RAP, a Permanent Solution for the Site is not attainable at the present time, and a Temporary Solution (i.e., Class C RAO) is suitable and timely for the Site. The remedial action alternative proposed in this section is intended to meet the requirements of the MCP, while allowing current use of the properties on the Site to be maintained. This section presents a summary of Site conditions, evaluates the feasibility of achieving a Permanent Solution and background conditions, presents the components of the selected Site-wide Temporary Solution remedial alternative, and describes the anticipated approach for implementation of the proposed remedy. Justification for the selection of a Temporary Solution is presented, including a list of definitive and enterprising steps toward identifying and achieving a Permanent Solution in the future.

For the purposes of this Phase III RAP, the former Malden MGP Site has been divided into five Remedial Action Alternative Areas, the limits of which are shown on Figure 15. Contamination identified at the Site has been categorized into six types: TSM, shallow DNAPL, deep DNAPL, LNAPL, BTEXSN in soil and groundwater, and petroleum-impacted Soil. The Site Risk Characterization (as revised, refer to Appendix B) was conducted to identify exposure pathways for which a condition of No Significant Risk could not be satisfied. Remedial alternatives were developed and evaluated in this Phase III RAP to address contamination in media that contribute to the exposure pathways identified in the Risk Characterization. A summary of the media and types of contamination for which remedial alternatives were developed on each Site Area is presented below in Table XXIII.

TABLE XXIII
SUMMARY OF REMEDIAL ACTION ALTERNATIVE AREAS AND ASSOCIATED IMPACTED MEDIA

Site Area	Area Description	Properties Located Within The Area	Types Of Contamination Identified	Media For Which Remedial Alternatives Were Evaluated[(2)]
AREA 1	Northern portion of Parcel E	100 Commercial Street	TSM Shallow DNAPL Deep DNAPL[(1)] LNAPL[(1)] Petroleum-impacted soil	Soil
AREA 2	Southern portion of Parcel E	100 Commercial Street	TSM Shallow DNAPL Deep DNAPL LNAPL	Soil
AREA 3	Northern portion of Parcel A	51 Commercial Street 65 Commercial Street 77 Commercial Street 89 Commercial Street	TSM Shallow DNAPL	Soil
AREA 4	Southern portion of Parcel A	99-109 Commercial Street	TSM LNAPL	Soil
AREA 5	Parcel B	129 Commercial Street	BTEXSN in soil and groundwater	Soil Groundwater Indoor Air

Notes:

1. LNAPL and deep DNAPL have been identified in monitoring wells in the past on Area 1; however recent monitoring has not observed these contaminants on Area 1.
2. Although groundwater contains elevated concentrations of contaminants, remediation of groundwater on Areas 1 through 4 is not required to achieve a condition of No Significant Risk. Groundwater is not used on these Areas as a resource (i.e., for drinking water or industrial use), and based on groundwater sampling data obtained during the Phase II investigation, plumes of groundwater contamination do not appear to be leaving the Site. Additionally, it is anticipated that remedial approaches to remediate LNAPL, DNAPL and soil will have a beneficial effect on groundwater quality.

10.02 Feasibility of Achieving a Permanent Solution or Background Concentrations

To achieve a Permanent Solution for the Site, a condition of No Significant Risk must be satisfied for the Site, including elimination of soil UCL exceedences through treatment or installation of an engineered barrier, and all source areas must be controlled or eliminated. At the former Malden MGP Site, this would involve the following:

- Removal of LNAPL and DNAPL present in thickness greater than ½ in. from the Site subsurface
- Elimination of soil material in which UCL exceedences have been observed, including contaminated soil and tar-saturated material (TSM), through either excavation, treatment, or placement of an engineered barrier to eliminate potential exposure pathways to UCL exceedences.
- Remediation of soil with contaminant concentrations that preclude satisfaction of a condition of No Significant Risk, or mitigation of potential risk through AULs

At the former Malden MGP Site, attainment of the NAPL remedial goal listed above is not reasonably feasible in the near term. DNAPL has been identified in monitoring wells on Areas 1, 2 and 3, and LNAPL has been identified on Areas 2 and 4. Based on NAPL thickness measurements, the total volume of DNAPL is estimated to be approximately 13,000 to 22,000 gallons, and the total LNAPL volume is estimated to be approximately 8,000 to 11,000 gallons. Based on the performance of the DNAPL extraction well operating on Area 2 since October 2001, DNAPL extraction is feasible at the Site, but a significant time period (approximately 10 years) will be required to reach the DNAPL remedial goals on each Site Area. Likewise, removal of LNAPL from the subsurface may be feasible at the Site, however LNAPL extraction typically requires an extended period of time as well. Furthermore, it is likely that DNAPL and LNAPL may be located beneath buildings on Areas 2, 3 and 4, and therefore may not be extractable under current site conditions.

As indicated above, achievement of a Permanent Solution would also require elimination of the potential for exposure to UCL exceedences at the Site. Exceedences of UCLs in soil are considered to exist within the limits of TSM contamination, which has been observed on Areas 1 through 4. Achievement of a Permanent Solution through excavation of soil contamination is not reasonably feasible because a significant portion of this contamination is overlain by buildings that are currently occupied by operating businesses. It is considered likely that TSM contamination exists beneath buildings located on Areas 2, 3, and potentially Area 4, and the soil contamination on Area 5 is located beneath a building. Demolition of the KeySpan Maintenance Garage would be required to excavate petroleum-impacted soils on Area 1. Likewise, installation of an Engineered Barrier would not reach a Permanent Solution at the Site, because the presence of the buildings on top of soils contaminated at levels greater than the UCLs does not eliminate potential exposure pathways, according to the MCP. The buildings on the Site would not satisfy MADEP requirements for an Engineered Barrier, and because the barrier must be contiguous across contaminated areas in order to remove potential exposure pathways to UCL exceedences, the presence of the buildings on the Site would render the barrier ineffective. In-situ remediation methods for soil would not be effective until NAPL-phase contaminants have been removed from the subsurface, and are likely not implementable beneath the buildings on the Site. Therefore, reduction of contaminant concentrations on the Site to less than the UCLs is not feasible at this time and a Permanent Solution for the Site is not reasonably feasible at present.

As described above, based on the detailed evaluation conducted in this Phase III RAP, a feasible Permanent Solution does not currently exist for the Site, and a Temporary Solution is proposed. Because a Permanent Solution cannot be attained, background concentrations of contaminants in soil and groundwater at the Site cannot be reached at the present time. The presence of contaminants beneath buildings and NAPL in the subsurface precludes restoration of soil and groundwater to background concentrations. Therefore, reduction of contaminant concentrations to background concentrations is not an attainable goal at present.

10.03 Selected Remedial Action Alternative

A. Selected Remedial Solution Components

The components of the proposed remedial alternative, which were selected in the evaluations for the Areas presented in Sections V through IX, are intended to result in progress toward the Site remedial goals. Specifically, the proposed remedy is intended to reduce the quantity of DNAPL and LNAPL in the subsurface at the Site, and reduce VOC concentrations in soil, groundwater and indoor air that contribute to exposure pathways for which a condition of No Significant Risk could not be satisfied. The remedial action alternatives selected for Areas 1 through 5 are listed below.

- Area 1: Alternative 1-4; Shallow DNAPL extraction using approximately five DNAPL extraction wells, shallow DNAPL migration control (if necessary), in-situ chemical oxidation of TSM and petroleum-impacted soils (once NAPL quantity has been sufficiently reduced), and an AUL to prevent exposure to contaminated soils. Wells in which LNAPL and deep DNAPL have been detected will be monitored for NAPL during implementation of the remedy.

- Area 2: Alternative 2-2; Shallow and deep DNAPL extraction using approximately 13 extraction wells, LNAPL extraction using approximately six wells equipped with belt-skimmers, shallow DNAPL migration control (if necessary), and AUL to prevent exposure to contaminated soils

- Area 3: Alternative 3-2; Shallow DNAPL extraction using approximately 12 DNAPL extraction wells, shallow DNAPL migration control (if necessary), and an AUL to prevent exposure to contaminated soils.

- Area 4: Alternative 4-2; LNAPL extraction using approximately 13 wells equipped with belt-skimmers and an AUL to prevent exposure to contaminated soils.

- Area 5: The focused evaluation conducted by Brown and Caldwell selected Alt-3, biosparging and SVE, installed using HDD methods beneath the 129 Commercial Street building. This alternative includes three horizontal biosparging delivery wells, four horizontal SVE wells, and six vertical SVE wells in front of the building.

- With the exception of Area 5, impacted groundwater does not contribute to risk and therefore remedial alternatives were not developed specifically to reduce contaminant concentrations in groundwater. However, implementation of the selected remedy described above is likely to have a positive impact on groundwater concentrations over the long term. In order to monitor groundwater quality on the Site, implementation of a Site-wide groundwater monitoring program is recommended. This program is anticipated to involve the sampling of approximately 20 to 25 monitoring wells on an annual basis, to ensure that site conditions remain stable during the implementation of the Temporary Solution on the Site.

- AULs may be implemented on properties located within the boundaries of the Site to mitigate potential exposure to contaminated soil. AULs may mandate the maintenance of a direct contact barrier (i.e., asphalt pavement) to prevent contact of Site employees, visitors and trespassers with contaminated soil.

Approximate locations of remedial components (including DNAPL and LNAPL extraction wells and potential locations for DNAPL migration control barriers) are shown on Figure 20. The proposed remedial measures are anticipated to reduce the quantity of LNAPL and DNAPL and reduce concentrations of OHM at the Site, and therefore reduce potential risk posed to human health and the environment by OHM at the Site. Due to the limitations discussed above, the selected remedy represents a Temporary Solution for the Site. The requirement for a Temporary Solution, as outlined in Section 3.03, is the elimination of Site Substantial Hazards. Because the Site Risk Characterization satisfied a condition of No Substantial Hazard for the terrestrial portion of the Site, this requirement has already been met for Areas 1 through 5.

Although not a required component of the proposed Temporary Solution, AULs may be instituted on selected properties as a risk reduction measure to reduce the potential for exposure to MGP residuals. Based on DEP guidance[1], in circumstances "where a Temporary Solution is expected to be in place for a long period of time, an AUL may be useful as a means of providing notice of the residual contamination to future holders of an interest in property at the disposal site." The AULs that may be placed on Site properties would require maintenance of a direct contact barrier (e.g., maintenance of the existing asphalt surfaces) to mitigate potential exposure to contaminated soil. Additionally, AULs may be used to mandate health & safety procedures to protect on-site commercial/industrial facility workers and construction workers during work to mitigate exposure hazards associated with contaminated soil. Such health and safety procedures may include the use of personal protective equipment and/or engineering controls that would reduce exposure to contaminated soil. AULs may also require that current property use be maintained (i.e., prohibit changes to more sensitive property uses, such as residential use) and mandate soil management plans unless necessary measures, such as engineering controls, are implemented to preclude future exposures.

B. Definitive and Enterprising Steps

The selected remedial alternative for the Site constitutes a Temporary Solution, because the requirements of a Permanent Solution cannot be met at the present time.

"Definitive and enterprising steps", as described in 310 CMR 40.0861(h), are remedial measures that represent progress toward a Permanent Solution. Several of the components of the selected remedy described above represent definitive and enterprising steps toward a Permanent Solution. The following "definitive and enterprising steps" are proposed:

- DNAPL recovery using extraction wells on Areas 1, 2 and 3
- LNAPL recovery using belt-skimmers on Areas 2 and 4
- Reduction of BTEXSN concentrations in soil, groundwater and indoor air through the installation of biosparging and SVE systems on Area 5
- Review of the performance of the Temporary Solution every five years, and assess whether new or emerging technologies may be able to contribute further toward the achievement of a Permanent Solution
- Monitor performance and effectiveness of the selected remedial components.

C. Anticipated Remedial Implementation Approach

The Temporary Solution components and definitive and enterprising steps listed in the Sections above are proposed to reduce concentrations of MGP residuals at the Site, and to progress toward accomplishment of these remedial objectives. The following key aspects have been identified as "critical path" elements of the remedial process, and are likely to dictate the schedule of the remedial implementation:

1. Property access and property use: The Former Malden MGP Site is comprised of seven properties, which are owned by entities other than MEC. Therefore, implementation of the remedy must be coordinated with the needs of property owners. The properties located within the limits of the Site are occupied by operating businesses, which must be allowed to function during implementation of the remedy.

2. Appropriate sequencing of remedial technologies: On Areas 1, 2, 3 and 4, the quantity of NAPL in the subsurface must be reduced to the extent practicable prior to the remediation of TSM and soil. Remediation of TSM or soil in the presence of LNAPL or DNAPL would be ineffective.

3. Other technical considerations: Technical factors regarding the effectiveness of the proposed remedial components will be taken into consideration during implementation of the remedy. For example, proper location of DNAPL extraction wells is dependent upon the elevation of the organic deposit, which has been observed to be highly irregular during subsurface investigations. Based on these observations, DNAPL extraction wells may be installed in stages, such that the locations of the second stage of DNAPL extraction wells would be determined based on the results obtained in the first stage. The most efficient placement of DNAPL or LNAPL extraction wells may result in the installation of extraction wells on one property before another.

4. Provisional installation of shallow DNAPL migration control barriers: Installation of vertical shallow DNAPL migration control barriers may be implemented in the event that certain conditions are encountered. In the event that the DNAPL remedial goals are accomplished on one Area before they are accomplished on adjacent Areas, a DNAPL migration control barrier may be installed if the potential exists for the migration of shallow DNAPL from the adjacent Areas. This remedial component is provisional and may not be required if the DNAPL remedial goals are attained in a similar timeframe on Areas 1, 2 and 3, or if the potential for DNAPL migration from one Area to another is considered small, based on the results of DNAPL

The proposed remedy for the Site will be implemented in accordance with and consideration of these critical elements. Based on the complexity of the contamination and ownership situation of the Site, it is likely that a phased approach to Site remediation will be followed. Components of the proposed remedy will be implemented as they become feasible in the overall Site remedial plan.

D. Estimated Net Present Value of the Selected Remedial Alternative

The estimated net present value of the selected remedial alternative, as summarized in Table XXIV, is approximately $4.95M. Assumed time requirements for the selected remedial components are also listed in Table XXIV.

10.04 Justification of Temporary Solution

A Permanent Solution for the Site cannot be reached at this time, because hazardous materials such as PAHs, VOCs, and TSM are present in soil at concentrations greater than MADEP UCLs and NAPL exists in several monitoring wells at a thickness greater than 0.5 in. As discussed in Section 10.02 above, removal through excavation, placement of an engineered barrier or remediation of these materials is not feasible at this time due to the current property use. In the event that there are future changes in property use, remedial technologies can be re-evaluated to assess the feasibility of a Permanent Solution. As part of the Temporary Solution for the Site, definitive and enterprising steps will be taken to (1) contain, and as possible remove DNAPL and LNAPL from the subsurface on the Site and (2) reduce VOC concentrations in groundwater and indoor air on the 129 Commercial Street property.

REFERENCES

1. MADEP/BWSC MCP Master Q&A, dated 25 March 1999. No. 185, p. 56.

2. Haley & Aldrich, Inc., "Report on Phase II Comprehensive Site Assessment, Former Malden MGP Site, Malden, Massachusetts", dated 28 December 2001

3. Haley & Aldrich, Inc., Tier II Extension Submittals, Former Malden Manufactured Gas Plant, dated 17 February 1995, 16 April 1996, 6 February 1997, 19 February 1998, and 17 February 1999

4. Haley & Aldrich, Inc., "Tier Reclassification Submittal and Tier 1A Permit Application, Former Malden MGP, Malden, Massachusetts", dated 20 August 1999

5. Haley & Aldrich, Inc., "Release Abatement Measure Plan, Former Manufactured Gas Site, Parcel B, 129 Commercial Street, Malden, Massachusetts, RTN-3-0362 and Linked RTNs 3-3757, 3-13310, and 3-13345", dated 2 July 1998

6. Haley & Aldrich, Inc., "Modification to Release Abatement Measure Plan, Former Malden MGP Site, Parcel B, 129 Commercial Street, Malden, Massachusetts", dated 9 April 1999

7. Haley & Aldrich, Inc., "Release Abatement Measure Status Report", Nos. 1 through 10, RTN 3-0362 and linked RTN 3-3757, dated 22 January 1999 through 7 April 2003

8. Haley & Aldrich, Inc., "Immediate Response Action Plan Update, RTN 3-0362 & 3-13754, West End Brook & Malden River Culverts", dated 12 March 1998

9. Haley & Aldrich, Inc., "Immediate Response Action Status Report", Nos. 1 through 14, RTN 3-0362 & 3-13754, West End Brook & Malden River Culverts, dated 11 September 1996 through 12 March 2003.

10. Haley & Aldrich, Inc., "Report on Oil and Hazardous Material Site Evaluation, Boston Gas Company, Commercial and Center Streets, Malden, Massachusetts", dated 26 August 1988.

11. Haley & Aldrich, Inc., "Report on Oil and Hazardous Material Site Evaluation, Boston Gas Company, Commercial and Charles Streets, Malden, Massachusetts", dated 20 September 1988.

12. Haley & Aldrich, Inc., "Report on Oil and Hazardous Material Site Evaluation and Conceptual Remedial Recommendation, Boston Gas Company, 100 Commercial Street, Malden, Massachusetts", Volumes I through III, dated 21 September 1988.

TABLE II
SUMMARY OF SUPPLEMENTAL SOIL SAMPLING RESULTS
51 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

LOCATION ID	MCP	MCP	MCP	SS-101	SS-101	SS-102	SS-102	SS-103
Depth Range	METHOD 1	METHOD 1	METHOD 1	0 to 3 feet	0.5 to 1 feet	0 to 3 feet	0.5 to 1 feet	0 to 3 feet
Sample ID	RCS-1	RCS-2	UCL	SS-101 C1	SS-101 S1	SS-102 C1	SS-102 S1	SS-103 C1
Sample Date	(ug/kg)	(ug/kg)	(ug/kg)	6/9/2002	6/9/2002	6/9/2002	6/9/2002	6/9/2002
VOCs (ug/kg)								
Naphthalene (VOC)	4000	1000000	10000000	- -	1300	- -	1900	- -
p/m-Xylene	500000	500000	500000	- -	ND(180)	- -	300	- -
SVOCs (ug/kg)								
1-Methylnaphthalene	N/A	N/A	N/A	ND(1100)	- -	940	- -	ND(570)
2-Methylnaphthalene	4000	1000000	10000000	ND(1800)	- -	980	- -	ND(920)
Acenaphthylene	100000	1000000	10000000	4200	- -	2400	- -	ND(570)
Anthracene	1000000	1000000	10000000	3400	- -	2600	- -	ND(570)
Benzo(a)anthracene	700	1000	100000	8100	- -	6000	- -	1100
Benzo(a)pyrene	700	700	100000	8300	- -	6200	- -	1100
Benzo(e)pyrene	N/A	N/A	N/A	6000	- -	4200	- -	760
Benzo(b)fluoranthene	700	1000	100000	7300	- -	4900	- -	920
Benzo(ghi)perylene	1000000	2500000	10000000	6600	- -	4600	- -	760
Benzo(k)fluoranthene	7000	10000	400000	6800	- -	4900	- -	890
Chrysene	7000	10000	400000	8400	- -	6300	- -	1100
Dibenzo(a,h)anthracene	700	700	100000	1900	- -	1300	- -	ND(570)
Fluoranthene	1000000	1000000	10000000	11000	- -	9500	- -	1600
Fluorene	400000	2000000	10000000	ND(1100)	- -	800	- -	ND(570)
Indeno(1,2,3-cd)pyrene	700	1000	100000	5800	- -	4100	- -	710
Naphthalene	4000	1000000	10000000	ND(1100)	- -	1400	- -	ND(570)
Perylene	N/A	N/A	N/A	2300	- -	1700	- -	ND(570)
Phenanthrene	100000	100000	10000000	4700	- -	8400	- -	820
Pyrene	700000	2000000	10000000	14000	- -	12000	- -	1800

TABLE II
SUMMARY OF SUPPLEMENTAL SOIL SAMPLING RESULTS
51 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

LOCATION ID Depth Range Sample ID Sample Date	MCP METHOD 1 RCS-1 (ug/kg)	MCP METHOD 1 RCS-2 (ug/kg)	MCP METHOD 1 UCL (ug/kg)	SS-101 0 to 3 feet SS-101 C1 6/9/2002	SS-101 0.5 to 1 feet SS-101 S1 6/9/2002	SS-102 0 to 3 feet SS-102 C1 6/9/2002	SS-102 0.5 to 1 feet SS-102 S1 6/9/2002	SS-103 0 to 3 feet SS-103 C1 6/9/2002
Metals (ug/kg)								
Arsenic	30000	30000	300000	7600	- -	9500	- -	8900
Barium	1000000	2500000	10000000	72000	- -	53000	- -	62000
Cadmium	30000	80000	800000	850	- -	ND(460)	- -	470
Chromium	1000000	2500000	10000000	38000	- -	17000	- -	16000
Lead	300000	600000	6000000	300000	- -	340000	- -	300000
Mercury	20000	60000	600000	410	- -	380	- -	250
Cyanide								
Cyanide, Total	100000	100000	4000000	5400	- -	6500	- -	1600
Cyanide, Physiologically Available				870	- -	1900	- -	400
EPH (ug/kg)								
C9-C18 Aliphatics	1000000	2500000	20000000	ND(102000)	- -	65400	- -	ND(34500)
C19-C36 Aliphatics	2500000	5000000	20000000	155000	- -	151000	- -	122000
C11-C22 Aromatics	200	2000000	10000000	542000	- -	1730000	- -	191000

Notes:
1. ND (5): Compound not detected above detection limit; detection limit is shown in parentheses.
2. VOCs: Volatile Organic Compounds;
   SVOCs: Semivolatile Organic Compounds;
3. Table lists detected compounds only; compounds that were not detected are not listed.

TABLE II
SUMMARY OF SUPPLEMENTAL SOIL SAMPLING RESULTS
51 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

LOCATION ID Depth Range Sample ID Sample Date	MCP METHOD 1 RCS-1 (ug/kg)	MCP METHOD 1 RCS-2 (ug/kg)	MCP METHOD 1 UCL (ug/kg)	SS-103 0 to 3 feet SS-103 C1 DUP 6/9/2002	SS-103 0.5 to 1 feet SS-103 S1 6/9/2002	SS-103 0.5 to 1 feet SS-103 S1 DUP 6/9/2002
VOCs (ug/kg)						
Naphthalene (VOC)	4000	1000000	10000000	- -	ND(890)	ND(860)
p/m-Xylene	500000	500000	500000	- -	ND(180)	ND(170)
SVOCs (ug/kg)						
1-Methylnaphthalene	N/A	N/A	N/A	ND(1100)	- -	- -
2-Methylnaphthalene	4000	1000000	10000000	ND(1800)	- -	- -
Acenaphthylene	100000	1000000	10000000	ND(1100)	- -	- -
Anthracene	1000000	1000000	10000000	ND(1100)	- -	- -
Benzo(a)anthracene	700	1000	100000	2400	- -	- -
Benzo(a)pyrene	700	700	100000	2400	- -	- -
Benzo(e)pyrene	N/A	N/A	N/A	1700	- -	- -
Benzo(b)fluoranthene	700	1000	100000	1800	- -	- -
Benzo(ghi)perylene	1000000	2500000	10000000	1700	- -	- -
Benzo(k)fluoranthene	7000	10000	400000	2100	- -	- -
Chrysene	7000	10000	400000	2600	- -	- -
Dibenzo(a,h)anthracene	700	700	100000	ND(1100)	- -	- -
Fluoranthene	1000000	1000000	10000000	3600	- -	- -
Fluorene	400000	2000000	10000000	ND(1100)	- -	- -
Indeno(1,2,3-cd)pyrene	700	1000	100000	1500	- -	- -
Naphthalene	4000	1000000	10000000	ND(1100)	- -	- -
Perylene	N/A	N/A	N/A	ND(1100)	- -	- -
Phenanthrene	100000	100000	10000000	2000	- -	- -
Pyrene	700000	2000000	10000000	4400	- -	- -

TABLE II
SUMMARY OF SUPPLEMENTAL SOIL SAMPLING RESULTS
51 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

LOCATION ID	MCP	MCP	MCP	SS-103	SS-103	SS-103
Depth Range	METHOD 1	METHOD 1	METHOD 1	0 to 3 feet	0.5 to 1 feet	0.5 to 1 feet
Sample ID	RCS-1	RCS-2	UCL	SS-103 C1 DUP	SS-103 S1	SS-103 S1 DUP
Sample Date	(ug/kg)	(ug/kg)	(ug/kg)	6/9/2002	6/9/2002	6/9/2002
Metals (ug/kg)						
Arsenic	30000	30000	300000	9500	- -	- -
Barium	1000000	2500000	10000000	65000	- -	- -
Cadmium	30000	80000	800000	510	- -	- -
Chromium	1000000	2500000	10000000	14000	- -	- -
Lead	300000	600000	6000000	330000	- -	- -
Mercury	20000	60000	600000	240	- -	- -
Cyanide						
Cyanide, Total	100000	100000	4000000	1300	- -	- -
Cyanide, Physiologically Available				450	- -	- -
EPH (ug/kg)						
C9-C18 Aliphatics	1000000	2500000	20000000	ND(11500)	- -	- -
C19-C36 Aliphatics	2500000	5000000	20000000	81000	- -	- -
C11-C22 Aromatics	200	2000000	10000000	127000	- -	- -

Notes:
1. ND (5): Compound not detected above detection limit; detection limit is shown in parentheses.
2. VOCs: Volatile Organic Compounds; SVOCs: Semivolatile Organic Compounds;
3. Table lists detected compounds only; compounds that were not detected are not listed.

TABLE III
SUMMARY OF SUPPLEMENTAL SOIL SAMPLING RESULTS
129 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

LOCATION ID SAMPLE ID SAMPLE DATE DEPTH INTERVAL	MCP METHOD 1 RCS-1 (ug/kg)	MCP METHOD 1 RCS-2 (ug/kg)	MCP METHOD 1 UCL (ug/kg)	02B-B917 02B-917-MW 2/18/2002 2.6 to 4.6 ft	02B-B917 02M-1001-MW 2/18/2002 2.6 to 4.6 ft	02B-B918 02B-918-MW 2/18/2002 14.2 to 16.2 ft	02B-B918 02B-918-MW/S10 2/19/2002 18.2 to 20.2 ft	02B-B919 02B-919-MW/S2 2/19/2002 3 to 5 ft
VOCs (ug/kg)								
1,2,4-Trimethylbenzene	1000000	10000000	N/A	ND(220)	ND(230)	ND(3500)	ND(350)	ND(300)
1,3,5-Trimethylbenzene	10000	100000	N/A	ND(220)	ND(230)	ND(3500)	ND(350)	ND(300)
n-Propylbenzene	N/A	N/A	N/A	ND(44)	ND(46)	ND(710)	ND(70)	ND(61)
Acetone	3000	60000	10000000	ND(440)	ND(460)	ND(7100)	ND(700)	ND(610)
Benzene	10000	60000	2000000	280	240	35000	1200	770
Chloroform	100	10000	5000000	ND(65)	ND(69)	ND(1100)	ND(100)	ND(92)
Ethylbenzene	80000	500000	10000000	ND(44)	ND(46)	15000	510	150
Isopropylbenzene	1000000	10000000	N/A	ND(44)	ND(46)	ND(710)	ND(70)	ND(61)
Methylene chloride	100	200000	7000000	ND(440)	ND(460)	ND(7100)	ND(700)	ND(610)
Naphthalene	4000	1000000	10000000	6300	3700	15000	1400	360
Styrene	2000	20000	1000000	ND(44)	ND(46)	970	200	ND(61)
Toluene	90000	500000	10000000	240	230	42000	2200	240
o-Xylene	500000	500000	500000	ND(44)	ND(46)	2900	220	ND(61)
p/m-Xylene	500000	500000	500000	100	120	10000	760	160
SVOCs (ug/kg)								
1-Methylnaphthalene	N/A	N/A	N/A	ND(13000)	ND(5400)	2600	ND(600)	ND(5300)
2-Methylnaphthalene	4000	1000000	10000000	ND(22000)	ND(8600)	3500	ND(950)	ND(8400)
Acenaphthene	20000	2500000	10000000	ND(13000)	ND(5400)	ND(610)	ND(600)	ND(5300)
Acenaphthylene	100000	1000000	10000000	14000	ND(5400)	ND(610)	ND(600)	ND(5300)
Anthracene	1000000	1000000	10000000	21000	ND(5400)	ND(610)	ND(600)	ND(5300)
Benzo(a)anthracene	700	1000	100000	48000	ND(5400)	ND(610)	ND(600)	6000
Benzo(a)pyrene	700	700	100000	40000	ND(5400)	ND(610)	ND(600)	6500
Benzo(e)pyrene	N/A	N/A	N/A	25000	ND(5400)	ND(610)	ND(600)	ND(5300)
Benzo(b)fluoranthene	700	1000	100000	32000	ND(5400)	ND(610)	ND(600)	ND(5300)
Benzo(ghi)perylene	1000000	2500000	10000000	24000	ND(5400)	ND(610)	ND(600)	ND(5300)
Benzo(k)fluoranthene	7000	10000	400000	34000	ND(5400)	ND(610)	ND(600)	ND(5300)
Chrysene	7000	10000	400000	46000	ND(5400)	ND(610)	ND(600)	6000
Dibenzo(a,h)anthracene	700	700	100000	ND(13000)	ND(5400)	ND(610)	ND(600)	ND(5300)

TABLE III
SUMMARY OF SUPPLEMENTAL SOIL SAMPLING RESULTS
129 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

LOCATION ID SAMPLE ID SAMPLE DATE DEPTH INTERVAL	MCP METHOD 1 RCS-1 (ug/kg)	MCP METHOD 1 RCS-2 (ug/kg)	MCP METHOD 1 UCL (ug/kg)	02B-B917 02B-917-MW 2/18/2002 2.6 to 4.6 ft	02B-B917 02M-1001-MW 2/18/2002 2.6 to 4.6 ft	02B-B918 02B-918-MW 2/18/2002 14.2 to 16.2 ft	02B-B918 02B-918-MW/S10 2/19/2002 18.2 to 20.2 ft	02B-B919 02B-919-MW/S2 2/19/2002 3 to 5 ft
Fluoranthene	1000000	1000000	10000000	95000	7400	ND(610)	ND(600)	12000
Fluorene	400000	2000000	10000000	ND(13000)	ND(5400)	ND(610)	ND(600)	ND(5300)
Indeno(1,2,3-cd)pyrene	700	1000	100000	23000	ND(7500)	ND(850)	ND(830)	ND(7400)
Naphthalene	4000	1000000	10000000	ND(13000)	ND(5400)	5300	ND(600)	ND(5300)
Phenanthrene	100000	100000	10000000	72000	ND(5400)	ND(610)	ND(600)	9000
Perylene	N/A	N/A	N/A	ND(13000)	ND(5400)	ND(610)	ND(600)	ND(5300)
Pyrene	700000	2000000	10000000	86000	7000	ND(610)	ND(600)	15000
Metals (ug/kg)								
Arsenic	30000	30000	300000	4500	6200	3300	1800	5200
Barium	1000000	2500000	10000000	62000	41000	6500	10000	25000
Cadmium	30000	80000	800000	ND(430)	ND(430)	ND(480)	ND(470)	ND(420)
Chromium	1000000	2500000	10000000	16000	22000	6200	9800	10000
Lead	300000	600000	6000000	110000	66000	ND(2400)	ND(2400)	38000
Mercury	20000	60000	600000	760	220	ND(100)	ND(90)	280
Selenium	400000	2500000	10000000	ND(860)	ND(860)	ND(960)	ND(940)	ND(830)
Silver	100000	200000	2000000	ND(430)	ND(430)	ND(480)	ND(470)	ND(420)
Cyanide								
Cyanide, Total	100000	100000	4000000	15000	6600	1200	440	3500

Notes:
1. ND (5): Compound not detected above detection limit; detection limit is shown in parentheses.
2. VOCs: Volatile Organic Compounds; SVOCs: Semivolatile Organic Compounds;
3. Table lists detected compounds only; compounds that were not detected are not listed.

TABLE III
SUMMARY OF SUPPLEMENTAL SOIL SAMPLING RESULTS
129 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

LOCATION ID SAMPLE ID SAMPLE DATE DEPTH INTERVAL	MCP METHOD 1 RCS-1 (ug/kg)	MCP METHOD 1 RCS-2 (ug/kg)	MCP METHOD 1 UCL (ug/kg)	02B-B920 02B-920-MW (.8-2.8) 2/20/2002 0.8 to 2.8 ft	02B-B920 02B-920-MW (14-16) 2/20/2002 14 to 16 ft	02B-B920 02B-920-MW/S9 2/21/2002 18 to 20 ft	02B-B921 02B-921-MW/S10 2/21/2002 19 to 21 ft	02B-B921 02B-921-MW/S2 2/21/2002 2.5 to 4.5 ft
Fluoranthene	1000000	1000000	10000000	5200	ND(620)	ND(640)	ND(620)	ND(520)
Fluorene	400000	2000000	10000000	ND(1100)	ND(620)	ND(640)	ND(620)	ND(520)
Indeno(1,2,3-cd)pyrene	700	1000	100000	2800	ND(620)	ND(900)	ND(860)	ND(720)
Naphthalene	4000	1000000	10000000	ND(1100)	ND(620)	ND(640)	ND(620)	ND(520)
Phenanthrene	100000	100000	10000000	3300	ND(620)	ND(640)	ND(620)	ND(520)
Perylene	N/A	N/A	N/A	1100	ND(620)	ND(640)	ND(620)	ND(520)
Pyrene	700000	2000000	10000000	7200	ND(620)	ND(640)	ND(620)	ND(520)
Metals (ug/kg)								
Arsenic	30000	30000	300000	6800	1700	3900	2700	11000
Barium	1000000	2500000	10000000	27000	7900	46000	26000	28000
Cadmium	30000	80000	800000	ND(430)	ND(490)	ND(500)	ND(480)	ND(410)
Chromium	1000000	2500000	10000000	10000	6200	12000	14000	20000
Lead	300000	600000	6000000	110000	ND(2400)	3000	2600	4000
Mercury	20000	60000	600000	640	ND(100)	ND(100)	ND(100)	ND(80)
Selenium	400000	2500000	10000000	ND(850)	ND(980)	ND(1000)	ND(970)	ND(820)
Silver	100000	200000	2000000	ND(430)	ND(490)	ND(500)	ND(480)	ND(410)
Cyanide								
Cyanide, Total	100000	100000	4000000	3800	8400	860	460	ND(170)

Notes:
1. ND (5): Compound not detected above detection limit; detection limit is shown in parentheses.
2. VOCs: Volatile Organic Compounds;
   SVOCs: Semivolatile Organic Compounds;
3. Table lists detected compounds only; compounds that were not detected are not listed.

TABLE III
SUMMARY OF SUPPLEMENTAL SOIL SAMPLING RESULTS
129 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

LOCATION ID SAMPLE ID SAMPLE DATE DEPTH INTERVAL	MCP METHOD 1 RCS-1 (ug/kg)	MCP METHOD 1 RCS-2 (ug/kg)	MCP METHOD 1 UCL (ug/kg)	02B-B923 02B-923-MW/S8 2/22/2002 15 to 17 ft	02B-B924 02B-B924-S7 7/28/2002 12.5 to 14.5 ft	02B-B924 02B-B924-S8 7/28/2002 14.5 to 16.5 ft
Fluoranthene	1000000	1000000	10000000	ND(600000)	ND(600)	ND(620)
Fluorene	400000	2000000	10000000	ND(600000)	ND(600)	ND(620)
Indeno(1,2,3-cd)pyrene	700	1000	100000	ND(830000)	ND(600)	ND(620)
Naphthalene	4000	1000000	10000000	4300000	ND(600)	ND(620)
Phenanthrene	100000	100000	10000000	ND(600000)	770	ND(620)
Perylene	N/A	N/A	N/A	ND(600000)	ND(600)	ND(620)
Pyrene	700000	2000000	10000000	ND(600000)	ND(600)	ND(620)
Metals (ug/kg)						
Arsenic	30000	30000	300000	2900	1400	1200
Barium	1000000	2500000	10000000	13000	12000	9600
Cadmium	30000	80000	800000	ND(470)	ND(470)	ND(480)
Chromium	1000000	2500000	10000000	7200	8200	7400
Lead	300000	600000	6000000	ND(2300)	2900	2400
Mercury	20000	60000	600000	ND(90)	ND(90)	ND(90)
Selenium	400000	2500000	10000000	ND(930)	ND(940)	ND(970)
Silver	100000	200000	2000000	ND(470)	ND(470)	ND(480)
Cyanide						
Cyanide, Total	100000	100000	4000000	620	- -	- -

Notes:
1. ND (5): Compound not detected above detection limit; detection limit is shown in parentheses.
2. VOCs: Volatile Organic Compounds;
   SVOCs: Semivolatile Organic Compounds;
3. Table lists detected compounds only; compounds that were not detected are not listed.

TABLE IV
SUMMARY OF SUPPLEMENTAL GROUNDWATER SAMPLING RESULTS
129 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

WELL/LOCATION ID	METHOD 1	METHOD 1	METHOD 1	02B-B918-OW	02B-B918-OW	02B-B918-OW	02B-B918-OW
SAMPLE ID	MCP	MCP	MCP	02B-B918-OW	02B-B900-DUP	02B-B918-OW	02B-B918-OW
SAMPLE DATE	GW-1	GW-2	UCL	3/10/2002	3/10/2002	5/5/2002	7/27/2002
SAMPLING NOTES	(ug/l)	(ug/l)	(ug/l)		Dup. Of 02B-B918-OW		
VOCs (ug/l)							
1,2,4-Trimethylbenzene	10000	100000	N/A	ND(5000)	ND(5000)	ND(1200)	ND(1200)
1,3,5-Trimethylbenzene	100	1000	N/A	ND(5000)	ND(5000)	ND(1200)	ND(1200)
2-Chlorotoluene	N/A	N/A	N/A	ND(5000)	ND(5000)	ND(1200)	ND(1200)
4-Isopropyltoluene	1000	10000	N/A	ND(1000)	ND(1000)	ND(250)	ND(250)
Acetone	3000	50000	100000	ND(10000)	ND(10000)	ND(2500)	ND(2500)
Benzene	5	2000	70000	56000	66000	55000	41000
Chlorobenzene	100	500	10000	ND(1000)	ND(1000)	ND(250)	ND(250)
Chloroform	5	400	100000	ND(1500)	ND(1500)	ND(380)	ND(380)
cis-1,2-Dichloroethene	70	30000	100000	ND(1000)	ND(1000)	ND(250)	ND(250)
trans-1,2-Dichloroethene	100	20000	100000	ND(1500)	ND(1500)	ND(380)	ND(380)
trans-1,3-Dichloropropene	N/A	N/A	N/A	ND(1000)	ND(1000)	ND(250)	ND(250)
Ethylbenzene	700	4000	100000	7100	10000	8200	8600
Isopropylbenzene	10000	100000	N/A	ND(1000)	ND(1000)	ND(250)	ND(250)
2-Butanone	400	50000	100000	ND(10000)	ND(10000)	ND(2500)	ND(2500)
Naphthalene	20	6000	60000	ND(5000)	ND(5000)	4200	ND(1200)
n-Butylbenzene	N/A	N/A	N/A	ND(1000)	ND(1000)	ND(250)	ND(250)
n-Propylbenzene	1000	10000	N/A	ND(1000)	ND(1000)	ND(250)	ND(250)
m,p-Xylene	6000	6000	N/A	3700	5100	4400	2800
o-Xylene	6000	6000	N/A	1200	1600	1300	940
sec-Butylbenzene	N/A	N/A	N/A	ND(1000)	ND(1000)	510	ND(250)
Styrene	100	900	100000	ND(1000)	ND(1000)	480	400
tert-Butylbenzene	1000	10000	N/A	ND(5000)	ND(5000)	ND(1200)	ND(1200)
Toluene	1000	6000	100000	30000	38000	31000	24000
Tetrachloroethene	5	3000	50000	ND(1000)	ND(1000)	ND(250)	ND(250)
Trichloroethene	5	300	100000	ND(1000)	ND(1000)	ND(250)	ND(250)

TABLE IV
SUMMARY OF SUPPLEMENTAL GROUNDWATER SAMPLING RESULTS
129 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

WELL/LOCATION ID	METHOD 1	METHOD 1	METHOD 1	02B-B918-OW	02B-B918-OW	02B-B918-OW	02B-B918-OW
SAMPLE ID	MCP	MCP	MCP	02B-B918-OW	02B-B900-DUP	02B-B918-OW	02B-B918-OW
SAMPLE DATE	GW-1	GW-2	UCL	3/10/2002	3/10/2002	5/5/2002	7/27/2002
SAMPLING NOTES	(ug/l)	(ug/l)	(ug/l)		Dup. Of 02B-B918-OW		
SVOCs (ug/l)							
1-Methylnaphthalene	N/A	N/A	N/A	420	260	430	330
2-Methylnaphthalene	10	3000	100000	ND(400)	ND(200)	200	170
2-Methylphenol	5000	50000	N/A	ND(300)	ND(150)	ND(120)	- -
Acenaphthene	20	5000	50000	ND(250)	ND(130)	ND(100)	ND(50)
Bis(2-ethylhexyl)phthalate	6	30	100000	ND(500)	ND(250)	ND(200)	- -
Fluorene	300	3000	30000	ND(250)	ND(130)	ND(100)	ND(50)
Naphthalene	20	6000	60000	2700	1700	2700	1500
Phenol	4000	30000	100000	ND(350)	180	220	- -
Metals (ug/l)							
Arsenic	50	400	4000	28	25	16	17
Barium	2000	30000	100000	80	80	90	80
Fluoride	N/A	N/A	N/A	- -	- -	- -	- -
Cyanide (ug/l)							
Cyanide, Total	10	10	N/A	786	836	732	128
Cyanide, Physiologically Available	N/A	N/A	2000	94	87	57	29

Notes:
1. ND (5): Compound not detected above detection limit; detection limit is shown in parentheses.
2. VOCs: Volatile Organic Compounds; SVOCs: Semivolatile Organic Compounds;
3. Table lists detected compounds only; compounds that were not detected are not listed.
4. Surrogates were not recovered for samples 02B-B922-OW and 02B-B923-OW collected on 27 July 2002, due to high concentrations of native compounds (i.e., naphthalene) in the samples.

TABLE IV
SUMMARY OF SUPPLEMENTAL GROUNDWATER SAMPLING RESULTS
129 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

WELL/LOCATION ID SAMPLE ID SAMPLE DATE SAMPLING NOTES	METHOD 1 MCP GW-1 (ug/l)	METHOD 1 MCP GW-2 (ug/l)	METHOD 1 MCP UCL (ug/l)	02B-B920-OW 02B-B920-OW 3/10/2002	02B-B920-OW 02B-B920-OW 5/5/2002	02B-B921-OW 02B-B921-OW 3/10/2002	02B-B921-OW 02B-B921-OW 5/5/2002	02B-B922-OW 02B-B922-OW 5/5/2002
VOCs (ug/l)								
1,2,4-Trimethylbenzene	10000	100000	N/A	5.3	ND(2.5)	28	ND(12)	ND(2500)
1,3,5-Trimethylbenzene	100	1000	N/A	ND(2.5)	ND(2.5)	5.8	ND(12)	ND(2500)
2-Chlorotoluene	N/A	N/A	N/A	ND(2.5)	ND(2.5)	ND(2.5)	ND(12)	ND(2500)
4-Isopropyltoluene	1000	10000	N/A	ND(0.5)	ND(0.5)	9.3	5	ND(500)
Acetone	3000	50000	100000	ND(5)	ND(5)	ND(5)	ND(25)	ND(5000)
Benzene	5	2000	70000	8	4.5	40	160	12000
Chlorobenzene	100	500	10000	ND(0.5)	ND(0.5)	ND(0.5)	ND(2.5)	ND(500)
Chloroform	5	400	100000	ND(0.75)	ND(0.75)	ND(0.75)	ND(3.8)	ND(750)
cis-1,2-Dichloroethene	70	30000	100000	ND(0.5)	ND(0.5)	ND(0.5)	ND(2.5)	ND(500)
trans-1,2-Dichloroethene	100	20000	100000	ND(0.75)	ND(0.75)	ND(0.75)	ND(3.8)	ND(750)
trans-1,3-Dichloropropene	N/A	N/A	N/A	ND(0.5)	ND(0.5)	ND(0.5)	ND(2.5)	ND(500)
Ethylbenzene	700	4000	100000	ND(0.5)	0.6	29	49	3900
Isopropylbenzene	10000	100000	N/A	1.4	0.79	10	8.8	ND(500)
2-Butanone	400	50000	100000	ND(5)	ND(5)	ND(5)	ND(25)	ND(5000)
Naphthalene	20	6000	60000	ND(2.5)	ND(2.5)	20	180	6400
n-Butylbenzene	N/A	N/A	N/A	ND(0.5)	ND(0.5)	ND(0.5)	ND(2.5)	ND(500)
n-Propylbenzene	1000	10000	N/A	ND(0.5)	ND(0.5)	2.6	3.6	ND(500)
m,p-Xylene	6000	6000	N/A	ND(0.5)	ND(0.5)	1.9	4.8	4800
o-Xylene	6000	6000	N/A	1.1	ND(0.5)	4	7.2	2100
sec-Butylbenzene	N/A	N/A	N/A	ND(0.5)	0.82	2.7	ND(2.5)	ND(500)
Styrene	100	900	100000	ND(0.5)	ND(0.5)	ND(0.5)	ND(2.5)	1800
tert-Butylbenzene	1000	10000	N/A	ND(2.5)	ND(2.5)	ND(2.5)	ND(12)	ND(2500)
Toluene	1000	6000	100000	ND(0.75)	ND(0.75)	1.6	ND(3.8)	27000
Tetrachloroethene	5	3000	50000	ND(0.5)	ND(0.5)	ND(0.5)	7.8	ND(500)
Trichloroethene	5	300	100000	ND(0.5)	ND(0.5)	ND(0.5)	ND(2.5)	ND(500)

TABLE IV
SUMMARY OF SUPPLEMENTAL GROUNDWATER SAMPLING RESULTS
129 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

WELL/LOCATION ID SAMPLE ID SAMPLE DATE SAMPLING NOTES	METHOD 1 MCP GW-1 (ug/l)	METHOD 1 MCP GW-2 (ug/l)	METHOD 1 MCP UCL (ug/l)	02B-B920-OW 02B-B920-OW 3/10/2002	02B-B920-OW 02B-B920-OW 5/5/2002	02B-B921-OW 02B-B921-OW 3/10/2002	02B-B921-OW 02B-B921-OW 5/5/2002	02B-B922-OW 02B-B922-OW 5/5/2002
SVOCs (ug/l)								
1-Methylnaphthalene	N/A	N/A	N/A	ND(5)	ND(5)	430	300	550
2-Methylnaphthalene	10	3000	100000	ND(8.1)	ND(8)	ND(40)	ND(40)	ND(800)
2-Methylphenol	5000	50000	N/A	ND(6.1)	ND(6)	ND(30)	ND(30)	ND(600)
Acenaphthene	20	5000	50000	7.5	6.4	ND(25)	ND(25)	ND(500)
Bis(2-ethylhexyl)phthalate	6	30	100000	ND(10)	ND(10)	ND(50)	ND(50)	ND(1000)
Fluorene	300	3000	30000	12	12	ND(25)	ND(25)	ND(500)
Naphthalene	20	6000	60000	ND(5)	ND(5)	ND(25)	110	9100
Phenol	4000	30000	100000	ND(7.1)	ND(7)	ND(35)	ND(35)	ND(700)
Metals (ug/l)								
Arsenic	50	400	4000	32	24	ND(10)	ND(10)	ND(10)
Barium	2000	30000	100000	130	110	140	210	60
Fluoride	N/A	N/A	N/A	--	--	--	--	--
Cyanide (ug/l)								
Cyanide, Total	10	10	N/A	513	727	940	1150	952
Cyanide, Physiologically Available	N/A	N/A	2000	81	64	76	86	70

Notes:

1. ND (5): Compound not detected above detection limit; detection limit is shown in parentheses.
2. VOCs: Volatile Organic Compounds; SVOCs: Semivolatile Organic Compounds;
3. Table lists detected compounds only; compounds that were not detected are not listed.
4. Surrogates were not recovered for samples 02B-B922-OW and 02B-B923-OW collected on 27 July 2002, due to high concentrations of native compounds (i.e., naphthalene) in the samples.

