MACTEC

November 22, 2004

3650040007

Mr. Kyle MacAfee
Bureau of Waste Site Cleanup
Massachusetts Department of Environmental Protection
One Winter Street
Boston, MA 02108

Subject: **Construction Release Abatement Measures Plan for the Property Located at 2472-2484 Massachusetts Avenue Cambridge, MA RTN 3-00013232**

Dear Mr. MacAfee:

On behalf of the current owner of the property, VLW Realty Trust of Cambridge, Massachusetts, MACTEC Engineering and Consulting (MACTEC) is enclosing herein a copy of a Construction Release Abatement Measures (RAM) Plan for the subject property formerly known as the Former Mass. Avenue Firestone Store and Gasoline Station. The purpose of this submittal is to provide documentation of a focused site characterization and focused risk assessment relative to the construction and operation of a commercial building constructed on grade at the property as part of the on-going redevelopment actions. This submittal utilizes the RAM as a regulatory vehicle to provide the results of the assessment and risk characterization conducted pursuant to the Bureau of Waste Site Cleanup Policy on Construction of Buildings in Contaminated Areas. The results of this work demonstrate that a condition of no significant risk exists for the construction and operation of a commercial building, in this case a restaurant, at the subject property.

If there are any questions regarding this information, please do not hesitate to contact me.

Sincerely,
MACTEC ENGINEERING AND CONSULTING

Robert Nicoloro, LSP
Senior Project Manager

CC: B. Woolkalis

Enclosure: Construction Release Abatement Measure Plan

[P:\W2-mfg\Best Gas Cambridge\Reports\construction ram transfer letter.doc]

MACTEC Engineering and Consulting
107 Audubon Road, Bldg 2, Suite 301 • Wakefield, MA 01880
781-245-6606 • Fax: 781-246-5060

CONSTRUCTION RELEASE ABATEMENT MEASURE PLAN

CONSTRUCTION OF A COMMERCIAL BUILDING AT
2472-2484 MASSACHUSETTS AVENUE
CAMBRIDGE, MASSACHUSETTS
RTN 3-0013232

NOVEMBER 2004

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC106

Release Tracking Number
3-13232

RELEASE ABATEMENT MEASURE (RAM) TRANSMITTAL FORM

Pursuant to 310 CMR 40.0444 - 0446 (Subpart D)

A. SITE LOCATION:

1. Site Name/Location Aid: Former Mass Avenue Firestone Store and Gasoline Station

2. Street Address: 2472-2484 Massachusetts Avenue

3. City/Town: Cambridge 4. ZIP Code: 02139-0000

☑ 5. Check here if a Tier Classification Submittal has been provided to DEP for this disposal site.

☐ a. Tier IA ☐ b. Tier IB ☐ c. Tier IC ☑ d. Tier II

6. If a Tier I Permit has been issued, provide Permit Number: _____

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

1. List Submittal Date of Initial RAM Written Plan (if previously submitted): _____ (mm/dd/yyyy)

☑ 2. Submit an **Initial Release Abatement Measure (RAM) Plan.**

☐ a. Check here if this RAM Plan received previous oral approval from DEP as a continuation of a Limited Removal Action (LRA).

b. List Date of Oral Approval: _____ (mm/dd/yyyy)

☐ 3. Submit a **Modified RAM Plan** of a previously submitted written RAM Plan.

☐ 4. Submit a **RAM Status Report.**

☐ 5. Submit a **RAM Completion Statement.**

☐ 6. Submit a **Revised RAM Completion Statement.**

7. Provide Additional RTNs:

☐ a. Check here if this RAM Submittal covers additional Release Tracking Numbers (RTNs). RTNs that have been previously linked to a Primary Tier Classified RTN do not need to be listed here. This section is intended to allow a RAM to cover more than one unclassified RTN and not show permanent linkage to a Primary Tier Classified RTN.

b. Provide the additional Release Tracking Number(s) covered by this RAM Submittal. ☐ - _____ ☐ - _____

(All sections of this transmittal form must be filled out unless otherwise noted above)

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC106

RELEASE ABATEMENT MEASURE (RAM) TRANSMITTAL FORM

Pursuant to 310 CMR 40.0444 - 0446 (Subpart D)

Release Tracking Number
3.(- 13232

C. RELEASE OR THREAT OF RELEASE CONDITIONS THAT WARRANT RAM:

1. Identify Media Impacted and Receptors Affected: (check all that apply)

☐ a. Air ☐ b. Basement ☐ c. Critical Exposure Pathway ☑ d. Groundwater ☐ e. Residence
☐ f. Paved Surface ☐ g. Private Well ☐ h. Public Water Supply ☐ i. School ☐ j. Sediments
☑ k. Soil ☐ l. Storm Drain ☐ m. Surface Water ☐ n. Unknown ☐ o. Wetland ☐ p. Zone 2
☐ q. Others Specify: _____

2. Identify all sources of the Release or Threat of Release, if known: (check all that apply)

☐ a. Above-ground Storage Tank (AST) ☐ b. Boat/Vessel ☐ c. Drums ☑ d. Fuel Tank
☑ e. Pipe/Hose/Line ☐ f. Tanker Truck ☐ g. Transformer ☑ h. Under-ground Storage Tank (UST)
☐ i. Vehicle ☐ j. Others Specify: _____

3. Identify Oils and Hazardous Materials Released: (check all that apply)

☑ a. Oils ☐ b. Chlorinated Solvents ☐ c. Heavy Metals
☑ d. Others Specify: Gasoline residuals

D. DESCRIPTION OF RESPONSE ACTIONS: (check all that apply, for volumes list cumulative amounts)

☐ 1. Assessment and/or Monitoring Only
☐ 2. Temporary Covers or Caps
☐ 3. Deployment of Absorbent or Containment Materials
☐ 4. Temporary Water Supplies
☐ 5. Structure Venting System
☐ 6. Temporary Evacuation or Relocation of Residents
☐ 7. Product or NAPL Recovery
☐ 8. Fencing and Sign Posting
☐ 9. Groundwater Treatment Systems
☐ 10. Soil Vapor Extraction
☐ 11. Bioremediation
☐ 12. Air Sparging
☑ 13. Excavation of Contaminated Soils

☑ a. Re-use, Recycling or Treatment ☐ i. On Site Estimated volume in cubic yards _____
☑ ii. Off Site Estimated volume in cubic yards <1,500 cy + < 20%

iia. Receiving Facility: American Reclaimation Town: Chalton State: MA

iib. Receiving Facility: _____ Town: _____ State: _____

iii. Describe: _____

D. DESCRIPTION OF RESPONSE ACTIONS (cont.): (check all that apply, for volumes list cumulative amounts)

☐ b. Store

☐ i. On Site Estimated volume in cubic yards _____

☐ ii. Off Site Estimated volume in cubic yards _____

iia. Receiving Facility: _____ Town: _____ State: _____

iib. Receiving Facility: _____ Town: _____ State: _____

☐ c. Landfill

☐ i. Cover Estimated volume in cubic yards _____

Receiving Facility: _____ Town: _____ State: _____

☐ ii. Disposal Estimated volume in cubic yards _____

Receiving Facility: _____ Town: _____ State: _____

☐ 14. Removal of Drums, Tanks or Containers:

a. Describe Quantity and Amount: _____

_____

b. Receiving Facility: _____ Town: _____ State: _____

c. Receiving Facility: _____ Town: _____ State: _____

☐ 15. Removal of Other Contaminated Media:

a. Specify Type and Volume: _____

_____

b. Receiving Facility: _____ Town: _____ State: _____

c. Receiving Facility: _____ Town: _____ State: _____

☑ 16. Other Response Actions:

Describe: Construction RAM - Movement, placement of on-site soils during construction; off site disposal of soils due to contamination or excess materials.

☐ 17. Use of Innovative Technologies:

Describe: _____

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC106

RELEASE ABATEMENT MEASURE (RAM) TRANSMITTAL FORM

Pursuant to 310 CMR 40.0444 - 0446 (Subpart D)

Release Tracking Number
3-0 - 13232

E. LSP SIGNATURE AND STAMP :

I attest under the pains and penalties of perjury that I have personally examined and am familiar with 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 309 CMR 4.03(2), and (iii) the provisions of 309 CMR 4.03(3), to the best of my knowledge, information and belief,

> *if Section B of this form indicates that a **Release Abatement Measure 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) comply(ies) with the identified provisions of all orders, permits, and approvals identified in this submittal;

> *if Section B of this form indicates that a **Release Abatement Measure Status 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) comply(ies) with the identified provisions of all orders, permits, and approvals identified in this submittal;

> *if Section B of this form indicates that a **Release Abatement Measure 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) comply(ies) 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.

1. LSP #: 4290

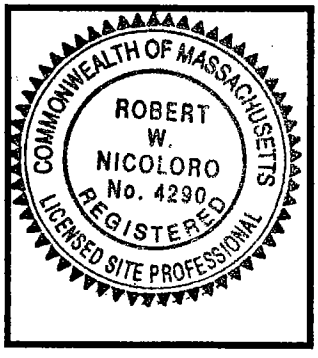
2. First Name: Robert 3. Last Name: Nicoloro

4. Telephone: (781) 245-6606 5. Ext.: 5632 6. FAX: (780) 246-5060

7. Signature: Robert Nicoloro

8. Date: 11/19/2004 (mm/dd/yyyy)

9. LSP Stamp:



Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

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RELEASE ABATEMENT MEASURE (RAM) TRANSMITTAL FORM

Pursuant to 310 CMR 40.0444 - 0446 (Subpart D)

Release Tracking Number
3.(- 13232

F. PERSON UNDERTAKING RAM:

1. Check all that apply: ☑ a. change in contact name ☑ b. change of address ☑ c. change in the person undertaking response actions

2. Name of Organization: VLW Realty Trust

3. Contact First Name: Brandon 4. Last Name: Woolkalis

5. Street: 10 Chatham Street 6. Title:

7. City/Town: Cambridge 8. State: MA 9. ZIP Code: 02139-1605

10. Telephone: (617) 216-2000 11. Ext.: 12. FAX: (617) 497-1285

G. RELATIONSHIP TO RELEASE OR THREAT OF RELEASE OF PERSON UNDERTAKING RAM:

☑ 1. RP or PRP ☑ a. Owner ☐ b. Operator ☐ c. Generator ☐ d. Transporter

☐ e. Other RP or PRP Specify:

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

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

☐ 4. Any Other Person Undertaking RAM Specify Relationship:

H. REQUIRED ATTACHMENT AND SUBMITTALS:

☐ 1. Check here if any Remediation Waste, generated as a result of this RAM, will be stored, treated, managed, recycled or reused at the site following submission of the RAM Completion Statement. You must submit a Phase IV Remedy Implementation Plan along with the appropriate transmittal form (BWSC108).

☐ 2. 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.

☑ 3. Check here to certify that the Chief Municipal Officer and the Local Board of Health have been notified of the implementation of a Release Abatement Measure.

☐ 4. Check here if any non-updatable information provided on this form is incorrect, e.g. Release Address/Location Aid. Send corrections to the DEP Regional Office.

☐ 5. If a RAM Compliance Fee is required for this RAM, check here to certify that a RAM Compliance Fee was submitted to DEP, P. O. Box 4062, Boston, MA 02211.

☑ 6. Check here to certify that the LSP Opinion containing the material facts, data, and other information is attached.

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC106

RELEASE ABATEMENT MEASURE (RAM) TRANSMITTAL FORM

Release Tracking Number
3.(- 13232

Pursuant to 310 CMR 40.0444 - 0446 (Subpart D)

I. CERTIFICATION OF PERSON UNDERTAKING RAM:

1. I, Brandon Woolkalis, 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.

2. By: _____ 3. Title: MANAGER
Signature

4. For: VLW Realty Trust 5. Date: 11/19/04
(Name of person or entity recorded in Section F) (mm/dd/yyyy)

☐ 6. Check here if the address of the person providing certification is different from address recorded in Section F.

7. Street: _____

8. City/Town: _____ 9. State: _____ 10. ZIP Code: _____

11. Telephone: _____ 12. Ext.: _____ 13. FAX: _____

YOU MUST LEGIBLY 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.

Date Stamp (DEP USE ONLY:)

CONSTRUCTION RELEASE ABATEMENT MEASURE PLAN

CONSTRUCTION OF A COMMERCIAL BUILDING AT
2472-2484 MASSACHUSETTS AVENUE
CAMBRIDGE, MASSACHUSETTS

Prepared for:

VLW Realty Trust
2480 Massachusetts Avenue
Cambridge, Massachusetts

Prepared by:

MACTEC Engineering and Consulting, Inc.
107 Audubon Road
Wakefield, Massachusetts

Project Number: 3650040007.05

November 2004

Reviewed and Approved by:

Robert Nicoloro

Michael J. Murphy

CONSTRUCTION RELEASE ABATEMENT MEASURE PLAN

CONSTRUCTION OF A COMMERCIAL BUILDING AT 2472-2484 MASSACHUSETTS AVENUE CAMBRIDGE, MASSACHUSETTS

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CAMBRIDGE, MASSACHUSETTS

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CONSTRUCTION RELEASE ABATEMENT MEASURE PLAN

CONSTRUCTION OF A COMMERCIAL BUILDING AT
2472-2484 MASSACHUSETTS AVENUE
CAMBRIDGE, MASSACHUSETTS

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CONSTRUCTION RELEASE ABATEMENT MEASURE PLAN

CONSTRUCTION OF A COMMERCIAL BUILDING AT
2472-2484 MASSACHUSETTS AVENUE
CAMBRIDGE, MASSACHUSETTS

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CONSTRUCTION RELEASE ABATEMENT MEASURE PLAN

CONSTRUCTION OF A COMMERCIAL BUILDING AT
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CAMBRIDGE, MASSACHUSETTS

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1.0 GENERAL INFORMATION

VLW Realty Trust (VLW) has requested that MACTEC Engineering & Consulting, Inc. (MACTEC), perform Licensed Site Professional (LSP) services to complete Response Actions at the property located at 2472-2484 Massachusetts Avenue in Cambridge, Massachusetts (hereafter referred to as the Site). The Site is identified as a Disposal Site under the Massachusetts Contingency Plan (MCP) due to the presence of oil and hazardous materials in the form of residual and weathered petroleum related constituents discovered in soil and groundwater at depth between 13 and 16 feet below ground surface throughout a portion of the property.

On behalf of VLW Realty Trust, MACTEC has prepared this construction RAM Plan in accordance with the MCP (310 CMR 40.0444) to serve as a method of assessment to evaluate the presence of oil an hazardous materials at the Site as related to planned redevelopment actions for the construction of a commercial building on the property. MACTEC and the Licensed Site Professional of Record for the site will provide periodic oversight of the construction of the building as that construction relates to the recommendations of this construction RAM. The Licensed Site Professional (LSP) of Record is:

Mr. Robert Nicoloro (License Number 4290)
MACTEC Engineering & Consulting, Inc.
107 Audubon Road, Suite 301
Wakefield, Massachusetts 01880
Phone: (781) 245-6606
Fax: (781) 246-5060

1.1 PARTY CONDUCTING RAM

The party conducting the RAM and the current owner of the Site is:

VLW Realty Trust
2480 Massachusetts Avenue
Cambridge, MA 02142
Contact: Mr. Brandon Woolkalis
617-216-2000

1.2 SITE DESCRIPTION

The Site is located at 2472-2484 (2480) Massachusetts Avenue in Cambridge Massachusetts and is situated on 11,507 square foot parcel of land identified in a commercial and residential zoned urban neighborhood (Figure 1). Until recently, the Site was used as a gasoline service station. Former use of the property included a Firestone Tire store in addition to the gasoline station operations. Currently, the majority of the site is bare ground as recent decommissioning and demolition activities razed the building, removed three underground gasoline storage tanks, a gasoline pump island, concrete pads and an over head canopy that until recently occupied a portion of the Site. These removal actions were conducted under a RAM submitted in September 2004.

1.3 DISPOSAL SITE HISTORY

The property was used as a gasoline service station from the 1930s until August 2004 when the property was sold to VLW Realty Trust. There were three cathodically protected, 6,000-gallon, single wall steel USTs present on site that were formerly used to store gasoline (GES, 1995). The USTs were closed and removed in accordance with a RAM Plan (MACTEC September 2004). During the removal of a UST and one of two pump islands conducted under the above-referenced RAM, a detection of greater than 100 parts per million of total organic vapors was measured by a field photoionization (PID) instrument 10 feet away from the outer wall of one UST and around the gas pump . This detection resulted in notification to the Massachusetts Department of Environmental Protection (MADEP) in accordance with 310 CMR 40.0313(2) and an Immediate Response Action (IRA) was initiated in accordance with 310 CMR 40.0412(2). The IRA involved the continued removal of the USTs, associated piping, the gasoline pump island, and soil that had been impacted by the release of gasoline occurring during the UST piping removal under the RAM, which triggered the notification and IRA.

The subject property is Tier Classified as Tier II, and currently undergoing environmental assessment Phase II Supplemental Comprehensive Site Assessment (Phase II) and Phase III Identification and Selection of Comprehensive Remedial Action Alternatives (Phase III). The Phase III is in its initial conception pending completion of Phase II actions associated with the decommissioning of the referenced USTs. The Supplemental Phase II is being conducted to evaluate temporal and seasonal variation of the extent of groundwater contamination and the possible presence of a soil contamination source area in the location of the former USTs.

The referenced Phase II activities are being conducted in compliance with the Massachusetts Contingency Plan (MCP) as a result of oil and hazardous materials (OHM) present in environmental media discovered during a site assessment conducted by Groundwater & Environmental Services, Inc., in 1995. This 1995 assessment lead to notification, designation of the site as a Disposal Site (RTN # 3-0013232) by the Massachusetts Department of Environmental Protection (MADEP). In 1997 Eklund Associates classified the site as a Tier II under the MCP (Eklund, 1997). The site assessment has identified OHM in groundwater at concentrations that have decreased over time but exceed MCP appropriate standards (risk-based Method 1 standards for GW-2/GW-3 groundwater category).

1.4 PURPOSE OF RAM PLAN

This construction RAM is being implemented to:

1. assess the potential risk associated with the construction and occupancy of the building to human health safety, public welfare and the environment;
2. based on the results of that assessment, take actions as needed to reduce potential risk; and
3. allow the construction of the commercial building planned for the redevelopment and future use of this property.

This RAM includes a combined Focused Site Characterization and Focused Risk Assessment Report (FSC/FRA) (Sections 3.0 through 11.0) to assess the potential for exposure to construction and utility workers during the excavation of soil at the Site. Excavation of soil is necessary to construct footings and foundations to a depth of 4 to 5 feet below ground surface, grade the building construction area and future paved lot, and excavation at 5 to 6 feet below ground surface to install utilities from the public rights of way to the new building construction.

2.0 RAM IMPLEMENTATION

2.1 RAM ACTIVITIES

The objective of this RAM is to assess and, based on the results of that assessment, implement any actions necessary, as determined by the Focused Risk Assessment, to demonstrate a condition of no significant risk associated with the construction of the planned commercial building (a restaurant) and planned occupancy of that building.

The Focused Risk Assessment (Sections 5 through 11 of this RAM Plan) has been conducted for the area in and around the footprint of the planned building construction and for the site grading activities that will occur prior to paving the lot. The Focused Risk Assessment utilizes analytical data from soil and groundwater samples collected during a Focused Site Characterization with consideration of other data collected both on and off the property. The results of the Focused Risk Assessment demonstrate that a condition of no significant risk exists for the construction of the building and for the occupancy of that building. No oil and hazardous materials were detected in soil or groundwater that exceed Upper Concentration Limits (UCLs) at the property. There is no risk to public safety at the property.

A Soil Management Plan remains in effect from the previous RAM (September 2004) associated with the removal of underground gasoline storage tanks, in the event that oil and hazardous materials are discovered above Reportable Concentrations during the construction excavation or grading work at the property for the new site use. If such a scenario exists, then the nature and extent of the oil and hazardous materials discovered during the construction phase will be addressed by the LSP of Record, most likely in the form of a RAM Plan Modification, unless an Immediate Response Action (IRA) is warranted. Construction activities will also be limited or halted depending on the nature of the conditions relative to the construction work being performed. There is no evidence to suggest that such conditions exist at the site or would be encountered during the construction excavation or grading activities.