TABLE IV
SUMMARY OF SUPPLEMENTAL GROUNDWATER SAMPLING RESULTS
129 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

WELL/LOCATION ID	METHOD 1	METHOD 1	METHOD 1	02B-B922-OW	02B-B923-OW	02B-B923-OW	02B-B923-OW
SAMPLE ID	MCP	MCP	MCP	02B-B922-OW	02B-B923-OW	02B-B923-OW	DUP-A
SAMPLE DATE	GW-1	GW-2	UCL	7/27/2002	5/5/2002	7/27/2002	5/5/2002
SAMPLING NOTES	(ug/l)	(ug/l)	(ug/l)				Dup. Of 02B-B923-OW
VOCs (ug/l)							
1,2,4-Trimethylbenzene	10000	100000	N/A	ND(2500)	280	ND(250)	ND(500)
1,3,5-Trimethylbenzene	100	1000	N/A	ND(2500)	ND(250)	ND(250)	ND(500)
2-Chlorotoluene	N/A	N/A	N/A	ND(2500)	ND(250)	ND(250)	ND(500)
4-Isopropyltoluene	1000	10000	N/A	ND(500)	ND(50)	ND(50)	ND(100)
Acetone	3000	50000	100000	ND(5000)	ND(500)	ND(500)	ND(1000)
Benzene	5	2000	70000	6500	2200	370	2300
Chlorobenzene	100	500	10000	ND(500)	ND(50)	ND(50)	ND(100)
Chloroform	5	400	100000	ND(750)	ND(75)	ND(75)	ND(150)
cis-1,2-Dichloroethene	70	30000	100000	ND(500)	ND(50)	ND(50)	ND(100)
trans-1,2-Dichloroethene	100	20000	100000	ND(750)	ND(75)	ND(75)	ND(150)
trans-1,3-Dichloropropene	N/A	N/A	N/A	ND(500)	ND(50)	ND(50)	ND(100)
Ethylbenzene	700	4000	100000	7400	160	130	160
Isopropylbenzene	10000	100000	N/A	ND(500)	ND(50)	ND(50)	ND(100)
2-Butanone	400	50000	100000	ND(5000)	ND(500)	ND(500)	ND(1000)
Naphthalene	20	6000	60000	5900	5100	3600	3600
n-Butylbenzene	N/A	N/A	N/A	ND(500)	ND(50)	ND(50)	ND(100)
n-Propylbenzene	1000	10000	N/A	ND(500)	ND(50)	ND(50)	ND(100)
m,p-Xylene	6000	6000	N/A	7800	890	330	920
o-Xylene	6000	6000	N/A	3000	490	180	500
sec-Butylbenzene	N/A	N/A	N/A	ND(500)	ND(50)	ND(50)	ND(100)
Styrene	100	900	100000	2700	ND(50)	ND(50)	ND(100)
tert-Butylbenzene	1000	10000	N/A	ND(2500)	ND(250)	ND(250)	ND(500)
Toluene	1000	6000	100000	54000	680	110	740
Tetrachloroethene	5	3000	50000	ND(500)	55	ND(50)	ND(100)
Trichloroethene	5	300	100000	ND(500)	ND(50)	ND(50)	ND(100)

TABLE IV
SUMMARY OF SUPPLEMENTAL GROUNDWATER SAMPLING RESULTS
129 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

WELL/LOCATION ID SAMPLE ID SAMPLE DATE SAMPLING NOTES	METHOD 1 MCP GW-1 (ug/l)	METHOD 1 MCP GW-2 (ug/l)	METHOD 1 MCP UCL (ug/l)	02B-B922-OW 02B-B922-OW 7/27/2002	02B-B923-OW 02B-B923-OW 5/5/2002	02B-B923-OW 02B-B923-OW 7/27/2002	02B-B923-OW DUP-A 5/5/2002 Dup. Of 02B-B923-OW
SVOCs (ug/l)							
1-Methylnaphthalene	N/A	N/A	N/A	420	340	220	310
2-Methylnaphthalene	10	3000	100000	540	450	230	400
2-Methylphenol	5000	50000	N/A	- -	ND(300)	- -	ND(300)
Acenaphthene	20	5000	50000	ND(250)	ND(250)	ND(100)	ND(250)
Bis(2-ethylhexyl)phthalate	6	30	100000	- -	ND(500)	- -	ND(500)
Fluorene	300	3000	30000	ND(250)	ND(250)	ND(100)	ND(250)
Naphthalene	20	6000	60000	5600	4200	1900	4000
Phenol	4000	30000	100000	- -	ND(350)	- -	ND(350)
Metals (ug/l)							
Arsenic	50	400	4000	ND(5)	ND(10)	ND(5)	ND(10)
Barium	2000	30000	100000	110	30	40	30
Fluoride	N/A	N/A	N/A	- -	- -	- -	- -
Cyanide (ug/l)							
Cyanide, Total	10	10	N/A	328	778	923	845
Cyanide, Physiologically Available	N/A	N/A	2000	32	120	190	128

Notes:
1. ND (5): Compound not detected above detection limit; detection limit is shown in parentheses.
2. VOCs: Volatile Organic Compounds; SVOCs: Semivolatile Organic Compounds;
3. Table lists detected compounds only; compounds that were not detected are not listed.
4. Surrogates were not recovered for samples 02B-B922-OW and 02B-B923-OW collected on 27 July 2002, due to high concentrations of native compounds (i.e., naphthalene) in the samples.

TABLE IV
SUMMARY OF SUPPLEMENTAL GROUNDWATER SAMPLING RESULTS
129 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

WELL/LOCATION ID SAMPLE ID SAMPLE DATE SAMPLING NOTES	METHOD 1 MCP GW-1 (ug/l)	METHOD 1 MCP GW-2 (ug/l)	METHOD 1 MCP UCL (ug/l)	97B-B617-OW 97B-617-OW 5/8/2002	97B-B617-OW 97B-B617-OW 3/12/2002	97B-B617-OW 97B-B617-OW 8/1/2002	97B-B618-OW 02B-B618-OW 3/11/2002	97B-B618-OW 97B-B618-OW 5/7/2002
VOCs (ug/l)								
1,2,4-Trimethylbenzene	10000	100000	N/A	ND(1200)	ND(1200)	ND(1200)	ND(2.5)	ND(2.5)
1,3,5-Trimethylbenzene	100	1000	N/A	ND(1200)	ND(1200)	ND(1200)	ND(2.5)	ND(2.5)
2-Chlorotoluene	N/A	N/A	N/A	ND(1200)	ND(1200)	ND(1200)	ND(2.5)	ND(2.5)
4-Isopropyltoluene	1000	10000	N/A	ND(250)	ND(250)	ND(250)	ND(0.5)	ND(0.5)
Acetone	3000	50000	100000	ND(2500)	ND(2500)	ND(2500)	ND(5)	ND(5)
Benzene	5	2000	70000	ND(250)	400	ND(250)	3.2	2.4
Chlorobenzene	100	500	10000	ND(250)	ND(250)	ND(250)	ND(0.5)	ND(0.5)
Chloroform	5	400	100000	ND(380)	ND(380)	ND(380)	ND(0.75)	ND(0.75)
cis-1,2-Dichloroethene	70	30000	100000	ND(250)	ND(250)	ND(250)	21	21
trans-1,2-Dichloroethene	100	20000	100000	ND(380)	ND(380)	ND(380)	ND(0.75)	ND(0.75)
trans-1,3-Dichloropropene	N/A	N/A	N/A	ND(250)	290	ND(250)	ND(0.5)	ND(0.5)
Ethylbenzene	700	4000	100000	11000	6800	7400	ND(0.5)	ND(0.5)
Isopropylbenzene	10000	100000	N/A	ND(250)	ND(250)	ND(250)	3.7	2.9
2-Butanone	400	50000	100000	ND(2500)	ND(2500)	ND(2500)	ND(5)	ND(5)
Naphthalene	20	6000	60000	2600	1200	3000	ND(2.5)	ND(2.5)
n-Butylbenzene	N/A	N/A	N/A	ND(250)	ND(250)	ND(250)	ND(0.5)	ND(0.5)
n-Propylbenzene	1000	10000	N/A	ND(250)	ND(250)	ND(250)	ND(0.5)	ND(0.5)
m,p-Xylene	6000	6000	N/A	13000	9200	10000	ND(0.5)	ND(0.5)
o-Xylene	6000	6000	N/A	4500	3200	3400	ND(0.5)	ND(0.5)
sec-Butylbenzene	N/A	N/A	N/A	590	ND(250)	ND(250)	ND(0.5)	0.8
Styrene	100	900	100000	21000	16000	20000	ND(0.5)	ND(0.5)
tert-Butylbenzene	1000	10000	N/A	ND(1200)	ND(1200)	ND(1200)	ND(2.5)	ND(2.5)
Toluene	1000	6000	100000	33000	26000	37000	ND(0.75)	ND(0.75)
Tetrachloroethene	5	3000	50000	ND(250)	ND(250)	ND(250)	ND(0.5)	ND(0.5)
Trichloroethene	5	300	100000	ND(250)	ND(250)	ND(250)	5.3	4.8

TABLE IV
SUMMARY OF SUPPLEMENTAL GROUNDWATER SAMPLING RESULTS
129 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

WELL/LOCATION ID SAMPLE ID SAMPLE DATE SAMPLING NOTES	METHOD 1 MCP GW-1 (ug/l)	METHOD 1 MCP GW-2 (ug/l)	METHOD 1 MCP UCL (ug/l)	97B-B617-OW 97B-617-OW 5/8/2002	97B-B617-OW 97B-B617-OW 3/12/2002	97B-B617-OW 97B-B617-OW 8/1/2002	97B-B618-OW 02B-B618-OW 3/11/2002	97B-B618-OW 97B-B618-OW 5/7/2002
SVOCs (ug/l)								
1-Methylnaphthalene	N/A	N/A	N/A	200	ND(260)	230	ND(5.2)	ND(5)
2-Methylnaphthalene	10	3000	100000	160	ND(410)	ND(200)	ND(8.3)	ND(8)
2-Methylphenol	5000	50000	N/A	ND(120)	ND(310)	180	ND(6.2)	ND(6)
Acenaphthene	20	5000	50000	ND(100)	ND(260)	ND(120)	ND(5.2)	ND(5)
Bis(2-ethylhexyl)phthalate	6	30	100000	ND(200)	ND(520)	ND(250)	ND(10)	ND(10)
Fluorene	300	3000	30000	ND(100)	ND(260)	ND(120)	ND(5.2)	ND(5)
Naphthalene	20	6000	60000	2000	1600	1800	ND(5.2)	ND(5)
Phenol	4000	30000	100000	ND(140)	ND(360)	ND(180)	ND(7.3)	ND(7)
Metals (ug/l)								
Arsenic	50	400	4000	ND(10)	10	9	ND(10)	ND(5)
Barium	2000	30000	100000	40	50	40	20	10
Fluoride	N/A	N/A	N/A	--	--	--	--	--
Cyanide (ug/l)								
Cyanide, Total	10	10	N/A	16	14	24	90	99
Cyanide, Physiologically Available	N/A	N/A	2000	6	ND(5)	ND(5)	ND(5)	34

Notes:
1. ND (5): Compound not detected above detection limit; detection limit is shown in parentheses.
2. VOCs: Volatile Organic Compounds; SVOCs: Semivolatile Organic Compounds;
3. Table lists detected compounds only; compounds that were not detected are not listed.
4. Surrogates were not recovered for samples 02B-B922-OW and 02B-B923-OW collected on 27 July 2002, due to high concentrations of native compounds (i.e., naphthalene) in the samples.

TABLE IV
SUMMARY OF SUPPLEMENTAL GROUNDWATER SAMPLING RESULTS
129 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

WELL/LOCATION ID	METHOD 1	METHOD 1	METHOD 1	97B-B627-OW	97B-B627-OW	97B-B627-OW	97B-B628-OW	97B-B628-OW
SAMPLE ID	MCP	MCP	MCP	97B-B627-OW	97B-B627-OW	97B-B627-OW	97B-B628-OW	97B-B628-OW
SAMPLE DATE	GW-1	GW-2	UCL	3/12/2002	5/7/2002	8/1/2002	3/12/2002	5/7/2002
SAMPLING NOTES	(ug/l)	(ug/l)	(ug/l)					
SVOCs (ug/l)								
1-Methylnaphthalene	N/A	N/A	N/A	ND(5.1)	ND(5)	ND(5)	ND(52)	ND(100)
2-Methylnaphthalene	10	3000	100000	ND(8.2)	ND(8)	ND(8)	ND(82)	ND(160)
2-Methylphenol	5000	50000	N/A	ND(6.1)	ND(6)	ND(6)	ND(62)	ND(120)
Acenaphthene	20	5000	50000	ND(5.1)	ND(5)	ND(5)	ND(52)	ND(100)
Bis(2-ethylhexyl)phthalate	6	30	100000	ND(10)	ND(10)	ND(10)	ND(100)	ND(200)
Fluorene	300	3000	30000	ND(5.1)	ND(5)	ND(5)	ND(52)	ND(100)
Naphthalene	20	6000	60000	ND(5.1)	ND(5)	ND(5)	390	390
Phenol	4000	30000	100000	ND(7.1)	ND(7)	ND(7)	ND(72)	ND(140)
Metals (ug/l)								
Arsenic	50	400	4000	ND(10)	ND(5)	ND(5)	ND(10)	ND(5)
Barium	2000	30000	100000	120	100	140	20	30
Fluoride	N/A	N/A	N/A	ND(200)	ND(200)	- -	220	ND(200)
Cyanide (ug/l)								
Cyanide, Total	10	10	N/A	122	229	745	1210	1650
Cyanide, Physiologically Available	N/A	N/A	2000	15	80	57	358	383

Notes:

1. ND (5): Compound not detected above detection limit; detection limit is shown in parentheses.
2. VOCs: Volatile Organic Compounds; SVOCs: Semivolatile Organic Compounds;
3. Table lists detected compounds only; compounds that were not detected are not listed.
4. Surrogates were not recovered for samples 02B-B922-OW and 02B-B923-OW collected on 27 July 2002, due to high concentrations of native compounds (i.e., naphthalene) in the samples.

TABLE IV
SUMMARY OF SUPPLEMENTAL GROUNDWATER SAMPLING RESULTS
129 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

WELL/LOCATION ID	METHOD 1	METHOD 1	METHOD 1	97B-B628-OW	GP98-103-OW	GP98-103-OW	GP98-103-OW	MW-1
SAMPLE ID	MCP	MCP	MCP	97B-B628-OW	GP98-103-OW	GP98-103-OW	GP98-103-OW	MW-1
SAMPLE DATE	GW-1	GW-2	UCL	8/1/2002	3/12/2002	5/8/2002	8/2/2002	3/11/2002
SAMPLING NOTES	(ug/l)	(ug/l)	(ug/l)					
SVOCs (ug/l)								
1-Methylnaphthalene	N/A	N/A	N/A	ND(10)	ND(5)	ND(5)	ND(5)	ND(5.2)
2-Methylnaphthalene	10	3000	100000	ND(16)	ND(8)	ND(8)	ND(8)	ND(8.3)
2-Methylphenol	5000	50000	N/A	ND(12)	ND(6)	ND(6)	- -	ND(6.2)
Acenaphthene	20	5000	50000	ND(10)	ND(5)	ND(5)	ND(5)	ND(5.2)
Bis(2-ethylhexyl)phthalate	6	30	100000	ND(20)	ND(10)	ND(10)	- -	ND(10)
Fluorene	300	3000	30000	ND(10)	ND(5)	ND(5)	ND(5)	ND(5.2)
Naphthalene	20	6000	60000	ND(10)	ND(5)	ND(5)	ND(5)	5.4
Phenol	4000	30000	100000	ND(14)	ND(7)	ND(7)	- -	ND(7.3)
Metals (ug/l)								
Arsenic	50	400	4000	ND(5)	ND(10)	ND(5)	ND(5)	ND(10)
Barium	2000	30000	100000	40	20	20	30	30
Fluoride	N/A	N/A	N/A	- -	- -	- -	- -	- -
Cyanide (ug/l)								
Cyanide, Total	10	10	N/A	7000	ND(5)	ND(5)	5	16
Cyanide, Physiologically Available	N/A	N/A	2000	1020		ND(5)	ND(5)	ND(5)

Notes:
1. ND (5): Compound not detected above detection limit; detection limit is shown in parentheses.
2. VOCs: Volatile Organic Compounds; SVOCs: Semivolatile Organic Compounds;
3. Table lists detected compounds only; compounds that were not detected are not listed.
4. Surrogates were not recovered for samples 02B-B922-OW and 02B-B923-OW collected on 27 July 2002, due to high concentrations of native compounds (i.e., naphthalene) in the samples.

TABLE IV
SUMMARY OF SUPPLEMENTAL GROUNDWATER SAMPLING RESULTS
129 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

WELL/LOCATION ID	METHOD 1	METHOD 1	METHOD 1	MW-1	MW-1	MW-5	MW-5	NC-1	NC-1
SAMPLE ID	MCP	MCP	MCP	MW-1	MW-1	MW-5	MW-5	NC-1	NC-1
SAMPLE DATE	GW-1	GW-2	UCL	5/7/2002	7/31/2002	5/8/2002	7/31/2002	3/11/2002	5/7/2002
SAMPLING NOTES	(ug/l)	(ug/l)	(ug/l)						
VOCs (ug/l)									
1,2,4-Trimethylbenzene	10000	100000	N/A	ND(2.5)	ND(2.5)	ND(5)	ND(5)	ND(2.5)	ND(2.5)
1,3,5-Trimethylbenzene	100	1000	N/A	ND(2.5)	ND(2.5)	ND(5)	ND(5)	ND(2.5)	ND(2.5)
2-Chlorotoluene	N/A	N/A	N/A	ND(2.5)	ND(2.5)	ND(5)	ND(5)	ND(2.5)	ND(2.5)
4-Isopropyltoluene	1000	10000	N/A	ND(0.5)	ND(0.5)	ND(1)	ND(1)	ND(0.5)	ND(0.5)
Acetone	3000	50000	100000	ND(5)	ND(5)	ND(10)	ND(10)	ND(5)	ND(5)
Benzene	5	2000	70000	ND(0.5)	0.77	33	250	2.8	2.5
Chlorobenzene	100	500	10000	ND(0.5)	ND(0.5)	ND(1)	ND(1)	2.6	2.1
Chloroform	5	400	100000	ND(0.75)	ND(0.75)	ND(1.5)	ND(1.5)	ND(0.75)	ND(0.75)
cis-1,2-Dichloroethene	70	30000	100000	ND(0.5)	ND(0.5)	ND(1)	ND(1)	0.54	ND(0.5)
trans-1,2-Dichloroethene	100	20000	100000	ND(0.75)	ND(0.75)	ND(1.5)	ND(1.5)	ND(0.75)	ND(0.75)
trans-1,3-Dichloropropene	N/A	N/A	N/A	ND(0.5)	ND(0.5)	ND(1)	ND(1)	ND(0.5)	ND(0.5)
Ethylbenzene	700	4000	100000	ND(0.5)	ND(0.5)	45	180	ND(0.5)	ND(0.5)
Isopropylbenzene	10000	100000	N/A	ND(0.5)	ND(0.5)	ND(1)	20	32	36
2-Butanone	400	50000	100000	ND(5)	ND(5)	ND(10)	ND(10)	ND(5)	ND(5)
Naphthalene	20	6000	60000	ND(2.5)	ND(2.5)	ND(5)	9.3	ND(2.5)	ND(2.5)
n-Butylbenzene	N/A	N/A	N/A	ND(0.5)	ND(0.5)	ND(1)	ND(1)	9.5	8.7
n-Propylbenzene	1000	10000	N/A	ND(0.5)	ND(0.5)	ND(1)	7.9	33	46
m,p-Xylene	6000	6000	N/A	ND(0.5)	ND(0.5)	ND(1)	ND(1)	ND(0.5)	ND(0.5)
o-Xylene	6000	6000	N/A	ND(0.5)	ND(0.5)	ND(1)	7.2	1.8	0.82
sec-Butylbenzene	N/A	N/A	N/A	ND(0.5)	ND(0.5)	ND(1)	ND(1)	19	20
Styrene	100	900	100000	ND(0.5)	ND(0.5)	ND(1)	ND(1)	ND(0.5)	ND(0.5)
tert-Butylbenzene	1000	10000	N/A	ND(2.5)	ND(2.5)	ND(5)	ND(5)	9.1	9.6
Toluene	1000	6000	100000	ND(0.75)	ND(0.75)	ND(1.5)	ND(1.5)	ND(0.75)	ND(0.75)
Tetrachloroethene	5	3000	50000	ND(0.5)	ND(0.5)	ND(1)	ND(1)	ND(0.5)	ND(0.5)
Trichloroethene	5	300	100000	ND(0.5)	ND(0.5)	ND(1)	ND(1)	ND(0.5)	ND(0.5)

TABLE IV
SUMMARY OF SUPPLEMENTAL GROUNDWATER SAMPLING RESULTS
129 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

WELL/LOCATION ID	METHOD 1	METHOD 1	METHOD 1	MW-1	MW-1	MW-5	MW-5	NC-1	NC-1
SAMPLE ID	MCP	MCP	MCP	MW-1	MW-1	MW-5	MW-5	NC-1	NC-1
SAMPLE DATE	GW-1	GW-2	UCL	5/7/2002	7/31/2002	5/8/2002	7/31/2002	3/11/2002	5/7/2002
SAMPLING NOTES	(ug/l)	(ug/l)	(ug/l)						
SVOCs (ug/l)									
1-Methylnaphthalene	N/A	N/A	N/A	ND(5)	ND(5.3)	ND(5)	13	ND(26)	ND(5)
2-Methylnaphthalene	10	3000	100000	ND(8)	ND(8.5)	ND(8)	ND(8.3)	ND(41)	ND(8)
2-Methylphenol	5000	50000	N/A	ND(6)	- -	ND(6)	- -	ND(31)	ND(6)
Acenaphthene	20	5000	50000	ND(5)	ND(5.3)	ND(5)	ND(5.2)	ND(26)	ND(5)
Bis(2-ethylhexyl)phthalate	6	30	100000	ND(10)	- -	ND(10)	- -	ND(52)	10
Fluorene	300	3000	30000	ND(5)	ND(5.3)	ND(5)	ND(5.2)	ND(26)	ND(5)
Naphthalene	20	6000	60000	ND(5)	ND(5.3)	ND(5)	ND(5.2)	ND(26)	ND(5)
Phenol	4000	30000	100000	ND(7)	- -	ND(7)	- -	ND(36)	ND(7)
Metals (ug/l)									
Arsenic	50	400	4000	ND(5)	ND(5)	33	36	32	24
Barium	2000	30000	100000	30	30	60	70	110	100
Fluoride	N/A	N/A	N/A	- -	- -	- -	- -	- -	- -
Cyanide (ug/l)									
Cyanide, Total	10	10	N/A	19	32	53	90	17	35
Cyanide, Physiologically Available	N/A	N/A	2000	5	11	17	8	6	7

Notes:

1. ND (5): Compound not detected above detection limit; detection limit is shown in parentheses.
2. VOCs: Volatile Organic Compounds; SVOCs: Semivolatile Organic Compounds;
3. Table lists detected compounds only; compounds that were not detected are not listed.
4. Surrogates were not recovered for samples 02B-B922-OW and 02B-B923-OW collected on 27 July 2002, due to high concentrations of native compounds (i.e., naphthalene) in the samples.

TABLE IV
SUMMARY OF SUPPLEMENTAL GROUNDWATER SAMPLING RESULTS
129 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

WELL/LOCATION ID	METHOD 1	METHOD 1	METHOD 1	NC-1	NC-2	NC-2	NC-2	NC-3	NC-3
SAMPLE ID	MCP	MCP	MCP	NC-1	NC-2	NC-2	NC-2	BOZ-1 DUP	DUP-B
SAMPLE DATE	GW-1	GW-2	UCL	7/31/2002	3/11/2002	5/8/2002	8/2/2002	8/1/2002	5/7/2002
SAMPLING NOTES	(ug/l)	(ug/l)	(ug/l)						Dup. Of NC-3
VOCs (ug/l)									
1,2,4-Trimethylbenzene	10000	100000	N/A	ND(5)	ND(2.5)	ND(2.5)	ND(2.5)	ND(500)	ND(1000)
1,3,5-Trimethylbenzene	100	1000	N/A	ND(5)	ND(2.5)	ND(2.5)	ND(2.5)	ND(500)	ND(1000)
2-Chlorotoluene	N/A	N/A	N/A	29	ND(2.5)	ND(2.5)	ND(2.5)	ND(500)	ND(1000)
4-Isopropyltoluene	1000	10000	N/A	ND(1)	ND(0.5)	1	ND(0.5)	ND(100)	ND(200)
Acetone	3000	50000	100000	ND(10)	ND(5)	ND(5)	ND(5)	ND(1000)	ND(2000)
Benzene	5	2000	70000	3	26	27	160	11000	26000
Chlorobenzene	100	500	10000	3.3	ND(0.5)	ND(0.5)	ND(0.5)	ND(100)	ND(200)
Chloroform	5	400	100000	ND(1.5)	ND(0.75)	ND(0.75)	ND(0.75)	ND(150)	ND(300)
cis-1,2-Dichloroethene	70	30000	100000	1.6	ND(0.5)	ND(0.5)	ND(0.5)	ND(100)	ND(200)
trans-1,2-Dichloroethene	100	20000	100000	2.3	ND(0.75)	ND(0.75)	ND(0.75)	ND(150)	ND(300)
trans-1,3-Dichloropropene	N/A	N/A	N/A	ND(1)	ND(0.5)	ND(0.5)	ND(0.5)	ND(100)	ND(200)
Ethylbenzene	700	4000	100000	ND(1)	ND(0.5)	ND(0.5)	7.3	1200	2700
Isopropylbenzene	10000	100000	N/A	20	ND(0.5)	1.1	1.9	ND(100)	ND(200)
2-Butanone	400	50000	100000	ND(10)	ND(5)	ND(5)	ND(5)	ND(1000)	ND(2000)
Naphthalene	20	6000	60000	ND(5)	ND(2.5)	2.8	4.2	ND(500)	1300
n-Butylbenzene	N/A	N/A	N/A	10	ND(0.5)	ND(0.5)	ND(0.5)	ND(100)	ND(200)
n-Propylbenzene	1000	10000	N/A	31	ND(0.5)	ND(0.5)	0.54	ND(100)	ND(200)
m,p-Xylene	6000	6000	N/A	ND(1)	ND(0.5)	ND(0.5)	0.61	110	570
o-Xylene	6000	6000	N/A	ND(1)	ND(0.5)	ND(0.5)	0.68	ND(100)	270
sec-Butylbenzene	N/A	N/A	N/A	17	0.78	1.8	1.7	ND(100)	ND(200)
Styrene	100	900	100000	ND(1)	ND(0.5)	ND(0.5)	0.56	ND(100)	ND(200)
tert-Butylbenzene	1000	10000	N/A	8.6	ND(2.5)	ND(2.5)	ND(2.5)	ND(500)	ND(1000)
Toluene	1000	6000	100000	ND(1.5)	ND(0.75)	ND(0.75)	2.8	210	320
Tetrachloroethene	5	3000	50000	ND(1)	ND(0.5)	ND(0.5)	ND(0.5)	ND(100)	ND(200)
Trichloroethene	5	300	100000	ND(1)	ND(0.5)	ND(0.5)	ND(0.5)	ND(100)	ND(200)

TABLE IV
SUMMARY OF SUPPLEMENTAL GROUNDWATER SAMPLING RESULTS
129 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

WELL/LOCATION ID	METHOD 1	METHOD 1	METHOD 1	NC-1	NC-2	NC-2	NC-2	NC-3	NC-3
SAMPLE ID	MCP	MCP	MCP	NC-1	NC-2	NC-2	NC-2	BOZ-1 DUP	DUP-B
SAMPLE DATE	GW-1	GW-2	UCL	7/31/2002	3/11/2002	5/8/2002	8/2/2002	8/1/2002	5/7/2002
SAMPLING NOTES	(ug/l)	(ug/l)	(ug/l)						Dup. Of NC-3
SVOCs (ug/l)									
1-Methylnaphthalene	N/A	N/A	N/A	ND(5.1)	ND(5.2)	ND(5)	ND(5)	34	49
2-Methylnaphthalene	10	3000	100000	ND(8.2)	ND(8.2)	ND(8)	ND(8)	ND(16)	ND(40)
2-Methylphenol	5000	50000	N/A	- -	ND(6.2)	ND(6)	- -	ND(12)	ND(30)
Acenaphthene	20	5000	50000	ND(5.1)	ND(5.2)	ND(5)	ND(5)	ND(10)	ND(25)
Bis(2-ethylhexyl)phthalate	6	30	100000	- -	ND(10)	ND(10)	- -	ND(20)	ND(50)
Fluorene	300	3000	30000	ND(5.1)	ND(5.2)	ND(5)	ND(5)	ND(10)	ND(25)
Naphthalene	20	6000	60000	ND(5.1)	ND(5.2)	ND(5)	ND(5)	120	370
Phenol	4000	30000	100000	- -	ND(7.2)	ND(7)	- -	ND(14)	ND(35)
Metals (ug/l)									
Arsenic	50	400	4000	31	14	ND(10)	12	22	16
Barium	2000	30000	100000	80	20	20	20	110	110
Fluoride	N/A	N/A	N/A	- -	- -	- -	- -	- -	- -
Cyanide (ug/l)									
Cyanide, Total	10	10	N/A	18	28	25	26	164	217
Cyanide, Physiologically Available	N/A	N/A	2000	ND(5)	9	9	ND(5)	8	17

Notes:

1. ND (5): Compound not detected above detection limit; detection limit is shown in parentheses.
2. VOCs: Volatile Organic Compounds; SVOCs: Semivolatile Organic Compounds;
3. Table lists detected compounds only; compounds that were not detected are not listed.
4. Surrogates were not recovered for samples 02B-B922-OW and 02B-B923-OW collected on 27 July 2002, due to high concentrations of native compounds (i.e., naphthalene) in the samples.

TABLE IV
SUMMARY OF SUPPLEMENTAL GROUNDWATER SAMPLING RESULTS
129 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

WELL/LOCATION ID SAMPLE ID SAMPLE DATE SAMPLING NOTES	METHOD 1 MCP GW-1 (ug/l)	METHOD 1 MCP GW-2 (ug/l)	METHOD 1 MCP UCL (ug/l)	NC-3 NC-3 3/12/2002	NC-3 NC-3 5/7/2002	NC-3 NC-3 8/1/2002	NC-3 NC-DUP 3/12/2002 Dup. Of NC-3
VOCs (ug/l)							
1,2,4-Trimethylbenzene	10000	100000	N/A	ND(500)	ND(500)	ND(500)	ND(500)
1,3,5-Trimethylbenzene	100	1000	N/A	ND(500)	ND(500)	ND(500)	ND(500)
2-Chlorotoluene	N/A	N/A	N/A	ND(500)	ND(500)	ND(500)	ND(500)
4-Isopropyltoluene	1000	10000	N/A	ND(100)	ND(100)	ND(100)	ND(100)
Acetone	3000	50000	100000	ND(1000)	ND(1000)	ND(1000)	ND(1000)
Benzene	5	2000	70000	10000	20000	12000	10000
Chlorobenzene	100	500	10000	ND(100)	ND(100)	ND(100)	ND(100)
Chloroform	5	400	100000	ND(150)	ND(150)	ND(150)	ND(150)
cis-1,2-Dichloroethene	70	30000	100000	ND(100)	ND(100)	ND(100)	ND(100)
trans-1,2-Dichloroethene	100	20000	100000	ND(150)	ND(150)	ND(150)	ND(150)
trans-1,3-Dichloropropene	N/A	N/A	N/A	ND(100)	ND(100)	ND(100)	ND(100)
Ethylbenzene	700	4000	100000	1100	2200	1300	990
Isopropylbenzene	10000	100000	N/A	ND(100)	ND(100)	ND(100)	ND(100)
2-Butanone	400	50000	100000	ND(1000)	ND(1000)	ND(1000)	ND(1000)
Naphthalene	20	6000	60000	ND(500)	720	ND(500)	ND(500)
n-Butylbenzene	N/A	N/A	N/A	ND(100)	ND(100)	ND(100)	ND(100)
n-Propylbenzene	1000	10000	N/A	ND(100)	ND(100)	ND(100)	ND(100)
m,p-Xylene	6000	6000	N/A	ND(100)	420	190	ND(100)
o-Xylene	6000	6000	N/A	130	220	ND(100)	110
sec-Butylbenzene	N/A	N/A	N/A	ND(100)	ND(100)	ND(100)	ND(100)
Styrene	100	900	100000	ND(100)	ND(100)	ND(100)	ND(100)
tert-Butylbenzene	1000	10000	N/A	ND(500)	ND(500)	ND(500)	ND(500)
Toluene	1000	6000	100000	ND(150)	190	250	ND(150)
Tetrachloroethene	5	3000	50000	ND(100)	ND(100)	ND(100)	ND(100)
Trichloroethene	5	300	100000	ND(100)	ND(100)	ND(100)	ND(100)

TABLE IV
SUMMARY OF SUPPLEMENTAL GROUNDWATER SAMPLING RESULTS
129 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

WELL/LOCATION ID	METHOD 1	METHOD 1	METHOD 1	NC-3	NC-3	NC-3	NC-3
SAMPLE ID	MCP	MCP	MCP	NC-3	NC-3	NC-3	NC-DUP
SAMPLE DATE	GW-1	GW-2	UCL	3/12/2002	5/7/2002	8/1/2002	3/12/2002
SAMPLING NOTES	(ug/l)	(ug/l)	(ug/l)				Dup. Of NC-3
SVOCs (ug/l)							
1-Methylnaphthalene	N/A	N/A	N/A	ND(130)	43	25	ND(53)
2-Methylnaphthalene	10	3000	100000	ND(210)	ND(16)	ND(16)	ND(84)
2-Methylphenol	5000	50000	N/A	ND(160)	ND(12)	ND(12)	ND(63)
Acenaphthene	20	5000	50000	ND(130)	ND(10)	ND(10)	ND(53)
Bis(2-ethylhexyl)phthalate	6	30	100000	ND(260)	ND(20)	ND(20)	ND(100)
Fluorene	300	3000	30000	ND(130)	ND(10)	ND(10)	ND(53)
Naphthalene	20	6000	60000	180	270	72	280
Phenol	4000	30000	100000	ND(180)	ND(14)	ND(14)	ND(74)
Metals (ug/l)							
Arsenic	50	400	4000	29	23	22	30
Barium	2000	30000	100000	120	110	110	120
Fluoride	N/A	N/A	N/A	--	--	--	--
Cyanide (ug/l)							
Cyanide, Total	10	10	N/A	210	221	157	217
Cyanide, Physiologically Available	N/A	N/A	2000	23	47	10	22

Notes:
1. ND (5): Compound not detected above detection limit; detection limit is shown in parentheses.
2. VOCs: Volatile Organic Compounds; SVOCs: Semivolatile Organic Compounds;
3. Table lists detected compounds only; compounds that were not detected are not listed.
4. Surrogates were not recovered for samples 02B-B922-OW and 02B-B923-OW collected on 27 July 2002, due to high concentrations of native compounds (i.e., naphthalene) in the samples.

TABLE V
SUMMARY OF SUPPLEMENTAL INDOOR AIR QUALITY DATA - OCTOBER 2001 THROUGH JUNE 2002
129 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

	Quarterly Sampling Events						MADEP Indoor Air Background
	10/11/2001	**1/10/2002**	**4/10/2002**	**6/25/2002**	**10/8/2002**	**1/24/2003**	
VOCs (ppbV)							
Site 2							
Benzene	--	0.71	ND(0.31)	ND(0.31)	ND(0.71)	0.6	6.6
Toluene	--	1.4	1.1	2.5	1.2	1.1	7.6
Ethylbenzene	--	ND(0.23)	0.52	ND(0.23)	ND(0.53)	ND(0.35)	2.2
m-&p-xylenes	--	0.74	ND(0.23)	0.64	0.36	0.57	9
Styrene	--	ND(0.23)	ND(0.23)	ND(0.23)	ND(0.54)	ND(0.36)	-
o-xylenes	--	ND(0.23)	ND(0.23)	ND(0.23)	ND(0.53)	0.35	9
Naphthalene	--	ND(0.19)	ND(0.19)	ND(0.19)	ND(0.44)	ND(0.29)	1
Total Detected VOCs	--	2.85	1.62		1.6	2.6	
Site 4							
Benzene	ND(0.31)	ND(0.31)	ND(0.31)	0.44	ND(0.37)	ND(0.48)	6.6
Toluene	5.5	5.2	5.1	**9.2**	6.5	0.63	7.6
Ethylbenzene	0.44	ND(0.23)	ND(0.23)	0.71	ND(0.27)	ND(0.35)	2.2
m-&p-xylenes	1.3	1.0	0.56	2	0.59	ND(0.35)	9
Styrene	ND(0.23)	ND(0.23)	ND(0.23)	ND(0.23)	ND(0.27)	ND(0.36)	-
o-xylenes	0.45	ND(0.23)	ND(0.23)	0.51	ND(0.27)	ND(0.35)	9
Naphthalene	ND(0.19)	ND(0.19)	ND(0.19)	ND(0.19)	ND(0.22)	ND(0.29)	1
Total Detected VOCs	7.7	6.2	5.7		7.1	0.6	
Site 5							
Benzene	ND(0.63)	ND(0.63)	ND(0.31)	ND(0.31)	--	ND(0.4)	6.6
Toluene	4.6	5.1	3.8	**13**	--	0.77	7.6
Ethylbenzene	ND(0.46)	ND(0.46)	0.31	0.57	--	ND(0.29)	2.2
m-&p-xylenes	0.81	1.1	1.0	1.5	--	0.36	9
Styrene	ND(0.47)	ND(0.47)	ND(0.23)	ND(0.23)	--	ND(0.30)	-
o-xylenes	ND(0.46)	ND(0.46)	ND(0.23)	ND(0.23)	--	ND(0.29)	9
Naphthalene	ND(0.38)	ND(0.38)	ND(0.19)	ND(0.19)	--	ND(0.24)	1
Total Detected VOCs	5.4	6.2	5.1		--	1.1	
Site 6							
Benzene	3.4	**12**	ND(6.3)	1.9	ND(0.66)	ND(0.51)	6.6
Toluene	**8.3**	**10**	ND(5.3)	**11**	**12**	0.64	7.6
Ethylbenzene	ND(0.23)	ND(0.92)	ND(4.6)	ND(0.23)	ND(0.49)	ND(0.37)	2.2
m-&p-xylenes	0.64	ND(0.92)	ND(4.6)	0.6	0.49	0.53	9
Styrene	ND(0.23)	ND(0.94)	ND(4.7)	ND(0.23)	ND(0.50)	ND(0.38)	-
o-xylenes	ND(0.23)	ND(0.92)	ND(4.6)	ND(0.23)	ND(0.49)	ND(0.37)	9
Naphthalene	ND(0.19)	ND(0.76)	ND(3.8)	ND(0.19)	ND(0.40)	ND(0.31)	1
Total Detected VOCs	12.3	22.0	ND		12.5	1.2	

NOTES AND ABBREVIATIONS:

1. MADEP Background: Indoor air background levels obtained from Users Guide. Risk Assessment Shortform Residential Exposure Scenario. Version 1.6. October 1992. Policy #WSC/ORS-142-92. Adapted from Table 6-4, p. 33. Massachusetts Department of Environmental Protection. Office of Research and Standards and Bureau of Waste Site Cleanup. Boston, MA.
2. VOC (ppb): volatile organic compounds with values in parts per billion by volume; analyzed by EPA Method T014.
3. ND: compound not detected above quantitation limit, number in parentheses is the quantitation limit.
4. TR: compound detected below the quantitation limit, number in parentheses is the quantitaion limit;
5. Total Detected VOCs: Sum of detected concentrations of target analytes.
6. Bold values identify test results which exceed MADEP indoor air background levels.

TABLE V
SUMMARY OF SUPPLEMENTAL INDOOR AIR QUALITY DATA - OCTOBER 2001 THROUGH JUNE 2002
129 COMMERCIAL STREET
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

	Quarterly Sampling Events						MADEP Indoor Air Background
	10/11/2001	1/10/2002	4/10/2002	6/25/2002	10/8/2002	1/24/2003	
VOCs (ppbV)							
Site 7							
Benzene	3.6	**14**	1.4	1.8	ND(0.62)	ND(0.70)	6.6
Toluene	2.9	3.5	3.0	5	2.3	0.6	7.6
Ethylbenzene	ND(0.23)	ND(0.92)	ND(0.46)	ND(0.23)	ND(0.46)	ND(0.51)	2.2
m-&p-xylenes	0.58	ND(0.92)	ND(0.46)	0.68	ND(0.46)	ND(0.51)	9
Styrene	ND(0.23)	ND(0.94)	ND(0.47)	ND(0.23)	ND(0.47)	ND(0.52)	-
o-xylenes	ND(0.23)	ND(0.92)	ND(0.46)	ND(0.23)	ND(0.46)	ND(0.51)	9
Naphthalene	ND(0.19)	ND(0.76)	ND(0.38)	ND(0.19)	ND(0.38)	ND(0.42)	1
Total Detected VOCs	7.08	17.5	4.4		2.3	0.6	
Site 8							
Benzene	3.9	**15**	ND(6.3)	0.97	ND(0.62)	ND(0.57)	6.6
Toluene	2.1	2.8	ND(5.3)	2.3	1.8	ND(0.48)	7.6
Ethylbenzene	ND(0.46)	ND(1.8)	ND(4.6)	ND(0.46)	ND(0.46)	ND(0.42)	2.2
m-&p-xylenes	0.68	ND(1.8)	ND(4.6)	0.68	ND(0.46)	ND(0.42)	9
Styrene	ND(0.47)	ND(1.9)	ND(4.7)	ND(0.47)	ND(0.47)	ND(0.43)	-
o-xylenes	ND(0.46)	ND(1.8)	ND(4.6)	ND(0.46)	ND(0.46)	ND(0.42)	9
Naphthalene	ND(0.38)	ND(1.5)	ND(3.8)	ND(0.38)	ND(0.38)	ND(0.35)	1
Total Detected VOCs	6.68	17.8	ND		1.8	ND	
Site 10							
Benzene	2.4	**10**	ND(6.3)	1.7	0.6	ND(0.55)	6.6
Toluene	2.2	2.9	ND(5.3)	2.2	2.5	0.54	7.6
Ethylbenzene	0.74	ND(1.8)	ND(4.6)	0.71	0.82	ND(0.40)	2.2
m-&p-xylenes	1.2	ND(1.8)	ND(4.6)	1.3	1.4	0.58	9
Styrene	3.7	2.1	ND(4.7)	4.7	5.5	1	-
o-xylenes	0.51	ND(1.8)	ND(4.6)	0.51	0.57	ND(0.90)	9
Naphthalene	ND(0.19)	ND(1.5)	ND(3.8)	ND(0.19)	ND(0.32)	ND(0.33)	1
Total Detected VOCs	10.75	15	ND		11.4	2.1	

NOTES AND ABBREVIATIONS:

1. MADEP Background: Indoor air background levels obtained from Users Guide. Risk Assessment Shortform Residential Exposure Scenario. Version 1.6. October 1992. Policy #WSC/ORS-142-92. Adapted from Table 6-4, p. 33. Massachusetts Department of Environmental Protection, Office of Research and Standards and Bureau of Waste Site Cleanup. Boston, MA.
2. VOC (ppb): volatile organic compounds with values in parts per billion by volume; analyzed by EPA Method T014.
3. ND: compound not detected above quantitation limit, number in parentheses is the quantitation limit.
4. TR: compound detected below the quantitation limit, number in parentheses is the quantitaion limit;
5. Total Detected VOCs: Sum of detected concentrations of target analytes.
6. Bold values identify test results which exceed MADEP indoor air background levels.

TABLE XI
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES
AREA 1: NORTHERN PORTION OF 100 COMMERCIAL STREET PROPERTY
PHASE III REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

Target Media	Technology Type	Process Option Description	Feasibility of Achieving a Permanent or Temporary Solution, Availability of Expertise, and Other Comments	Initial Screening Outcome
DNAPL (Shallow)	Extraction	**DNAPL Extraction using Recovery Wells:** Installation of large-diameter DNAPL extraction wells, equipped with a submersible pump to extract DNAPL from the subsurface. Extracted DNAPL stored in tanks inside small buildings on the property and transported off-site for disposal.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Technology is applicable to both shallow and deep DNAPL, and is reasonably likely to be feasible based on existing DNAPL extraction well that has been operating successfully on the southern portion of Parcel E (Area 2).	**Retain**
DNAPL (Shallow)	Extraction/ Migration control	**DNAPL Extraction/Migration Control using Trenches:** Excavation of trenches that are keyed into the low-permeability organic deposit, and backfilled with gravel for collection of DNAPL. One or more recovery wells equipped with a submersible pump for extraction of DNAPL would be installed in the trench.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Would likely be significantly more difficult than extraction wells to install, due to subsurface obstructions, odors, space for excavation, and disposal of excavated soil material.	**Retain**
DNAPL (Shallow)	Migration control	**Vertical Subsurface Barrier:** Install barrier to DNAPL flow. May be slurry wall, sheet piling, or Waterloo™ barrier, dependent upon Phase IV design.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Would likely be required in the event that DNAPL is removed from Area 1, and potential remains for DNAPL migration from an adjacent impacted area. May be difficulties in installing due to the presence of subsurface utilities.	**Retain**
Shallow DNAPL/ LNAPL	Disposal/ Incineration	**Disposal or Incineration:** Off-site transport of extracted NAPL for incineration or disposal.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Would be required in the event that DNAPL or LNAPL are removed from the subsurface.	**Retain**
LNAPL	Extraction	**Multi-phase extraction:** Extraction of groundwater, soil vapor and LNAPL through the application of a vacuum to specially designed extraction wells. Requires separation of LNAPL from groundwater and ex-situ treatment of both soil vapor and groundwater.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Would likely be a more rapid method of LNAPL extraction than passive methods or belt-skimmers. However, LNAPL has not been observed in recent monitoring; therefore the need for an LNAPL extraction system is not currently justified.	**Eliminate**
LNAPL	Extraction	**Belt-skimmer:** Extraction of LNAPL using belt-skimmers, consisting of two pulleys that drive a hydrophobic belt through the water table in a monitoring well, bring LNAPL oil to the surface, and skim the oil into a collection container. System is driven by electric motor.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Appropriate for LNAPL removal in areas of potential public access, on which gradual LNAPL removal is consistent with remedial objectives. However, LNAPL has not been observed in recent monitoring; therefore the need for an LNAPL extraction system is not currently justified.	**Eliminate**
LNAPL	Extraction	**Passive LNAPL extraction methods:** LNAPL extraction methods that rely on siphons, absorbent pads, or other passive methods for LNAPL collection.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Passive LNAPL removal (absorbent pads, siphons without a pump) has been attempted on the Site, however the rate of LNAPL recovery was too gradual to meet remedial goals. LNAPL has not been observed in recent monitoring; therefore the need for an LNAPL extraction system is not currently justified.	**Eliminate**

TABLE XI
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES
AREA 1: NORTHERN PORTION OF 100 COMMERCIAL STREET PROPERTY
PHASE III REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

Target Media	Technology Type	Process Option Description	Feasibility of Achieving a Permanent or Temporary Solution, Availability of Expertise, and Other Comments	Initial Screening Outcome
Shallow and Deep DNAPL/ LNAPL	Monitoring	**DNAPL or LNAPL Monitoring:** Conduct semi-annual monitoring of NAPL thickness in monitoring wells using oil/water interface probes. Place monitoring wells strategically to detect off-site migration.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: NAPL monitoring may be an applicable component for a Temporary or Permanent Solution, if recoverable LNAPL or deep DNAPL are not present.	**Retain**
Soil/TSM	No Action	**Natural Attenuation:** Allow natural processes such as biodegradation and volatilization to reduce concentrations or toxicity of contaminants	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: This approach is not applicable for remediation of soil containing high PAH concentrations or TSM.	**Eliminate**
Soil/TSM	Physical removal	**Excavation and off-site treatment:** Excavate contaminated soil and DNAPL/LNAPL, where present, and transport off-site for treatment.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Excavation of TSM would likely be difficult due to the generation of odors, support of excavations and buildings, disposal of excavated soil, etc.	**Retain**
Soil/TSM	Capping	**Installation of Engineered Barrier:** RCRA-type engineered barrier consistent with 310 CMR 40. Excavate 3 feet of soil, install barrier, backfill soil and re-vegetate on top of barrier.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Installation of an engineered barrier may limit future development options for the Area.	**Retain**
Soil/TSM	Capping	**Installation/maintenance of a direct contact barrier:** Prevent potential exposure to shallow soils by maintaining 3 feet of clean soil or asphalt cover.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Maintenance of a direct contact barrier would likely be required as part of an AUL to restrict potential exposure to contaminated soils.	**Retain**
Soil/TSM	*Ex-situ* treatment	**Incineration:** Treat excavated material off-site using incineration.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Would be appropriate for treatment of extracted LNAPL and DNAPL, or soils that are not suitable for thermal desorption treatment.	**Retain**
Soil/TSM	*Ex-situ* treatment	**Thermal desorption:** Treat excavated soil material using thermal desorption with an afterburner. May be performed on-site using a mobile thermal desorption unit, or material may be sent off-site for treatment.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: On-site thermal desorption unlikely to be reasonably feasible due to limited available space, odors, and air emissions. Off-site thermal desorption is reasonably feasible.	**Retain**
Soil/TSM	*Ex-situ* treatment	**Soil washing:** Separate silt and clay fraction from sand fraction, and desorb contaminants into the aqueous phase.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: This technology is unlikely to be effective at this site; TSM is unlikely to be removed from soil through washing.	**Eliminate**
Soil/TSM	*Ex-situ* treatment	**Stabilization:** Reduce leachability of organic contaminants through physical encapsulation and/or cement stabilization. Treated soil may be re-used as backfill on the site or sent to appropriate receiving facilities for disposal.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Not reasonably feasible due to the anticipated volume of soil to be treated and the limited space available on the Area.	**Eliminate**

TABLE XI
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES
AREA 1: NORTHERN PORTION OF 100 COMMERCIAL STREET PROPERTY
PHASE III REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

Target Media	Technology Type	Process Option Description	Feasibility of Achieving a Permanent or Temporary Solution, Availability of Expertise, and Other Comments	Initial Screening Outcome
Soil/TSM	*Ex-situ* treatment	**Asphalt batching:** Treat excavated soil by mixing with asphalt emulsion to create asphaltic roadbase material. Process may be conducted on- or off-site, and asphalt product may be re-used on-site or off-site.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: May be appropriate treatment method for some impacted soil. However, this process is generally not considered feasible for MGP waste, as it is not compatible with hazardous wastes or soil containing free product or cyanide. TCLP analyses on selected TSM samples have failed TCLP due to elevated benzene concentrations.	**Eliminate**
Soil/TSM	*Ex-situ* treatment	**Landfarming:** Excavated material is spread on the ground surface and is periodically tilled and aerated to promote biological removal of organic contaminants.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Not feasible due to urban setting of the site.	**Eliminate**
Soil/TSM	*Ex-situ* treatment	**Bioslurry Reactors:** Excavated soil material is slurried with water and nutrients and is placed in a stirred, aerated reactor to promote biodegradation of organic contaminants.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: High concentrations of contaminants limit the feasibility of this technology.	**Eliminate**
Soil/TSM	*Ex-situ* treatment	**MGP-REM Process:** Chemically treat recalcitrant organics with Fenton's reagent (ferrous iron and hydrogen peroxide) to chemically oxidize and biodegrade organic contaminants. May be conducted as either a landfarming or bioreactor process.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: This treatment method is not feasible for Area 1 due to the relatively small area available for treatment and the potential for emissions that may impact the public.	**Eliminate**
Soil/TSM	*In-situ* treatment	***In-situ* thermal desorption:** Application of heat and vacuum to *in-situ* soil to volatilize, destroy and extract organic contaminants.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: This technology is not feasible due to the presence of subsurface utilities and the urban setting of the Site. Additionally, the application of this technology in the presence of DNAPL is unreliable.	**Eliminate**
Soil/TSM	*In-situ* treatment	***In-situ* stabilization:** Mix soil *in-situ* with stabilizing agents using large-diameter hollow-stem auger drilling .	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: This technology is not feasible on the scale required at the Site, and subsurface obstructions on Area 1 also limit the feasibility of this technology.	**Eliminate**
Soil/TSM	*In-situ* treatment	**Bioventing** (unsaturated zone soils): Inject air into vadose zone soils to stimulate aerobic degradation of organic contaminants.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: This technology is not feasible for high concentrations of PAH contamination.	**Eliminate**
Soil/TSM	*In-situ* treatment	***In-situ* chemical oxidation:** Injection of hydrogen peroxide mixture into in-situ soil using geoprobe equipment or wells to chemically break down organic contaminants to innocuous compounds.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Feasible remedial technology for MGP and petroleum-impacted soil. In-situ treatment method may be preferable due to the public location of Area 1. Injection of chemical oxidant into the soil beneath asphalt parking areas and buildings may generate excessive heat and vapors - ventilation may be required.	**Retain**
Soil/TSM	Restrictions	**Activity and Use Limitations (AULs):** Place restrictions on future property use to prevent exposure through pathways for which a condition of No Significant Risk could not be established.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Would likely be implemented to prevent potential future exposures to contaminated soil and indoor air.	**Retain**

TABLE XI
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES
AREA 1: NORTHERN PORTION OF 100 COMMERCIAL STREET PROPERTY
PHASE III REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

Target Media	Technology Type	Process Option Description	Feasibility of Achieving a Permanent or Temporary Solution, Availability of Expertise, and Other Comments	Initial Screening Outcome
Soil/TSM	Restrictions	**Fencing**: Limit site access using fencing.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Although Area 1 is located in a relatively public commercial area, public access to the 100 Commercial Street property is currently limited with a fence surrounding a portion of the property. Additional restrictions to public access are not reasonably feasible.	**Eliminate**
Soil/TSM	Disposal	**Off-site Disposal:** Dispose non-hazardous soils off-site in a landfill.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: This option is considered less favorable than thermal treatment options, which treat contaminated soil prior to disposal. Because off-site thermal desorption treatment is retained, off-site disposal is not necessary to achieve a Temporary or Permanent Solution.	**Eliminate**

TABLE XIII
DETAILED EVALUATION OF REMEDIAL ACTION ALTERNATIVES
AREA 1 - NORTHERN PORTION OF PARCEL E
PHASE III REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

REMEDIAL ACTION ALTERNATIVE	DESCRIPTION OF REMEDIAL ACTION ALTERNATIVE	EFFECTIVENESS	RELIABILITY (SHORT-TERM/LONG-TERM)	IMPLEMENTABILITY	COST (NPV)	RISKS	BENEFITS	TIMELINESS	EFFECT ON NON-PECUNIARY INTERESTS
Alternative 1-1: - Excavation of DNAPL, LNAPL, TSM and petroleum-impacted soil - Deep DNAPL monitoring - Shallow DNAPL migration control - AUL	Excavation of impacted soil to remove shallow DNAPL, LNAPL, TSM, and petroleum impacts. Transport contaminated soil off-site for thermal desorption treatment, and backfill with acceptable excavated soil or imported clean soil. Monitor LNAPL and deep DNAPL, control shallow DNAPL migration onto the Area from adjacent Areas if necessary with a vertical subsurface barrier (i.e., sheet piling or Waterloo Barrier) located on Area 1.	**High**. Excavation of soil is likely to be an effective method for removal of the sources of LNAPL, DNAPL and contaminated soil. Likely to achieve a Permanent Solution for the Area.	**Short term: High,** excavation of contaminated soil has a high probability of removing impacted soil and shallow DNAPL. **Long-term: High,** likely to be reliable over the long term due to source removal. Vertical barriers to DNAPL migration onto the Area will prevent future re-contamination of soil.	**Difficult.** - Large excavation area (approximately 5100 sy; 20,250 cu yd) - High degree of disruption to Malden Center Area (construction noise, potential odors, truck traffic) - Limited access to property during remediation - Level B respiratory protection may be required for workers - Construction of a temporary enclosure to prevent escape of odors would be required - Excavation of soil from beneath the maintenance garage would require demolition of the building. - Dewatering of the excavation and water treatment would be required	Selected Components: TSM Excavation: $1.3M Excavation of petroleum-impacted soil: $2.6M Shallow DNAPL migration control: $50K Engineering/Design: $260K **NPV: $4.9M**	**High.** Risks to workers and passersby due to inhalation of vapors during excavation; would require using an enclosure during excavation, and Level B protection measures (i.e., supplied air) for workers.	Achieves a likely Permanent Solution in relatively brief time frame.	**Relatively Timely.** Design and implementation expected to require approximately 1 to 3 years.	**High.** Use of the property would be very limited during excavation. Disruption to the Malden Center area would be significant; an estimated total of 1,300 trucks would pass through the city transporting contaminated soil off-site for treatment and importing clean soil for backfill. High potential for nuisance odors in public areas due to vapors emanating from the excavation site and from trucks transporting contaminated soil.
Alternative 1-2: - Excavation of shallow DNAPL, LNAPL and TSM soil - In-situ chemical oxidation of petroleum-impacted soil - Deep DNAPL monitoring - Shallow DNAPL migration control - AUL	Excavation to remove shallow DNAPL, LNAPL, and TSM contamination. Transport contaminated soil material off-site for thermal desorption treatment, and backfill excavation with acceptable excavated soil or imported clean soil. Monitor LNAPL and deep DNAPL, inject chemical oxidant into petroleum-impacted soils to promote in-situ remediation of petroleum-impacted soils (Assume 3 injections required). Control shallow DNAPL migration (if necessary) onto the Area with a subsurface barrier located on Area 1. An AUL involving the maintenance of a direct contact barrier (i.e., pavement) may be used to restrict future exposure to contaminated soils.	**High**. Excavation of soil is likely to be an effective method for removal of the sources of LNAPL, DNAPL and contaminated soil. Chemical oxidation has been successfully at other sites for in-situ reduction of concentrations of petroleum constituents in soil. Likely to achieve a Permanent Solution for the Area. AULs have been used at other sites as an effective method for limiting exposure to contaminated soil remaining in place.	**Short term: High,** both excavation and in-situ chemical oxidation have been used effectively at other MGP and petroleum contamination sites to remediate soil. **Long term: High,** due to removal of DNAPL source material, and use of an accepted method of in-situ treatment. Vertical barriers to the flow of DNAPL onto the Area will prevent future re-contamination of soil.	**Difficult.** - Moderate excavation size (approximately 1900 sy, 7450 cu. yd) - Highly disruptive to Malden Center area (construction noise, potential odors, truck traffic) - Use of the property would be limited during excavation. - Level B respiratory protection may be required for workers - Would require an enclosure - Would require dewatering of excavation and water treatment - Injection of chemical oxidant would be readily implementable, although injection beneath the maintenance garage may be difficult.	Selected Components: TSM Excavation: $1.3M In-situ chemical oxidation of petroleum-impacted soil: $320K Shallow DNAPL migration control: $50K Engineering/Design: $160K **NPV: $2.3M**	**High.** Risks to workers and passersby due to inhalation of vapors during excavation; would require using an enclosure during excavation, and Level B protection measures (i.e., supplied air) for workers; risks to workers handling oxidant during excavation, risk to subsurface structures (e.g., maintenance garage foundation) due to vapor buildup during oxidant injection.	Achieves a likely Permanent Solution in a relatively brief time frame. Chemical oxidant injection in the petroleum contaminated area is less intrusive than excavation. May result in Permanent Solution if contaminant concentrations are reduced to less than UCLs.	**Relatively Timely.** Excavation and 3 injections of chemical oxidants expected to require less than 4 years.	**High.** Use of the property would be very limited during excavation. Disruption to the Malden Center area would be significant; an estimated total of 300 trucks would pass through the city transporting contaminated soil off-site for treatment and importing clean soil for backfill. High potential for nuisance odors in public areas due to vapors emanating from the excavation site and from trucks transporting contaminated soil.

TABLE XIII
DETAILED EVALUATION OF REMEDIAL ACTION ALTERNATIVES
AREA 1 - NORTHERN PORTION OF PARCEL E
PHASE III REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

REMEDIAL ACTION ALTERNATIVE	DESCRIPTION OF REMEDIAL ACTION ALTERNATIVE	EFFECTIVENESS	RELIABILITY (SHORT-TERM/LONG-TERM)	IMPLEMENTABILITY	COST (NPV)	RISKS	BENEFITS	TIMELINESS	EFFECT ON NON-PECUNIARY INTERESTS
Alternative 1-3: - Installation of an Engineered Barrier - Shallow DNAPL recovery wells - LNAPL and deep DNAPL monitoring - Provisional shallow DNAPL migration control - AUL	Excavation of shallow surface soil, and construction of Engineered Barrier over TSM and petroleum-impacted soil. Installation of 5 shallow DNAPL recovery wells, monitoring of LNAPL and deep DNAPL and, if necessary, a vertical subsurface barrier located on Area 1 to prevent DNAPL migration onto the property. A DNAPL storage building would be required on the property to house DNAPL storage. An AUL involving the maintenance of the engineered barrier may be used to restrict future exposure to contaminated soils.	**Moderate**. Engineered Barrier eliminates potential for exposure to contaminated soils. DNAPL recovery wells are likely to be effective for DNAPL extraction. Would achieve a Temporary Solution in the near term, and would eventually result in a Permanent Solution, once DNAPL removal is complete. AULs have been used at other sites as an effective method for limiting exposure to contaminated soil remaining in place.	**Short term: Moderate.** Engineered Barrier eliminates potential soil exposure pathways, but does not eliminate NAPL-related UCLs. DNAPL recovery wells provide reliable but slow DNAPL recovery; A DNAPL extraction well has functioned reliably on Area 2 since October 2001. **Long term: Moderate,** Would likely result in a Permanent Solution over the longer term (estimated 7 years), once DNAPL remedial goals have bet met. Vertical barriers to the flow of DNAPL onto the Area will prevent future re-contamination of soil.	**Moderately Difficult.** Installation of an Engineered Barrier requires excavation to a depth of 3 feet over a large portion of the property, which would be highly disruptive. Installation would likely require several months to complete, during which time use of the property would be severely limited. Would also likely require clean corridors for utility access, and may involve re-installation of utility lines across the property.	Selected Components: Engineered Barrier Installation: $1.1M Shallow DNAPL Recovery System Installation: $100K Shallow DNAPL migration control: $50K Engineering/Design: $220K O & M: $180K **NPV: $2.1M**	**Low.** Contaminants (TSM, DNAPL, LNAPL) are located deeper than 3 feet, therefore contact with highly contaminated material during construction is anticipated to be low. Risks associated with installation of extraction wells anticipated to be low.	May result in a Permanent Solution once DNAPL removal is complete, although this is estimated to require approximately 7 years. Does not involve excavation of highly contaminated soil and therefore is less disruptive than Alternatives 1-1 and 1-2. An AUL would be used to ensure that the barrier is maintained.	**Requires Long-term Implementation.** Estimated time for completion is approximately 6 to 9 years.	**Moderate.** Installation of the Engineered Barrier on the property would require several months to complete; site use would be severely limited during this time. Much less impact on the surrounding area than in alternatives 1-1 and 1-2; less excavation of heavily impacted material, less nuisance odor, less truck traffic. Options for future development are limited once the barrier is installed.
Alternative 1-4: - Shallow DNAPL recovery wells - Monitoring of LNAPL and deep DNAPL - Provisional Shallow DNAPL migration control - In-situ chemical oxidation of TSM and petroleum – impacted soil - AUL	This alternative involves the installation of 5 shallow DNAPL extraction wells, construction of a DNAPL storage building and monitoring of LNAPL and deep DNAPL. When appropriate (i.e., TSM soil is accessible and/or DNAPL has been reduced to less than 1/2 inch in wells) in-situ chemical oxidation would be conducted in areas of contaminated soil. If necessary, DNAPL migration onto the property would be prevented using a subsurface barrier located on Area 1. An AUL involving the maintenance of a direct contact barrier (i.e., pavement) may be used to restrict future exposure to contaminated soils.	**Moderate.** May eventually achieve Permanent Solution. DNAPL recovery has been demonstrated to be effective at one location on Area 2, and chemical oxidation has been used effectively at other MGP and petroleum contamination sites to reduce concentrations of VOCs and PAHs in soil. Chemical oxidation would not be effective in TSM areas until the quantity of DNAPL has been reduced. AULs have been used at other sites as an effective method for limiting exposure to contaminated soil remaining in place.	**Short term: Moderate,** DNAPL extraction well has functioned reliably on Area 2 since October 2001. Extraction system will require maintenance to continue to operate. Unlikely to accomplish remedial goals in short term. **Long-term: Moderate,** DNAPL extraction system will require long term maintenance and replacement of parts to continue to operate.	**Readily Implementable.** This alternative requires relatively little intrusion into current facility operations. If required, injection of chemical oxidants beneath the maintenance garage may require either injection through the garage floor slab, or demolition of the garage structure.	Selected Components: Shallow DNAPL Recovery System Installation: $100K Chemical Oxidation of Soil: $430K Shallow DNAPL migration control: $50K Engineering/Design: $160K O & M: $180K **NPV: $1.1M**	**Moderate.** Relatively little risk associated with the installation of extraction wells. Risks to workers during injection of oxidants for chemical oxidation. Some risk of damage to the WEB Culvert, the maintenance garage foundation, and subsurface utilities during injection of chemical oxidants due to potential for heat and vapor buildup during injection.	This alternative is relatively unobtrusive (to facility operations and to the surrounding Malden Center area) and requires little interruption of facility operations to install and maintain. An AUL would limit the potential for exposure to contaminated soils.	**Requires Long-term Implementation.** Accomplishment of remedial goals with respect to DNAPL thickness is likely to require approximately 5 to 7 years using extraction wells in this Area. In-situ chemical oxidation of soils would require an additional 1 to 2 years to implement. Therefore, the estimated time to attain the remedial goals is 6 to 9 years.	**Low.** Would require relatively little intrusion to facility operations to install and maintain. Does require a DNAPL storage shed for storage of extracted DNAPL. Also relatively little disturbance to surrounding community of Malden under this alternative.

TABLE XIII
DETAILED EVALUATION OF REMEDIAL ACTION ALTERNATIVES
AREA 1 - NORTHERN PORTION OF PARCEL E
PHASE III REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

REMEDIAL ACTION ALTERNATIVE	DESCRIPTION OF REMEDIAL ACTION ALTERNATIVE	EFFECTIVENESS	RELIABILITY (SHORT-TERM/LONG-TERM)	IMPLEMENTABILITY	COST (NPV)	RISKS	BENEFITS	TIMELINESS	EFFECT ON NON-PECUNIARY INTERESTS
Alternative 1-5: - Shallow DNAPL recovery - LNAPL and deep DNAPL monitoring - Provisional Shallow DNAPL migration control - AUL	This Alternative is less intrusive than Alternatives 1-1 through 1-4. It involves the installation of 5 shallow DNAPL recovery wells, LNAPL and deep DNAPL monitoring, and would require the construction of a small shed to store extracted DNAPL. If necessary, migration of DNAPL onto the property could be prevented through the installation of a subsurface barrier on Area 1. An AUL involving the maintenance of a direct contact barrier (i.e., pavement) may be used to restrict future exposure to contaminated soils.	**Low.** Would result in reduction of NAPL thickness over approximately 7 years. However, would not result in a Permanent Solution because soil containing concentrations of contaminants greater than the UCLs would remain. Would achieve a Temporary Solution in the short term. AULs have been used at other sites as an effective method for limiting exposure to contaminated soil remaining in place.	**Short term: Moderate,** DNAPL extraction well has functioned reliably on Area 2 since October 2001. Extraction system will require maintenance to continue to operate. Unlikely to accomplish remedial goals in short term. **Long-term: Low,** Extraction system will require long-term maintenance and replacement of parts to continue to operate. Likely to accomplish remedial goals with respect to reduction in NAPL thickness; however this alternative will not reduce contaminant concentrations in soil.	**Readily Implementable.** This alternative requires the least intrusion into facility operations to implement among alternatives 1-1 through 1-4.	Selected Components: Shallow DNAPL Recovery System Installation: $100K Shallow DNAPL migration control: $50K Engineering/Design: $90K O & M: $130K **NPV: $540K**	**Low.** Few risks associated with this alternative. Some level of risk associated with handling of extracted DNAPL.	Requires little interruption of facility operations, and accomplishes removal of DNAPL source material from the subsurface. Removes UCLs due to presence of NAPL over the long term. An AUL would limit the potential for exposure to contaminated soils.	**Requires Long-term Implementation.** Expected to require approximately 5 to 7 years to accomplish DNAPL reduction remedial goals. Not expected to reduce soil contaminant concentrations to less than UCLs.	**Low.** This alternative results in little disruption to facility operations. Minimal impacts include the need for a DNAPL storage shed on the property, and maintenance work on the DNAPL extraction wells and pumps on the property. As with Alternative 1-4, this alternative results in minimal disruption to the surrounding neighborhood.
Alternative 1-6: - LNAPL and deep DNAPL monitoring - AUL	This alternative involves continued monitoring of subsurface conditions to ensure that DNAPL located in the subsurface on Area 1 does not migrate off-site. An AUL involving the maintenance of a direct contact barrier (i.e., pavement) may be used to restrict future exposure to contaminated soils.	**Low.** Would not result in reduction of NAPL thickness or reduction in contaminant concentrations in soil. Therefore would not result in a Permanent Solution. Would achieve a Temporary Solution in the short term. AULs have been used at other sites as an effective method for limiting exposure to contaminated soil remaining in place.	**Not Applicable:** No remedy is installed under this alternative.	**Readily Implementable.** This alternative requires the least intrusion into facility operations to implement.	**NPV: $110K**	**Low.** Few risks associated with this alternative.	Requires little interruption of facility operations.	**Requires Long-term Implementation.** Monitoring would continue for the foreseeable future until a Permanent Solution can be implemented.	**Low.** This alternative results in little disruption to facility operations. As with Alternatives 1-4 and 1-5, this alternative results in minimal disruption to the surrounding neighborhood.

Notes:
1. Cost estimates include contractor mobilizations, contingencies and other additional components in addition to selected components listed; Refer to Cost Estimate Tables in Appendix D for detailed breakdown of cost components.
2. Cost estimates represent an opinion of probable cost for comparison purposes.

TABLE XIV
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES
AREA 2: SOUTHERN PORTION OF 100 COMMERCIAL STREET PROPERTY
PHASE III REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

Target Media	Technology Type	Process Option Description	Feasibility of Achieving a Permanent or Temporary Solution, Availability of Expertise, and Other Comments	Initial Screening Outcome
DNAPL (Shallow and Deep)	Extraction	**DNAPL Extraction using Recovery Wells:** Installation of large-diameter DNAPL extraction wells, equipped with a submersible pump to extract DNAPL from the subsurface. Extracted DNAPL stored in tanks inside small buildings on the property and transported off-site for disposal.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Technology is applicable to both shallow and deep DNAPL. Reasonably likely to be feasible based on an existing DNAPL extraction well that has been operating successfully on the southern portion of Parcel E (Area 2).	**Retain**
DNAPL	Extraction/ Migration control	**DNAPL Extraction/Migration Control using Trenches:** Excavation of trenches that are keyed into the low-permeability organic deposit, and backfilled with gravel for collection of DNAPL. One or more recovery wells equipped with a submersible pump for extraction of DNAPL would be installed in the trench.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Would likely be significantly more difficult than extraction wells to install, due to subsurface obstructions, odors, space for excavation, and disposal of excavated soil material.	**Retain**
DNAPL	Migration control	**Vertical Subsurface Barrier:** Install barrier to DNAPL flow. May be slurry wall, sheet piling, or Waterloo™ barrier, dependent upon Phase IV design. Would also involve injection of grout through the base of the WEB Culvert to prevent DNAPL migration beneath the culvert.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Would likely be required in the event that DNAPL is removed from Area 2 and potential remains for DNAPL migration from an adjacent area.	**Retain**
Shallow & Deep DNAPL/ LNAPL	Disposal/ Incineration	**Disposal or Incineration:** Off-site transport of extracted NAPL for incineration or disposal.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Would be required in the event that DNAPL or LNAPL are removed from the subsurface.	**Retain**
LNAPL	Extraction	**Multi-phase extraction:** Extraction of groundwater, soil vapor and LNAPL through the application of a vacuum to specially designed extraction wells. Requires separation of LNAPL from groundwater and ex-situ treatment of both soil vapor and groundwater.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Appropriate for LNAPL removal, and removal of volatile compounds (such as BTEX) from groundwater.	**Retain**
LNAPL	Extraction	**Belt-skimmer:** Extraction of LNAPL using belt-skimmers, consisting of two pulleys that drive a hydrophobic belt through the water table in a monitoring well, bring LNAPL oil to the surface, and skim the oil into a collection container. System is driven by an electric motor.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Appropriate for LNAPL removal in areas of high public access, on which gradual LNAPL is consistent with remedial goals	**Retain**

TABLE XIV
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES
AREA 2: SOUTHERN PORTION OF 100 COMMERCIAL STREET PROPERTY
PHASE III REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

Target Media	Technology Type	Process Option Description	Feasibility of Achieving a Permanent or Temporary Solution, Availability of Expertise, and Other Comments	Initial Screening Outcome
LNAPL	Extraction	**Passive LNAPL extraction methods:** LNAPL extraction methods that rely on siphons, absorbent pads, or other passive methods for LNAPL collection.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Passive methods of LNAPL removal (absorbent pads, siphons without a pump) have been tried on the Site in the past, however rates of LNAPL extraction have not been consistent with remedial goals.	**Eliminate**
DNAPL/ LNAPL	Monitoring	**DNAPL or LNAPL Monitoring:** Conduct semi-annual monitoring of NAPL thickness in monitoring wells using oil/water interface probes. Place monitoring wells strategically to detect off-site migration.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: NAPL monitoring may be an applicable component for a Temporary or Permanent Solution.	**Eliminate**
Soil/TSM	No Action	**Natural Attenuation:** Allow natural processes such as biodegradation and volatilization to reduce concentrations or toxicity of contaminants	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: This approach is not applicable for remediation of soil containing high concentrations of PAH compounds.	**Eliminate**
Soil/TSM	Physical removal	**Excavation and off-site treatment:** Excavate contaminated soil and DNAPL/LNAPL, where present, and transport off-site for treatment.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Excavation of TSM would likely be difficult due to the generation of odors, support of excavations and buildings, disposal of excavated soil, etc.	**Retain**
Soil/TSM	Capping	**Installation of Engineered Barrier:** RCRA-type engineered barrier consistent with 310 CMR 40. Excavate 3 feet of soil, install barrier, backfill soil and re-vegetate on top of barrier.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Installation of an engineered barrier would eliminate potential for exposure to contaminated soil. However, this technology would not attain a Permanent Solution due to the presence of the 100 Commercial Street building on Area 2.	**Retain**
Soil/TSM	Capping	**Installation/maintenance of a direct contact barrier:** Prevent potential exposure to shallow soils by maintaining 3 feet of clean soil or asphalt cover.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Maintenance of a direct contact barrier would likely be required as part of an AUL to restrict potential exposure to contaminated soils.	**Retain**
Soil/TSM	*Ex-situ* treatment	**Incineration:** Treat excavated material off-site using incineration	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Would be appropriate for treatment of extracted LNAPL and DNAPL, or soils that are not suitable for thermal desorption treatment.	**Retain**
Soil/TSM	*Ex-situ* treatment	**Thermal desorption:** Treat excavated soil using thermal desorption with an afterburner. May be performed on-site using a mobile thermal desorption unit, or material may be sent off-site for treatment.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: On-site thermal desorption unlikely to be reasonably feasible due to limited available space, odors, and air emissions. Off-site thermal desorption is reasonably feasible.	**Retain**

TABLE XIV
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES
AREA 2: SOUTHERN PORTION OF 100 COMMERCIAL STREET PROPERTY
PHASE III REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

Target Media	Technology Type	Process Option Description	Feasibility of Achieving a Permanent or Temporary Solution, Availability of Expertise, and Other Comments	Initial Screening Outcome
Soil/TSM	*Ex-situ* treatment	**Soil washing:** Separate silt and clay fraction from sand fraction, and desorb contaminants into the aqueous phase.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? No. Are experts available to implement the technology? Yes. Comments/Concerns/Explanation: This technology is unlikely to be effective at this site; TSM is unlikely to be removed from soil through washing.	**Eliminate**
Soil/TSM	*Ex-situ* treatment	**Stabilization:** Reduce leachability of organic contaminants through physical encapsulation and/or cement stabilization. Treated soil may be re-used as backfill on the site or sent to appropriate receiving facilities for disposal.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? No. Are experts available to implement the technology? Yes. Comments/Concerns/Explanation: Not reasonably feasible due to the anticipated volume of soil to be treated and the limited space available on the Area.	**Eliminate**
Soil/TSM	*Ex-situ* treatment	**Asphalt batching:** Treat excavated soil by mixing with asphalt emulsion to create asphaltic roadbase material. Process may be conducted on- or off-site, and asphalt product may be re-used on-site or off-site.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? No. Are experts available to implement the technology? Yes. Comments/Concerns/Explanation: May be appropriate treatment method for some impacted soil. However, this process is generally not considered feasible for MGP waste, as it is not compatible with hazardous wastes or soil containing free product or cyanide. TCLP analyses on selected TSM samples have failed TCLP due to elevated benzene concentrations.	**Eliminate**
Soil/TSM	*Ex-situ* treatment	**Landfarming:** Excavated material is spread on the ground surface and is periodically tilled and aerated to promote biological removal of organic contaminants.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? No. Are experts available to implement the technology? Yes. Comments/Concerns/Explanation: Not feasible due to urban setting of the site.	**Eliminate**
Soil/TSM	*Ex-situ* treatment	**Bioslurry Reactors:** Excavated soil material is slurried with water and nutrients and is placed in a stirred, aerated reactor to promote biodegradation of organic contaminants.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? No. Are experts available to implement the technology? Yes. Comments/Concerns/Explanation: High concentrations of contaminants limit the feasibility of this technology.	**Eliminate**
Soil/TSM	*Ex-situ* treatment	**MGP-REM Process:** Chemically treat recalcitrant organics with Fenton's reagent (ferrous iron and hydrogen peroxide) to chemically oxidize and biodegrade organic contaminants. May be conducted as either a landfarming or bioreactor process.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? No. Are experts available to implement the technology? Yes. Comments/Concerns/Explanation: This treatment method is not feasible for Area 2 due to the relatively small area available for treatment and the potential for emissions that may impact the public.	**Eliminate**
Soil/TSM	*In-situ* treatment	***In-situ* thermal desorption**: Application of heat and vacuum to *in-situ* soil to volatilize, destroy and extract organic contaminants	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? No. Are experts available to implement the technology? Yes. Comments/Concerns/Explanation: This technology is not feasible due to the presence of subsurface utilities and the urban setting of the Site. Additionally, the application of this technology in the presence of DNAPL is unreliable.	**Eliminate**
Soil/TSM	*In-situ* treatment	***In-situ* stabilization:** Mix soil *in-situ* with stabilizing agents using large-diameter hollow-stem auger drilling rigs	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? No. Are experts available to implement the technology? Yes. Comments/Concerns/Explanation: This technology is not feasible on the scale required at the Site, and subsurface obstructions on Area 2 also limit the feasibility of this technology.	**Eliminate**

TABLE XIV
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES
AREA 2: SOUTHERN PORTION OF 100 COMMERCIAL STREET PROPERTY
PHASE III REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

Target Media	Technology Type	Process Option Description	Feasibility of Achieving a Permanent or Temporary Solution, Availability of Expertise, and Other Comments	Initial Screening Outcome
Soil/TSM	*In-situ* treatment	**Bioventing** (unsaturated zone soils): Inject air into vadose zone soils to stimulate aerobic degradation of organic contaminants	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: This technology is not feasible for high concentrations of PAH contamination.	**Eliminate**
Soil/TSM	*In-situ* treatment	***In-situ* chemical oxidation:** Injection of hydrogen peroxide mixture into in-situ soil using geoprobe equipment or wells to chemically break down organic contaminants to innocuous compounds.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Feasible remedial technology for MGP-impacted soil. In-situ treatment method may be preferable due to the public location of Area 2. Injection of chemical oxidant into the soil beneath asphalt parking areas and buildings may generate excessive heat and vapors - ventilation may be required.	**Retain**
Soil/TSM	Restrictions	**Activity and Use Limitations (AULs):** Place restrictions on future property use to prevent exposure through pathways for which a condition of No Significant Risk could not be established.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Would likely be implemented to prevent potential future exposures to contaminated soils.	**Retain**
Soil/TSM	Restrictions	**Fencing**: Limit site access using fencing	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Although Area 2 is located in a relatively public commercial area, public access to the 100 Commercial Street property is currently limited with a fence surrounding a portion of the property. Additional restrictions to public access are not reasonably feasible.	**Eliminate**
Soil/TSM	Disposal	**Off-site Disposal:** Dispose non-hazardous soils off-site in a landfill	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: This option is considered less favorable than thermal treatment options, which treat contaminated soil prior to disposal. Because off-site thermal desorption treatment is retained, off site disposal is not necessary to achieve a Temporary or Permanent Solution.	**Eliminate**

TABLE XVI
DETAILED EVALUATION OF REMEDIAL ACTION ALTERNATIVES
AREA 2 - SOUTHERN PORTION OF PARCEL E
PHASE III REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

REMEDIAL ACTION ALTERNATIVE	DESCRIPTION OF REMEDIAL ACTION ALTERNATIVE	EFFECTIVENESS	RELIABILITY (SHORT-TERM/LONG-TERM)	IMPLEMENTABILITY	COST (NPV)	RISKS	BENEFITS	TIMELINESS	EFFECT ON NON-PECUNIARY INTERESTS
Alternative 2-1: - Shallow and deep DNAPL recovery using extraction wells - LNAPL extraction using Multi-phase extraction (MPE) - In-situ chemical oxidation of accessible TSM and LNAPL-impacted soils - Provisional shallow DNAPL migration control - AUL	Install shallow and deep DNAPL recovery wells, and MPE wells to extract LNAPL. Install a groundwater treatment facility on site to separate LNAPL from groundwater and treat extracted groundwater. Construct NAPL storage shed to store extracted LNAPL and DNAPL. Once both LNAPL and DNAPL thicknesses have been reduced to the extent practical, install in-situ chemical oxidation system to remove residual contaminants from soil. A vertical subsurface barrier to shallow DNAPL flow (e.g., sheet piling, Waterloo Barrier) may be installed on Area 2, if it is necessary to prevent DNAPL flow from adjacent areas onto Area 2. An AUL involving the maintenance of a direct contact barrier (i.e., pavement) may be used to restrict future exposure to contaminated soils.	**Moderate.** This alternative is unlikely to reach a Permanent Solution, as DNAPL and TSM would remain beneath the 100 Commercial Street building. Cannot inject chemical oxidant beneath 100 Commercial Street building, both due to the presence of DNAPL and access limitations. Therefore, because DNAPL and TSM (i.e., soil exceeding UCLs) remains on the Area, a Permanent Solution is unlikely to result in this alternative. However, this alternative would achieve a Temporary Solution.	**Short term: Moderate**, MPE and DNAPL extraction wells are reliable systems in the short term, however would require maintenance to continue operation. A DNAPL extraction well has bee functioning reliably on Area 2 since October 2001. **Long-term: Moderate**, MPE and DNAPL extraction wells are reliable in the long term, however would likely continue to operate for the foreseeable future.	**Moderately Implementable.** Installation of DNAPL extraction and LNAPL MPE system is relatively straightforward, and chemical oxidation system can be designed and implemented. This alternative requires that an MPE system, a groundwater treatment facility, and a NAPL storage shed be located on Area 2, which may interfere with the owner's use of the Area. Soil beneath the 100 Commercial Street building in inaccessible for DNAPL removal or for chemical oxidation treatment.	Selected Components: DNAPL Recovery System Installation: $200K MPE System Installation: $270K Chemical Oxidation of TSM and LNAPL-impacted soil: $560K Shallow DNAPL migration control: $110K Engineering: $270K O & M: $280K **NPV: $2.4M**	**Moderate.** Risks associated with implementation of this alternative include risks to workers handling extracted NAPL and chemical oxidants. Some risk associated with injection of chemical oxidant beneath pavement or structures, (such as the building or WEB Culvert) due to the generation of heat and gasses during injection.	Removal of LNAPL and DNAPL, and remediation of contaminated soil (over time) in accessible areas	**Requires Long-term Implementation.** Extraction of estimated quantities of LNAPL using MPE would likely be relatively timely, requiring approximately 2 years. However, extraction of DNAPL from the subsurface on Area 2 is likely to require an extended period of time (i.e., 7 to 10 years) to accomplish. LNAPL extraction using MPE is likely to achieve more rapid LNAPL extraction rates than other methods of LNAPL removal.	**Moderate.** The presence of a NAPL storage shed, MPE system, and groundwater treatment system will occupy space on the property and will affect the current use of the Area somewhat. However, based on the nature of the current use of the Area, it is not anticipated that the presence of these facilities will have a significant effect on these interests.
Alternative 2-2: - Shallow and deep DNAPL recovery using extraction wells - LNAPL extraction using belt-skimmers - Provisional shallow DNAPL migration control - AUL	Install 13 shallow and deep DNAPL recovery wells, and 6 wells equipped with belt-skimmers to extract LNAPL. Construct NAPL storage shed to store extracted LNAPL and DNAPL. A vertical subsurface barrier to shallow DNAPL flow (e.g., sheet piles, Waterloo Barrier) may be installed on Area 2 if it is necessary to prevent DNAPL flow from adjacent areas onto Area 2. An AUL involving the maintenance of a direct contact barrier (i.e., pavement) may be used to restrict future exposure to contaminated soils.	**Moderate.** This alternative is unlikely to achieve a Permanent Solution, as DNAPL and TSM would likely remain beneath the 100 Commercial Street building. However, this alternative would achieve a Temporary Solution.	**Short term: Moderate**, Belt-skimmer and DNAPL extraction wells are reliable systems, but will require maintenance to continue operation. A DNAPL extraction well has bee functioning reliably on Area 2 since October 2001. **Long-term: Moderate**, Belt-skimmer and DNAPL extraction wells are reliable in the long term, however will likely continue to operate for the foreseeable future.	**Readily Implementable.** Installation of DNAPL and LNAPL belt-skimmer wells is relatively straightforward. This alternative requires construction of a NAPL storage shed on Area 2. Access to soils beneath the 100 Commercial Street building for DNAPL removal is limited.	Selected Components: DNAPL Recovery System Installation: $200K LNAPL Recovery System Installation: $130K Shallow DNAPL migration control: $110K Engineering: $180K O & M: $280K **NPV: $1.3M**	**Low.** Risks associated with this alternative include risks to workers handling extracted NAPL.	This alternative involves significantly less impact on property use than Alternative 2-1, as it does not require an MPE system or a groundwater treatment system.	**Requires Long-term Implementation.** Extraction of estimated quantities of LNAPL and DNAPL in the subsurface on Area 2 may require an extended period of time (i.e., 4 to 6 years and 7 to 10 years, respectively) in this alternative.	**Low.** This alternative involves little impact on property use, other than construction of a small NAPL storage shed on the Area.
Alternative 2-3: - LNAPL and shallow and deep DNAPL monitoring - AUL	This alternative involves continued monitoring of subsurface conditions to ensure that NAPL located in the subsurface on Area 2 does not migrate off-site. An AUL involving the maintenance of a direct contact barrier (i.e., pavement) may be used to restrict future exposure to contaminated soils.	**Low.** Does not achieve a Permanent Solution, and does not extract DNAPL or LNAPL from the subsurface. An AUL is a relatively effective method for restricting future exposure to contaminated soils. This alternative meets the requirements of a Temporary Solution.	**Not Applicable:** No remedy is installed under this alternative.	**Readily Implementable.** Implementation of a monitoring program on the Area would be relatively straightforward, as monitoring wells currently exist on Area 2.	**NPV: $110K**	**Low.** Very low risk for exposure to hazardous materials by workers in this alternative.	This alternative involves very little impact on property use. Little potential for exposure to contaminants under current/foreseeable future property uses.	**Requires Long-term Implementation.** This alternative does not extract LNAPL or DNAPL from the subsurface; therefore monitoring will continue under a Temporary Solution until a change in Area conditions allows remedial measures that result in a Permanent Solution.	**Low.** This alternative involves very little impact on property use.