Soil samples were collected in the area of the construction footprint (Figure 2) as part of the Focused Site Characterization (Section 4). The results of those surface samples indicate two hot spot locations (Section 7.1 of the RAM Plan), one associated with polycyclic aromatic hydrocarbons (PAHs) at 2.5 feet below ground surface (bgs) near a former hydraulic lift oil reserve tank removed from below grade at the maintenance bay of the former gasoline station and a subsurface hot spot of volatile organic hydrocarbons in the saturated zone at two sampling locations 15 to 16 feet bgs and 13 to 15 feet bgs. The hot spot associated with the hydraulic fluid tank, may also be associated with the paved area near this former tank and is outside of the immediate area of the building construction but will be considered during the grading phase of the parking lot construction. The subsurface hot spot involves two locations at a depth of 7 to 10 feet below the lowest point of planned excavation for the building. These results are evaluated in the Focused Risk Assessment. A condition of no significant risk to health is demonstrated for all constituents detected in soil and groundwater with respect to construction and/or occupancy of the building. The RAM Plan will stay active until soil excavation and grading activities are completed and the site is paved.

A vapor barrier will be installed within the footprint of the building during its construction. The Focused Feasibility Study (Section 12.0) presents the details concerning the vapor barrier and its installation.

Remediation Waste

Remediation waste is defined in the Construction of Buildings in Contaminated Areas Policy as soil and groundwater containing concentrations of oil and hazardous materials equal to or greater than applicable Reportable Concentrations as listed in the MCP. There is an area on site, identified above, as the hot spot area, (TANK-S Sampling Location) where the concentrations of PAHs exceed Reportable Concentrations for an S-2 Soil Category. These soils meet the definition of Remediation Waste. These soils will be moved and graded in place at the property. Excess soil stockpiled from the excavation and earthwork that is characterized as Remediation Waste will be taken off site for proper treatment or disposal. The estimated volume of excess soil that may require off-site treatment or disposal is less than 100 cubic yards. Soils that remain on site will eventually be below pavement as a parking area and drive-thru lane on the property once construction is completed.

Environmental monitoring is limited at this time to oversight by the LSP and the screening for total volatile organic compounds in soil. Based on data collected during this monitoring, confirmation samples may be collected for laboratory analysis and samples from soil stockpile will be collected for disposal characterization. This monitoring will continue through final earthwork activities. The Focused Risk Characterization demonstrates that a condition of no significant risk exists for down-wind receptors for fugitive dust. However, if monitoring indicates a change in conditions, this focused risk assessment will be updated with the new data.

There are no federal, state or local permits associated with the RAM. Local building permits are in place that allow the construction to begin.

Soils Management Plan

If contaminated soil is excavated as part of the construction activities, the soil will be staged on 6-mil polyethylene sheeting within a constructed bermed area. The LSP will oversee and direct the excavation of the contaminated soil and will collect confirmatory samples following the removal of the impacted material. Waste characterization samples will also be collected from the temporary stockpiled soil to determine waste characterization and disposal requirements. The stockpile will be covered with 6-mil polyethylene sheeting at the end of each workday, and the cover will be secured with tires, hay bales, or other appropriate methods. The stockpile will be staged on-site within the fence enclosure until the disposal facility approves the material for shipment and treatment/disposal. Once approved, the material will be transported to the selected treatment/disposal facility and tracked under an appropriate shipping document in accordance with the MCP (310 CMR 40.0000 and 310 CMR 30.0000). Soil contaminated with petroleum residuals generated during the previous RAM activities (September 2004) at the site involving the removal of underground storage tanks, was shipped to American Reclamation Corp., Charlton, MA for cold asphalt batch processing. It is expected that any additional remediation waste generated during the construction or cleanup activities will also be sent to this off-site facility.

As stated in the MCP (310 CMR 40.0442(4)), Release Abatement Measures shall not involve the excavation and disposal of greater than 500 cubic yards or the excavation and off-site treatment, recycling, or re-use of greater than 1,500 cubic yards (cumulative, for the disposal site in question) of soil

contaminated by OHM at concentrations equal to or greater than applicable Reportable Concentrations, unless a statement is provided in the RAM Plan by the RP, PRP or Other Person conducting the response actions certifying that, based on information and opinions provided by an LSP, such persons have sufficient financial resources to manage excavated materials in the manner and time frames specified in 310 CMR 40.0030. It is assumed that soil contaminated with OHM, if encountered, will be suitable for acceptance at a treatment, recycling, or re-use facility and it is not anticipated that greater than 1,500 cubic yards of soil contaminated by OHM will require removal. A 20% margin of error in calculating the anticipated volume of soil applies to this number.

Health and Safety Procedures

Evaluation in the Focused Risk Assessment of potential sensitive populations in the area of the construction activities at the property identify the residential properties located to the west, southwest and abutting the property to the east. The residential homes located to the west and south west of the site are approximately 35 feet at the closest point to the southwestern-most boundary of the subject property. The residences abutting the subject property to the east are within a mixed use (commercial offices and apartments) brick building close to the subject property boundary. All other properties are commercial operations. There are no schools or institutions in the vicinity of the subject property.

Measures to protect residences from dust that may contain polycyclic aromatic hydrocarbons from TANK-S sampling location, identified as a hot spot, will involve the use of a light water spray as needed to keep down dust when working in this area. Based on other data collected at the site, other construction activities on site, expected to be limited to the top 6 feet or less of soil are not expected to generate dust containing oil or hazardous materials at concentrations that require protective actions. In the event that oil and hazardous materials are discovered during excavation, such activities will then be conducted under the direction of the LSP of Record to include the implementation of protective measures to excavate contaminated soil without generating on or off site hazardous conditions. These measures include dust suppression using a light water spray, covering daily stockpiles of remediation waste, and the use of fencing to restrict access to the property.

In the event that oil and hazardous materials are discovered during the oversight and soil screening activities of the earthwork, at concentrations above Reportable Concentrations, notification will be made to the Massachusetts Department of Environmental Protection of a change in conditions. In this scenario, the construction activity will be halted to allow the LSP to assess the on- and off-site conditions, potential exposure risks, health and safety procedures, the suitability of the construction crew to conduct waste site cleanup work, and to implement the soils management plan.

Construction workers involved in activities that are associated with potential exposures to soils will be trained and work under health and safety procedures to the extent they are required by the Occupational Safety and Health Administration (OSHA) and the MCP. If it is deemed necessary to engage a remediation contractor, the remediation contractor will have the required permits, licenses, training, health and safety plan, knowledge of site conditions to satisfy the MCP and the requirements of the Occupational Safety and Health Administration (OSHA) for a site cleanup worker. The LSP on site directing remedial actions, if such actions are necessary, and the LSP's support staff working on site under the LSP's direction will also be OSHA trained, briefed on the potential hazards at the site and equipped with a health and safety plan reviewed by each support person on site.

The scope and detail of the health and safety procedures shall be commensurate with the degree and nature of the risks posed to human health and ecological populations. Such measures may include:

- Control of dust and other environmental media;
- Decontamination of vehicles and equipment to minimize the spread of contaminated soils;
- Secure on-site excavations and stockpiles of contaminated materials; and
- Discontinue response actions where necessary to protect public health and safety.

Site security involves an existing 6-foot high temporary fence around the property and construction area. This fence is secured at the end of each day. The fence is kept in good condition and will be maintained through out the construction activities. The fence will likely be removed during the pavement activities in order to access all the areas to be paved.

There is no evidence to suggest that air or dust monitoring is necessary. However, if conditions change based on periodic real time measurements for total volatile organic vapors in soils, then air monitoring for such vapors will be implemented to protect the public.

3.0 INTRODUCTION TO FOCUSED SITE CHARACTERIZATION / FOCUSED RISK ASSESSMENT

3.1 PURPOSE

This combined Focused Site Characterization and Focused Risk Assessment (FSC/FRA) Report has been prepared for the Property located at 2472-2484 Massachusetts Avenue in Cambridge, Massachusetts (the Property), to evaluate the health, safety, and public welfare risks that will be associated with a proposed re-development of the property. A Site Location Map is provided as Figure 1. The Property is part of the Former Mass Avenue Firestone Store and Gasoline Station Site (Release Tracking Number [RTN] 3-13232, 2480 Massachusetts Avenue). The FRA incorporates (but is not limited to) environmental data collected on the Property since 1995, including representative samples from areas of the Property that have been remediated (Appendix A), and considers the specific redevelopment plan for the property as shown in Figure 2. This risk assessment should be considered an interim update with respect to the entire Massachusetts Contingency Plan (MCP) disposal site because investigations of nature and extent of oil and hazardous materials (OHM) are on-going. Section 2.0 of this report is the FSC. The remaining sections of the report comprise the FRA.

There has been a specific redevelopment plan formulated for the property. The plan calls for the construction of a commercial space housing a Dunkin Donuts restaurant and a Baskin Robbins restaurant. The commercial space will consist of a single-story, 2,200 square-foot slab-on-grade building to be constructed with a vapor barrier. A paved parking area will surround the building. Landscaped borders will be constructed between the building and Edmunds Street, between the building and Massachusetts Avenue, and between the paved parking areas and adjoining properties (Figure 2). The landscaped borders will be approximately five feet wide except for the border between the building and Edmunds Street, which will be approximately 10 feet wide. This site configuration and use is considered the current and foreseeable use in this risk assessment.

The redevelopment plan is based on a site development plan identifying locations of structures and surface treatments for areas of the property, provided by VLW Trust (July 19, 2004). The FRA is based on the human exposures to OHM at the property and surrounding area that may occur during construction and subsequent operation of the proposed redevelopment. Specifically, the FRA evaluates construction worker exposures to surface and subsurface soil within and adjacent to the building footprint, and surface soil throughout the remainder of the property where the paved parking area and landscaped areas will be constructed. The FRA also evaluates potential exposures to dust that may migrate to off-Property receptor locations during the construction activities. The presence of the pavement will prevent contact with soil by employees, patrons, and the general public. The presence of the vapor barrier will prevent exposures to vapors, if any, that could migrate from soil or groundwater to indoor air.

3.2 RISK ASSESSMENT PROCESS

The risk assessment process can be divided into four steps: hazard identification, dose-response assessment, exposure assessment, and risk characterization and uncertainty analysis. The hazard identification determines what substances are present at a site, whether a substance causes adverse effects, and identifies those effects. The dose response assessment describes the relationship between the

level of exposure and the likelihood and/or severity of an adverse effect. The exposure assessment identifies potential routes of exposure, characterizes the populations exposed, and determines the frequency, duration, and extent of exposure. The last step, risk characterization, combines the information from the previous three steps to describe the type (e.g., carcinogenic and non-carcinogenic) and magnitude of potential risks to the exposed populations. It also identifies the uncertainty in the characterization of potential risks.

3.3 REGULATORY CONTEXT AND REQUIREMENTS

This FSC/FRA was prepared consistent with the MCP promulgated under Massachusetts General Law Chapter 21E on October 3, 1988 (310 CMR 40.0000) and amended through June 27, 2003, and the "Guidance for Disposal Site Risk Characterization" (Massachusetts Department of Environmental Protection [MADEP], 1995) and Technical Updates (MADEP, 2002). Supplemental guidance was provided by "Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A), Interim Final" (United States Environmental Protection Agency [USEPA], 1989).

According to MADEP policy, "Building Construction in Contaminated Areas" (January 2000), a focused site characterization must be conducted within and adjacent to the footprint of the proposed building and associated subsurface structures, to adequately define the nature and degree of contamination and a focused risk assessment is to be conducted to support the construction of buildings in contaminated areas. The policy requires that a focused risk assessment be conducted within and adjacent to the footprint of the planned building, to characterize the nature of risks to construction workers, surrounding populations, and future occupants of the building, and to ensure that such risks are within limits permitted by the MCP. In addition, the risk assessment should demonstrate that there are not concentrations above Upper Concentration Limits (UCLs) within the footprint of the building because permanent structures should not be built if they would interfere with or prevent remediation to eliminate concentrations above UCLs. If there are exceedances of UCLs, the policy states that a formal Phase III is required for that portion of the Property to support the redevelopment.

The focused risk assessment includes all analytical data collected to date for appropriate media and is conducted in a manner consistent with the MCP (June 27, 2003).

3.4 SELECTION OF METHOD FOR CONDUCTING THIS RISK ASSESSMENT

Three risk assessment methods are described in the MCP. Method 1 risk assessments involve comparisons of soil and groundwater concentrations to published, generic risk-based cleanup standards. Method 2 risk assessments evaluate potential risks using site-specific risk-based cleanup standards for individual chemicals, possibly in conjunction with Method 1 standards for other chemicals. Both Methods 1 and 2 are chemical-specific assessment/management approaches. Method 3 risk assessments evaluate the cumulative cancer and non-cancer risks associated with possible exposures at a site and also consider applicable or suitably analogous public health standards. The Method 3 approach is a cumulative risk approach rather than a chemical-specific approach. Method 3 is the approach that has been selected as the method for the FRA at the property.

4.0 FOCUSED SITE CHARACTERIZATION

The property was used as a gasoline service station from the 1930s until August 2004 when the property was sold to VLW Realty Trust. Three 6,000-gallon USTs used to store gasoline were removed by the new owners of the Property on October 4, 2004 as a Release Abatement Measure (RAM). The tanks, which were installed circa 1984, reportedly replaced three 3,000 gallon gasoline USTs. No documentation of the removal of these pre-1984 tanks is known to exist. In addition, two 510-gallon USTs, one used to store diesel and the other waste oil, have been removed from the Property through past owner activities. Documentation from the removal of these tanks is not available.

The subject property is currently undergoing Phase II Supplemental Comprehensive Site Assessment (Phase II) and Phase III Identification, and Selection of Comprehensive Remedial Action Alternatives (Phase III). The Phase III is in its initial stages pending completion of Phase II actions being conducted to evaluate temporal and seasonal variation of the extent of groundwater contamination and the possible presence of a soil contamination source area in the location of the former USTs.

The referenced Phase II activities are being conducted in compliance with MCP as a result of OHM present in environmental media discovered during a site assessment conducted by Groundwater & Environmental Services, Inc., in 1995. This 1995 assessment led to the notification and designation of the Property as a Disposal Site (RTN # 3-0013232) by the MADEP. In 1997 Eklund Associates classified the Property as a Tier II Disposal Site (Eklund, 1997). The site assessments conducted to this point have identified degradable OHM (e.g., volatile petroleum hydrocarbons [VPH] and target analytes) in groundwater at concentrations that have decreased over time but exceed appropriate MCP standards (risk-based Method 1 standards for GW-3 groundwater category). There are ten groundwater monitoring wells located on the property and five monitoring wells located down gradient and off-property adjacent to residential property to the west and southwest of the disposal site. There have been 21 borings on site. Other groundwater investigation wells and borings have been installed in the area of the subject property resulting from investigations of other disposal sites and releases not associated with the subject Property. Currently, VPH concentrations in soil and/or groundwater in the vicinity of locations B-9 and B-4 exceed applicable MCP soil and/or groundwater standards. As a result, continued assessment and compliance with the MCP is necessary for this Property.

4.1 BRIEF DESCRIPTION OF THE PROPERTY AND SURROUNDING AREA

The property is located at 2472-2484 (2480) Massachusetts Avenue in Cambridge, Massachusetts and is situated on an 11,507 square foot parcel of land identified in a commercial and residential zoned urban neighborhood (Figure 2). The surrounding area is urban and densely populated with residential and commercial land use. Currently the entire property is bare ground and there are no structures. Recent decommissioning and demolition activities razed the building that until recently occupied a portion of the property and also removed the pavement that once covered the entire property. The entire property is currently enclosed by a temporary chain-link fence.

Soils at the property consist of dense, well graded sand and gravel fill to depths of between four to six feet below ground surface (bgs), underlain by brown, loose, medium sand to depths ranging from 10 to 20 feet bgs. Beneath the layer of medium sand is a layer of dense, fine silty sand approximately 5 feet

thick, which is underlain by very soft silty clay. Depth to bedrock is not known. Groundwater at the property is between approximately 12 and 13 feet bgs and flows in a westerly direction.

4.2 SUMMARY OF RESPONSE ACTIONS AND OTHER INVESTIGATIONS 1995 - 2003

In 1995, as part of a Phase I and Phase II Real Estate Assessment conducted by Groundwater & Environmental Services, Inc. (GES) for Jiffy Lube International, Inc., total petroleum hydrocarbons (TPH) were detected in soil and groundwater above reportable concentrations and a Release Notification Form was submitted to the MADEP. The MADEP assigned Release Tracking Number (RTN) 3-13232. Since 1995, several investigations and response actions have been performed at the Property. Information available to MACTEC is limited on many of these response actions and investigations. What is known about them and the general impact they have had on site conditions, is described below and in Section 2.4.

UST Tightness Testing (RG Contractors, 1997). According to NewPath, RG Contractors pressure tested the five USTs on the property (three 6,000-gallon gasoline USTs, a 510-gallon diesel fuel UST, and a 510-gallon waste oil UST) in March 1997 and all five tested tight (NewPath, 2004).

Tier Classification (Eklund Associates, 1997). Eklund Associates submitted a Tier Classification to the MADEP in August 1997, which was based on the Phase I Assessment performed in 1995. The Property was classified as a Tier II site.

Preliminary Site Assessment (IES, 2001). According to NewPath, IES, Inc., Preliminary Site Assessment was performed during July and August 2001 on behalf of the then owner of the property. The assessment included the installation of five soil borings and the installation of three monitoring wells. The assessment identified extractable petroleum hydrocarbon (EPH) and VPH compounds at concentration that exceeded Method 1 standards and concluded that a Response Action Outcome (RAO) could not be achieved using available information (NewPath, 2004).

Phase II Comprehensive Site Assessment (Eklund Associates, 2001). According to NewPath, Eklund Associates completed a MCP Phase II Comprehensive Site Assessment in October 2001 using the data obtained by IES during the Preliminary Site Assessment. The Phase II reportedly concluded that "the disposal site did not pose a significant potential hazard to human health, safety, and welfare pursuant to the MCP." (NewPath, 2004)

Additional Subsurface Investigation (BEEA, 2002). According to NewPath, Boston Environmental Engineering Consultants (BEEA) conducted and additional subsurface investigation during 2002 to further define the nature and extent of OHM and to evaluate potential options for achieving a permanent solution. BEEA installed 13 soil borings, eleven of which were completed as monitoring wells. NewPath states that "the investigation determined that volatile petroleum hydrocarbons (VPH) were present in soil and groundwater above applicable standards across approximately 75% of the property and extractable petroleum hydrocarbons (EPH) were present above standards across approximately 15% of the property" and that these residuals were "moving west with groundwater across Edmunds Street." BEEA concluded that remediation would be required to achieve a level of No Significant Risk for residential use. BEEA also detected volatile organic compounds (VOCs) in an off-property well (BE-11) located within 30 feet of two residences (9-11 and 13-15 Edmunds Street) exceeding MADEP Reportable

Concentrations in Groundwater Soil-2 (RCGW-2) criteria. This triggered a notification to MADEP and an IRA requirement (NewPath, 2004).

IRA Indoor Air (NewPath, 2003). NewPath, LLC, conducted an IRA during 2003 to determine if a condition of Substantial Release Migration (SRM) or Critical Exposure Pathway (CEP) existed within the residences located at 9-11 and 13-15 Edmunds Street. The IRA included indoor air sampling and groundwater sampling at two wells nearest to the properties (BE-10 and BE-11). NewPath concluded that a condition of SRM or CEP did not exist and, because the sources (leaks in fuel lines from gasoline USTs removed in 1984 and the waste oil UST and the diesel fuel UST removed in 1999) had been removed, will most likely not exist in the future (NewPath, 2003).

Additional Groundwater Sampling (NewPath, 2003). During August 2004, NewPath re-sampled 10 wells at the property and off the property. Residual concentrations detected in groundwater during this investigation were for the most part consistent with the previous groundwater sampling conducted by BEEA. NewPath concluded that all sources had been removed but that remediation would still be required to achieve a level of "No Significant Risk" for residential use (NewPath, 2004).

4.3 SUMMARY OF MACTEC RESPONSE ACTIONS AND INVESTIGATIONS 2004

Groundwater Sampling (April 2004). MACTEC began its evaluation of the Property in 2004 with the review of the past information and data, as well as discussions with the current owner, residents, and the Licensed Site Professional (LSP) of Record for the Property. Following this evaluation, MACTEC implemented a due diligence property transfer assessment monitoring/sampling event, independent of MCP compliance activities conducted by the then property owner and the then LSP of Record. This event was conducted in March 2004 and involved groundwater sampling at four well locations, two wells on-property at EW-1 and EW-2 and two off-property wells at BE-9 and BE-11 (Figure 2). The results indicated lower levels of OHM in groundwater compared to the results of previous investigations. Based on these results, MACTEC concluded that at the time of sampling there was a condition of No Significant Risk at the two off-property groundwater sampling locations (based on comparison of groundwater data to MCP groundwater standards). A determination of a condition of No Significant Risk could not be made for on-Property locations and MACTEC recommended additional response actions involving additional sampling.