Notes:
1. Cost estimates include contractor mobilizations, contingencies and other additional components in addition to selected components listed; Refer to Cost Estimate Tables in Appendix D for detailed breakdown of cost components.
2. Cost estimates represent an opinion of probable cost for comparison purposes.

TABLE XVII
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES
AREA 3: NORTHERN PORTION OF PARCEL A
PHASE III REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

Target Media	Technology Type	Process Option Description	Feasibility of Achieving a Permanent or Temporary Solution, Availability of Expertise, and Other Comments	Initial Screening Outcome
DNAPL	Extraction	**DNAPL Extraction using Recovery Wells:** Installation of large-diameter DNAPL extraction wells, equipped with a submersible pump to extract DNAPL from the subsurface. Extracted DNAPL stored in small buildings on the property and transported off-site for disposal.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Technology is applicable to both shallow and deep DNAPL. Reasonably likely to be feasible based on an existing DNAPL extraction well that has been operating successfully on the southern portion of Parcel E (Area 2).	**Retain**
DNAPL	Extraction/ Migration control	**DNAPL Extraction/Migration Control using Trenches:** Excavation of trenches that are keyed into the low-permeability organic deposit, and backfilled with gravel for collection of DNAPL. One or more recovery wells equipped with a submersible pump for extraction of DNAPL would be installed in the trench.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Would likely be significantly more difficult than extraction wells to install, due to subsurface obstructions, odors, space for excavation, and disposal of excavated soil material.	**Retain**
DNAPL	Migration control	**Vertical Subsurface Barrier:** Install barrier to DNAPL flow. May be slurry wall, sheet piling, or Waterloo™ barrier, dependent upon Phase IV design. Would also involve injection of grout through the base of the WEB Culvert to prevent DNAPL migration beneath the culvert.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Would likely be required in the event that DNAPL is removed from Area 3 and potential remains for DNAPL migration from an adjacent area.	**Retain**
DNAPL	Disposal/ Incineration	**Disposal or Incineration:** Off-site transport of extracted NAPL for incineration or disposal.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Would be required in the event that DNAPL or LNAPL are removed from the subsurface.	**Retain**
DNAPL	Monitoring	**DNAPL Monitoring:** Conduct semi-annual monitoring of DNAPL thickness in monitoring wells using oil/water interface probes. Place monitoring wells strategically to detect off-site migration.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: NAPL monitoring may be an applicable component for a Temporary or Permanent Solution, especially if NAPL extraction is not feasible.	**Eliminate**
Soil/TSM	No Action	**Natural Attenuation:** Allow natural processes such as biodegradation and volatilization to reduce concentrations or toxicity of contaminants	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: This technology is not applicable for remediation of soil containing high PAH concentrations or TSM.	**Eliminate**
Soil/TSM	Physical removal	**Excavation and off-site treatment:** Excavate contaminated soil and DNAPL/LNAPL, where present, and transport off-site for treatment. Would require support of excavations and building foundations during excavation, and may require demolition of buildings on the property.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Excavation of TSM would likely be difficult due to the generation of odors, support of excavations and buildings, disposal of excavated soil, etc.	**Retain**
Soil/TSM	Capping	**Installation of Engineered Barrier:** RCRA-type engineered barrier consistent with 310 CMR 40. Excavate 3 feet of soil, install barrier, backfill soil and re-vegetate on top of barrier.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Installation of an engineered barrier would eliminate potential for exposure to contaminated soil. However, this technology is unlikely to attain a Permanent Solution due to the presence of buildings on properties in the Area.	**Retain**

TABLE XVII
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES
AREA 3: NORTHERN PORTION OF PARCEL A
PHASE III REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

Target Media	Technology Type	Process Option Description	Feasibility of Achieving a Permanent or Temporary Solution, Availability of Expertise, and Other Comments	Initial Screening Outcome
Soil/TSM	Capping	**Installation/maintenance of a direct contact barrier:** Prevent potential exposure to shallow soils by maintaining 3 feet of clean soil or asphalt cover.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Maintenance of a direct contact barrier would likely be required as part of an AUL to restrict potential exposure to contaminated soils.	**Retain**
Soil/TSM	*Ex-situ* treatment	**Incineration:** Treat excavated material off-site using incineration	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Would be appropriate for treatment of extracted DNAPL or soils that are not suitable for thermal desorption treatment.	**Retain**
Soil/TSM	*Ex-situ* treatment	**Thermal desorption:** Treat excavated soil material using thermal desorption with an afterburner. May be performed on-site using a mobile thermal desorption unit, or material may be sent off-site for treatment.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: On-site thermal desorption unlikely to be reasonably feasible due to limited available space, odors, and air emissions. Off-site thermal desorption is reasonably feasible.	**Retain**
Soil/TSM	*Ex-situ* treatment	**Soil washing:** Separate silt and clay fraction from sand fraction, and desorb contaminants into the aqueous phase.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: This technology is unlikely to be effective at this site; TSM is unlikely to be removed from soil through washing.	**Eliminate**
Soil/TSM	*Ex-situ* treatment	**Stabilization:** Reduce leachability of organic contaminants through physical encapsulation and/or cement stabilization. Treated soil may be re-used as backfill on the site or sent to appropriate receiving facilities for disposal.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Not reasonably feasible due to the anticipated volume of soil to be treated and the limited space available on the Area.	**Eliminate**
Soil/TSM	*Ex-situ* treatment	**Asphalt batching:** Treat excavated soil by mixing with asphalt emulsion to create asphaltic roadbase material. Process may be conducted on- or off-site, and asphalt product may be re-used on-site or off-site.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: May be appropriate treatment method for some impacted soil. However, this process is generally not considered feasible for MGP waste, as it is not compatible with hazardous wastes or soil containing free product or cyanide. TCLP analyses on selected TSM samples have failed TCLP due to elevated benzene concentrations.	**Eliminate**
Soil/TSM	*Ex-situ* treatment	**Landfarming:** Excavated material is spread on the ground surface and is periodically tilled and aerated to promote biological removal of organic contaminants.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Not feasible due to urban setting of the site.	**Eliminate**
Soil/TSM	*Ex-situ* treatment	**Bioslurry Reactors:** Excavated soil material is slurried with water and nutrients and is placed in a stirred, aerated reactor to promote biodegradation of organic contaminants.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: High concentrations of contaminants limit the feasibility of this technology.	**Eliminate**
Soil/TSM	*Ex-situ* treatment	**MGP-REM Process:** Chemically treat recalcitrant organics with Fenton's reagent (ferrous iron and hydrogen peroxide) to chemically oxidize and biodegrade organic contaminants. May be conducted as either a landfarming or bioreactor process.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: This treatment method is not feasible for Area 3 due to the relatively small area available for treatment and the potential for emissions that may impact the public.	**Eliminate**

TABLE XVII
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES
AREA 3: NORTHERN PORTION OF PARCEL A
PHASE III REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

Target Media	Technology Type	Process Option Description	Feasibility of Achieving a Permanent or Temporary Solution, Availability of Expertise, and Other Comments	Initial Screening Outcome
Soil/TSM	*In-situ* treatment	***In-situ* thermal desorption:** Application of heat and vacuum to *in-situ* soil to volatilize, destroy and extract organic contaminants	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: This technology is not feasible due to the presence of subsurface utilities and the urban setting of the Site. Additionally, the application of this technology in the presence of DNAPL is unreliable.	**Eliminate**
Soil/TSM	*In-situ* treatment	***In-situ* stabilization:** Mix soil *in-situ* with stabilizing agents using large-diameter hollow-stem auger drilling rigs	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: This technology is not feasible on the scale required at the Site, and subsurface obstructions on Area 3 also limit the feasibility of this technology.	**Eliminate**
Soil/TSM	*In-situ* treatment	**Bioventing** (unsaturated zone soils): Inject air into vadose zone soils to stimulate aerobic degradation of organic contaminants	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: This technology is not feasible for high concentrations of PAH contamination.	**Eliminate**
Soil/TSM	*In-situ* treatment	***In-situ* chemical oxidation:** Injection of hydrogen peroxide mixture or other oxidant into in-situ soil using geoprobe equipment or wells to chemically break down organic contaminants to innocuous compounds.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Feasible remedial technology for MGP and petroleum-impacted soil. In-situ treatment method may be preferable due to the public location of Area 3. Injection of chemical oxidant into the soil beneath asphalt parking areas and buildings may generate excessive heat and vapors - ventilation may be required.	**Retain**
Soil/TSM	Restrictions	**Activity and Use Limitations (AULs):** Place restrictions on future property use to prevent exposure through pathways for which a condition of No Significant Risk could not be established.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Would likely be implemented to prevent potential future exposures to contaminated soil and indoor air.	**Retain**
Soil/TSM	Restrictions	**Fencing:** Limit site access using fencing	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Area 3 contains several commercial businesses that must remain accessible to the public; therefore public access to these properties cannot be restricted.	**Eliminate**
Soil/TSM	Disposal	**Off-site Disposal:** Dispose non-hazardous soils off-site in a landfill	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: This option is considered less favorable than thermal treatment options, which treat contaminated soil prior to disposal. Because off-site thermal desorption treatment is retained, off-site disposal is not necessary to achieve a Temporary or Permanent Solution.	**Eliminate**

TABLE XIX
DETAILED EVALUATION OF REMEDIAL ACTION ALTERNATIVES
AREA 3 - NORTHERN PORTION OF PARCEL A
PHASE III REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

REMEDIAL ACTION ALTERNATIVE	DESCRIPTION OF REMEDIAL ACTION ALTERNATIVE	EFFECTIVENESS	RELIABILITY (SHORT-TERM/LONG-TERM)	IMPLEMENTABILITY	COST (NPV)	RISKS	BENEFITS	TIMELINESS	EFFECT ON NON-PECUNIARY INTERESTS
Alternative 3-1: - Shallow DNAPL recovery wells - Provisional Shallow DNAPL migration control - In-situ chemical oxidation of accessible TSM – impacted soil - AUL	This alternative involves the installation of shallow DNAPL extraction wells on properties located on Area 3. A DNAPL storage shed would be constructed on a centrally located property to store extracted DNAPL. When appropriate (i.e., TSM soil is accessible and DNAPL has been reduced to less than 1/2 inch), chemical oxidation of TSM soils will be conducted. A vertical subsurface barrier to shallow DNAPL flow (e.g., sheet piling, Waterloo Barrier) may be installed on Area 3, if necessary. An AUL involving the maintenance of a direct contact barrier (i.e., pavement) may be used to restrict future exposure to contaminated soils.	**Moderate.** Implementation of this alternative is likely to meet remedial goals with respect to DNAPL removal and reduction of contaminant concentrations in soil on portions of the Area without buildings. DNAPL recovery has been demonstrated to be effective at one location on Area 2, and chemical oxidation has been used effectively at other MGP sites to reduce concentrations of VOCs and PAHs in soil. However, access to DNAPL and TSM soils beneath the buildings on Area 3 is limited, and DNAPL and TSM would likely remain beneath the buildings. Therefore, a Permanent Solution is unlikely to result from implementation of this Alternative.	**Short term: Moderate,** DNAPL extraction wells are reasonably reliable; one DNAPL extraction well on Area 2 has functioned reliably since October 2001. DNAPL extraction system will require maintenance to continue to operate; unlikely to accomplish remedial goals in short term. **Long-term: Moderate,** Systems are reliable. Will require long-term maintenance, however is likely to continue to function reliably over the long term.	**Moderately Implementable.** Installation of a DNAPL extraction system will impact property use; current retail uses of properties within Area 3 involve high degree of public access. Injection of chemical oxidants would not be conducted beneath the buildings located on Area 3, due to inaccessibility of the soil and the potential for adverse affects of chemical oxidation reactions beneath buildings.	Selected Components: DNAPL recovery system installation: $180K Chemical oxidation of TSM soil: $550K Shallow DNAPL Migration Control: $220K Engineering: $190K O & M: $140K **NPV: $1.6M**	**Moderate.** Relatively little risk associated with the installation of extraction wells, although measures would be required to ensure that pubic access to DNAPL storage facility is prevented. Some risk exists to workers during injection of oxidants for chemical oxidation. Some risk of damage to the WEB Culvert, building foundations, and subsurface utilities due to heat and vapor generation during chemical oxidation.	Removes UCLs due to both DNAPL and contaminated soil impacts over the long term in accessible portions of Area 3; however, residual contamination would remain beneath buildings.	**Requires Long-term Implementation.** Accomplishment of remedial goals with respect to DNAPL thickness is likely to require approximately 3 to 5 years using extraction wells in this Area.	**Moderate.** Would impact current property uses to install and maintain, and requires a DNAPL storage shed for storage of extracted DNAPL. Operation of DNAPL extraction and in-situ chemical oxidation system may be undesirable on some properties due to negative perceptions associated with contamination on the property.
Alternative 3-2: - Shallow DNAPL recovery wells - Provisional shallow DNAPL migration control - AUL	This alternative is similar to Alternative 3-1, however it does not include chemical oxidation of TSM soils, based on the assumption that DNAPL extraction goals are not met in a reasonable time frame, and that chemical oxidation is not feasible due to the presence of the buildings on Area 3. If necessary, vertical barriers to shallow DNAPL flow may be installed on Area 3 to prevent migration of shallow DNAPL onto Area 3. An AUL involving the maintenance of a direct contact barrier (i.e., pavement) may be used to restrict future exposure to	**Moderate.** Similar to Alternative 3-1, this alternative is reasonably likely to meet DNAPL remedial goals on portions of Area 3 without buildings. However, access to DNAPL beneath buildings on Area 3 is limited, and DNAPL is likely to remain beneath buildings. This alternative would not result in a Permanent Solution because DNAPL would likely remain beneath buildings and soil containing concentrations of contaminants greater than the UCLs (i.e., TSM) would remain. Would meet the requirements of a Temporary Solution.	**Short term: Moderate,** DNAPL extraction wells are reasonably reliable; one DNAPL extraction well on Area 2 has functioned reliably since October 2001. DNAPL extraction system will require maintenance. **Long-term: Moderate,** Systems are reliable. Will require long-term maintenance, however is likely to continue to function reliably over the long term.	**Readily Implementable.** This alternative requires some degree of intrusion into the operations of businesses on Area 3. Construction of a DNAPL storage shed (for shared use among the properties in Area 3) is likely to be implementable on one of the Area 3 properties.	Selected Components: DNAPL recovery system installation: $180K Shallow DNAPL Migration Control: $220K Engineering: $120K O & M: $140K **NPV: $870K**	**Low.** Relatively little risk associated with the installation of extraction wells, although measures would be required to ensure that pubic access to DNAPL storage facility is prevented.	Requires little interruption of facility operations, and accomplishes removal of DNAPL source material from the subsurface. Removes UCLs due to presence of DNAPL over the long term in accessible portions of Area 3; however, residual contamination would remain beneath buildings.	**Requires Long-term Implementation.** Accomplishment of remedial goals with respect to DNAPL thickness is likely to require approximately 3 to 5 years using extraction wells in this Area.	**Moderate.** Would require some intrusion to current property uses to install and maintain, and requires a DNAPL storage shed for storage of extracted DNAPL. Operation of DNAPL extraction system may be undesirable on some properties due to negative perceptions associated with contamination on the property.
Alternative 3-3: - DNAPL monitoring - AUL	This is the least intrusive of the alternatives for Area 3, as it only involves continued monitoring of conditions to ensure that off-site migration of DNAPL does not occur. An AUL involving the maintenance of a direct contact barrier (i.e., pavement) may be used to restrict future exposure to contaminated soils.	**Low.** Would not result in reduction of NAPL thickness or significant reductions in contaminant concentrations. Would not result in a Permanent Solution because DNAPL and TSM would remain in the subsurface and soil containing concentrations of contaminants greater than the UCLs would remain. Would meet the requirements of a Temporary Solution.	**Not Applicable;** a remedy is not installed in this Alternative.	**Readily Implementable.** This alternative requires the least intrusion into facility operations to implement.	**NPV: $110K**	**Low.** Few risks associated with this alternative.	Requires little interruption of facility operations.	**Requires Long-term Implementation.** Monitoring would continue indefinitely, until installation of a Permanent Solution is feasible.	**Low.** This alternative results in little disruption to facility operations. Minimal impacts include access to the properties on the Area for monitoring of DNAPL conditions.

Notes:
1. Cost estimates include contractor mobilizations, contingencies and other additional components in addition to selected components listed; Refer to Cost Estimate Tables in Appendix D for detailed breakdown of cost components.
2. Cost estimates represent an opinion of probable cost for comparison purposes.

TABLE XX
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES
AREA 4: SOUTHERN PORTION OF PARCEL A
PHASE III REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

Target Media	Technology Type	Process Option Description	Feasibility of Achieving a Permanent or Temporary Solution, Availability of Expertise, and Other Comments	Initial Screening Outcome
LNAPL	Extraction	**Multi-phase extraction:** Extraction of groundwater, soil vapor and LNAPL through the application of a vacuum to specially designed extraction wells. Requires separation of LNAPL from groundwater and ex-situ treatment of both soil vapor and groundwater.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Appropriate for LNAPL removal, and removal of volatile compounds (such as BTEX) from groundwater.	**Retain**
LNAPL	Extraction	**Belt-skimmer:** Extraction of LNAPL using belt-skimmers, consisting of two pulleys that drive a hydrophobic belt through the water table in a monitoring well, bring LNAPL oil to the surface, and skim the oil into a collection container. System is driven by an electric motor.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Appropriate for LNAPL removal in areas of high public access, on which gradual LNAPL is consistent with remedial goals	**Retain**
LNAPL	Extraction	**Passive LNAPL extraction methods:** LNAPL extraction methods that rely on siphons, absorbent pads, or other passive methods for LNAPL collection.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Passive methods of LNAPL removal (absorbent pads, siphons without a pump) have been tried on the Site in the past, however rates of LNAPL extraction have not been consistent with remedial goals.	**Eliminate**
LNAPL	Monitoring	**LNAPL Monitoring:** Conduct semi-annual monitoring of LNAPL thickness in monitoring wells using oil/water interface probes. Place monitoring wells strategically to detect off-site migration.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: LNAPL monitoring may be feasible component for a Temporary or Permanent Solution.	**Retain**
LNAPL	Disposal/ Incineration	**Disposal or Incineration:** Off-site transport of extracted NAPL for incineration or disposal.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Would be required in the event that DNAPL or LNAPL are removed from the subsurface.	**Retain**
Soil/TSM	No Action	**Natural Attenuation:** Allow natural processes such as biodegradation and volatilization to reduce concentrations or toxicity of contaminants	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: This technology is not applicable for remediation of soil containing high concentrations of PAH compounds.	**Eliminate**
Soil/TSM	Physical removal	**Excavation and off-site treatment:** Excavate contaminated soil and DNAPL/LNAPL, where present, and transport off-site for treatment. Would require support of excavations and building foundations during excavation, and may require demolition of buildings.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Excavation of contaminated soil and TSM would likely be difficult due to the generation of odors, support of excavations and buildings, disposal of excavated soil, etc.	**Retain**
Soil/TSM	Capping	**Installation of Engineered Barrier:** RCRA-type engineered barrier consistent with 310 CMR 40. Excavate 3 feet of soil, install barrier, backfill soil and re-vegetate on top of barrier.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Installation of an engineered barrier would eliminate potential for exposure to contaminated soil. However, this technology would not attain a Permanent Solution due to the presence of buildings on Area 4.	**Retain**

TABLE XX
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES
AREA 4: SOUTHERN PORTION OF PARCEL A
PHASE III REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

Target Media	Technology Type	Process Option Description	Feasibility of Achieving a Permanent or Temporary Solution, Availability of Expertise, and Other Comments	Initial Screening Outcome
Soil/TSM	Capping	**Installation/maintenance of a direct contact barrier:** Prevent potential exposure to shallow soils by maintaining 3 feet of clean soil or asphalt cover.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Maintenance of a direct contact barrier would likely be required as part of an AUL to restrict potential exposure to contaminated soils.	**Retain**
Soil/TSM	*Ex-situ* treatment	**Incineration:** Treat excavated material off-site using incineration	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Would be appropriate for treatment of extracted LNAPL or soils that are not suitable for thermal desorption treatment.	**Retain**
Soil/TSM	*Ex-situ* treatment	**Thermal desorption:** Treat excavated soil material using thermal desorption with an afterburner. May be performed on-site using a mobile thermal desorption unit, or material may be sent off-site for treatment.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: On-site thermal desorption unlikely to be reasonably feasible due to limited available space, odors, and air emissions. Off-site thermal desorption is reasonably feasible.	**Retain**
Soil/TSM	*Ex-situ* treatment	**Soil washing:** Separate silt and clay fraction from sand fraction, and desorb contaminants into the aqueous phase.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: This technology is unlikely to be effective at this site; MGP oils and TSM are unlikely to be removed from soil through washing.	**Eliminate**
Soil/TSM	*Ex-situ* treatment	**Stabilization:** Reduce leachability of organic contaminants through physical encapsulation and/or cement stabilization. Treated soil may be re-used as backfill on the site or sent to appropriate receiving facilities for disposal.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Not reasonably feasible due to the anticipated volume of soil to be treated and the limited space available on the Area.	**Eliminate**
Soil/TSM	*Ex-situ* treatment	**Asphalt batching:** Treat excavated soil by mixing with asphalt emulsion to create asphaltic roadbase material. Process may be conducted on- or off-site, and asphalt product may be re-used on-site or off-site.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: May be appropriate treatment method for some impacted soil. However, this process is generally not considered feasible for MGP waste, as it is not compatible with hazardous wastes or soil containing free product or cyanide. TCLP analyses on selected TSM samples have failed TCLP due to elevated benzene concentrations.	**Eliminate**
Soil/TSM	*Ex-situ* treatment	**Landfarming:** Excavated material is spread on the ground surface and is periodically tilled and aerated to promote biological removal of organic contaminants.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Not feasible due to urban setting of the site.	**Eliminate**
Soil/TSM	*Ex-situ* treatment	**Bioslurry Reactors:** Excavated soil material is slurried with water and nutrients and is placed in a stirred, aerated reactor to promote biodegradation of organic contaminants.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **No.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: High concentrations of contaminants limit the feasibility of this technology.	**Eliminate**

TABLE XX
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES
AREA 4: SOUTHERN PORTION OF PARCEL A
PHASE III REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

Target Media	Technology Type	Process Option Description	Feasibility of Achieving a Permanent or Temporary Solution, Availability of Expertise, and Other Comments	Initial Screening Outcome
Soil/TSM	*Ex-situ* treatment	**MGP-REM Process:** Chemically treat recalcitrant organics with Fenton's reagent (ferrous iron and hydrogen peroxide) to chemically oxidize and biodegrade organic contaminants. May be conducted as either a landfarming or bioreactor process.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? No. Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: This treatment method is not feasible for Area 4 due to the relatively small area available for treatment and the potential for emissions that may impact the public.	**Eliminate**
Soil/TSM	*In-situ* treatment	***In-situ* thermal desorption**: Application of heat and vacuum to *in-situ* soil to volatilize, destroy and extract organic contaminants	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? No. Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: This technology is not feasible due to the presence of subsurface utilities and the urban setting of the Site.	**Eliminate**
Soil/TSM	*In-situ* treatment	***In-situ* stabilization**: Mix soil *in-situ* with stabilizing agents using large-diameter hollow-stem auger drilling rigs	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? No. Are experts available to implement the technology? Yes. Comments/Concerns/Explanation: This technology is not feasible on the scale required at the Site, and subsurface obstructions on Area 4 also limit the feasibility of this technology.	**Eliminate**
Soil/TSM	*In-situ* treatment	**Bioventing** (unsaturated zone soils): Inject air into vadose zone soils to stimulate aerobic degradation of organic contaminants	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? No. Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: This technology is not feasible for high concentrations of PAH contamination.	**Eliminate**
Soil/TSM	*In-situ* treatment	***In-situ* chemical oxidation:** Injection of hydrogen peroxide mixture or other oxidizing agent into in-situ soil using geoprobe equipment or wells to chemically break down organic contaminants to innocuous compounds.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? Yes. Are experts available to implement the technology? Yes. Comments/Concerns/Explanation: Feasible remedial technology for MGP and petroleum-impacted soil. In-situ treatment method may be preferable due to the public location of Area 4. Injection of chemical oxidant into the soil beneath asphalt parking areas and buildings may generate excessive heat and vapors - ventilation may be required.	**Retain**
Soil/TSM	Restrictions	**Activity and Use Limitations (AULs)**: Place restrictions on future property use to prevent exposure through pathways for which a condition of No Significant Risk could not be established.	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: Would likely be implemented to prevent potential future exposures to contaminated soils.	**Retain**
Soil/TSM	Restrictions	**Fencing**: Limit site access using fencing	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? No. Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: The properties on Area 4 are currently commercial and retail businesses that require public access; therefore access to Area 4 cannot be limited.	**Eliminate**
Soil/TSM	Disposal	**Off-site Disposal:** Dispose non-hazardous soils off-site in a landfill	Is the technology reasonably likely to achieve a Permanent or Temporary Solution? **Yes.** Are experts available to implement the technology? **Yes.** Comments/Concerns/Explanation: This option is considered less favorable than thermal treatment options, which treat contaminated soil prior to disposal. Because off-site thermal desorption treatment is retained, off-site disposal is not necessary to achieve a Temporary or Permanent Solution.	**Eliminate**

TABLE XXII
DETAILED EVALUATION OF REMEDIAL ACTION ALTERNATIVES
AREA 4 - SOUTHERN PORTION OF PARCEL A
PHASE III REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

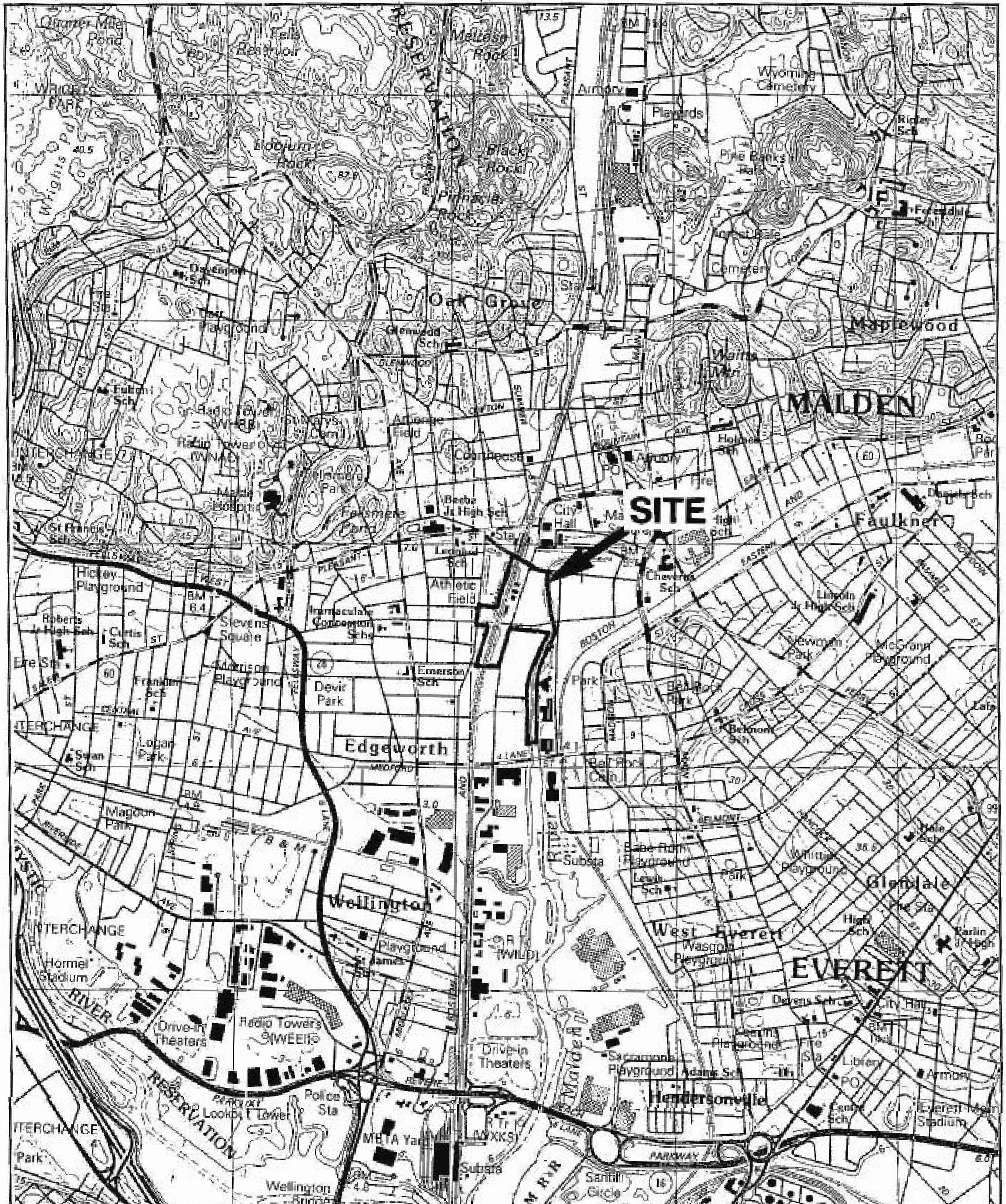
REMEDIAL ACTION ALTERNATIVE	DESCRIPTION OF REMEDIAL ACTION ALTERNATIVE	EFFECTIVENESS	RELIABILITY (SHORT-TERM/LONG-TERM)	IMPLEMENTABILITY	COST (NPV)	RISKS	BENEFITS	TIMELINESS	EFFECT ON NON-PECUNIARY
Alternative 4-1: - LNAPL extraction using Multi-phase extraction (MPE) - In-situ chemical oxidation of accessible TSM and LNAPL-impacted soils - AUL	Install MPE system to extract LNAPL, and a groundwater treatment facility on site to separate LNAPL from groundwater and treat extracted groundwater. Construct NAPL storage shed to store extracted LNAPL. Once LNAPL thickness has been reduced to the extent practical, install in-situ chemical oxidation system to remove residual contaminants from TSM and LNAPL - impacted soils. An AUL involving maintenance of a direct contact barrier (i.e., pavement) may be used to restrict future exposure to contaminated soils.	**Moderate.** LNAPL extraction using MPE is likely to be more effective than belt-skimmers in Alternative 4-2, and may remove a portion of the LNAPL that may be located beneath buildings on the Area. Cannot inject chemical oxidant beneath the buildings, both due to the presence of LNAPL and access limitations. Therefore, because LNAPL, and TSM (i.e., soil exceeding UCLs) may remain on the Area, a Permanent Solution is unlikely to result in this alternative. However, this alternative does reduce LNAPL volume on the Area and achieves a Temporary Solution, and an AUL is a relatively effective means of restricting exposure to contaminated soil.	**Short term: Moderate.** Because MPE combines groundwater and LNAPL extraction, it results in reliable LNAPL removal. System would require maintenance to continue operation. **Long-term: Moderate,** MPE system would likely continue to operate for the foreseeable future.	**Moderately Implementable.** Installation of MPE system is relatively straightforward, and chemical oxidation system can be designed and implemented. This alternative requires that an MPE system, a groundwater treatment facility, and a NAPL storage shed be located on a property on Area 4, which would require an access agreement with the property owner. Soil beneath buildings is inaccessible for LNAPL removal or for chemical oxidation treatment.	Selected Components: MPE System Installation: $370K Chemical oxidation of LNAPL and TSM soil: $220K Engineering: $210K O & M: $280K **NPV: $1.3M**	**Moderate.** Risks associated with this alternative include risks to workers handling chemical oxidants and extracted LNAPL. Some risk associated with injection of chemical oxidant beneath pavement or adjacent to structures, due to the generation of heat and vapors during injection.	Relatively rapid removal of LNAPL from subsurface, reduction of contaminant concentrations in soil in accessible portions of Area 4; however, residual contamination would remain beneath buildings.	**Relatively Timely.** Extraction of estimated quantities of LNAPL in the subsurface on Area 4 using MPE technology is likely to require up to approximately 2 years. LNAPL extraction using MPE is likely to achieve more rapid LNAPL extraction rates than other methods of LNAPL removal. However, LNAPL may remain in inaccessible portions of the Area (i.e., underneath buildings)	**Moderate.** The presence of a NAPL storage shed, MPE system, and groundwater treatment system will occupy space on the property and will affect current use of properties on the Area; would require access agreement with the property owner.
Alternative 4-2 - LNAPL extraction using belt-skimmers - AUL	Install LNAPL extraction wells equipped with belt-skimmers to extract LNAPL, and construct NAPL storage shed to store extracted LNAPL. This alternative does not include chemical oxidation of TSM and LNAPL-impacted soils, based on the assumption that LNAPL extraction goals are not met in a reasonable time frame, and that chemical oxidation is not feasible due to the presence of the buildings on Area 4. An AUL involving maintenance of a direct contact barrier (i.e., pavement) may be used to restrict future exposure to contaminated soils.	**Moderate.** This alternative is unlikely to achieve a Permanent Solution, as LNAPL and TSM will likely remain beneath the buildings on the Area. However, this alternative does reduce the volume of LNAPL on the Area and achieves a Temporary Solution, and an AUL is a relatively effective means of restricting exposure to contaminated soil.	**Short term: Moderate,** Belt-skimmers are reliable method of LNAPL extraction; would require maintenance to continue operation. **Long-term: Moderate,** Belt-skimmer extraction system would likely continue to operate for the foreseeable future.	**Moderately Implementable.** Installation of LNAPL belt-skimmer wells is relatively straightforward. This alternative requires construction of a NAPL storage shed on Area 4, which would require approval of the property owner. Access to soils beneath buildings on the Area for LNAPL removal is limited.	Selected Components: LNAPL extraction system installation: $160K Engineering: $90K O & M: $140K **NPV: $510K**	**Low.** Risks associated with this alternative include risks to workers handling extracted LNAPL.	This alternative involves significantly less intrusion into property use than Alternative 4-1, as it does not require an MPE system or a groundwater treatment system.	**Requires Long-term Implementation.** Extraction of estimated quantities of LNAPL in the subsurface on Area 4 may require an extended period of time (i.e., 3 to 5 years).	**Low.** This alternative involves little impact on property use, other than construction of a small LNAPL storage shed on the Area.
Alternative 4-3: - LNAPL monitoring - AUL	This alternative involves continued monitoring of subsurface conditions to ensure that LNAPL located in the subsurface on Area 4 does not migrate off-site. An AUL involving maintenance of a direct contact barrier (i.e., pavement) may be used to restrict future exposure to contaminated soils.	**Low.** Does not achieve a Permanent Solution, and does not extract LNAPL from the subsurface. This alternative meets the requirements of a Temporary Solution, and an AUL is a relatively effective means of restricting exposure to contaminated soil.	**Not Applicable:** No remedy is installed under this alternative.	**Readily Implementable.** Implementation of a monitoring program on the Area would be relatively straightforward, as monitoring wells currently exist on Area 4. Would require access from property owner.	**NPV: $100K**	**Low.** Very low risk for exposure to hazardous materials by workers in this alternative.	This alternative involves very little impact on property use.	**Requires Long-term Implementation.** This alternative does not extract LNAPL from the subsurface; therefore monitoring will continue under a Temporary Solution until a change in Area conditions allows installation of a Permanent Solution.	**Low.** This alternative involves very little impact on property use.

Notes:
1. Cost estimates include contractor mobilizations, contingencies and other additional components in addition to selected components listed; Refer to Cost Estimate Tables in Appendix D for detailed breakdown of cost components.
2. Cost estimates represent an opinion of probable cost for comparison purposes.

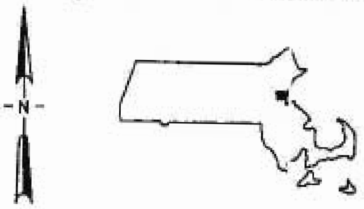
TABLE XXIV
SUMMARY OF COSTS FOR THE SELECTED REMEDIAL ALTERNATIVE
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

REMEDIAL ALTERNATIVE AREA	AREA DESCRIPTION	REMEDIAL ALTERNATIVE DESCRIPTION	ESTIMATED TIME TO COMPLETE ALTERNATIVE	NET PRESENT VALUE (NPV[1])
Area 1	Northern portion of the 100 Commercial Street property	Alternative 1-4: DNAPL extraction, provisional DNAPL migration control, in-situ chemical oxidation of TSM and petroleum-impacted soils, and monitoring of LNAPL and deep DNAPL.	6 to 9 years	$ 1,100,000
Area 2	Southern portion of the 100 Commercial Street property	Alternative 2-2: DNAPL extraction, LNAPL extraction using belt-skimmers, and provisional DNAPL migration control.	7 to 10 years	$ 1,300,000
Area 3	Northern portion of Parcel A	Alternative 3-2: Shallow DNAPL extraction and provisional shallow DNAPL migration control.	3 to 5 years	$ 870,000
Area 4	Southern portion of Parcel A	Alternative 4-2: LNAPL extraction using belt-skimmers	3 to 5 years	$ 510,000
Area 5	Parcel B	Brown and Caldwell Alt-3: Biosparging and SVE	6 to 7 years	$ 970,000
Groundwater Monitoring		Implementation of a site-wide annual groundwater monitoring program	30 years	$ 200,000
SUM OF ESTIMATED NPV FOR FORMER MALDEN MGP SITE[2]:				**$ 4,950,000**

Notes:
1. Cost estimates represent an opinion of probable cost for comparison purposes.
2. Refer to the Focused Feasibility Study prepared by Brown and Caldwell (Appendix E) for Area 5 estimated costs.



SITE COORDINATES: 42°25'15"N 71°04'27"W



U.S.G.S. QUADRANGLE: BOSTON NORTH, MA

HALEY & ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

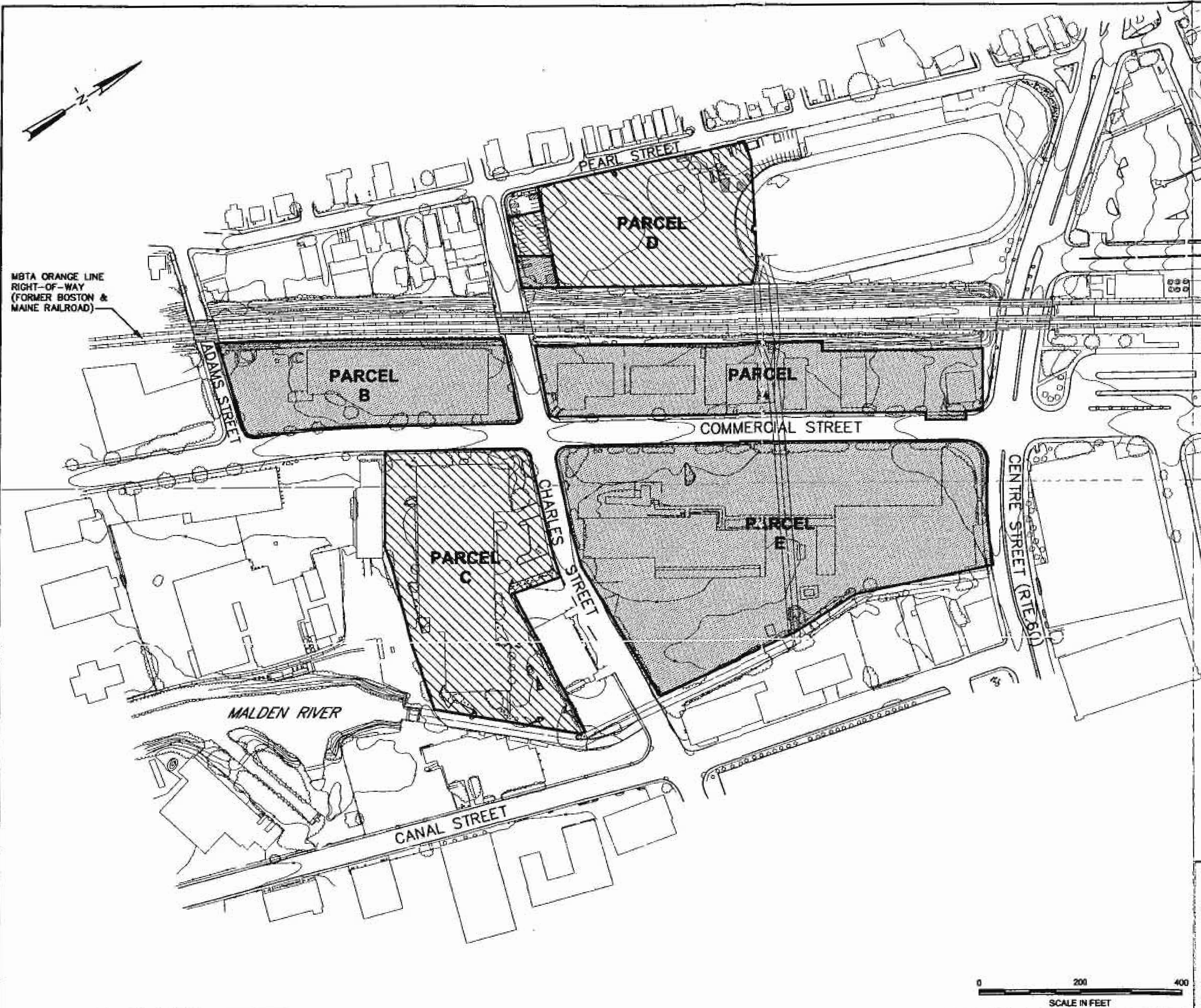
PROJECT LOCUS

APPROXIMATE SCALE: 1:25,000

JUNE 2003

FIGURE 1

29847-000 A01



LEGEND:

WAIVER COMPLETION STATEMENT OR RAO FILED WITH MADEP

RTN 3-0362

NOTES:

1. BASE PLAN SOURCE: "TOPOGRAPHIC WORKSHEET OF THE MANUFACTURED GAS PLANT, MALDEN, MA." FOR MASSACHUSETTS ELECTRIC COMPANY, WESTBOROUGH, MA. BY EASTERN TOPOGRAPHICS, WOLFEBORO, NH. SCALE 1"=40', CONTOUR INTERVAL: 2', PHOTO DATE: 23 MAY 1995, COMPILATION DATE: 22 JUNE 1995. SITE CONDITIONS ON PARCEL D ARE FROM "AS BUILT SITE PLAN OF WILLIAM R. CALLAHAN MEMORIAL PARK, MALDEN, MASS." BY MEDFORD ENGINEERING & SURVEY, 10 OCTOBER 1996.
2. THE EXTENT OF PARCEL BOUNDARIES IS APPROXIMATE BASED ON AVAILABLE HISTORIC PLANS.
3. BOUNDARIES OF DEP SITES ARE APPROXIMATE.