Additional Subsurface Investigation (May 2004). MACTEC performed additional investigation activities at the Property in May 2004 including the advancement of six borings, one of which was located off-property completed as monitoring well BE-10R to replace damaged monitoring well BE-10, and the collection of additional groundwater samples. In addition to sampling the new off-property monitoring well, MACTEC sampled one existing off-property well (BE-12) and six existing on-property wells (MW-1, MW-2, MW-3, BE-3F, BE-7, BE-8). Sampling results indicated that EPH, VPH, BTEX (benzene, ethylbenzene, toluene, and xylene) compounds persist in groundwater beneath the property at concentrations consistent with previous investigations. Concentrations of gasoline residuals in off-property monitoring well BE-10R were higher than concentrations detected in MW-10 during previous investigations but below Method 1 standards for GW-2 groundwater category. The increase indicates either residuals are continuing to migrate off the property or temporal variability.

The five on-property borings were collected in the vicinity of and downgradient from the former diesel UST to determine if soils on the property had been impacted by a release from the UST. Soil samples were collected from each boring every four feet of depth as the boring advanced. Samples were analyzed in the field for total VOCs using the MADEP recommended Jar Headspace Technique. Soil boring B-1 was advanced at the center location of the former diesel UST and a soil sample was collected from beneath the fill materials at approximately 7-8 feet bgs to determine if a release from the UST had occurred. Soil boring B-2 was advanced at the location of the former diesel pump and a sample was collected from approximately 2-4 feet bgs to determine if a release had occurred at the pump or from piping beneath the pump. Soil borings B-3 through B-5 were advanced in a line downgradient of the former UST and a former 2,000 gallon fuel oil UST on the adjacent property (18 Edmunds Street) that was used to store fuel oil. Soil samples from each boring exhibiting the highest headspace reading were collected for laboratory analysis. No headspace reading was observed in boring B-5 so a sample was collected from just above the water table. Soil results indicated that unsaturated zone soils at the Property had not been impacted by a release from the former diesel fuel UST or the former fuel oil UST on the adjacent property. However residual EPH, VPH, and BTEX compounds were present in soils beneath the groundwater table.

Groundwater Sampling (August 2004). In August, 2004, MACTEC sampled the three remaining wells on the Property that were not sampled during March or May. These wells were BE-3B, BE-4, and BE-14 (Figure 2). As with other on-property wells, analytical results from these wells were consistent with previous investigations.

Building Demolition and Asphalt Stripping (September 2004). During September 2004, the service station building and a storage trailer were demolished by G/J Towing, Inc., of Revere, Massachusetts. During the building demolition, three hydraulic lifts and one underground 50-gallon hydraulic oil reservoir were removed. The piston of the hydraulic lifts extended eight feet bgs. MACTEC was on site to collect soil samples from beneath the lifts. Soil samples were also collected from the bottom and four sidewalls of the reservoir grave. The two samples from the reservoir grave with the highest PID readings were submitted for analysis. Sample results indicated the presences of EPH compounds and polycyclic aromatic hydrocarbons (PAHs) in soil within the hydraulic reservoir grave. Low levels of EPH compounds were also detected beneath both of the former hydraulic lifts.

IRA/RAM UST Removal (October 2004). In September 2004, MACTEC submitted a RAM Plan to the MADEP for the removal of the three gasoline USTs and associated piping and pumps. Implementation of The RAM Plan began on September 29, 2004. On October 4, 2004, the USTs were removed from the property. During the oversight of the UST removal, MACTEC collected several soil samples from the tank excavation area in accordance with the "Commonwealth of Massachusetts Underground Storage Tank Closure Assessment Manual." (MADEP, 1993) Soil samples were screened in the field using the MADEP recommended Jar Headspace Technique. The results of the soil screening were, for the most part, below 10 parts per million (ppm). However, there were four samples from beneath the two end tanks of the three-tank series, where soil headspace readings exceeded 100 ppm. The highest was from beneath the eastern most UST with a headspace reading of 1056 ppm. These results triggered a Release Notification requirement and Immediate Response Action.

MACTEC contacted the MADEP (Mr. Paul Giddings) and the Fire Department (Captain Francis) on October 5, 2004 as required by the MCP and the State Fire Marshall Fire Protection Regulations within

24 hours of the confirmation of results and within the 72 hour notification time period stated in the MCP. A verbal plan of addressing the release as an IRA was presented to and approved by MADEP at the time of the notification. Approximately 30 cubic yards of soil was excavated for off-property recycling from the UST excavation. An additional 20 cubic yards of material was excavated from beneath the former pump islands and piping associated with the former USTs. Results of confirmation sampling with headspace readings and laboratory analyses indicated that the removal actions were successful at significantly reducing levels of OHM in soil.

Additional Subsurface Investigation (October 2004). To support the focused risk assessment, MACTEC performed additional subsurface investigations during October 2004. A total of five additional borings were advanced (soil borings B-6 through B-10), four within the footprint of the proposed building (B-7 through B-10), and one new monitoring well (MW-7) was installed near the center of the proposed building (Figure 2). Consistent with other borings advanced at the property, these borings encountered sand and gravel fill material in the top four to six feet and well sorted medium sands beneath the fill layer. Fill material different than that observed over most of the Property was observed in boring B-8 from the bottom of the general fill layer at approximately 4 feet bgs to approximately 11 feet bgs. Samples were collected from 0-3 feet (surface soil), 6-9 feet (maximum depth expected during construction) and 11-13 (interval immediately above groundwater table) of each boring advanced within the footprint of the proposed building to support the focused risk characterization. Soil samples were collected from just below the groundwater table in borings B-6 and B-9 to characterize saturated zone soil and a groundwater sample was collected from MW-7 to characterize groundwater beneath the proposed building.

4.4 NATURE AND EXTENT

This section provides an overview of the nature and extent of OHM on the Property, as represented after completion of the remedial actions and investigations discussed in previous sections of this report. This discussion of nature and extent is based on the analytical data selected for use in the FRA, which generally represent the most recent analytical results for each OHM and location, and exclude all data for samples that are representative of soils and sediments that have been excavated during the remedial activities. A summary of soil data used in the FRA is presented in Table 1; a summary of groundwater data used in the FRA is presented in Table 2. Analytical data are presented in Appendix A.

4.4.1 On-Property Soil

As described above, soil samples collected from the gasoline UST graves confirm that IRA activities were successful at removing OHM impacted soil. Only low levels of VPH compounds were detected in confirmation samples. Likewise, confirmation samples collected from the area of the former pipe island and beneath piping associated with the former USTs indicate that removal actions substantially reduced concentrations of OHM in soils on the Property. The only VPH compounds detected in confirmation samples collected from the former UST excavation area were C9-C10 aromatics, detected in one sample at a concentration of 4.9 milligrams per kilogram (mg/kg); C9-C12 aliphatics, detected in one sample at a concentration of 3.18 mg/kg; and MTBE, detected in two samples at concentrations of 0.206 and 3.18 mg/kg.

Low levels of EPH compounds were detected in samples collected from beneath the two former hydraulic lifts. EPH compounds were also detected in soil samples collected from the excavation of the

former hydraulic fluid reservoir associated with one of the lifts and several PAHs were detected in one sample collected from that excavation. It is likely that the OHM detected in these soil samples resulted from a release during removal, as the reservoir was punctured during removal but otherwise appeared to be in good condition. The release is likely very minor in extent as less than one gallon of hydraulic fuel was released as a result of the puncture. Low levels of PAHs were also detected in a sample collected from fill material in soil boring B-8. These PAHs are likely attributable to urban fill and not a release of OHM at the property.

OHM-impacted soil within the groundwater table beneath the property appears to be widespread. Analytical results of two soil samples collected from below the groundwater table and results of jar-headspace screening of additional samples collected from below the water table indicate that soils within the saturated zone are impacted over two-thirds to three-quarters of the property.

4.4.2 On-Property Groundwater

Eleven on Property monitoring wells were sampled by MACTEC during 2004, including one newly installed well (MW-7) constructed in the middle of the proposed building footprint. The other on-Property wells located across the Property that were sampled (MW-1, MW-2, MW-3, BE-3, BE-4, BE-7, BE-8, BE-13, and BE-14) were installed during previous investigations. Both VPH and EPH residuals were detected in the groundwater samples.

VPH compounds (fractions and targets) were detected in all but three on-property monitoring wells. BTEX compounds were detected in all but four. The highest concentrations of VPH and BTEX compounds were detected in samples collected from BE-4 and BE-7. Concentrations decrease in wells cross-gradient of wells BE-4 and BE-7 (EW-1, EW-2, BE-8, MW-3, and MW-7) and were mostly not present in wells BE-3B, BE-3F, BE-14, MW-1, and MW-2, which are upgradient of BE-4. The highest concentration of C5-C8 aliphatics was detected in BE-7 at a concentration of 1.86 milligrams per liter (mg/L). The highest concentrations of C9-C12 aliphatics, C9-C12 aromatics, benzene, ethylbenzene, and xylenes were detected in BE-7 at concentrations of 4.26 mg/L, 7.86 mg/L, 0.504 mg/L, 1.32 mg/L, and 1.99 mg/L respectively.

EPH compounds were also detected in all but three on-property wells. The EPH fraction C9-C18 aliphatics was detected at concentrations ranging from 0.108 to 1.18 mg/L; the C19-C36 aliphatics fraction was detected at concentrations ranging from 0.102 to 0.276 mg/L; and the C11-C22 aromatics fraction was detected at concentrations ranging from 0.233 to 0.644 mg/L. The PAHs naphthalene and 2-methylnaphthalene were also detected. Naphthalene was detected in four wells at concentrations ranging from 0.0294 to 0.126 mg/L and 2-methylnaphthalene was detected in eight wells at concentrations ranging from 0.0351 to 0.146.

4.5 CONCEPTUAL SITE MODEL

Based on previous investigations of releases of OHM and the fate and transport of OHM at the property and in the surrounding environment, a conceptual site model has been developed. The conceptual site model identifies potential source areas from which OHM may have been released and also identifies the migration pathways through which OHM may have been transported and/or translocated to other environmental media where possible exposure may occur.

The risk assessment is based on a conceptual site model and a site redevelopment proposal. The conceptual site model identifies potential source areas from which OHM may have been released, migration mechanisms and pathways, receiving media, and potential receptors.

Both EPH and VPH compounds were detected in groundwater beneath the Property. The conceptual site model indicates that multiple sources likely contributed to the residual OHM detected in groundwater at the property as analytical results indicate that gasoline, diesel fuel, and/or number 2 fuel oil residuals are present in groundwater.

4.5.1 Potential Sources

Within the Property, all known underground storage tanks (potential sources) have been removed. Three 6,000-gallon gasoline USTs were removed in October 2004. The USTs were cathodically protected and in very good condition with no visible corrosion or deterioration of the protective coating. Although minor releases from piping associated with these former USTs occurred, impacted soils were removed and residual gasoline compounds did not extend to groundwater. These USTs reportedly replaced three 3,000 gasoline USTs in 1984.

A 510-gallon diesel fuel UST and a 510-gallon waste oil UST were recently removed. Although documentation of the removal of the diesel fuel and waste oil USTs is not available, the results of MACTEC's May 2004 investigation indicated that the diesel fuel UST was not a source to soil or groundwater and OHM detected on the property are not consistent with waste oil. A former waste oil UST located on the adjacent property at 18 Edmunds Street reportedly was overfilled in the past causing pooled oil on the ground surface. Documentation of the removal of this UST is not available, but release(s) associated with this UST may have affected groundwater at the property. Groundwater samples collected from monitoring wells EW-1 and EW-2 indicate that residual fuel oil compounds are present in groundwater at these locations as well as residual gasoline compounds.

Based on the aerial extent and concentrations of residual gasoline compounds in groundwater beneath the property and the presumed groundwater flow direction, the source of gasoline compounds to groundwater appears to have been located in the vicinity of or immediately east of monitoring well BE-4. No source feature has been found. The gasoline USTs pulled in October 2004 did not appear to leak and releases to the soil likely occurred during removal. Releases from associated piping appeared to be very minor, where removed during the IRA, and did not extend to groundwater. Therefore, the most likely source was either the gasoline USTs that were removed in 1984, earlier gasoline USTs, or both. Since concentrations of residual gasoline compounds in groundwater have remained relatively constant since 2002, and since there have been no significant detections of OHM in soil above the groundwater table that have not been removed, it is unlikely that there is an area of soil contamination acting as a continuing source at the water table at higher concentrations than surrounding areas.

4.5.2 Migration and Receiving Media

As discussed above, OHM were likely released to groundwater from a historic leaking UST(s) located in the vicinity of or immediately east of monitoring well BE-4 and have since migrated over time with groundwater flow to the southwestern portion of the property where they may have mixed with fuel oil residuals from a release associated with a former UST on the adjacent property. The migration pathways

have been managed through the removal of potential sources, as described above, and through natural attenuation.

4.5.3 Potential Exposure Pathways

The FRA evaluates potential exposures associated with the land uses and activities that are consistent with the proposed property redevelopment.

The planned redevelopment includes construction of a single story slab-on-grade commercial building (fast-food restaurant) that incorporates a vapor barrier, and construction of paved parking areas and a small landscaped border throughout the remainder of the property (Figure 2). Construction of the building will involve excavation of soils as deep as 5 to 6 ft bgs at the building footprint area to permit construction of foundation footings, installation of the vapor barrier, and construction of the building floor slab. A utility trench up to 6 feet deep will be excavated between the building and Massachusetts Avenue to permit sewer, water, electricity and communications hook-up. Soil at other portions of the Property may be graded to prepare the surface for paving. During excavation of soil, grading, and during general construction work at the property, construction workers may contact OHM in the soil via incidental soil ingestion, dermal contact, and dust and vapor inhalation. Soil that is excavated from the ground will be managed under a Construction RAM; evaluation of potential exposures to the soil after excavation from the ground is not within the context of this FRA. In other words, it is assumed that after the completion of redevelopment activities that these soils will not be accessible to potential human receptors.

During construction activities, particularly during active excavation and grading activities, dust may be generated. The FRA evaluates potential exposures to dust that may be carried with air movement (breezes and wind) to off-property, down-wind locations. Receptors located at down-wind locations, including employees and consumers at businesses, and residents, may under this scenario be exposed to dust by breathing the air.

The planned construction and excavation activities do not involve excavation of soils to depths that would intersect the groundwater table. Therefore, direct contact with groundwater and inhalation of vapors from groundwater are not potentially complete exposure pathways for construction workers.

The building that will be constructed at the property will by typical design incorporate a suitable vapor barrier beneath the floor slab. Therefore, possible vapor migration from shallow groundwater and/or soil to indoor air is not a complete exposure pathway. Therefore, no significant risks to on-property workers, patrons, or visitors would be posed by indoor air. As indicated in Figure 2, the property will be completely covered with asphalt with the exception of a landscaped border around the property between 5 and 10 feet wide. Therefore, there are not complete exposure pathways to soils within the Property for facility employees.

There are no potentially complete exposures to groundwater under the planned redevelopment. There is no planned use of the groundwater for potable and non-potable purposes.

No receptors other than commercial employees, commercial patrons, and visitors are expected to use the property. The facility employee serves as a conservative surrogate for the industrial/commercial visitor (such as truck drivers, delivery personnel, etc.).

5.0 HAZARD IDENTIFICATION

5.1 SELECTION OF ANALYTICAL DATA FOR THE RISK ASSESSMENT

The following section provides a summary of the data collected and evaluated in this FRA.

5.1.1 Soil Data

This FRA includes analytical data collected to date for soil within the property boundary, as described in Section 2.

Soil data are available for VOCs, semi-volatile organic compounds (SVOCs), inorganics, EPH, and VPH. OHM that been detected in soil are summarized in Table 1. Appendix A provides a list of the sample locations included in the FRA, and Figure 2 shows the locations of the soil samples. The soil data are presented in Appendix A. OHM of potential concern are selected using these data summaries as described in Subsection 3.2. From the data presented in Appendix A, three primary soil data sets are evaluated in this FRA, as described in detail in Section 5:

- Soil 0-17 ft bgs (the depth of the deepest sample collected) within the property boundary. These data are used to identify hot spots and are evaluated with respect to UCLs in the public welfare risk characterization (Section 7).
- Soil within the building footprint that may be contacted during construction of the proposed building. These data are generally for soils 0-5 ft bgs and are used in the human health risk characterization to evaluate cancer and non-cancer risks associated with construction of the proposed building (i.e., construction worker and off-property, down wind resident).
- Soil outside of the building footprint that may be contacted by construction workers during grading/paving activities. These data are 0-3 ft bgs and are used in the human health risk characterization to evaluate cancer and non-cancer risks associated with use of the proposed development.

In Table 1, the frequency of detection, range of detected concentrations, arithmetic mean of all samples with one-half the sample quantitation limit (SQL) assigned to non-detects, are presented for each OHM. Calculation of the statistics excluded field and laboratory duplicate samples, as they are considered QC samples. In addition, for OHM that were analyzed using more than one analytical method (e.g., ethylbenzene by volatile analysis and VPH analysis), the data associated with each analytical method were evaluated, and the analytical method that yielded the more conservative assessment was included in the risk characterization. Therefore, data sets that would not exclude the OHM from the FRA on the basis of low frequency and concentration, and data sets that provided for a more conservative exposure point concentration (as described in Section 5), were selected.

5.1.2 Groundwater Data

For risk assessment purposes, the most recent groundwater data for each OHM at each monitoring well associated with the Property are used. The groundwater data include four locations (BE-12, BE-11, BE-

10R, BE-9) that are located off-property, but in which site-related OHM have been detected. These wells were included in the FRA to evaluate whether a UCL exceedance existed that could be potentially linked to a source area within the redevelopment area that might need to be addressed prior to development. It is believed that these most recent data best represent current property conditions because OHM levels in groundwater are decreasing in some areas and may be increasing or exhibiting temporal variability in other areas.

Table 2 provides a summary of the groundwater data. Appendix A provides a list of the samples that were used in the FRA and Figure 2 shows the monitoring well locations that are evaluated in the FRA. All of the groundwater data are presented in Appendix A.

5.2 SELECTION OF OIL OR HAZARDOUS MATERIALS OF POTENTIAL CONCERN (OHMPC)

Selection of OHMPC was conducted in a manner consistent with the MCP. In general, all detected analytes have been retained as OHMPCs unless they meet certain criteria. MADEP guidance (1995) lists several reasons why an individual chemical may be eliminated from the quantitative risk characterization, including:

- reported levels are consistent with background and there is no evidence that their presence is related to disposal at the property; or
- chemicals are present at low frequency of detection and low concentration and there is no history of past use and no evidence of current use of the OHM at the property.

These criteria were used to eliminate constituents as OHMPC in media, as described below.

5.2.1 Soil

A summary of on-property soil data are presented, and soil OHMPCs are selected as shown in Table 1. The soil data included in Table 1 are from all soil locations on the property, and from all depths sampled. Several of the samples are from depths below 15 ft bgs, within the saturated zone. A review of Table 1 shows that no OHM met the criteria for elimination as OHMPC based on low frequency and concentration (although a number of OHM were detected at low concentration, the number of samples analyzed did not permit exclusion based on low frequency of detection). Site-specific background data were not collected. MADEP-published background data for urban soils were not used in this FRA; however, it appears that the maximum concentrations of PAHs in soils would have exceeded the MADEP-published background values. Therefore, use of MADEP-published background values would not likely have resulted in exclusion of any OHM as OHMPC.

5.2.2 Groundwater

A summary of the Property groundwater data are presented in Table 2. All OHM detected at least once in groundwater were retained for evaluation in the FRA. However, as discussed in Section 5, there are no potentially complete exposure pathways to groundwater. Therefore, groundwater data are used only for evaluation of risks to public welfare (i.e., groundwater data are used solely in comparisons to groundwater UCL values).

6.0 TOXICITY ASSESSMENT

The objective of the toxicity assessment is to quantify the relationship between the intake, or dose, of OHM and the likelihood that an adverse health effect may result from exposure to the OHM. There are two major types of adverse health effects evaluated in the FRA: non-carcinogenic, and carcinogenic. Following USEPA guidance (USEPA, 1989b), these two effects (non-carcinogenic and carcinogenic) are evaluated separately.

There are two types of dose-response values: cancer slope factors (CSFs) and unit risk (UR) values for carcinogens; and reference concentrations (RfCs) and reference doses (RfDs) for non-carcinogens. For potentially carcinogenic OHM, both types of values have been developed by USEPA because these OHM may elicit both carcinogenic and noncarcinogenic (systemic) effects. In addition, because toxicity and/or carcinogenicity can depend on the route of exposure (i.e., oral or inhalation), unique dose-response values have been developed for the oral, dermal, and inhalation exposure routes.

Dose-Response Values for Carcinogenic Effects. It has been generally assumed historically that carcinogenic effects are non-threshold effects. This means that any dose, no matter how small, is assumed to pose a finite probability of generating a response. Thus, no dose of a carcinogen is thought to be risk-free. For carcinogenic effects, USEPA uses a two-part evaluation in which the substance is first assigned a weight-of-evidence classification, and then a CSF or UR is calculated to reflect the carcinogenic potency.

The weight-of-evidence evaluation involves determining the likelihood that the agent is a human carcinogen. USEPA has developed a system for characterizing the overall weight of evidence for a chemical's carcinogenicity based on the availability of animal, human, and other supportive data (USEPA, 1989b). The weight-of-evidence classification rates the likelihood that an agent is a human carcinogen. It qualitatively affects the interpretation of potential health risks. Three major factors are considered in characterizing the overall weight-of-evidence for carcinogenicity: (1) the quality of evidence from human studies; (2) the quality of evidence from animal studies; and (3) other supportive information, such as mutagenicity data and structure-activity data.

USEPA's final classification of the overall weight-of-evidence has the following five categories; these categories will be redefined when USEPA adopts the Final Guidelines for Carcinogen Risk Assessment:

Group A - Human Carcinogen. This category indicates there is sufficient evidence from epidemiological studies to support a causal association between an agent and human cancer.

Group B - Probable Human Carcinogen. This category generally indicates there is at least limited evidence from epidemiologic studies of carcinogenicity to humans (Group B1) or that, in the absence of data on humans, there is sufficient evidence of carcinogenicity in animals (Group B2).

Group C - Possible Human Carcinogen. This category indicates that there is limited evidence of carcinogenicity in animals in the absence of data on humans.

Group D - Not Classified. This category indicates that the evidence for carcinogenicity in animals is inadequate.

Group E - No Evidence of Carcinogenicity to Humans. This category indicates that there is evidence of noncarcinogenicity in at least two adequate animal tests in different species or in both epidemiologic and animal studies.

USEPA's draft revised guidelines for cancer risk assessment (USEPA, 1999b) have been adopted as agency policy for cancer risk assessment. These guidelines contain a revised classification system for carcinogenic effects with the following classifications.

- Carcinogenic to humans
- Likely to be carcinogenic to humans
- Suggestive evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential
- Data inadequate for an assessment of human carcinogenic potential
- Not likely to be carcinogenic in humans

In the Integrated Risk Information System (IRIS), the weight of evidence classification for a given chemical may reflect either of the two classification schemes identified above.

CSF and UR values are typically calculated for chemicals in Groups A, B1, B2, and "Carcinogenic to humans" and "Likely to be carcinogenic to humans". Cancer dose-response values for chemicals in Group C are calculated on a case-by-case basis. The CSF is an estimate of the upper 95% Confidence Limit of the slope of the dose-response curve extrapolated to low doses.

For some chemicals, human epidemiologic data is the basis of an estimate of the carcinogenic potency, although the most common basis of these values is an animal study. The CSF is given in units of $(mg/kg/day)^{-1}$ and is based upon the concept of a lifetime average daily dose (LADD). Oral CSFs are used to estimate the risks associated with exposure to carcinogens via ingestion. No CSFs are available for the dermal route of exposure, but are instead calculated from oral CSFs using the methodology described below.

Unit risk (UR) is the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 ug/L in water, or 1 ug/m^3 in air (USEPA, 2004b). In this FRA, inhalation URs are used to estimate the incremental risks associated with inhalation of carcinogenic OHM in vapor emissions.

The CSF and UR values and supporting documentation for the OHM evaluated in the health risk assessment are provided in Appendix B.

Dose-Response Values for Non-Carcinogenic Effects. In contrast to carcinogens, noncarcinogens are believed to have threshold exposure levels below which adverse effects are not expected. USEPA has derived standards and guidelines based on acceptable levels of exposure for such compounds. Noncarcinogenic effects of concern on which many of the standards and guidelines are based include liver toxicity, reproductive effects, neurotoxicity, teratogenicity, and other chronic toxicities. Various

criteria have been developed from experiments that can be used to estimate the dose-response relationship of noncarcinogens. Some of the same uncertainties involved in deriving cancer risk estimates (namely, selection of an appropriate data set and extrapolation of high-dose animal data to low-dose human exposure) are also involved in deriving noncarcinogenic dose-response criteria. Dose-response values used most often to evaluate noncarcinogenic effects are RfDs.

The RfD, expressed in units of mg/kg/day, is defined as an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime (USEPA, 1989b). When available, the RfD is the dose-response criterion most appropriate for quantitatively estimating noncarcinogenic effects. The RfD is derived from the following equation:

$$RfD\ (mg/kg/day) = \frac{NOAEL\ or\ LOAEL}{UF\ and/or\ MF}$$

The No Observable Adverse Effect Level (NOAEL) represents the dose of a chemical at which there are no statistically or biologically significant differences in the frequency of an adverse effect between the exposed population and its appropriate control. The Lowest Observable Adverse Effect Level (LOAEL) represents the lowest dose at which a statistically significant difference in the frequency of an effect is noted. Both the NOAEL and the LOAEL are reported in terms of mg/kg/day. An uncertainty factor (UF) of ten per type of uncertainty is used to account for interspecies and intraspecies differences, severity of the adverse effect, whether the dose was an NOAEL or an LOAEL, and the adequacy of the data. The magnitude of the UF will therefore vary from chemical to chemical, ranging from 10 to 10,000. A modifying factor (MF), ranging from 1 to 10 may also be included to reflect qualitative uncertainties not explicitly addressed in the UFs. The toxicity endpoint upon which the RfD is derived and the UF and/or MF used in the calculation are presented in the dose-response tables. No RfDs are available for the dermal route of exposure, but are instead calculated from oral RfDs using the methodology described below.

The RfC, in units of mg/m^3, is analogous to the RfD and is developed through a similar process. However, unlike RfDs, which represent a dose (in mg/kg/day) at which adverse or deleterious effects are unlikely, RfCs represent air concentrations (in mg/m^3) at which adverse or deleterious effects are unlikely (i.e., an air concentration corresponding to a Hazard Index (HI) = 1.0). In this FRA, inhalation RfCs are used to estimate the non-cancer risks associated with inhaling OHM in vapor emissions.

The use of chronic RfDs and RfCs to evaluate the potential for adverse health effects resulting from substantially less-than-lifetime exposures may be overly protective. Subchronic Reference Doses and Subchronic Reference Concentrations (RfD_ss/RfC_ss) have been developed for many chemicals to evaluate the potential noncarcinogenic effects of limited duration exposures. RfD_ss/RfC_ss are similar to chronic RfDs/RfCs; the distinction is the length of exposure duration. The construction worker scenario is the only scenario evaluated in this risk assessment that is associated with subchronic exposures. Therefore, when available, subchronic RfDs and RfCs are used to evaluate potential non-cancer risks for the construction worker. When subchronic values are not available, chronic RfDs and RfCs are used. Chronic RfDs and RfCs are used for all other receptor scenarios.

The RfD and RfC values and supporting documentation for the OHM evaluated in the health risk assessment are provided in Appendix B.

Sources of Dose-Response Values. The sources of dose-response values used in this FRA are as follows:

1. Integrated Risk Information System (IRIS), current as of July 2004 (USEPA, 2004).
2. Dose-response values recommended by MADEP and presented in supporting documentation for the proposed revised MCP numerical standards (MADEP, 2001). These values were used when values were not available in IRIS. The hierarchy of sources (other than IRIS) used by MADEP to identify dose-response values is as follows:
   - Health Effects Assessment Summary Tables (HEAST)
   - Values withdrawn from HEAST and/or IRIS
   - CHEM/AAL
   - Values developed by MADEP Office of Research and Standards
   - Values derived by route-to-route extrapolation (e.g., calculation of an RfC from and oral RfD)

Dose-response values recommended by MADEP, but which have since been superceded by a revised IRIS assessment, were obtained from IRIS rather than the MADEP-recommended source. Dose-response information for EPH and VPH fractions was obtained from MADEP.

7.0 EXPOSURE ASSESSMENT

This exposure assessment consists of several components, including identification of: current and future land use (see Section 1) and limitations on land use; potential human receptors; exposure points; exposure routes; soil and groundwater MCP categories; exposure point concentrations (EPCs); and daily doses or average exposure concentrations.

7.1 DESCRIPTION OF CURRENT AND FORESEEABLE FUTURE PROPERTY USES

A description of current and potential future property uses is provided in Section 1. In summary, the current and foreseeable use of the property is a single story slab-on-grade commercial building that will house a fast food restaurant. A paved parking area and small landscaped border areas will also be constructed at the property (Figure 2). After construction, the property will be used by full-time commercial workers (facility employees), restaurant patrons, and visitors.

The construction phase of the redevelopment project assumes that construction workers will not be contacting soils deeper than those required to install building footings and utilities (5 to 6 ft bgs).

7.1.1 Limitations on Future Activities and Uses

This risk assessment assumes current and future land use is consistent with the proposed redevelopment. No groundwater uses are assumed.

7.2 IDENTIFICATION OF POTENTIAL HUMAN RECEPTORS

The MCP requires that all exposure pathways for each potential receptor be identified. The human receptors that could be potentially exposed to OHM at or resulting from the property under the planned redevelopment scenario are listed below:

- Redevelopment construction worker
  - potential exposure to OHM in soil as deep as 6 feet bgs within the property boundary via ingestion, dermal, and dust inhalation.
- Off-property downwind resident
  - potential exposure to OHM in soil as deep as 6 feet bgs within the property boundary via inhalation of dust that may migrate in wind to off-property locations.
- Utility worker
  - potential exposure to OHM in soil as deep as 6 feet bgs within the property boundary via ingestion, dermal, and dust inhalation.

There are no potential OHM exposures to restaurant employees, patrons, or visitors because the bituminous pavement will prevent exposures to soil, and the vapor barrier incorporated into the building design will prevent exposure to vapors that could potentially migrate from soil or groundwater to indoor air.

7.3 SOIL AND GROUNDWATER CATEGORIZATION

Based on the proposed re-development and the classification scheme described in 310 CMR 40.0933(5), (6), and (7), covered surface soil (0-3 feet bgs) within the property boundary is classified as S-2 for the following reasons:

- surface soil is "potentially accessible" because OHM is present in samples between 0 and 3 feet bgs, the soil is covered with pavement, and utility or construction-related excavation would not be prohibited;
- possible exposure is expected to be of high intensity for adult excavation workers;
- possible exposure is expected to be of low frequency for adult excavation workers;
- children and adults may be present at high frequency, but no exposure to soil will occur per Land Use Restriction obligations to maintain pavement and perform future soil excavations in accordance with the soils management plan.

Based on the proposed re-development and the classification scheme described in 310 CMR 40.0933(5), (6), and (7), covered subsurface soil (3-15 feet bgs) within the property boundary is classified as S-3 for the following reasons:

- subsurface soil is "potentially accessible" because OHM is present in samples between 3 and 15 feet bgs, the soil is either covered with pavement or uncovered, and utility or construction-related excavation will occur;
- soil beneath the proposed building will be "isolated";
- possible exposure is expected to be of high intensity for adult excavation workers;
- possible exposure is expected to be of low frequency for adult excavation workers;
- children and adults may be present at high frequency, but no exposure to soil will occur due to pavement at the Property.

All soils found at greater than 15 feet bgs are classified as "isolated" and are therefore classified as S-3 soils.

The groundwater associated with the Property is not Category GW-1 because it is not within a Current Drinking Water Source Area or within a Potential Drinking Water Source Area. Although groundwater at the Property is within 15 feet of the ground surface, the planned building at the property will incorporate a vapor barrier to prevent migration of vapors to indoor air. Theoretically, GW-2 does apply to the property. However, with the vapor barrier included in the building, no complete vapor intrusion pathway has been identified. All groundwater is considered to be Category GW-3. Therefore, Category GW-3 is the applicable groundwater category at the Property.

7.4 IDENTIFICATION OF EXPOSURE POINTS AND EXPOSURE ROUTES

As defined in the MCP, an exposure point is the location of potential contact between a human or environmental receptor and a release of OHM. An exposure point may describe an area or zone as well as a single point. Exposure routes describe how human contact with a given exposure point may occur,

and include ingestion, dermal contact, and inhalation. Potential exposure points were identified to characterize risk of harm to human health, as well as to characterize risk of harm to public welfare.

The identification of exposure points has been accomplished by first identifying any hot spots in soil and groundwater. Hot spots must be considered separate exposure points for public welfare risk characterization, and may be considered separate exposure points for health risk characterization. After hot spots were identified, the exposure points applicable to receptors associated with the proposed redevelopment were identified. Hot spots or portions of hot spots that occurred within those exposure points were accounted for in the derivation of EPCs for the receptor scenarios.

7.4.1 Hot Spot Analysis

Consistent with the MCP (310 CMR 40.0924(2)) and the Guidance For Disposal Site Risk Characterization (MADEP, 1995), discrete areas of contamination that meet the MCP definition of a hot spot (310 CMR 40.0006) may be evaluated as additional, individual exposure points. A hot spot is identified based on concentrations of a constituent within a contaminated area and spatial pattern of that contamination. In all cases, a discrete area where the concentration of an OHM is greater than 100 times the concentration in the surrounding area shall be considered a hot spot. Discrete areas where the concentration difference is greater than 10 but less than 100 shall be considered a hot spot unless:

(a) there is no evidence that the discrete area would be associated with greater exposure potential than the surrounding area; and

(b) a site-specific evaluation indicates that the area should not be considered a hot spot considering concentrations and distributions of OHM, background variability and/or appropriate statistical analyses.

Where the concentration is at or below the applicable Method 1 standard, a hot spot does not exist. For this Property, it was determined that a discrete area where the concentration of an OHM is greater than 100 times the concentration in the surrounding area would be considered a hot spot. Generally, discrete areas where the concentration difference is greater than 10 but less than 100 were not considered a hot spot because at this Property there is no evidence that potential hot spot areas would be associated with greater exposure potential than other areas of the Property under the proposed redevelopment. However, professional judgment has been applied to confirm hot spots where review of data and figures clearly indicated a very localized area of elevated concentrations.

It is important to identify hot spots in various environmental media prior to identification of the final list of exposure points. According to MADEP guidance, an elevated concentration at a single sample location does not necessarily constitute a hot spot. For soil, the exposure point is determined by the horizontal and vertical distribution of OHM and the applicable soil categories. When a contiguous volume of contaminated soil has more than one soil category within it, the soil in each category is considered a separate exposure point.

7.4.1.1 Soil Hot Spot Analysis

The soil hot spot analysis is discussed below under the assumption that planned redevelopment occurs (i.e., where there will be areas covered with pavement or a building and other areas where surface soils

will be uncovered and accessible). The hot spot analysis consisted of identifying OHM that could be present at concentrations indicative of a potential hot spot, then reviewing the analytical data for those OHM to determine if a hot spot exists at the Property.

Hot spot OHM were identified by comparing concentrations to Method 1 standards and evaluating the variability in detected concentrations. This analysis is presented in Table 3. The maximum concentrations of OHM in soil from locations within the property boundary were compared to the appropriate Method 1 Standards. For this analysis, the S-3/GW-3 standard is the applicable Method 1 standard because the majority of analytical data for the property are associated with soils deeper than 3 ft bgs (i.e., Category S-3 soils). As discussed below, OHM detected in surface soil (Category S-2 soils) are either greater than both the S-2 and S-3 standards, or are below the S-2 and S-3 standards. Therefore, use of the S-3 standard to identify potential hot spot OHM does not result in dismissal of potential hot spot OHM. According to the MCP, in no case shall concentrations of OHM equal to or less than an applicable Method 1 standard be considered indicative of a hot spot (310 CMR 40.0006). Therefore, OHM with maximum detected concentrations below the applicable Method 1 standards need not be further considered in the hot spot analysis.

OHM with maximum concentrations that exceeded Method 1 standards were then evaluated to determine if a hot spot could potentially exist. A hot spot would be potentially indicated if the range of detected concentrations spanned more than 100-fold, or the OHM had a very low frequency of detection and more than a 100-fold difference between the maximum detected concentration and lowest reporting limit. A hot spot would not exist for OHM that do not meet these criteria because a discrete area where the concentration is more than 100-times greater than the surrounding area could not exist. OHM which were present at concentrations indicative of a potential hot spot were confirmed by reviewing the analytical data for the Property to determine if a discrete area with an elevated concentration could potentially exist.

As indicated in Table 3, VPH fractions and PAHs exceeded the applicable Method 1 standards. In addition, several petroleum-related VOCs for which Method 1 standards are not promulgated were considered potential hot spot OHM. Based on review of data for these OHM (see Appendix A for raw data), two hot spots in soil were identified:

1) Surface soil hot spot. Sample TANK-S, collected at 2.5 ft bgs from the area near a former hydraulic fluid tank, contained PAHs at concentrations in excess of Method 1 S-3/GW-3 standards and at concentrations more than 100-times the immediate surrounding samples. This location is therefore considered to be a soil hot spot. The OHM detected in surface soil are either greater than the S-3 standard or less than the S-2 standard; therefore, use of the S-3 standard to identify potential hot spots in surface soil does not result in overlooking potential hot spots.
2) Subsurface soil hot spot. Concentrations of C5-C8 aliphatic VPH and C9-C10 aromatic VPH in samples B-4D and B-9D are greater than 100-times the concentrations in the surrounding samples. In addition, petroleum-related VOCs that were identified as potential hot spot OHM, such as trimethylbenzenes, isopropylbenzene, and butylbenzenes, are also located in these samples. Samples B-4D and B-9D are located in the saturated zone.

7.4.1.2 Groundwater Hot Spot Analysis

Potential hot spot analytes in groundwater were identified to evaluate the existence of potential hot spots in site groundwater per MCP requirements and for comparison to UCLs. The groundwater hot spot analysis was performed using the approach described for the soil hot spot analysis. Documentation of the groundwater hot spot analysis is presented in Table 4. As indicated in Table 4, concentrations of C9-C10 aromatic VPH, unadjusted for target analyte concentrations included in the fraction, exceeded the GW-3 standard; the adjusted C9-C10 aromatic concentration did not exceed the GW-3 standard. Several petroleum-related VOCs for which no Method 1 standards are promulgated were also identified as potential hot spot OHM. However, the range of detected concentrations for the OHM identified as potential hot spot OHM were within the 100-times criterion. In addition, review of the analytical data did not reveal any discrete locations with concentrations more than 100-times the immediate surrounding locations. Therefore, no groundwater hot spots were identified.

7.4.2 Soil Exposure Points

Soil exposure points are identified for hot spots, areas outside the hot spots (termed non-hot spot area), and specific locations that may be contacted by receptors during the foreseeable activities at the property; those locations may include hot spots. For characterization of risk to public welfare via comparison of site conditions to UCLs, each hot spot and the non-hot spot area were considered to be separate exposure points. For the planned redevelopment, exposure points were identified for:

1) Potentially accessible soils 0-6 ft bgs within the building footprint area that utility and construction workers may contact via ingestion, dermal contact, and dust inhalation, and that may be a source of dust emissions to downwind residents. Contact with these soils would potentially occur during excavation of soil for the building footings and floor slab, concrete work, backfilling and grading, and during utility installation. The soil data included in the building footprint exposure point were from locations within an immediately adjacent to the footprint. The analytical data representative of samples from depths between ground surface and 8 ft bgs were included in the exposure point to provide a conservative assessment of potential exposure conditions. The samples included in the exposure point are listed in EPC Table (Table 7).
2) Surface soils 0-3 ft bgs outside of the building footprint area that construction workers may contact via ingestion, dermal contact, and dust inhalation, and that may be a source of dust emissions to downwind residents. Contact with these soils would potentially occur during general construction work at the property, and during active grading and asphalt paving. The analytical data included in this exposure point are associated with surface soil samples from the former hydraulic tank area (samples TANK-E, TANK-S, B-2A). As discussed in Section 2, there are no known or suspected surface releases at other portions of the Property.

7.4.3 Groundwater Exposure Points

Since there are no exposures to groundwater at the property, groundwater exposure points were identified strictly for the public welfare risk characterization (i.e., for UCL comparison purposes). Since there are no groundwater hot spots, the Property groundwater is evaluated as a single, contiguous exposure point. Samples included in the groundwater exposure point are identified in Appendix A.