HALEY & ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

PARCEL DESIGNATIONS

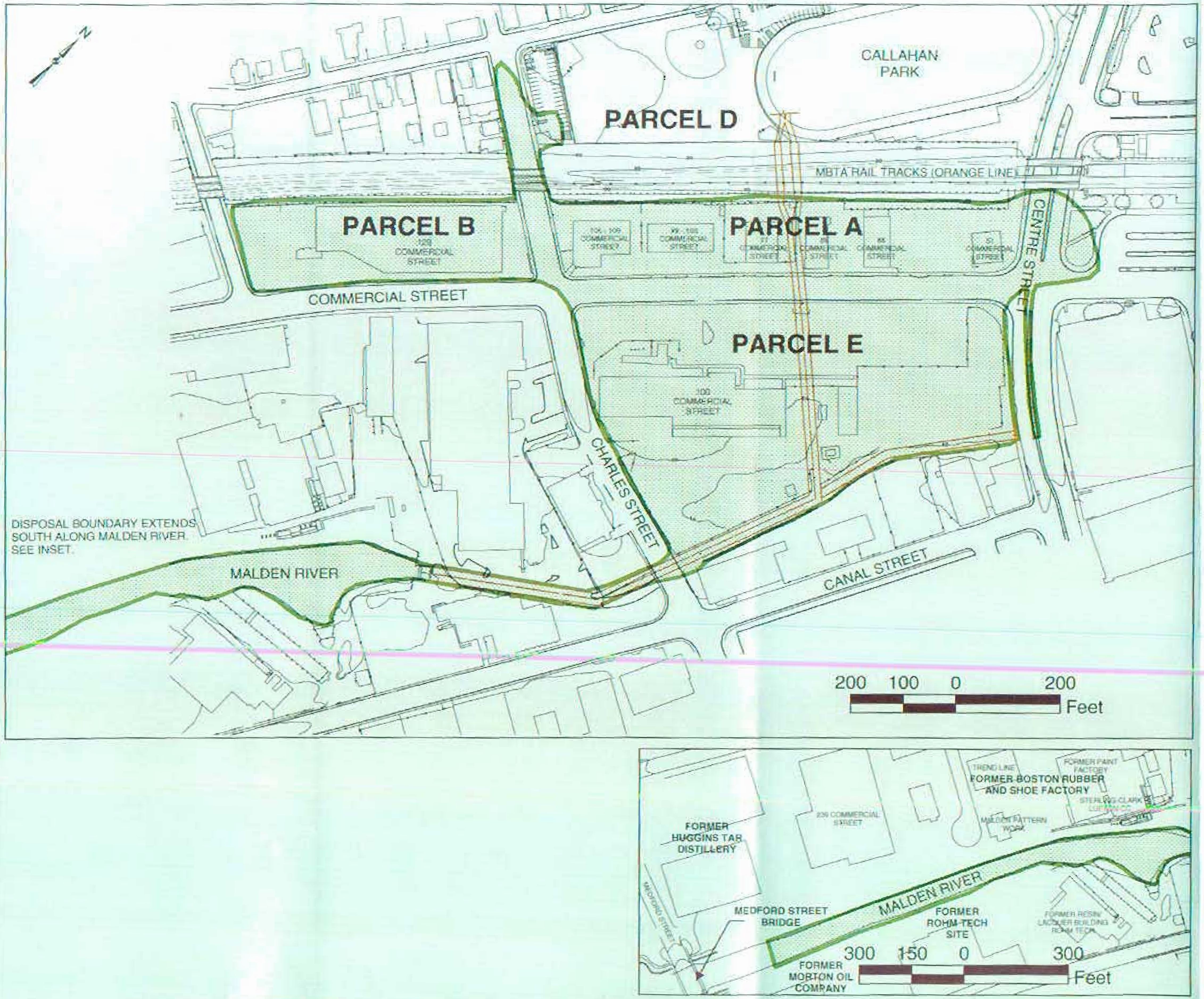
SCALE: AS SHOWN

JUNE 2003

29847-000 B02

FIGURE 2

G:/06558/616 Ph II/ArcView/Phase_III_Arc_Map_Figures/Fig3.mxd ARCGIS



LEGEND:

- FORMER MALDEN MGP DISPOSAL SITE BOUNDARY
- PILE-SUPPORTED CONCRETE CULVERTS INSTALLED BY MDC
- EXISTING CHAIN LINK FENCE
- GROUND SURFACE CONTOUR
- RAILROAD TRACKS

NOTES:
1. BASE PLAN ADAPTED FROM "TOPOGRAPHIC WORKSHEET OF THE MANUFACTURED GAS PLANT, MALDEN, MA" FOR MASSACHUSETTS ELECTRIC COMPANY BY EASTERN TOPOGRAPHICS, JUNE 1995, AND CITY OF MALDEN ASSESSOR'S PLAN SHEETS 1 AND 2, JUNE 1995, AND SHEET NO. 53 BY FAY, SPOFFORD &THORNDIKE, INC., REVISED 30 JULY 1979.
2. ELEVATIONS ARE IN FEET AND RELATIVE TO NGVD.

HALEY & ALDRICH
UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

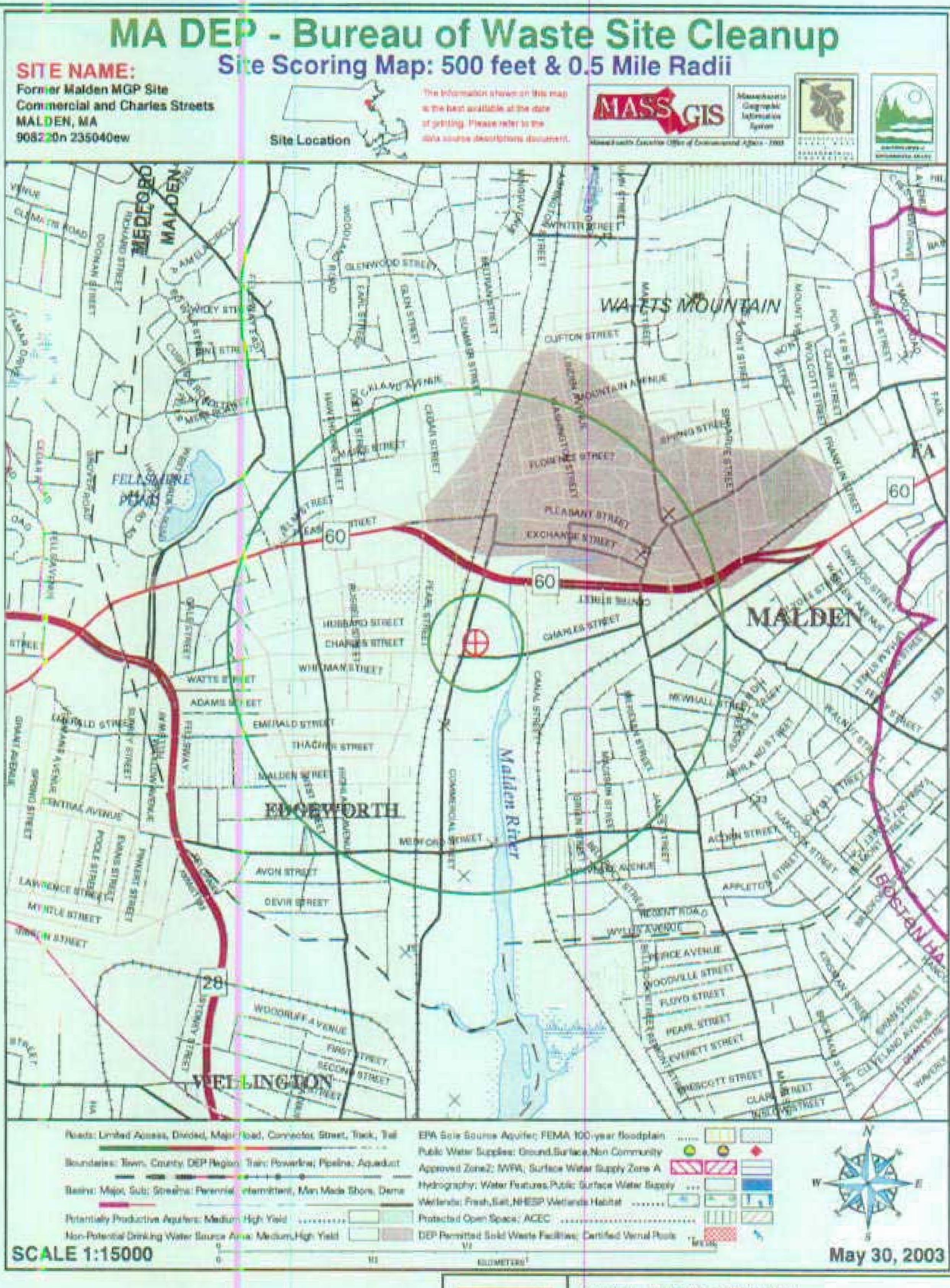
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

DISPOSAL SITE BOUNDARY

SCALE AS SHOWN

JUNE 2003

FIGURE 3



PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

HALEY & ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

MA DEP SITE
NATURAL RESOURCES MAP

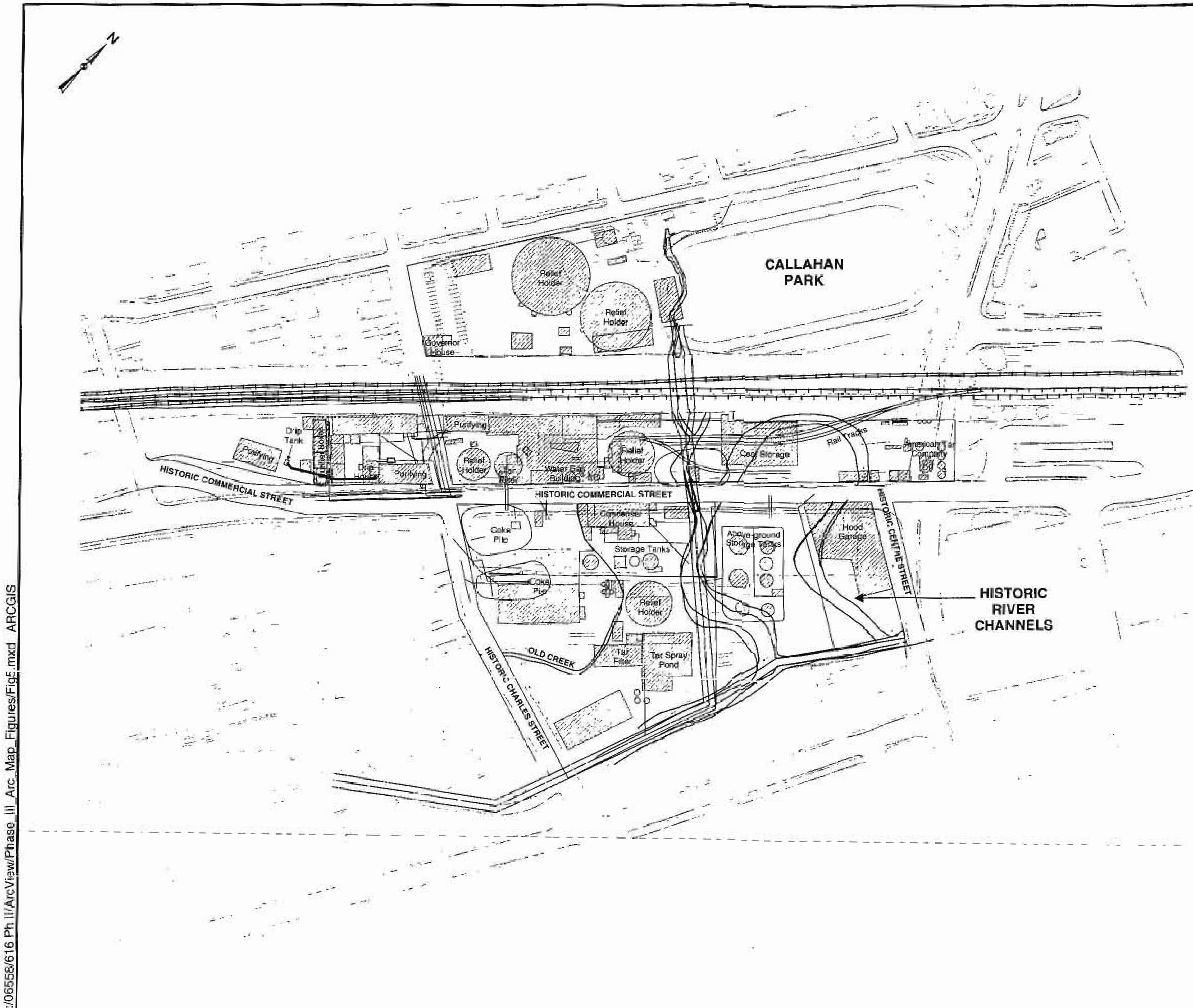
NOT TO SCALE

JUNE 2003

29847-000 A11

FIGURE 4

G:/06558/616 Ph II/ArcView/Phase_III_Arc_Map_Figures/Fig5.mxd ARCGIS



LEGEND:

- HISTORIC MGP OPERATIONAL FEATURES
- APPROXIMATE LIMITS OF HISTORIC WATER FEATURES, 1907 AND 1916
- PRESENT-DAY BASEMAP FEATURES
- RAILROAD TRACKS
- EXISTING PILE-SUPPORTED CONCRETE CULVERTS (INSTALLED CIRCA 1970)

NOTES:
1. BASE PLAN ADAPTED FROM "TOPOGRAPHIC WORKSHEET OF THE MANUFACTURED GAS PLANT, MALDEN, MA" FOR MASSACHUSETTS ELECTRIC COMPANY BY EASTERN TOPOGRAPHICS, JUNE 1995, AND CITY OF MALDEN ASSESSOR'S PLAN SHEETS 1 AND 2, JUNE 1995, AND SHEET NO. 53 BY FAY, SPOFFORD &THORNDIKE, INC., UPDATED JUNE 1976 AND REVISED 30 JULY 1979.
2. HISTORIC RIVER LIMITS AND MGP STRUCTURES ESTIMATED BASED ON HISTORIC SANBORN PLANS, "MALDEN AND MELROSE GAS LIGHT CO., LAND PLAN", 1907, AND "MALDEN AND MELROSE GAS LIGHT CO., MALDEN MASS., PLAN OF WORKS", 1916.

200 100 0 200 Feet

HALEY & ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

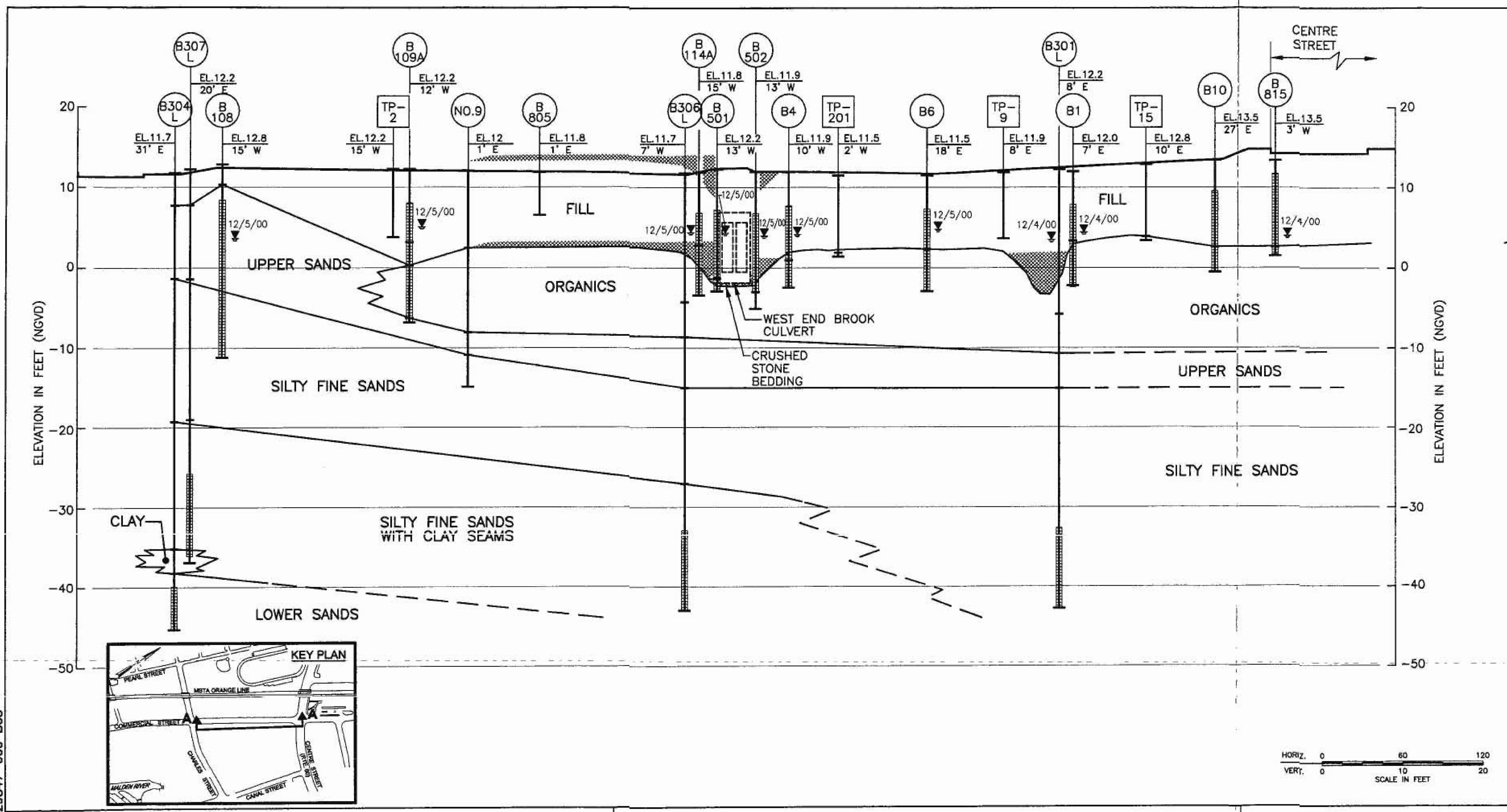
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

HISTORIC MGP
OPERATIONAL FEATURES

SCALE AS SHOWN

JUNE 2003

FIGURE 5



LEGEND:

TP-15	TEST PIT DESIGNATION
B 815	TEST BORING DESIGNATION
EL.13.5 3' W	APPROXIMATE GROUND SURFACE ELEVATION OFFSET DISTANCE (IN FEET) AND DIRECTION FROM PROFILE LINE
	INDICATES APPROXIMATE LOCATION OF TAR SATURATED MATERIAL
	INTERPRETED GEOLOGIC STRATUM INTERFACE DASHED WHERE INFERRED
	LOCATION OF WELL SCREEN INSTALLED IN COMPLETED BOREHOLE
12/4/00	WATER LEVEL MEASURED IN OBSERVATION WELL AND DATE OF OBSERVATION
	BOTTOM OF EXPLORATION

GEOLOGY LEGEND:

FILL	SAND WITH SILT, ASH, SLAG, CINDERS, WOOD, BRICK AND OTHER URBAN INDUSTRIAL MATERIAL
ORGANIC DEPOSIT	PEAT GRADING TO ORGANIC SILT
UPPER SANDS	FINE TO MEDIUM SAND WITH SOME COARSE SAND
SILTY FINE SANDS	SILTY FINE SAND BECOMING FINER WITH DEPTH
SILTY FINE SAND WITH CLAY SEAMS	SILTY FINE SAND WITH SEAMS AND LENSES OF CLAY
CLAY	SILTY CLAY WITH TRACES OF FINE SAND
LOWER SANDS	COARSE TO FINE SAND WITH SOME GRAVEL

NOTE:

1. TOP OF ORGANIC DEPOSIT STRATUM INTERFACE DERIVED FROM TOP OF ORGANIC DEPOSIT CONTOUR PLAN PRESENTED ON FIGURE 9.

HALEY & ALDRICH
UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

PHASE III – REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

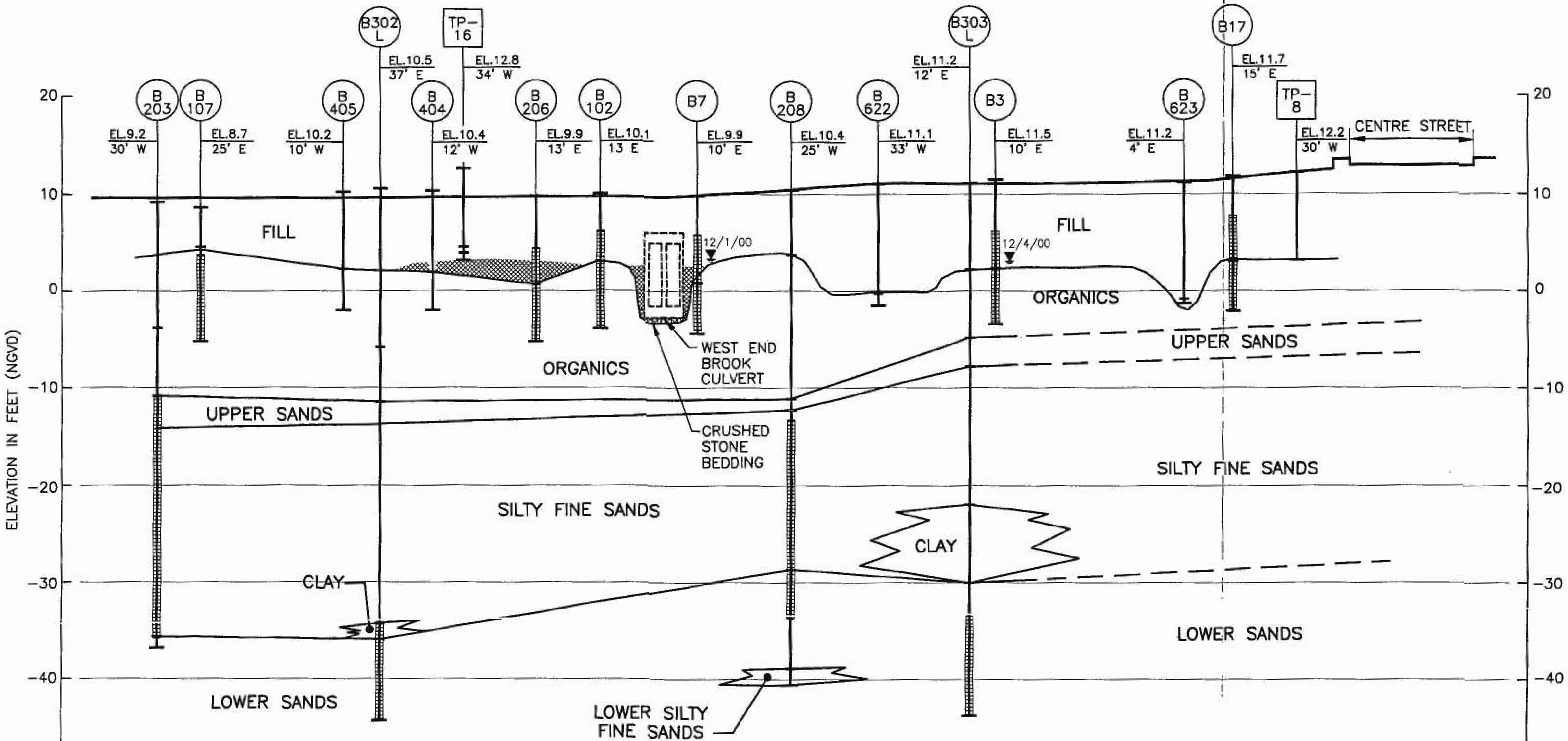
PROFILE A–A

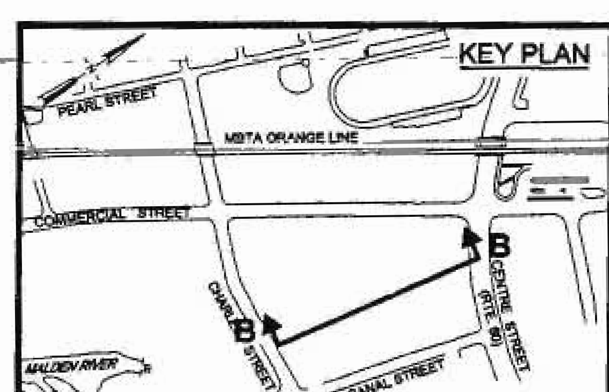
SCALE: AS SHOWN

JUNE 2003

FIGURE 6A

29847-000 B04 (B03)





NOTE:

SEE FIGURE 6A FOR LEGEND AND NOTES.

HORIZ. 0 60 120
VERT. 0 10 20
SCALE IN FEET

HALEY & ALDRICH
UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

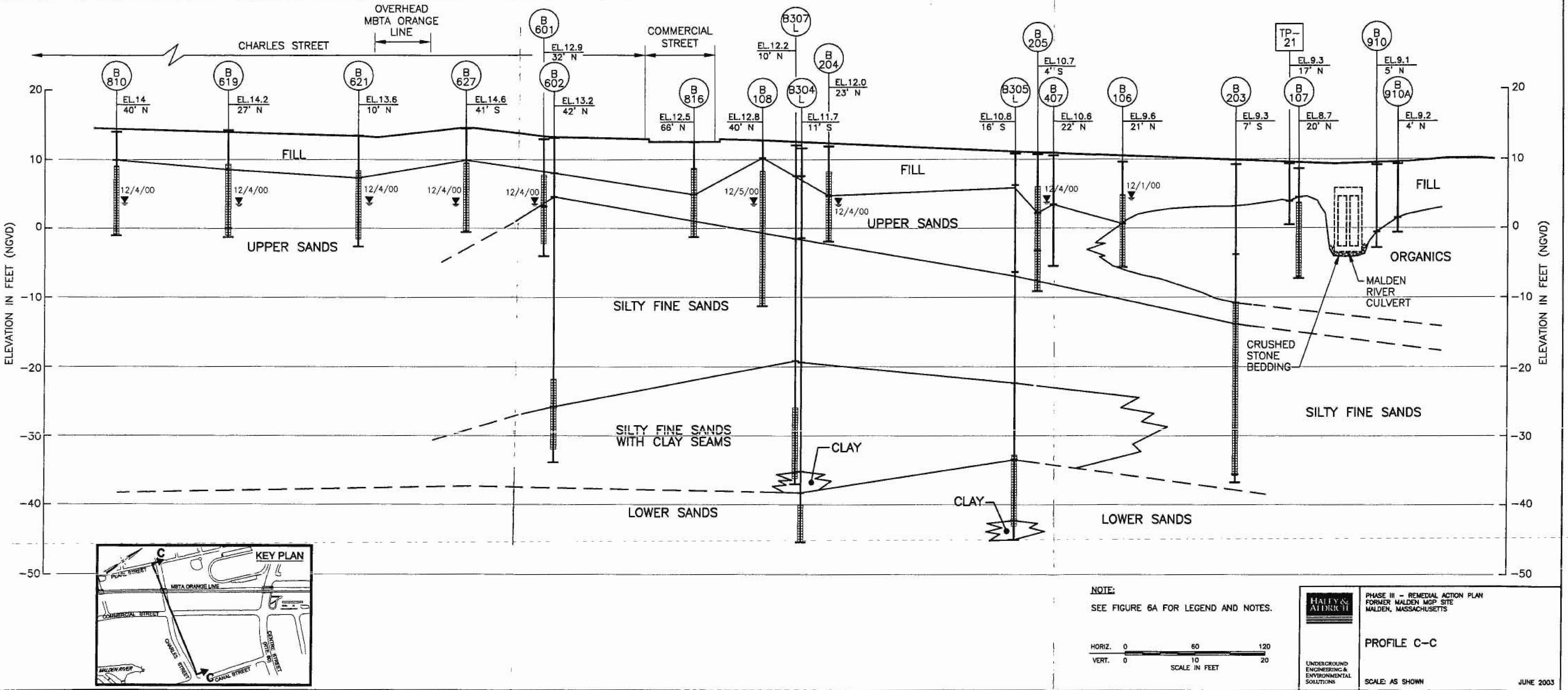
PROFILE B-B

SCALE: AS SHOWN

JUNE 2003

FIGURE 6B

29847-000 B05 (B03)



NOTE:

SEE FIGURE 6A FOR LEGEND AND NOTES.

HORIZ. 0 60 120
VERT. 0 10 20
SCALE IN FEET

HALEY & ALDRICH
UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

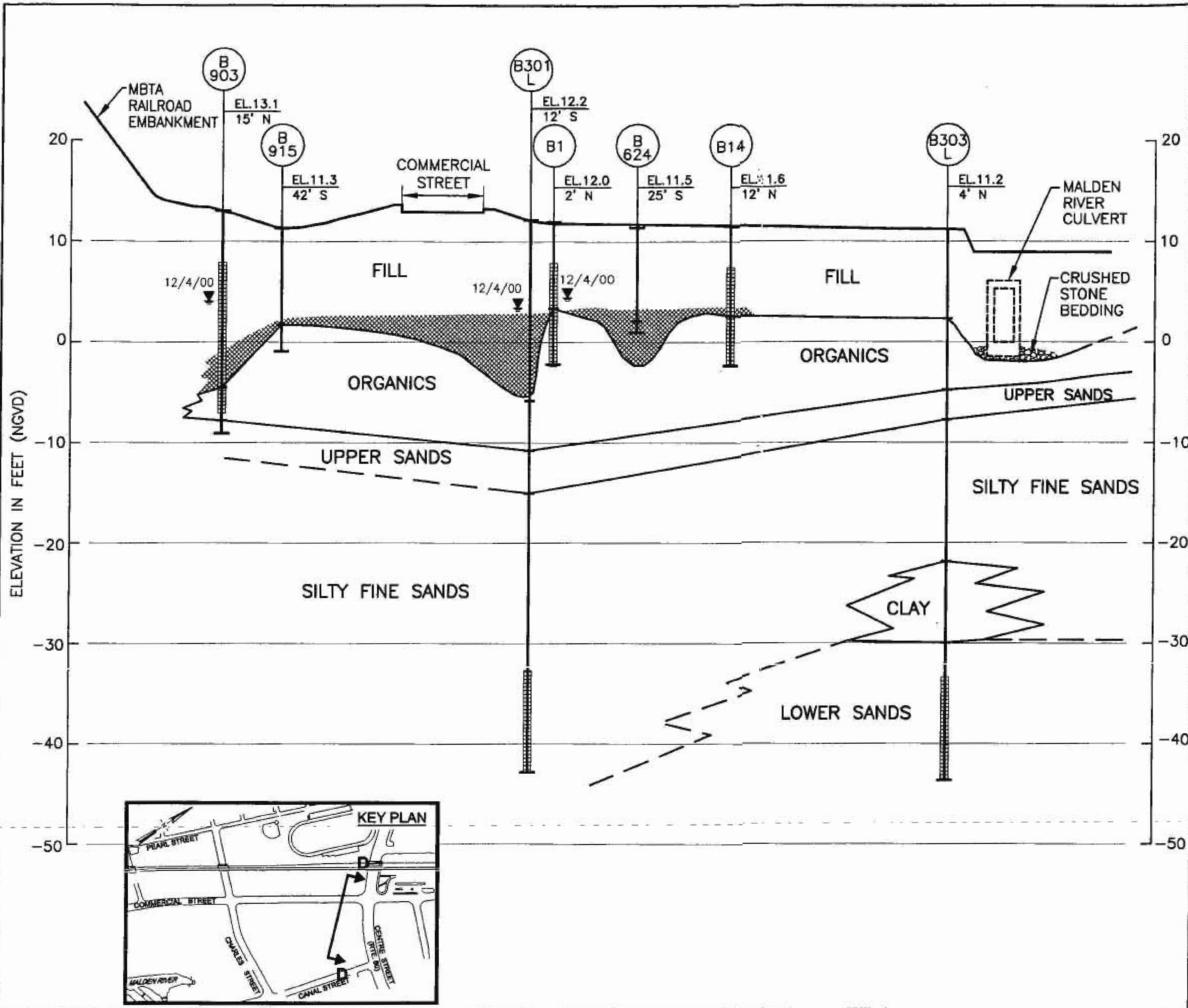
PHASE III – REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

PROFILE C–C

SCALE: AS SHOWN

JUNE 2003

FIGURE 6C



NOTE:

SEE FIGURE 6A FOR LEGEND AND NOTES.

HORIZ. 0 60 120
VERT. 0 10 20
SCALE IN FEET

HALEY & ALDRICH
UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

PHASE III – REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

PROFILE D–D

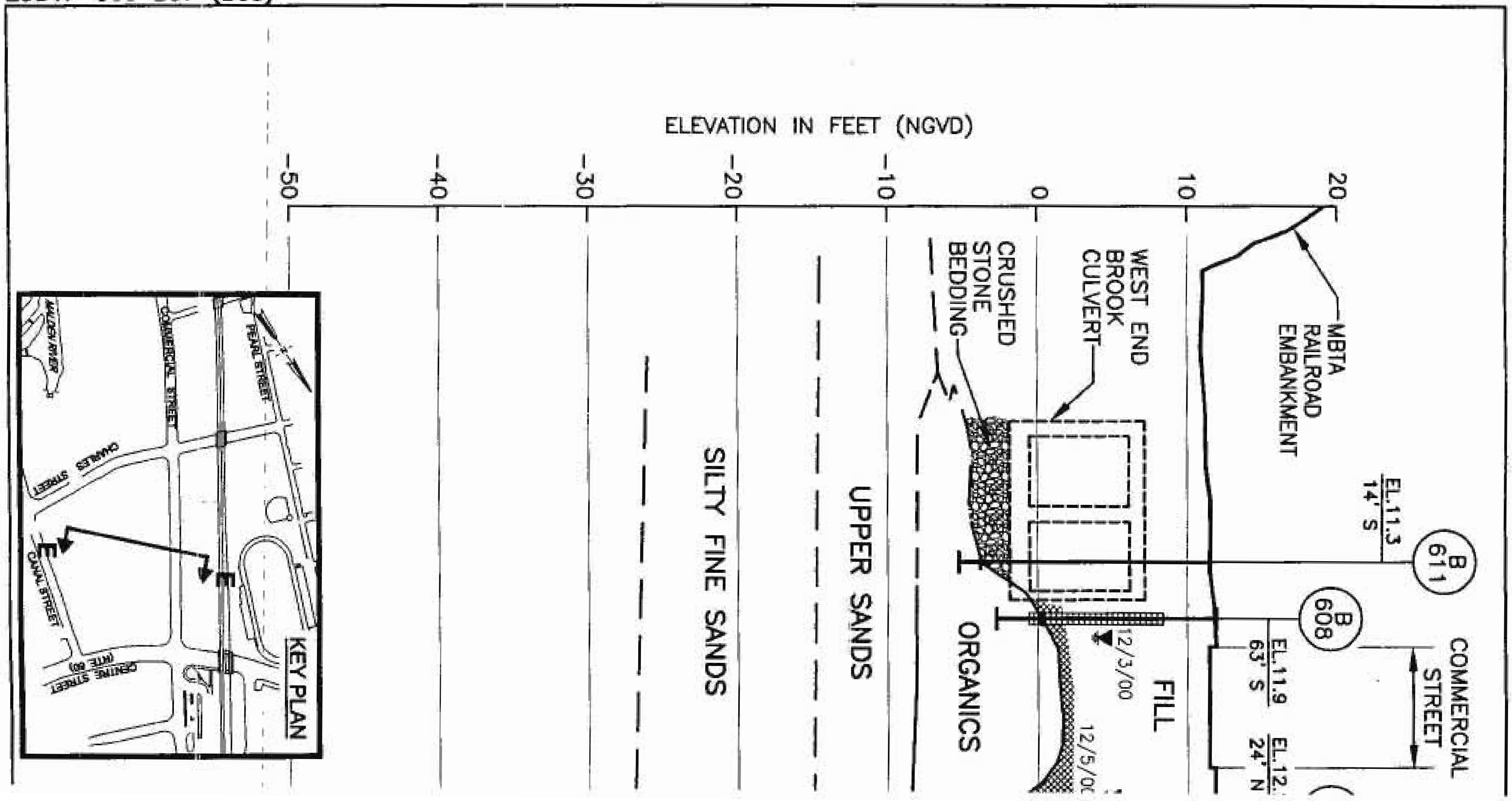
SCALE: AS SHOWN

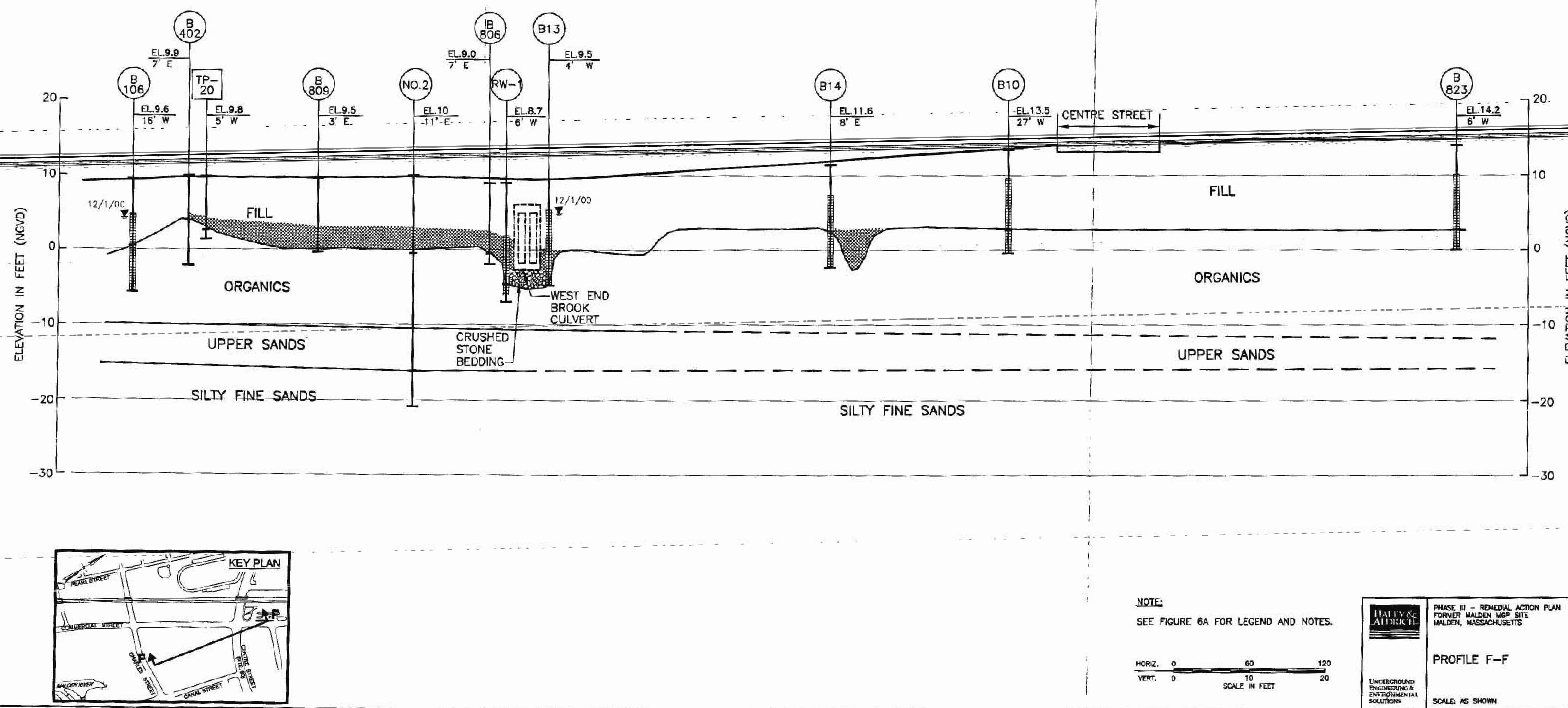
JUNE 2003

FIGURE 6D

29847-000 B06 (B03)

29847-000 B07 (B03)





29847-000 B08 (B03)

NOTE:

SEE FIGURE 6A FOR LEGEND AND NOTES.

HORIZ. 0 60 120
VERT. 0 10 20
SCALE IN FEET

HALEY & ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

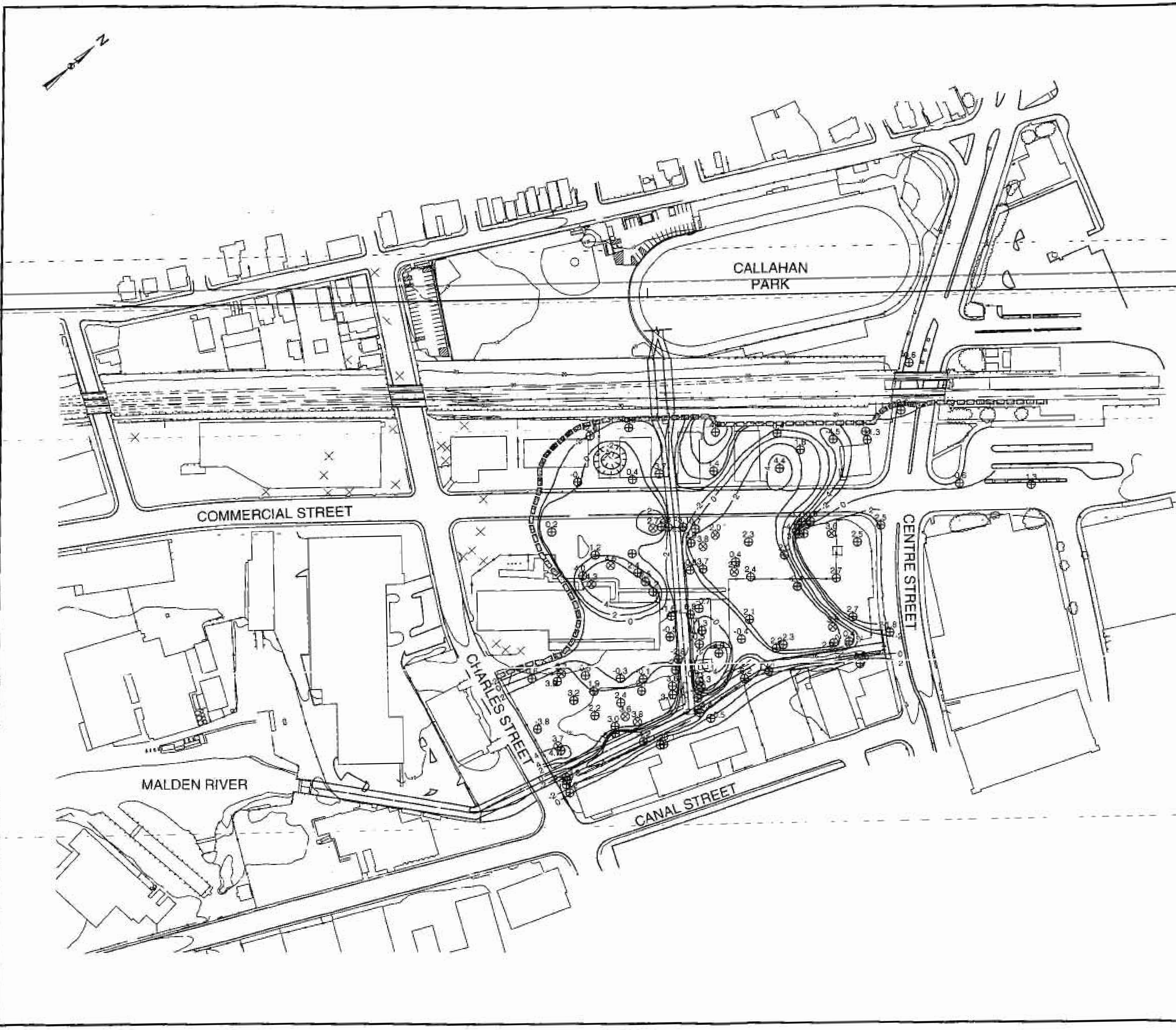
PROFILE F-F

SCALE: AS SHOWN

JUNE 2003

FIGURE 6F

G:/06558/616 Ph II/ArcView/Phase_III_Arc_Map_Figures/Fig7.mxd ARCGIS



LEGEND:

- ⊕ 4.64 — ELEVATION OF THE TOP OF THE ORGANIC DEPOSIT BASED ON TEST BORING OBSERVATIONS
- ⊗ 4.64 — ELEVATION OF THE TOP OF THE ORGANIC DEPOSIT BASED ON TEST PIT OBSERVATIONS
- × — ORGANIC DEPOSIT NOT DETECTED AT THIS LOCATION
- — 10 — GROUND SURFACE CONTOUR (10-FOOT INTERVAL)
- — 4 — ELEVATION CONTOURS OF THE TOP OF THE ORGANIC DEPOSIT (2-FOOT INTERVAL)
- ▭▭▭▭ APPROXIMATE LIMITS OF THE ORGANIC DEPOSIT
- —— EXISTING CONDITIONS
- —— PILE-SUPPORTED CONCRETE CULVERTS

NOTES:

1. BASE PLAN ADAPTED FROM "TOPOGRAPHIC WORKSHEET OF THE MANUFACTURED GAS PLANT, MALDEN, MA" FOR MASSACHUSETTS ELECTRIC COMPANY BY EASTERN TOPOGRAPHICS, JUNE 1995, AND CITY OF MALDEN ASSESSOR'S PLAN SHEETS 1 AND 2, JUNE 1995, AND SHEET NO. 53 BY FAY, SPOFFORD &THORNDIKE, INC., UPDATED JUNE 1976 AND REVISED 30 JULY 1979.
2. ELEVATIONS ARE IN FEET AND RELATIVE TO NGVD.

200 100 0 200 Feet

HALEY & ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

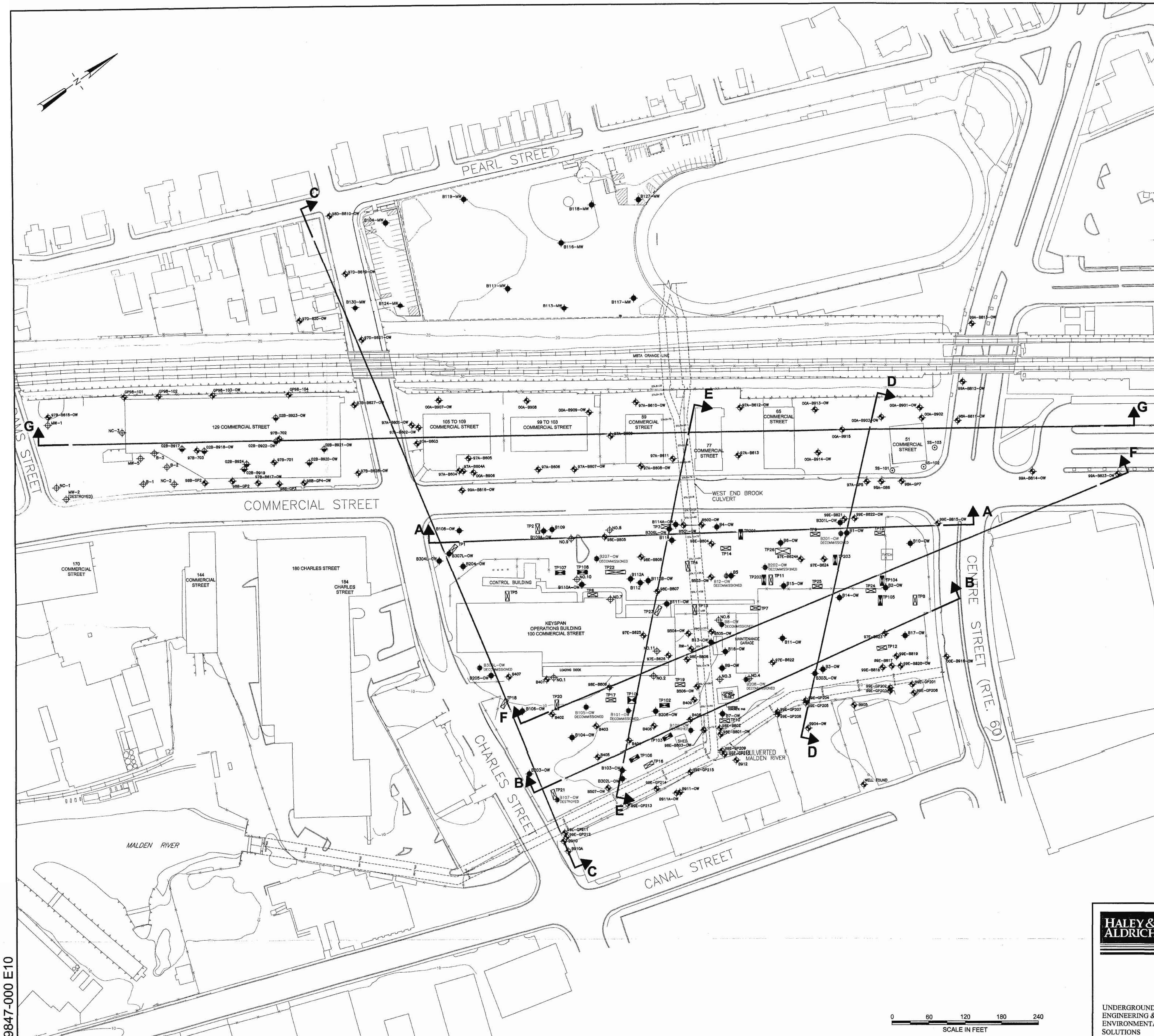
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

TOP OF ORGANIC DEPOSIT CONTOUR PLAN

SCALE AS SHOWN

JUNE 2003

FIGURE 7



LEGEND:

DESIGNATION AND APPROXIMATE LOCATION OF BORINGS DRILLED BY GEOLOGIC, INC., UNDER TECHNICAL OBSERVATION OF HALEY & ALDRICH, INC.:

- 98E-B801 DRILLED 19 NOVEMBER – 10 DECEMBER 1998 AND 23 JULY – 25 AUGUST 1999
- 97A-B601 DRILLED 8-26 JULY 1997
- B403 DRILLED 5-7 APRIL 1995
- B301L DRILLED 18 JANUARY TO 12 FEBRUARY 1991
- B201 DRILLED 27-29 JULY AND 1-11 AUGUST 1988
- B101 DRILLED 2-7 MAY 1988
- B1 DRILLED 23-25 NOVEMBER AND 1-3 DECEMBER 1987

DESIGNATION AND APPROXIMATE LOCATION OF BORINGS DRILLED BY GUILD DRILLING CO., INC. UNDER TECHNICAL OBSERVATION OF HALEY & ALDRICH, INC.:

- B501 DRILLED 25-30 JULY 1996
- 97B-701 DRILLED 13-15 FEBRUARY 1998
- 02B-B917 DRILLED 18-21 FEBRUARY 2002 AND 28 JULY 2002

DESIGNATION AND APPROXIMATE LOCATION OF GEOPROBES DRILLED BY TECHNICAL DRILLING CO., INC. UNDER TECHNICAL OBSERVATION OF HALEY & ALDRICH, INC.:

- GP98-101 DRILLED 24 APRIL 1998
- 98B-GP1 DRILLED 3 FEBRUARY 1998
- 99B-GP201 DRILLED 2-4 AUGUST 1999

NO.1 DESIGNATION AND APPROXIMATE LOCATION OF BORING DRILLED BY CARR-DEE CORPORATION, ON 29 SEPTEMBER-2 OCTOBER 1975

OW INDICATES GROUNDWATER MONITORING WELL WAS INSTALLED IN THE COMPLETED BOREHOLE

TP202 DESIGNATION AND APPROXIMATE LOCATION OF MACHINE-EXCAVATED TEST PITS BY J. MARCHESE & SONS, INC., EVERETT, MASSACHUSETTS ON 2 SEPTEMBER 1998.

TP102 DESIGNATION AND APPROXIMATE LOCATION OF MACHINE-EXCAVATED TEST PITS BY J. MARCHESE & SONS, INC., EVERETT, MASSACHUSETTS ON 18 TO 21 MARCH 1995.

TP8 DESIGNATION AND APPROXIMATE LOCATION OF MACHINE-EXCAVATED TEST PITS BY CROSSROADS CONSTRUCTION CO., INC., MELROSE, MASSACHUSETTS ON 6 TO 14 AUGUST 1988.

SS-101 DESIGNATION AND APPROXIMATE LOCATION OF SURFACE SOIL SAMPLES BY HALEY & ALDRICH, INC. ON 9 JUNE 2002

A A DESIGNATION, APPROXIMATE LOCATION AND ORIENTATION OF SUBSURFACE PROFILE (SEE FIGURES 6A THRU 6G)

NOTES:

1. BASE PLAN ADAPTED FROM "TOPOGRAPHIC WORKSHEET OF THE MANUFACTURED GAS PLANT, MALDEN, MA" FOR MASSACHUSETTS ELECTRIC COMPANY, WESTBOROUGH, MA, BY EASTERN TOPOGRAPHICS, WOLFEBORO, NH, SHEETS 1 AND 2, AT A SCALE OF 1 IN. EQUALS 40 FT., JUNE 1995, AND CITY OF MALDEN ASSESSOR'S PLAN SHEET NO. 53, BY FAY, SPOFFORD & THORNDIKE, INC., BOSTON, MA, AT A SCALE OF 1 IN. EQUALS 40 FT., UPDATED JUNE 1976 AND REVISED 30 JULY 1979.
2. LOCATION OF TEST BORINGS AND TEST PITS WERE DETERMINED BY HALEY & ALDRICH, INC.

HALEY & ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

SUBSURFACE EXPLORATION AND SAMPLING LOCATION PLAN

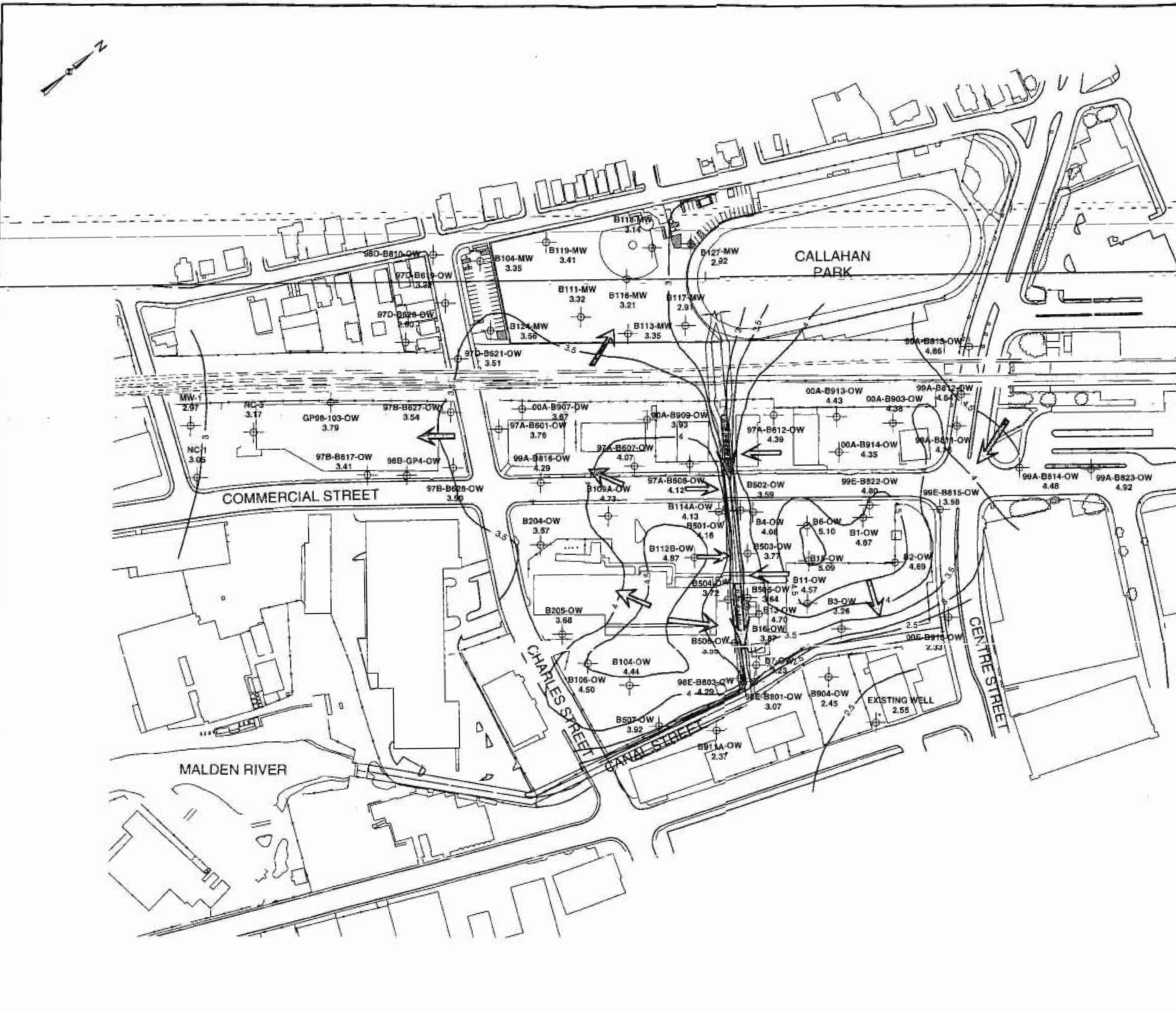
SCALE: AS SHOWN

JUNE 2003

29847-000 E10

FIGURE 8

G:/06558/616 Ph II/ArcView/Phase_III_Arc_Map_Figures/Fig9.mxd ARCGIS



LEGEND:

- 98E-B803-OW 4.29 — DESIGNATION AND APPROXIMATE LOCATION OF MONITORING WELL AND GROUNDWATER ELEVATION USED IN SHALLOW GROUNDWATER CONTOURING, DECEMBER 2000
- — 4 — GROUNDWATER ELEVATION CONTOURS DECEMBER 2000
- APPROXIMATE GROUNDWATER FLOW DIRECTION
- EXISTING CONDITIONS
- PILE-SUPPORTED CONCRETE CULVERTS

NOTES:

1. BASE PLAN ADAPTED FROM "TOPOGRAPHIC WORKSHEET OF THE MANUFACTURED GAS PLANT, MALDEN, MA" FOR MASSACHUSETTS ELECTRIC COMPANY BY EASTERN TOPOGRAPHICS, JUNE 1995, AND CITY OF MALDEN ASSESSOR'S PLAN SHEETS 1 AND 2, JUNE 1995, AND SHEET NO. 53 BY FAY, SPOFFORD &THORNDIKE, INC., UPDATED JUNE 1976 AND REVISED 30 JULY 1979.
2. ELEVATIONS ARE IN FEET AND RELATIVE TO NGVD.

200 100 0 200
Feet

HALEY & ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

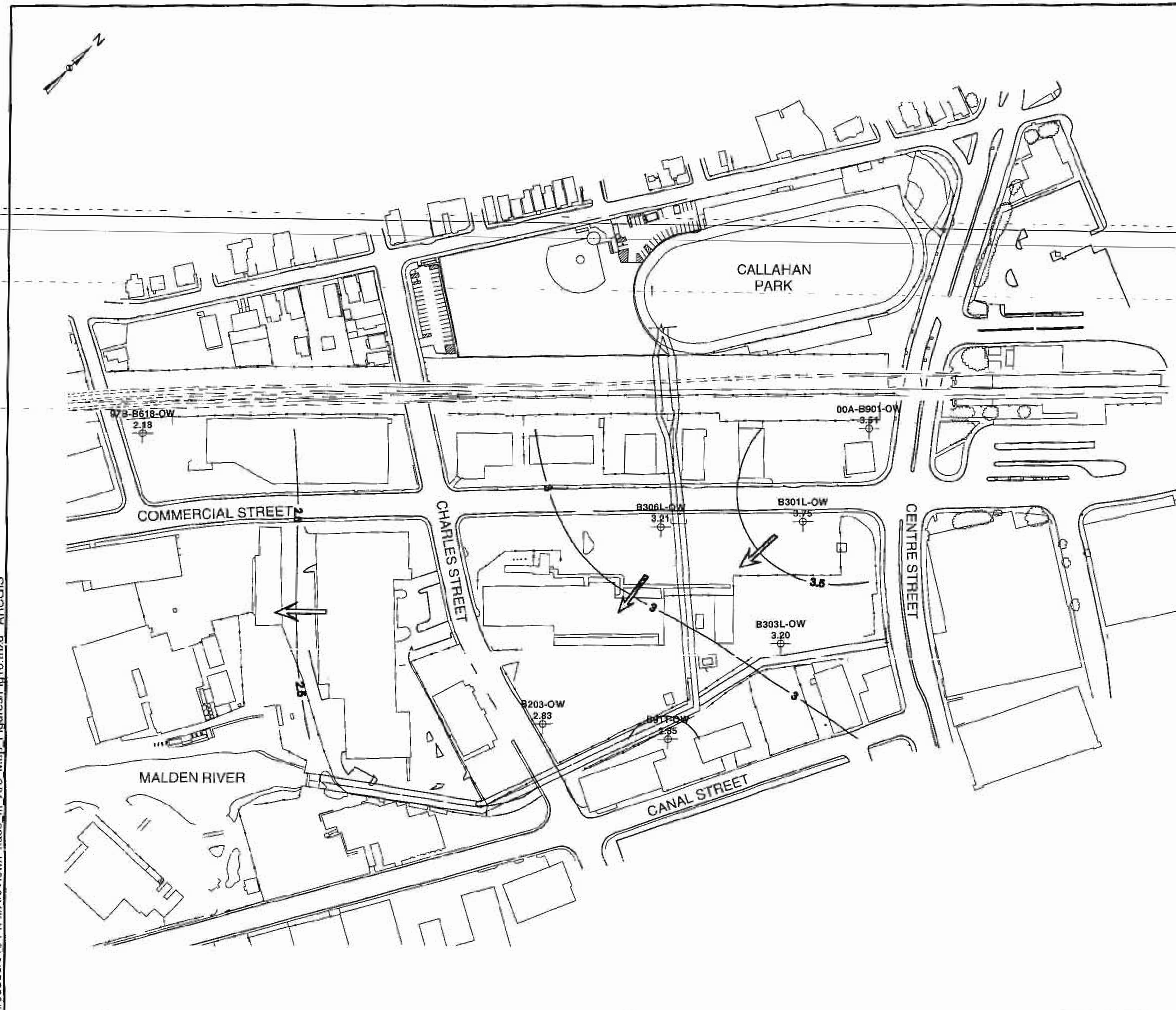
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

SHALLOW GROUNDWATER
ELEVATION CONTOURS
DECEMBER 2000

SCALE AS SHOWN

JUNE 2003

FIGURE 9



G:/06558/616 Ph II/ArcView/Phase_III_Arc_Map_Figures/Fig10.mxd ARCGIS

LEGEND:

B303L-OW 4.64 — DESIGNATION AND APPROXIMATE LOCATION OF DEEP MONITORING WELL AND GROUNDWATER HYDRAULIC HEAD, AUGUST 2001

— 4 — DEEP GROUNDWATER HYDRAULIC HEAD CONTOURS, AUGUST 2001

APPROXIMATE FLOW DIRECTION OF DEEP GROUNDWATER

EXISTING CONDITIONS

PILE-SUPPORTED CONCRETE CULVERTS

NOTES:

1. BASE PLAN ADAPTED FROM "TOPOGRAPHIC WORKSHEET OF THE MANUFACTURED GAS PLANT, MALDEN, MA" FOR MASSACHUSETTS ELECTRIC COMPANY BY EASTERN TOPOGRAPHICS, JUNE 1995, AND CITY OF MALDEN ASSESSOR'S PLAN SHEETS 1 AND 2, JUNE 1995, AND SHEET NO. 53 BY FAY, SPOFFORD &THORNDIKE, INC., UPDATED JUNE 1976 AND REVISED 00 JULY 1070.
2. ELEVATIONS ARE IN FEET AND RELATIVE TO NGVD.

200 100 0 200 Feet

HALEY & ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

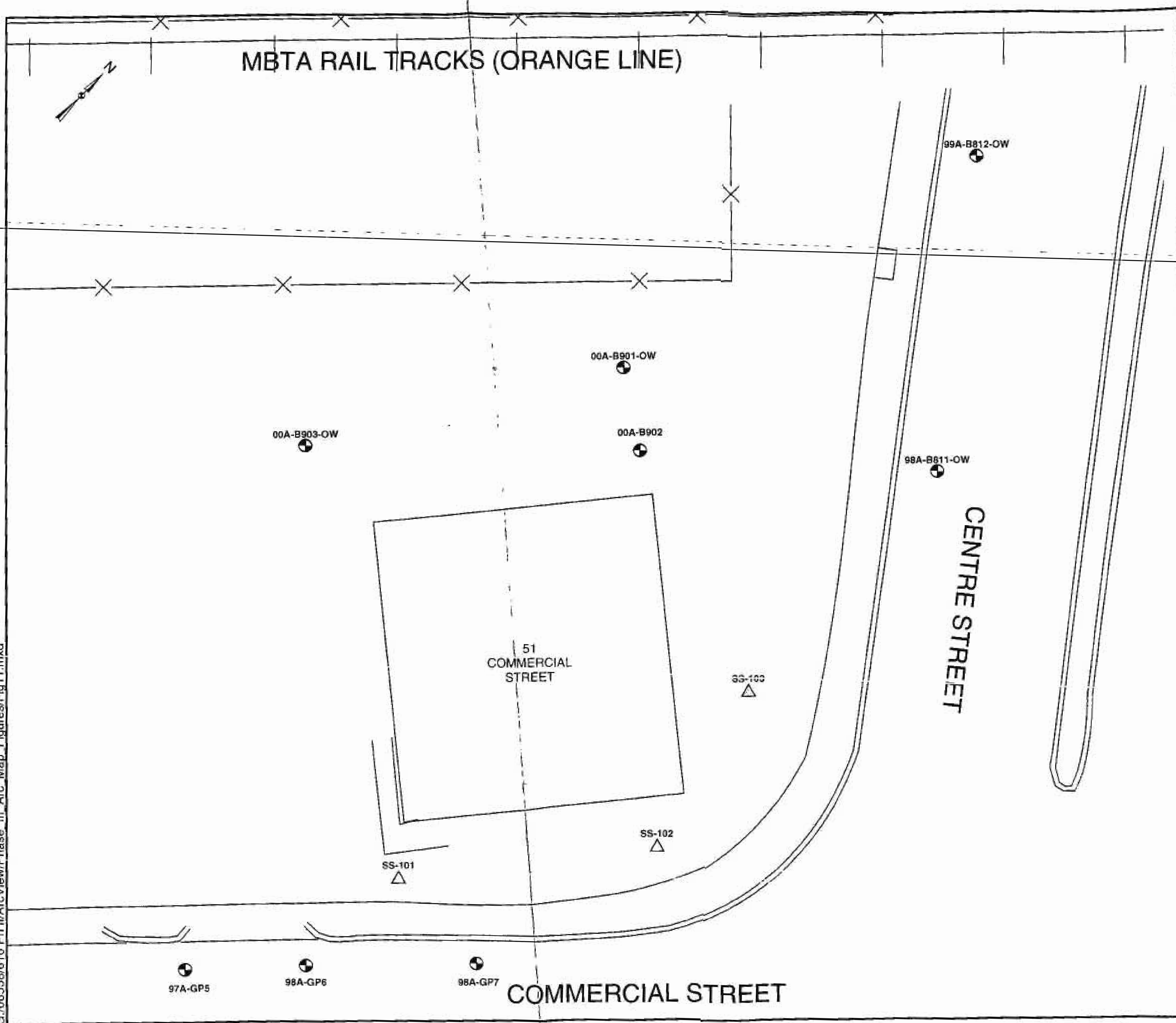
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

DEEP GROUNDWATER ELEVATIONS
AUGUST 2001

SCALE AS SHOWN

JUNE 2003

FIGURE 10



LEGEND:

SS-101 ▲	DESIGNATION AND APPROXIMATE LOCATION OF SUPPLEMENTAL PHASE III SURFACE SOIL SAMPLE COLLECTED BY HALEY & ALDRICH, INC ON 9 JUNE 2002
00A-B903-OW	DESIGNATION AND APPROXIMATE LOCATION OF SHALLOW SOIL SAMPLE (0 TO 3 FT BGS) USED IN ORIGINAL RISK CHARACTERIZATION
98A-B811-OW	DESIGNATION AND APPROXIMATE LOCATION OF SOIL BORING OR MONITORING WELL COMPLETED DURING PHASE II INVESTIGATIONS

NOTES:

1. BASE PLAN ADAPTED FROM "TOPOGRAPHIC WORKSHEET OF THE MANUFACTURED GAS PLANT, MALDEN, MA" FOR MASSACHUSETTS ELECTRIC COMPANY BY EASTERN TOPOGRAPHICS, JUNE 1005, AND CITY OF MALDEN ASSESSOR'S PLAN SHEETS 1 AND 2, JUNE 1995, AND SHEET NO. 53 BY FAY, SPOFFORD & THORNDIKE, INC., UPDATED JUNE 1976 AND REVISED 30 JULY 1979.

20 10 0 20 Feet

HALEY & ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

PHASE III SUPPLEMENTAL
SOIL SAMPLE LOCATIONS
51 COMMERCIAL STREET

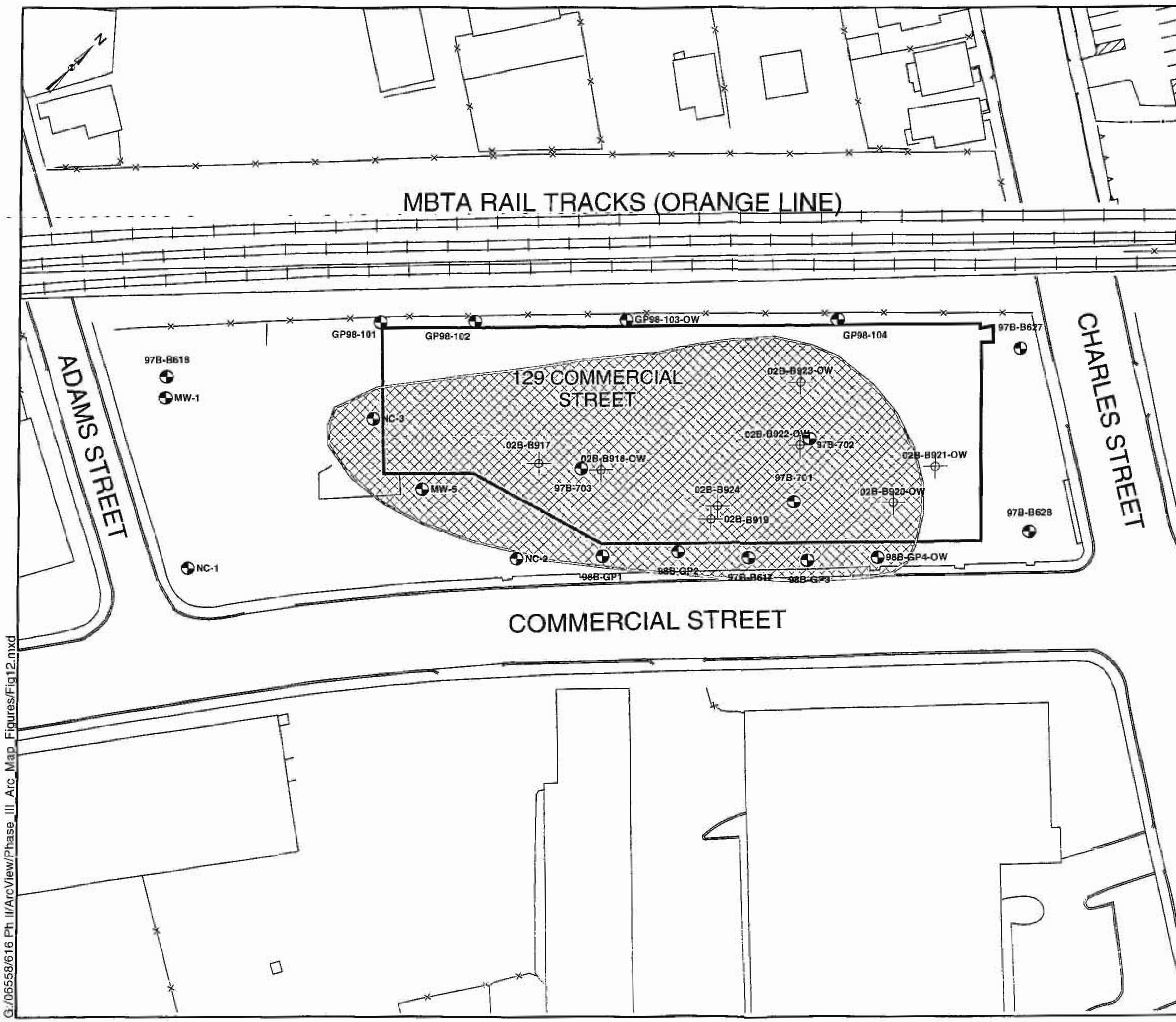
SCALE AS SHOWN

JUNE 2003

FIGURE 11

G:/06558/616 Ph II/ArcView/Phase_III_Arc_Map_Figures/Fig11.mxd

G:/06558/616 Ph II/ArcView/Phase_III_Arc_Map_Figures/Fig12.mxd



LEGEND:

02B-918-OW — DESIGNATION AND APPROXIMATE LOCATION OF SOIL BORING OR OBSERVATION WELL INSTALLED DURING SUPPLEMENTAL PHASE III INVESTIGATIONS BETWEEN FEBRUARY AND JULY 2002

02B-B919 — DESIGNATION AND APPROXIMATE LOCATION OF SOIL BORING OR MONITORING WELL INSTALLED DURING PHASE II INVESTIGATIONS

LIMITS OF AREA IN WHICH BTEXSN IMPACTS HAVE BEEN OBSERVED IN SOIL AND GROUNDWATER

NOTES:

1. BASE PLAN ADAPTED FROM "TOPOGRAPHIC WORKSHEET OF THE MANUFACTURED GAS PLANT, MALDEN, MA" FOR MASSACHUSETTS ELECTRIC COMPANY BY EASTERN TOPOGRAPHICS, JUNE 1005, AND CITY OF MALDEN ASSESSOR'S PLAN SHEETS 1 AND 2, JUNE 1995, AND SHEET NO. 53 BY FAY, SPOFFORD & THORNDIKE, INC., UPDATED JUNE 1976 AND REVISED 30 JULY 1979.

60 30 0 60 Feet

HALEY & ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

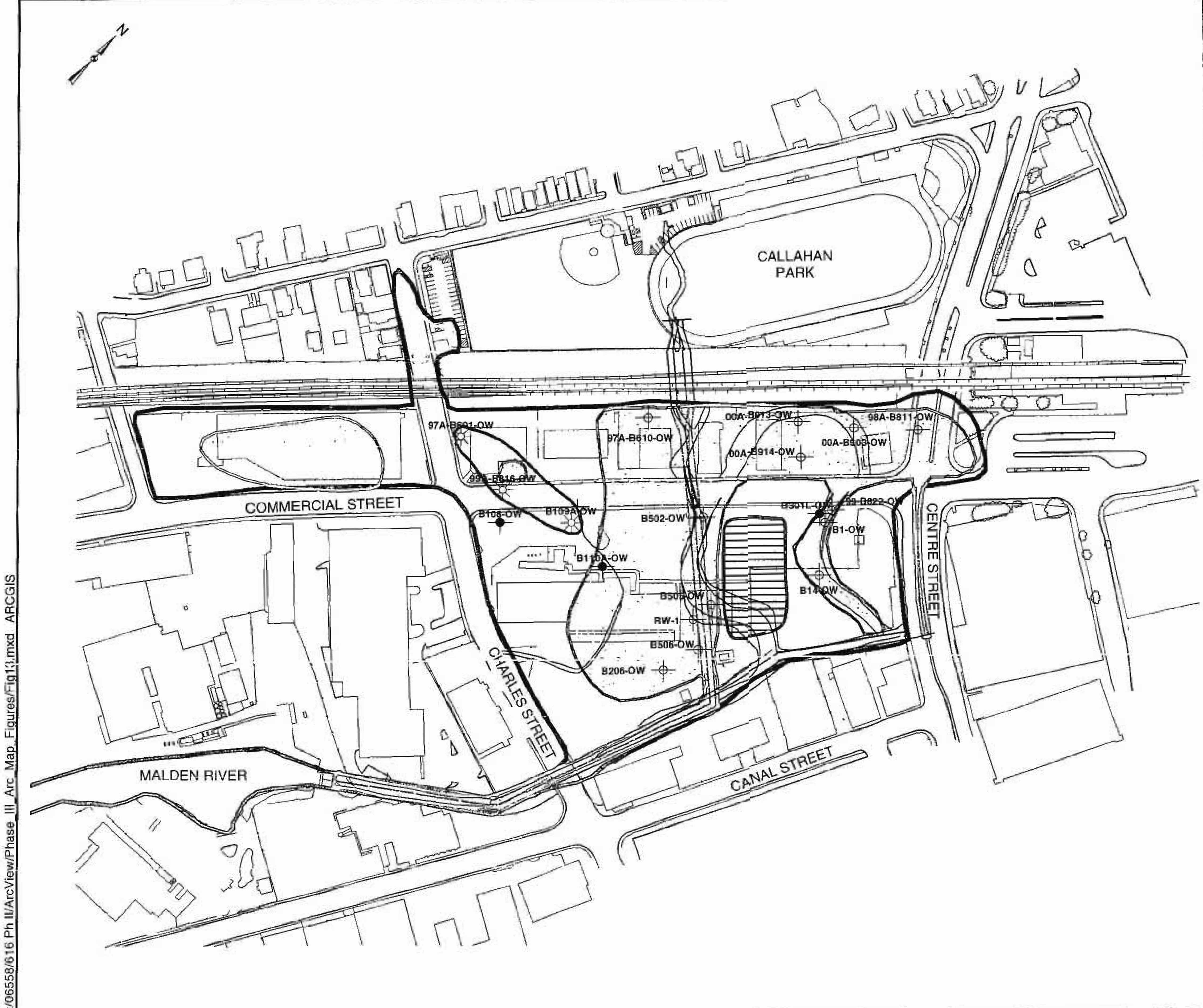
PHASE III SUPPLEMENTAL INVESTIGATION
129 COMMERCIAL STREET

SCALE AS SHOWN

JUNE 2003

FIGURE 12

G:/06558/616 Ph II/ArcView/Phase_III_Arc_Map_Figures/Fig13.mxd ARCGIS



LEGEND:

- B206-OW — DESIGNATION AND APPROXIMATE LOCATION OF SHALLOW MONITORING WELL AT WHICH DNAPL HAS BEEN DETECTED
- B110A-OW — DESIGNATION AND APPROXIMATE LOCATION OF DEEP MONITORING WELL AT WHICH DNAPL HAS BEEN DETECTED
- B109A-OW — DESIGNATION AND APPROXIMATE LOCATION OF MONITORING WELL AT WHICH LNAPL HAS BEEN DETECTED
- APPROXIMATE OBSERVED EXTENT OF TSM
- APPROXIMATE EXTENT OF PETROLEUM-IMPACTED SOIL ON PARCEL E
- APPROXIMATE EXTENT OF BTEXSN-IMPACTED SOIL AND GROUNDWATER ON PARCEL B
- APPROXIMATE OBSERVED EXTENT OF LNAPL
- APPROXIMATE EXTENT OF GOVERNOR HOUSE CONTAMINATION
- APPROXIMATE LIMITS OF FORMER MALDEN MGP DISPOSAL SITE
- PILE-SUPPORTED CONCRETE CULVERTS
- APPROXIMATE LIMITS OF HISTORIC WATER FEATURES, 1907 AND 1916

NOTES:

1. BASE PLAN ADAPTED FROM "TOPOGRAPHIC WORKSHEET OF THE MANUFACTURED GAS PLANT, MALDEN, MA" FOR MASSACHUSETTS ELECTRIC COMPANY BY EASTERN TOPOGRAPHICS, JUNE 1995, AND CITY OF MALDEN ASSESSOR'S PLAN SHEETS 1 AND 2, JUNE 1995, AND SHEET NO. 53 BY FAY, SPOFFORD &THORNDIKE, INC., UPDATED JUNE 1976 AND REVISED 30 JULY 1979.

3. HISTORIC RIVER LIMITS AND MGP STRUCTURES ESTIMATED BASED ON HISTORIC SANBORN PLANS, "MALDEN AND MELROSE GAS LIGHT CO., LAND PLAN", 1907, AND "MALDEN AND MELROSE PLAN OF WORKS", 1916.

200 100 0 200
Feet

HALEY & ALDRICH
UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

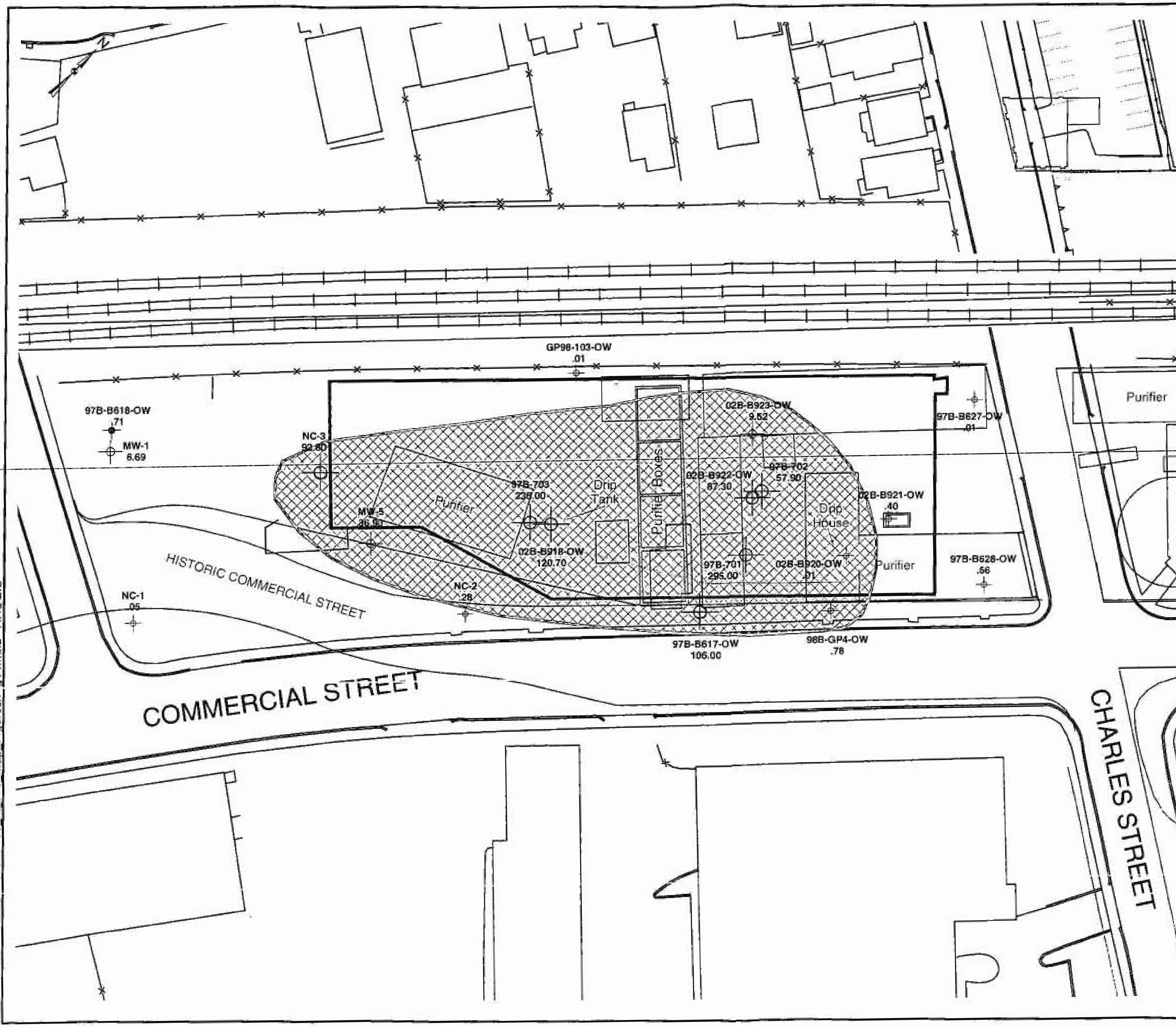
NATURE AND EXTENT OF OBSERVED CONTAMINATION

SCALE AS SHOWN

JUNE 2003

FIGURE 13

G:/06558/616 Ph II/ArcView/Phase_III_Arc_Map_Figures/Fig14.mxd ARCGIS



LEGEND:

97B-B628-OW, 100 — DESIGNATION AND APPROXIMATE LOCATION OF SHALLOW GROUNDWATER MONITORING WELL AND MAXIMUM OBSERVED BTEXSN CONCENTRATION (mg/l)

MAXIMUM OBSERVED BTEXSN CONCENTRATION = 50 to 300 mg/l

MAXIMUM OBSERVED BTEXSN CONCENTRATION = 1.0 to 50 mg/l

MAXIMUM OBSERVED BTEXSN CONCENTRATION = ND to 1.0 mg/l

DESIGNATION AND APPROXIMATE LOCATION OF DEEP GROUNDWATER MONITORING WELL TOTAL BTEXSN CONCENTRATION = 0 to 1.0 mg/l

HISTORIC MGP STRUCTURE

RAILROAD TRACKS

EXISTING CONDITIONS

APPROXIMATE LIMITS OF AREA IN WHICH BTEXSN IMPACTS HAVE BEEN OBSERVED IN SOIL AND GROUNDWATER

NOTES:

1. BASE PLAN ADAPTED FROM "TOPOGRAPHIC WORKSHEET OF THE MANUFACTURED GAS PLANT, MALDEN, MA" FOR MASSACHUSETTS ELECTRIC COMPANY BY EASTERN TOPOGRAPHICS, JUNE 1995, AND CITY OF MALDEN ASSESSOR'S PLAN SHEETS 1 AND 2, JUNE 1995, AND SHEET NO. 53 BY FAY, SPOFFORD &THORNDIKE, INC., UPDATED JUNE 1976 AND REVISED 30 JULY 1979.

2. CONCENTRATIONS SHOWN REPRESENT THE MAXIMUM SUM OF BENZENE, TOLUENE, ETHYLBENZENE, XYLENE, STYRENE AND NAPHTHALENE OBSERVED IN A SINGLE SAMPLE.

60 30 0 60 Feet

HALEY & ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

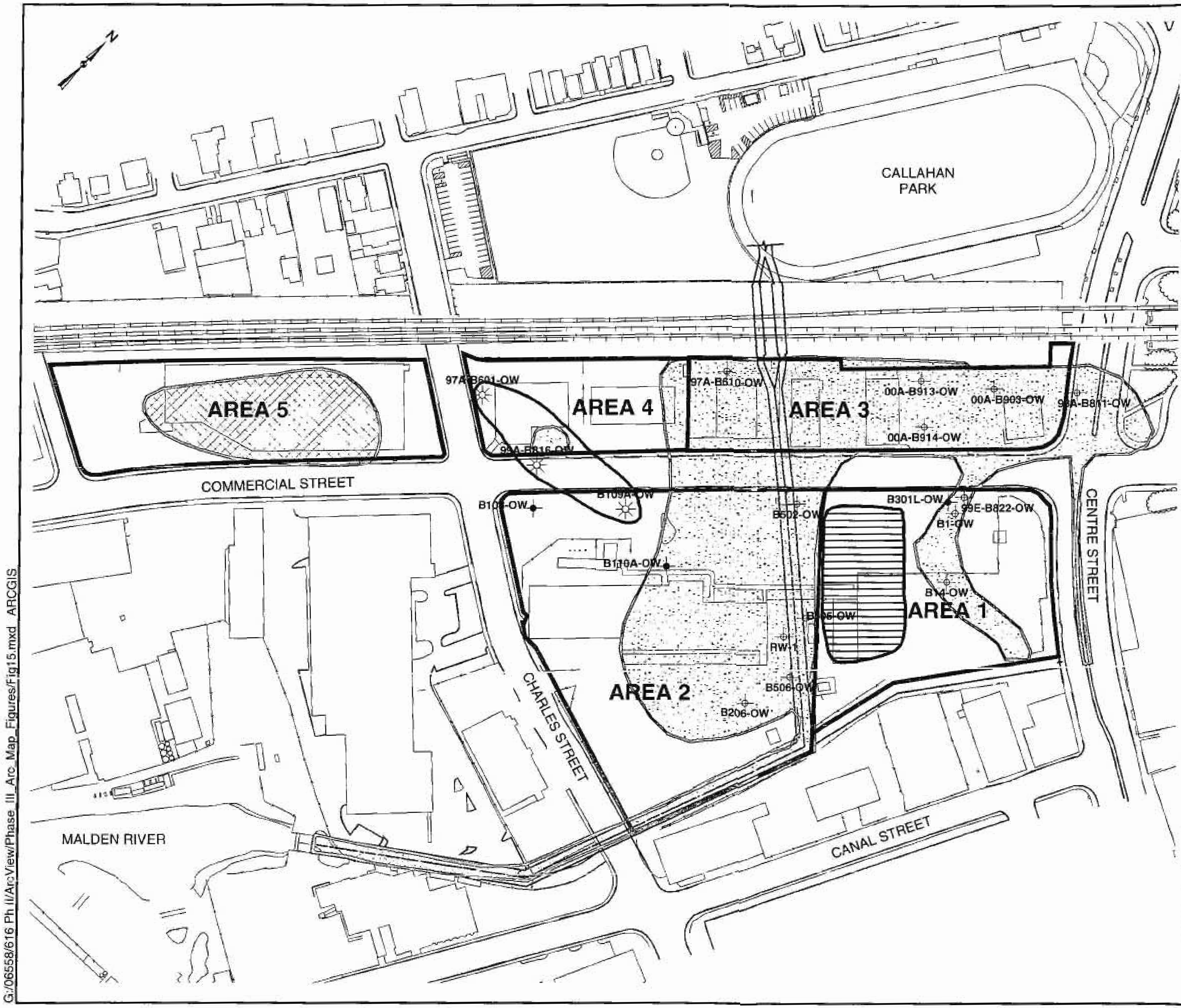
MAXIMUM TOTAL BTEXSN CONCENTRATIONS OBSERVED IN GROUNDWATER
129 COMMERCIAL STREET

SCALE AS SHOWN

JUNE 2003

FIGURE 14

G:/06558/616 Ph II/ArcView/Phase_III_Arc_Map_Figures/Fig15.mxd ARCGIS



LEGEND:

- LIMITS OF REMEDIAL ALTERNATIVE AREAS
- B506-OW — DESIGNATION AND APPROXIMATE LOCATION OF SHALLOW MONITORING WELLS AT WHICH DNAPL HAS BEEN DETECTED
- B108-OW — DESIGNATION AND APPROXIMATE LOCATION OF DEEP MONITORING WELLS AT WHICH DNAPL HAS BEEN DETECTED
- B109A-OW — DESIGNATION AND APPROXIMATE LOCATION OF MONITORING WELLS AT WHICH LNAPL HAS BEEN DETECTED
- APPROXIMATE OBSERVED EXTENT OF TSM
- APPROXIMATE EXTENT OF PETROLEUM-IMPACTED SOIL ON PARCEL E
- APPROXIMATE EXTENT OF BTEXSN-IMPACTED SOIL AND GROUNDWATER ON PARCEL B
- APPROXIMATE OBSERVED EXTENT OF LNAPL
- PILE-SUPPORTED CONCRETE CULVERTS

NOTES:

1. BASE PLAN ADAPTED FROM "TOPOGRAPHIC WORKSHEET OF THE MANUFACTURED GAS PLANT, MALDEN, MA" FOR MASSACHUSETTS ELECTRIC COMPANY BY EASTERN TOPOGRAPHICS, JUNE 1995, AND CITY OF MALDEN ASSESSOR'S PLAN SHEETS 1 AND 2, JUNE 1995, AND SHEET NO. 53 BY FAY, SPOFFORD &THORNDIKE, INC., UPDATED JUNE 1976 AND REVISED 30 JULY 1979.