7.5 DEVELOPMENT OF EXPOSURE PROFILES

Exposure profiles identifying potential receptors, potential exposure points, exposure medium and route, frequency of exposure, duration of the exposure event, and duration of the exposure period are summarized in Tables 9 and 10 and are provided in risk calculation spreadsheets.

Exposure parameters pertaining to soil ingestion and dermal contact rates, and averaging time were obtained from MADEP guidance (MADEP, 1995), including recent technical updates (MADEP, 2000, 2002a, 2002b). Exposure parameters for exposure frequency and duration are site-specific values that are based on the planned redevelopment, and are discussed below.

7.5.1 Construction Worker

The total duration of the construction project will be 6 months or less. Although it is likely that different individuals will be involved in each phase of construction (e.g., excavation workers, masons, steel workers, etc), the construction worker scenario evaluates a composite worker who is assumed to be at the Property during the entire duration of the construction project. Therefore, the exposure frequency and duration values for each of the exposure pathways are as follows:

Incidental ingestion and dermal contact: Exposure frequency of 130 days over a duration of 1/2 year. This assumes work on-site 5 days per week for 26 weeks.

Inhalation of respirable dusts: Exposure frequency of 130 days over a duration of 1/2 year. This assumes work on-site 5 days per week for 26 weeks. Inhalation exposure is 8 hours each day. The respirable particulate concentration in air is ([RP]air) is conservatively assumed to be 60 ug/m^3 for construction workers (MADEP, 2002).

The construction worker exposure scenario is protective for a utility worker who may be exposed to soils during installation or repair of underground utilities, because the duration of exposure for that type of work is generally only a few days.

7.5.2 Off-Property, Down-wind Resident

This receptor is assumed to be potentially exposed to dust that becomes entrained in wind and migrate off-property in the down-wind direction. Potential receptors could include commercial and industrial workers, pedestrians, and residents. Among these, the resident is the most sensitive receptor because the resident is assumed to be stationary at a residence (where most of their time is spent) and, therefore, may incur greater exposures than other receptors. To provide a streamlined, yet conservative assessment, dispersion modeling is not performed to account for dilution of dust concentrations as they migrate down-wind. It is conservatively assumed that downwind off-property residents would be exposed to the same particulate matter concentration in air that is present on-property during the construction period.

The resident receptor is selected as a young child (ages 0 – 8), as young children are more sensitive receptors than older children and adults. Since the exposure duration is subchronic (i.e., only 1/2 year), carcinogenic effects that may be attributable to a many years of exposure over long period of residency are not a concern and, therefore, it is not necessary to evaluate multiple age groups of the resident

receptor. Potential exposure to dust is assumed to occur over the duration of the construction phase of the project, described above.

Inhalation of respirable dusts: Exposure frequency of 130 days per year over a duration of 1/2 year. This assumes that a resident is at the residence 7 days per week over a 26 week period, but that rain on 28% of the days (equal to 104 days per 365 days (USEPA, 1985)) suppresses dust, thus eliminating the pathway on those days. Inhalation exposure 24 hours each day, which accounts for migration of dusts indoors. During the eight-hour work-day when invasive soil activities occur, this receptor is exposed to 60 ug/m^3 PM_{10} (assumed to be completely derived from Property soils). At all other times, the off-property resident would be exposed to 32 ug/m^3 (includes workdays and weekends but excludes the eight-hour period on days of invasive soil activity). The average PM_{10} for the off-property downwind resident is 39 ug/m^3 and is calculated as follows:

(60 ug/m^3 x 5 d/7 d x 8 hr/24 hr) + (32 ug/m^3 x 5 d/7 d x 16 hr/24 hr) + (32 ug/m^3 x 2 d/7 d x 24 hr/24 hr)

7.6 IDENTIFICATION AND ESTIMATION OF EXPOSURE POINT CONCENTRATIONS

Exposure point concentrations (EPCs) are identified for each exposure point and exposure scenario described previously. EPCs for soil ingestion and dermal contact exposure routes are based on measured soil concentration data. Air EPCs for soil particulate inhalation are estimated via modeling of measured soil concentration data.

Per 310 CMR 40.0926(3), the concentration used to represent each OHM should be a conservative estimate of the arithmetic average concentration. As defined in the MCP (310 CMR 40.0926(3)(b)), upper percentile or maximum concentrations should be used to provide a conservative estimate of the mean when a simple arithmetic average is likely to underestimate the true mean, including data with a high degree of variability. In this assessment, the variability of concentrations in each exposure point was reviewed to determine if the simple arithmetic average concentration provided a conservative estimate of the mean.

The EPCs for soil within the building footprint, evaluated as soil 0-8 ft bgs from locations within and adjacent to the building footprint (to conservatively represent the depths were soil contact may realistically occur (0-6 ft bgs), were selected as the maximum detected concentrations. This approach was used because the majority of OHM at this exposure point were detected in fewer than one-half the samples. Consequently, the arithmetic mean concentrations could potentially underestimate the true mean. The use of maximum detected concentrations provides a conservative approach which helps ensure that exposures are not underestimated. The EPCs for this exposure point are documented in Table 7.

The EPCs for surface soil outside the building footprint, evaluated as soil 0-3 bgs from locations at the property that were not included in the building footprint exposure point, were selected as the maximum detected concentrations. This approach was used to account for the presence of the surface soil hot spot (represented by location TANK-S) within this exposure point. The use of maximum detected concentrations provides a conservative approach which helps ensure that exposures are not underestimated. The EPCs for this exposure point are documented in Table 8.

7.7 ESTIMATION OF AVERAGE DAILY DOSES (ADDS)

The average daily dose (ADD) is the amount of OHM absorbed into the body. When appropriate, it is the product of the average daily exposure multiplied by a relative absorption factor (RAF). For evaluating inhalation exposures, average daily exposure concentrations (ADEs) of OHM in air are compared to toxicity values in units of concentration instead of calculating ADDs.

A LADD is calculated in order to estimate carcinogenic risk. The Averaging Period (AP) over which the total intake of contaminant is averaged is 70 years for carcinogenic effects (MADEP, 2000).

The general form of the ADD equation is:

$$ADD = \frac{(Total\ Amount\ of\ OHM\ Intake)}{(Body\ Weight_{avg})\ (Averaging\ Period)}$$

The ADD and ADE values are calculated using the EPCs in Tables 7 and 8 with the receptor-specific exposure parameters shown in Tables 5 and 6. The specific ADD and ADE equations for the ingestion, dermal, and dust inhalation exposure routes, for the construction worker and down-wind resident receptors, are shown in Appendix C. Appendix C also provides documentation of the intake calculations for each exposure point and receptor scenario.

8.0 HUMAN HEALTH RISK CHARACTERIZATION

Potential risks to human health associated with possible exposure to OHM at the property are characterized in this section. Risk is a function both of exposure and toxicity. The magnitude of risk depends on the nature, duration, and frequency of exposure to OHM and characteristics of the exposed population. Information presented in the Exposure Assessment section of this report, combined with the dose-response toxicity data presented in the Dose-Response Assessment of this report, is the basis for this risk characterization. Per the requirements of the MCP at 310 CMR 40.0993(6), risk of harm to human health is characterized by:

1. Comparing Cumulative Receptor Cancer Risk to the Cumulative Receptor Cancer Risk Limit (10^{-5}) for current and future land use;
2. Comparing Cumulative Receptor Noncancer Risk to the Cumulative Receptor Non-cancer Risk Limit (Hazard Index of 1) for current and future land use; and
3. Comparing exposure point concentrations to applicable or suitably analogous public health standards.

8.1 CUMULATIVE RECEPTOR RISKS

The technical approach used to generate the potential carcinogenic and noncarcinogenic risks at this Property is presented in the following subsections.

8.1.1 Cumulative Receptor Cancer Risk

For possible oral and dermal exposure to soil, carcinogenic risk estimates for known or probable human carcinogens are calculated by multiplying the CSF of the chemical (expressed as $(mg/kg\text{-}day)^{-1}$) by the LADD (expressed as mg/kg-day). The product of these two values is an estimate of the excess lifetime cancer risk (ELCR), which is defined as the excess probability that an individual will develop cancer over a lifetime due to exposure to the chemical of potential concern. This incremental lifetime risk is over and above what is considered an individual's background chances of developing cancer. In the U.S., approximately one in three people develop cancer during their lifetime (American Cancer Society, 1997).

For inhalation exposures to soil particulates, both air EPCs and carcinogenic toxicity values are expressed in units of concentration (EPCs - ug/m^3; Unit Risk [UR_{inh}] - $1/ug/m^3$). Since the toxicity value is based on concentration and not dose, ELCRs were directly calculated without the need to calculate LADDs.

The method used to estimate potential carcinogenic risks is based on USEPA's linearized, multistage model of carcinogenic dose-response. This model assumes that no threshold exposure level exists below which exposure to a carcinogen can be considered safe or risk-free. Therefore, any dose is assumed to result in a finite increment to an individual's lifetime risk of developing cancer.

The Cumulative Receptor Cancer Risk (CRCR) is calculated by estimating the potential cancer risk for each potentially carcinogenic OHMPC in each medium/potential exposure pathway associated with each

receptor for current and future land use. For a given receptor and land use all of the cancer risks are summed to yield the CRCR.

The ELCR for each chemical in each medium is calculated as follows:

For ingestion and dermal exposures,

$$ELCR_i = LADD_i \times CSF$$

For inhalation exposure,

$$ELCR_i = LAC_i \times UR_i$$

Where:

$ELCR_i$	=	Excess Lifetime Cancer Risk associated with the exposure to chemical in each exposure route for the relevant medium.
$LADD_i$	=	Lifetime Average Daily Dose of substance i in each medium received by the theoretical individual.
CSF_i	=	EPA's published cancer slope value for substance i in the appropriate medium.
LAC_i	=	The Lifetime Average Concentration of substance i in air.
UR_i	=	EPA's published carcinogenic Unit Risk for substance i in air.

The CRCR for a given medium (e.g., soil) and exposure route (ingestion, dermal contact, inhalation) is the sum of the cancer risks for the OHMPCs included in that potential exposure route. The CRCR is the sum of all cancer risks for all OHMPCs in all media and potential exposure routes associated with that receptor for a given land use. In this assessment, risk calculation spreadsheets in Appendix C document potential risks for each OHMPC in each medium and potential exposure route. Table 9 provides a summary of Cumulative Receptor Cancer and Non-Cancer Risks. This table presents total potential risk for each exposure route for each medium, the total potential risk for each medium, and the CRCR for each receptor.

In the risk characterization, each CRCR is compared to the MCP Cumulative Receptor Cancer Risk Limit of 1×10^{-5}.

8.1.2 Cumulative Receptor Non Cancer Risk

Noncarcinogenic effects associated with possible OHM exposure include a variety of effects on various tissues and organ systems. These effects are considered to have a threshold value below which toxicant exposure results in no adverse effects.

For ingestion and dermal exposure to soil, noncarcinogenic potential risk estimates are generated by comparing the average daily dose (ADD) for each OHM to the most applicable dose-response value (RfD). The ratio of the estimated body dose levels to these dose-response values is used to evaluate risk. For each individual chemical, this ratio is referred to as the hazard quotient (HQ).

To evaluate inhalation exposures, average concentrations are calculated and are compared to inhalation toxicity values (RfCs), which are in units of concentration (ug/m^3).

The HQ is calculated for each chemical, via ingestion or dermal contact, as:

$$HQ = ADD_i/RfD_i$$

and for inhalation exposure,

$$HQ = AC_i/RfC_i$$

Where:

ADD_i	=	The average daily dose of substance i via the particular exposure route.
RfD_i	=	The allowable daily dose for exposure to substance.
AC_i	=	The average concentration of substance i in air.
RfC_i	=	The Reference Concentration for substance i in air.

The RfD and RfC values used for the construction worker and off-property, down-wind resident are subchronic values (chronic values used when subchronic values are unavailable) because the exposure duration is only one year.

For a mixture of chemicals, a screening hazard index is estimated by summing the individual HQs for all OHMPCs in the media and potential routes of exposure. This approach assumes that multiple subthreshold exposures may result in adverse effects even if no single chemical exceeds its reference level.

Because of the assumption of dose additivity, the use of the HI is most appropriate if chemicals in the mixture are expected to exert similar toxic effects by the same mechanism. Therefore, summing the HQs of a mixture of compounds that are not expected to induce the same effects could overestimate the total risk. Therefore, if the screening HI is greater than 1, the OHMPC should be divided into groups based on the toxic endpoint or target organ on which the toxicity value (usually RfD) is based. Separate HIs would then be calculated for each group of OHMPC and those HIs would be compared to the Cumulative Receptor Non-cancer Risk Limit.

The following sections describe the potential risk estimates calculated for the various exposure scenarios under the current land use, planned redevelopment, and unspecified future land use scenario. The HQs and HI values are documented in spreadsheets in Appendix C and Table 9.

8.2 Comparison of Exposure Point Concentrations to Applicable and Suitably Analogous Standards

The Massachusetts Maximum Contaminant Levels (MMCLs) as promulgated in the Massachusetts Drinking Water Standards (310 CMR 22.00) (MADEP, 2001) are not applicable to groundwater associated with the Property because the groundwater is not characterized as Category GW-1. There are no suitably analogous standards for soil.

8.3 RISK CHARACTERIZATION RESULTS

In the following sections, CRCR, Cumulative Receptor Non-Cancer Risk, and comparison of EPCs to applicable or suitably analogous standards are presented.

8.3.1 Cumulative Receptor Cancer Risk and Non Cancer Risk

Table 9 summarizes Cumulative Receptor Cancer and Non-Cancer Risks for the proposed redevelopment. Those risk estimates represent the risks for the current and foreseeable future use conditions at the property.

For the FRA, the following receptors and exposure pathways have been considered:

- Construction Worker – exposure to soil 0-8 ft bgs within the building footprint area by ingestion and dermal contact, and soil particulate inhalation; exposure to soil 0-3 ft bgs outside of the building footprint area by ingestion and dermal contact, and soil particulate inhalation.
- Off-Property Downwind Resident – exposure to soil 0-8 ft bgs within the building footprint area by particulate inhalation; exposure to soil 0-3 ft bgs outside of the building footprint area by soil particulate inhalation.

As shown in Table 9, for all receptors under the planned site redevelopment, Cumulative Receptor Cancer Risks and Cumulative Non-cancer Risks are below the corresponding MCP Cumulative Receptor Risk Limits. As discussed previously, the construction worker risk estimates are conservative for a utility worker and, therefore, cumulative risks for a utility worker would also be below the MCP risk limits.

Table 9 also shows that risks for exposures to soil within the building footprint and outside of the building footprint, when summed together, are below the MCP risk limits. This estimate of risk is very conservative because it essentially "double-counts" soil exposures, as the risks for each exposure point were calculated under the assumption that all exposure to soil at the property occurs at a single exposure point.

These results indicate that a Condition of No Significant Risk of harm to health exists for the soil at the property, for the proposed redevelopment.

9.0 CHARACTERIZATION OF RISK OF HARM TO SAFETY AND PUBLIC WELFARE

According to 310 CMR 40.0994, a Method 3 public welfare risk characterization shall consist of two major components:

- A consideration of such factors as the existence of nuisance conditions, loss of property value, the unilateral restriction of the use of another person's property, and any monetary or non-pecuniary costs not otherwise considered in the characterization of risk of harm to health, safety, and the environment but which may accrue due to the degradation of public or private resources directly attributable to the release of the oil and/or hazardous material; and
- Comparison of the concentrations of oil and/or hazardous material to the UCLs in soil and groundwater as described in 310 CMR 40.0996.

With respect to the first component, this FRA concludes the following:

- No unilateral restriction of the use of the Property has been implemented, no nuisance conditions have been identified.

With respect to the second component, EPCs for OHM in soil and groundwater have been compared to UCLs. These comparisons are presented in Tables 10 and 11. The comparisons to UCLs were performed using the maximum detected OHM concentrations in soil and groundwater. This approach ensures that hot spots in soil have been evaluated as discrete exposure points for the purposes of UCLs comparisons. As shown in Tables 10 and 11, no OHM have been detected at maximum concentrations that exceed UCLs. In addition, no non-aqueous phase liquid (NAPL) has been identified at the Property; therefore, the UCL for NAPL has not been exceeded.

These results indicate that a Condition of No Significant Risk of harm to public welfare exists for the soil and groundwater at the property.

Per the MCP at 40.0960, the risk to safety is characterized using the following criteria:

(1) A level of no significant risk to safety exists or has been achieved if the conditions at the disposal site which are related to a release of oil and/or hazardous material do not currently and will not in the foreseeable future pose a threat of physical harm or bodily injury to people. Such release-related conditions may include, but are not limited to:

   (a) the presence of rusted or corroded drums or containers, open pits, lagoons or other dangerous structures;

   (b) any threat of fire or explosion, including the presence of explosive vapors resulting from a release of oil and/or hazardous material; and

   (c) any uncontained materials which exhibit the characteristics of corrosivity, reactivity or flammability described at 310 CMR 40.0347.

There have been no observations for current conditions, of the presence of rusted or corroded drums or containers, open pits, lagoons or other dangerous structures; any threat of fire or explosion, including the presence of explosive vapors resulting from a release of oil and/or hazardous material; and any uncontained materials which exhibit the characteristics of corrosivity, reactivity or flammability described at 310 CMR 40.0347. Therefore, a condition of No Significant Risk of harm to Safety exists for the Property.

10.0 UNCERTAINTY ANALYSIS

It should be emphasized that the risks estimated here are based on numerous assumptions. Each of these assumptions is associated with some uncertainty. Several types of uncertainties should be considered in any risk evaluation:

- uncertainties associated with estimating the frequency, duration, and magnitude of exposure;
- uncertainties associated with assigning exposure parameters to a heterogeneous population that includes both men and women and young and old (e.g., body weight and ventilation rates);
- uncertainties in estimating carcinogenic slope factors and/or noncarcinogenic measures of toxicity (e.g., RfDs or RfCs); and/or
- uncertainties about possible synergistic or antagonistic chemical interactions of a chemical mixture.

The general approach to addressing many of these uncertainties is to use upper-bound (90th or 95th percentile) estimates of input values, such as exposure parameters and toxicity values. When considered together, the total receptor risk reflects an estimate that is greater than the 99th percentile of the possible distribution of risks. Thus it is probable that the risks presented in this document are upper-bound estimates of actual risks.

The uncertainties associated with estimating exposure result from the variance in sampling and analytical techniques, and quantifying parameters that are not directly observed (e.g., frequency and duration of exposure). Because some of these parameters are functions of the behavior patterns and personal habits of the exposed populations, no single value can be assumed to be representative of all possible exposure conditions. However, we have incorporated assumptions or procedures in the risk assessment that are conservative and should result in an overestimate of risk.

Uncertainties for this assessment are discussed below.

Hazard Identification. The concentrations of C9-C12 aliphatic VPH and C9-C10 aromatic VPH were reported as "adjusted concentrations" to account for target compounds within those fractions. The "adjusted concentrations" for some samples (e.g., B-9D) are considerably lower than the "unadjusted" fractions. To provide a conservative assessment in this FRA, both the adjusted and unadjusted fraction data were compared to UCLs.

Toxicity Assessment. The use of toxicity measures (e.g., RfDs and slope factors) introduces additional uncertainties. Slope factors are generally based on animal studies, many of which use high doses relative to the site-specific exposures actually experienced. These data require interpretation and/or extrapolation in the low-dose area of the dose-response curve. The slope factors used in the risk assessment generally represent 95th percent upper confidence limits of mean values measured in animal trials. Use of these factors may result in an overestimate of risk.

Among PAH compounds, only benzo(a)pyrene has a published oral cancer slope factor. MADEP's Office of Research and Standards (MADEP, 1995) has published Relative Potency Factors (RPFs) to be

applied to those carcinogenic PAHs without published SFs. The RPFs suggest that each of the carcinogenic PAHs other than dibenz(a,h)anthracene is at least 10 times less potent than benzo(a)pyrene, generally considered the most potent carcinogenic PAH. The application of the RPFs is a realistic means of evaluating the risk associated with the carcinogenic PAHs.

Exposure Assessment. There is also uncertainty associated with assigning quantitative values to exposure parameters such as body weight, ventilation rate, and absorption factors. The parameters used in this exposure assessment were based on actual or extrapolated values from surveys reported in the literature and professional judgment; therefore, they may not be representative of specific individuals at this area. However, the parameters are either mean or upper-bound (90th percentile) values and are considered representative of the populations described in the exposure pathways and are those specified by the MADEP or the USEPA to be used in risk assessments. Use of these parameters may overestimate risk, but is unlikely to underestimate it.

The identification of EPCs was performed in a manner that provided a conservative assessment of potential exposures. Specifically, EPCs were based on maximum detected concentrations within each exposure point. This approach clearly overestimates potential exposures to OHM because it bases the EPCs on the elevated concentrations that represent only a small portion of the overall exposure areas.

The redevelopment plan of the property will include landscaped buffer areas around the property perimeter. It is likely that these buffer areas will include grass and shrubbery that requires maintaining, such as by a contracted landscaper. It is possible that a landscape worker could be exposed to soil during these activities. However, such exposures would likely be negligible based on the presence of top soil that will be brought to the property to permit growing grass and shrubbery, the presence of grass and landscaping materials (which act as natural barriers to soil contact), and the very minimal amount of time that would be spent at the property maintaining the small amount of landscaped area (e.g., less than one hour, no more than one-day per week, spring, summer and fall). Moreover, the releases at the Property were primarily confined to subsurface soil; the only OHM detected at the Property are associated with location TANK-S, at a depth of 2.5 ft bgs. Location TANK-S will be beneath the paved parking area, and not at the landscaped border area.

Potential exposures to vapors that may migrate from soil to ambient air were not quantitatively evaluated because volatile concentrations in soil at the soil exposure points was relatively low. For example, the maximum concentrations of volatile petroleum-related compounds (e.g., BTEX) in soil 0-8 ft bgs was 0.65 mg/kg for xylene, a concentration more than three orders of magnitude below the S-3 soil standard. Other OHM detected in soil are marginally volatile (e.g., C11-C22 aromatic EPH, 2-methynaphthalene), and were also detected at maximum concentrations more than one order of magnitude below S-3 soil standards. This indicates that vapor migration to ambient air would not be an exposure concern.

Risk Characterization. To assess the overall effects of multiple chemical exposures, USEPA developed "Guidelines for the Health Risk Assessment of Chemical Mixtures" (USEPA, 1986). This guidance states that if sufficient data are not available on the effects of the chemical mixture of concern, or a reasonably similar mixture, the proposed approach is to assume additivity of effects of the constituents of the mixture. This assumption, according to USEPA, is expected to yield generally neutral risk estimates (i.e., neither conservative nor lenient). More recent guidance from USEPA (USEPA, 1989) also references the "Guidelines for the Health Risk Assessment of Chemical Mixtures", but further states that

the assumption of additivity assumes independence of action and that if this assumption is incorrect, over- or underestimation of the actual multiple substance risk may occur. If OHM that have dissimilar mechanisms are evaluated, the assumption of additivity of effects may actually overestimate risk.

It is unlikely that cancer and non-cancer risks reported in this FRA are underestimated, but may in fact be substantially overestimated. Consequently, this FRA presents a conservative assessment of potential health risks associated with the proposed property redevelopment.

11.0 FOCUSED RISK ASSESSMENT CONCLUSIONS

The following conclusions are drawn from this risk assessment:

- The assessment of risk of harm to human health indicates that for the current and foreseeable land use, cancer and non-cancer risks for the receptors that might be exposed to OHM associated with the property (utility worker, construction worker, and off-property down-wind resident) do not exceed the corresponding MCP Cumulative Receptor Cancer and NonCancer Risk Limits. A Condition of No Significant Risk of harm to health exists for those receptors.
- A condition of no significant risk of harm to safety exists at the Property.
- The risk of harm to welfare was evaluated by comparing site concentrations to UCLs for soil and groundwater and by evaluating the presence of NAPL. No OHM were detected in soil and groundwater at maximum concentrations that exceed UCLs, and no NAPL has been identified at the Property. Therefore, a Condition of No Significant Risk of harm to public welfare exists for the property.

12.0 FOCUSED FEASIBILITY STUDY

Massachusetts Department of Environmental Protection policy applicable to building construction in areas that have been contaminated by a release of oil and/or hazardous material states that a focused feasibility study must be conducted within, and adjacent to, the footprint of the proposed building to determine if it is feasible to reduce soil contaminant levels to concentrations that achieve or approach a background condition, and if so, to ensure that such remediation is conducted before or during construction of the overlying portions of the building. Based on data collected from the Focused Site Characterization, it can be demonstrated that the concentrations of oil and hazardous materials, present as petroleum hydrocarbon constituents, above background concentrations are primarily found at the highest concentrations detected on site at depth in subsurface soil (12 to 16 feet bgs) and in groundwater at this same depth. Lesser concentrations of oil and hazardous materials (present as petroleum hydrocarbon constituents) are found in shallower soil at various non-contiguous locations on site. These shallow locations are of lesser concentrations than at depth and are generally below the applicable S-2 Soil Category with the exception of a shallow Hot Spot (2.5 feet bgs) where polycyclic aromatic hydrocarbons were detected above the S-2 Soil Category at sampling location TANK-S (see Figure 1). The presence of oil and hazardous materials as PAHs is in the approximate location of a less than 10 gallon release of hydraulic fluid occurring during the removal of a hydraulic lift and oil piston unit from the former gasoline station maintenance bay. This portion of the site was also paved before demolition. It is theorized that the PAHs are the result of pavement residuals in the soil sample since there were no significant concentrations of petroleum residuals with the PAH detections as would be expected if from a petroleum release. The presence of PAHs at this Hot Spot was carried through the Focused Risk Assessment. The results of that assessment demonstrate a condition of No Significant Risk exists.

Two evaluation approaches are used here to demonstrate the cost-benefits of remedial actions.

12.1 COST BENEFIT AND ACCESSIBILITY

The feasibility of reducing oil and hazardous materials (petroleum hydrocarbon residuals) to background or to approach background concentrations would involve target excavations of discrete areas of the Site. These discrete areas would first be identified through extensive sampling across the Site. The cost benefit of the sampling and excavation, and disposal actions would be significant, in the order of an estimated $60,000 to $70,000 to reduce concentrations from below the applicable S-2 Soil Category standards to background concentrations. The ability to identify all of these areas is considered questionable.

The feasibility of reducing oil and hazardous materials (weathered petroleum hydrocarbon residuals) at the depth of greater than 10 feet bgs is at the low range of feasibility to conduct excavation over the area of the planned building footprint and the rest of the Site that will be paved. The estimated area is 8,000 square feet of the approximate 11,000 square foot lot. To excavate down to 10 feet before reaching the zone of contamination would require the excavation of approximately 3,000 cubic yards of soil. The average cost per yard to excavate soil is $16/yard, which equates to approximately $47,000 for excavation of clean soil. This would be followed by the excavation of the 3 foot contaminated zone across the area for an additional $14,000.

Stockpiling 3,000 yards of clean soil and approximately 900 yards of contaminated soil on this small site would create a challenge and certainly a nuisance for the time response actions that are being conducted. Since the Site is being redeveloped, the soil would be placed back into the excavation to include the additional 900 yards to replace the contaminated soil that was removed. Backfill cost would add an additional estimated $12,500 to the remedial costs. This backfill soil would need to be compacted from 16 feet bgs to grade in 2-foot lifts down. This would increase the cost for backfill operations to approximately $58,000 over what has been spent for excavation. Additionally, the water table would be breached at the depth of 13 feet; therefore water pumping and treatment would be needed, adding additional complexity and cost to the remedial actions. The disposal of approximately 900 yards of soil to include transportation is estimated at $40/ton, which equates to an additional $55,000. Therefore, the estimated total cost to reduce oil and hazardous materials in shallow and deep soils is in excess of $250,000 not including engineering fees, permits, laboratory analysis and other associated costs.

12.2 DEGRADABILITY

Independent of the analysis above, the Massachusetts Department of Environmental Protection has identified petroleum hydrocarbon residuals in recent guidance (WSC-40-160; Conducting Feasibility Evaluations under the MCP; July 16, 2004), as found at this Site, to be degradable non-persistent contaminants. This determination is demonstrated on site by the weathered signature and decreasing concentrations over time of these constituents, especially in the deep contaminated zone. The benefits of approaching or achieving background for these constituents is considered to be insufficient to justify the costs, especially where the accessibility of these constituents in the soil is questionable.

This Focused Feasibility Study concludes that remedial actions on soil and groundwater within the construction area of this Site to reduce concentrations to approach or achieve background are not feasible.

12.3 VAPOR BARRIER

The architectural design of the planned restaurant building includes specification for a vapor barrier to be installed below the slab concrete floor. These specifications call for a typical gravel base with a fine sand layer followed by the installation of a 12 mil thickness poly barrier material, seamed and draped up over the foundation walls to ensure a tight seal. The vapor barrier is being installed as part of the normal construction specification, but has beneficial use to eliminate the potential for volatile organic vapor intrusion into the building space, if such a condition exists onsite within the footprint of the building.

ACRONYMS

AC	Average concentration
ADD	Average daily dose
ADE	Average daily exposure
BEEA	Boston Environmental Engineering Consultants
bgs	Below ground surface
BTEX	Benzene, toluene, ethylbenzene, and xylene
BW	Body weight
CEP	Critical exposure pathway
CMR	Code of Massachusetts Regulations
CPC	Chemical of potential concern
CRCR	Cumulative receptor cancer risk
CSF	Cancer slope factor
ED	Exposure duration
EF	Exposure frequency
ELCR	Estimated lifetime cancer risk
EP	Exposure point
EPC	Exposure point concentration
EPH	Extractable petroleum hydrocarbons
FRA	Focused Risk Assessment
FSC	Focused Site Characterization
HEAST	Health Effects Assessment Summary Tables
HI	Hazard index
HQ	Hazard quotient
IRA	Immediate Response Action
IRIS	Integrated Risk Information System
kg	kilograms
LAC	Lifetime average concentration
LADD	Lifetime average daily dose
LOAEL	Lowest observable adverse effect level
LSP	Licensed Site Professional
MADEP	Massachusetts Department of Environmental Protection
MCP	Massachusetts Contingency Plan
MF	Modifying factor
mg	Milligrams
MMCL	Massachusetts Maximum Contaminant Level
MTBE	Methyl tertiary butyl ether

NAPL	Non-aqueous phase liquid
NOAEL	No observed adverse effect level
OHM	Oil or hazardous material
OHMPC	Oil or hazardous materials of potential concern
PAH	Polynuclear/polycyclic aromatic hydrocarbons
PID	Photoionization detector
ppm	parts per million
PRP	Potentially responsible party
QC	Quality control
RA	Risk assessment
RAF	Relative absorption factor
RAM	Release Abatement Measure
RAO	Response Action Outcome
RCGW	Reportable Concentrations in Groundwater Soil
RfC	Reference concentration
RfD	Reference dose
RP	Responsible party
RPF	Relative potency factor
RTN	Release tracking number
SQL	Sample quantitation limit
SRM	Substantial release migration
SVOC	Semi-volatile organic compound
TPH	Total petroleum hydrocarbons
UCL	Upper concentration limit
UF	Uncertainty factor
µg	Micrograms
UR	Unit risk
USEPA	United States Environmental Protection Agency
UST	Underground storage tank
VOC	Volatile organic compound
VPH	Volatile petroleum hydrocarbons

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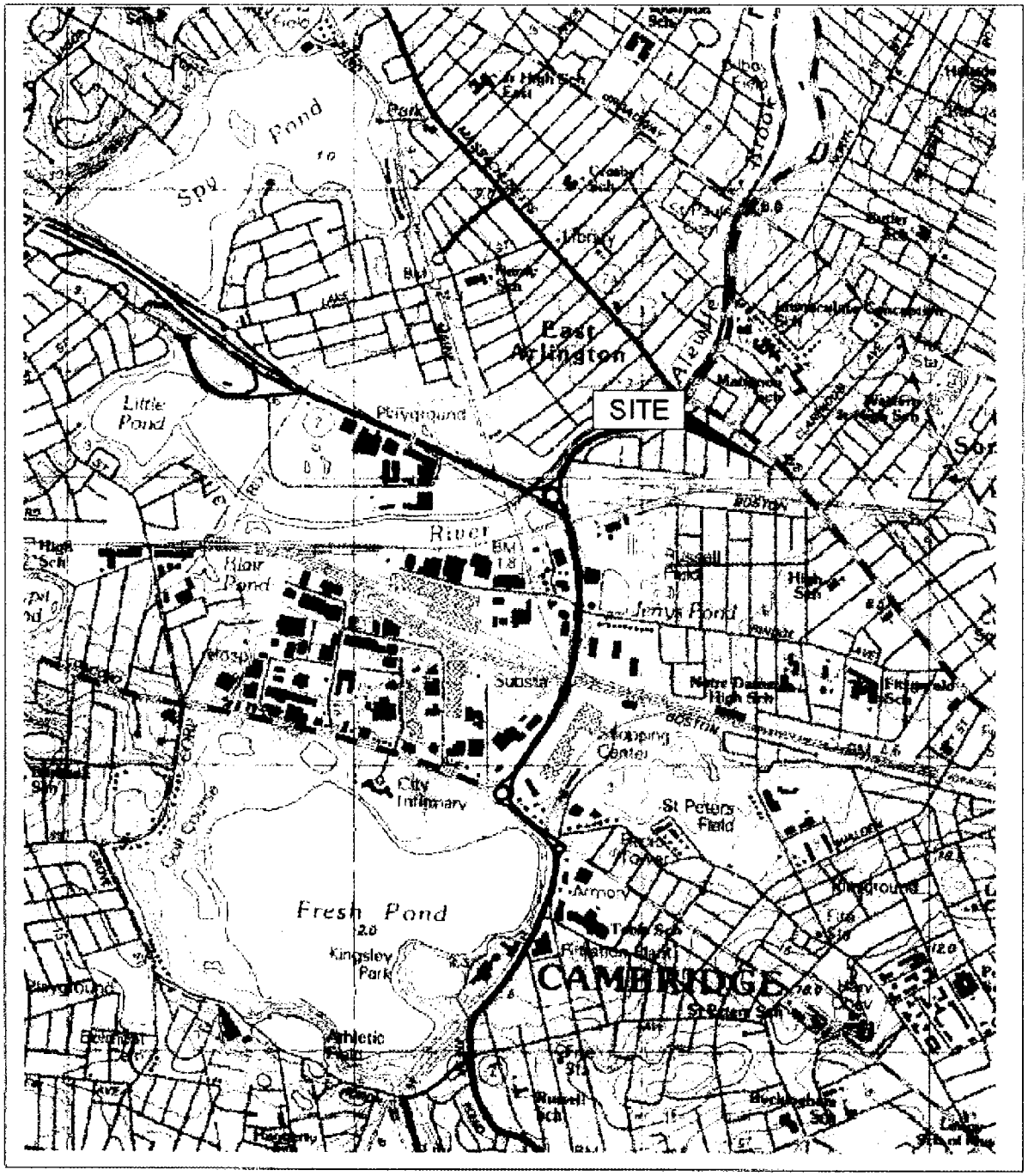
FIGURES



SOURCE: TOPOZONE, MAPS A LA CARTE INC

GRAPHIC SCALE
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FIGURE 1
SITE LOCATION MAP
2480 MASSACHUSETTS AVENUE
CAMBRIDGE, MASSACHUSETTS

MACTEC

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TABLES

Table 1
Identification of Human Health OHM of Potential Concern in Surface and Subsurface Soils

Focused Risk Assessment
2480 Massachusetts Avenue
Cambridge, MA

OHM	Frequency of Detection [1]	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Arithmetic Mean	OHM of Potential Concern? [2]
Volatile Organics (mg/Kg)							
1,2,4-Trimethylbenzene	1 / 2	0.61	0.61	390	390	195	Yes
1,3,5-Trimethylbenzene	1 / 2	0.61	0.61	120	120	60	Yes
Ethylbenzene	2 / 5	0.006	0.75	55	70	25	Yes
Isopropylbenzene	2 / 2			1.1	6.4	3.8	Yes
Naphthalene	1 / 2	0.61	0.61	34	34	17	Yes
n-Butylbenzene	2 / 2			3.5	28	16	Yes
n-Propylbenzene	2 / 2			4.1	45	25	Yes
o-Xylene	1 / 2	0.12	0.12	11	11	5.5	Yes
p/m-Xylene	1 / 2	0.12	0.12	280	280	140	Yes
p-Isopropyltoluene	2 / 2			1.1	6.5	3.8	Yes
sec-Butylbenzene	1 / 2	2.8	2.8	1.9	1.9	1.7	Yes
Xylenes, Total	1 / 3	0.006	0.75	290	290	97	Yes
PCBs (mg/Kg)							
Aroclor 1260	2 / 4	0.0351	0.0355	0.0427	0.0726	0.038	Yes
Inorganics (mg/Kg)							
Lead, Total	10 / 10			2.6	200	40	Yes
Solids, Total	35 35			80	96	90	
TPH (mg/Kg)							
Fuel Oil #2/Diesel	2 / 5	8	1200	2000	2400	1013	Yes
Gasoline	3 / 5	120	1200	0.064	3200	779	Yes
Motor Oil	1 / 5	8	1200	950	950	338	Yes
Unknown Hydrocarbon	2 / 2			520	1900	1210	Yes
VPH (mg/Kg)							
Benzene	1 / 29	0.08	11.6	0.126	0.126	0.46	Yes
Ethylbenzene	2 / 29	0.08	0.572	21.6	50.6	2.6	Yes
Methyl tert butyl ether	2 / 29	0.12	22.9	0.206	3.18	0.9	Yes
Naphthalene	3 / 29	0.399	114	0.55	77	5.1	Yes
o-Xylene	2 / 29	0.08	11.4	0.124	18.1	0.9	Yes
p/m-Xylene	5 / 29	0.08	0.572	0.283	252	13	Yes
Toluene	3 / 29	0.08	11.6	0.128	0.404	0.48	Yes
C5-C8 Aliphatics	4 / 29	1.99	4.76	3.27	1640	80	Yes
C5-C8 Aliphatics, Adjusted	3 / 29	1.99	4.76	19.7	1640	80	Yes
C9-C10 Aromatics	5 / 29	1.99	4.76	4.9	2970	165	Yes
C9-C12 Aliphatics	9 / 29	1.99	4.76	3.53	4510	256	Yes
C9-C12 Aliphatics, Adjusted	9 / 29	1.99	4.76	3.11	1370	75	Yes
EPH (mg/Kg)							
2-Methylnaphthalene	5 / 30	0.347	3.55	1.19	44.4	3.3	Yes
Acenaphthene	3 / 30	0.347	3.55	1.51	2.44	0.50	Yes
Anthracene	2 / 30	0.347	2.01	6.23	7.74	0.71	Yes
Benzo(a)anthracene	4 / 30	0.347	2.01	0.407	19.4	1.1	Yes
Benzo(a)pyrene	4 / 30	0.347	2.01	0.578	15.5	0.92	Yes
Benzo(b)fluoranthene	4 / 30	0.347	2.01	0.505	11.4	0.74	Yes
Benzo(g,h,i)perylene	4 / 30	0.347	2.01	0.464	6.24	0.55	Yes
Benzo(k)fluoranthene	4 / 30	0.347	2.01	0.494	15.4	0.89	Yes
Chrysene	4 / 30	0.347	2.01	0.538	21	1.1	Yes
Fluoranthene	5 / 30	0.347	2.01	0.433	36.7	1.9	Yes
Fluorene	2 / 30	0.347	3.55	1.26	3.65	0.46	Yes
Indeno(1,2,3-cd)Pyrene	4 / 30	0.347	2.01	0.458	8.06	0.61	Yes
Naphthalene	3 / 30	0.347	3.55	8.54	32.4	2.0	Yes
Phenanthrene	6 / 30	0.347	2.01	0.43	20.1	1.7	Yes
Pyrene	6 / 30	0.347	2.01	0.42	33.2	1.7	Yes
C11-C22 Aromatics	13 / 30	6.94	36.6	8.49	899	112	Yes
C11-C22 Aromatics, Adjusted	13 / 30	6.94	36.6	8.49	836	97	Yes
C19-C36 Aliphatics	11 / 30	6.94	70.9	18.7	2120	112	Yes
C9-C18 Aliphatics	9 / 30	6.94	70.9	8.31	2650	165	Yes

Notes:

[1] Samples included in data set are listed in Appendix A.

The arithmetic mean represents the arithmetic average of all sample results, with one-half the SQL used as the value for non-detects.

[2] OHM of potential concern are OHM that are inconsistent with background conditions and not detected at a low frequency and low concentration.