150 75 0 150 Feet

HALEY & ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

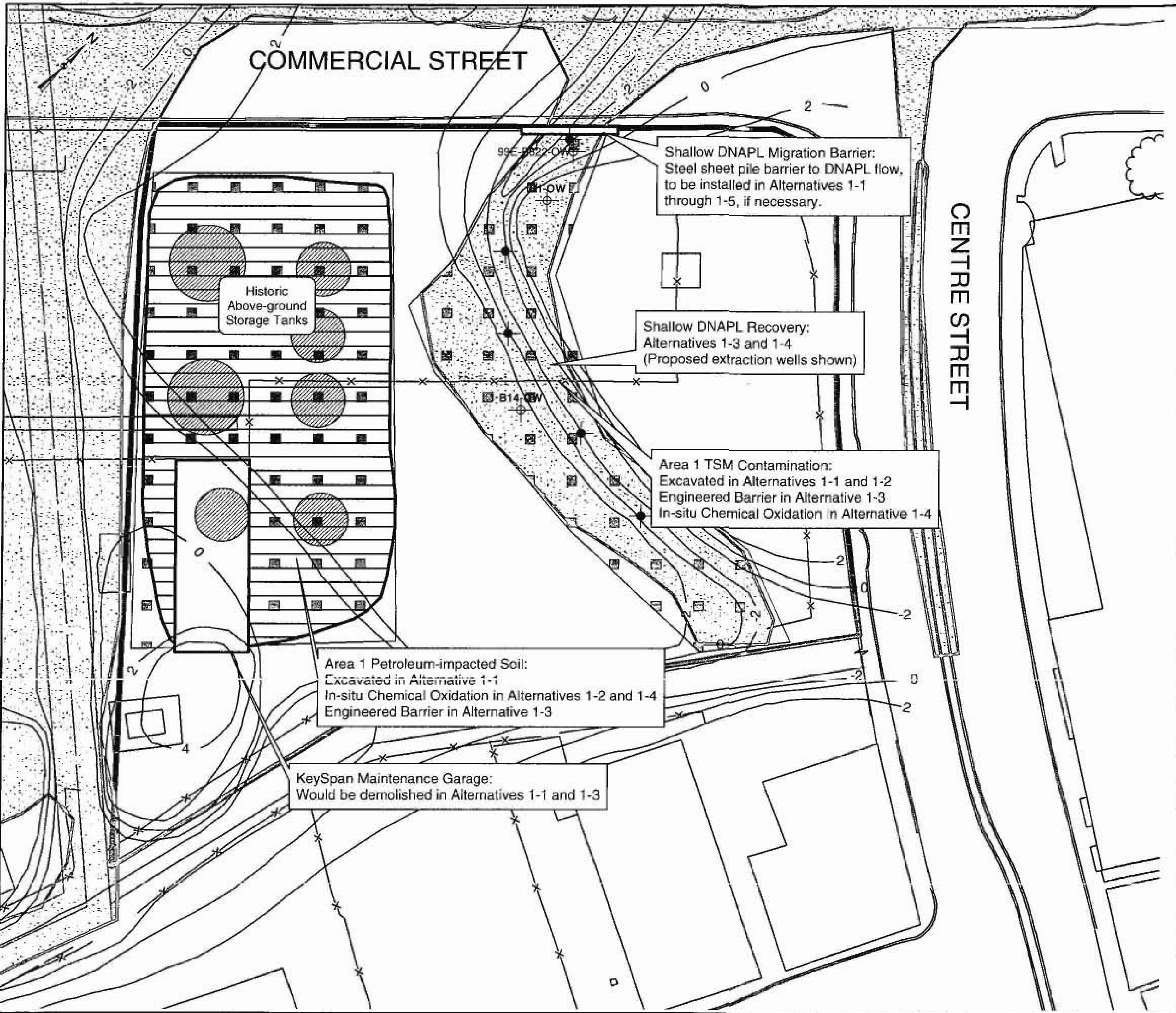
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

REMEDIAL ACTION ALTERNATIVE AREAS

SCALE AS SHOWN

JUNE 2003

FIGURE 15



G:/06558/616_Ph_II/ArcView/Phase_III_Arc_Map_Figures/Fig16.mxd ARCGIS

LEGEND:

- APPROXIMATE LOCATION OF PROPOSED DNAPL EXTRACTION WELL
- APPROXIMATE LOCATION OF PROPOSED SHALLOW DNAPL MIGRATION BARRIER
- APPROXIMATE LIMITS OF PROPOSED REMEDIAL AREA (EXCAVATION OR IN-SITU CHEMICAL OXIDATION)
- APPROXIMATE LIMITS OF REMEDIAL ALTERNATIVE AREA 1
- B14-OW DESIGNATION AND APPROXIMATE LOCATION OF MONITORING WELL AT WHICH SHALLOW DNAPL HAS BEEN OBSERVED
- — 4 — ELEVATION CONTOURS OF THE TOP OF THE ORGANIC DEPOSIT (2-FOOT INTERVAL)
- EXISTING BUILDINGS LOCATED WITHIN AREA 1
- SELECTED HISTORICAL MGP FEATURES
- LIMITS OF AREA IN WHICH TSM IMPACTS HAVE BEEN OBSERVED
- LIMITS OF AREA IN WHICH PETROLEUM-IMPACTED SOIL HAS BEEN OBSERVED

NOTES:

1. BASE PLAN ADAPTED FROM "TOPOGRAPHIC WORKSHEET OF THE MANUFACTURED GAS PLANT, MALDEN, MA" FOR MASSACHUSETTS ELECTRIC COMPANY BY EASTERN TOPOGRAPHICS, JUNE 1005, AND CITY OF MALDEN ASSESSOR'S PLAN SHEETS 1 AND 2, JUNE 1995, AND SHEET NO. 53 BY FAY, SPOFFORD & THORNDIKE, INC., UPDATED JUNE 1976 AND REVISED 30 JULY 1979.
2. ELEVATIONS ARE IN FEET AND RELATIVE TO NGVD.

50 25 0 50 Feet

HALEY & ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

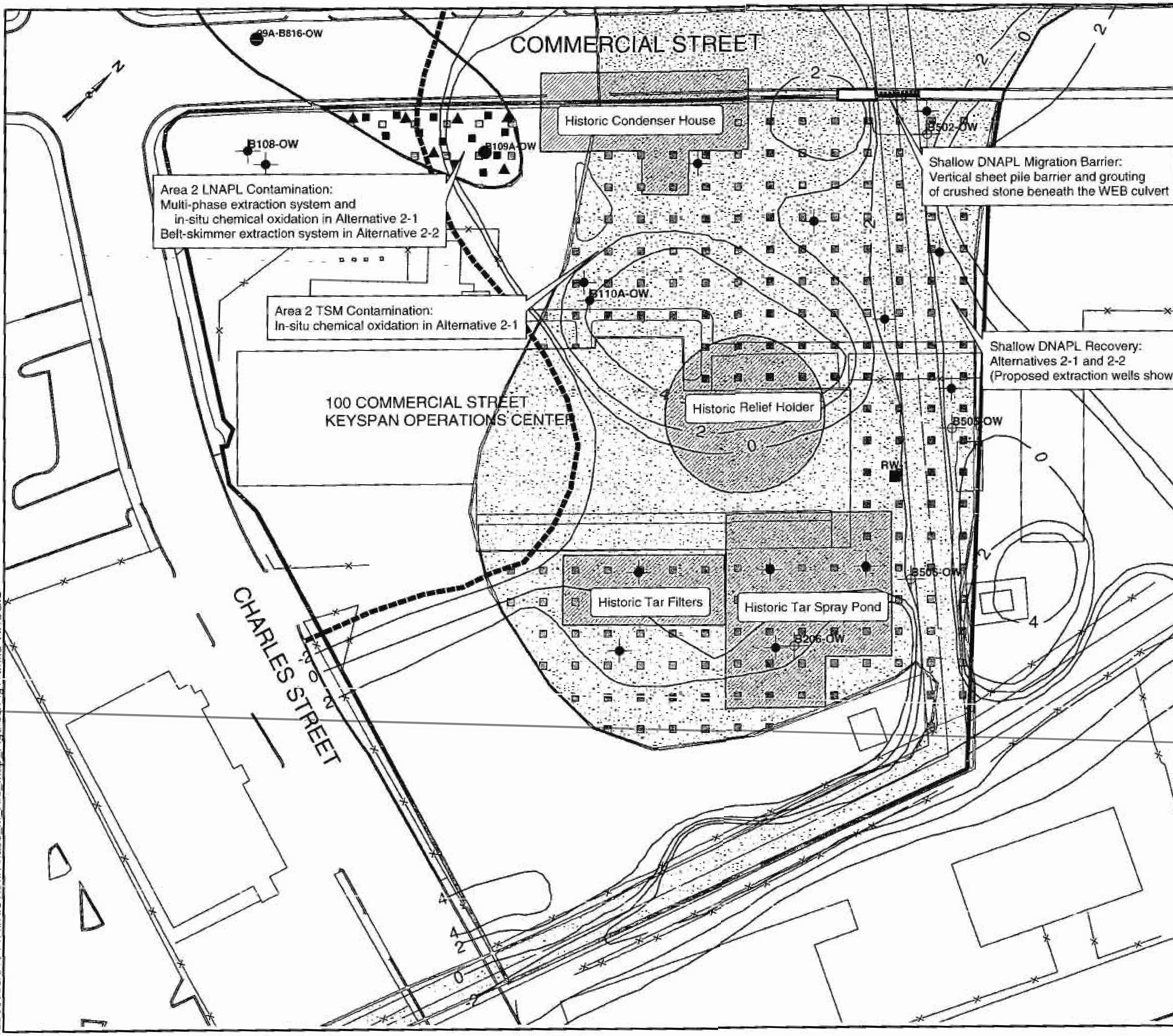
PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

LOCATIONS OF PROPOSED REMEDIAL COMPONENTS AREA 1

SCALE AS SHOWN

JUNE 2003

FIGURE 16



LEGEND:

- APPROXIMATE LOCATION OF PROPOSED DNAPL EXTRACTION WELL
- APPROXIMATE LOCATION OF PROPOSED LNAPL EXTRACTION WELL
- APPROXIMATE LOCATION OF PROPOSED LNAPL MULTI-PHASE EXTRACTION (MPE) WELL
- APPROXIMATE EXTENT OF PROPOSED IN-SITU CHEMICAL OXIDATION REMEDIATION (APPROXIMATE SPACING SHOWN)
- APPROXIMATE LOCATION OF PROPOSED SHALLOW DNAPL MIGRATION BARRIER
- GROUT INJECTED INTO CRUSHED STONE BASE BENEATH THE WEB CULVERT
- APPROXIMATE LIMITS OF REMEDIAL ALTERNATIVE AREA 2
- SELECTED HISTORIC MGP FEATURES
- —4— ELEVATION CONTOURS OF THE TOP OF THE ORGANIC DEPOSIT (2-FOOT INTERVAL)
- APPROXIMATE LIMITS OF THE ORGANIC DEPOSIT
- B109A-OW DESIGNATION AND APPROXIMATE LOCATION AT WHICH LNAPL HAS BEEN OBSERVED
- RW-1 DESIGNATION AND APPROXIMATE LOCATION OF EXISTING EXTRACTION WELL
- B502-OW DESIGNATION AND APPROXIMATE LOCATION OF MONITORING WELL AT WHICH SHALLOW DNAPL HAS BEEN OBSERVED
- B110A-OW DESIGNATION AND APPROXIMATE LOCATION OF MONITORING WELL AT WHICH DEEP DNAPL HAS BEEN OBSERVED
- LIMITS OF AREA IN WHICH LNAPL IMPACTS HAVE BEEN OBSERVED
- LIMITS OF AREA IN WHICH TSM IMPACTS HAVE BEEN OBSERVED

NOTES:

1. BASE PLAN ADAPTED FROM "TOPOGRAPHIC WORKSHEET OF THE MANUFACTURED GAS PLANT, MALDEN, MA" FOR MASSACHUSETTS ELECTRIC COMPANY BY EASTERN TOPOGRAPHICS, JUNE 1005, AND CITY OF MALDEN ASSESSOR'S PLAN SHEETS 1 AND 2, JUNE 1995, AND SHEET NO. 53 BY FAY, SPOFFORD & THORNDIKE, INC., UPDATED JUNE 1976 AND REVISED 30 JULY 1979.
2. ELEVATIONS ARE IN FEET AND RELATIVE TO NGVD.

60 30 0 60
Feet

HALEY & ALDRICH
UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

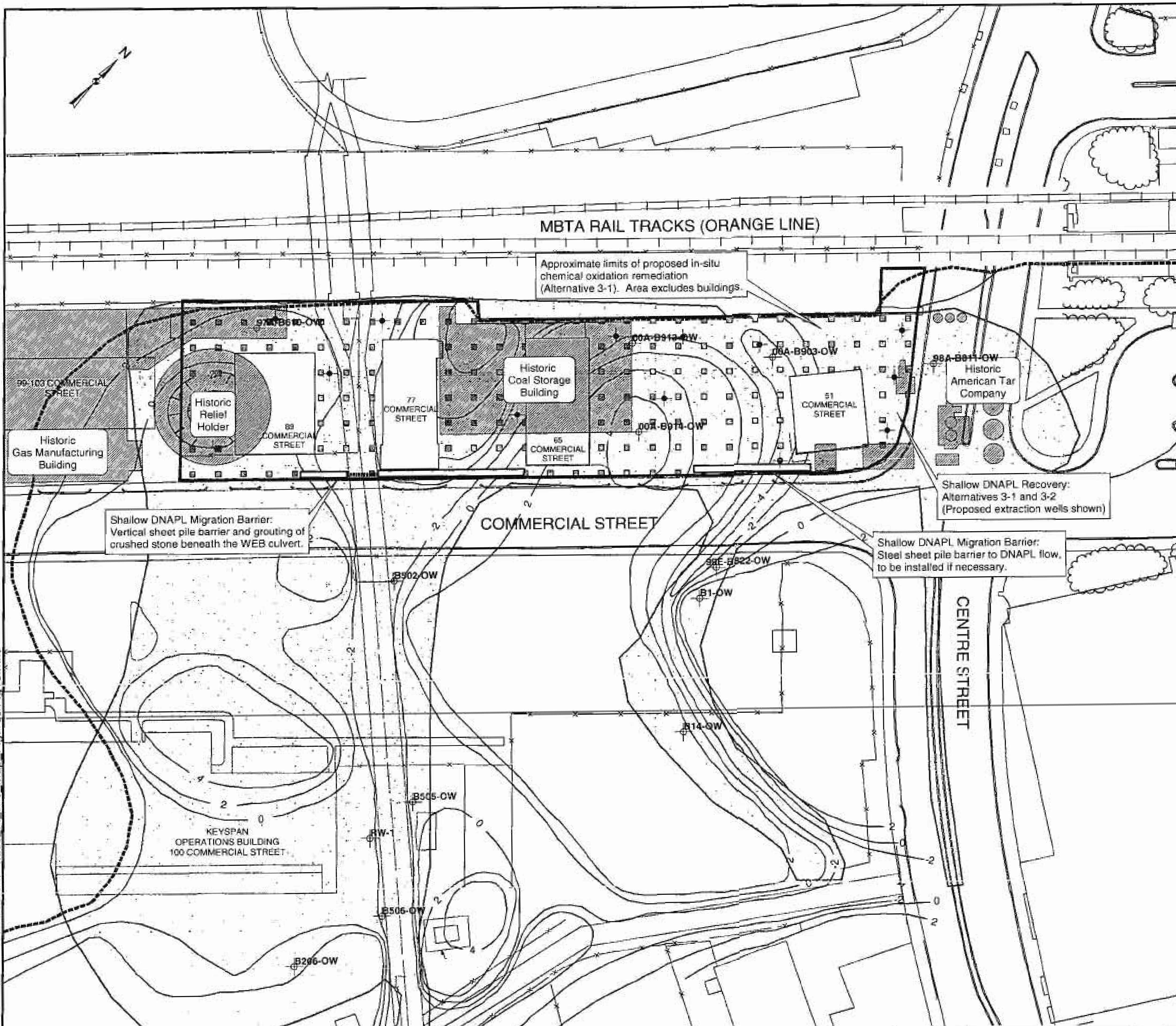
LOCATIONS OF PROPOSED REMEDIAL COMPONENTS AREA 2

SCALE AS SHOWN | JUNE 2003

FIGURE 17

G:/06558/616 Ph II/ArcView/Phase_III_Arc_Map_Figures/Fig17.mxd ARCGIS

G:/06558/616 Ph II/ArcView/Phase_III_Arc_Map_Figures/Fig18.mxd



LEGEND:

	APPROXIMATE LOCATION OF PROPOSED DNAPL EXTRACTION WELL
	APPROXIMATE EXTENT OF PROPOSED IN-SITU CHEMICAL OXIDATION REMEDIATION (APPROXIMATE SPACING SHOWN)
	APPROXIMATE LOCATION OF PROPOSED SHALLOW DNAPL MIGRATION BARRIER
	GROUT INJECTED INTO CRUSHED STONE BASE BENEATH THE WEB CULVERT
	APPROXIMATE LIMITS OF REMEDIAL ALTERNATIVE AREA 3
B502-OW	DESIGNATION AND APPROXIMATE LOCATION OF MONITORING WELL AT WHICH SHALLOW DNAPL HAS BEEN OBSERVED
	BUILDINGS LOCATED WITHIN THE LIMITS OF AREA 3
	SELECTED HISTORIC MGP FEATURES
— 4 —	ELEVATION CONTOURS OF THE TOP OF THE ORGANIC DEPOSIT (2-FOOT INTERVAL)
	APPROXIMATE LIMITS OF THE ORGANIC DEPOSIT
	LIMITS OF AREA IN WHICH TSM IMPACTS HAVE BEEN OBSERVED

NOTES:

1. BASE PLAN ADAPTED FROM "TOPOGRAPHIC WORKSHEET OF THE MANUFACTURED GAS PLANT, MALDEN, MA" FOR MASSACHUSETTS ELECTRIC COMPANY BY EASTERN TOPOGRAPHICS, JUNE 1005, AND CITY OF MALDEN ASSESSOR'S PLAN SHEETS 1 AND 2, JUNE 1995, AND SHEET NO. 53 BY FAY, SPOFFORD & THORNDIKE, INC., UPDATED JUNE 1976 AND REVISED 30 JULY 1979.

2. ELEVATIONS ARE IN FEET AND RELATIVE TO NGVD.

80 40 0 80 Feet

HALEY & ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

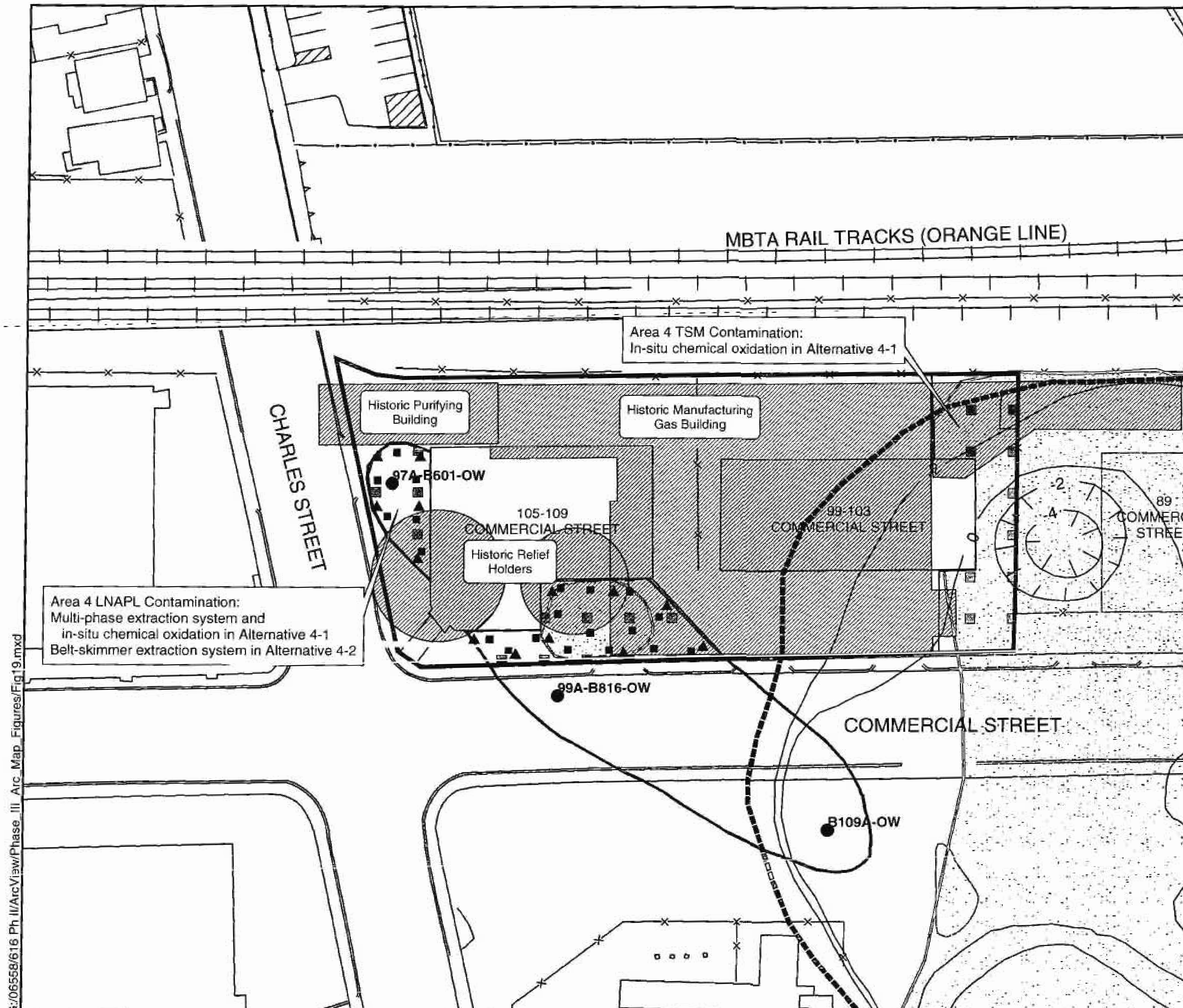
LOCATIONS OF PROPOSED REMEDIAL COMPONENTS AREA 3

SCALE AS SHOWN

JUNE 2003

FIGURE 18

G:/06558/616 Ph II/ArcView/Phase_III_Arc_Map_Figures/Fig19.mxd



LEGEND:

- APPROXIMATE LOCATION OF PROPOSED LNAPL EXTRACTION WELL
- APPROXIMATE LOCATION OF PROPOSED MULTI-PHASE EXTRACTION (MPE) WELL
- APPROXIMATE EXTENT OF PROPOSED IN-SITU CHEMICAL OXIDATION REMEDIATION (APPROXIMATE SPACING SHOWN)
- APPROXIMATE LIMITS OF REMEDIAL ALTERNATIVE AREA 4
- BUILDINGS LOCATED WITHIN THE LIMITS OF AREA 4
- SELECTED HISTORIC MGP FEATURES
- –4– ELEVATION CONTOURS OF THE TOP OF THE ORGANIC DEPOSIT (2-FOOT INTERVAL)
- APPROXIMATE LIMITS OF THE ORGANIC DEPOSIT
- B109A-OW DESIGNATION AND APPROXIMATE LOCATION OF MONITORING WELL AT WHICH LNAPL HAS BEEN OBSERVED
- LIMITS OF AREA IN WHICH LNAPL IMPACTS HAVE BEEN OBSERVED
- LIMITS OF AREA IN WHICH TSM IMPACTS HAVE BEEN OBSERVED

NOTES:

1. BASE PLAN ADAPTED FROM "TOPOGRAPHIC WORKSHEET OF THE MANUFACTURED GAS PLANT, MALDEN, MA" FOR MASSACHUSETTS ELECTRIC COMPANY BY EASTERN TOPOGRAPHICS, JUNE 1995, AND CITY OF MALDEN ASSESSOR'S PLAN SHEETS 1 AND 2, JUNE 1995, AND SHEET NO. 53 BY FAY, SPOFFORD & THORNDIKE, INC., UPDATED JUNE 1976 AND REVISED 30 JULY 1979.
2. ELEVATIONS ARE IN FEET AND RELATIVE TO NGVD.

50 25 0 50 Feet

HALEY & ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

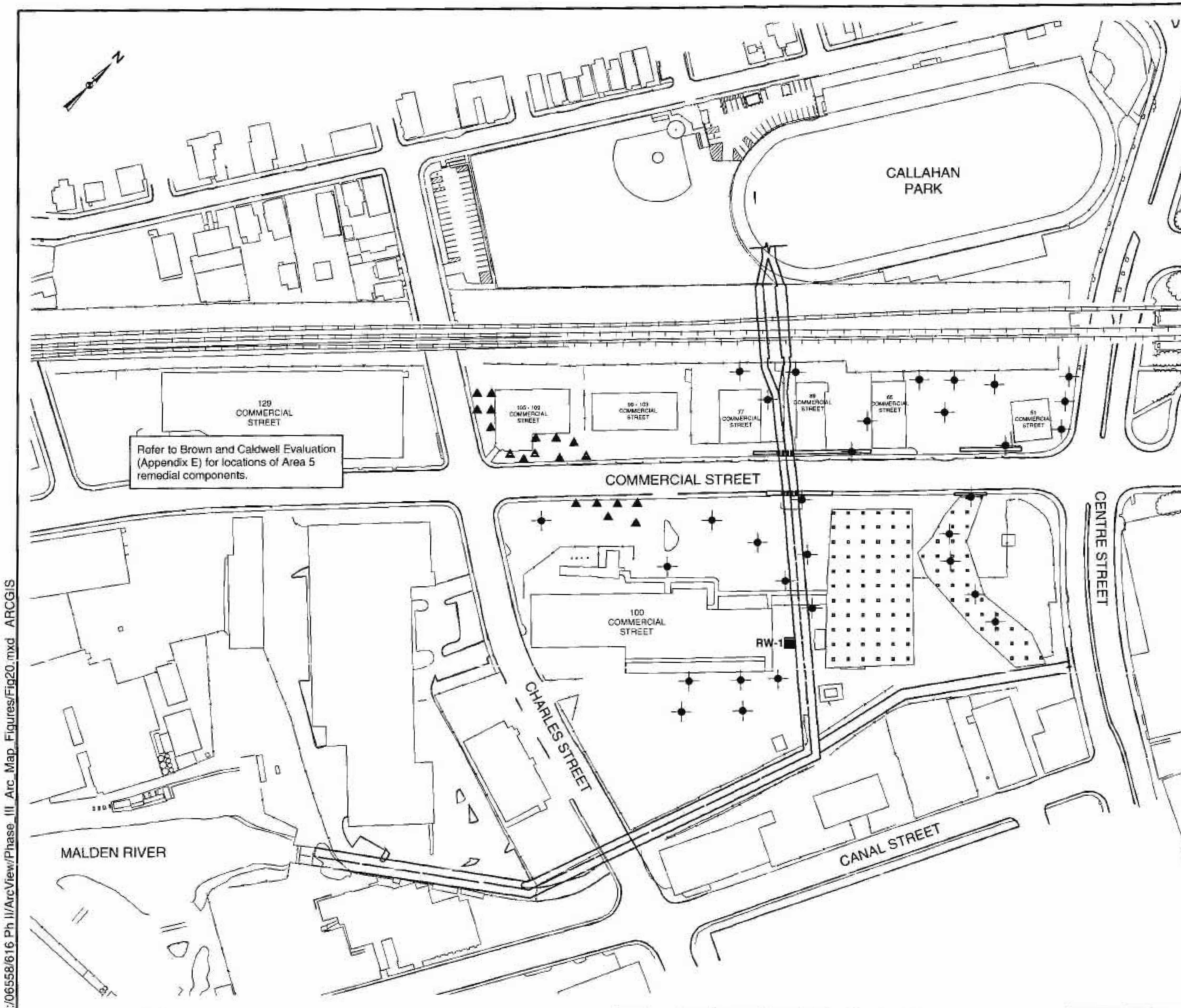
LOCATIONS OF PROPOSED REMEDIAL COMPONENTS AREA 4

SCALE AS SHOWN

JUNE 2003

FIGURE 19

G:/06558/616 Ph II/ArcView/Phase_III_Arc_Map_Figures/Fig20.mxd ARCGIS



LEGEND:

- APPROXIMATE LOCATION OF PROPOSED DNAPL EXTRACTION WELL
- APPROXIMATE LOCATION OF PROPOSED LNAPL EXTRACTION WELL
- RW-1 DESIGNATION AND APPROXIMATE LOCATION OF EXISTING DNAPL EXTRACTION WELL
- APPROXIMATE EXTENT OF PROPOSED IN-SITU CHEMICAL OXIDATION REMEDIATION (APPROXIMATE SPACING SHOWN)
- APPROXIMATE LOCATIONS OF PROVISIONAL DNAPL MIGRATION CONTROL BARRIERS
- GROUT INJECTED INTO CRUSHED STONE BASE BENEATH THE WEB CULVERT
- PILE-SUPPORTED CONCRETE CULVERTS

NOTES:

1. BASE PLAN ADAPTED FROM "TOPOGRAPHIC WORKSHEET OF THE MANUFACTURED GAS PLANT, MALDEN, MA" FOR MASSACHUSETTS ELECTRIC COMPANY BY EASTERN TOPOGRAPHICS, JUNE 1995, AND CITY OF MALDEN ASSESSOR'S PLAN SHEETS 1 AND 2, JUNE 1995, AND SHEET NO. 53 BY FAY, SPOFFORD &THORNDIKE, INC., UPDATED JUNE 1976 AND REVISED 30 JULY 1979.

150 75 0 150 Feet

HALEY & ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

PHASE III - REMEDIAL ACTION PLAN
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

LOCATIONS OF SELECTED REMEDIAL ALTERNATIVE COMPONENTS

SCALE AS SHOWN

JUNE 2003

FIGURE 20

APPENDIX A

Copy of Transmittal Form BWSC-108 and Public Notification of Availability Letters

Massachusetts Electric
A **National Grid** Company

27 June 2003

Massachusetts Department of Environmental Protection
Northeast Regional Office
One Winter Street
Boston, Massachusetts 02108

Attention: Site Management Branch

Subject: Phase III – Remedial Action Plan
Former Malden Manufactured Gas Plant (MGP) Site – Upland Portion
Malden, Massachusetts
RTN 3-0362 and Linked RTNs 3-3757, 3-11581, 3-12448, 3-13310, 3-13345, 3-13753, and 3-13754
Tier IB Permit Number 7378

Dear Ladies and Gentlemen:

Massachusetts Electric Company (MEC) is pleased to submit this report entitled "Phase III – Remedial Action Plan, Former Manufactured Gas Plant (MGP) Site - Upland Portion, Malden, Massachusetts, RTN 3-0362, Tier IB Permit 7378," prepared by Haley & Aldrich, Inc. This report is designed to meet the Phase III requirements under the Massachusetts Contingency Plan (310 CMR 40.0000) for the upland portions of the former Malden MGP Site. The Malden River portion of the Site will be addressed separately, as discussed below.

As MEC discussed in a meeting with Massachusetts Department of Environmental Protection (MADEP) officials on April 3, 2003, MEC intends to address the sediments in the Malden River within the Site boundary as a separate operable unit. MGP-related impacts attributable to the former MGP Site were identified during the Phase II assessment in Malden River sediments from the Malden River culvert outfall to a point approximately 1,400 feet downstream (just north of the Medford Street bridge). The Mystic Valley Development Commission (MVDC), through the TeleCom City partnership, has formed a group of parties with interest in Malden River sediment remediation from the culvert outfall to the Amelia Earhart Dam. The Telecom City partnership formed due to the development of a telecommunications research and development park on 200 acres of land situated in Malden, Medford and Everett. This area is located along the Malden River downstream of the Site boundary. The MVDC has partnered with the Army Corps of Engineers to conduct a study of the nature and extent of sediment impacts and to identify potential remedial measures that may be undertaken in the area. It is also our understanding that MADEP is participating in this work. MEC is contributing technical and financial support to this project and intends to participate in this study, which has been designated the Malden River Ecosystem Restoration Study. MEC also intends to participate in discussions regarding the remediation and restoration of the Malden River. In light of these recent developments, remedial measures related to Malden River sediments associated with the MGP Site are best conducted in

55 Bearfoot Road
Northborough, MA 01532-1555
508.421.7000

conjunction with the efforts along the larger portion of the River to ensure consistency and coordination. Representatives of MADEP endorsed this approach at our April 3 meeting and during conversations thereafter.

An original signed copy of transmittal form BWSC-108 is submitted, unbound, along with this report. A copy of the signed form and this cover letter are provided in Appendix A of this report along with copies of Notification of Availability letters to appropriate Malden municipal officials.

Please contact me at 508-421-7564 with any questions or comments regarding this matter.

Sincerely,

Michele V. Leone (BAN)

Michele V. Leone
Senior Environmental Engineer

cc: Gregg Hunt, DEP (without enclosure)
Rick Standish, H&A
File

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

COPY ✓

BWSC-108

COMPREHENSIVE RESPONSE ACTION TRANSMITTAL FORM & PHASE I COMPLETION STATEMENT

Pursuant to 310 CMR 40.0484 (Subpart D) and 40.0800 (Subpart H)

Release Tracking Number: 3 - 362

A. SITE LOCATION:

Site Name: (optional) Former Malden MGP Site

Street: 100 Commercial Street   Location Aid: Commercial & Charles Streets

City/Town: Malden   ZIP Code: 02148-5510

Related Release Tracking Numbers that this Form Addresses: 3-3757, 3-11581, 3-12448, 3-13310, 3-13345, 3-13753, 3-13754

Tier Classification: (check one of the following) ☐ Tier IA ☑ Tier IB ☐ Tier IC ☐ Tier II ☐ Not Tier Classified

If a Tier I Permit has been issued, state the Permit Number: Permit No. 7378, effective date 12/28/1999

B. THIS FORM IS BEING USED TO: (check all that apply)

☐ Submit a **Phase I Completion Statement**, pursuant to 310 CMR 40.0484 (complete Sections A, B, C, G, H, I and J).

☐ Submit a **Phase II Scope of Work**, pursuant to 310 CMR 40.0834 (complete Sections A, B, C, G, H, I and J).

☐ Submit a final **Phase II Comprehensive Site Report and Completion Statement**, pursuant to 310 CMR 40.0836 (complete Sections A, B, C, D, G, H, I and J).

☑ Submit a **Phase III Remedial Action Plan and Completion Statement**, pursuant to 310 CMR 40.0862 (complete Sections A, B, C, G, H, I and J).

☐ Submit a **Phase IV Remedy Implementation Plan**, pursuant to 310 CMR 40.0874 (complete Sections A, B, C, G, H, I and J).

☐ Submit an **As-Built Construction Report**, pursuant to 310 CMR 40.0875 (complete Sections A, B, C, G, H, I and J).

☐ Submit a **Phase IV Final Inspection Report and Completion Statement**, pursuant to 310 CMR 40.0878 and 40.0879 (complete Sections A, B, C, E, G, H, I and J).

☐ Submit a periodic **Phase V Inspection & Monitoring Report**, pursuant to 310 CMR 40.0892 (complete Sections A, B, C, G, H, I and J).

☐ Submit a final **Phase V Inspection & Monitoring Report and Completion Statement**, pursuant to 310 CMR 40.0893 (complete Sections A, B, C, F, G, H, I and J).

You must attach all supporting documentation required for each use of form indicated, including copies of any Legal Notices and Notices to Public Officials required by 310 CMR 40.1400.

C. RESPONSE ACTIONS:

☐ Check here if any response action(s) that serves as the basis for the Phase submittal(s) involves the use of Innovative Technologies. (DEP is interested in using this information to create an Innovative Technologies Clearinghouse.)

Describe Technologies: ______

D. PHASE II COMPLETION STATEMENT:

Specify the outcome of the Phase II Comprehensive Site Assessment:

☐ Additional Comprehensive Response Actions are necessary at this Site, based on the results of the Phase II Comprehensive Site Assessment.

☐ The requirements of a Class A Response Action Outcome have been met and a completed Response Action Outcome Statement (BWSC-104) will be submitted to DEP.

☐ The requirements of a Class B Response Action Outcome have been met and a completed Response Action Outcome Statement (BWSC-104) will be submitted to DEP.

☐ Rescoring of this Site using the Numerical Ranking System is necessary, based on the results of the final Phase II Report.

E. PHASE IV COMPLETION STATEMENT:

Specify the outcome of Phase IV activities:

☐ Phase V operation, maintenance or monitoring of the Comprehensive Response Action is necessary to achieve a Response Action Outcome. (This site will be subject to a Phase V Operation, Maintenance and Monitoring Annual Compliance Fee.)

☐ The requirements of a Class A Response Action Outcome have been met. No additional operation, maintenance or monitoring is necessary to ensure the integrity of the Response Action Outcome. A completed Response Action Outcome Statement (BWSC-104) will be submitted to DEP.

☐ The requirements of a Class C Response Action Outcome have been met. No additional operation, maintenance or monitoring is necessary to ensure the integrity of the Response Action Outcome. A completed Response Action Outcome Statement (BWSC-104) will be submitted to DEP.

SECTION E IS CONTINUED ON THE NEXT PAGE

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC-108

COPY

COMPREHENSIVE RESPONSE ACTION TRANSMITTAL FORM & PHASE I COMPLETION STATEMENT

Pursuant to 310 CMR 40.0484 (Subpart D) and 40.0800 (Subpart H)

Release Tracking Number

3 - 362

E. PHASE IV COMPLETION STATEMENT: (continued)

☐ The requirements of a Class C Response Action Outcome have been met. Further operation, maintenance or monitoring of the remedial action is necessary to ensure that conditions are maintained and that further progress is made toward a Permanent Solution. A completed Response Action Outcome Statement (BWSC-104) will be submitted to DEP.

Indicate whether the operation and maintenance will be Active or Passive. (Active Operation and Maintenance is defined at 310 CMR 40.0006.):

○ Active Operation and Maintenance ○ Passive Operation and Maintenance

(Active Operation and Maintenance makes the Site subject to a Post-RAO Class C Active Operation and Maintenance Annual Compliance Fee.)

F. PHASE V COMPLETION STATEMENT:

Specify the outcome of Phase V activities:

☐ The requirements of a Class A Response Action Outcome have been met and a completed Response Action Outcome Statement (BWSC-104) will be submitted to DEP.

☐ The requirements of a Class C Response Action Outcome have been met. No additional operation, maintenance or monitoring is necessary to ensure the integrity of the Response Action Outcome. A completed Response Action Outcome Statement (BWSC-104) will be submitted to DEP.

☐ The requirements of a Class C Response Action Outcome have been met. Further operation, maintenance or monitoring of the remedial action is necessary to ensure that conditions are maintained and that further progress is made toward a Permanent Solution. A completed Response Action Outcome Statement (BWSC-104) will be submitted to DEP.

Indicate whether the operation and maintenance will be Active or Passive. (Active Operation and Maintenance is defined at 310 CMR 40.0006.):

○ Active Operation and Maintenance ○ Passive Operation and Maintenance

(Active Operation and Maintenance makes the Site subject to a Post-RAO Class C Active Operation and Maintenance Annual Compliance Fee.)

G. LSP OPINION:

I attest under the pains and penalties of perjury that I have personally examined and am familiar with the information contained in this transmittal form, including any and all documents accompanying this submittal. In my professional opinion and judgment based upon application of (i) the standard of care in 309 CMR 4.02(1), (ii) the applicable provisions of 309 CMR 4.02(2) and (3), and (iii) the provisions of 309 CMR 4.03(5), to the best of my knowledge, information and belief,

> *if Section B indicates that a* ***Phase I, Phase II, Phase III, Phase IV or Phase V Completion Statement*** *is being submitted*, the response action(s) that is (are) the subject of this submittal (i) has (have) been developed and implemented in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, (ii) is (are) appropriate and reasonable to accomplish the purposes of such response action(s) as set forth in the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, and (iii) complies(y) with the identified provisions of all orders, permits, and approvals identified in this submittal;

> *if Section B indicates that a* ***Phase II Scope of Work*** *or a* ***Phase IV Remedy Implementation Plan*** *is being submitted*, the response action(s) that is (are) the subject of this submittal (i) has (have) been developed in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, (ii) is (are) appropriate and reasonable to accomplish the purposes of such response action(s) as set forth in the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, and (iii) complies(y) with the identified provisions of all orders, permits, and approvals identified in this submittal;

> *if Section B indicates that an* ***As-Built Construction Report*** *or a* ***Phase V Inspection and Monitoring Report*** *is being submitted*, the response action(s) that is (are) the subject of this submittal (i) is (are) being implemented in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, (ii) is (are) appropriate and reasonable to accomplish the purposes of such response action(s) as set forth in the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, and (iii) complies(y) with the identified provisions of all orders, permits, and approvals identified in this submittal.

I am aware that significant penalties may result, including, but not limited to, possible fines and imprisonment, if I submit information which I know to be false, inaccurate or materially incomplete.

☐ Check here if the Response Action(s) on which this opinion is based, if any, are (were) subject to any order(s), permit(s) and/or approval(s) issued by DEP or EPA. If the box is checked, you MUST attach a statement identifying the applicable provisions thereof.

LSP Name: Richard P. Standish LSP #: 2242 Stamp:

Telephone: 860-282-9400 Ext.: 3150

FAX: (optional) 860-282-9500

Signature: Richard P. Standish

Date: June 16, 2003

COMMONWEALTH OF MASSACHUSETTS
RICHARD P. STANDISH No. 2242
REGISTERED
LICENSED SITE PROFESSIONAL

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

COPY

BWSC-108

COMPREHENSIVE RESPONSE ACTION TRANSMITTAL FORM & PHASE I COMPLETION STATEMENT

Pursuant to 310 CMR 40.0484 (Subpart D) and 40.0800 (Subpart H)

Release Tracking Number

3 - 362

H. PERSON UNDERTAKING RESPONSE ACTION(S):

Name of Organization: Massachusetts Electric Company

Name of Contact: Michele V. Leone Title: Senior Environmental Engineer

Street: 55 Bearfoot Road

City/Town: Northborough State: MA ZIP Code: 01532-0000

Telephone: 508-421-7564 Ext.: FAX: (optional) 508-890-4706

☐ Check here if there has been a change in the person undertaking the Response Action.

I. RELATIONSHIP TO SITE OF PERSON UNDERTAKING RESPONSE ACTION(S): (check one)

☑ RP or PRP Specify: ◯ Owner ◯ Operator ◯ Generator ◯ Transporter Other RP or PRP: Party of Interest

☐ Fiduciary, Secured Lender or Municipality with Exempt Status (as defined by M.G.L. c. 21E, s. 2)

☐ Agency or Public Utility on a Right of Way (as defined by M.G.L. c. 21E, s. 5(j))

☐ Any Other Person Undertaking Response Action Specify Relationship:

J. CERTIFICATION OF PERSON UNDERTAKING RESPONSE ACTION(S):

I, Michele V. Leone, attest under the pains and penalties of perjury (i) that I have personally examined and am familiar with the information contained in this submittal, including any and all documents accompanying this transmittal form, (ii) that, based on my inquiry of those individuals immediately responsible for obtaining the information, the material information contained in this submittal is, to the best of my knowledge and belief, true, accurate and complete, and (iii) that I am fully authorized to make this attestation on behalf of the entity legally responsible for this submittal. I/the person or entity on whose behalf this submittal is made am/is aware that there are significant penalties, including, but not limited to, possible fines and imprisonment, for willfully submitting false, inaccurate, or incomplete information.

By: MVLeone Title: Senior Environmental Engineer
(signature)

For: Massachusetts Electric Company Date: 06/25/03
(print name of person or entity recorded in Section H)

Enter address of the person providing certification, if different from address recorded in Section H:

Street:

City/Town: State: ZIP Code:

Telephone: Ext.: FAX: (optional)

YOU MUST COMPLETE ALL RELEVANT SECTIONS OF THIS FORM OR DEP MAY RETURN THE DOCUMENT AS INCOMPLETE. IF YOU SUBMIT AN INCOMPLETE FORM, YOU MAY BE PENALIZED FOR MISSING A REQUIRED DEADLINE.

UNDERGROUND
ENGINEERING &
ENVIRONMENTAL
SOLUTIONS

Haley & Aldrich, Inc.
465 Medford Street
Suite 2200
Boston, MA 02129-1400
Tel: 617.886.7400
Fax: 617.886.7600
www.HaleyAldrich.com

HALEY & ALDRICH

27 June 2003
File No. 06558

City of Malden Office of the Mayor
200 Pleasant Street
Malden, Massachusetts 02148

Attention: Mayor Richard C. Howard

Subject: Public Notification of Availability Under 310 CMR 40.1403
Phase III - Remedial Action Plan
Former Malden Manufactured Gas Plant (MGP) Site – Upland Portion
Malden, Massachusetts
RTN 3-0362
Tier IB Permit No. 7378

Ladies and Gentlemen:

On behalf of the Massachusetts Electric Company (MEC) and in accordance with the Massachusetts Contingency Plan (MCP), 310 CMR 40.0000, Haley & Aldrich, Inc., is notifying you of the availability of the above document.

This letter serves as notice of availability to the Malden Chief Municipal Officer in accordance with the MCP under 310 CMR 40.1403(3)(e), of a report entitled "Report on Phase III – Remedial Action Plan, Former Malden MGP Site – Upland Portion, Malden, Massachusetts, RTN 3-0362, Tier IB Permit No. 7378," dated June 2003, and prepared by Haley & Aldrich, Inc.

A copy of this Phase III – Remedial Action Plan report is available for review at the Massachusetts Department of Environmental Protection, Northeast Regional Office.

If you have questions concerning this letter, please contact Ms. Michele V. Leone of MEC at 508-421-7564, or the undersigned at 860-290-3150.

Sincerely yours,
HALEY & ALDRICH, INC.