OHM = Oil and/or Hazardous Material

SQL = Sample Quantitation Limit

EPH = Extractable Petroleum Hydrocarbons

VPH = Volatile Petroleum Hydrocarbons

Prepared by: JHP
Checked by: KJA

Table 2
Summary of Groundwater Data

Focused Risk Assessment
2480 Massachusetts Avenue
Cambridge, MA

OHM	Frequency of Detection [1]	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Arithmetic Mean
Volatile Organics (mg/L)						
1,2,4-Trimethylbenzene	1 / 3	0.0025	0.0025	0.11	0.11	0.038
1,3,5-Trimethylbenzene	1 / 3	0.0025	0.0025	0.0088	0.0088	0.0038
Benzene	1 / 3	0.0005	0.0005	0.15	0.15	0.050
Ethylbenzene	1 / 3	0.0005	0.0005	0.094	0.094	0.032
Isopropylbenzene	2 / 3	0.0005	0.0005	0.0023	0.084	0.03
Methyl tert butyl ether	1 / 3	0.001	0.0025	0.0019	0.0019	0.0012
Naphthalene	1 / 3	0.0025	0.0025	0.041	0.041	0.015
n-Butylbenzene	2 / 3	0.0005	0.0005	0.0055	0.027	0.011
n-Propylbenzene	2 / 3	0.0005	0.0005	0.0026	0.16	0.054
o-Xylene	1 / 3	0.0005	0.0005	0.009	0.009	0.0032
p/m-Xylene	1 / 3	0.0005	0.0005	0.059	0.059	0.020
p-Isopropyltoluene	2 / 3	0.0005	0.0005	0.0015	0.0042	0.0020
sec-Butylbenzene	2 / 3	0.0005	0.0005	0.011	0.012	0.0078
Tetrahydrofuran	2 / 3	0.01	0.01	0.013	0.03	0.016
Toluene	1 / 3	0.00075	0.00075	0.0065	0.0065	0.0024
VPH (mg/L)						
Benzene	4 / 17	0.002	0.01	0.00251	0.504	0.045
Ethylbenzene	9 / 17	0.002	0.002	0.00519	1.32	0.14
Methyl tert butyl ether	2 / 17	0.003	0.08	0.00864	0.0314	0.0093
Naphthalene	4 / 17	0.01	0.4	0.0158	0.214	0.047
o-Xylene	8 / 17	0.002	0.01	0.0035	0.131	0.023
p/m-Xylene	7 / 17	0.002	0.002	0.0344	1.89	0.27
Toluene	4 / 17	0.002	0.04	0.00208	0.00832	0.0048
C5-C8 Aliphatics	10 / 17	0.04	0.25	0.067	2.36	0.53
C5-C8 Aliphatics, Adjusted	9 / 17	0.04	0.25	0.0821	1.86	0.48
C9-C10 Aromatics	12 / 17	0.04	0.05	0.118	7.86	1.3
C9-C12 Aliphatics	12 / 17	0.04	0.05	0.135	13.4	2.2
C9-C12 Aliphatics, Adjusted	9 / 17	0.04	0.8	0.226	4.26	0.45
EPH (mg/L)						
2-Methylnaphthalene	10 / 17	0.01	0.0213	0.0351	0.146	0.061
Benzo(b)fluoranthene	1 / 17	0.01	0.0213	0.0277	0.0277	0.0099
Benzo(k)fluoranthene	1 / 17	0.01	0.0213	0.0202	0.0202	0.0095
Chrysene	1 / 17	0.01	0.0213	0.0274	0.0274	0.0099
Fluoranthene	1 / 17	0.01	0.0213	0.0338	0.0338	0.010
Naphthalene	5 / 17	0.01	0.0213	0.0294	0.126	0.032
Pyrene	1 / 17	0.01	0.0213	0.0241	0.0241	0.0097
C11-C22 Aromatics	12 / 17	0.1	0.106	0.313	0.811	0.44
C11-C22 Aromatics, Adjusted	12 / 17	0.1	0.106	0.212	0.669	0.35
C19-C36 Aliphatics	5 / 17	0.1	0.106	0.102	0.365	0.097
C9-C18 Aliphatics	9 / 17	0.1	0.106	0.108	1.18	0.24

Notes:

[1] Samples included in data set are listed in Appendix A.

The arithmetic mean represents the arithmetic average of all sample results, with one-half the SQL used as the value for non-detects.

OHM = Oil and/or Hazardous Material

SQL = Sample Quantitation Limit

EPH = Extractable Petroleum Hydrocarbons

VPH = Volatile Petroleum Hydrocarbons

Prepared by: JHP
Checked by: KJA

Table 3
Identification of Hot Spot OHM in Surface and Subsurface Soils

Focused Risk Assessment
2480 Massachusetts Avenue
Cambridge, MA

OHM	Frequency of Detection [1]	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Arithmetic Mean	S-3/GW-3 Standard [2]	Maximum > S-3/GW-3? [3]	Potential Hot Spot OHM? [4, 5]
Volatile Organics (mg/Kg)									
1,2,4-Trimethylbenzene	1 / 2	0.61	0.61	390	390	195		Yes	Yes
1,3,5-Trimethylbenzene	1 / 2	0.61	0.61	120	120	60		Yes	Yes
Ethylbenzene	2 / 5	0.006	0.75	55	70	25	500	No	No
Isopropylbenzene	2 / 2			1.1	6.4	3.8		Yes	Yes
Naphthalene	1 / 2	0.61	0.61	34	34	17	1000	No	No
n-Butylbenzene	2 / 2			3.5	28	16		Yes	Yes
n-Propylbenzene	2 / 2			4.1	45	25		Yes	Yes
o-Xylene	1 / 2	0.12	0.12	11	11	5.5	2500	No	No
p/m-Xylene	1 / 2	0.12	0.12	280	280	140	2500	No	No
p-Isopropyltoluene	2 / 2			1.1	6.5	3.8		Yes	Yes
sec-Butylbenzene	1 / 2	2.8	2.8	1.9	1.9	1.7		Yes	No
Xylenes, Total	1 / 3	0.006	0.75	290	290	97	2500	No	No
PCBs (mg/Kg)									
Aroclor 1260	2 / 4	0.0351	0.0355	0.0427	0.0726	0.038	2	No	No
Inorganics (mg/Kg)									
Lead, Total	10 / 10			2.6	200	40	600	No	No
Solids, Total	35 35			80	96	90			
TPH (mg/Kg)									
Fuel Oil #2/Diesel	2 / 5	8	1200	2000	2400	1013	5000 [a]	No	No
Gasoline	3 / 5	120	1200	0.064	3200	779	5000 [a]	No	No
Motor Oil	1 / 5	8	1200	950	950	338	5000 [a]	No	No
Unknown Hydrocarbon	2 / 2			520	1900	1210	5000 [a]	No	No
VPH (mg/Kg)									
Benzene	1 / 29	0.08	11.6	0.126	0.126	0.46	200	No	No
Ethylbenzene	2 / 29	0.08	0.572	21.6	50.6	2.6	500	No	No
Methyl tert butyl ether	2 / 29	0.12	22.9	0.206	3.18	0.9	200	No	No
Naphthalene	3 / 29	0.399	114	0.55	77	5.1	1000	No	No
o-Xylene	2 / 29	0.08	11.4	0.124	18.1	0.9	2500	No	No
p/m-Xylene	5 / 29	0.08	0.572	0.283	252	13	2500	No	No
Toluene	3 / 29	0.08	11.6	0.128	0.404	0.48	2500	No	No
C5-C8 Aliphatics	4 / 29	1.99	4.76	3.27	1640	80	500	Yes	
C5-C8 Aliphatics, Adjusted	3 / 29	1.99	4.76	19.7	1640	80	500	Yes	Yes
C9-C10 Aromatics	5 / 29	1.99	4.76	4.9	2970	165	500	Yes	Yes
C9-C12 Aliphatics	9 / 29	1.99	4.76	3.53	4510	256	5000	No	No
C9-C12 Aliphatics, Adjusted	9 / 29	1.99	4.76	3.11	1370	75	5000	No	No
EPH (mg/Kg)									
2-Methylnaphthalene	5 / 30	0.347	3.55	1.19	44.4	3.3	1000	No	No

Table 3

Identification of Hot Spot OHM in Surface and Subsurface Soils

Focused Risk Assessment
2480 Massachusetts Avenue
Cambridge, MA

OHM	Frequency of Detection [1]	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Arithmetic Mean	S-3/GW-3 Standard [2]	Maximum > S-3/GW-3? [3]	Potential Hot Spot OHM? [4, 5]
Acenaphthene	3 / 30	0.347	3.55	1.51	2.44	0.50	4000	No	No
Anthracene	2 / 30	0.347	2.01	6.23	7.74	0.71	5000	No	No
Benzo(a)anthracene	4 / 30	0.347	2.01	0.407	19.4	1.1	4	Yes	Yes
Benzo(a)pyrene	4 / 30	0.347	2.01	0.578	15.5	0.92	0.7	Yes	Yes
Benzo(b)fluoranthene	4 / 30	0.347	2.01	0.505	11.4	0.74	4	Yes	Yes
Benzo(g,h,i)perylene	4 / 30	0.347	2.01	0.464	6.24	0.55	2500	No	No
Benzo(k)fluoranthene	4 / 30	0.347	2.01	0.494	15.4	0.89	40	No	No
Chrysene	4 / 30	0.347	2.01	0.538	21	1.1	40	No	No
Fluoranthene	5 / 30	0.347	2.01	0.433	36.7	1.9	1000	No	No
Fluorene	2 / 30	0.347	3.55	1.26	3.65	0.46	4000	No	No
Indeno(1,2,3-cd)Pyrene	4 / 30	0.347	2.01	0.458	8.06	0.61	4	Yes	Yes
Naphthalene	3 / 30	0.347	3.55	8.54	32.4	2.0	1000	No	No
Phenanthrene	6 / 30	0.347	2.01	0.43	20.1	1.7	100	No	No
Pyrene	6 / 30	0.347	2.01	0.42	33.2	1.7	5000	No	No
C11-C22 Aromatics	13 / 30	6.94	36.6	8.49	899	112	5000	No	No
C11-C22 Aromatics, Adjusted	13 / 30	6.94	36.6	8.49	836	97	5000	No	No
C19-C36 Aliphatics	11 / 30	6.94	70.9	18.7	2120	112	5000	No	No
C9-C18 Aliphatics	9 / 30	6.94	70.9	8.31	2650	165	5000	No	No

Notes:

[1] Samples included in data set are listed in Appendix A.

The arithmetic mean represents the arithmetic average of all samples results, with one-half the SQL used as the value for non-detects.

[2] The applicable Method 1 Standards are the S-3/GW-3 (310 CMR 40.0974).

[3] Per 310 CMR 40.0006, concentrations less than the applicable Method 1 Standard shall not be considered indicative of a Hot Spot. Therefore, OHM with maximum concentrations less than the applicable Method 1 Standard are not Hot Spot OHM.

[4] Per 310 CMR 40.0006, a discrete area where concentrations that are above the applicable Method 1 Standards (see Note 4) and are greater than 100-times the concentrations in the surroundir area shall be considered a hot spot. This comparison identifies OHM that exceed the applicable Method 1 Standards (or for which a Standard does not exist) and exhibit a 100-fold difference in the range of detected concentrtions. Such OHM are potential hot spot OHM.

[5] A Potential Hot Spot OHM is an OHM with a maximum concentration that exceeds the applicable Method 1 Standard and may be present at the Site in a discrete area at concentrations more than 100-times the surrounding area.

Yes: The criteria are met for consideration of this OHM as a potential Hot Spot OHM. A review of the spatial distribution of concentrations is used to determine if one or more Hot Spots for this OHM exist.

No: The criteria are not met for consideration of this OHM as a potential Hot Spot OHM because the OHM was either not detected at a maximum concentration in excess of the applicable Method 1 Standard.

[a] S-3/GW-3 Standard is the S-3/GW-3 Standard for TPH

OHM = Oil and/or Hazardous Material

SQL = Sample Quantitation Limit

EPH = Extractable Petroleum Hydrocarbons

VPH = Volatile Petroleum Hydrocarbons

Prepared by: JHP
Checked by: KJA

Table 4
Identification of Hot Spot OHM in Groundwater

Focused Risk Assessment
2480 Massachusetts Avenue
Cambridge, MA

OHM	Frequency of Detection [1]	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Arithmetic Mean	GW-3 Standard [2]	Maximum > GW-3? [3]	Potential Hot Spot OHM? [4, 5]
Volatile Organics (mg/L)									
1,2,4-Trimethylbenzene	1 / 3	0.0025	0.0025	0.11	0.11	0.04		Yes	No
1,3,5-Trimethylbenzene	1 / 3	0.0025	0.0025	0.0088	0.0088	0.0038		Yes	No
Benzene	1 / 3	0.0005	0.0005	0.15	0.15	0.050	7	No	No
Ethylbenzene	1 / 3	0.0005	0.0005	0.094	0.094	0.032	4	No	No
Isopropylbenzene	2 / 3	0.0005	0.0005	0.0023	0.084	0.029		Yes	No
Methyl tert butyl ether	1 / 3	0.001	0.0025	0.0019	0.0019	0.0012	50	No	No
Naphthalene	1 / 3	0.0025	0.0025	0.041	0.041	0.015	6	No	No
n-Butylbenzene	2 / 3	0.0005	0.0005	0.0055	0.027	0.011		Yes	No
n-Propylbenzene	2 / 3	0.0005	0.0005	0.0026	0.16	0.054		Yes	No
o-Xylene	1 / 3	0.0005	0.0005	0.009	0.009	0.0032	50	No	No
p/m-Xylene	1 / 3	0.0005	0.0005	0.059	0.059	0.020	50	No	No
p-Isopropyltoluene	2 / 3	0.0005	0.0005	0.0015	0.0042	0.0020		Yes	No
sec-Butylbenzene	2 / 3	0.0005	0.0005	0.011	0.012	0.0078		Yes	No
Tetrahydrofuran	2 / 3	0.01	0.01	0.013	0.03	0.016		Yes	No
Toluene	1 / 3	0.00075	0.00075	0.0065	0.0065	0.0024	50	No	No
VPH (mg/L)									
Benzene	4 / 17	0.002	0.01	0.00251	0.504	0.045	7	No	No
Ethylbenzene	9 / 17	0.002	0.002	0.00519	1.32	0.14	4	No	No
Methyl tert butyl ether	2 / 17	0.003	0.08	0.00864	0.0314	0.0093	50	No	No
Naphthalene	4 / 17	0.01	0.4	0.0158	0.214	0.047	6	No	No
o-Xylene	8 / 17	0.002	0.01	0.0035	0.131	0.023	50	No	No
p/m-Xylene	7 / 17	0.002	0.002	0.0344	1.89	0.27	50	No	No
Toluene	4 / 17	0.002	0.04	0.00208	0.00832	0.0048	50	No	No
C5-C8 Aliphatics	10 / 17	0.04	0.25	0.067	2.36	0.53	4	No	No
C5-C8 Aliphatics, Adjusted	9 / 17	0.04	0.25	0.0821	1.86	0.48	4	No	No
C9-C10 Aromatics	12 / 17	0.04	0.05	0.118	7.86	1.3	4	Yes	No
C9-C12 Aliphatics	12 / 17	0.04	0.05	0.135	13.4	2.2	20	No	No
C9-C12 Aliphatics, Adjusted	9 / 17	0.04	0.8	0.226	4.26	0.45	20	No	No
EPH (mg/L)									
2-Methylnaphthalene	10 / 17	0.01	0.0213	0.0351	0.146	0.061	3	No	No
Benzo(b)fluoranthene	1 / 17	0.01	0.0213	0.0277	0.0277	0.0099	3	No	No
Benzo(k)fluoranthene	1 / 17	0.01	0.0213	0.0202	0.0202	0.0095	3	No	No
Chrysene	1 / 17	0.01	0.0213	0.0274	0.0274	0.0099	3	No	No

Table 4
Identification of Hot Spot OHM in Groundwater

Focused Risk Assessment
2480 Massachusetts Avenue
Cambridge, MA

OHM	Frequency of Detection [1]	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Arithmetic Mean	GW-3 Standard [2]	Maximum > GW-3? [3]	Potential Hot Spot OHM? [4, 5]
Fluoranthene	1 / 17	0.01	0.0213	0.0338	0.0338	0.010	0.2	No	No
Naphthalene	5 / 17	0.01	0.0213	0.0294	0.126	0.032	6	No	No
Pyrene	1 / 17	0.01	0.0213	0.0241	0.0241	0.0097	3	No	No
C11-C22 Aromatics	12 / 17	0.1	0.106	0.313	0.811	0.44	30	No	No
C11-C22 Aromatics, Adjusted	12 / 17	0.1	0.106	0.212	0.669	0.35	30	No	No
C19-C36 Aliphatics	5 / 17	0.1	0.106	0.102	0.365	0.097	20	No	No
C9-C18 Aliphatics	9 / 17	0.1	0.106	0.108	1.18	0.24	20	No	No

Notes:

[1] Samples included in data set are listed in Appendix A.

The arithmetic mean represents the arithmetic average of all sample results, with one-half the SQL used as the value for non-detects.

[2] The applicable Method 1 Standard is GW-3 (310 CMR 40.0974).

[3] Per 310 CMR 40.0006, concentrations less than the applicable Method 1 Standard shall not be considered indicative of a Hot Spot. Therefore, OHM with maximum concentrations less than the applicable Method 1 Standard are not Hot Spot OHM.

[4] Per 310 CMR 40.0006, a discrete area where concentrations that are above the applicable Method 1 Standards (see Note 3) and are greater than 100-times the concentrations in the surrounding area shall be considered a hot spot. This comparison identifies OHM that exceed the applicable Method 1 Standards (or for which a Standard does not exist) and exhibit a 100-fold difference in the range of detected concentrtions. Such OHM are potential hot spot OHM.

[5] A Potential Hot Spot OHM is an OHM with a maximum concentration that exceeds the applicable Method 1 Standard and may be present at the Site in a discrete area at concentrations more than 100-times the surrounding area.

Yes: The criteria are met for consideration of this OHM as a potential Hot Spot OHM. A review of the spatial distribution of concentrations is used to determine if one or more Hot Spots for this OHM exist.

No: The criteria are not met for consideration of this OHM as a potential Hot Spot OHM because the OHM was either not detected at a maximum concentration in excess of the applicable Method 1 Standard.

OHM = Oil and/or Hazardous Material
SQL = Sample Quantitation Limit
EPH = Extractable Petroleum Hydrocarbons
VPH = Volatile Petroleum Hydrocarbons

Prepared by: JHP
Checked by: KJA

Table 5
Exposure Parameters - Construction Worker

Focused Risk Assesment
2480 Massachusetts Avenue
Cambridge, MA

PARAMETER	CONSTRUCTION WORKER	UNITS	SOURCE
Soil Ingestion Rate			
Incidental ingestion: hand-mouth contact	100	mg/day	MADEP, 2002a
Incidental ingestion: particulate inhalation	3.46	mg/day	MADEP, 2002b [2]
Total	103.5	mg/day	
Body Weight	58.3	Kg	MADEP, 2002b
Exposure Frequency - Total	130	events/year	MADEP, 2002b
Exposure Period	182	days	MADEP, 2002b
Exposure Duration	1	day/event	Assumption [1]
Surface Area of Exposed Skin	5070	cm^2	MADEP, 2000
Soil Adherence Factor	0.29	mg/cm^2	MADEP, 2002c
Particulate Air Concentration	60	ug/m^3	MADEP, 2002b
Proportion of Particulates from Site	100%		Assumption [1]
Inhalation Rate	60	L/min	MADEP, 2002b
Exposure Time	8	hr/day	MADEP, 2002b
Averaging Time			
Cancer	70	years	MADEP, 2000
Noncancer	0.5	years	Equal to Exposure Period

Notes:

[1] - Assumes that the entire day's exposure to environmental media occurs at the site.

[2] - Calculated as (2 x particulate air concentration x inhalation rate x exposure time x conversion factors), per MADEP (2002b)

mg = milligrams

m^3 = cubic meters

Kg = kilograms

cm^2 = centimeters squared

MADEP, 2000. Soil Exposure Assumptions. S-3 Soils [www.mass.gov/dep/bwsc/files/workgrps/numbers/numbers.htm]

MADEP, 2002a. Calculation of Enhanced Soil Ingestion Rate. Update to Appendix B of Guidance for Disposal Site Risk Characterization. [www.mass.gov/dep/bwsc/files/workgrps/numbers/numbers.htm]

MADEP, 2002b. Characterization of Risks Due to Inhalation of Particulates by Construction Workers. Update to Appendix B of Guidance for Disposal Site Risk Characterization. [www.mass.gov/dep/bwsc/files/workgrps/numbers/numbers.htm]

MADEP, 2002c. Weighted Skin-Soil Adherence Factors. Update to Appendix B of Guidance for Disposal Site Risk Characterization. [www.mass.gov/dep/bwsc/files/workgrps/numbers/numbers.htm]

Prepared by: JHP
Checked by: KJA

Table 6
Exposure Parameters - Off-Site, Down-Wind Resident

Focused Risk Assesment
2480 Massachusetts Avenue
Cambridge, MA

PARAMETER	CHILD RESIDENT (ages 1 to 8)	UNITS	SOURCE
Body Weight (ages 1 - 8)	16.8	Kg	MADEP, 2000
Exposure Frequency - Particulates	130	days/year	Site-specific [1]
Exposure Period	182	days	Site-specific [1]
Exposure Time	24	hours/day	Site-specific [2]
Particulate Air Concentration	39	ug/m^3	MADEP, 2002b [3]
Averaging Time			
Cancer	70	years	MADEP, 2000
Noncancer	0.5	year	Equal to Exposure Period

Notes:

[1] - Total construction project is assumed to be one-half year or less. Rain occurs 28% of days (USEPA, 1985), which suppresses dust (180 days per year x 72% = 130 days per year).

[2] - Assumes that dusts transported indoors are re-suspended; therefore, residents are assumed to be exposed to dusts 24-hours per day.

[3] - Intrusive excavation activities associated with 60 ug/m^3 particulate generation occurs 8 hours/day for the construction period, and non-instrusive construction activities associated with 32 ug/m^3 particulate generation and wind erosion of exposed soil occurs over the balance of the exposure period: ([60 ug/m^3 x 5 d/7 d x 8 hr/24 hr] + [32 ug/m^3 x 5 d/7 d x 16 hr/24 hr] + [32 ug/m^3 x 2 d/7 d x 24 hr/24 hr])

mg = milligrams
m^3 = cubic meters
Kg = kilograms
cm^2 = centimeter squared

MADEP, 2000. Soil Exposure Assumptions. [www.mass.gov/dep/bwsc/files/workgrps/numbers/numbers.htm]

Prepared by: JHP
Checked by: KJA

Table 7
Identification of Exposure Point Concentrations - Soil (0-8 ft bgs) within Building Footprint

Focused Risk Assessment
2480 Massachusetts Avenue
Cambridge, MA

OHM of Potential Concern	Frequency of Detection [1]	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Arithmetic Mean	Exposure Point Concentration [2]
VPH (mg/Kg)							
Benzene	1 / 8	0.095	0.117	0.126	0.126	0.063	0.126
o-Xylene	1 / 8	0.095	0.117	0.124	0.124	0.063	0.124
p/m-Xylene	3 / 8	0.096	0.117	0.283	0.653	0.204	0.653
Toluene	3 / 8	0.096	0.117	0.128	0.404	0.129	0.404
C9-C12 Aliphatics, Adjusted	2 / 8	2.39	2.92	3.11	5.75	2.13	5.75
EPH (mg/Kg)							
2-Methylnaphthalene	1 / 8	0.358	1.83	3.56	3.56	0.699	3.56
Acenaphthene	1 / 8	0.358	1.83	2.44	2.44	0.559	2.44
Anthracene	1 / 8	0.358	1.83	6.23	6.23	1.03	6.23
Benzo(a)anthracene	3 / 8	0.358	1.83	0.407	4.62	0.913	4.62
Benzo(a)pyrene	3 / 8	0.358	1.83	0.578	3.81	0.835	3.81
Benzo(b)fluoranthene	3 / 8	0.358	1.83	0.505	2.77	0.696	2.77
Benzo(g,h,i)perylene	3 / 8	0.358	1.83	0.464	1.98	0.604	1.98
Benzo(k)fluoranthene	3 / 8	0.358	1.83	0.494	3.16	0.744	3.16
Chrysene	3 / 8	0.358	1.83	0.538	4.95	1.01	4.95
Fluoranthene	3 / 8	0.358	1.83	0.433	11	1.94	11
Fluorene	1 / 8	0.358	1.83	3.65	3.65	0.710	3.65
Indeno(1,2,3-cd)Pyrene	3 / 8	0.358	1.83	0.458	2.1	0.601	2.1
Naphthalene	1 / 8	0.358	1.83	8.54	8.54	1.32	8.54
Phenanthrene	2 / 8	0.358	1.83	1.75	17.9	2.69	17.9
Pyrene	3 / 8	0.358	1.83	0.42	8.32	1.48	8.32
C11-C22 Aromatics, Adjusted	5 / 8	7.17	36.6	19.4	137	37.1	137
C19-C36 Aliphatics	5 / 8	7.17	36.6	32	66.3	32.5	66.3
C9-C18 Aliphatics	1 / 8	7.17	36.6	8.5	8.5	6.62	8.50

Notes:

[1] Samples included in data set are B-7A, B-7B, B-8A, B-8B, B-9A, B-9B, B-10A, B-10B. The depths of the samples included in this exposure point are 0-8 ft bgs. The arithmetic mean represents the arithmetic average of all samples results, with one-half the SQL used as the value for non-detects.

[2] The exposure point concentration is selected as the maximum detected concentration to intentionally overestimate the potential risks and to account for the possibility that the arithmetic mean may be biased low by the low frequency of detection.

OHM = Oil and/or Hazardous Material

SQL = Sample Quantitation Limit

EPH = Extractable Petroleum Hydrocarbons

VPH = Volatile Petroleum Hydrocarbons

Prepared by: JHP
Checked by: KJA

Table 8
Identification of Exposure Point Concentrations - Surface Soil (0-3 ft bgs) Outside Building Footprint

Focused Risk Assessment
2480 Massachusetts Avenue
Cambridge, MA

OHM of Potential Concern	Frequency of Detection	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Arithmetic Mean	Exposure Point Concentration [2]
PCBs (mg/Kg)							
Aroclor 1260	1 / 2	0.0355	0.0355	0.0726	0.0726	0.045	0.0726
Metals (mg/Kg)							
Lead	1 / 1			140	140	140	140
EPH (mg/Kg)							
2-Methylnaphthalene	1 / 3	0.588	3.55	1.19	1.19	1.09	1.19
Anthracene	1 / 3	0.588	0.749	7.74	7.74	2.80	7.74
Benzo(a)anthracene	1 / 3	0.588	0.749	19.4	19.4	6.69	19.4
Benzo(a)pyrene	1 / 3	0.588	0.749	15.5	15.5	5.39	15.5
Benzo(b)fluoranthene	1 / 3	0.588	0.749	11.4	11.4	4.02	11.4
Benzo(g,h,i)perylene	1 / 3	0.588	0.749	6.24	6.24	2.30	6.24
Benzo(k)fluoranthene	1 / 3	0.588	0.749	15.4	15.4	5.36	15.4
Chrysene	1 / 3	0.588	0.749	21	21	7.22	21
Fluoranthene	1 / 3	0.588	0.749	36.7	36.7	12.5	36.7
Indeno(1,2,3-cd)Pyrene	1 / 3	0.588	0.749	8.06	8.06	2.91	8.06
Phenanthrene	1 / 3	0.588	0.749	20.1	20.1	6.92	20.1
Pyrene	2 / 3	11.8	11.8	0.805	33.2	13.3	33.2
C11-C22 Aromatics, Adjusted	2 / 3	11.8	11.8	303	676	328	676
C19-C36 Aliphatics	1 / 3	11.8	70.9	2120	2120	720	2120
C9-C18 Aliphatics	1 / 3	11.8	70.9	126	126	55.8	126

Notes:

[1] Samples included in data set are are TANK-E, TANK-S, and B-2A. The depths of the samples included in this exposure point are 2.5 ft bgs, and therefore in surface soil 0-3 ft
The arithmetic mean represents the arithmetic average of all sample results, with one-half the SQL used as the value for non-detects.

[2] The exposure point concentration is selected as the maximum detected concentration to represent the OHM concentrations at the surface soil hot spot.

OHM = Oil and/or Hazardous Material
SQL = Sample Quantitation Limit
EPH = Extractable Petroleum Hydrocarbons
VPH = Volatile Petroleum Hydrocarbons

Prepared by: JHP
Checked by: KJA

Table 9
Risk Summary Table

Focused Risk Assessment
2480 Massachusetts Avenue
Cambridge, MA

Exposure Scenario	Medium	Exposure Route	HI	ELCR
Construction Worker - Building Footprint Area	Soil (0-8 ft bgs)	Ingestion/Dermal	0.005	2E-07
	Soil (0-8 ft bgs)	Particulate Inhalation	0.0001	1E-09
		Total Risk for Receptor	**0.005**	**2E-07**
Construction Worker - Outside Building Footprint	Soil (0-3 ft bgs)	Ingestion/Dermal	0.2	7E-07
	Soil (0-3 ft bgs)	Particulate Inhalation	0.002	4E-09
		Total Risk for Receptor	**0.2**	**7E-07**
	Total Risk - Construction Worker:		**0.2**	**9E-07**
Off-Site Downwind Resident - Building Footprint Area	Soil (0-8 ft bgs)	Particulate Inhalation	0.0002	2E-09
		Total Risk for Receptor	**0.0002**	**2E-09**
Off-Site Downwind Resident - Outside Building Footprint	Soil (0-3 ft bgs)	Particulate Inhalation	0.004	8E-09
		Total Risk for Receptor	**0.004**	**8E-09**
	Total Risk - Construction Worker:		**0.004**	**1E-08**

HI - Hazard Index
ELCR - Excess Lifetime Cancer Risk
ft bgs - feet below ground surface

Prepared by: JHP
Checked by: KJA

Table 10
Comparison of OHM Concentrations in Surface and Subsurface Soils (0-17 ft bgs) to Soil UCLs

Focused Risk Assessment
2480 Massachusetts Avenue
Cambridge, MA

OHM	Frequency of Detection [1]	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Arithmetic Mean	SOIL UCL [2]	Max > UCL?
Volatile Organics (mg/Kg)								
1,2,4-Trimethylbenzene	1 / 2	0.61	0.61	390	390	195	1000 [a]	No
1,3,5-Trimethylbenzene	1 / 2	0.61	0.61	120	120	60	1000 [a]	No
Ethylbenzene	2 / 5	0.006	0.75	55	70	25	10000	No
Isopropylbenzene	2 / 2			1.1	6.4	3.8	1000 [a]	No
Naphthalene	1 / 2	0.61	0.61	34	34	17	10000	No
n-Butylbenzene	2 / 2			3.5	28	16	1000 [a]	No
n-Propylbenzene	2 / 2			4.1	45	25	1000 [a]	No
o-Xylene	1 / 2	0.12	0.12	11	11	5.5	10000	No
p/m-Xylene	1 / 2	0.12	0.12	280	280	140	10000	No
p-Isopropyltoluene	2 / 2			1.1	6.5	3.8	1000 [a]	No
sec-Butylbenzene	1 / 2	2.8	2.8	1.9	1.9	1.7	1000 [a]	No
Xylenes, Total	1 / 3	0.006	0.75	290	290	97	10000	No
PCBs (mg/Kg)								
Aroclor 1260	2 / 4	0.0351	0.0355	0.0427	0.0726	0.038	100	No
Inorganics (mg/Kg)								
Lead, Total	10 / 10			2.6	200	40	6000	No
Solids, Total	35 35			80	96	90		
TPH (mg/Kg)								
Fuel Oil #2/Diesel	2 / 5	8	1200	2000	2400	1013	10000 [b]	No
Gasoline	3 / 5	120	1200	0.064	3200	779	10000 [b]	No
Motor Oil	1 / 5	8	1200	950	950	338	10000 [b]	No
Unknown Hydrocarbon	2 / 2			520	1900	1210	10000 [b]	No
VPH (mg/Kg)								
Benzene	1 / 29	0.08	11.6	0.126	0.126	0.46	2000	No
Ethylbenzene	2 / 29	0.08	0.572	21.6	50.6	2.6	10000	No
Methyl tert butyl ether	2 / 29	0.12	22.9	0.206	3.18	0.9	5000	No
Naphthalene	3 / 29	0.399	114	0.55	77	5.1	10000	No
o-Xylene	2 / 29	0.08	11.4	0.124	18.1	0.9	10000	No
p/m-Xylene	5 / 29	0.08	0.572	0.283	252	13	10000	No
Toluene	3 / 29	0.08	11.6	0.128	0.404	0.48	10000	No
C5-C8 Aliphatics	4 / 29	1.99	4.76	3.27	1640	80	5000	No
C5-C8 Aliphatics, Adjusted	3 / 29	1.99	4.76	19.7	1640	80	5000	No

Table 10
Comparison of OHM Concentrations in Surface and Subsurface Soils (0-17 ft bgs) to Soil UCLs

Focused Risk Assessment
2480 Massachusetts Avenue
Cambridge, MA

OHM	Frequency of Detection [1]	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Arithmetic Mean	SOIL UCL [2]	Max > UCL?
C9-C10 Aromatics	5 / 29	1.99	4.76	4.9	2970	165	5000	No
C9-C12 Aliphatics	9 / 29	1.99	4.76	3.53	4510	256	20000	No
C9-C12 Aliphatics, Adjusted	9 / 29	1.99	4.76	3.11	1370	75	20000	No
EPH (mg/Kg)								
2-Methylnaphthalene	5 / 30	0.347	3.55	1.19	44.4	3.3	10000	No
Acenaphthene	3 / 30	0.347	3.55	1.51	2.44	0.50	10000	No
Anthracene	2 / 30	0.347	2.01	6.23	7.74	0.71	10000	No
Benzo(a)anthracene	4 / 30	0.347	2.01	0.407	19.4	1.1	100	No
Benzo(a)pyrene	4 / 30	0.347	2.01	0.578	15.5	0.92	100	No
Benzo(b)fluoranthene	4 / 30	0.347	2.01	0.505	11.4	0.74	100	No
Benzo(g,h,i)perylene	4 / 30	0.347	2.01	0.464	6.24	0.55	10000	No
Benzo(k)fluoranthene	4 / 30	0.347	2.01	0.494	15.4	0.89	400	No
Chrysene	4 / 30	0.347	2.01	0.538	21	1.1	400	No
Fluoranthene	5 / 30	0.347	2.01	0.433	36.7	1.9	10000	No
Fluorene	2 / 30	0.347	3.55	1.26	3.65	0.46	10000	No
Indeno(1,2,3-cd)Pyrene	4 / 30	0.347	2.01	0.458	8.06	0.61	100	No
Naphthalene	3 / 30	0.347	3.55	8.54	32.4	2.0	10000	No
Phenanthrene	6 / 30	0.347	2.01	0.43	20.1	1.7	10000	No
Pyrene	6 / 30	0.347	2.01	0.42	33.2	1.7	10000	No
C11-C22 Aromatics	13 / 30	6.94	36.6	8.49	899	112	10000	No
C11-C22 Aromatics, Adjusted	13 / 30	6.94	36.6	8.49	836	97	10000	No
C19-C36 Aliphatics	11 / 30	6.94	70.9	18.7	2120	112	20000	No
C9-C18 Aliphatics	9 / 30	6.94	70.9	8.31	2650	165	20000	No

Notes:

[1] Samples included in data set are listed in Appendix A.

The arithmetic mean represents the arithmetic average of all sample results, with one-half the SQL used as the value for non-detects.

[2] UCL = Upper Concentration Limit in Soil (310 CMR 40.0996)

[a] For any OHM not listed in 310 CMR 40.0996, the UCL is 1,000 mg/kg.

[b] UCL is the UCL value for TPH

OHM = Oil and/or Hazardous Material

SQL = Sample Quantitation Limit

EPH = Extractable Petroleum Hydrocarbons

VPH = Volatile Petroleum Hydrocarbons

Prepared by: JHP
Checked by: KJA

Table 11
Comparison of OHM Concentrations in Groundwater to Groundwater UCLs

Focused Risk Assessment
2480 Massachusetts Avenue
Cambridge, MA

OHM	Frequency of Detection [1]	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Arithmetic Mean	Groundwater UCL [2]	Is Maximum > UCL?
Volatile Organics (mg/L)								
1,2,4-Trimethylbenzene	1 / 3	0.0025	0.0025	0.11	0.11	0.038	10 [a]	No
1,3,5-Trimethylbenzene	1 / 3	0.0025	0.0025	0.0088	0.0088	0.0038	10 [a]	No
Benzene	1 / 3	0.0005	0.0005	0.15	0.15	0.050	70	No
Ethylbenzene	1 / 3	0.0005	0.0005	0.094	0.094	0.032	100	No
Isopropylbenzene	2 / 3	0.0005	0.0005	0.0023	0.084	0.029	10 [a]	No
Methyl tert butyl ether	1 / 3	0.001	0.0025	0.0019	0.0019	0.0012	100	No
Naphthalene	1 / 3	0.0025	0.0025	0.041	0.041	0.015	60	No
n-Butylbenzene	2 / 3	0.0005	0.0005	0.0055	0.027	0.011	10 [a]	No
n-Propylbenzene	2 / 3	0.0005	0.0005	0.0026	0.16	0.054	10 [a]	No
o-Xylene	1 / 3	0.0005	0.0005	0.009	0.009	0.0032	100	No
p/m-Xylene	1 / 3	0.0005	0.0005	0.059	0.059	0.020	100	No
p-Isopropyltoluene	2 / 3	0.0005	0.0005	0.0015	0.0042	0.0020	10 [a]	No
sec-Butylbenzene	2 / 3	0.0005	0.0005	0.011	0.012	0.0078	10 [a]	No
Tetrahydrofuran	2 / 3	0.01	0.01	0.013	0.03	0.016	10 [a]	No
Toluene	1 / 3	0.00075	0.00075	0.0065	0.0065	0.0024	100	No
VPH (mg/L)								
Benzene	4 / 17	0.002	0.01	0.00251	0.504	0.045	70	No
Ethylbenzene	9 / 17	0.002	0.002	0.00519	1.32	0.14	100	No
Methyl tert butyl ether	2 / 17	0.003	0.08	0.00864	0.0314	0.0093	100	No
Naphthalene	4 / 17	0.01	0.4	0.0158	0.214	0.047	60	No
o-Xylene	8 / 17	0.002	0.01	0.0035	0.131	0.023	100	No
p/m-Xylene	7 / 17	0.002	0.002	0.0344	1.89	0.27	100	No
Toluene	4 / 17	0.002	0.04	0.00208	0.00832	0.0048	100	No
C5-C8 Aliphatics	10 / 17	0.04	0.25	0.067	2.36	0.53	100	No
C5-C8 Aliphatics, Adjusted	9 / 17	0.04	0.25	0.0821	1.86	0.48	100	No
C9-C10 Aromatics	12 / 17	0.04	0.05	0.118	7.86	1.3	100	No
C9-C12 Aliphatics	12 / 17	0.04	0.05	0.135	13.4	2.2	100	No
C9-C12 Aliphatics, Adjusted	9 / 17	0.04	0.8	0.226	4.26	0.45	100	No

Table 11
Comparison of OHM Concentrations in Groundwater to Groundwater UCLs

Focused Risk Assessment
2480 Massachusetts Avenue
Cambridge, MA

OHM	Frequency of Detection [1]	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Arithmetic Mean	Groundwater UCL [2]	Is Maximum > UCL?
EPH (mg/L)								
2-Methylnaphthalene	10 / 17	0.01	0.0213	0.0351	0.146	0.061	100	No
Benzo(b)fluoranthene	1 / 17	0.01	0.0213	0.0277	0.0277	0.0099	30	No
Benzo(k)fluoranthene	1 / 17	0.01	0.0213	0.0202	0.0202	0.0095	30	No
Chrysene	1 / 17	0.01	0.0213	0.0274	0.0274	0.0099	30	No
Fluoranthene	1 / 17	0.01	0.0213	0.0338	0.0338	0.010	3	No
Naphthalene	5 / 17	0.01	0.0213	0.0294	0.126	0.032	60	No
Pyrene	1 / 17	0.01	0.0213	0.0241	0.0241	0.0097	30	No
C11-C22 Aromatics	12 / 17	0.1	0.106	0.313	0.811	0.44	100	No
C11-C22 Aromatics, Adjusted	12 / 17	0.1	0.106	0.212	0.669	0.35	100	No
C19-C36 Aliphatics	5 / 17	0.1	0.106	0.102	0.365	0.097	100	No
C9-C18 Aliphatics	9 / 17	0.1	0.106	0.108	1.18	0.24	100	No

Notes:

[1] Samples included in data set are listed in Appendix A.

The arithmetic mean represents the arithmetic average of all sample results, with one-half the SQL used as the value for non-detects.

[2] UCL = Upper Concentration Limit in Groundwater (310 CMR 40.0996)

[a] For any OHM not listed in 310 CMR 40.0996, the UCL is 10 mg/L.

OHM = Oil and/or Hazardous Material
SQL = Sample Quantitation Limit
EPH = Extractable Petroleum Hydrocarbons
VPH = Volatile Petroleum Hydrocarbons

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