William W. Beck

Richard P. Standish, LSP-of-Record
Vice President

c: Massachusetts Electric Company; Attn: Ms. Michele V. Leone
KeySpan Energy Delivery New England; Attn: Mr. Alexander G. Taft
City of Malden Board of Health; Attn: Mr. Walter F. Carlan

G:\06558\634 Phase III\Final_Phase_III_Report\Phase III public notification mayor.doc

OFFICES
Charles Town, West Virginia
Cleveland, Ohio
Denver, Colorado
Detroit, Michigan
Hartford, Connecticut
Los Angeles, California
Manchester, New Hampshire
Newark, New Jersey
Portland, Maine
Rochester, New York
San Diego, California
San Francisco, California
Washington, District of Columbia

UNDERGROUND
ENGINEERING &
ENVIRONMENTAL
SOLUTIONS

Haley & Aldrich, Inc.
465 Medford Street
Suite 2200
Boston, MA 02129-1400
Tel: 617.886.7400
Fax: 617.886.7600
www.HaleyAldrich.com

HALEY & ALDRICH

27 June 2003
File No. 06558

City of Malden Board of Health
200 Pleasant Street
Malden, Massachusetts 02148

Attention: Mr. Walter F. Carlan
Director of Public Health

Subject: Public Notification of Availability Under 310 CMR 40.1403
Phase III - Remedial Action Plan
Former Malden Manufactured Gas Plant (MGP) Site – Upland Portion
Malden, Massachusetts
RTN 3-0362
Tier IB Permit No. 7378

Ladies and Gentlemen:

On behalf of the Massachusetts Electric Company (MEC) and in accordance with the Massachusetts Contingency Plan (MCP), 310 CMR 40.0000, Haley & Aldrich, Inc., is notifying you of the availability of the above document.

This letter serves as notice of availability to the Malden Board of Health in accordance with the MCP under 310 CMR 40.1403(3)(e), of a report entitled "Report on Phase III – Remedial Action Plan, Former Malden MGP Site – Upland Portion, Malden, Massachusetts, RTN 3-0362, Tier IB Permit No. 7378," dated June 2003, and prepared by Haley & Aldrich, Inc.

A copy of this Phase III – Remedial Action Plan report is available for review at the Massachusetts Department of Environmental Protection, Northeast Regional Office.

If you have questions concerning this letter, please contact Ms. Michele V. Leone of MEC at 508-421-7564, or the undersigned at 860-290-3150.

Sincerely yours,
HALEY & ALDRICH, INC.

William W Beck

Richard P. Standish, LSP-of-Record
Vice President

c: Massachusetts Electric Company; Attn: Ms. Michele V. Leone
KeySpan Energy Delivery New England; Attn: Mr. Alexander G. Taft
City of Malden, Chief Municipal Officer; Attn: Mayor Richard C. Howard

G:\06558\634 Phase III\Final_Phase_III_Report\Phase III public notification BOH.doc

OFFICES
Charles Town
West Virginia
Cleveland
Ohio
Denver
Colorado
Detroit
Michigan
Hartford
Connecticut
Los Angeles
California
Manchester
New Hampshire
Newark
New Jersey
Portland
Maine
Rochester
New York
San Diego
California
San Francisco
California
Washington
District of Columbia

APPENDIX B

Revised AMEC Risk Characterization

amec

Amendment to Method 3 Risk Characterization and Substantial Hazard Evaluation
Portion of Former Manufactured Gas Plant Site
Malden, Massachusetts

Submitted to:

Massachusetts Electric Company
Northborough, Massachusetts

Submitted by:

AMEC Earth & Environmental
Boston, Massachusetts

February, 2003

6-7037-0500

1.0 INTRODUCTION

A Method 3 Human Health Risk Characterization was performed in December 2001 as part of a Phase II Comprehensive Site Investigation (Haley and Aldrich, 2001) for portions of the Former Malden Manufactured Gas Plant (MGP) Site (referred to herein as "The Site"), including parcels at 100 Commercial Street, 129 Commercial Street, 99-109 Commercial Street, 89 Commercial Street, 77 Commercial Street, 65 Commercial Street, 51 Commercial Street, Charles Street and the Governor House located at the corner of Pearl and Charles Street. These parcels are collectively referred to as the Upper Site; the portion of the Site consisting of the Malden River from the Malden River culvert outfall to the Medford Street Bridge is not addressed in this evaluation.

The conclusions of that assessment indicated that a condition of No Significant Risk to human health under current Site conditions exists at 100 Commercial Street, 99-109 Commercial Street, 89 Commercial Street, 77 Commercial Street, 65 Commercial Street, Charles Street, and Governor House. At the remaining two parcels that comprise the Upper Site, the Phase II Risk Characterization concluded that a condition of No Significant Risk to human health did not exist under current conditions for the following identified current receptors and exposure pathways:

- At the 129 Commercial Street parcel: the excess risk was associated with potential exposures to a current commercial/industrial worker who is assumed to inhale contaminants of potential concern (CPCs) in indoor air. Estimated excess cancer risk estimates for the current commercial/industrial worker exceeded the risk management criterion based on an average concentration of benzene. However, the average concentration of benzene (16.5 ug/m^3) in indoor air samples (representing December 2000, March 2001, June 2001, and October 2001) was less than MADEP's published indoor air background concentration (21 ug/m^3).

- At the 51 Commercial Street parcel: the excess risk was associated with a current landscape worker who is assumed to have direct exposure to soils. No soil data from the limited landscaped area on this parcel were available when the Risk Characterization was conducted. Rather, a single surrogate soil sample from an adjacent paved area (representing a depth interval 1 to 3 feet below ground surface [fbgs]) was used to estimate potential risks.

Four indoor air sampling events have been conducted at 129 Commercial Street following submission of the Method 3 Human Health Risk Characterization in December, 2001. These occurred on January 15, April 12, June 26, and October 14, 2002 (Haley and Aldrich, 2002; 2003). Additionally, three soil borings were collected and analyzed from 51 Commercial Street in June, 2002 (Haley and Aldrich, 2002). These data were used herein to update the results of the human health risk characterization for these two parcels.

A Substantial Hazard Evaluation was also conducted to determine whether a temporary solution has been achieved at portions of the Site in support of a Class C Response Action Outcome (RAO) in accordance with the Massachusetts Contingency Plan (MCP) (310 CMR 40.0956, 310 who may be exposed to volatile compounds in indoor air, the results of this Risk Characterization utilizing recent indoor air data indicate that the Cumulative Receptor Cancer Risk and Non-cancer Risk are less than the MADEP risk management criteria. The risk estimates for the utility worker, the landscape worker, and the trespasser, which represent conclusions of the Method 3 Risk Characterization (AMEC 2001) at 129 Commercial Street, are also less than the MADEP risk management criteria. Therefore, a condition of No Significant Risk to Human Health exists at 129 Commercial Street.

2.2 51 Commercial Street

The parcel located at 51 Commercial Street is currently used as an office building (dentist office and chiropractor office). A single building composed of multiple offices currently exists on the property, with landscaped areas surrounding the sides abutting Commercial and Centre Streets. Under current conditions, office workers, utility workers, trespassers, and landscapers are assumed to exist at this parcel. The complete exposure pathways for these receptors include inhalation of indoor air, incidental ingestion of soil, dermal contact with soil, incidental ingestion of groundwater, dermal contact with groundwater, inhalation of constituents in ambient air (volatilized from soil), inhalation of constituents in ambient air (volatilized from groundwater), and inhalation of particulates from soil. The conclusion of the Phase II Risk Characterization for current Site conditions was that a condition of No Significant Risk exists for the current office worker, utility worker, and the current trespasser.

For current landscapers, the basis of the exposure point concentration in the landscaped area adjacent to the building at 51 Commercial Street (soil exposure point) in the Phase II Risk Characterization was surrogate soil analytical data. The soil analytical data consisted of a single surface (0 to 3 fbgs) soil sample obtained from beneath pavement located near the boundary with the parcel at 65 Commercial Street. However, this is not soil to which landscapers could actually be exposed. Therefore, in June 2002, three soil borings were installed in the landscaped area with soil samples collected from the 0.5 to 1 foot interval and 0 to 3 feet interval (Haley and Aldrich 2002; see Attachment B for locations). Soil samples collected from the 0.5 to 1 foot interval were analyzed for Volatile Petroleum Hydrocarbon fractions (VPH) and target analytes; soil samples from the 0 to 3 feet interval were analyzed for Extractable Petroleum Hydrocarbon fractions (EPH) and target analytes. A summary of the data is presented in Table 4.

The entire landscaped area is considered a single exposure point, with the three soil samples (0 to 3 fbgs) considered representative of the exposure point. The results for naphthalene from the VPH analysis representing the 0.5 to 1 foot depth interval is used to represent the 0 to 3 feet depth interval because the detected concentrations were higher relative to that from the EPH analysis. For each detected compound, the soil exposure point concentration is based on the arithmetic average concentration of the detected concentrations and values equal to one-half the laboratory reporting limit. Field duplicate samples and primary samples were averaged prior to incorporation into the exposure point concentration. The soil exposure point concentrations are presented in Table 5.

3.0 HUMAN HEALTH SUBSTANTIAL HAZARD EVALUATION

Despite the fact that no significant risk was found to receptors at either 129 Commercial Street or 51 Commercial Street, a Substantial Hazard Evaluation was conducted for these two parcels. Each is described in the following sections.

3.1 129 Commercial Street

As described in Section 2.1, the parcel located at 129 Commercial Street is currently used as a commercial bread bakery. Under current conditions, utility workers, trespassers, commercial (site) workers, and landscapers are assumed to exist at this parcel. The complete exposure pathways for these receptors include incidental ingestion of soil, dermal contact with soil, incidental ingestion of groundwater, dermal contact with groundwater, inhalation of constituents in ambient air (volatilized from soil), inhalation of constituents in ambient air (volatilized from groundwater), inhalation of indoor air, and inhalation of particulates from soil. The conclusion of the Method 3 Risk Characterization for current Site conditions was that a condition of No Significant Risk exists for the current utility worker, the current landscape worker, and the current trespasser. Therefore, a condition of No Substantial Hazard to Human Health exists for these receptors at 129 Commercial Street. As such, only commercial workers are included in this Substantial Hazard Evaluation.

Commercial workers are assumed to be present at 129 Commercial Street for 8-hour shifts 24 hours per day. The identified exposure pathway for current workers to identified OHM at this Site is via inhalation of indoor air. For the current commercial worker, exposures to OHM in indoor air are evaluated in this Substantial Hazard Evaluation based on indoor air data representing current Site conditions (collected on December 12, 2000, March 16, 2001, June 29, 2001, October 17, 2001, January 15, 2002, April 12, 2002, June 26, 2002, and October 14, 2002 [Haley and Aldrich, 2002]). Exposure point concentrations for indoor air are shown in Table 1 and were derived as described in Section 2.1. This represents the only current potential exposure pathway for this receptor.

The ADD for this receptor was calculated using the equations presented in Section 2.1 above. With the exception of the exposure duration and the averaging period for non-cancer risk estimates, the algorithm represents the same equation and assumptions utilized in the Method 3 Risk Characterization (AMEC, 2001) for current commercial workers at 129 Commercial Street. For this Substantial Hazard Evaluation, the period of exposure is a total of 19 years, representing January 1989 (the date of "site notification") to September 2007 (five years from the date of this evaluation) (310 CMR 40.0956(1)(b)). The toxicity values (reference dose [RfD] and Cancer Slope Factor [CSF]) and relative absorption values used in this Substantial Hazard Evaluation (see Table 8) are the same values used in the Method 3 Risk Characterization (AMEC, 2001), and represent currently available information regarding potential toxicity.

In order to determine whether a condition of No Substantial Hazard exists at this parcel, a risk characterization was conducted. As stated in Section 1.0, a condition of No Substantial Hazard to Human Health exists if, for an appropriate Exposure Period, no Cumulative Receptor Cancer Risk and no Cumulative Receptor Non-cancer Risk is greater than the Cumulative Receptor Risk Limits, defined as one in one hundred thousand (10^{-5}) for carcinogenic effects and 1 for non-cancer health effects (MADEP Risk Management Criteria) (310 CMR 40.0956; 310 CMR

TABLE 1
SUMMARY OF INDOOR AIR EXPOSURE POINT CONCENTRATIONS
129 COMMERCIAL STREET
FORMER MALDEN MANUFACTURED GAS PLANT
MALDEN, MASSACHUSETTS

Constituent	No. of Detections	Total No. of Samples	Minimum Detection (mg/m^3)	Maximum Detection (mg/m^3)	Arithmetic Mean (mg/m^3)
Benzene	31	46	0.0014	0.0480	0.0132
Ethylbenzene	43	46	0.0010	0.0110	0.0025
Naphthalene	18	46	0.0013	0.0423	0.0029
Styrene	36	46	0.0012	0.0258	0.0043
Toluene	12	46	0.0068	0.0988	0.0232
m-&p-xylenes	16	46	0.0021	0.0232	0.0053
o-xylenes	10	46	0.0010	0.0070	0.0023

Note:

(1) This table presents the summary of data collected during the eight most recent monitoring events conducted on December, 2000; March 2001; June 2001; October 17, 2001, January 15, 2002, April 12, 2002, June 26, 2002, and October 14, 2002.

(2) Exposure Point concentration based on arithmetic mean concentration of detected concentrations and values equal to one-half reporting limit for non-detects.

Table 2
Potential Carcinogenic Risk Following Exposure via Inhalation of Indoor Air--129 Commercial Street
Amendment to Method 3 Risk Characterization
Former Malden MGP, Malden, Massachusetts

Receptor: Site Worker (Adult)

$$\text{LADD (mg/kg-day)} = \frac{CA \times AAF \times IR \times ET \times EF \times ED}{BW \times AP}$$

ELCR = LADD (mg/kg-day) * CSF (1/mg/kg-day)

Parameter (units)		Value
LADD =	Lifetime Average Daily Dose Due to Inhalation (mg/kg-day)	See Below
CA =	Compound Concentration in Air (mg/m^3)	Chemical-Specific
AAF =	Absorption Adjustment Factor (unitless)	Chemical-Specific
IR =	Inhalation Rate (m^3/hr)	1.2
ET=	Exposure Time (hr/day)	8
EF =	Exposure Frequency (days/year)	250
ED =	Exposure Duration (years)	27
BW =	Body Weight (kg)	70
AP =	Averaging Period (days) (75 years x 365 days/yr, cancer)	27375
CSF=	Cancer Slope Factor (1/mg/kg-day)	Chemical-Specific
ELCR=	Estimated Lifetime Cancer Risk	Calculated

Compound	Compound (mg/m^3)	AAF (unitless)	ADD (mg/kg-day)	Inhalation CSF (1/mg/kg-day)	Inhalation (unitless)
Benzene	0.0132	1	4E-04	0.0273	1E-05
Ethylbenzene	0.0025	1	9E-05	Class D	NA
Naphthalene	0.0053	1	2E-04	Class D	NA
Styrene	0.0029	1	1E-04	NA	NA
Toluene	0.0023	1	8E-05	Class D	NA
m-&p-xylenes	0.0043	1	1E-04	NA	NA
o-xylenes	0.0232	1	8E-04	Class D	NA
ELCR =					1.E-05

Table 4
Summary of Soil Data
51 Commercial Street
Former Malden Manufactured Gas Plant
Malden, Massachusetts

Detected Compound	SS-101 0.5-1 mg/kg	SS-101 0-3 mg/kg	SS-102 0.5-1 mg/kg	SS-102 0-3 mg/kg	SS-103 0.5-1 mg/kg	SS-103 0-3 mg/kg	SS-103 DUP 0.5-1 mg/kg	SS-103 DUP 0-3 mg/kg	Average Concentration 0.5-1	Average Concentration 0-3	Frequency of Detect 0.5-1	Frequency of Detect 0-3
1-Methylnaphthalene	---	1.1 U	---	0.94	---	0.57 U	---	1.1 U	---	0.64	---	1 of 3
2-Methylnaphthalene	---	1.8 U	---	0.98	---	0.92 U	---	1.8 U	---	0.85	---	1 of 3
Acenaphthylene	---	4.2	---	2.4	---	0.57 U	---	1.1 U	---	2.34	---	2 of 3
Anthracene	---	3.4	---	2.6	---	0.57 U	---	1.1 U	---	2.14	---	2 of 3
Arsenic	---	7.6	---	9.5	---	8.9	---	9.5	---	8.77	---	3 of 3
Barium	---	72	---	53	---	62	---	65	---	62.83	---	3 of 3
Benzo(a)anthracene	---	8.1	---	6	---	1.1	---	2.4	---	5.28	---	3 of 3
Benzo(a)pyrene	---	8.3	---	6.2	---	1.1	---	2.4	---	5.42	---	3 of 3
Benzo(b)fluoranthene	---	7.3	---	4.9	---	0.92	---	1.8	---	4.52	---	3 of 3
Benzo(e)pyrene	---	6	---	4.2	---	0.76	---	1.7	---	3.81	---	3 of 3
Benzo(g,h,i)perylene	---	6.6	---	4.6	---	0.76	---	1.7	---	4.14	---	3 of 3
Benzo(k)fluoranthene	---	6.8	---	4.9	---	0.89	---	2.1	---	4.40	---	3 of 3
C11-C22 Aromatics	---	542	---	1730	---	191	---	127	---	810.33	---	3 of 3
C19-C36 Aliphatics	---	155	---	151	---	122	---	81	---	135.83	---	3 of 3
C9-C18 Aliphatics	---	102 U	---	65.4	---	34.5 U	---	11.5 U	---	42.63	---	1 of 3
Cadmium	---	0.85	---	0.46 U	---	0.47	---	0.51	---	0.52	---	2 of 3
Chromium	---	38	---	17	---	16	---	14	---	23.33	---	3 of 3
Chrysene	---	8.4	---	6.3	---	1.1	---	2.6	---	5.52	---	3 of 3
Cyanide, Physiologically A	---	0.87	---	1.9	---	0.4	---	0.45	---	1.07	---	3 of 3
Cyanide, Total	---	5.4	---	6.5	---	1.6	---	1.3	---	4.45	---	3 of 3
Dibenzo(a,h)anthracene	---	1.9	---	1.3	---	0.57 U	---	1.1 U	---	1.21	---	2 of 3
Fluoranthene	---	11	---	9.5	---	1.6	---	3.6	---	7.70	---	3 of 3
Fluorene	---	1.1 U	---	0.8	---	0.57 U	---	1.1 U	---	0.59	---	1 of 3
Indeno(1,2,3-cd)pyrene	---	5.8	---	4.1	---	0.71	---	1.5	---	3.67	---	3 of 3
Lead	---	300	---	340	---	300	---	330	---	318.33	---	3 of 3
Mercury	---	0.41	---	0.38	---	0.25	---	0.24	---	0.35	---	3 of 3
Naphthalene	---	1.1 U	---	1.4	---	0.57 U		1.1 U	---	0.79	---	1 of 3
Naphthalene (VOC)	1.3	---	1.9	---	0.89 U	---	0.86 U	---	1.215	1.22	2 of 3	---
p/m-Xylene	0.18 U	---	0.3	---	0.18 U	---	0.17 U	---	0.16	0.16	1 of 3	---
Perylene	---	2.3	---	1.7	---	0.57 U	---	1.1 U	---	1.47	---	2 of 3
Phenanthrene	---	4.7	---	8.4	---	0.82	---	2	---	4.84	---	3 of 3
Pyrene	---	14	---	12	---	1.8	---	4.4	---	9.70	---	3 of 3

Notes:
Data represent soil samples collected in June 2002 (Haley and Aldrich, 2002)
Average Concentration represents arithmetic average of detects and one-half laboratory reporting limit for non-detects.
"---" = Not Evaluated
Table4.xls

Table 6a
Potential Hazard Quotient and Risk Following Exposure via Incidental Ingestion of Soil - 51 Commercial Street
Amendment to Method 3 Risk Characterization
Former Malden MGP, Malden, Massachusetts

Scenario:	Current Occupational Scenario (0 - 3 ft.)
Receptor:	Landscaper

$$\text{Intake (mg/kg-day)} = \frac{CS \times IR \times FI \times RAFo \times EF \times ED \times CF}{BW \times AT}$$

Hazard Quotient (HQ) = Intake (mg/kg-day) / RfD (mg/kg-day)
Cancer Risk (ELCR) = Intake (mg/kg-day) * CSF [1/(mg/kg-day)]

Parameter (units)		Value
ADD =	Average Daily Dose Due to Ingestion (mg/kg-day)	See Below
CS =	Compound Concentration in Soil (mg/kg)	Chemical-Specific
IR =	Soil Ingestion Rate (mg/day)	50
FI=	Fraction of Soil Ingested from the Site (unitless)	1
RAFo =	Relative Absorption Factor (Oral-Soil) (unitless)	Chemical-Specific
EF =	Exposure Frequency (days/year)	24
ED =	Exposure Duration (years)	27
CF =	Conversion Factor (kg/mg)	1E-06
BW =	Body Weight (kg)	70
AT =	Averaging Time (days) (ED x 365 days/yr, noncancer	9855
AT =	Averaging Time (days) (75 yr. x 365 days/yr, cancer)	27375
RfD=	Reference Dose (mg/kg-day)	Chemical-Specific
CSF=	Cancer Slope Factor [1/(mg/kg-day)]	Chemical-Specific

		Noncancer Hazard Quotient				Excess Lifetime Cancer Risk			
Compound	Soil Concentration (0 - 3 ft.) (mg/kg)	Oral-Soil RAF (unitless)	Intake (Noncancer) (mg/kg-day)	Chronic Oral RfD (mg/kg-day)	Soil Ingestion HQ (unitless)	Oral-Soil RAF (unitless)	Intake (Cancer) (mg/kg-day)	Oral CSF $(mg/kg\text{-}day)^{-1}$	Soil Ingestion Risk (unitless)
1-Methylnaphthalene	0.64	0.43	1.3E-08	2.0E-02	6.4E-07	NA	NA	NA	NA
2-Methylnaphthalene	0.85	0.43	1.7E-08	2.0E-02	8.6E-07	NA	NA	NA	NA
Acenaphthylene	2.3	0.43	4.7E-08	6.0E-02	7.9E-07	NA	NA	Class D	NA
Anthracene	2.1	0.43	4.3E-08	3.0E-01	1.4E-07	NA	NA	Class D	NA
Arsenic	8.8	0.51	2.1E-07	3.0E-04	7.0E-04	5.1E-01	7.6E-08	1.5E+00	1.1E-07
Barium	63	1	3.0E-06	7.0E-02	4.2E-05	NA	NA	NA	NA
Benzo(a)anthracene	5.3	0.27	6.7E-08	4.0E-02	1.7E-06	2.7E-01	2.4E-08	7.3E-01	1.8E-08
Benzo(a)pyrene	5.4	0.27	6.9E-08	4.0E-02	1.7E-06	2.7E-01	2.5E-08	7.3E+00	1.8E-07
Benzo(b)fluoranthene	4.5	0.27	5.7E-08	4.0E-02	1.4E-06	2.7E-01	2.1E-08	7.3E-01	1.5E-08
Benzo(e)pyrene	3.8	0.43	7.7E-08	3.0E-02	2.6E-06	NA	NA	Class D	NA
Benzo(g,h,i)perylene	4.1	0.27	5.3E-08	4.0E-02	1.3E-06	NA	NA	Class D	NA
Benzo(k)fluoranthene	4.4	0.27	5.6E-08	4.0E-02	1.4E-06	2.7E-01	2.0E-08	7.3E-02	1.5E-09
C11-C22 Aromatics	810	0.43	1.6E-05	3.0E-02	5.5E-04	NA	NA	NA	NA
C19-C36 Aliphatics	136	0.91	5.8E-06	2.0E+00	2.9E-06	NA	NA	NA	NA
C9-C18 Aliphatics	43	0.91	1.8E-06	1.0E-01	1.8E-05	NA	NA	NA	NA
Cadmium	0.5	1	2.5E-08	1.0E-03	2.5E-05	NA	NA	NA	NA
Chromium	23	0.3	3.3E-07	3.0E-03	1.1E-04	NA	NA	NA	NA
Chrysene	5.5	0.27	7.0E-08	4.0E-02	1.7E-06	2.7E-01	2.5E-08	7.3E-03	1.8E-10
Cyanide, Physiologically Av	1.1	1	5.0E-08	2.0E-02	2.5E-06	NA	NA	Class D	NA
Cyanide, Total	4.5	0.2	4.2E-08	2.0E-02	2.1E-06	NA	NA	Class D	NA
Dibenzo(a,h)anthracene	1.2	0.27	1.5E-08	4.0E-02	3.8E-07	2.7E-01	5.5E-09	7.3E+00	4.0E-08
Fluoranthene	7.7	0.43	1.6E-07	4.0E-02	3.9E-06	NA	NA	Class D	NA
Fluorene	0.59	0.43	1.2E-08	4.0E-02	3.0E-07	NA	NA	Class D	NA
Indeno(1,2,3-cd)pyrene	3.7	0.27	4.7E-08	4.0E-02	1.2E-06	2.7E-01	1.7E-08	7.3E-01	1.2E-08
Lead	318	0.3	4.5E-06	7.5E-04	6.0E-03	NA	NA	NA	NA
Mercury	0.35	2	3.2E-08	3.0E-04	1.1E-04	NA	NA	Class D	NA
Naphthalene (VOC)	1.2	0.43	2.5E-08	2.0E-02	1.2E-06	NA	NA	NA	NA
p/m-Xylene	0.16	1	7.5E-09	2.0E+00	3.8E-09	NA	NA	Class D	NA
Perylene	1.5	0.43	3.0E-08	3.0E-02	9.9E-07	NA	NA	Class D	NA
Phenanthrene	4.8	0.43	9.8E-08	4.0E-02	2.4E-06	NA	NA	Class D	NA
Pyrene	10	0.43	2.0E-07	3.0E-02	6.5E-06	NA	NA	Class D	NA
				Hazard Index:	0.008			Total Cancer Risk:	3.8.E-07

Notes:
Pyrene RAF, RfD, and CSF are used as a surrogate values for Benzo(e)pyrene and Perylene.

Table6.xlsTable6a

TABLE 7
SUMMARY OF RISK ESTIMATES
51 COMMERCIAL STREET
AMENDMENT TO METHOD 3 RISK CHARACTERIZATION
FORMER MALDEN MANUFACTURED GAS PLANT
MALDEN, MASSACHUSETTS

Receptor	Exposure Pathway	Estimated Lifetime Cancer Risk (ELCR)	Hazard Index (HI)	Exceeds MADEP Target Risk Levels*
Current				
Landscaper [1]	Incidental Ingestion of Soil	4E-07	8E-03	No
	Dermal Contact with Soil	3E-07	3E-03	No
	TOTAL RISK	**7E-07**	**1E-02**	**No**
Trespasser (Utility Scenario)	Incidental Ingestion of Soil	1E-07	1E-04	No
	Dermal Contact with Soil	9E-08	3E-05	No
	Inhalation of Fugitive Dust	7E-10	3E-06	No
	Inhalation of Vapors	6E-09	3E-03	No
	TOTAL RISK	**2E-07**	**3E-03**	**No**
Utility Worker	Incidental Ingestion of Soil	1E-06	4E-04	No
	Dermal Contact with Soil	8E-07	4E-04	No
	Inhalation of Fugitive Dust	4E-08	8E-05	No
	Inhalation of Vapors	5E-08	7E-03	No
	TOTAL RISK	**2E-06**	**8E-03**	**No**
Site Worker	Inhalation of Indoor Air	2E-06	1E-01	No
	TOTAL RISK	**2E-06**	**1E-01**	**No**

Notes:
* = MADEP establishes a condition of No Significant Risk if the hazard index is less than or equal to one and the estimated lifetime cancer risk is less than or equal to 1E-5.
(1) Represents revised risks using recent data. All other risk estimates from Phase II Risk Characterization (AMEC 2001).

Table 8
Potential Carcinogenic Risk Following Exposure via Inhalation of Indoor Air
Substantial Hazard Evaluation
Former Malden MGP, Malden, Massachusetts

Receptor: Site Worker (Adult)

$$\text{LADD (mg/kg-day)} = \frac{CA \times AAF \times IR \times ET \times EF \times ED}{BW \times AP}$$

ELCR = LADD (mg/kg-day) * CSF (1/mg/kg-day)

Parameter (units)		Value
LADD =	Lifetime Average Daily Dose Due to Inhalation (mg/kg-day)	See Below
CA =	Compound Concentration in Air (mg/m^3)	Chemical-Specific
AAF =	Absorption Adjustment Factor (unitless)	Chemical-Specific
IR =	Inhalation Rate (m^3/hr)	1.2
ET=	Exposure Time (hr/day)	8
EF =	Exposure Frequency (days/year)	250
ED =	Exposure Duration (years)	19
BW =	Body Weight (kg)	70
AP =	Averaging Period (days) (75 years x 365 days/yr, cancer)	27375
CSF=	Cancer Slope Factor (1/mg/kg-day)	Chemical-Specific
ELCR=	Estimated Lifetime Cancer Risk	Calculated

Compound	Compound (mg/m^3)	AAF (unitless)	ADD (mg/kg-day)	Inhalation CSF (1/mg/kg-day)	Inhalation (unitless)
Benzene	0.0132	1	3E-04	0.0273	9E-06
Ethylbenzene	0.0025	1	6E-05	Class D	NA
Naphthalene	0.0029	1	7E-05	NA	NA
Styrene	0.0043	1	1E-04	NA	NA
Toluene	0.0232	1	6E-04	Class D	NA
m-&p-xylenes	0.0053	1	1E-04	Class D	NA
o-xylenes	0.0023	1	6E-05	Class D	NA
ELCR =					9.E-06

Table 10a
Potential Exposure via Incidental Ingestion of Soil - 51 Commercial Street
Substantial Hazard Evaluation
Former Malden MGP, Malden, Massachusetts

Scenario:	Current Occupational Scenario (0 - 3 ft.)
Receptor:	Landscaper

$$\text{ADD/LADD (mg/kg-day)} = \frac{CS \times IR \times FI \times RAFo \times EF \times ED \times CF}{BW \times AT}$$

Hazard Quotient (HQ) = ADD (mg/kg-day) / RfD (mg/kg-day)
Cancer Risk (ELCR) = LADD (mg/kg-day) * CSF [1/(mg/kg-day)]

Parameter (units)		Value
ADD =	Average Daily Dose Due to Ingestion (mg/kg-day)	See Below
LADD =	Lifetime Average Daily Dose (mg/kg-day)	See Below
CS =	Compound Concentration in Soil (mg/kg)	Chemical-Specific
IR =	Soil Ingestion Rate (mg/day)	50
FI=	Fraction of Soil Ingested from the Site (unitless)	1
RAFo =	Relative Absorption Factor (Oral-Soil) (unitless)	Chemical-Specific
EF =	Exposure Frequency (days/year)	24
ED =	Exposure Duration (years)	19
CF =	Conversion Factor (kg/mg)	1E-06
BW =	Body Weight (kg)	70
AT =	Averaging Time (days) (ED x 365 days/yr, noncancer)	6935
AT =	Averaging Time (days) (75 yr. x 365 days/yr, cancer)	27375
RfD=	Reference Dose (mg/kg-day)	Chemical-Specific
CSF=	Cancer Slope Factor [1/(mg/kg-day)]	Chemical-Specific

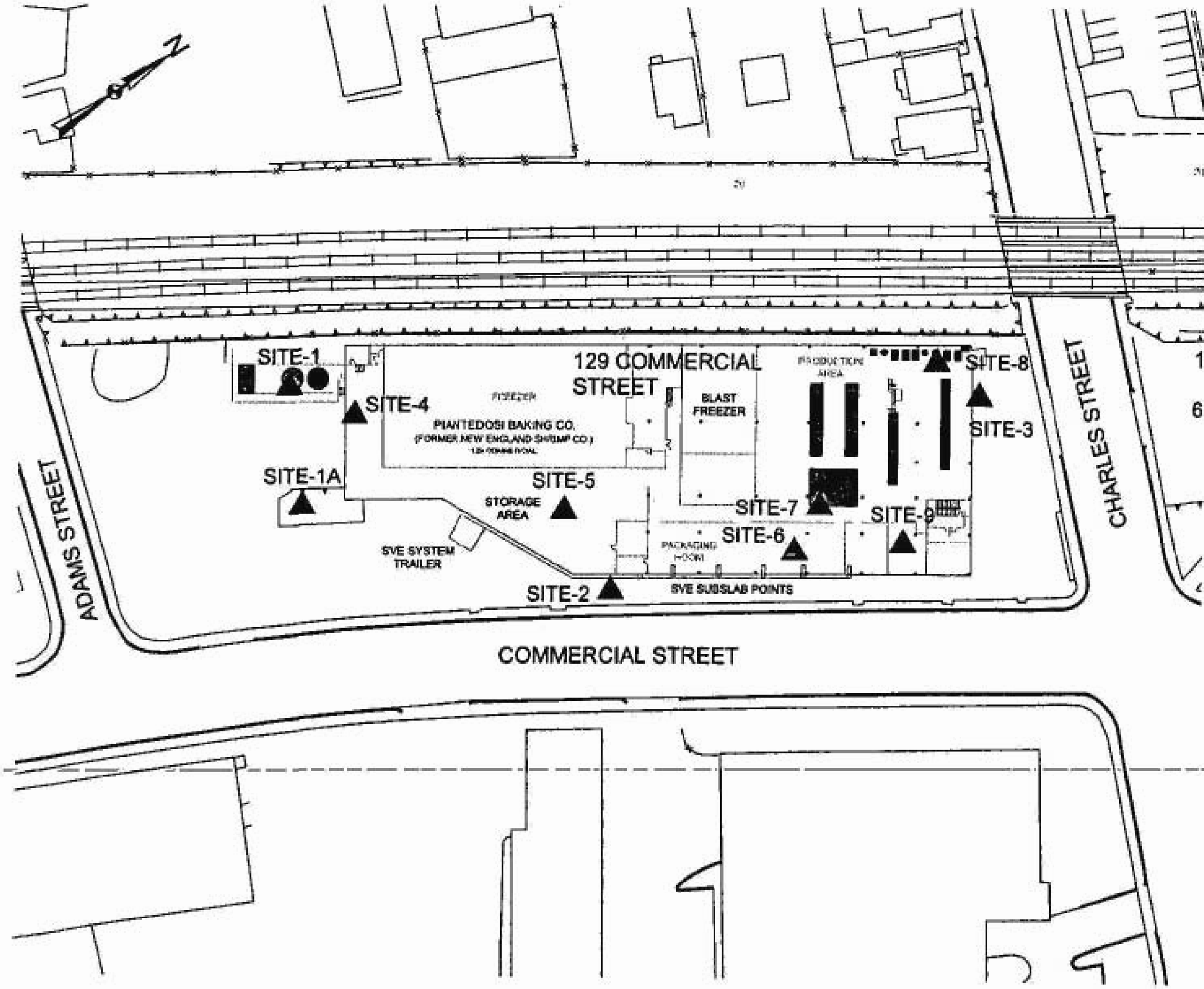
		Noncancer Hazard Quotient				Excess Lifetime Cancer Risk			
Compound	Soil Concentration (0 - 3 ft.) (mg/kg)	Oral-Soil RAF (unitless)	ADD (Noncancer) (mg/kg-day)	Chronic Oral RfD (mg/kg-day)	Soil Ingestion HQ (unitless)	Oral-Soil RAF (unitless)	LADD (Cancer) (mg/kg-day)	Oral CSF $(mg/kg\text{-}day)^{-1}$	Soil Ingestion Risk (unitless)
1-Methylnaphthalene	0.64	0.43	1.3E-08	0.02	6.4E-07	NA	NA	NA	NA
2-Methylnaphthalene	0.85	0.43	1.7E-08	0.02	8.6E-07	NA	NA	NA	NA
Acenaphthylene	2.34	0.43	4.7E-08	0.06	7.9E-07	NA	NA	Class D	NA
Anthracene	2.14	0.43	4.3E-08	0.3	1.4E-07	NA	NA	Class D	NA
Arsenic	8.77	0.51	2.1E-07	0.0003	7.0E-04	0.51	5.3E-08	1.5	8.0E-08
Barium	63	1	3.0E-06	0.07	4.2E-05	NA	NA	NA	NA
Benzo(a)anthracene	5	0.27	6.7E-08	0.04	1.7E-06	0.27	1.7E-08	0.73	1.2E-08
Benzo(a)pyrene	5.42	0.27	6.9E-08	0.04	1.7E-06	0.27	1.7E-08	7.3	1.3E-07
Benzo(b)fluoranthene	5	0.27	5.7E-08	0.04	1.4E-06	0.27	1.5E-08	0.73	1.1E-08
Benzo(e)pyrene	4	0.43	7.7E-08	0.03	2.6E-06	NA	NA	Class D	NA
Benzo(g,h,i)perylene	4	0.27	5.3E-08	0.04	1.3E-06	NA	NA	Class D	NA
Benzo(k)fluoranthene	4	0.27	5.6E-08	0.04	1.4E-06	0.27	1.4E-08	0.073	1.0E-09
C11-C22 Aromatics	810.33	0.43	1.6E-05	0.03	5.5E-04	NA	NA	NA	NA
C19-C36 Aliphatics	136	0.91	5.8E-06	2	2.9E-06	NA	NA	NA	NA
C9-C18 Aliphatics	43	0.91	1.8E-06	0.1	1.8E-05	NA	NA	NA	NA
Cadmium	1	1	2.5E-08	0.001	2.5E-05	NA	NA	NA	NA
Chromium	23.33	0.3	3.3E-07	0.003	1.1E-04	NA	NA	NA	NA
Chrysene	6	0.27	7.0E-08	0.04	1.7E-06	0.27	1.8E-08	0.0073	1.3E-10
Cyanide, Physiologically Av	1	1	5.0E-08	0.02	2.5E-06	NA	NA	Class D	NA
Cyanide, Total	4	0.2	4.2E-08	0.02	2.1E-06	NA	NA	Class D	NA
Dibenzo(a,h)anthracene	1	0.27	1.5E-08	0.04	3.8E-07	0.27	3.9E-09	7.3	2.8E-08
Fluoranthene	7.70	0.43	1.6E-07	0.04	3.9E-06	NA	NA	Class D	NA
Fluorene	0.59	0.43	1.2E-08	0.04	3.0E-07	NA	NA	Class D	NA
Indeno(1,2,3-cd)pyrene	4	0.27	4.7E-08	0.04	1.2E-06	0.27	1.2E-08	0.73	8.6E-09
Lead	318	0.3	4.5E-06	0.00075	6.0E-03	NA	NA	NA	NA
Mercury	0	2	3.2E-08	0.0003	1.1E-04	NA	NA	Class D	NA
Naphthalene (VOC)	1	0.43	2.5E-08	0.02	1.2E-06	NA	NA	NA	NA
p/m-Xylene	0.16	1	7.5E-09	2	3.8E-09	NA	NA	Class D	NA
Perylene	1.47	0.43	3.0E-08	0.03	9.9E-07	NA	NA	Class D	NA
Phenanthrene	4.84	0.43	9.8E-08	0.04	2.4E-06	NA	NA	Class D	NA
Pyrene	10	0.43	2.0E-07	0.03	6.5E-06	NA	NA	Class D	NA
				Hazard Index:	0.008			Total Cancer Risk:	2.7.E-07

Notes:
Toxicity information for Pyrene used as surrogate values for Benzo(e)pyrene and Perylene.

TABLE 11
SUMMARY OF RISK ESTIMATES
51 COMMERCIAL STREET
SUBSTANTIAL HAZARD EVALUATION
FORMER MALDEN MANUFACTURED GAS PLANT
MALDEN, MASSACHUSETTS

Receptor	Exposure Pathway	Estimated Lifetime Cancer Risk (ELCR)	Hazard Index (HI)	Exceeds MADEP Target Risk Levels*
Current				
Landscaper [(1)]	Incidental Ingestion of Soil	3E-07	8E-03	No
	Dermal Contact with Soil	2E-07	3E-03	No
	TOTAL RISK	**5E-07**	**1E-02**	**No**
Trespasser (Utility Scenario)	Incidental Ingestion of Soil	1E-07	1E-04	No
	Dermal Contact with Soil	9E-08	3E-05	No
	Inhalation of Fugitive Dust	7E-10	3E-06	No
	Inhalation of Vapors	6E-09	3E-03	No
	TOTAL RISK	**2E-07**	**3E-03**	**No**
Utility Worker	Incidental Ingestion of Soil	1E-06	4E-04	No
	Dermal Contact with Soil	8E-07	4E-04	No
	Inhalation of Fugitive Dust	4E-08	8E-05	No
	Inhalation of Vapors	5E-08	7E-03	No
	TOTAL RISK	**2E-06**	**8E-03**	**No**
Site Worker	Inhalation of Indoor Air	2E-06	1E-01	No
	TOTAL RISK	**2E-06**	**1E-01**	**No**

Notes:
* = MADEP establishes a condition of No Significant Risk if the hazard index is less than or equal to one and the estimated lifetime cancer risk is less than or equal to 1E-5.
(1) Represents revised risks using recent data in Substantial Hazard Evaluation. All other risk estimates from Phase II Risk Characterization (AMEC 2001).



LEGEND:

SGC-1 ▲ INDOOR AIR SAMPLE LOCATION

BASEMAP FEATURES

PILE - SUPPORTED CONCRETE CULVERTS

NOTES:

1. BASE PLAN ADAPTED FROM "TOPOGRAPHIC WORKSHEET OF THE MANUFACTURED GAS PLANT, MALDEN, MA" FOR MASSACHUSETTS ELECTRIC COMPANY BY EASTERN TOPOGRAPHICS, JUNE 1995, AND CITY OF MALDEN ASSESSOR'S PLAN, SHEETS 1 AND 2, JUNE 1995, AND SHEET NO. 53 BY FAY, SPOFFORD & THORNDIKE, INC., UPDATED JUNE 1976 AND REVISED 30 JULY 1979.

60 0 60 Feet

HALEY & ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

PHASE III SUPPLEMENTAL INDOOR AIR SAMPLING
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

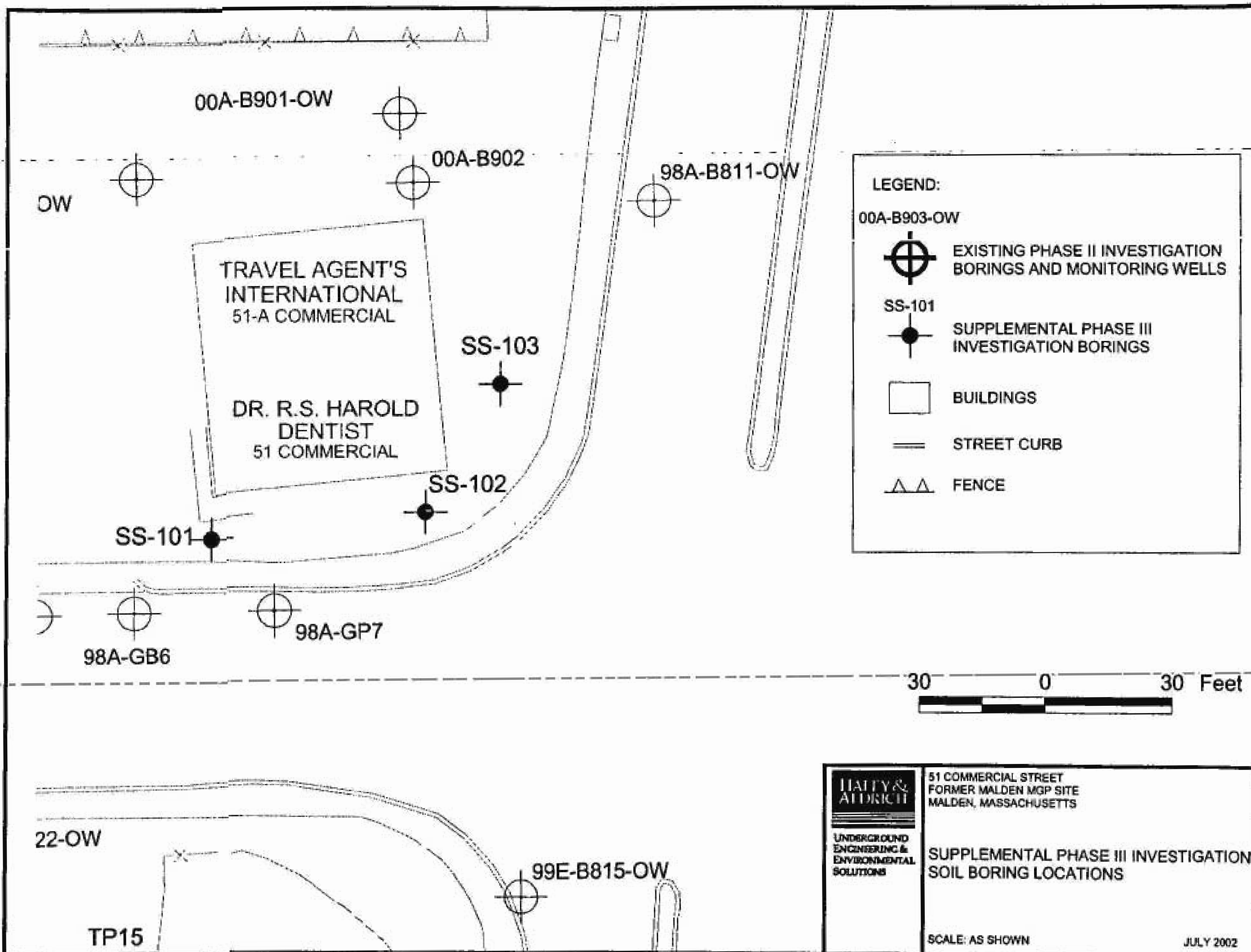
INDOOR AIR SAMPLE LOCATIONS

SCALE: AS SHOWN

AUGUST 2002

FIGURE 25

g:/06558/616/ARCVIEW/MALDEN MGP.APR



51 COMMERCIAL STREET
FORMER MALDEN MGP SITE
MALDEN, MASSACHUSETTS

SUPPLEMENTAL PHASE III INVESTIGATION
SOIL BORING LOCATIONS

SCALE: AS SHOWN

JULY 2002